Appendix 14-D

Instream Flow Assessment

HARPER CREEK PROJECT

Application for an Environmental Assessment Certificate / Environmental Impact Statement

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT



INSTREAM FLOW ASSESSMENT

PREPARED FOR:

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VA101-458/15-3
Rev 0
October 17, 2014

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OHSAS 18001 - OHS 550122

HARPER CREEK MINING CORP
HARPER CREEK PROJECT

INSTREAM FLOW ASSESSMENT
VA101-458/15-3

Rev	Description	Date	Approved
0	Issued in Final	October 17, 2014	KB

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EXECUTIVE SUMMARY

Harper Creek Mining Corporation proposes to construct and operate the Harper Creek Project, an open pit copper mine near Vavenby, British Columbia. The Project is located approximately 150 km northeast of Kamloops along Yellowhead Highway #5.

The Project has an estimated 28-year mine life based on a process plant throughput of 70,000 tonnes per day (25 million tonnes per year). Ore will be processed on site through a conventional crushing, grinding and flotation process to produce a copper concentrate, with gold and silver by-products, which will be trucked from the Project site along approximately 24 km of existing access roads to a rail load-out facility located at Vavenby. The concentrate will be transported via the existing Canadian National Railway network to the existing Vancouver Wharves storage, handling and loading facilities located at the Port of Vancouver for shipment to overseas smelters.

The Project consists of an open pit mine, on-site processing facility, tailings management facility (for tailings solids, subaqueous storage of potentially acid generating waste rock, and recycling of water for processing), waste rock stockpiles, low grade and overburden stockpiles, a temporary construction camp, ancillary facilities, mine haul roads, sewage and waste management facilities, a 24 km access road between the Project site and a rail load-out facility located on private land owned by Harper Creek Mining Corporation in Vavenby, and a 12 km power line connecting the Project site to the BC Hydro transmission line corridor in Vavenby.

An instream flow assessment has been undertaken, with the objective to quantify changes in streamflow, physical fish habitat and stream temperature. These analyses have been prepared support the assessment of effects to fish habitat.

Changes in daily streamflow were quantified by comparison to three flow based habitat suitability methods. The three methods applied were the BC flow thresholds for fish bearing streams, BC modified Tennant method, and the indicators of hydrologic alteration methodology. These methods were applied at 13 locations (nodes) and six mine stages, including construction (year -1), operation 1 (year 10), operation 2 (year 22), operation 3 (year 27), closure (year 30), and post-closure (year 50). The results of this analysis are summarised as follows:

- Under operational conditions, the Project will reduce annual and monthly flows at many of the 13 nodes more than are recommended by the BC flow thresholds for fish bearing streams. However, this result is at least in part a result of the threshold methodology (and hydrologic regime of the Project streams), which calculates that only approximately 5% of the flow should be diverted, while the threshold authors suggest that this methodology should allow approximately 22% flow reduction.
- When comparing Project affected flows to the BC modified Tennant method recommendations for summer rearing (adults and juveniles) and overwintering, two general results are observed 1) if pre-mine flow exceeds the flow recommendation, operational flows typically exceed the flow recommendation, and 2) if pre-mine flow does not exceed the flow recommendation, operational flows do not exceed the flow recommendation.
- The indicators of hydrological alteration analysis aims to describe the range of variability (1 standard deviation from the mean) in many hydrologic parameters under pre-mine conditions and then compare this to the variability during operations conditions. Rather than calculating a flow recommendation, the results are more subjective and require interpretation as to whether variability has been materially changed.

Physical habitat modelling was conducted in the fish bearing reaches of P-Creek and T-Creek using PHABSIM and in Harper Creek below T-Creek using River2D. Project specific depth, velocity and cover bull trout habitat suitability criteria were developed based on fish observations in Harper, P and T-Creeks. Weighted usable area was calculated in each of the models for bull trout fry, rearing and spawning suitability. In P and T-Creeks, the modelling suggests that weighted usable area generally:

- Increases during operations for fry and rearing life stages during May, June and July as the reduced streamflow reduces depth and velocity to more suitable conditions.
- Decreases during operations for fry and rearing life stages during in September and October as the reduced streamflow reduces depth and velocity below preferred conditions.
- Decreases during operations for spawning life stages as the reduced streamflow reduces depth and velocity below preferred conditions.
- Similar to baseline conditions for all life stages during post closure, except in rearing P-Creek where flow conditions remain reduced.

Temperature is an important environmental factor in aquatic ecosystems as it plays a pivotal role over biological activity (development, growth and reproduction). Seasonal temperature differences strongly influence the biological activity of aquatic organisms. Increases in surface water temperature beyond diurnal or seasonal averages, have the potential to accelerate embryo development, alter the timing of emergence, growth and downstream migration of juveniles, reduce metabolic efficiencies of food conversion into growth, alter adult spawning migration and spawning timing, increase susceptibility to disease and shift the competitive advantage of salmonids over non-salmonid species. In order to assess the change in instream flows on the stream temperature, modelling was completed to calculate the magnitude of temperature change predicted. The difference in temperature change per kilometer between pre-mine and year 22 conditions was calculated to assess the predicted temperature change due to change in streamflow. These values show that typically the rate of change per kilometer is in the order of no change to 0.08°C/km in Harper Creek and no change to 0.25°C/km in the tributaries.

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ACRONYMS AND ABBREVIATIONS

1D	One - dimensional
2D	Two - dimensional
BC	British Columbia
EA	Environmental Assessment
EFP	Empirical frequency pairing
EIS	Environmental impact statement
HCMC	Harper Creek Mining Corporation
HSI	Habitat suitability index
IFA	Instream flow assessment
KP	Knight Piésold Ltd.
LWD	Large woody debris
LOM	Life of Mine
LSA	Local Study Area
MAD	Mean annual discharge
MOE	Ministry of Environment
NTS	National Topographic System
PHABSIM	Physical Habitat Simulation
Project	Harper Creek Copper-Gold-Silver Project
Proponent	Harper Creek Mining Corp.
SSTEMP	Stream Segment Temperature
TMF	Tailings Management Facility
USGS	United States Geological Service
VAF	Velocity adjustment factor
WSC	Water Survey of Canada
WUA	Weighted useable area
WUW	Wetted useable width
YMI	Yellowhead Mining Inc.

LIST OF UNITS AND SYMBOLS

d	Day
°	Degree
°C	Degrees Celsius
k_s	Bed roughness parameter
km	kilometre
m	Metre
m^2	Metres squared
m/s	Metres per second
m^3/s	Cubic metres per second
masl	metres above sea level

1 – INTRODUCTION

1.1 PROJECT DESCRIPTION

Harper Creek Mining Corporation (HCMC) proposes to construct and operate the Harper Creek Project (the Project), an open pit copper mine near Vavenby, British Columbia (BC). The Project has an estimated 28-year mine life based on a process plant throughput of 70,000 tonnes per day (25 million tonnes per year). Ore will be processed on site through a conventional crushing, grinding and flotation process to produce a copper concentrate, with gold and silver by-products, which will be trucked from the Project site along approximately 24 km of existing access roads to a rail load-out facility located at Vavenby. The concentrate will be transported via the existing Canadian National Railway network to the existing Vancouver Wharves storage, handling and loading facilities located at the Port of Vancouver for shipment to overseas smelters.

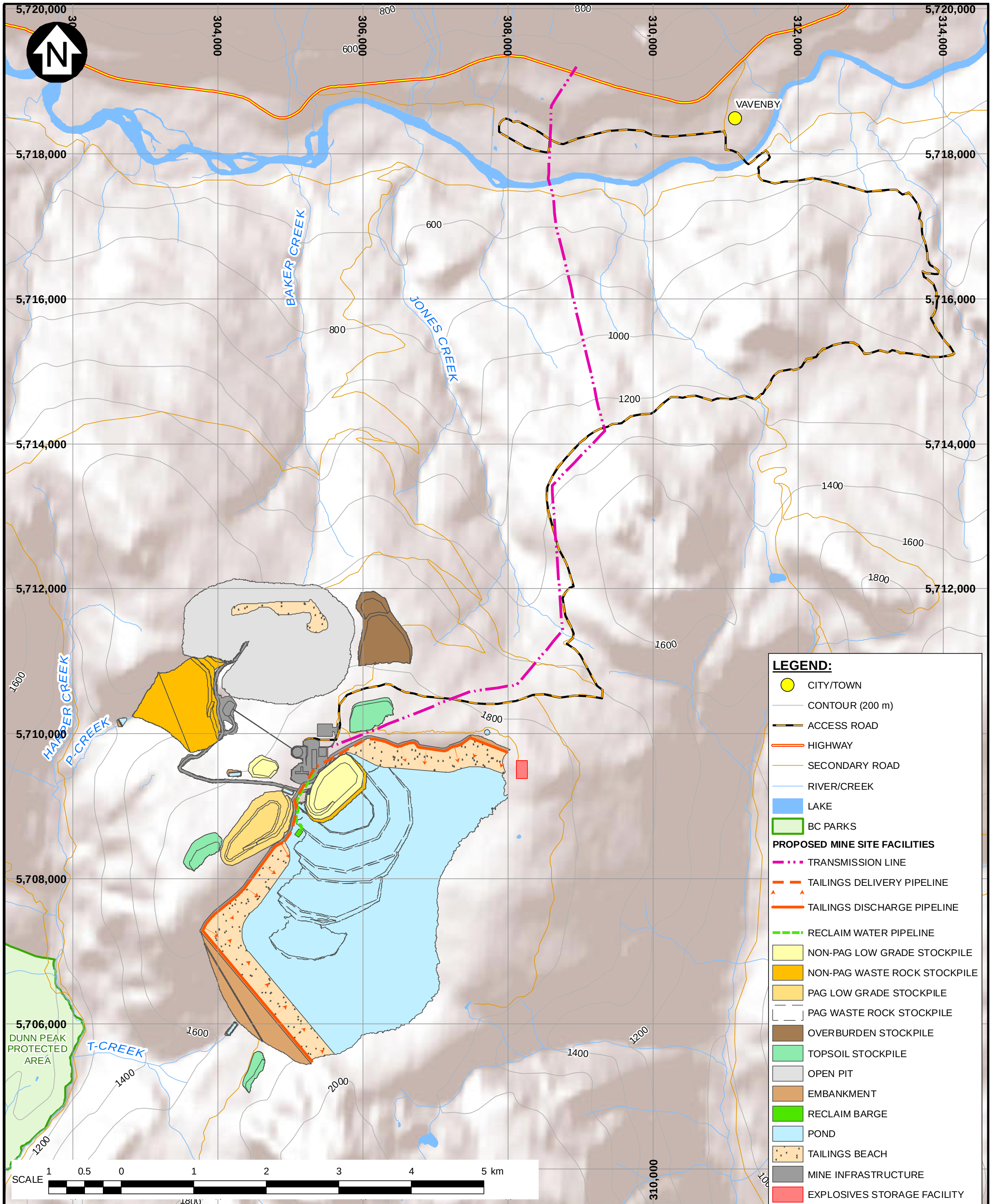
The Project consists of an open pit mine, on-site processing facility, tailings management facility (TMF) (for tailings solids, subaqueous storage of PAG waste rock, and recycling of water for processing), waste rock stockpiles, low grade and overburden stockpiles, a temporary construction camp, ancillary facilities, mine haul roads, sewage and waste management facilities, a 24 km access road between the Project site and a rail load-out facility located on private land owned by HCMC in Vavenby, and a 12 km power line connecting the Project site to the BC Hydro transmission line corridor in Vavenby. The Project general arrangement is shown on Figure 1.1.

1.2 PROJECT LOCATION

The Project is located in the Thompson-Nicola area of BC, approximately 150 km northeast of Kamloops along Yellowhead Highway #5, approximately 10 km southwest of the unincorporated municipality of Vavenby, BC. The Project is located within National Topographic System (NTS) map sheets 82M/5 and 82M/12, is geographically centred at 51º30'N latitude and 119º48'W longitude, and is situated at approximately 1800 m above sea level (masl). The mineral claims comprising the Project cover an area of 42,636.48 ha. The Project location is shown on Figure 1.2.

1.3 PROJECT PROPONENT

The Proponent of the Project is HCMC, a wholly owned subsidiary of Yellowhead Mining Inc. (YMI). YMI was formed in 2005 as a private BC company specifically to acquire, explore and, if feasible, develop the Project. YMI is now a publicly owned BC based mineral development company trading on the Toronto Stock Exchange in Canada. HCMC's strategy is to engineer, permit, finance, construct, and operate the Project.



NOTES:

1. BASE MAP: TRIM AND NTS MAPPING, ESRI ARCGIS ONLINE SHADED RELIEF.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:75,000 FOR 8.5x11 (LETTER) PAPER.
4. FACILITIES REPRESENT MAXIMUM FOOTPRINT FOR MINE LIFE AT YEAR 24.

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HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

HARPER CREEK PROJECT
GENERAL ARRANGEMENT (YEAR 24)

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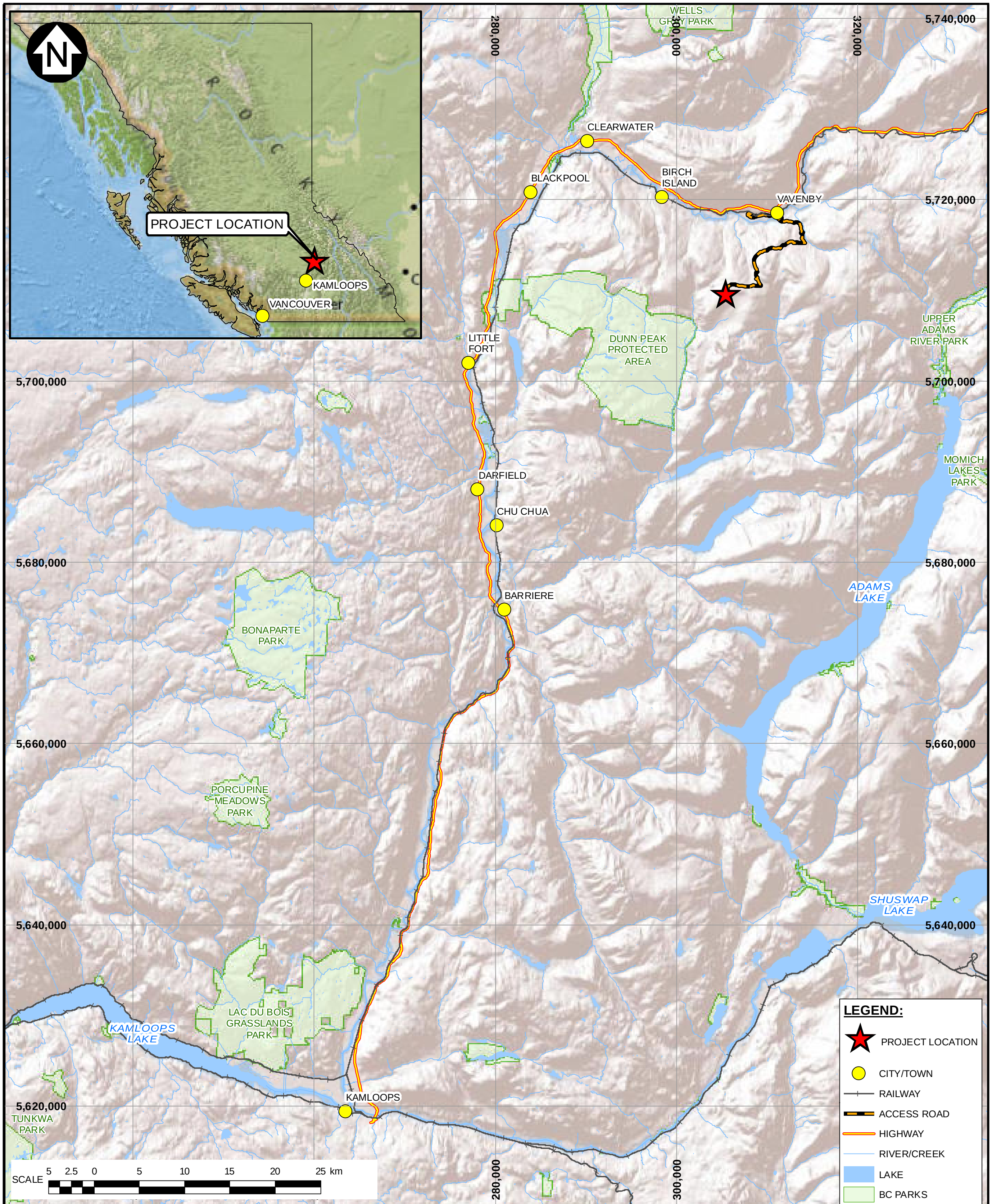
FIGURE 1.1 | REV 0



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1. BASE MAP: TRIM AND NTS MAPPING, ESRI ARCGIS ONLINE SHADED RELIEF.
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HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

PROJECT LOCATION

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P/A NO. VA101-458/15

REF NO. 3

FIGURE 1.2

REV 0

1.4 STUDY OBJECTIVES

The instream flow assessment (IFA) was undertaken to characterize baseline and Life of Mine (LOM) hydrologic and physical fish habitat conditions in the Project area, to support the fisheries impact assessment for the Application/EIS.

In March 2013, Knight Piésold Ltd. (KP) completed an Instream Flow Assessment (KP, 2013a) as part of the fish and aquatic habitat impact assessment for the Project. Since this report was issued the mine development plan has been modified and screening level comments were received from Provincial and Federal reviewers. The objectives of this updated analysis and report include:

- Addressing the instream flow related screening review comments
- Updating the predicted physical fish habitat impacts, given updated baseline and operational hydrology
- Updating streamflow temperature impacts, given updated baseline and operational hydrology
- Assessment of risk to habitat based on flow threshold methodologies

This instream flow assessment report provides a detailed description of the methodologies used in the study and the results obtained. The results of these analyses are quantitative but not definitive. Rather, the results need to be interpreted with respect to their biological significance. This interpretation is outside the scope of this report.

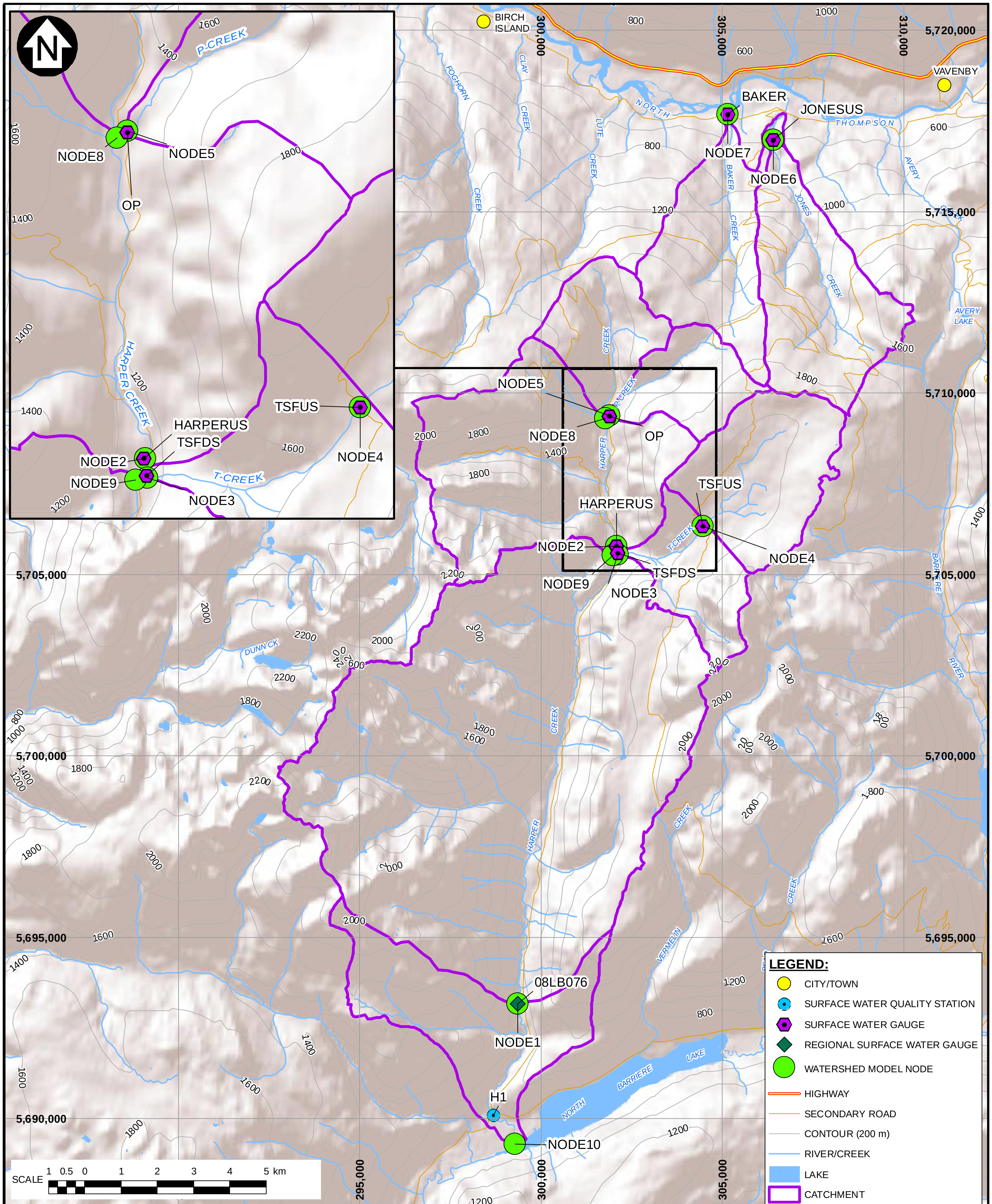
1.5 STUDY AREA

The Project is located in the North Thompson River watershed on the sub-watershed divide between two small tributaries that flow north directly into the North Thompson River (Baker and Jones Creeks) and Harper Creek that drains south into the Barriere River, which in turn drains into the North Thompson River.

The study area is defined as the Baker Creek, Jones Creek, and Harper Creek watersheds. Within the Harper Creek watershed, the most intensive data collection efforts were focussed on the upper part of the watershed where mine infrastructure would be located. The Pre-mine and LOM watershed models (KP, 2014a) were used for flow inputs for the analysis presented in this report. Simulated streamflow and groundwater flows were modelled at the downstream extent of each sub-catchment area, referred to as a “Node”. The nodes defined in the watershed model were used in this analysis. Some nodes are located at Project hydrology gauges and one is located at a regional WSC gauge. The rest of the nodes were located at confluences of interest. The nodes are defined as below:

- Node 1: Harper Creek near the Mouth (WSC 08LB076)
- Node 2: Harper Creek above T-Creek confluence (at the HARPERUS Gauge)
- Node 3: T-Creek at Harper Creek confluence (at the TSFDS Gauge)
- Node 4: T-Creek upstream of Harper Creek confluence (at the TSFUS Gauge)
- Node 5: P-Creek at Harper Creek confluence (at the OP Gauge)
- Node 6: Jones Creek above North Thompson River confluence (at the JONESUS Gauge)
- Node 7: Baker Creek at North Thompson River confluence (at the BAKER Gauge)
- Node 8: Harper Creek below P-Creek confluence
- Node 9: Harper Creek below T-Creek confluence
- Node 10: Harper Creek at Barriere River confluence

Nodes 1 to 10 are shown on Figure 1.3.



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NOTES:

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HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

STUDY AREA SURFACE WATER NODES AND CATCHMENTS

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REF NO. 3

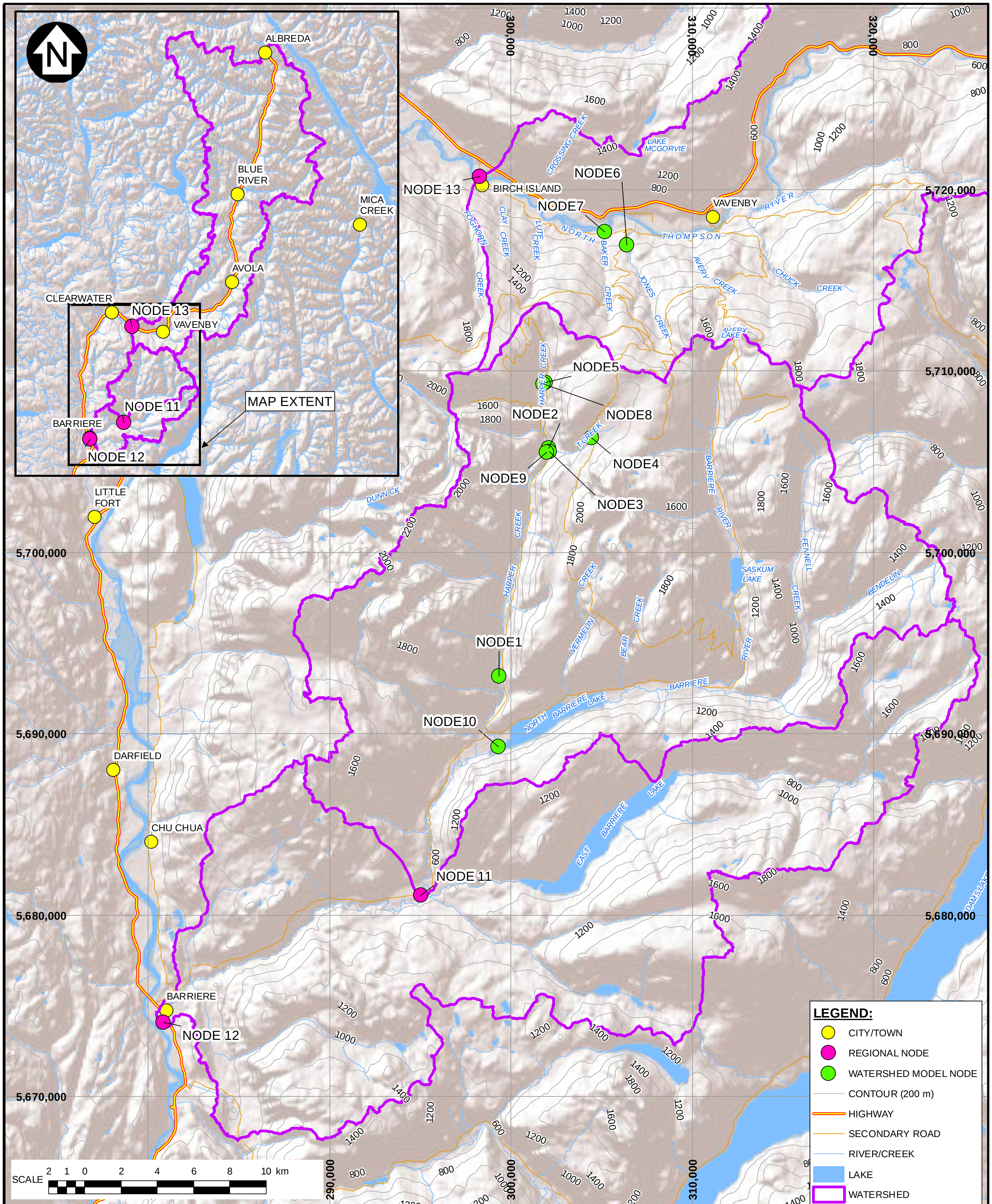
FIGURE 1.3

REV 0

Three regional modelling nodes were selected to assess Project impacts on a regional scale. Nearby WSC gauges with relatively long historical records overlapping the modelled period were selected as “Nodes”. These nodes are not modelled in the watershed models, but watershed model outputs in conjunction with the WSC data are used to predict flow conditions at several stages through the Project life. This analysis was completed for the following 3 nodes:

- Node 11: Barriere River below Sprague Creek (WSC 08LB069)
- Node 12: Barriere River at the Mouth (WSC 08LB020)
- Node 13: North Thompson River at Birch Island (WSC 08LB047)

The regional WSC stations considered in the IFA analyses are shown on Figure 1.4.



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REGIONAL MODELLING NODES AND CATCHMENTS

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FIGURE 1.4 | REV 0

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1.6 MINE DEVELOPMENT

The sequence of mine development, mine waste production and management, and associated mine water management is essential to the design of water management systems and the modelling of predicted water quantity effects. Five stages of mine development were considered:

- Construction (two preproduction years, referred to as Year -2 and Year -1)
- Operations I (during active mining in the open pit, Year 1 through a portion of Year 23)
- Operations II (during low-grade ore processing, from end of active mining through Year 28)
- Closure (during active closure and reclamation phase while open pit and TMF are filling)
- Post Closure (steady-state long-term closure condition following active closure)

1.7 PROJECT SETTING

The Harper Creek Project is located within the Shuswap Highlands in the western foothills of the Columbia Mountains. This is a transitional region between the interior plateaus and the eastern mountain ranges. Physical characteristics of the Project area and study area watersheds are described below.

1.7.1 Climate and Runoff Patterns

Weather systems typically track from west to east over the region. Precipitation and runoff generally increase with elevation, as weather systems are forced up and over the Columbia Mountains. Air temperatures in the Project area are cool with a mean annual temperature near 0°C at the Mine site (elevation 1800 masl). Minimum and maximum mean monthly temperatures are approximately -10°C and 10°C, occurring in December and July, respectively. The mean annual precipitation at the proposed mine site is estimated to be in the order of 1050 mm, with 40% falling as rain and 60% falling as snow (KP, 2013b).

Regional runoff patterns are characterized by low flows during the winter months when precipitation falls almost exclusively as snow, high flows during the spring and early summer snowmelt (nival) freshet period, low flows during the dry late summer months, and moderate flows during the fall months when rainfall increases. A change in runoff patterns and volumes with elevation is also evident in the region, with lower elevation watersheds generally experiencing less precipitation and corresponding lower runoff than higher elevation watersheds, and also experiencing an earlier onset of the spring freshet resulting from warm spring temperatures arriving earlier at lower elevations. Annual hydrographs in the region typically have a uni-modal shape, with the majority of runoff occurring in May and June during the snowmelt freshet period. Minimum low flows typically occur during late summer or late winter. Peak flows occur primarily during the spring and early summer snowmelt freshet, and may result from either snowmelt or rain-on-snow events, although high flows can also occur in autumn due to intense convective or frontal rainfall.

1.7.2 Watersheds

Baker and Jones Creeks both drain north-facing watersheds and flow approximately 5 km from their headwaters at the mine site to the North Thompson River, as shown on Figure 1.1. Harper Creek flows south from the proposed mine site and discharges into the western end of North Barriere Lake, just upstream of the lake outlet, as shown on Figure 1.2. The Barriere River flows out of the lake and travels in a southwesterly direction for approximately 27 km (valley length) before meeting the North

Thompson River at the community of Barriere, 58 km north of Kamloops. The largest tributary to the Barriere River is the East Barriere River, which joins the Barriere River approximately 18 km (valley length) upstream of the North Thompson River confluence.

The proposed mine infrastructure would be mainly located in the upper, eastern part of the Harper Creek watershed, and in the headwaters of Baker and Jones Creeks, at elevations between approximately 1600 masl and 1900 masl (metres above sea level), as shown on Figure 1.1. The Baker, Jones, and Harper Creek watersheds are described below, along with two sub-watersheds of Harper Creek, P-Creek and T-Creek, which lie within the proposed mine site.

The distributions of elevation within each watershed are plotted in the form of hypsometric curves on Figure 1.4. These curves show that the maximum elevations in Baker, Jones, and P-Creeks are similar, at around 1850 to 1900 masl, which is consistent with these watersheds sharing drainage divides within the proposed mine site. Baker and Jones Creeks have lower median elevations than P-Creek because they descend into the lower North Thompson River valley (430 masl), as compared to the Harper Creek valley for P-Creek (1215 masl). Harper Creek has higher maximum elevations than its sub-watersheds, P-Creek and T-Creek, because its watershed contains higher alpine terrain to the west of the proposed mine site.

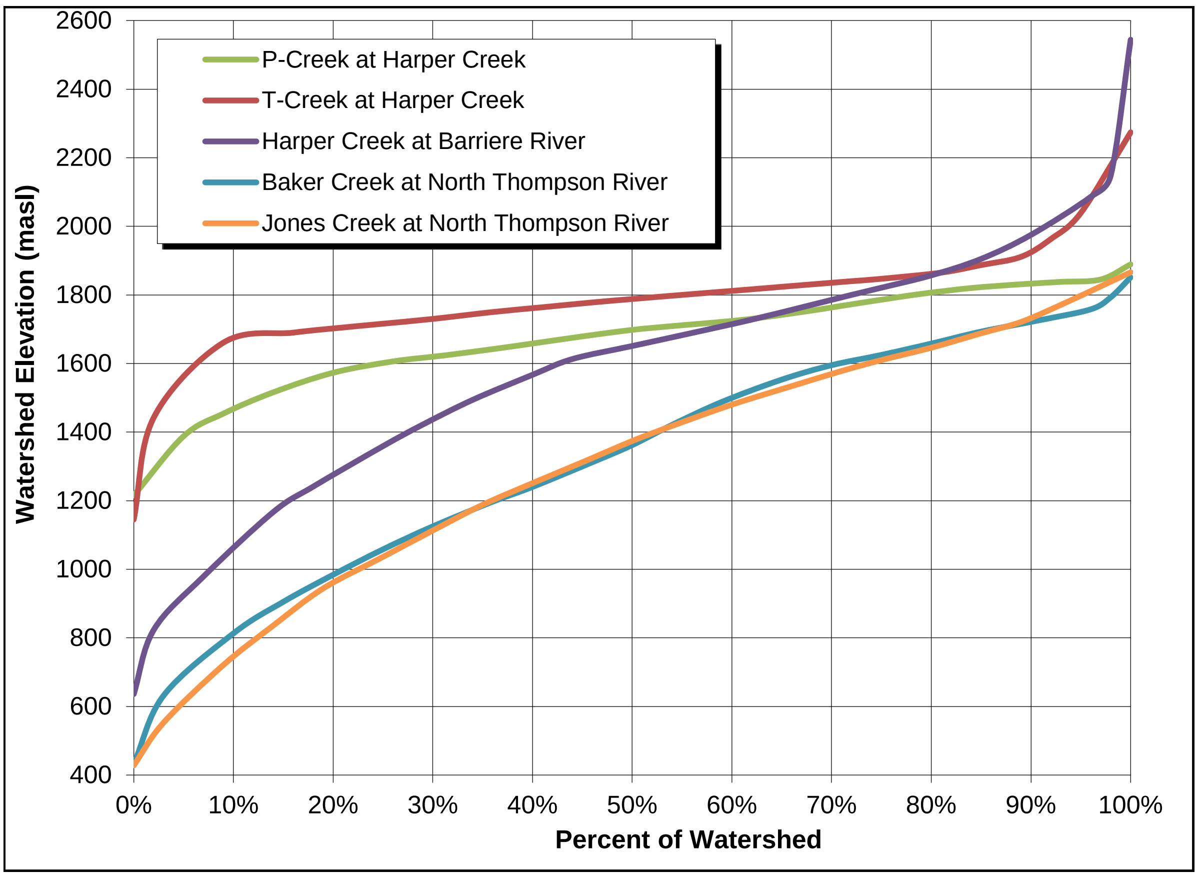


Figure 1.5 Hypsometric Curves

1.7.2.1 Baker Creek Watershed

Baker Creek drains a north-facing watershed with an area of 13.9 km^2. Baker Creek drains steep, high-elevation terrain that transitions to moderate gradient terrain prior to the creek's confluence with the North Thompson River. The average channel gradient of Baker Creek is 16.6% (KP, 2014b). The watershed is covered in coniferous forest with some logging activity throughout. Additionally, some farming activity is present in the lower section of the watershed and a few small intakes remove water from lower Baker Creek for irrigation. The watershed elevation ranges from 1850 masl to 430 masl, with a median elevation of 1360 masl. The hypsometric curve for the Baker Creek watershed is presented on Figure 1.4.

The Baker Creek channel is confined by the hillslopes and the dominant stream morphology is step-pool (Montgomery and Buffington, 1997). Bed materials consist primarily of cobbles and gravels. The dominant riparian vegetation includes immature and mature trees along mossy banks.

1.7.2.2 Jones Creek Watershed

Jones Creek drains a north-facing watershed with an area of 18.3 km^2. The Jones Creek headwaters drain moderate-gradient, higher-elevation catchments and the mainstem channel continues at a moderate gradient until it confluences with the North Thompson River. The average channel gradient of Jones Creek is 12.9% (KP, 2014b). The watershed is covered in coniferous forest with some logging activity throughout. Additionally, some farming activity is present in the lower section of the watershed and a few small intakes remove water from lower Jones Creek for irrigation. The watershed elevation ranges from 1865 to 430 masl, with a median elevation of 1375 masl. The hypsometric curve for the Jones Creek watershed is presented on Figure 1.4.

The Jones Creek channel is confined by hillslopes and the dominant stream morphology is step-pool (Montgomery and Buffington, 1997). Bed material consists primarily of cobbles and gravels. Riparian vegetation includes immature and mature trees along mossy banks.

1.7.2.3 Harper Creek Watershed

Harper Creek drains a southerly facing watershed with an area of 186 km^2. The Harper Creek headwaters and tributaries drain steep mountain catchments. The mainstem channel is confined by valley hillslopes throughout much of its length, although the channel meanders slightly in some places through areas where a small valley flat has developed. The creek crosses a low-gradient fan before discharging near the outlet of North Barriere Lake. The catchment is partially covered in coniferous forest with extensive logging on the east side of the watershed. The west side of the watershed consists of higher mountains with alpine terrain and some exposed rock. The average channel gradient of Harper Creek is 3.0% (KP, 2014b); however, the creek transitions from moderate gradient sections in the upper watershed to low gradient sections through much of the middle and lower watershed. Elevations in the Harper Creek watershed range from approximately 640 masl near the creek's confluence with North Barriere Lake to over 2600 m at the peak of Granite Mountain. The hypsometric curve for the Harper Creek watershed is presented on Figure 1.4.

The dominant stream morphology in Harper Creek is plane bed (Montgomery and Buffington, 1997), although intermittent low gradient sections occur where the morphology is pool-riffle and the channel is less confined. Alluvial bed materials consisting primarily of cobbles interspersed with boulders and gravels occur throughout Harper Creek. The dominant riparian vegetation includes overhanging alders with mature trees along mossy banks. The banks are undercut in some sections and can be 0.5 m high.

1.7.2.4 P-Creek Watershed

P-Creek drains a south–southwest facing watershed with an area of 7.7 km^2. The upper portion of this creek overlaps the proposed open pit for the Project. The confluence of P-Creek and Harper Creek is at km 24.4 of Harper Creek (toward the upper end of Harper Creek). The watershed is partially covered in coniferous forest but has undergone extensive logging. The average channel gradient of the lower sections of P-Creek is 9.6% (KP, 2014b); the upper portion of the watershed is very steep, and gradually transitions to lower gradients near the Harper Creek confluence. The watershed elevation ranges from 1890 to 1215 masl, with a median elevation of 1700 masl. The hypsometric curve for the P-Creek watershed is presented on Figure 1.4.

The dominant stream morphology in P-Creek is cascade (Montgomery and Buffington, 1997) with bedrock controls. Bed material in P-Creek is primarily coarse materials with the vast majority being classified as angular cobble with some boulders. The dominant riparian vegetation is overhanging alders and mature trees along the mossy creek banks. Some large instream woody debris produces log jam stream features as they are filled with bed material. Below the Harper Creek Forest Service Road (FSR), the channel flows onto a fan and the Harper valley flat and is less confined by the hillslopes. The channel meanders somewhat and channel avulsions were noted.

1.7.2.5 T-Creek Watershed

T-Creek drains a west-facing watershed with an area of 23.4 km^2. The upper portion of this watershed contains the proposed tailings management facility (TMF) for the Project. The confluence of T-Creek and Harper Creek is at river km 20.3 of Harper Creek (toward the upper end of Harper Creek). The watershed is partially covered in coniferous forest but has undergone extensive logging. The average channel gradient of T-Creek is 7.3% (KP, 2014b); however, much of the upper watershed contains a low-gradient hanging valley, which then drops steeply to meet Harper Creek. The watershed elevation ranges from 2275 to 1145 masl, with a median elevation of 1790 masl. The hypsometric curve for the T-Creek watershed is presented on Figure 1.4.

The dominant stream morphology in lower T-Creek is step-pool and cascade (Montgomery and Buffington, 1997). Bed material is primarily coarse materials with the vast majority being classified as boulder and cobbles with some gravels. In contrast, in the upper hanging valley the morphology is pool-riffle and bed material is gravel dominated. The dominant riparian vegetation is overhanging alders and mature trees along the mossy banks. Some large instream woody debris produce log jam stream features as they are filled with bed material. The channel is largely confined by the hillslopes or incised within remnant fan deposits until approximately 100 m upstream of the Harper Creek confluence.

1.8 FISH DISTRIBUTION AND PERIODICITY

1.8.1 Rainbow Trout

Rainbow trout are the primary fish species of interest in Baker Creek and Jones Creek. The following is a short summary of information on rainbow trout, relevant to the IFA. This information is based on analysis presented in the Fish and Aquatic Baseline report (KP, 2014c).

Rainbow trout are native to the Pacific slope drainages of North America from northern Mexico to Bristol Bay, Alaska and the Peace and Athabasca Rivers. They may be the most widely introduced fish species in the world and reproducing populations have been established on every continent with the exception of Antarctica. Both sanctioned and unsanctioned stocking of rainbow trout has also occurred throughout British Columbia.

Rainbow trout adults spawn during late spring in response to increasing water temperature/photoperiod and their fry emerge from the gravel in mid-summer. During the summer growing season, rainbow trout behaviour is characterized by the establishment of feeding stations in proximity to cover and abundant food supply. In the fall, rainbow trout respond to decreasing water temperature/photoperiod by moving to deep pools, off-channel ponds, and/or cover elements such as coarse substrates where they remain relatively inactive until spring.

Rainbow trout egg incubation time is temperature dependent, with an optimum incubation temperature of approximately 11°C. Egg survival is also dependent on oxygen supply to the redds. Substrate permeability, inter-gravel current velocities, and groundwater influences potentially affect egg development and survival. Rainbow trout fry emerge from the gravel 45 days to 75 days after egg deposition and move into riffle areas to rear for the remainder of the summer.

Fish access to Baker Creek and Jones Creek is restricted by existing poorly installed culverts at Birch Island - Lost Creek Road. Increasing channel gradient with elevation limits resident rainbow trout distribution to the first <1.8 km of Baker Creek and Jones Creek. Late summer and winter flows may be limiting for rainbow trout due to low flows, water abstraction and lack of deep pool habitat.

The relative abundance of rainbow trout in Jones Creek is characterized as a moderately dense population and was almost twice that observed in lower Harper Creek. The distribution of rainbow trout in lower Baker Creek continued upstream similar to that observed in Jones Creek until a series of high gradient cascades limited their distribution approximately 1.6 km upstream from the road crossing. The relative abundance and size distribution of rainbow trout within Baker Creek were very similar to those observed in the fish bearing sections of Jones Creek, and again, like Jones Creek the abundance in Baker Creek was almost twice those observed within lower Harper Creek.

1.8.2 Bull Trout

Bull trout are the primary fish species of interest in the Harper Creek watershed. The following is a short summary of bull trout specific information related to the IFA. This information is based on analysis presented in the Fish and Aquatic Baseline report (KP, 2014c).

Bull trout are an endemic western North American char whose historical range extends from northern California to the southeastern headwaters of the Yukon River. In British Columbia, bull trout are mainly an interior species, although they are present in several coastal drainages.

Bull trout adults spawn during fall in response to decreasing water temperature/photoperiod and their eggs incubate in the gravel over the winter, normally hatching before the end of January. Alevin absorb their yolk sacs over a period of two to three months and emerge from the gravel as fry in late spring. During the summer growing season, behaviour is characterized by the establishment of feeding stations in proximity to cover and abundant food supply. Like other salmonids, they respond to decreasing water temperature/photoperiod in late fall by moving to deep pools, off-channel ponds, and/or cover elements such as coarse substrates where they remain relatively inactive until spring.

Bull trout are better adapted to cold conditions than other salmonids and their eggs can tolerate temperatures just above freezing (0°C). Bull trout egg survival is linked to the quality of spawning bed material. Bull trout fry emerge from the gravel approximately six months after egg deposition and after achieving neutral buoyancy, they move to low velocity channel margins, side-channels, and small pools for the remainder of the summer.

1.8.2.1 Lower Harper Creek

The highest fish species diversity and quality of aquatic habitat occurs in the lower 1.5 km of Harper Creek as it crosses an alluvial fan before discharging to the outlet of North Barriere Lake. The channel consists primarily of riffle-pool habitat with cobble and gravel bed material. Large woody debris is prevalent in the both the mainstem and the distributary channel where in the latter it has formed complex log jams. The fish fauna of North Barriere Lake and the first two reaches of Harper Creek are linked due to the largely unrestricted connection between lake and creek habitats.

Above the North Barriere Lake Forest Service Road bridge the channel slope of Harper Creek increases. This increased slope in combination with the confined and relatively straight channel increases the water energy and turbulence which actively transports both sediment and woody debris. Habitat for fish is provided by roughened (i.e. boulder) channel elements in the main channel and along channel margins and intermittent widening of the active channel floodplain. This section of Harper Creek is characterized by decreasing fish species diversity and a shift towards bull trout as lone fish species above river km 9.5. The species shift to bull trout is in part influenced by channel gradient, water energy, and increasing distance from North Barriere Lake.

Above these reaches, Harper Creek reverts to more moderate slopes with some short stepped sections. Bull trout is the only fish species sampled to date in this section of Harper Creek. A 2 m high waterfall located at river km 18.5 from the mouth of Harper Creek acts to limit upstream migration or colonization by fish species other than bull trout.

1.8.2.2 Upper Harper Creek

Upper Harper Creek includes two low gradient reaches upstream and downstream from its confluence with T-Creek at river km 20.3. Tree windfall has contributed relatively high amounts of large woody debris to the active floodplain of these reaches increasing sediment storage, secondary channel and deep pool development, and habitat complexity for fish. These reaches include patches of gravel, some of which are suitable for bull trout spawning. Summer rearing conditions are suitable for bull trout.

Bull trout were the only fish species observed in the mainstem portion of upper Harper Creek and the relative abundance was approximately three times that observed in lower Harper Creek. The presence of fry throughout the sampling season and the observation of bull trout redds near river km 20.1, coupled with observations of adfluvial spawners and resident fish in spawning condition, suggest that portions of upper Harper Creek are used for bull trout spawning. The majority of bull trout fry were observed downstream of the confluence of T-Creek among braided sections of river containing loose cobble and gravel that was associated with pools, woody debris and riparian cover. All of the redds observed were situated in shallow water over a substrate of gravel and small cobble. Redds were situated along the river banks in the tailout of pools upstream of riffles and were always associated with overhanging riparian cover.

1.8.2.3 T-Creek and P-Creek

T-Creek and P-Creek both have fish barriers, which are located 336 m and 429 m, respectively, upstream of their confluences with Harper Creek. Multiple fish surveys upstream of the barriers located in T-Creek and P-Creek did not yield any fish captures and stream reaches in these areas are considered fishless.

The lowermost 336 m of T-Creek is fish bearing. Habitat conditions are suitable for rearing due to the prevalence of rough cobble and boulder channel elements combined with turbulent flow. T-Creek is warmer than the Harper Creek mainstem in summer and this temperature difference is thought to attract bull trout to these creeks for summer rearing. Late summer and winter low flows may be limiting for bull trout 1 due to lack of flow and absence of deep pools.

The relative abundance of bull trout juveniles observed within T-Creek varied by sampling date and suggests that abundance of bull trout were higher later in the sampling season (August – September). The seasonally averaged relative abundance of bull trout in T-Creek is very similar to those observed in the mainstem sampling locations in upper Harper Creek. The majority of bull trout observed in Lower T-Creek were parr and older juveniles, although some fry were observed near slower low gradient sections at the Harper Creek confluence. One male bull trout in spawning condition was observed in the tributary. There is limited spawning habitat in the fish bearing portion of T-Creek and it is unclear whether this fish was using this area as a potential spawning location.

The lowermost 469 m of P-Creek is fish bearing. Habitat conditions below the waterfall barrier are suitable for rearing due to the prevalence of angular cobble and large woody debris elements combined with turbulent flow. Late summer and winter low flows may be limiting for bull trout due to lack of flow, unconfined channel sections, and relative absence of deep pools. The relative abundance of bull trout in P-Creek during late summer was slightly less than half the average values observed in T-Creek and upper Harper Creek.

The densities of bull trout in both T-Creek and P-Creek averaged approximately 1.5 to 2 times those observed in three East Kootenay watersheds (Wigwam, Skookumchuck, and White rivers) located in eastern British Columbia and suggest that the habitat in upper Harper Creek are productive rearing environments for both juvenile and resident bull trout.

2 – DAILY FLOW SERIES

2.1 GENERAL

In order to assess some of the instream flow impacts from the Project, daily flow series for pre-mine and life-of-mine is needed (e.g., Hatfield et al. 2003). Some relationships, like habitat suitability, aren't linear with discharge so using a daily timestep provides a more accurate representation of conditions compared to monthly flow series. In order to develop daily flow series, two datasets developed as part of previous analyses were used. Development of these datasets is summarized below.

2.1.1 Baseline Hydrology Synthetic Flow Series

Long-term synthetic streamflow series were generated for the four HCMC gauging stations that had the most complete records: JONESUS, OP, HARPERUS, and TSFDS. These flow series were generated primarily for use in calibrating the watershed model and for fish habitat modelling. Development of these synthetic flow series are presented in the Surface Hydrology Baseline report (KPL, 2014b). Salient details are summarised below.

The daily streamflow records from these four gauging stations were compared to the concurrent provisional daily streamflow record from the WSC gauging station on Harper Creek (08LB076). Seasonal correlation relationships were developed between the four HCMC stations and the WSC station using the empirical frequency pairing (EFP) technique (Butt, 2013). The EFP technique compares the frequency distribution of flows at two stations on a seasonal basis and develops scaling relationships between the flows at the two stations, which can then be applied to the long-term record of one station to generate a long-term synthetic flow series for the other station. The EFP technique involves ranking the daily discharge data in the two streamflow records in descending order of magnitude. Each flow value of equal rank in the two datasets has an equal probability of exceedance in its respective dataset since the datasets are of equal length. A comparison of ranked daily flows therefore amounts to a comparison of flow frequency distributions. The EFP technique assumes that the flow frequency relationships developed from the sample (period of concurrent record) is generally representative of the relationships that would exist between concurrent long-term records.

The EFP approach helps address errors common to the chronological pairing approach that result from differences in both the timing and magnitude of runoff events in the flow records of two creeks being correlated. The objective of the EFP technique is not necessarily to reproduce exact historical flow sequences, but rather to generate datasets that provide a representation of the expected future long-term mean annual discharge and the associated year to year, month to month, and day to day variability of flows.

For the Project EFP analysis, two seasons were selected to represent the two main hydrologic mechanisms in the baseline study area: spring/summer (April through July) to represent the snowmelt and rain-on-snow season, and autumn (August through October) to represent the post-snowmelt season that is dominated by groundwater discharge and periodic rainstorm events.

The seasonal EFP relationships for each of the four HCMC gauging stations were applied to the long-term record at the WSC station on Harper Creek to generate long-term synthetic series of daily streamflow at the HCMC stations for the months of April to October.

During November to March, scaling factors were calculated from the ratios of instantaneous discharge measurements at the HCMC stations to the Harper Creek (08LB076) flows on concurrent dates. A scaling factor for each calendar day was then determined by interpolating between the observed conditions. In this way, the shape of the Harper Creek (08LB076) record was transposed to the HCMC stations, but the flow magnitude was scaled to match the conditions observed.

2.1.2 Watershed Model Flow Series

Long-term synthetic monthly streamflow series were generated for 10 nodes within the watershed model to represent the magnitude, distribution and variability of monthly and annual flows that would likely be experienced over the Project life as mine infrastructure is developed and reclaimed. Development of these synthetic flow series are presented in the Watershed Modelling report (KPL, 2014c). Salient details are summarised below.

A Baseline watershed model was developed for the Project to improve the understanding of local pre-Project hydrologic and hydrogeological conditions, and provide a baseline condition from which to assess potential effects of the planned mine development and operations on surface water and groundwater systems in the Project area. The Baseline watershed model was calibrated to measured streamflow data at the WSC gauges “Harper Creek near the mouth” (WSC 08LB076) and long-term synthetic daily streamflow series generated for the four HCMC gauging stations that had the most complete records: JONESUS, OP, HARPERUS, and TSFDS.

To assess potential effects of the Harper Creek Project on pre-development hydrological conditions, a Life of Mine (LOM) watershed models was developed. The calibrated Baseline watershed model was modified to include key mine facilities and water management strategies during all phases of the Project. Modelling includes two years before production (Year -2) and was run for a period of one hundred years. The LOM model was used to estimate the change from natural surface water and groundwater flows during the various stages of mine development including:

- Construction (Years -2 through -1)
- Operations I – Open Pit Mining (Years 1 through 23.4)
- Operations II – Low Grade Ore Processing (Years 23.5 through 28)
- Closure – Active Closure Phase (Years 29 through 35)
- Post-Closure (Years 36 through 100+)

2.2 METHODOLOGY

2.2.1 Baseline Daily Flows at Watershed Model Nodes

In order to translate the monthly watershed model flow series at the 10 nodes into daily flows, the ratio of the daily streamflow on a given date from the EFP analysis over the monthly mean streamflow from the EFP analysis for the same month and year was developed. This ratio was then applied to the monthly flow from the watershed model to produce a 36 year daily flow series.

For example:

1. Daily flow from EFP analysis for TSFDS for June 1, 1974 = 1.92 m^3/s
2. Monthly flow from EFP analysis for TSFDS for June 1974 = 4.14 m^3/s
3. Ratio of daily to monthly flow for June 1, 1974 = 1.92/4.14 = 0.46
4. Pre-mine monthly flow for Node 3 for June 1974 = 1.97 m^3/s

5. Pre-mine daily flow for Node 3 for June 1, 1974 = 1.97 * 0.46 = 0.92 m^3/s.

The example above highlights the differences between the flows calculated from the EFP analysis and flows developed from the watershed model. The difference between the monthly flows from item 2 and item 4 are a result of the calibration of the watershed model, which is discussed in the Watershed Model report (KP, 2014a).

This methodology introduces reasonable variability into daily series while maintaining the monthly mean flows predicted by the watershed model. Mean monthly flows for Node 3 (T-Creek at Harper Creek confluence) from the pre-mine watershed model and mean daily flows developed for Node 3 are presented on Figure 2.1.

As synthetic daily flows were only developed for four gauging stations using the EFP approach, the above methodology could not be applied to all analysis nodes. At nodes where EFP daily flows were not available, pre-mine daily flows were calculated by drainage area scaling from the nearest node where this analysis had been completed, as outlined below:

- Node 1: Harper Creek near the Mouth — WSC 08LB076
- Node 2: Harper Creek above T-Creek confluence — HARPERUS Gauge
- Node 3: T-Creek at Harper Creek confluence — TSFDS Gauge
- Node 4: T-Creek upstream of Harper Creek confluence — TSFDS Gauge
- Node 5: P-Creek at Harper Creek confluence — OP Gauge
- Node 6: Jones Creek above North Thompson River confluence — JONESUS Gauge
- Node 7: Baker Creek at North Thompson River confluence — JONESUS Gauge
- Node 8: Harper Creek below P-Creek confluence — OP Gauge
- Node 9: Harper Creek below T-Creek confluence — HARPERUS Gauge
- Node 10: Harper Creek at Barriere River confluence — WSC 08LB076

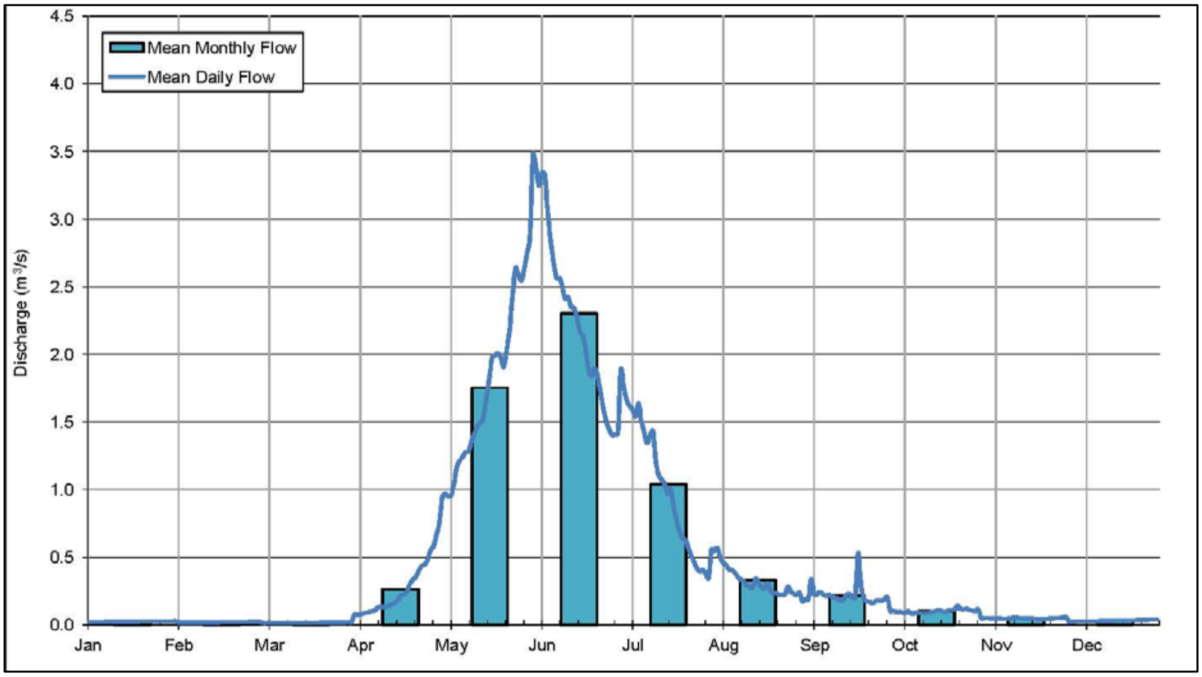


Figure 2.1 Comparison of Mean Monthly and Daily Flows for Node 3, T-Creek at the Harper Creek Confluence

2.2.2 Life of Mine Daily Flows at Watershed Model Nodes

In order to asses flow changes due to Project development, the daily ratio calculated from the baseline conditions was applied to the monthly flow series from the LOM model. Daily flow series were developed for the following mine stages through the mine development:

1. Year -1 – End of Construction
2. Year 10 – Operations I
3. Year 22 – Operations I
4. Year 27 – Operations II
5. Year 30 – Closure
6. Year 50 – Post Closure

Daily flow series for pre-mine and the six mine stages for Node 3, T-Creek at Harper Creek confluence for January to December 1974 are presented on Figure 2.2. The year 1974 was selected as an example year within the 36 year record.

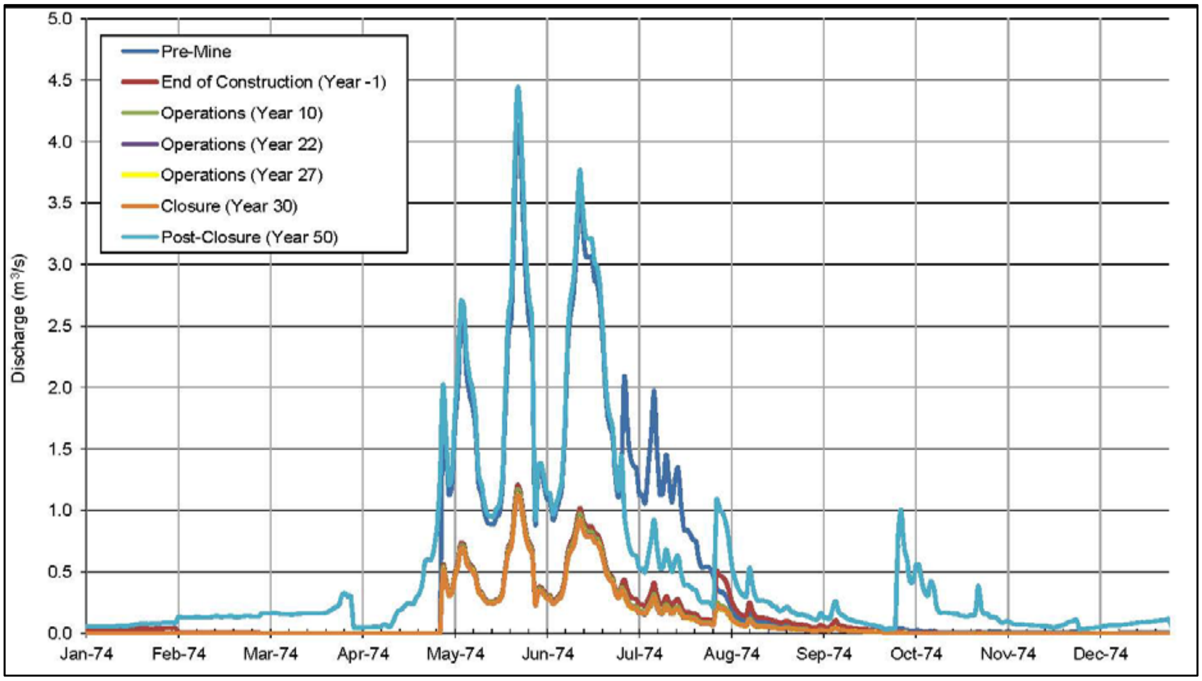


Figure 2.2 Comparison of Life of Mine flows for Node 3, T-Creek at the Harper Creek Confluence, for 1974

2.2.3 Regional Nodes

As the regional nodes are located at WSC stations, measured daily flows are available for the concurrent 36 year period. These measured flows were used to create a pre-mine dataset for the three regional nodes. In order to assess mine effects at the regional nodes, pre-mine daily flows were reduced or increased by the change from pre-mine at the farthest downstream LOM model node contributing the regional node: Node 10, Harper Creek at Barriere River confluence was used to assess net change from Pre-Mine for Nodes 11 and 12, both on the Barriere River. For Node 13, North Thompson River at Birch Island, net change from baseline was summed from Nodes 6 and 7, Jones and Baker Creek respectively.

2.3 RESULTS

Daily streamflows for all 13 nodes were developed for a 36 year period for pre-mine and 6 mine stages. These data were used to support the analyses in Sections 3 and 4. Hydrologic data are summarised and presented in Section 3.

3 – FLOW THRESHOLDS

3.1 GENERAL

Flow thresholds were calculated from three distinct methodologies and compared to the daily flow series for pre-mine and over the life-of-mine (LOM) generated for 13 modelling nodes described in Section 2.0 above. The six LOM stages assessed included construction (year -1), operation 1 (year 10), operation 2 (year 22), operation 3 (year 27), closure (year 30), and post-closure (year 50). The purpose of this approach was to identify locations and times of year where flow thresholds could not be met for pre-mine and LOM modelled flows. This information is intended as a coarse filer tool to inform the impact assessment concerning the potential effects of the Project on stream flows and fish and aquatic habitat resources.

3.2 METHODOLOGY

3.2.1 BC Instream Flow Thresholds

The recommended flow threshold for fish bearing streams was generated from the pre-mine flow series for each of the 13 modelling nodes using the methodology described in Hatfield et al. (2003). This threshold is a seasonally-adjusted flow calculated as percentiles of natural mean daily flows for each calendar month and varies through the year to ensure higher protection during low flow months than during high flow months. The threshold is intended to maintain the most important features of a natural hydrograph from a biological and physical perspective. Flows that do not meet the threshold have the potential to negatively affect fish and aquatic habitat. Thus the threshold methodology is a useful screening tool to evaluate the potential impacts of flow changes resulting from the Project.

3.2.2 BC Modified Tennant Method

The BC Modified Tennant Method was developed by the BC Fisheries Branch as a screening tool to identify the minimum flow related biological requirements of fish throughout the region. The methodology and its technical rationale are described in Ptolemy and Lewis (2002). The BC Modified Tennant flow criteria used in this assessment are as follows:

Biological or Physical Requirement	Recommended Flow Threshold (% MAD)	Duration
Juvenile summer rearing	20%	Months
Adult summer rearing	>55%	Months
Overwintering	20%	Months
Spawning	equation: $1.56 * MAD^{0.63}$	Days-weeks
Egg Incubation	20%	Days to a Week
Short-term Maintenance	10%	Days to a Week
Channel maintenance	>400%	Days
Wetland linkage	100%	Weeks

The durations for juvenile and adult summer rearing, overwintering, spawning, and egg incubation are based on the life history timing of bull trout for modelling nodes in the Barriere River and Harper Creek catchments, and are summarized below. Rainbow trout periodicity is similarly summarized below.

Biological or Physical Requirement	Period/Duration for bull trout	Period/Duration for rainbow trout
Juvenile summer rearing	May 1 to October 31	May 1 to October 31
Adult summer rearing	May 1 to October 31	May 1 to October 31
Overwintering	November 1 to April 30	November 1 to April 30
Spawning	August 16 to September 15	May 16 to June 30
Egg Incubation	September 16 to February 28	July 1 to August 31
Short-term maintenance	Days to a week	Days to a week
Channel maintenance	Days to a week	Days to a week
Wetland linkage	Weeks	Weeks

3.2.3 Indicators of Hydrologic Alteration

The Indicators of Hydrologic Alteration (IHA) method was developed by Richter et al. (1996) as a tool to assess the degree of hydrologic alteration attributable to human influence within a watershed. The method uses 32 parameters organized within 5 groups to quantify hydrologic variation and generate 64 IHA for pre-impact and post-impact conditions. For this assessment we compared pre-mine conditions to Operations Year 22 (maximum flow impacts occur in Year 22) based on 31 IHA parameters. The IHA results where then evaluated against flow management Range of Variability (RVA) targets determined from +/- one standard deviation from the pre-mine mean condition as described in Richter et al. (1996). The rate of non-attainment with the RVA targets was then calculated for pre-mine and operations Year 22 for each of the 31 IHA parameters. The outcome of this approach was to highlight IHA parameters where the greatest change was predicted from pre-mine conditions.

3.3 RESULTS AND DISCUSSION

3.3.1 Overview

The flow thresholds analysis results are presented in Appendix A as follows:

- Appendix A1 includes tables with monthly BC instream flow threshold values, monthly pre-mine flows, and monthly flows for six phases of project development for the 13 nodes in the study area. The flow values are presented in flow units and as % MAD. Appendix A1 also includes a graphed comparison of pre-mine to LOM mean monthly flows for the six phases of mine development at each of the 13 nodes in the study area. The BC instream flow thresholds and BC Modified Tennant thresholds are shown on the graph for comparison to the mean monthly flow values. Monthly flow duration curves for pre-mine and LOM conditions are also provided for each of the 13 nodes.
- Appendix A2 includes tables with the BC Modified Tennant instream flow threshold values for the 13 nodes in the study area. Nodes 1-5 and 8-12 use the life history timing of bull trout for modelling nodes in the Barriere River and Harper Creek. Nodes 6, 7, and 13 use the life history timing of rainbow trout for modelling nodes in the North Thompson River, Baker Creek, and

Jones Creek. The primary difference between bull trout and rainbow trout in the analysis is the timing on spawning and egg incubation. Rearing and overwintering periods are the same.

- Appendix A3 includes tables that compare 31 IHA parameters between pre-mine and Operations Year 22 (worst case) conditions for the 13 nodes in the study area. The rate of non-attainment with the RVA targets is presented for each pre-mine and Operations Year 22.
- Appendix A4 includes monthly flow duration curves for the six phases of mine development at each of the 13 nodes in the study area.

3.3.2 BC Instream Flow Thresholds

The results of the BC Instream Flow Thresholds analysis are presented in table format and graphically in Appendix A1.

The predicted LOM flows generally met >80% of the mean annual BC Instream Flow Threshold guideline at Nodes 1, 2, and 10 on Harper Creek and Nodes 11 and 12 on the Barriere River at Operations Year 22. The flow effects of the Project at Node 13 on the North Thompson River were negligible. These results are expected due to the relatively small size of the mine footprint relative to the total watershed area of these catchments. This includes Node 2 on Harper Creek which is just upstream of T-Creek.

Node 9 on Harper Creek below T-Creek met >70% of the mean annual BC Instream Flow Threshold guideline for Operations Year 22, and >90% of the BC Instream Flow Threshold at closure.

Node 8 on Harper Creek below P-Creek met >69% of the mean annual BC Instream Flow Threshold guideline for mine stages through to post-closure.

Node 3 (lower T-Creek) met >26% of the BC Instream Flow Threshold at Operations Year 22, and pre-mine baseflows were restored at closure and through post-closure.

Node 5 (lower P-Creek) met >35% of the annual BC Instream Flow Threshold guideline.

Node 6 (lower Jones Creek) meets or exceeds the mean annual BC Instream Flow Threshold guideline for all mine stages, except Year 10.

Node 7 (lower Baker Creek) met >90% of the mean annual BC Instream Flow Threshold guideline for all months through to post-closure.

3.3.3 BC Modified Tennant Method

The results of the BC Modified Tennant Method analysis are presented in table format in Appendix A2 and shown graphically in Appendix A1.

The analysis shows that pre-mine baseflows are below the overwintering threshold for during March at nodes 1 – 10 under pre-mine conditions.

The summer rearing thresholds were not met at baseline or operations in August, September or October at most nodes.

The duration of short term maintenance, channel maintenance and wetland linkage under operational conditions can be assessed by reviewing the flow duration curves in Appendix A4. These indicate that can be these conditions are met for days to a week under operational conditions at Nodes 1, 2, 7, 8, 9, 10 and 13. At Nodes 3, 4, 5, and 6 they are not met during operations. At the regional nodes (11 and 12) pre-mine flows rarely exceed 400% MAD due to the hydrologic regime of the Barriere River.

3.3.4 Indicators of Hydrologic Alteration

The results of the IHA analysis are presented in table format in Appendix A3. This analysis indicates that although the mean flow condition is reduced (focussing on monthly flows, 7-day minimum and 30-day minimum flows as the most biologically important metrics) at Nodes 1, 2 and 7 to 13, much flow variability remains and flow conditions are within the RVA targets almost as frequently in the operational condition as pre-mine conditions. In comparison, flows are outside the RVA targets much more of the time under operational conditions at nodes 3, 4 and 5, (T-Creek and P-Creek).

4 – PHYSICAL HABITAT MODELLING

In order to characterise changes to fish habitat caused by modified flow regimes, two dimensional (2D) and one dimensional (1D) physical habitat modelling was undertaken. Physical habitat modelling refers to the use of hydraulic models to predict changes in water depth, water velocity and a third physical habitat characteristic (typically cover or substrate) due to modified flow conditions. These methodologies are based on the premise that fish have preferred ranges of depth, velocity, substrate, and cover types, depending on the species and life stage. Habitat modelling aims to quantify the usable habitat available under Project modified flow conditions. This method assumes that physical habitat limits fish production.

The PHABSIM software (USGS, 2012) was used for 1D modelling, while the 2D modelling was completed with River2D (Steffler and Blackburn, 2002). Data post processing for both models was completed in Excel. Methodology for these models was guided by the BC Instream Flow Methodology as described in Lewis et al. (2004) and Hatfield et al. (2007).

4.1 METHODOLOGY

4.1.1 Habitat Suitability Indexes

In order to characterize the hydraulic conditions most favourable to bull trout in Harper Creek, data from fish studies during 2011 and 2012 were compiled to develop Habitat Suitability Index (HSI) curves. During these fish sampling efforts, depth and velocity data were recorded at the location of 57 juvenile bull trout observations, 19 bull trout fry observations and 10 locations where indications of spawning were observations. These data were collected in P-Creek, T-Creek and Harper Creek from just below the km 18.5 barrier falls to T-Creek. Different curves were developed for fry, rearing and spawning life stages. Observed depths and velocities were binned into 0.05 m and 0.05 m/s bins, respectively, and then preference was calculated relative to the maximum number of observations in a bin. This approach results in a preference of 1 for the bin with the maximum number of observations and 0 for the bin where no fish are observed. Fish observations for each life stage are presented on Figures 4.1, 4.3 and 4.5. This approach follows the methodology presented in the Washington State Instream Flow Study Guidelines (WDFW and WDE, 2004), except that the observations aren't weighted by the percent of total stream area for each bin. The Harper Creek curves developed from observed data were then "smoothed" to better represent typical suitability and with consideration to the preferences reported by McPhail (2007), McPhail and Murray (1980), Baxter (1997), and Bustard (1996). The smoothed HSI relationships used in the 1D and 2D modelling are presented on Figures 4.2, 4.4, and 4.6.

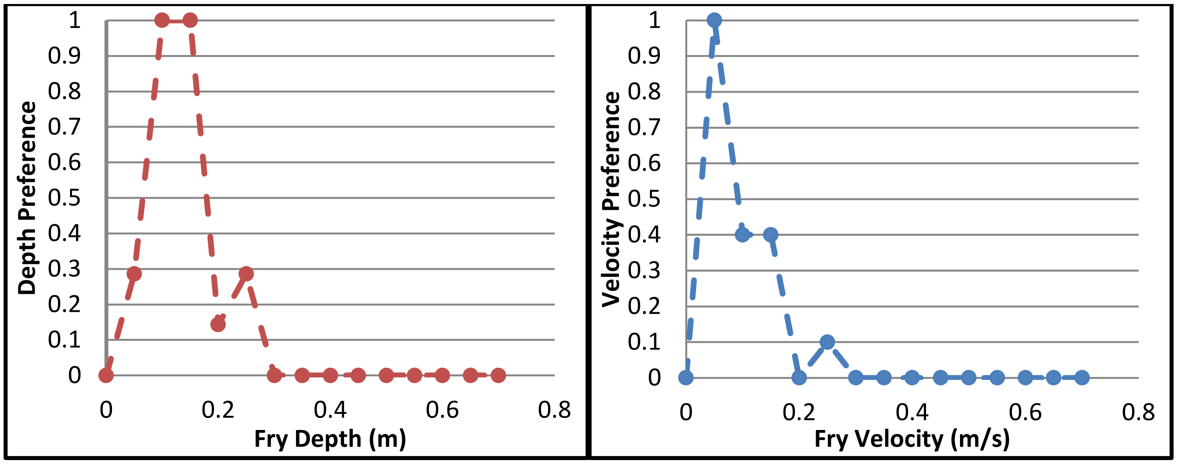


Figure 4.1 Observed Bull Trout Fry Depth and Velocity Preference

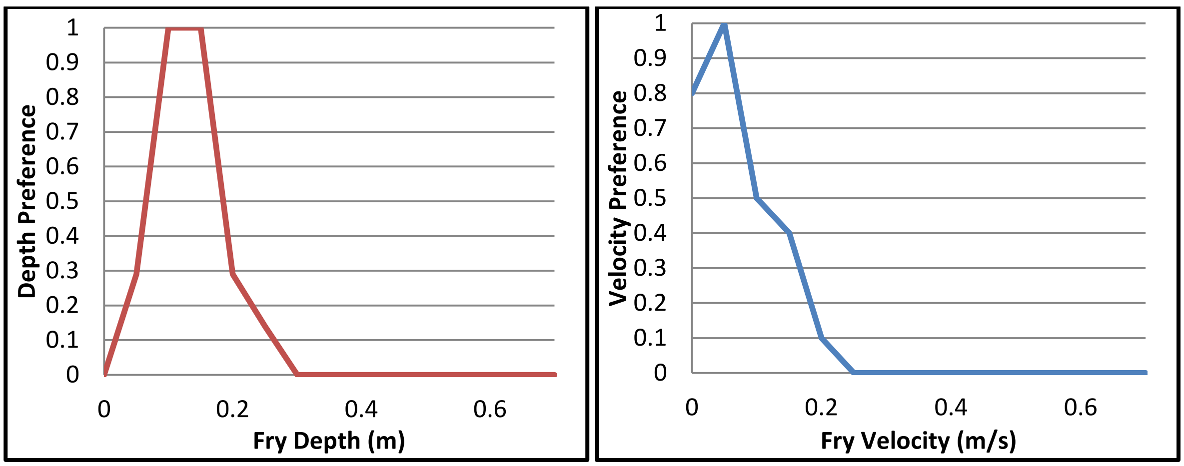


Figure 4.2 Recommended Bull Trout Fry Depth and Velocity Preference

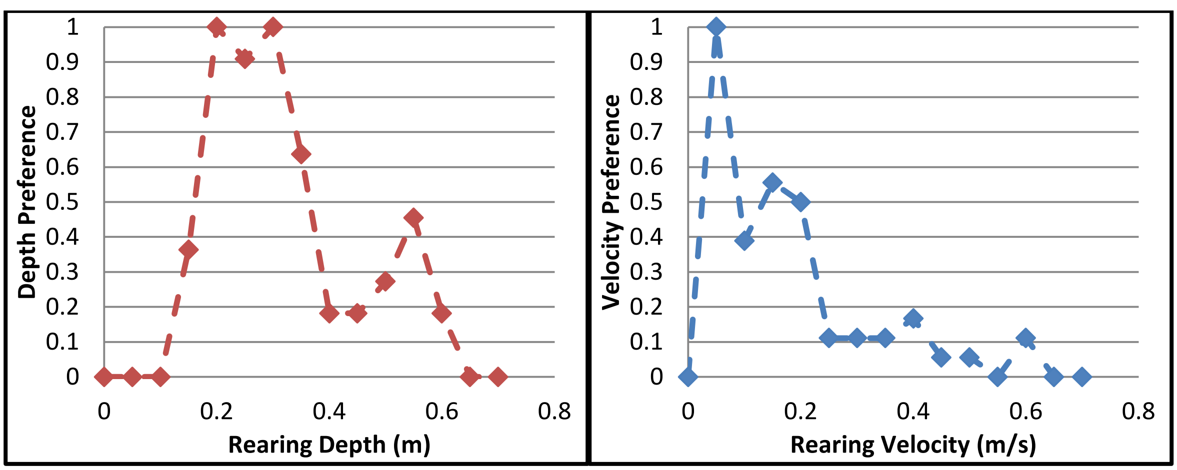


Figure 4.3 Observed Bull Trout Rearing Depth and Velocity Preference

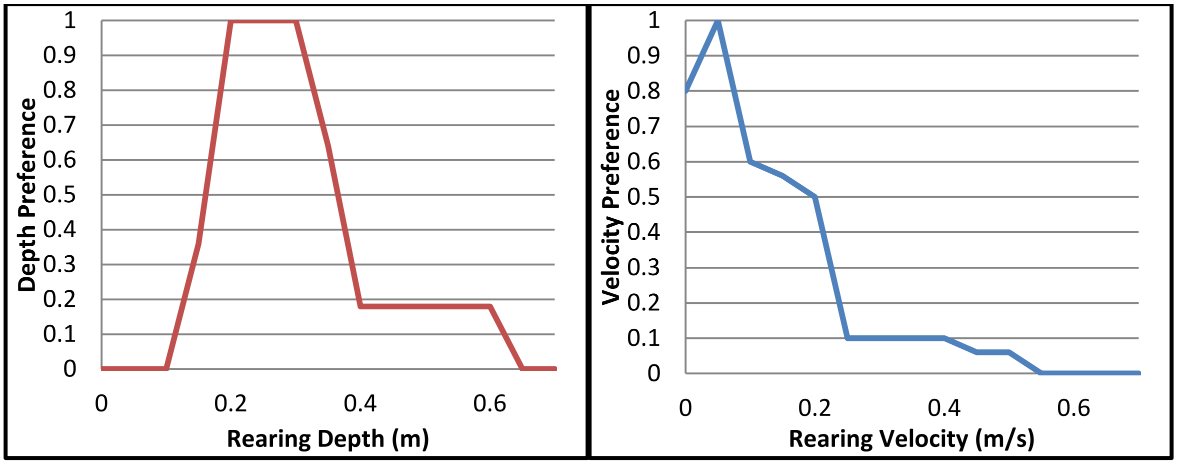


Figure 4.4 Recommended Bull Trout Rearing Depth and Velocity Preference

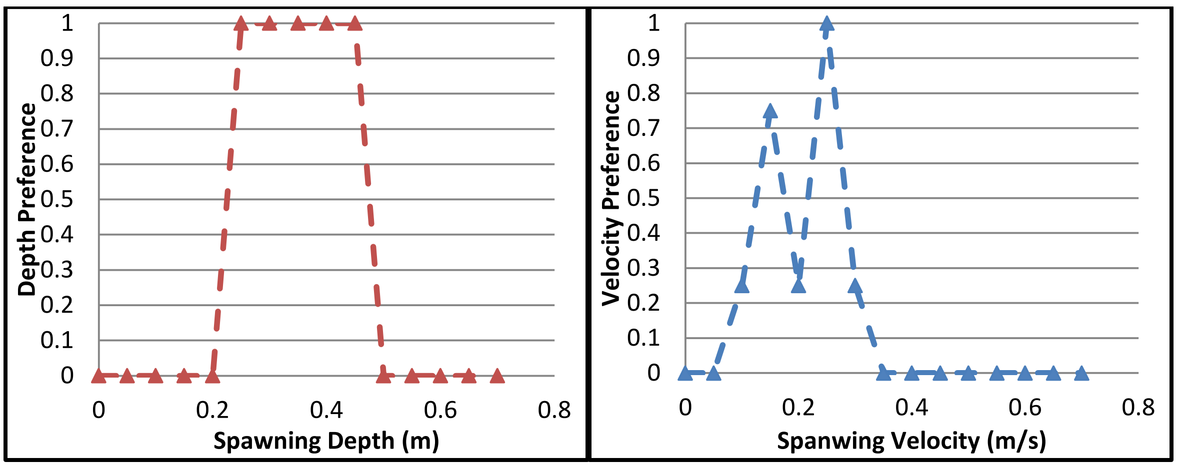


Figure 4.5 Observed Bull Trout Spawning Depth and Velocity Preference

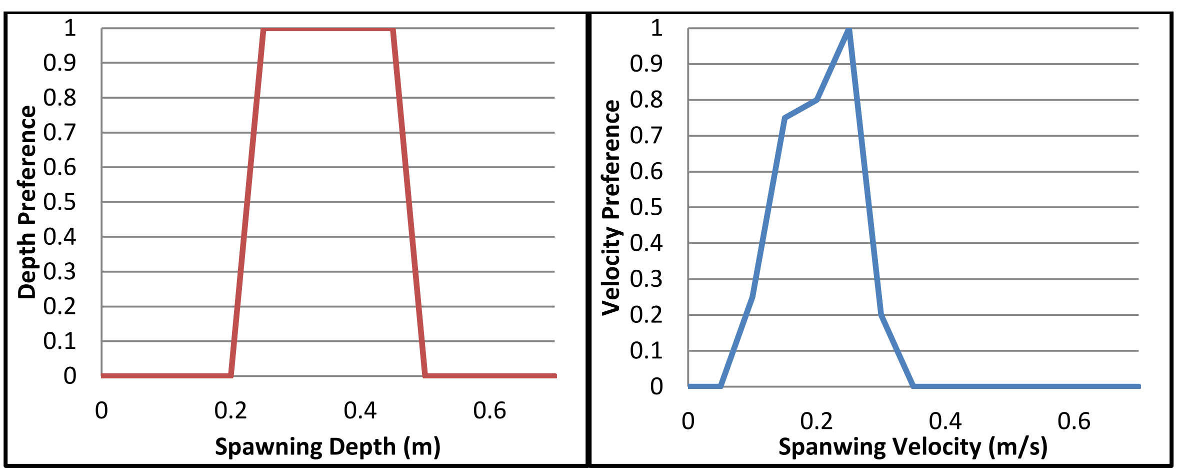


Figure 4.6 Recommended Bull Trout Spawning Depth and Velocity Preference

These HSI curves define "good" habitat suitability to a narrower range of depths and velocities than other published curves like those developed in Washington State (WDFW and WDE, 2004). This is likely due to the small bodied animals observed in Harper Creek above the falls, in T-Creek and P-Creek. The differences between the Washington and KP curves are displayed on Figures 4.7 and 4.8, below. The Washington curves for Juvenile bull trout show a preference for depth and velocities outside of those where bull trout in Harper Creek study area were found. Similarly, the Washington HSI curves for spawning bull trout show a much larger range of preferential values. As site specific field data were collected to characterize depth and velocity preferences for three life stages of bull trout within the study areas, the decision was made to use site specific HSI curves to more accurately represent the bull trout in Harper Creek.

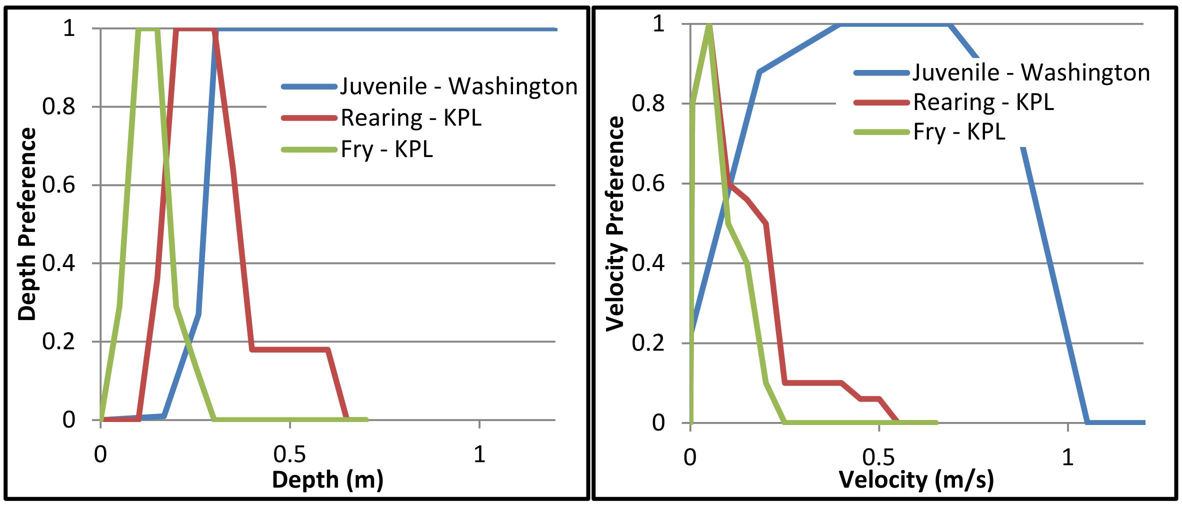


Figure 4.7 Comparison of Washington State and Recommended HSI Curves for Juvenile Bull Trout

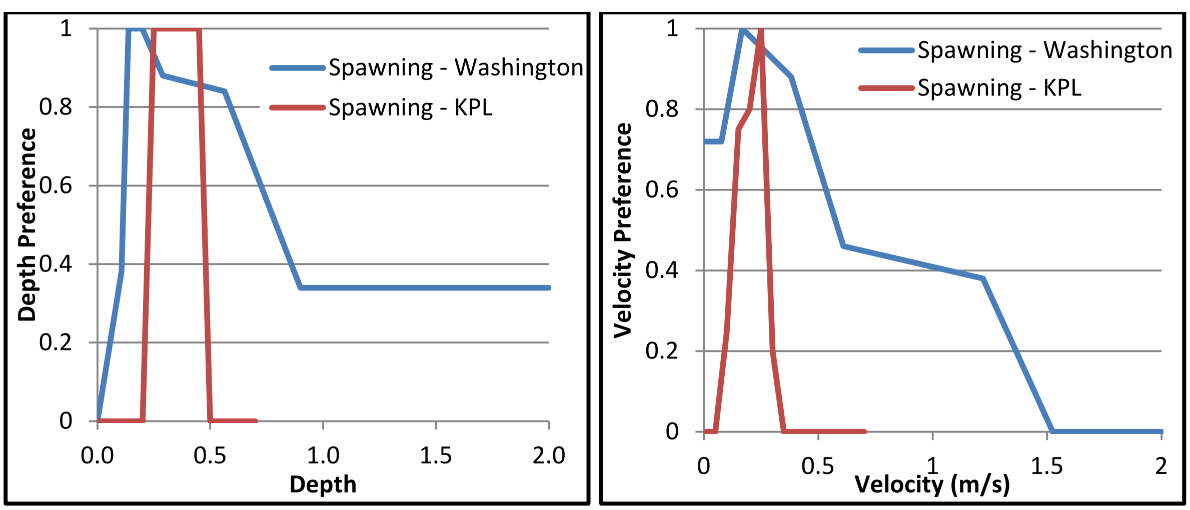


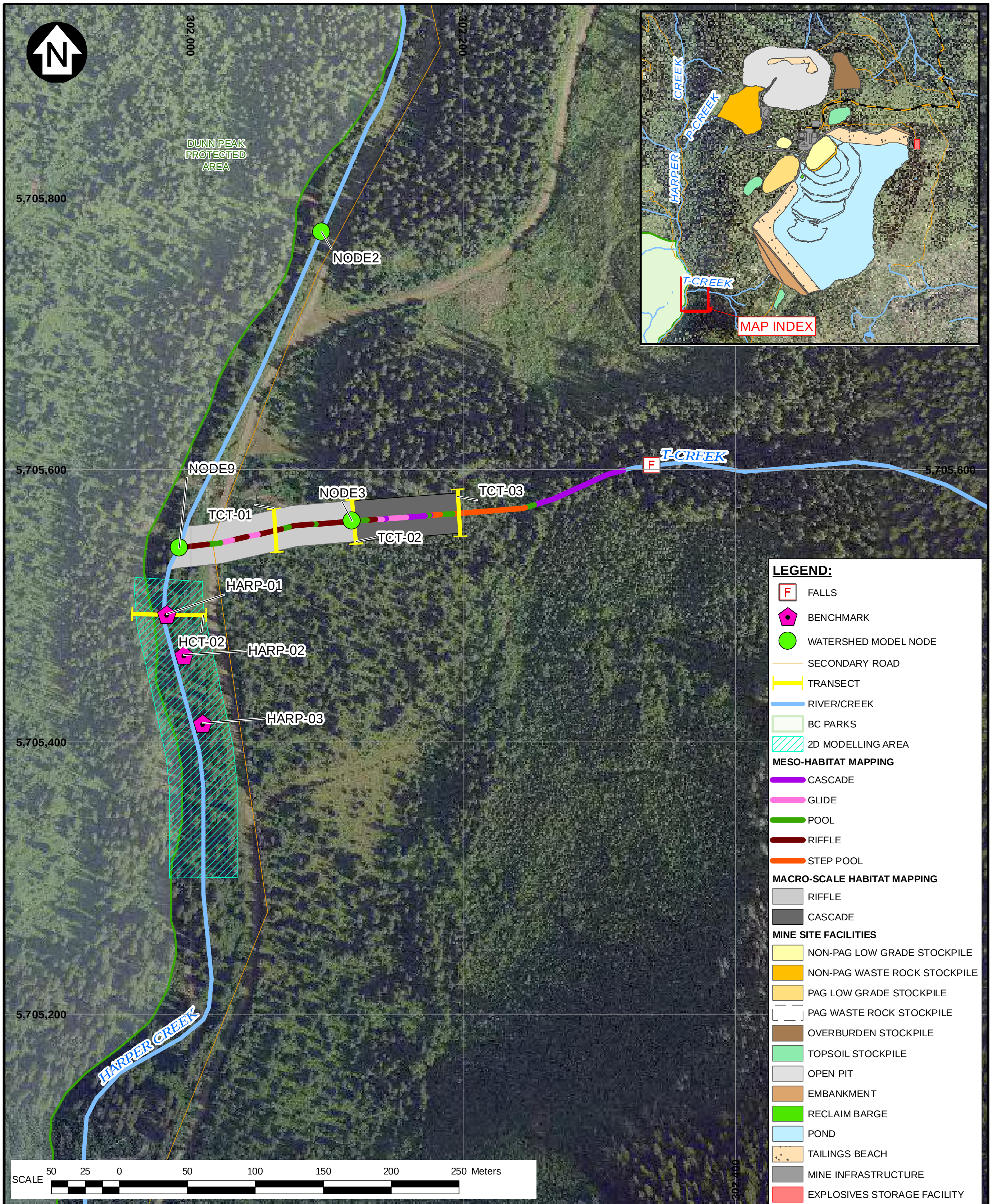
Figure 4.8 Comparison of Washington State and Recommended HSI Curves for Spawning Bull Trout

4.1.2 One-Dimensional Model Development

The modelling program, PHABSIM (USGS, 2012) was selected for use in this Project to undertake both habitat and hydraulic simulations. PHABSIM was used to create a 1D model of the fish bearing reaches of T-Creek and P-Creek. Water depth and velocity values were modelled at transects using the PHABSIM tools to provide depth and velocity conditions at a range flow conditions. The user can then input channel index and HSI curves to translate the hydraulic data into habitat preference. The model calculates this habitat preference as a wetted useable width (WUW) of the cross section for each flow. These results can then be used to approximate the surrounding creek area by multiplying the width value by the length of mesohabitat unit that transect represents to develop a weighted useable area (WUA).

4.1.2.1 Site Description

Transects were placed in the fish bearing sections of T-Creek and P-Creek as illustrated on Figures 4.9 and 4.10. All three transects in T-Creek and two transects P-Creek were modelled using PHABSIM.



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NOTES:

1. BASE MAP: TRIM AND NTS MAPPING, ESRI ARCGIS ONLINE SHADED RELIEF.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:4,000 FOR 8.5x11 (LETTER) PAPER.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	16OCT'14	ISSUED WITH REPORT	CAC	CAC	ACA	KJB

HARPER CREEK MINING CORP.

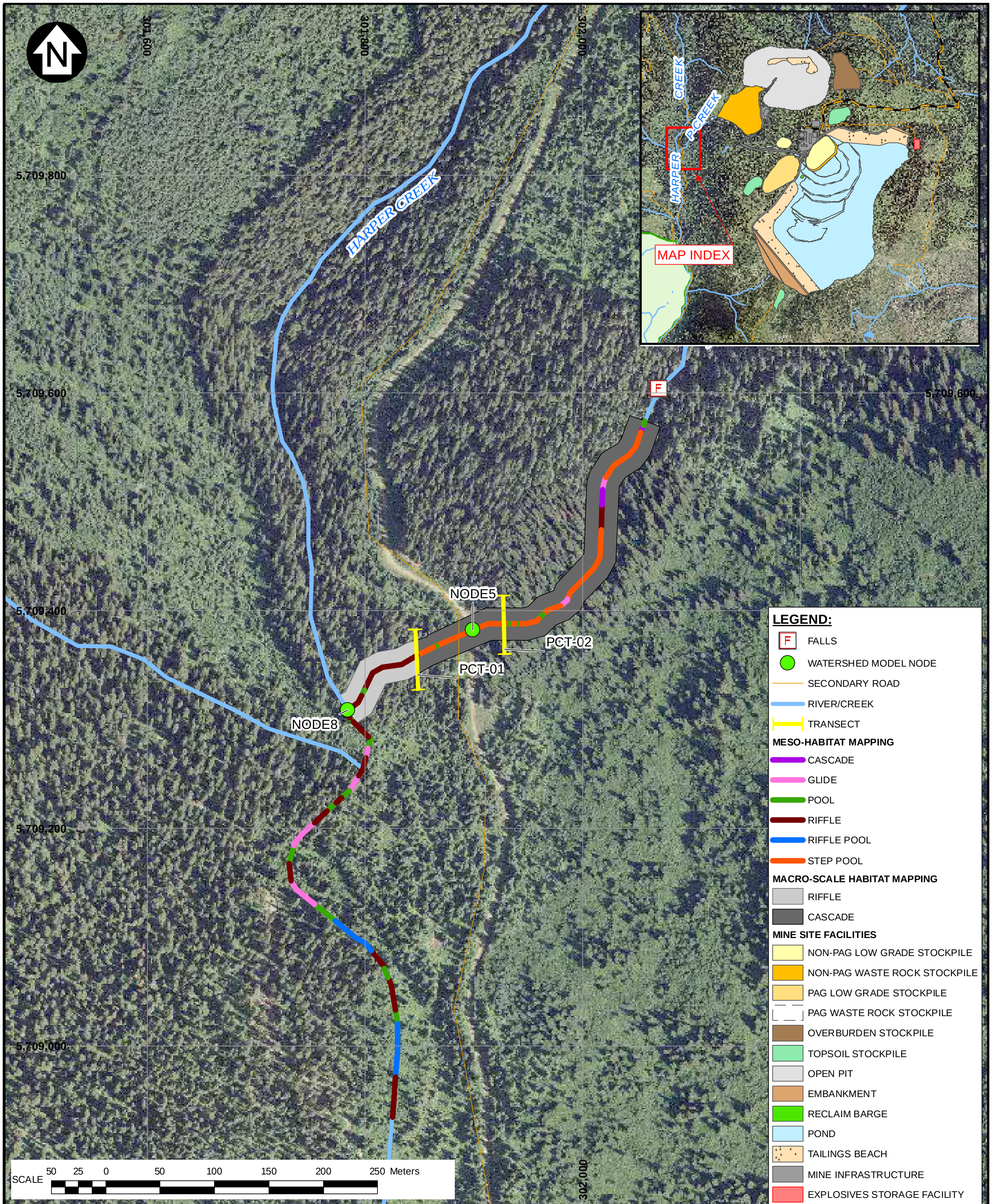
HARPER CREEK PROJECT

INSTREAM FLOW HABITAT IMPACT STUDY SITES: T-CREEK AND HARPER CREEK

Knight Piésold CONSULTING

P/A NO. VA101-458/15 | REF NO. 3

FIGURE 4.9 REV 0



NOTES:

1. BASE MAP: TRIM AND NTS MAPPING, ESRI ARCGIS ONLINE SHADED RELIEF.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 11N.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:5,000 FOR 8.5x11 (LETTER) PAPER.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

INSTREAM FLOW HABITAT IMPACT STUDY SITES: UPPER HARPER CREEK AND P-CREEK

Knight Piésold CONSULTING

P/A NO. VA101-458/15 | REF NO. 3

FIGURE 4.10 | REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
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T-Creek upstream of the confluence with Harper Creek is a medium gradient creek (approx. 4% at the transect locations) with step pool and pool riffle morphology as illustrated in Figure 4.11. Large gravel, cobbles and boulder bed material and dense alder cover on both banks provide excellent cover for rearing bull trout. The fish bearing reach of T-Creek begins at the confluence with Harper Creek and continues for 340 m upstream. T-Creek has a fish proof waterfall barrier located 340 m upstream from its confluence with Harper Creek. Repeated sampling during 2011-2013 confirmed that the T-Creek watershed is fishless upstream of this barrier. T-Creek is utilized by bull trout for summer rearing. Due to the limited availability of spawning substrate and lack of pools, spawning and overwintering habitat are considered marginal. Transects were established to characterize available summer rearing habitat for bull trout.

Three transects, referred to as TCT-01, TCT-02 and TCT-03, were established within the lower sections of T-Creek. TCT-01 and TCT-02 were located in riffle habitat and TCT-03 was located in cascade habitat, which are the two predominant mesohabitat types where fish have been found in T-Creek. Habitat units were characterized following Fish Habitat Assessment Procedures (Johnson and Slaney, 1996). The transects were placed near the streamflow monitoring station on T-Creek and were visited up to seven times between September 2011 and August 2012. During these visits water surface elevation, water depth and velocity profile data were collected. During high flow conditions, T-Creek is unsafe to wade and during these site visits, only water surface elevation information was collected. Additionally, a cross sectional survey was performed during an early site visit.

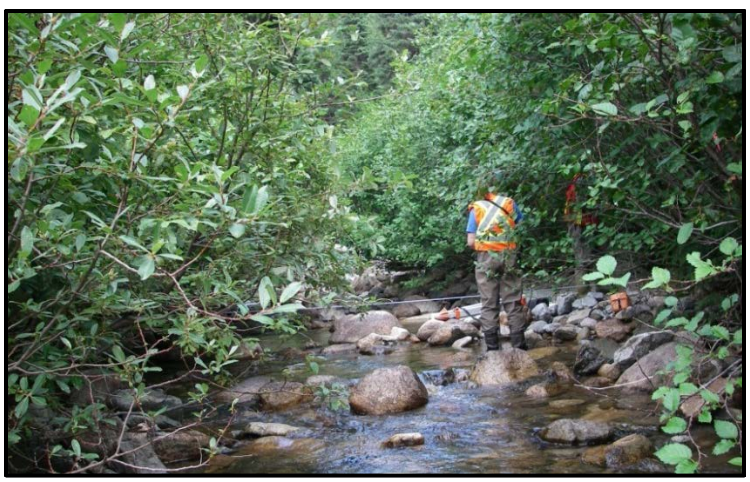


Figure 4.11 Typical T-Creek Transect Morphology (TCT-02)

P-Creek upstream of the confluence with Harper Creek is a medium gradient creek (approx. 4.5% at the transect locations) with a mix of step pool and pool riffle morphology as shown in Figure 4.12. Gravel, cobbles and some boulders make up the bed material. Alders and small trees provide edge cover throughout the study area. The fish barring reach of P-Creek begins at the confluence with Harper Creek and continues for 430 m upstream. P-Creek has a fish proof waterfall barrier located 430 m upstream from its confluence with Harper Creek. Repeated sampling during 2011-2013 confirmed that the P-Creek watershed is fishless upstream of this barrier. P-Creek is utilized by bull trout for summer rearing. Due to the limited availability of spawning substrate and lack of pools, spawning and overwintering habitat are considered marginal. Transects were established to characterize available summer rearing habitat for bull trout. Two transects, named PCT-01 and PCT-02, were established within the lower sections of P-Creek. PCT-01 was located riffle mesohabitat, while PCT-02 was located in cascade mesohabitat. Habitat units were characterized following Fish Habitat Assessment Procedures (Johnson and Slaney, 1996). These transects were visited 6 and 5 times, respectively, between September 2011 and August 2012. During these visits water surface elevation and water depth and velocity data were collected to aid model development and calibration. Additionally, a cross sectional survey was performed during low flows to define the transect geometry.

Figure 4.12 Typical P-Creek Transect Morphology (PCT-02)

4.1.2.2 Model Development

PHABSIM transect models were developed using the cross sectional survey data to denote channel bed topography. Water surface elevations were surveyed at six flows at PCT-01 and five flows at PCT-02 ranging from 8 %MAD to 569 %MAD, as summarized below. These data, along with a stage of zero flow, were used to develop a discharge - water surface relationship for each transect. Velocity data were also measured at the same time as the water surface elevations and these were added to the model.

Table 4.1 Observed Flow Conditions in P-Creek

Date	PCT-01		PCT-02	
	m^3/s	%MAD	m^3/s	%MAD
September 14, 2011	0.03	20%	0.03	20%
May 4, 2012	0.25	166%	0.25	166%
May 14, 2012	0.50	330%	0.53	365%
May 28, 2012	0.85	569%	0.85	569%
July 6, 2012	0.44	295%	-	-
August 21, 2012	0.015	10%	0.013	8%

Water surface elevations were surveyed at seven flows at TCT-01 and five flows at TCT-02 and TCT-03, at flows ranging from 4 %MAD to over 1000 %MAD, as summarized below. These data, along with a stage of zero flow, were used to develop a discharge - water surface relationship for each transect. Velocity data were also measured, but only on September 14, 2011, May 5, 2012 and August 22, 2012 because flows were too high on the other occasions to safely measure velocity.

Table 4.2 Observed Flow Conditions in T-Creek

Date	TCT-01		TCT-02		TCT-03	
	m^3/s	%MAD	m^3/s	%MAD	m^3/s	%MAD
September 14, 2011	0.02	4%	0.02	4%	0.02	4%
May 5, 2012	0.78	149%	0.78	149%	0.78	149%
May 16, 2012	2.56	492%	2.56	492%	2.53	486%
May 17, 2012	1.99	384%	-	-	-	-
May 28, 2012	4.15	798%	3.95	759%	3.78	727%
June 6, 2012	6.20	1193%	-	-	-	-
August 22, 2012	0.04	8%	0.04	8%	0.04	8%

Channel Index values were designated for chainages across the transects based on observed conditions, as discussed below. HSI curves for three life stages of bull trout were also inputted into the models. Depth and velocity suitability is calculated in the model by applying the HSI relationships to the depth and velocity values calculated by the model.

Channel Index

As available cover is a very important habitat characteristic for bull trout, a channel index value was assigned to each model to account for cover preferences. The banks of T-Creek and P-Creek in the modelled areas are well treed and have overhanging alder bushes along the creek edge. Often channel index is used to represent substrate preferences within the modelled reach. The choice to ignore substrate preference and focus on vegetation cover preference was at the direction of the fisheries team.

In the PHABSIM models, channel index values were assigned to transect chainages for each cross section. A value of 1 indicated excellent channel suitability, excellent cover, while a value of 0.5 indicated less optimal channel conditions. Values less than 0.5 were not assigned. Channel index values were designated based on field experience and photos. As these transects are meant to represent overall channel conditions, not just the specific transect locations, channel index values were consistent within transects from the same creek. The channel index values will help to represent bull trout’s preference for cover and will help constrain WUW to areas with adequate cover.

The channel cross section topography, channel index and a velocity profile for transect, TCT-01 are illustrated on Figure 4.13. The channel index of 1.0 has been designated along the edges of the channel to denote the cover provided by trees and alders along the bank. The center of the channel is more exposed, however the dense forest around a smaller channel provide some residual cover and a channel index value of 0.75 was selected.

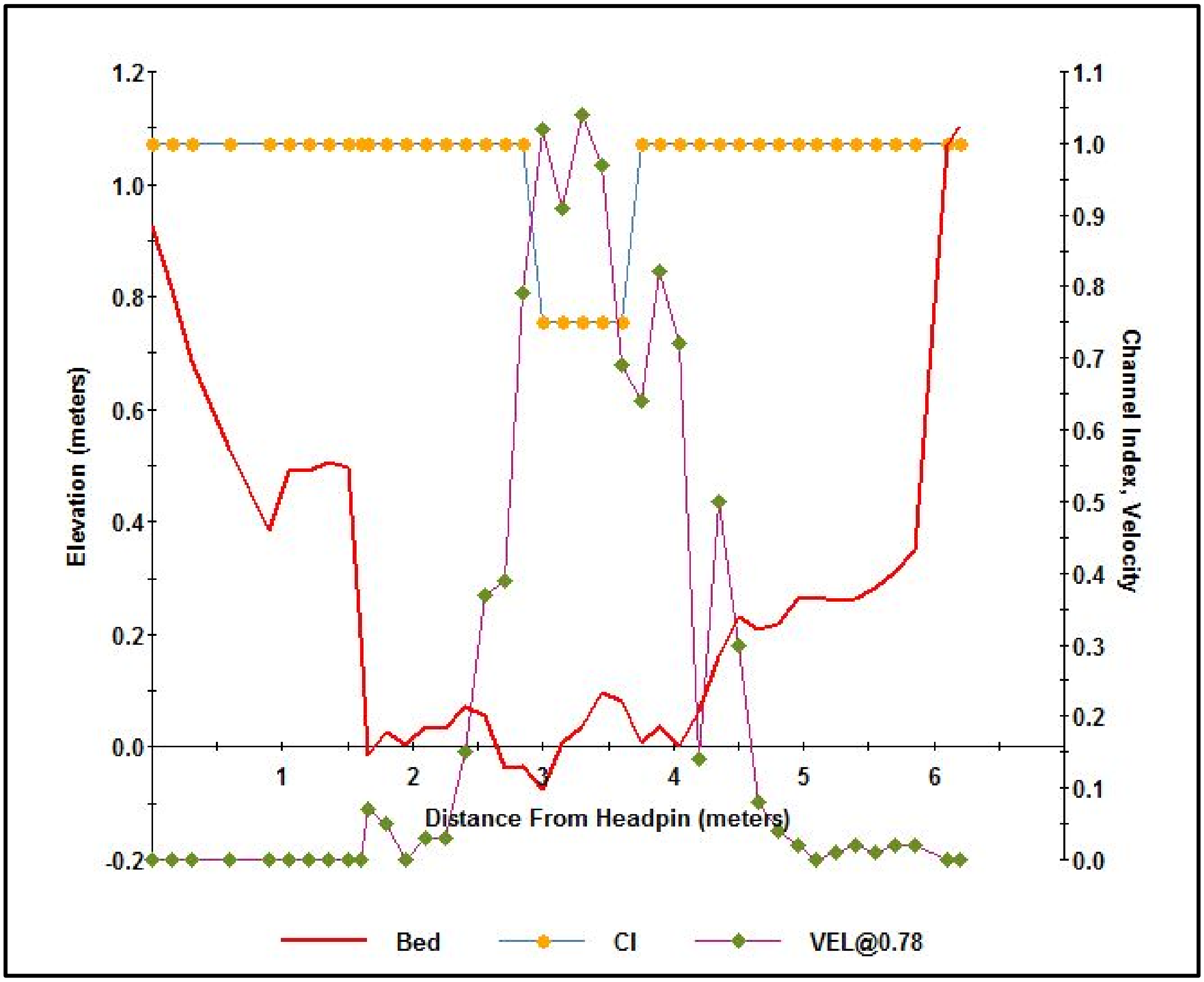


Figure 4.13 Channel Index for TCT-01

4.1.2.3 Model Calibration

PHABSIM models are calibrated in terms of water surface elevation and velocity profiles separately and then scaling factors are applied to the velocity values to maintain flow continuity through the transect for each modelled flow.

Water surface elevation was calibrated using regression based on the field measured flow and elevation data. The modelled and measured water surface–discharge relationship for transect PCT-02 is shown on Figure 4.14. The measured and modelled data agree well, except at the lowest measured discharge. Low flow discharge measurements are generally associated with greater uncertainty.

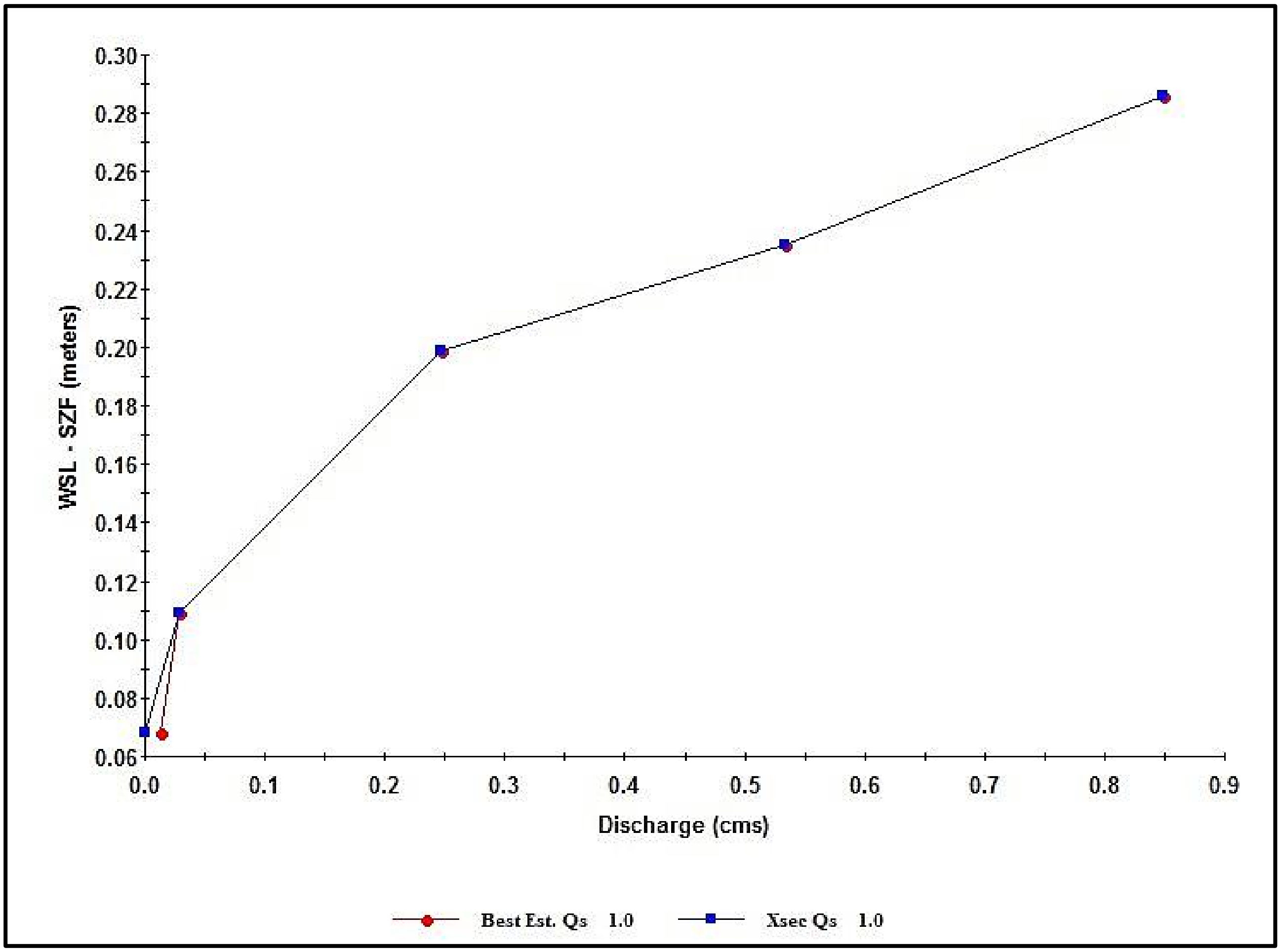


Figure 4.14 Discharge - Water Surface Elevation Plot for Transect PCT-02

The discharge–water surface elevation relationship was then used to develop simulated water surface elevations over the range of modelled flows. A comparison to the simulated and measured water surfaces for PCT-02 is presented in Figure 4.15. In the legend, simulated water surfaces are listed first in order of increasing flow followed by measured water surfaces. As is illustrated, the agreement between the modelled and measured water surfaces ranges from 0.004 m to 0.014 m. In contrast, the range of measured water surface elevation differences between the left bank and the right bank is 0.002 to 0.070 m. Therefore, the calibration of the model is within the range of measured difference in water level between the transect edges. This was a common finding among the modelled transects; the bank to bank variation of water surface was typically greater than the error between the measured and modelled.

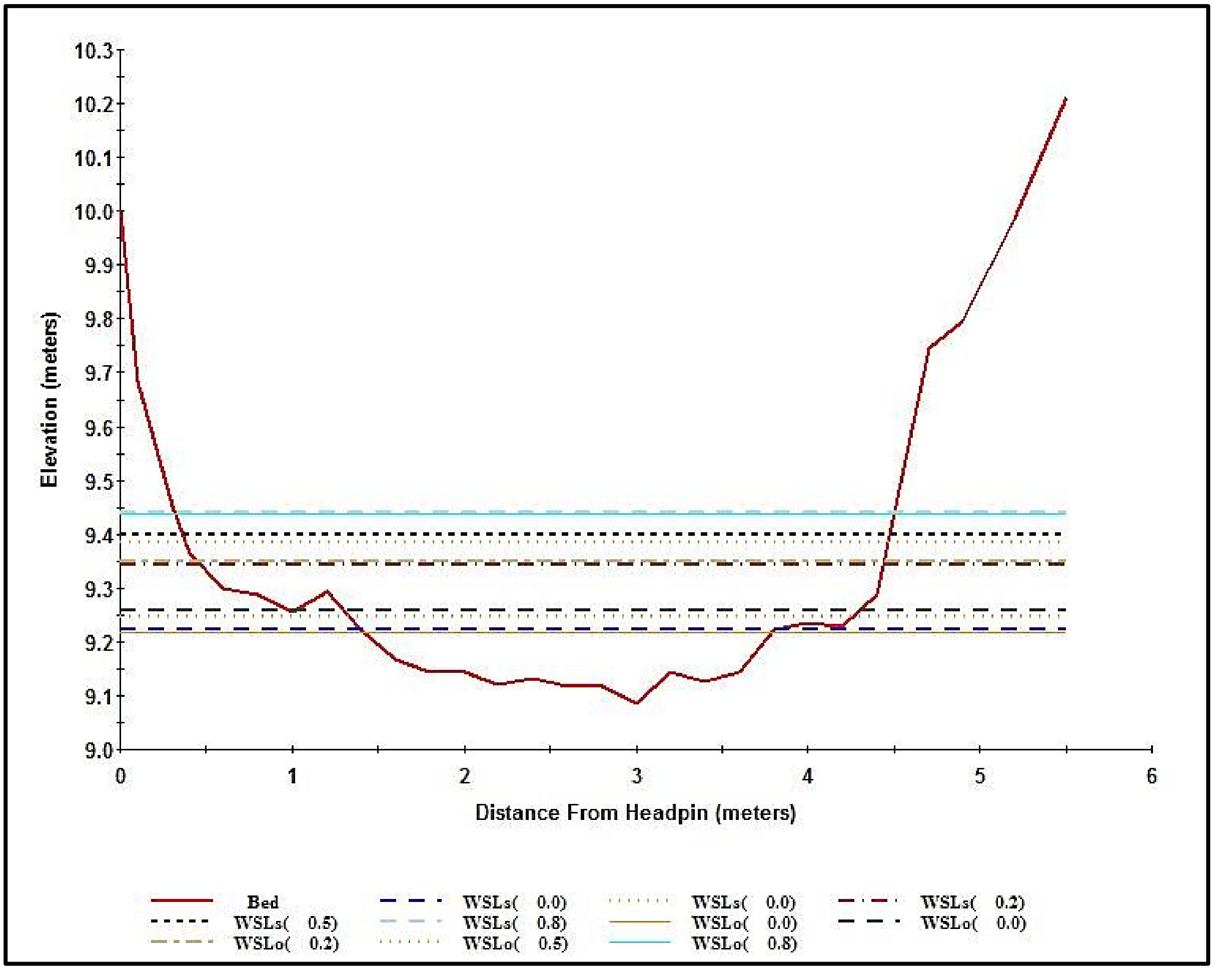


Figure 4.15 Measured and Modelled Water Surface Elevations for Transect PCT-02

Velocity profiles were simulated using only one measured velocity profile. For these models the velocity profile measured during the highest flow was used to simulate profiles at other flows. This technique is recommended by the developers of PHABSIM as it generally provides the most reasonable results. The simulated velocity profiles were compared to measured profiles over the range of observed flows as shown on Figure 4.16. The legend of the figure lists the simulated velocity profiles followed by the measured profiles by associated discharge. The simulated velocity profiles maintain the shape of the calibration profile, in this case the profile for a discharge of 0.85 m^3/s.

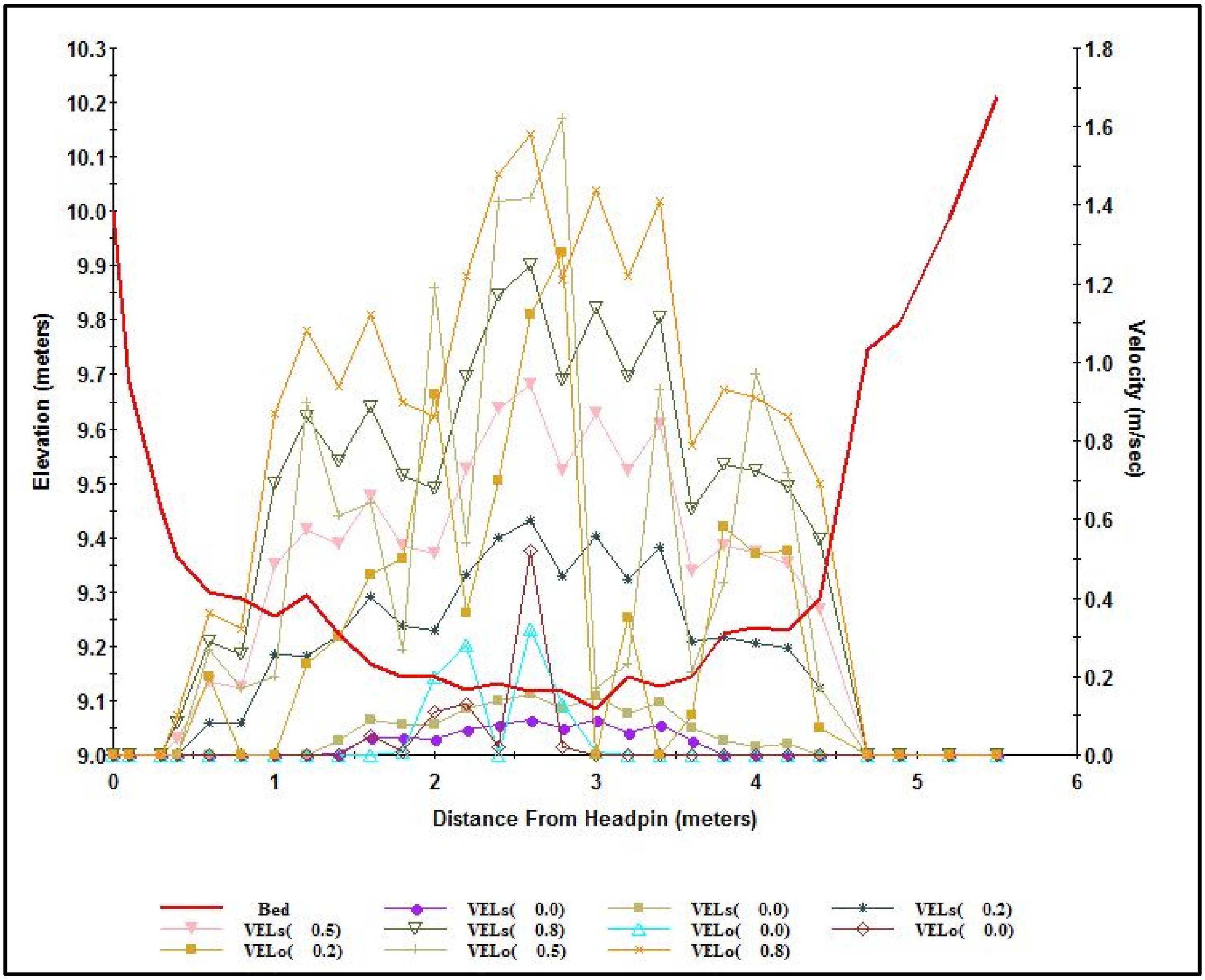


Figure 4.16 Measured and Modelled Velocity Profiles for Transect PCT-02

The agreement between the measured and modelled profiles shows similar magnitude and profile shape in the mid-range of calibration flows. At the lowest flows, the shape of the velocity profiles are driven by large gravel and boulders in the transect and show a mix of stagnant water behind rocks and water flowing quickly between rocks. As the driving factors in the low flow velocity profiles are different than those at higher flows, the measured and simulated profiles don't match well, however the magnitude of the velocity profile is in keeping with the average observed condition. As the simulated profiles tend to be more consistent at lower flows, the transects are likely underrepresenting the range of velocity encountered at low flow.

The model is then run over the range of flows to be simulated and the predicted water surface elevation and velocity were checked for appropriateness. High flows were compared to bankfull elevations and observed high water marks. Velocity data were checked to ensure the velocity distribution seemed reasonable and no velocity "spikes" were generated.

PHABSIM models are calibrated in terms of water surface elevation and velocity profiles separately and then scaling factors (velocity adjustment factor, VAF) are applied to the velocity values to maintain flow continuity throughout the transect for each modelled flow.

4.1.2.4 Discharge – Weighted Useable Area Relationship

Weighted useable width (WUW) is calculated as:

$$WUW = \sum W \times D_{HSI} \times V_{HSI} \times S_{HSI}$$

Where:

W = cell width

D_{HSI} = depth suitability

V_{HSI} = velocity suitability

S_{HSI} = substrate or cover suitability

Separate relationships between discharge - WUW were developed for fry, rearing and spawning life stages.

In addition to the modelled data, WUW was calculated from the measured depth and velocity data.

The discharge-WUW relationships were translated into discharge-weighted useable area (WUA) relationships by multiplying the WUW values by the length of mesohabitat that each relationship represents, as per the “Idealized River Reach Approach” (USGS, 2012). In order to represent the entire fish bearing reach, two overarching macro-scale habitat units were defined in each creek. Riffle habitat (Johnson and Slaney, 1996) was characteristic of the area upstream of the confluence with Harper Creek in both T-Creek and P-Creek. Cascade habitat is typical of the upper fish bearing reaches of both Creeks. These classifications are outlined on Figure 4.9 and Figure 4.10 along with the mesohabitat classification presented in the Fish and Aquatic Habitat Baseline report (KP, 2014c). In T-Creek, two transects were located in riffle habitat which represents 134 m of habitat and one in cascade habitat which represents 202 m of habitat. The discharge-WUW relationship for the two riffle transects in T-Creek were equally weighted to represent the total riffle habitat. In P-Creek, one transect is located in riffle habitat which represents 87 m of the total habitat, while the other transect is located in cascade habitat which accounts for the remaining 342 m of habitat. WUA relationships for the fish bearing sections of T-Creek and P-Creek were developed by summing the WUA values for all transects at all applicable discharge levels. This created discharge - WUA curves which are illustrated on Figure 4.17 and Figure 4.18 for T-Creek and P-Creek respectively.

The discharge – WUA relationships for T-Creek illustrate that T-Creek habitat suitability for fry rearing and spawning generally decreases with increasing flows. The total wetted area of this section of T-Creek at mean annual discharge (MAD) is in the order of 1650 m^2, assuming a wetted channel width of 4.9 m. Consequently, the modelled WUAs indicate that roughly 10% of the wetted area is suitable for bull trout during MAD and the suitable area decreases steadily with increasing flow.

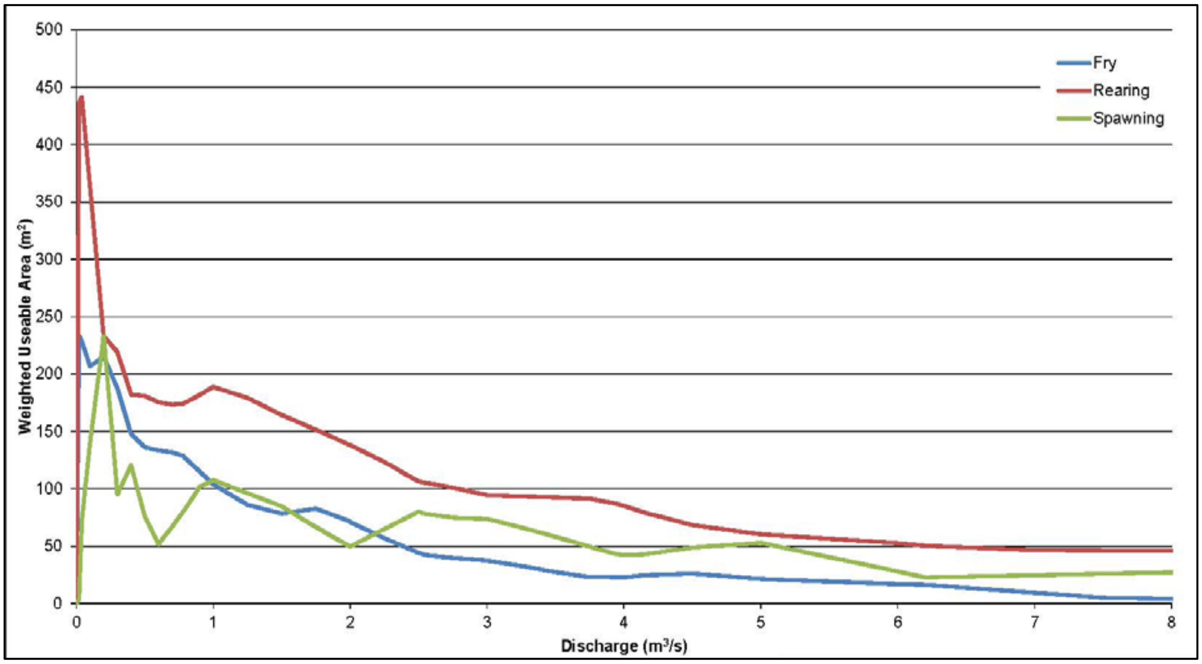


Figure 4.17 Discharge - Weighted Useable Area Curves for T-Creek

The discharge – WUA relationships for P-Creek illustrate that P-Creek habitat suitability for fry and rearing decreases with increasing flows. Habitat suitability for spawning is minimal and suitable habitat is only present for flows greater than 2 m^3/s. The total wetted area of this section of P-Creek is in the order of 1500 m^2 at MAD, assuming a wetted channel width of 3.5 m. Consequently, the modelled WUAs indicate that a large portion of the wetted area is suitable for bull trout fry at very low flows but during all other flow conditions only a small portion of the wetted area is suitable for bull trout in any life stage.

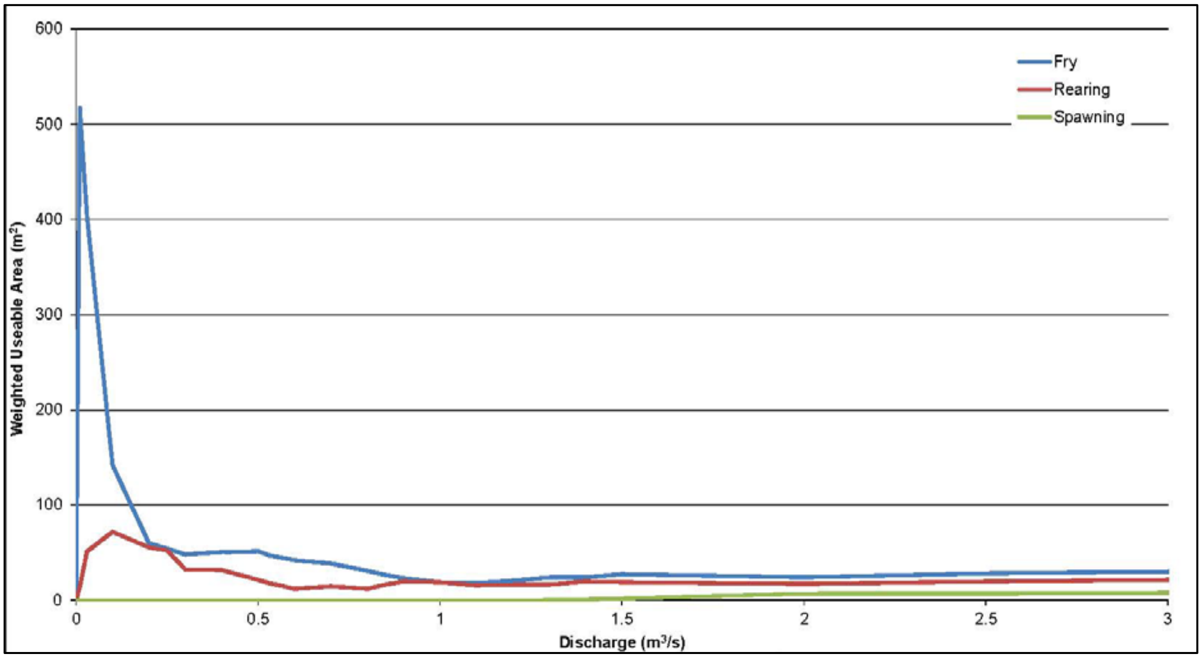


Figure 4.18 Discharge - Weighted Useable Area Curves for P-Creek

4.1.3 Two-Dimensional Model Development

A habitat model was developed using River2D, which is a two dimensional (2D) depth-averaged finite element hydrodynamic model developed at the University of Alberta (Steffler and Blackburn, 2002). This model was selected due to its ability to integrate habitat parameters into the hydraulic model and well documented successful use of the model in rivers with similar morphology.

River2D produces depth averaged velocity vectors distributed through the model domain on the finite element mesh. The model provides high resolution data, but remains a simplification of the channel and is not able to represent small channel features (e.g., micro-scale habitat associated with cobbles, woody debris or abrupt geometry) but does capture meso-scale habitat features such as pools, riffles, glides and runs.

4.1.3.1 Site Description

The reach selected for modelling is a fish bearing section of Harper Creek just downstream of the confluence with T-Creek as shown in Figure 4.9. Data were collected to model approximately 260 m of channel. This reach of Harper Creek is low to moderate gradient (approximately 0.7% at the study site) with pool-riffle morphology and some split-flow sections during lower flows. Typical conditions are shown on Figure 4.19. The model reach is generally representative of the 2 km upstream from the model reach. Tree windfall has contributed relatively high amounts of large woody debris to the active channel and floodplain of these reaches increasing sediment storage, secondary channel and deep pool development, and habitat complexity for fish. The bed material is fluvial gravel and cobbles and includes patches of gravel which are suitable for bull trout spawning. Alder and other vegetation provide cover along the banks and in many cases overhang the banks for roughly a meter.

4.1.3.2 Topographic Survey

In order to adequately model the selected reach, detailed topographic information is required. A topographic survey was performed between July 30 and August 2, 2012 by Bazett Land Surveying and KP. The survey was completed using a RTK GPS system and a total station. The RTK GPS was used to set survey control points in order to geo-reference the survey and to collect data where the sky view permitted. In areas of dense vegetation, the total station was used. A survey report from Bazett is attached as Appendix B1. Data were collected to characterise meso-scale channel features and efforts were focused on geometry up to bankfull elevation. Relatively few points were collected to define overbank conditions. Almost 1,000 topographic data points were collected in the 260 m long model reach.

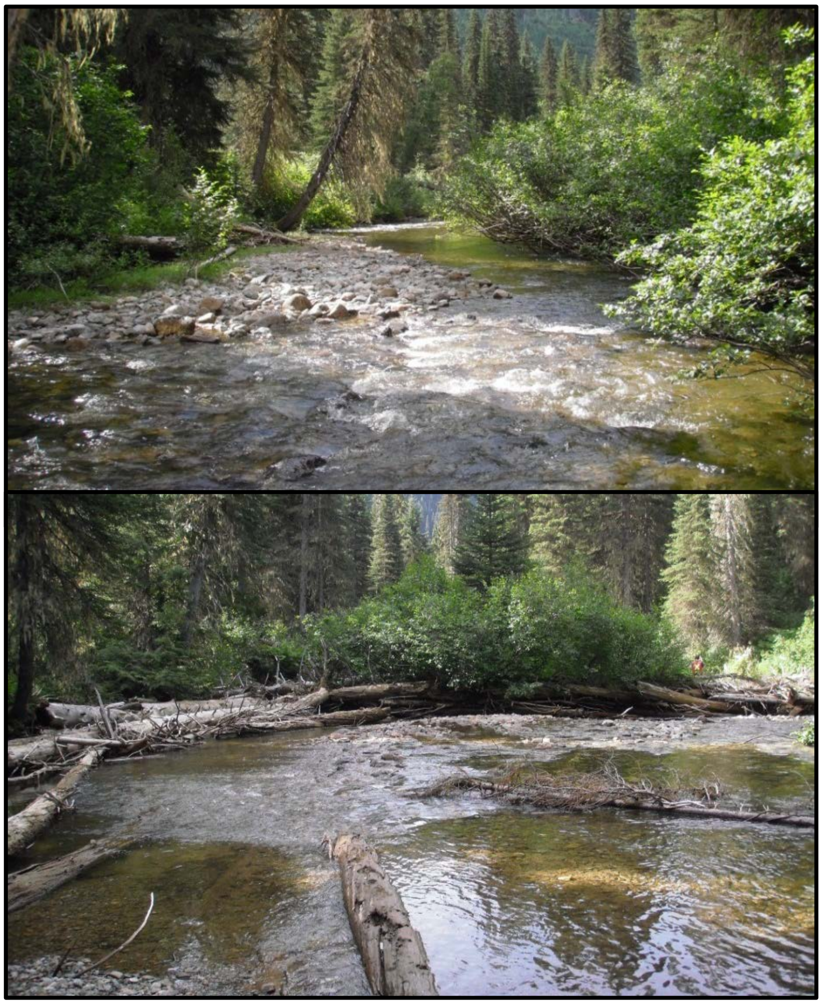


Figure 4.19 Typical Harper Creek Morphology within 2D Model Reach. Both photos are taken looking downstream.

4.1.3.3 Model Development

The River2D model was developed using the topographical survey data to develop a bed elevation file, as shown on Figure 4.20. River2D_Bed was used to define breaklines to join similar survey points to create representative topography throughout the modelled area. Overall, the surveyed dataset was altered very little and additional points where added where necessary to define breaklines along the thalweg, water's edge, riffle crests and toes, and top of bank terrace. River2D_Mesh was then used to create and apply a two-dimensional mesh over the bed elevation file to develop the final model.

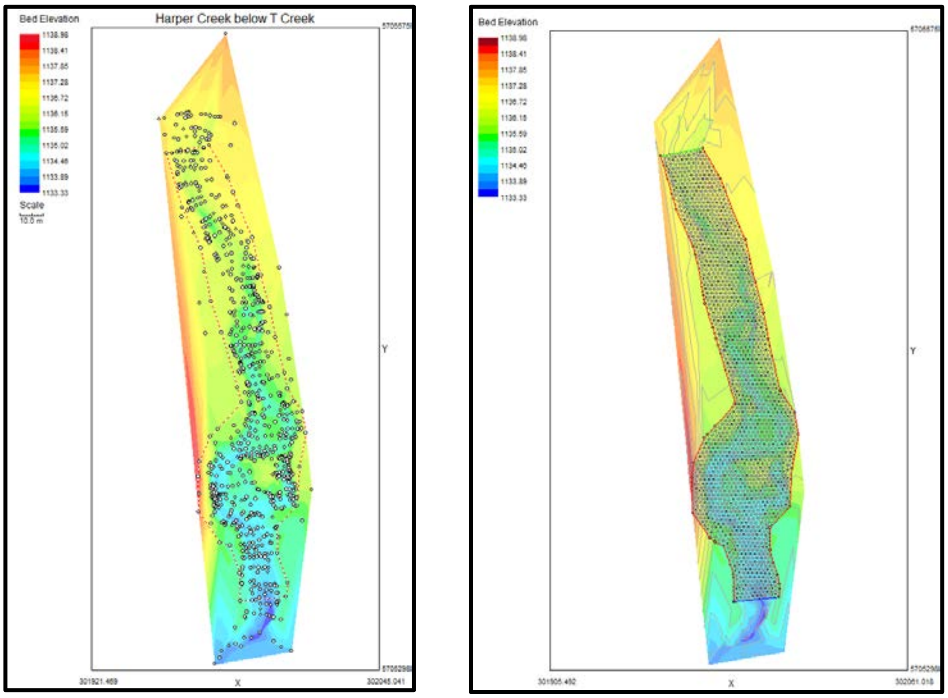


Figure 4.20 River2D Surveyed Nodes and Mesh

The modelled area was selected within the surveyed area where sufficient survey nodes were available to characterize the topography. The boundaries along the edge of the model, running roughly north/south, were designated as no-flow boundaries. The boundary at the top of the model defines the inflow into the model, while the boundary at the bottom defines the outflow water surface elevation.

Channel Index

In the River2D model, channel index values were assigned to the surveyed nodes within the bed elevation file, as shown on Figure 4.21. As in the one-dimensional models, a value of 1 indicated excellent channel suitability, excellent cover, while a value of 0.5 indicated less optimal channel conditions. Channel index values were assigned based on field experience and photos.

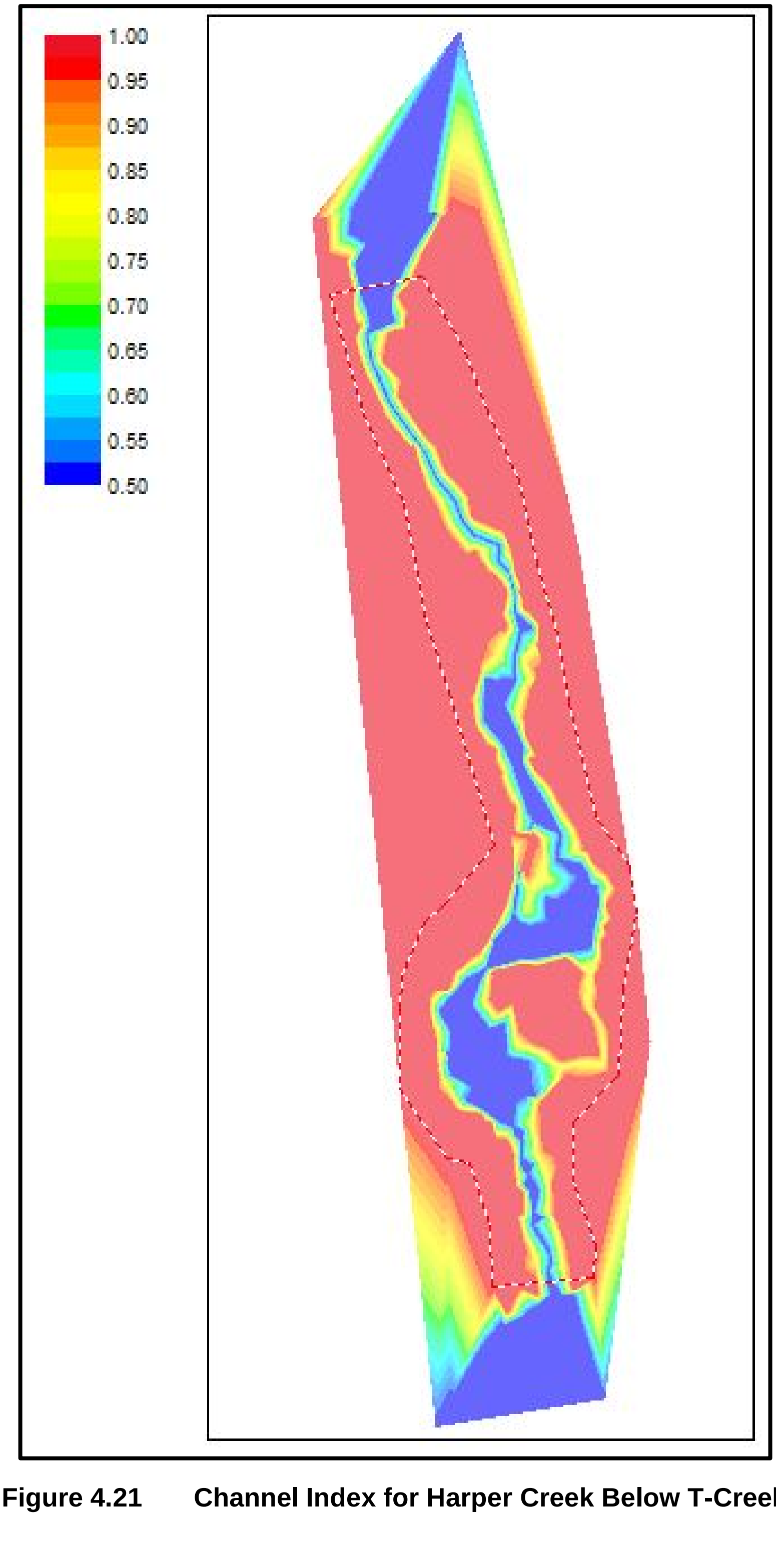


Figure 4.21 Channel Index for Harper Creek Below T-Creek

4.1.3.4 Model Calibration

The model was calibrated to the flow observed during the topographical survey, at which time the water's edge was delineated throughout the model domain. By calibrating to the water surface elevation, flow continuity must be maintained (i.e., if the model has the same flow and similar channel geometry to the observed condition, the velocities must also be similar).

The model was also calibrated to the represent the flow split between two channels in the lower third of the model indicated on Figure 4.22. The entrance to the left bank channel is largely blocked with woody debris and a gravel bar that forces flow into the right bank channel. The left bank channel is predominately backwatered at low flows but active during high flow, and it was important to accurately distribute flow between the two channels.

In addition to the specific points of interest and measurement, six channel cross sections where developed from the surveyed data. Data from three of the six are presented in the report and they are indicated as Section A, B and C on Figure 4.22. The same points where then extracted from the model to compare the model along the cross sections spaced across the model reach. These cross sections provide an indication of how the model is representing the surveyed channel geometry.

Water Surface Elevation Calibration

The bed roughness height parameter, ks, was used to calibrate the model to the observed condition. Millar (1999) suggest that ks values typically range from 5 to 6.8 times the bed material median diameter, D50. A roughness value of 0.85 was found to accurately represent the surveyed water surface data and this value is within acceptable values for streams of this type bed material size. The match between modelled water surface and surveyed water surface elevation is shown on Figure 4.23.

It is also useful to look at the difference between the modelled and surveyed values, the residual, along the stream profile. The residual is plotted on Figure 4.24 and appears to be evenly distributed above and below the centerline. The mean residual is 0.001 m and the standard deviation of this dataset is 0.073 m. These statistics illustrate the strong match between the surveyed and modelled water surface elevation. These values also represent the standard of accuracy the model can be expected to reproduce during validation. Again, the model is not expected to represent perfectly all the individual features that control water surface elevation, but to provide a representative picture.

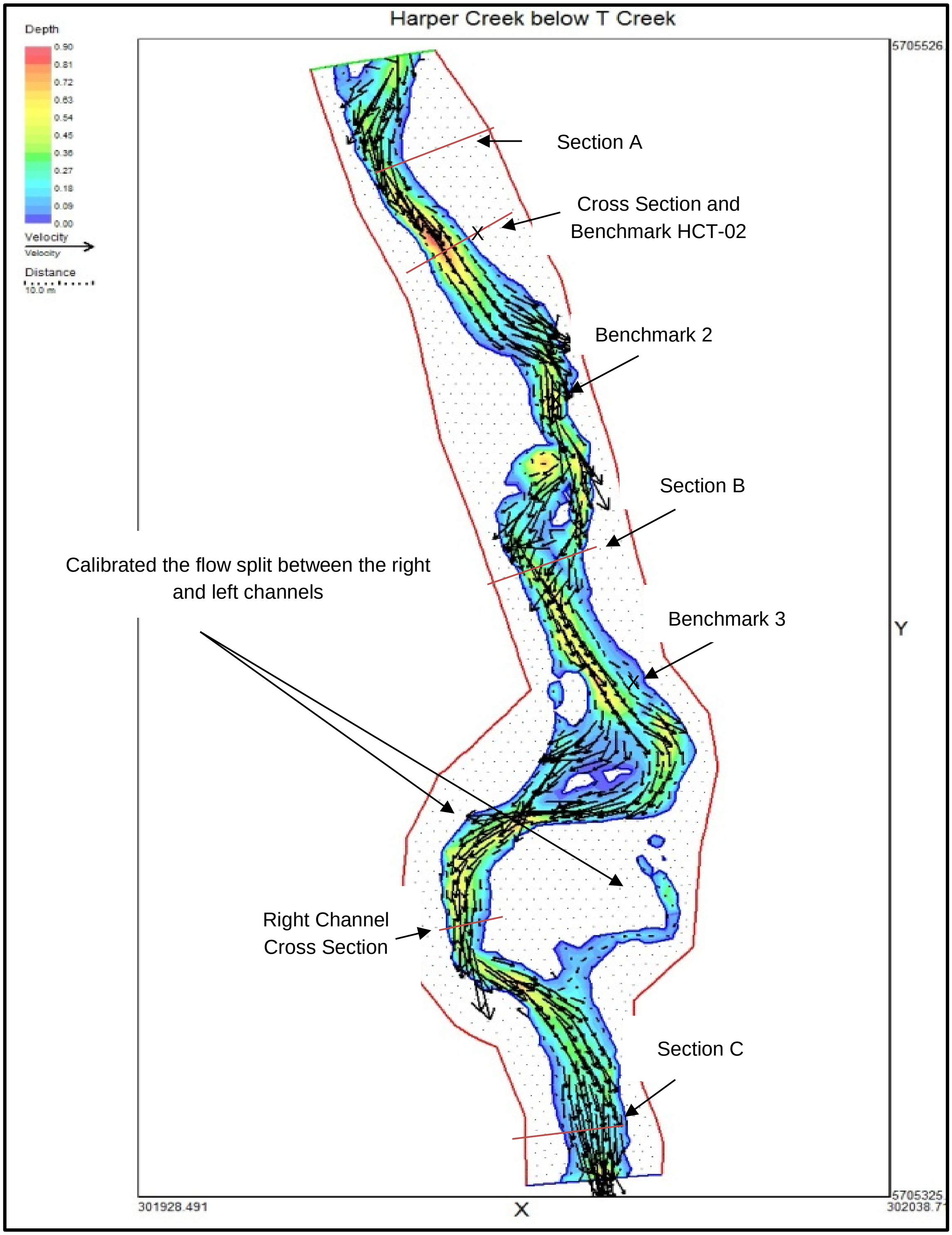


Figure 4.22 River2D Model at Calibration Flow

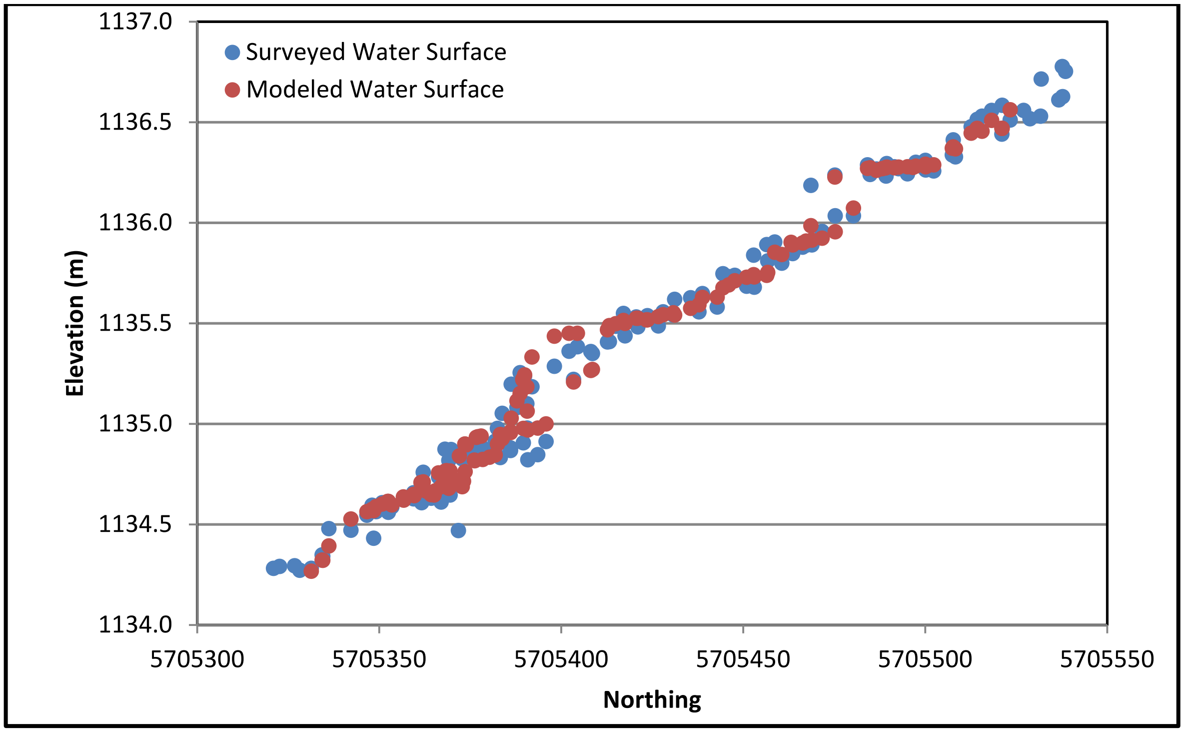
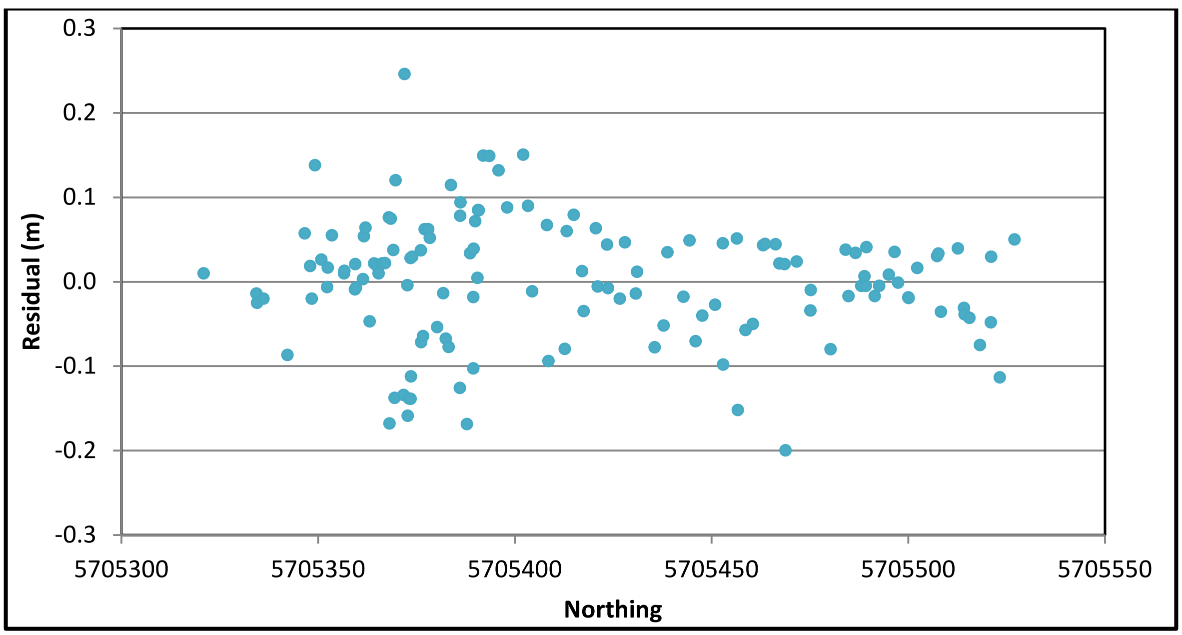


Figure 4.23 Water Surface Elevation Profile Comparison



NOTES:

1. RESIDUAL IS THE DIFFERENCE BETWEEN THE MODELLED AND MEASURED WATER SURFACE ELEVATIONS.

Figure 4.24 Residual Plotted Along the Channel Profile

Flow Split Calibration

The model was also calibrated to the represent the flow split between two channels in the lower third of the model indicated in Figure 4.22. This flow split was accomplished partly through channel topographically and partly through increasing the model's standard groundwater transmissivity value to better represent site conditions. As part of separate work for this Project, Knight Piésold is developing a groundwater model which represents observed groundwater conditions and calibrated to observed surface water conditions. For the groundwater model, a groundwater transmissivitiy of 0.015 m2/s was developed and this value has been used in the surface water model developed here. During the topographic survey, the flow in the right bank channel was measured along with the total flow in the creek. The overall flow was 0.94 m^3/s, while the flow in the right bank channel was 0.80 m3/s. At this calibration flow, the flow in the right bank channel in the model was 0.83 m3/s, a three percent increase; well within the discharge measurement error.

The measured bed elevation, water depth and velocity profile along the right bank channel was compared to modelled results as illustrate in Figure 4.25. The channel where the cross section was measured has a very steep right bank (low chainage value) and a gradual left bank. The model has a hard time reproducing sharp changes in geometry due to the mesh spacing, and as expected, the model doesn't reproduce the right bank geometry perfectly. Due to this difference in bed elevation, the water depth profile doesn't match the measured values along the right bank; however the match along the left bank is very good. Similarly, the velocity profile does not match the measured profile exactly but the magnitude and profile of the modelled velocity provide a representative match to the measured data.

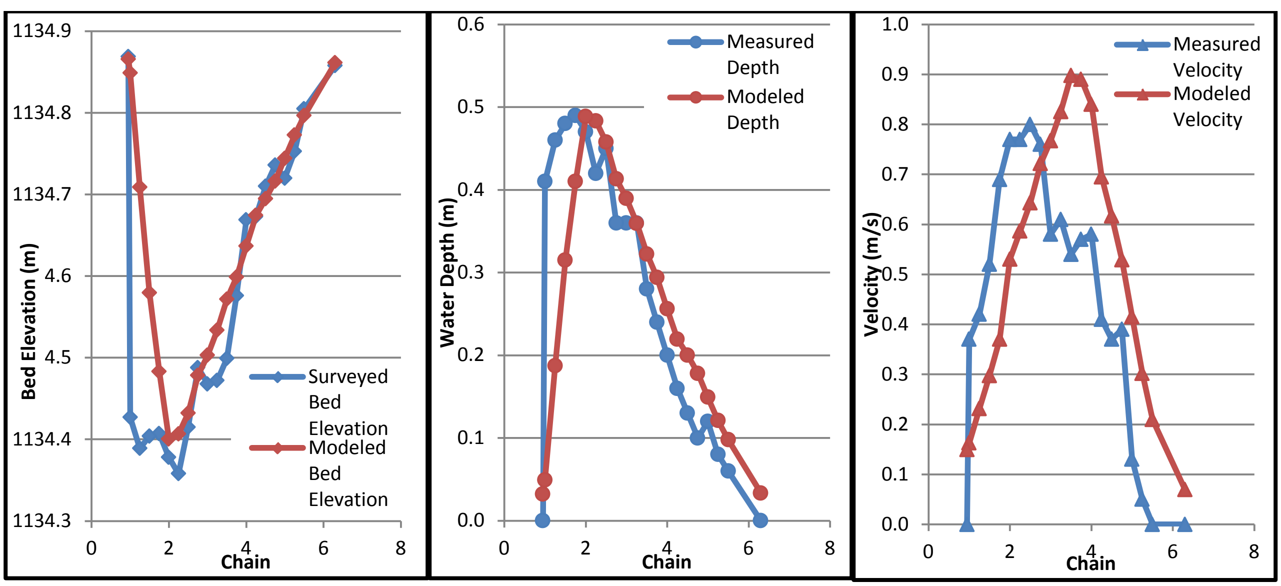


Figure 4.25 Right Channel Cross Section Profiles

NOTES:

1. DEPTH AND VELOCITY MEASUREMENTS WERE TAKEN WITH A FLOW METER AUGUST 2, 2012.

Comparison of Channel Cross Sections

In addition to the specific points of interest and measurement, six channel cross sections where extracted from the surveyed data and the model. These cross sections provide an indication of how the model is representing the surveyed dataset along the modelled reach. The location of the sections is shown on Figure 4.22. Three of the six cross sections are presented here on Figures 4.26 to 4.28. Overall, the cross sections show that the model is accurately representing the bed elevation and water surface elevation throughout the modelled reach.

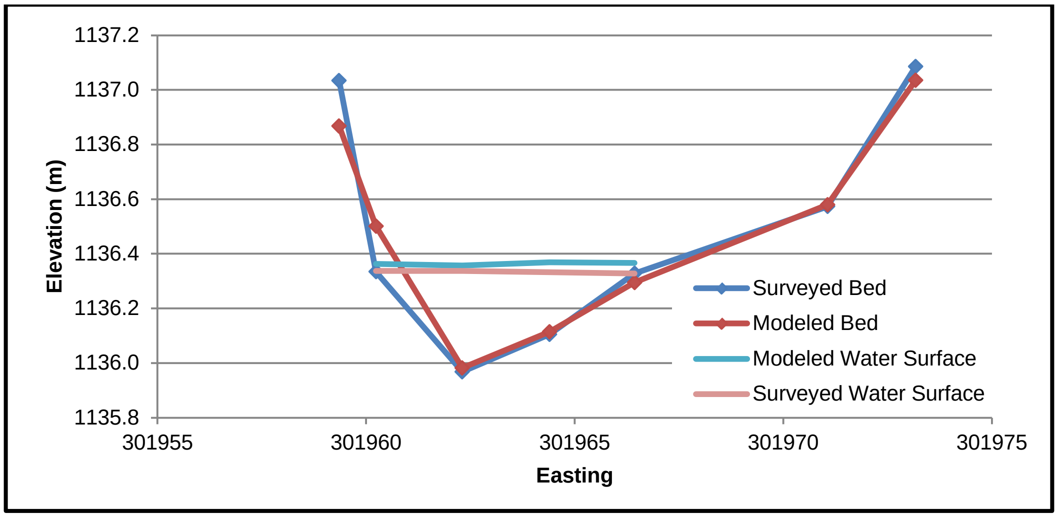


Figure 4.26 Cross Section A

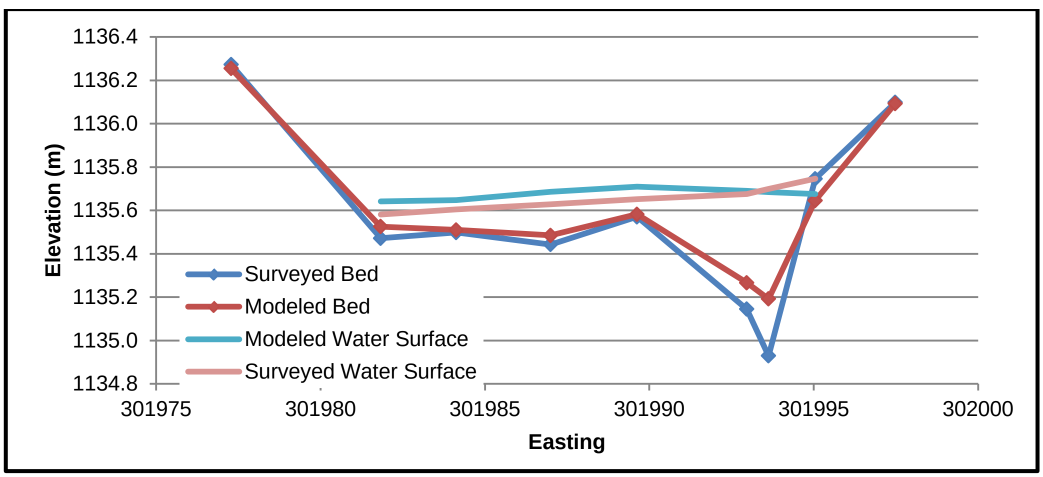


Figure 4.27 Cross Section B

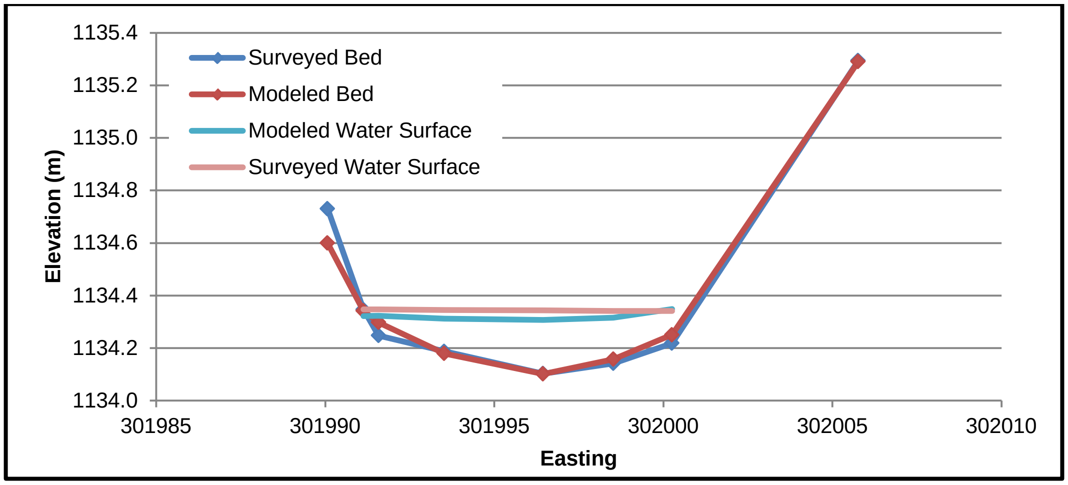


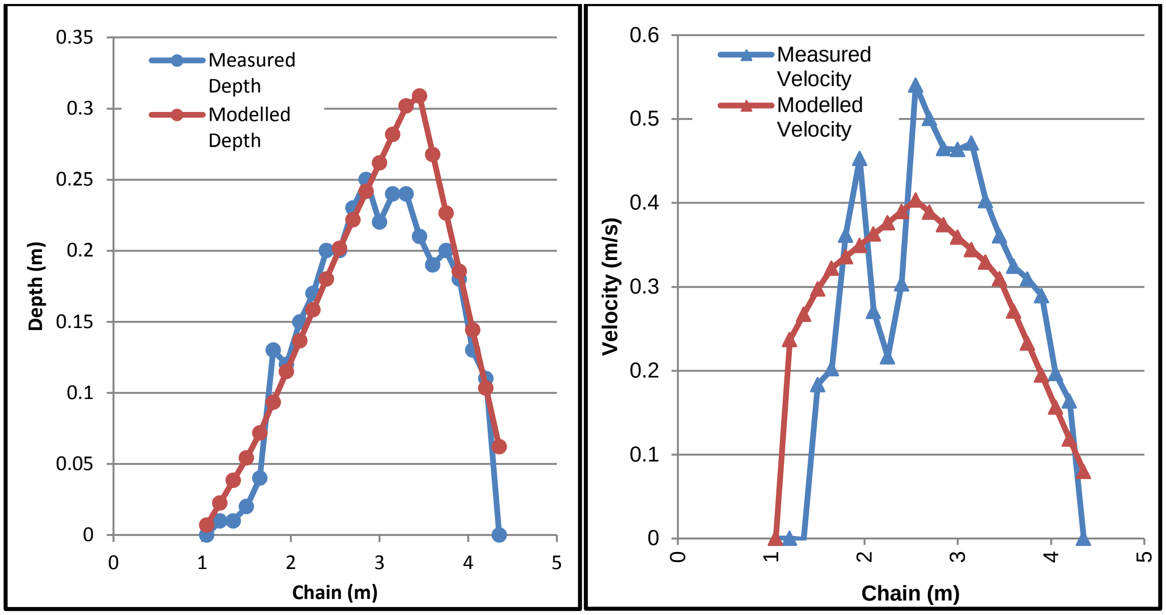
Figure 4.28 Cross Section C

4.1.3.5 Model Validation

The model was validated by running the model at various observed flow conditions and comparing the modelled results to the measured conditions. Depth and velocity profiles were measured at the right channel flow split at two flow conditions and at section HCT-02 at several flow conditions.

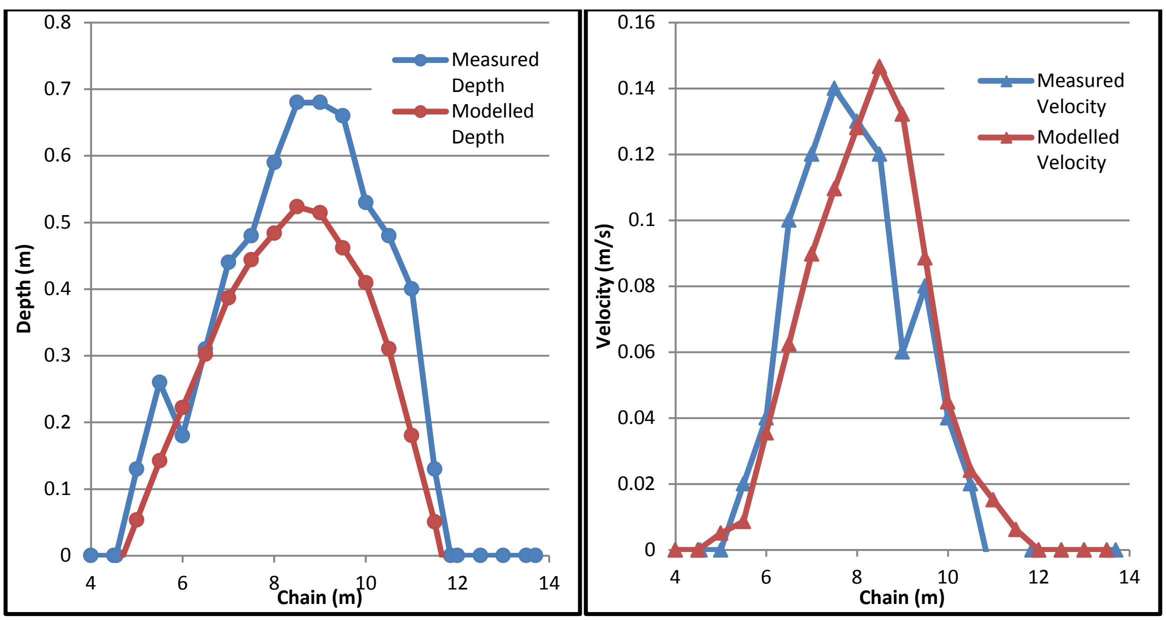
At a discharge of 0.21 m^3/s, roughly 20% of the calibration flow, depth and velocity profiles were measured at the right channel flow split and at the cross section HCT-02. The HCT-02 section consists of two survey pins installed on each bank and is one of many sections used in the one-dimensional modelling described elsewhere in this report. As HCT-02 is within the modelled area, the measurements at this section are used to help validate the model results. The location of HCT-02 is indicated on Figure 4.22.

The measured and modelled depth and velocity profiles show strong similarities in shape and magnitude at both cross sections as shown on Figure 4.29 and Figure 4.30. The model overestimates the water depth and underestimates velocity at the right channel sections, and underestimates depth and overestimates velocity at HCT-02. These differences could be explained by locational influences outside of the scope of the model, like large cobbles creating eddies at such a low flow, however, these differences are well within the expected bounds of the model.



NOTES:
1. DEPTH AND VELOCITY MEASUREMENTS TAKEN WITH A FLOW METER SEPTEMBER 19, 2012.

Figure 4.29 Depth and Velocity Profiles at Right Channel Cross Section (Discharge = 0.21 m^3/s)



NOTES:
1. DEPTH AND VELOCITY MEASUREMENTS TAKEN WITH A FLOW METER SEPTEMBER 14, 2011.

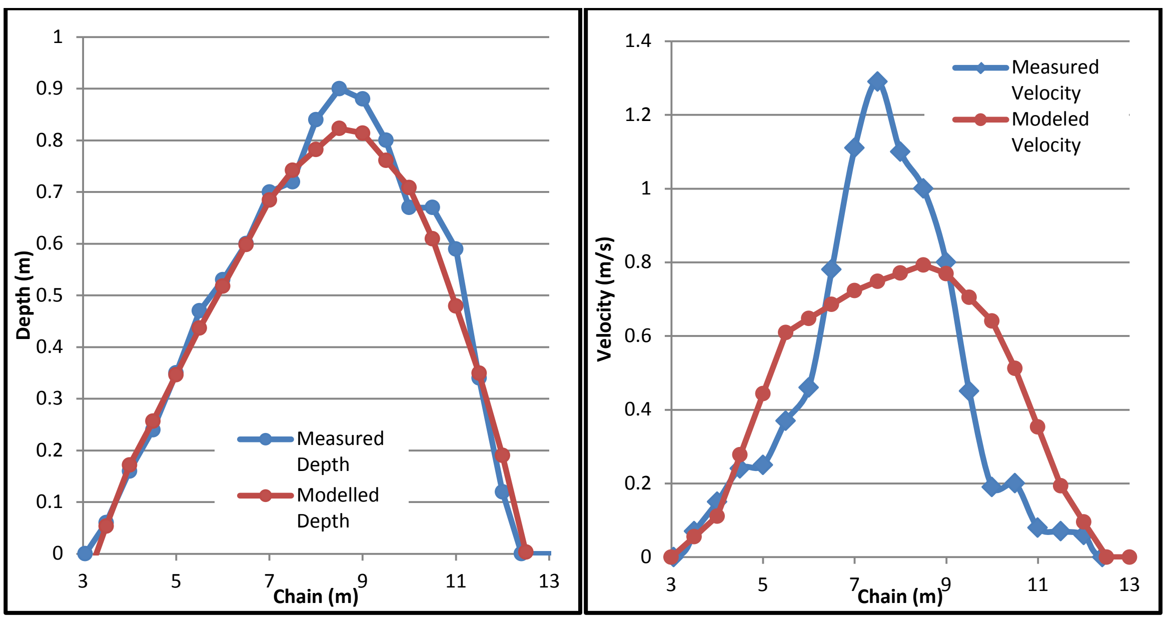
Figure 4.30 Depth and Velocity Profiles at HT-02 Discharge = 0.21 m^3/s)

As a depth and velocity measurement was taken at the right channel cross section, a comparison between the measured and modelled flow was reviewed. The measured discharge in the right channel was 0.18 m^3/s and the modelled discharge is 0.17 m^3/s, indicating that at low flows the model is distributing flow accurately between the two channels.

At a higher discharge of 3.00 m^3/s, over three times the calibration flow, measured and modelled depth and velocity profiles were compared at HCT-02 as shown on Figure 4.31. The model shows strong similarity to the measured water depth; however the modelled velocity profile does not match the measured velocity profile particularly well. The high velocities in the center of the channel and lower velocities along the edges in the measured data are likely due resistance on the banks caused by vegetation, which is not captured in the model.

Water surface elevation was also measured at three benchmarks along the modelled reach: HARP-01,HARP-02 and HARP-03. The water surface elevation surveys where done when the discharge was too high to safely wade the cross sections. Although the benchmarks are located within the modelled space, the exact location of the water surface measurement was not identified. As water surface can vary significantly depending on location and local river features, this difference in location could account for some differences between the modelled and measured values.

The first survey was done at a discharge of 8.08 m^3/s on May 30, 2012. Water surface elevation was measured at all three benchmarks. The difference between the modelled and measured water surface elevation was 0.007 m at HARP-01, 0.139 m at HARP-02 and 0.053 at HARP-03.



NOTES:
1. DEPTH AND VELOCITY MEASUREMENTS TAKEN WITH A FLOW METER MAY 4, 2012.

Figure 4.31 Depth and Velocity Profiles at HT-02 (Discharge = 3.00 m^3/s)

A second survey was done at a discharge of 5.67 m^3/s on July 4, 2012. Water survey elevation was measured at HARP-02 and HARP--03. The difference between the modelled and measured water surface elevation was 0.035 m at HARP-02 and 0.003 m at HARP-03. Overall, the difference in water surface elevation with the exception of the one measurement is within the standard deviation of the calibration water surface elevation series.

The validation result presented in this section suggest that the model does a good job at modelling condition outside the calibration range and indicates that generally the model is producing reasonable and realistic results.

4.1.3.6 Model Sensitivity

The model is run at different flows by defining a discharge at the upstream end of the model and a water surface elevation at the outflow. As the water surface elevation at the outflow isn't known, a "best guess" was developed based a few known water surface/discharge observations and the rating curve of the upstream hydrometric station. A sensitivity analysis was performed to confirm that the effect of this "guess" has on the modelled values.

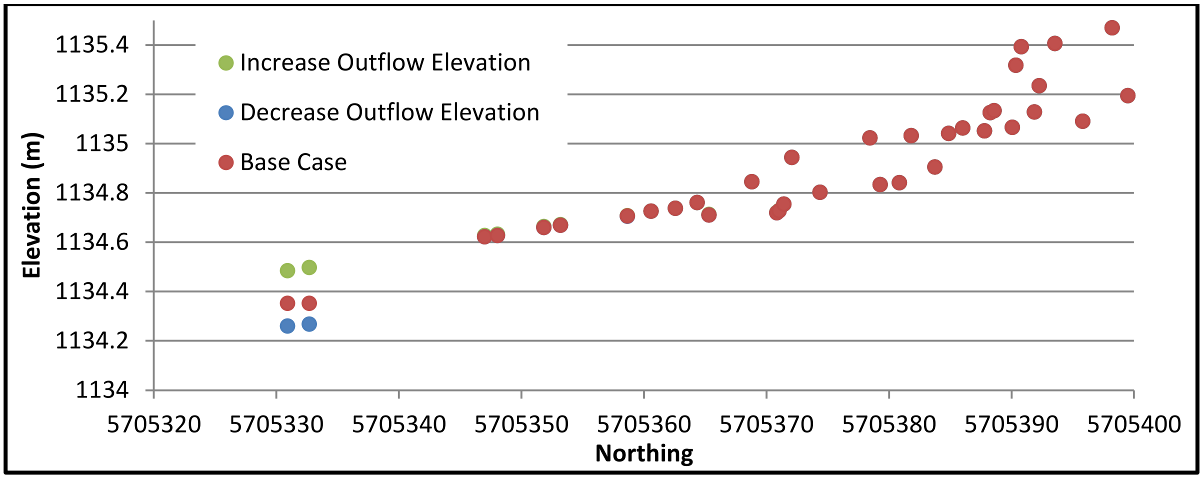
Sensitivity analysis was done by running the model with the initial outflow elevation, then increasing and decreasing the elevation by 0.1 m and rerunning the model. This was done at two flow levels to show the effects at a flow level near MAD and at a higher more extreme flow.

Just above the outflow boundary there is a short riffle crest that is expected to backwater the model. The hypothesis is that this creek feature controls the water surface upstream and the model is not sensitive to the boundary condition.

At a discharge of 1.5 m^3/s the model converged to 0.003 m of difference in water surface elevation within 21 m (measured along the thalweg) when the outflow elevation was increase by 0.1 m. The model converged to identical water surface elevations within 16 m when the outflow elevation was decreased by 0.1 m, as shown on Figure 4.32. This quick convergence indicates that the effect of the choice of outflow boundary condition at mid-range flows is resolved by the model within 25 m of the downstream boundary.

At a discharge of 10 m^3/s, the model converged to 0.003 m difference in water surface elevation within 16 m when the outflow elevation was decreased by 0.1 m.

The sensitivity analysis indicates that the model resolves differences in estimated outflow elevation quickly at a range of flow conditions. The choice of outflow elevation is not expected to influence the modelled results.



NOTES:

1. DATA PLOTTED INDICATE SURVEY POINTS THAT WERE INDICATED TO BE ALONG THE THALWEG OF THE CREEK.

Figure 4.32 Model Sensitivity to Outflow Elevation (Discharge = 1.5 m^3/s)

4.1.3.7 Discharge – Weighted Useable Area Relationships

Once the model is sufficiently calibrated and validated, the model was run at a range of flows to develop a relationship between discharge and weighted useable area (WUA). WUA is a sum of the product of depth and velocity suitability, channel index and cell area within the entire modelled reach. Depth and velocity suitability is calculated in the model by applying the HSI relationships to the depth and velocity values calculated by the model. Separate discharge–WUA relationships were developed for fry, rearing and spawning life stages. The relationships between discharge and WUA for bull trout in the modelled reach of Harper Creek is illustrated on Figure 4.33. For reference, the total wetted area within the model is in the order of 2450 m^2 during mean annual flow.

The discharge –WUA relationships for all life stages have a bi-modal shape. This is driven by the increase in channel cover at higher flows (increased wetted width), and the difference in shapes of the depth and velocity HSI curves. The modelled reach of Harper Creek appears to be better habitat for fry than all other life stages; however rearing habitat appears to be equal in value during flows greater than 2 m^3/s. Spawning habitat sees very little variation in value in comparison to fry and rearing, however the suitability is higher during lower flows which are typical of later August to early September during spawning season.

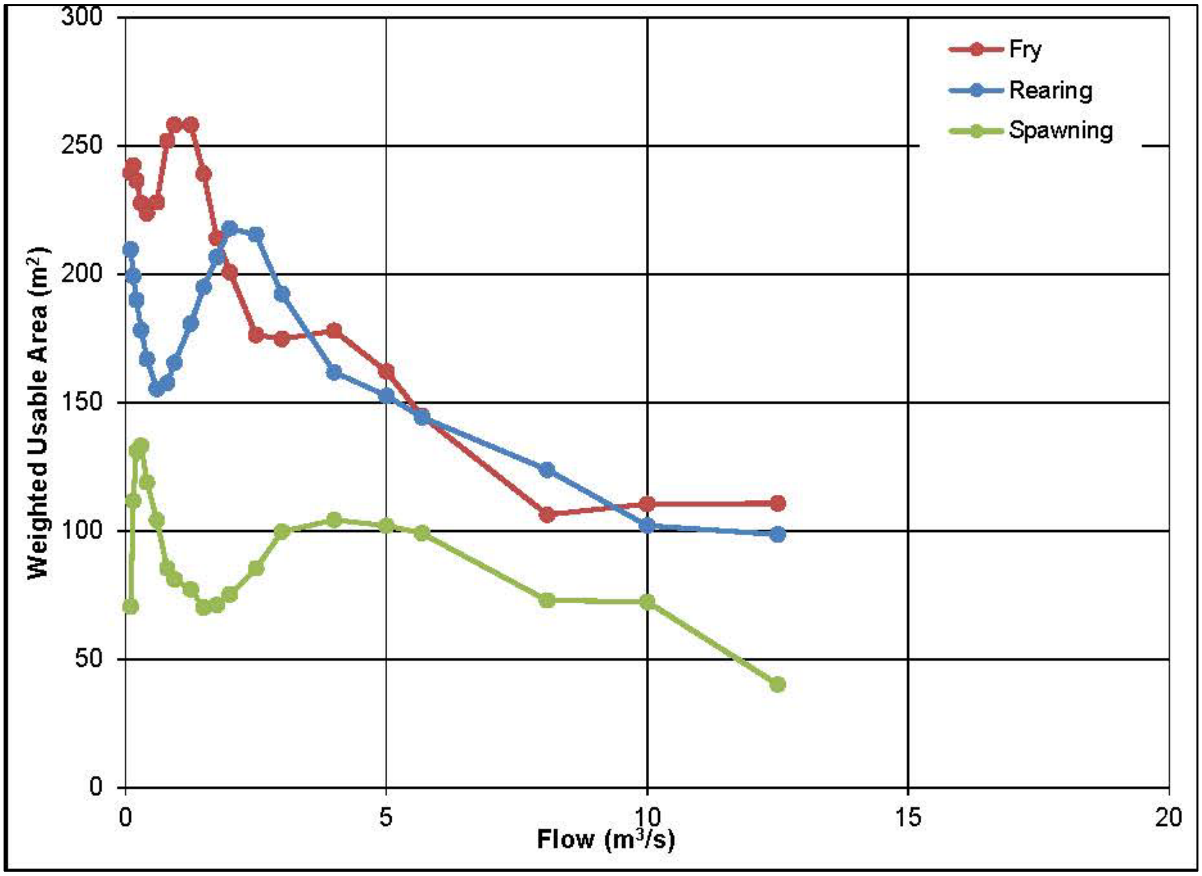


Figure 4.33 Discharge - Weighted Useable Area Relationship for Bull Trout in Harper Creek Below T-Creek

4.2 RESULTS AND DISCUSSION

4.2.1 General

The discharge–WUA relationship was used to assess habitat suitability as a function of flow. In order to develop baseline habitat suitability, the discharge-WUA relationship was applied the 36 year synthetic pre-mine daily flow series. Baseline daily WUA values were calculated for each life stage. Fry and rearing WUA values were calculated for the open water period (approximately May to October), while spawning WUA values were only calculated during the spawning period, August 16 to September 15.

Long term synthetic daily flow series for various mine life stages were used to assess the effects of the instream flow reductions. The discharge-WUA relationships were applied to the flow series for each mine life and results were compiled on a mean monthly basis. As was done for the baseline habitat suitability, bull trout fry and rearing WUA values were calculated for open water months (May to October) while spawning WUA values were calculated from August 16 to September 15.

4.2.2 One-Dimensional Model Results

4.2.2.1 T-Creek

T-Creek pre-mine suitable habitat results show that the T-Creek habitat is most suitable to rearing bull trout, with suitability increasing during the late summer and fall as shown in Figure 4.34. Fry habitat suitability is stable during the open water season. Steady spawning suitability is shown throughout the spawning period.

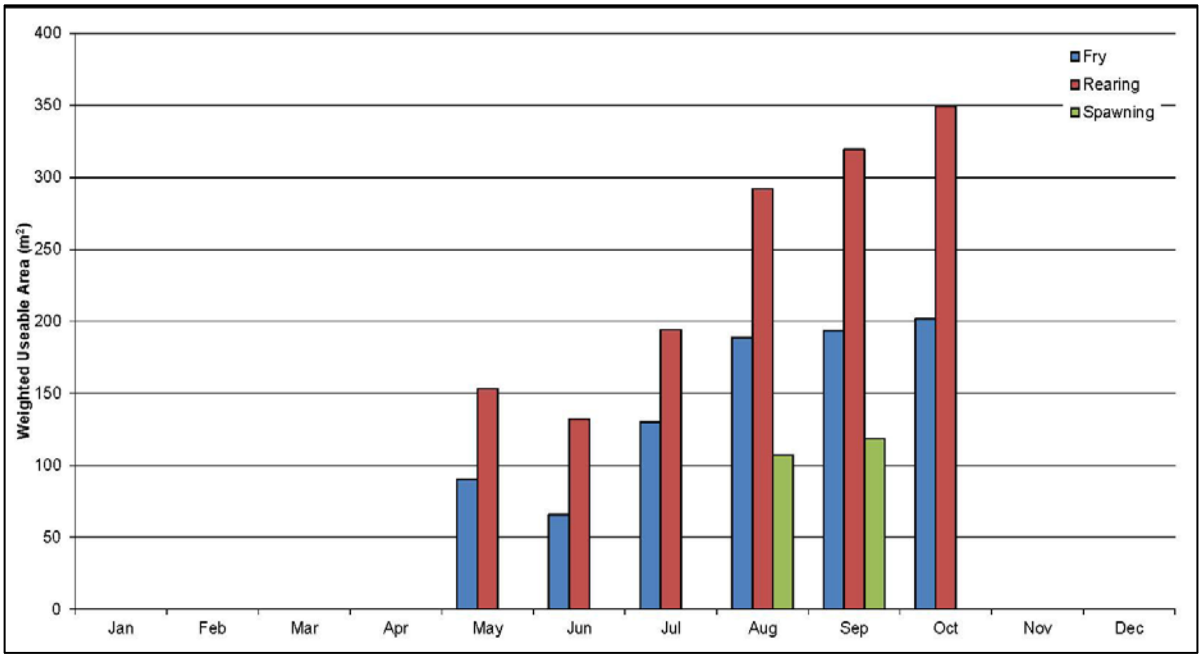


Figure 4.34 Pre-Mine Mean Monthly Weighted Useable Area for T-Creek

Over the LOM, suitable habitat for bull trout fry remains increase above baseline conditions during the spring and early summer (May to July) as shown in Figure 4.35. However, during August and September suitable habitat levels drop below baseline conditions during operations and closure, but post-closure sees levels return to near pre-mine conditions. Figure 4.36 shows habitat suitability for rearing bull trout decrease during mine operations during the fall but increase in the spring and summer. During closure and post-closure, suitable habitat levels return to pre-mine conditions. Similarly, suitable spawning habitat decreases during mine operations but returns to pre-mine levels during post-closure as shown in Figure 4.37. Tables outlining these results can be found in Appendix B2.

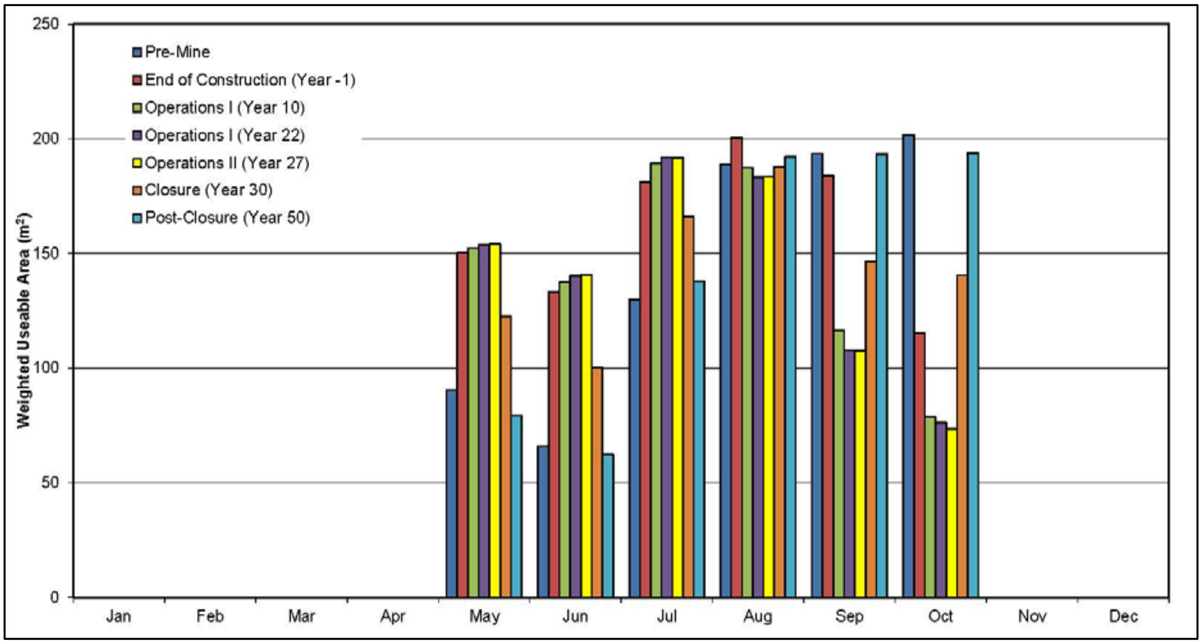


Figure 4.35 Life of Mine Mean Monthly Weighted Useable Area for Bull Trout Fry for T-Creek

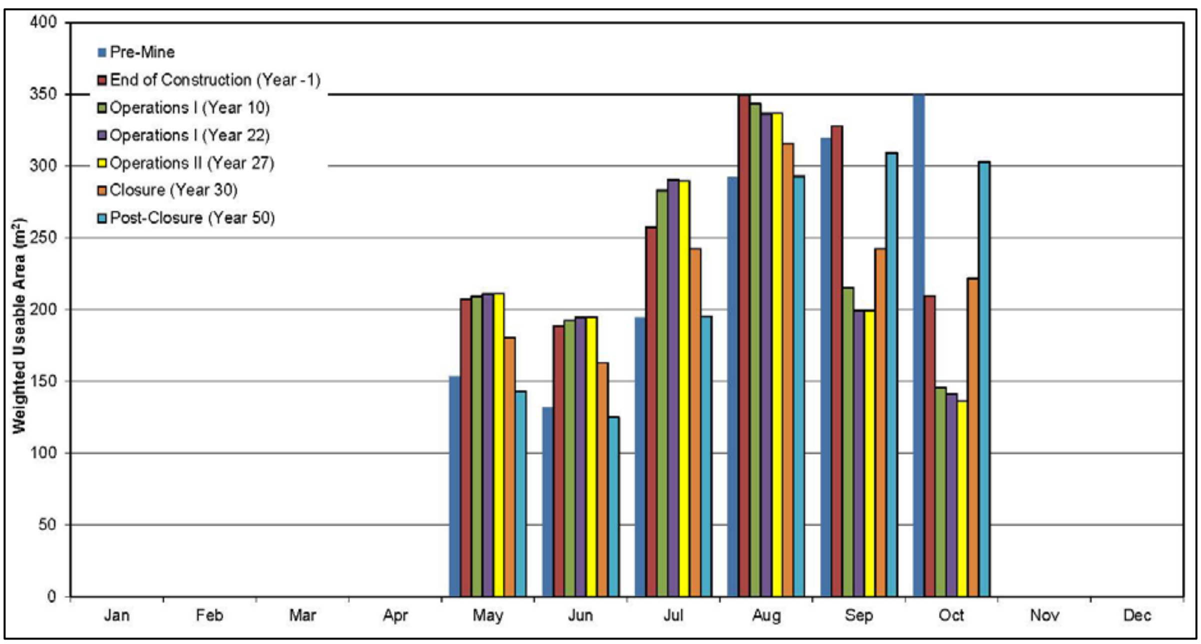


Figure 4.36 Life of Mine Mean Monthly Weighted Useable Area for Rearing Bull Trout for T-Creek

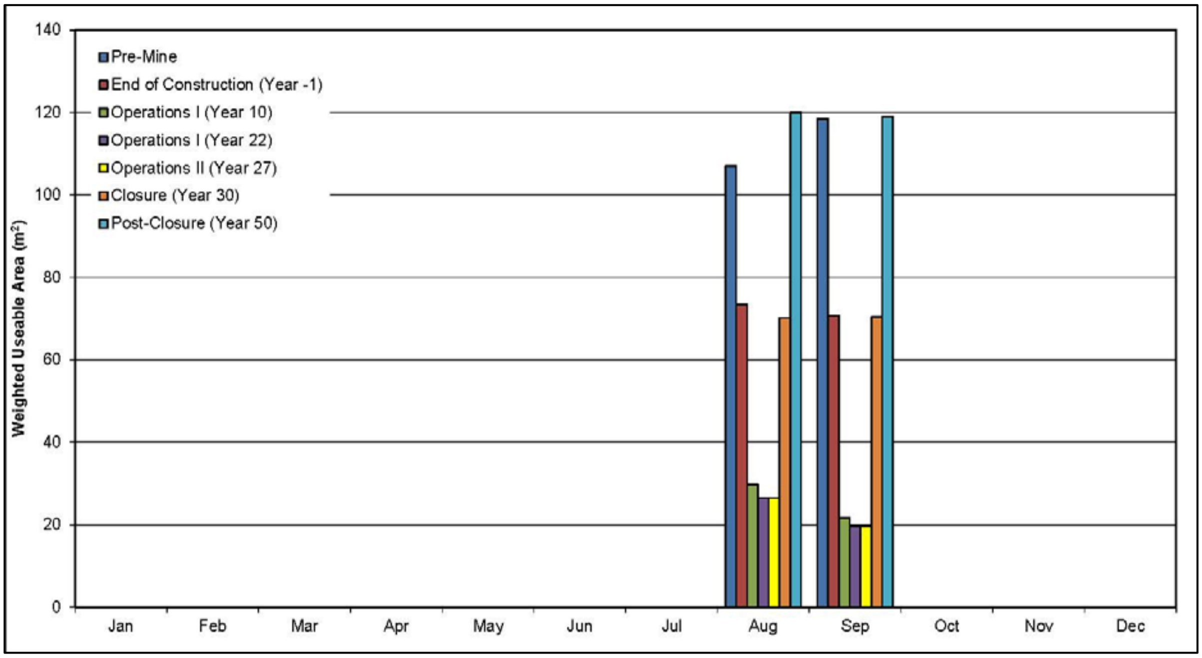


Figure 4.37 Life of Mine Mean Monthly Weighted Useable Area for Spawning Bull Trout for T-Creek

4.2.2.2 P-Creek

The pre-mine habitat suitability for P-Creek illustrates that there is more suitable habitat for bull trout fry than rearing bull trout, with suitability for both life stages increasing during the late summer and fall, as shown on Figure 4.38. P-Creek had very little suitable spawning habitat over the bull trout spawning period.

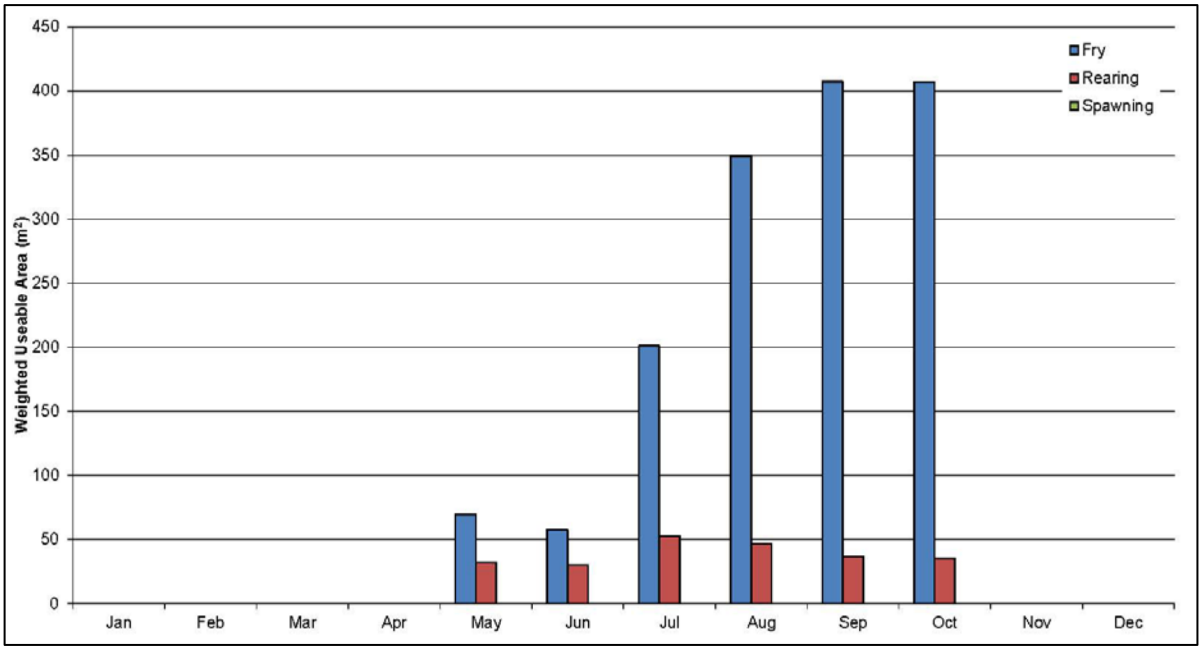


Figure 4.38 Mean Monthly Weighted Useable Area for P-Creek

Over the LOM, suitable habitat levels for bull trout fry increase during May to July during mine operations as shown on Figure 4.39, but decrease in August to October. Suitable habitat area remains depressed during post-closure during the summer and fall. Figure 4.40 shows suitable rearing habitat increases during the spring and early summer but decreases during the late summer and fall during mine operations, closure and post-closure. Minimal spawning habitat is present during pre-mine conditions and no spawning suitable spawning habitat is available during all mine stages as shown on Figure 4.41. Tables outlining these results can be found in Appendix B3.

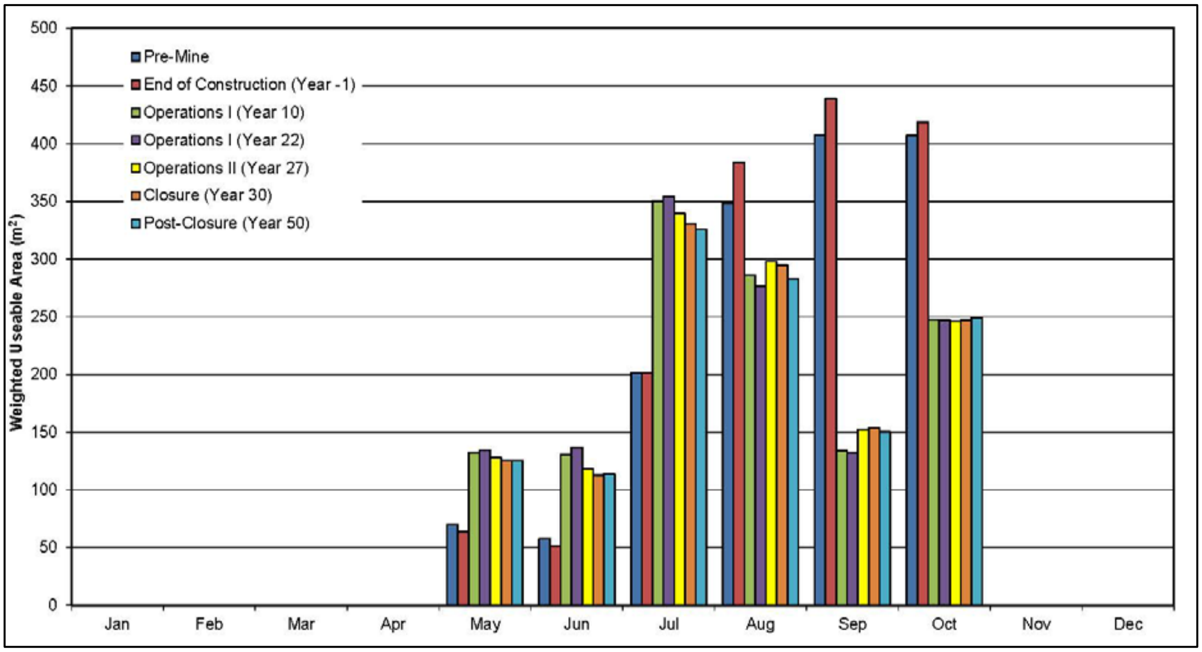


Figure 4.39 Life of Mine Mean Monthly Weighted Useable Area for Bull Trout Fry for P-Creek

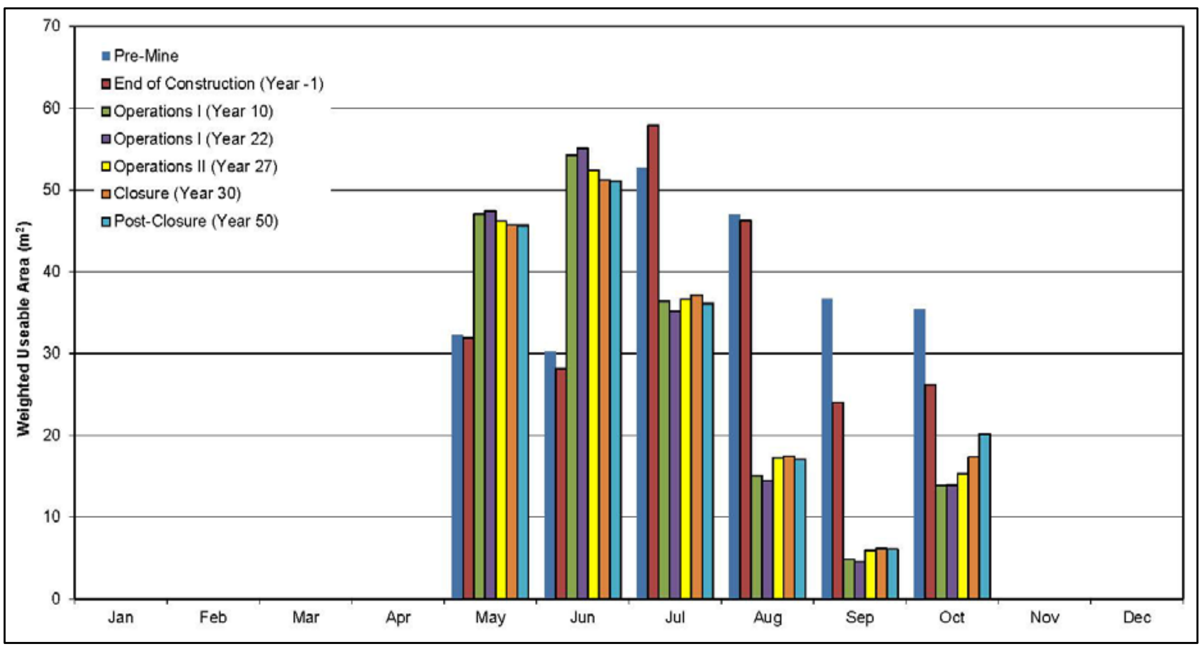


Figure 4.40 Life of Mine Mean Monthly Weighted Useable Area for Rearing Bull Trout for P-Creek

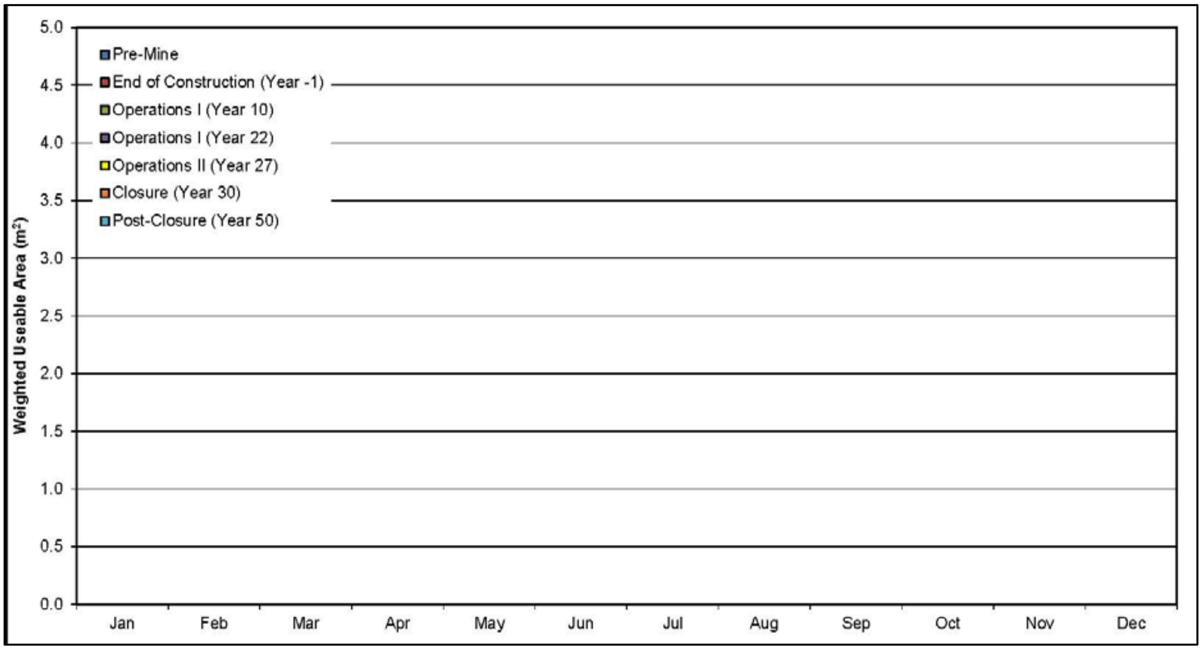


Figure 4.41 Life of Mine Mean Monthly Weighted Useable Area for Spawning Bull Trout for P-Creek

4.2.3 Two-Dimensional Model Results

The pre-mine habitat suitability results for Harper Creek below T-Creek confluence show similar amounts of suitable habitat for bull trout fry and rearing bull trout in the spring, but fry habitat suitability increases in the summer and fall while rearing habitat suitability levels are maintained. Figure 4.42 presents the habitat suitability results for all life stages. Steady spawning suitability is shown throughout the spawning period.

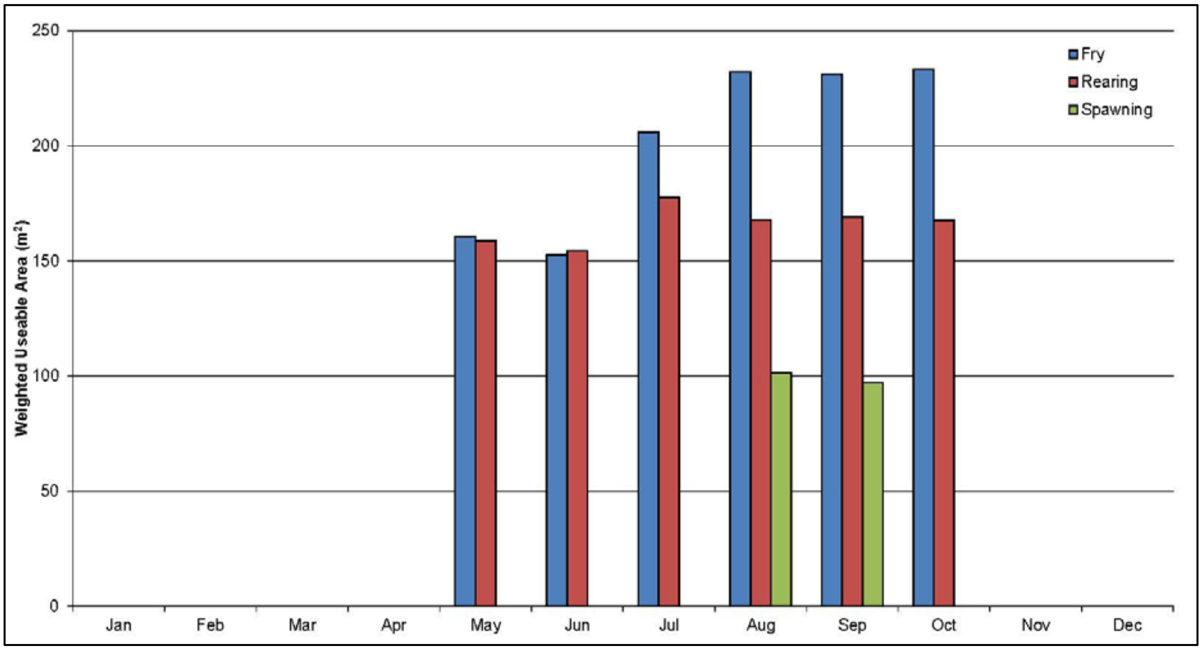


Figure 4.42 Mean Monthly Weighted Useable Area for Harper Creek Below T-Creek

Over the LOM, suitable habitat levels for bull trout fry increase slightly in the spring during operations but are similar during the summer and fall as shown on Figure 4.43. Suitable fry habitat area remains similar to pre-mine area during post-closure. Figure 4.44 shows suitable rearing habitat increases during the spring during operations but returns to pre-mine levels during post-closure in all seasons. Spawning habitat suitability increases slightly in September during operations but levels return to pre-mine during post-closure as shown on Figure 4.45. Tables outlining these results can be found in Appendix B4.

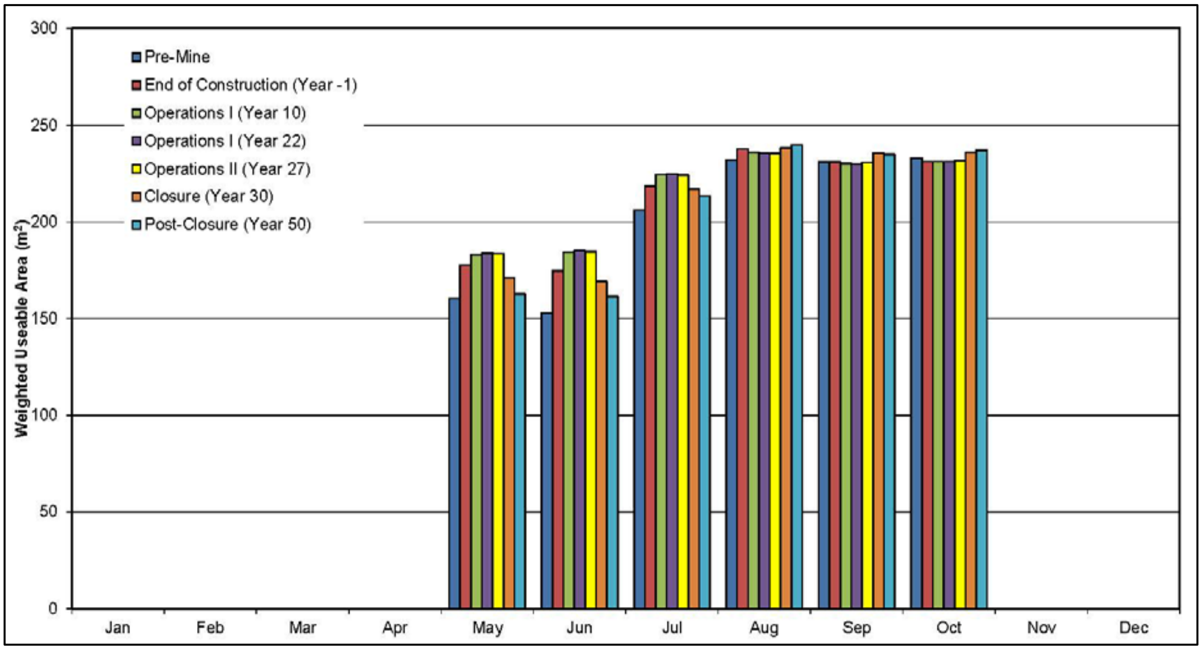


Figure 4.43 Life of Mine Mean Monthly Weighted Useable Area for Bull Trout Fry for Harper Creek Below T-Creek Confluence

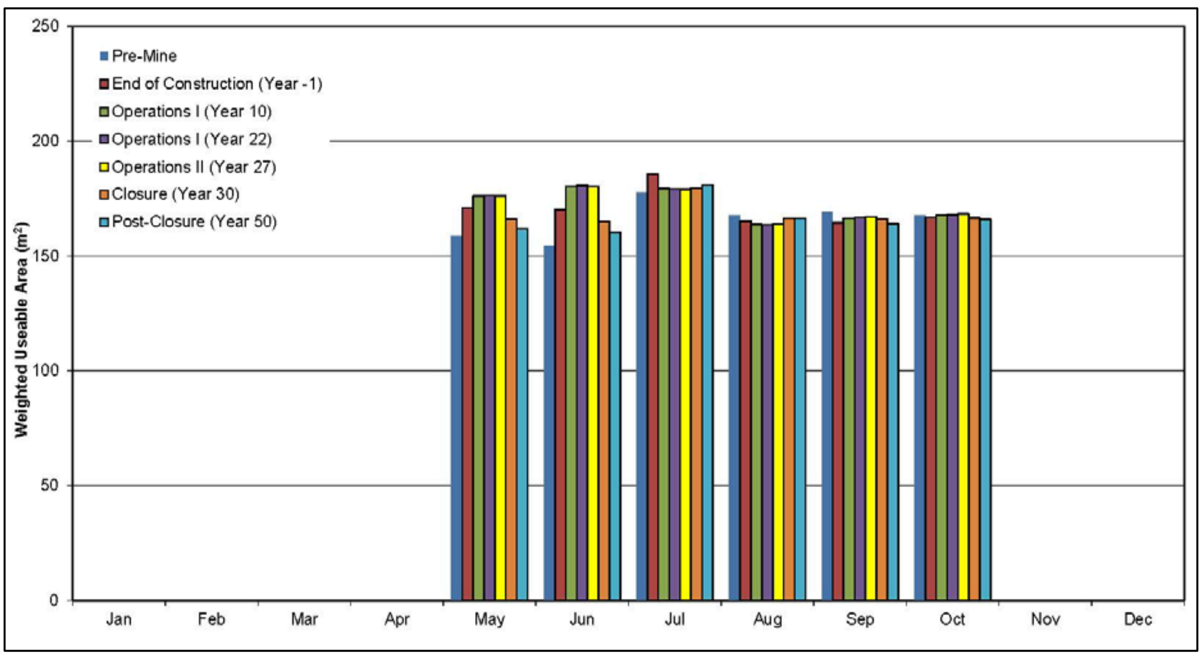


Figure 4.44 Life of Mine Mean Monthly Weighted Useable Area for Rearing Bull Trout for Harper Creek Below T-Creek Confluence

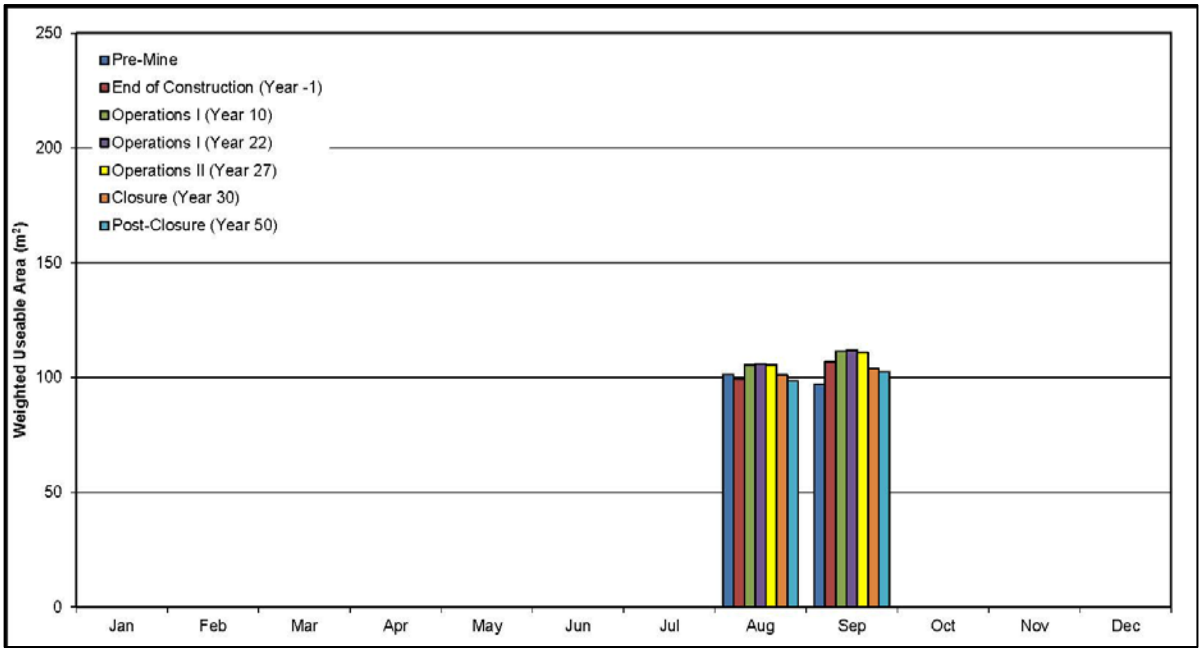


Figure 4.45 Life of Mine Mean Monthly Weighted Useable Area for Spawning Bull Trout for Harper Creek Below T-Creek Confluence

5 – STREAM TEMPERATURE IMPACTS

5.1 GENERAL

Temperature is an important environmental factor in aquatic ecosystems as it plays a pivotal role over biological activity (development, growth and reproduction). Seasonal temperature differences strongly influence the biological activity of aquatic organisms. Increases in surface water temperature beyond diurnal or seasonal averages, have the potential to accelerate embryo development, alter the timing of emergence, growth and downstream migration of juveniles, reduce metabolic efficiencies of food conversion into growth, alter adult spawning migration and spawning timing, increase susceptibility to disease and shift the competitive advantage of salmonids over non-salmonid species (Oliver, 2001).

In order to assess the change in instream flows on the stream temperature, modelling was completed to calculate the magnitude of temperature change predicted.

5.2 GUIDELINES

The water quality guideline for stream temperature in BC recommend an optimum temperature range for salmonids and cold water fish by fish life stage (MOE, 2001). A summary of recommendations for fish species of interest to the Project are presented in Table 5.1 and Table 5.2.

Table 5.1 Summary of Water Quality Guidelines for Temperature for BC

Water Use	Recommended Guideline	
Freshwater Aquatic Life for streams with bull trout and/or Dolly Varden	Maximum Daily Temperature	15°C
	Maximum Incubation Temperature	10°C
	Minimum Incubation Temperature	2°C
	Maximum Spawning Temperature	10°C
Freshwater Aquatic Life for streams with known fish distribution	Change above or below the optimum temperature range by life stage (Table 5.2) of the most sensitive salmonid species present	+/-1°C
	Maximum hourly rate of change	1°C

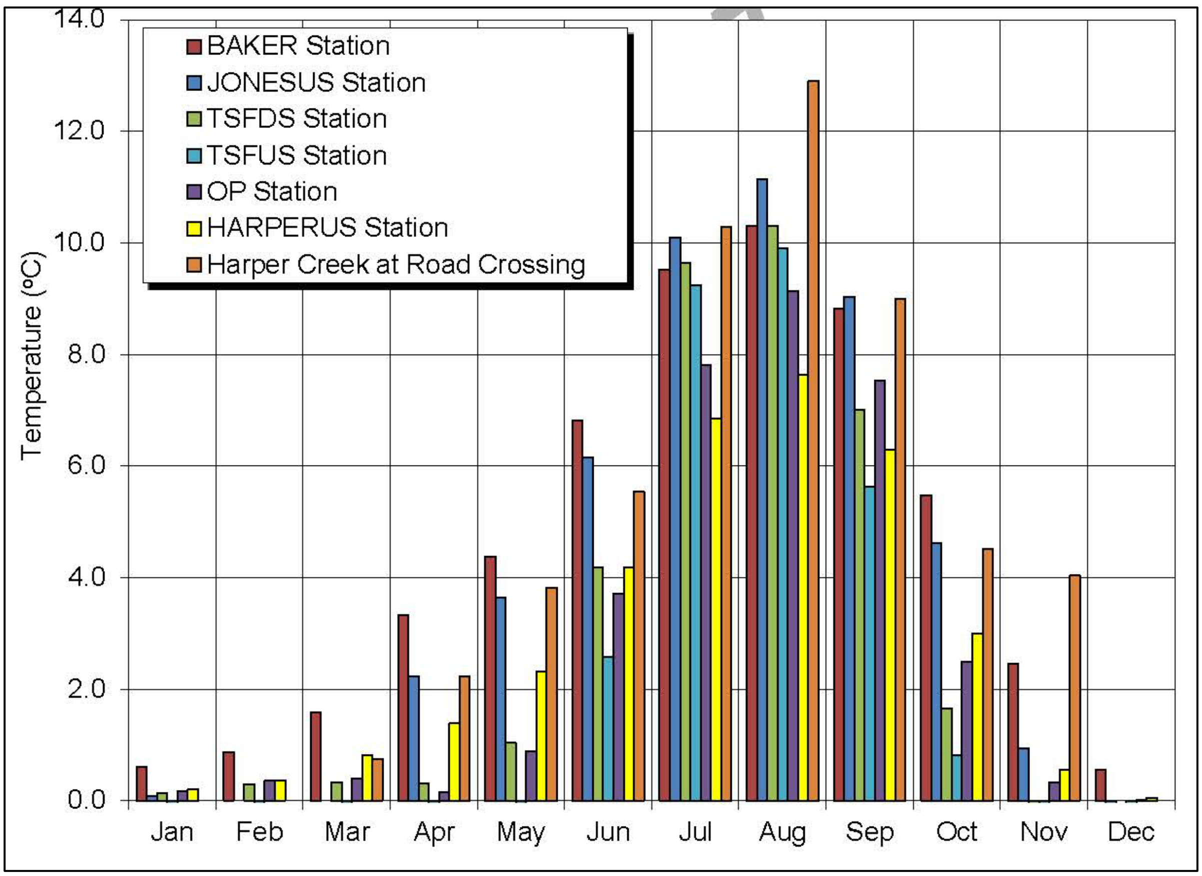
Table 5.2 Optimum Temperature Ranges by Life Stage for BC

Species	Incubation	Rearing	Spawning
Rainbow Trout	10 to 12°C	16 to 18°C	10 to 15.5°C
Bull Trout	2 to 6°C	6 to 14°C	5 to 9°C

5.3 METHODOLOGY

5.3.1 Data Collection Locations

Stream temperature was collected at the HCMC gauging stations during operational periods (i.e., they were typically removed during the winter). In addition, four Tidbit temperature sensors were installed at Project hydrology and water quality stations to collect year round temperature data. The locations of the station are presented on Figure 1.2. A summary of mean monthly temperature is presented on Figure 5.1. Plots of daily temperature data over the period used in this analysis are presented in Appendix C1 for each station.



NOTES:

1. NO DATA ARE CURRENTLY AVAILABLE FOR HARPER CREEK AT ROAD CROSSING STATIONS DURING DECEMBER, JANUARY AND FEBRUARY.
2. ANY RECORDED MEAN MONTHLY TEMPERATURES LESS THAN ZERO ARE SHOWN TO BE ZERO.

Figure 5.1 Mean Monthly Temperature at HCMC Gauging Stations

5.3.2 Stream Temperature Model Development

Temperature variation due to flow reductions was modelled using the Stream Segment Temperature Model (SSTEMP) Version 2.0 developed by the USGS Biological Resource Division (Bartholow, 2002). SSTEMP models stream temperature within a single stream reach for a single time period. The program requires inputs describing the average stream geometry, as well as hydrology, meteorology and stream shading. The model then predicts the mean water temperature at a specified distance downstream.

Model inputs were developed using regional and Project specific data to produce average monthly or average annual values. Six Project reaches were selected to model at the nodes listed below:

- Node 2: Harper Creek above T-Creek confluence
- Node 3: T-Creek at Harper Creek confluence
- Node 5: P-Creek at Harper Creek confluence
- Node 6: Jones Creek above North Thompson River confluence
- Node 7: Baker Creek at North Thompson River confluence
- Node 9: Harper Creek below T-Creek confluence

Each modelled reach is 0.5 km long. The model was run on a monthly time step for the open water months from May through October. Winter months were not modelled as the model isn't suitable for modelling ice covered conditions.

5.3.2.1 Input Parameters for Pre-Mine Modelling

SSTEMP input parameters are divided in four categories: hydrology, stream geometry, meteorology and shade as shown in Figure 5.2.

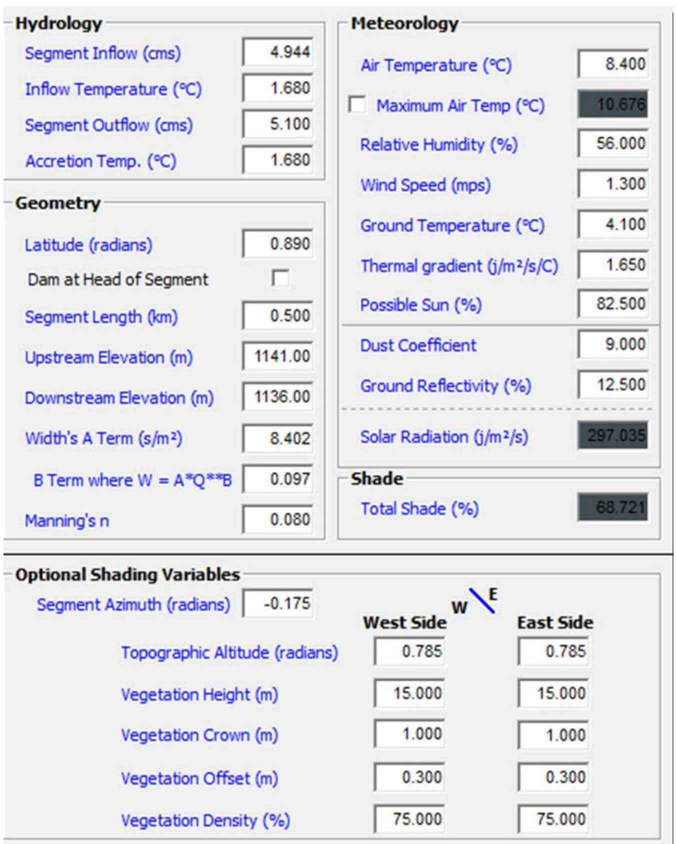


Figure 5.2 SSTEMP Input Screen for Node 9, Harper Creek below T-Creek Confluence

Parameter selection within each category selected is described in detail below.

Hydrology Parameters

Segment Inflow: Mean monthly discharge values from the pre-mine watershed model were used as segment outflow values from the model reach.

Inflow Temperature: Inflow temperatures inputs were developed from the collected data. At Node 9, the only node without a gauging station, the inflow temperature was calculated from the measured temperature at Node 2 and Node 3 and assumed that the two creeks were fully mixed by Node 9.

Segment Outflow: Segment inflow values were scaled by the difference in watershed area from their downstream node.

Accreditation Temperature: In all cases, accreditation temperature was assumed to be the same as inflow temperature. Insufficient groundwater temperature data was available to refine this assumption.

Stream Geometry Variables

Latitude: The latitude of the Project was used in the models.

Segment Length: In all cases a 0.5 km segment was modelled.

Upstream and Downstream Elevation: The upstream and downstream end of each modelled segment was determined from Project maps.

Width A and B Terms: A relationship between wetted width and discharge was developed for each modelled segment using collected field data. The relationship takes the form:

$$\text{Wetted width} = A * \text{Discharge}^{B}$$

Manning's n: A manning's n was defined for each modelled segment using field data and experience

Meteorology Variables

Air Temperature, Relative Humidly and Wind Speed: Mean monthly values were taken from the Hydrometeorology Report (KP, 2013b). Temperature was adjusted to the segment elevation using a standard moist air adiabatic lapse rate of 6.5 C/1000 m.

Ground Temperature: As no ground temperature data was available, mean annual air temperature was used as recommended by the USGS (Barthlow, 2002).

Thermal Gradient: A standard thermal gradient of 1.65 J/m^2/s/°C was used at the recommendation of the USGS (Barthlow, 2002).

Possible Sun: As this parameter is an inverse measure of cloud cover, rough estimation of possible sun was obtained from climate normal: days with precipitation as presented by the Meteorological Services of Canada for Barriere and Vavenby.

Dust Coefficient: This variable represents the amount of dust in the air and a regionally representative value was selected as an annual value.

Ground Reflectivity: An albedo value for leaf and needle forests was selected as an annual value (Barthlow, 2002).

Shade Variables:

Azimuth: The azimuth of each segment was used.

Topographical Altitude: An estimate of topographical altitude was defined from field data, mapping and experience.

Vegetation Height, Crown, Offset and Density: Average values were estimated for all parameters using field experience and typical values.

5.3.2.2 Input Parameters for Operations I (Year 22) Modelling

In order to assess effects on stream temperature due to flow reductions, a monthly model was developed using the same parameters as the baseline model with the exception of inflow and outflow discharge. Inflow discharge values were taken from the synthetic series for Operations I, Year 22. This year of mine life produces the largest flow reduction and is expected to produce the greatest change in instream temperature as a result. Outflow discharge values were scaled from the Year 22 inflow values using the same area proration as was used in the pre-mine case. Although the drainage area at all nodes will be reduced by mine activities, the relative ratio between the inflow drainage area and outflow drainage area will remain the same.

Inflow temperature values were maintained at the pre-mine levels so a change in temperature due to the change in stream flow could be defined. In reality, the inflow temperature would change due the waters travel through the upstream channel. Because of this assumption, the model outputs do not represent an absolute estimate of stream temperatures at each node but rather the temperature change per unit stream length that could be expected.

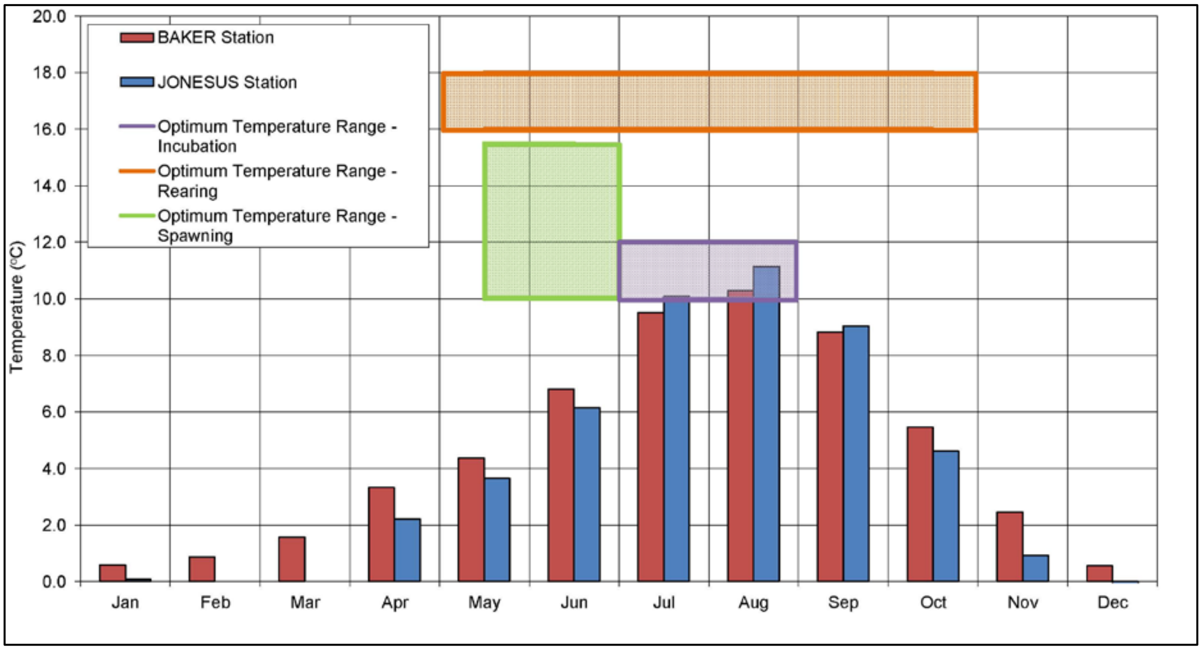
5.3.2.3 Uncertainty Analysis

SSTEMP has the ability to run an uncertainty analysis by running a number of trials varying the input parameters within a user defined range. In order to assess the uncertainty and sensitivity of the model to many of the input parameters, an uncertainty of 25% was applied to all parameters except flow and known values like latitude, elevation and stream azimuth, which were held constant. This analysis provides a 95% confidence interval for the mean outflow temperature.

5.4 RESULTS AND DISCUSSION

5.4.1 Adherence to Guidelines

A comparison of collected temperature to the optimum temperature range for rainbow trout and bull trout are presented in Figure 5.3 and 5.4 respectively. The stream temperature data collected to date in Baker and Jones Creek are well below the optimum temperature range for rainbow trout for rearing and spawning. Stream temperatures for egg incubation are within the optimum range in August for both creeks and just meeting the lower range in Jones Creek in July. A moderately dense population of resident rainbow trout is present in Baker and Jones Creek (KP, 2014c) and likely has adjusted to local water temperature conditions.

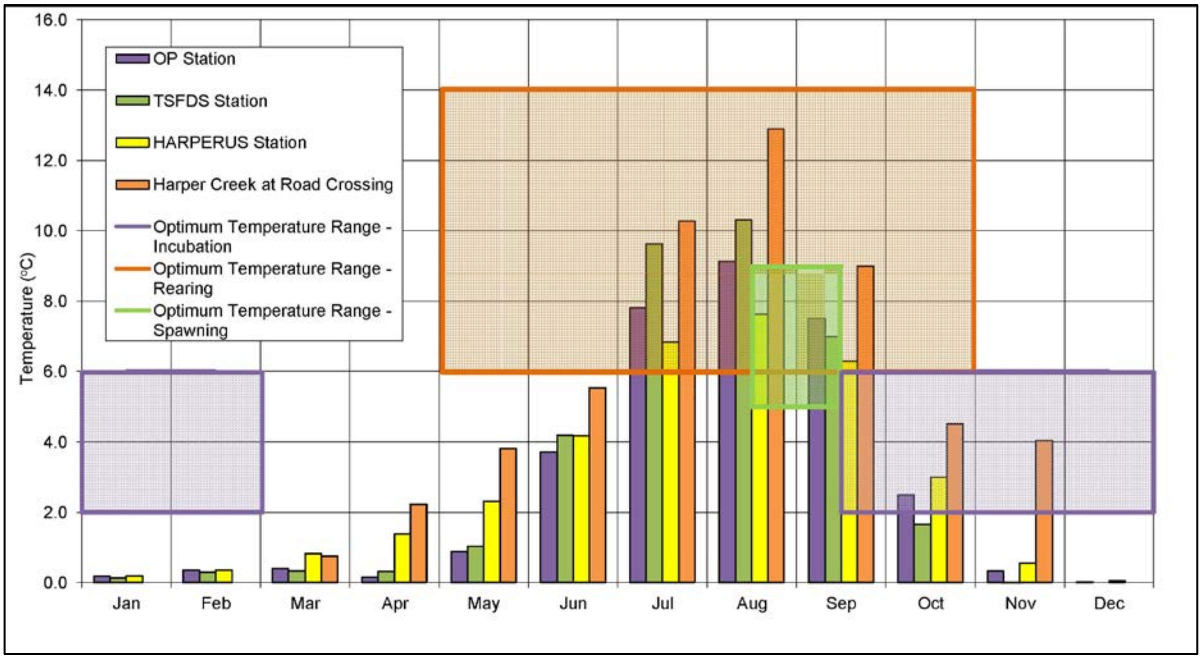


NOTES:

1. NO DATA ARE CURRENTLY AVAILABLE FOR JONES CREEK DURING FEBRUARY AND MARCH.
2. ANY RECORDED MEAN MONTHLY TEMPERATURES LESS THAN ZERO ARE SHOWN TO BE ZERO.

Figure 5.3 Mean Monthly Stream Temperature at JONESUS and BAKER Stations Compared to Optimum Temperature Range for Rainbow Trout

The stream temperature data collected to date in the upper portion of the Harper Creek watershed are within optimum temperature range for bull trout egg incubation during the fall but drop below the range through the winter. The lower Harper Creek stream temperatures are above the optimum range during the beginning of the egg incubation period, are within the range during the late fall and drop below the range in the winter. Data collected during the rearing period falls within the optimum range during the middle of the rearing period but the stream temperatures are cooler than the optimum range during the spring and late fall. Stream temperatures in upper Harper Creek fall within the optimum range for spawning but temperatures in lower Harper Creek are warmer than the specified range. Stream temperatures in T-Creek and P-Creek are warmer than the optimum rearing range in July, August and September. Bull trout are a cold water adapted species and Upper Harper Creek is populated with bull trout (KP, 2014c).



NOTES:

1. NO DATA ARE CURRENTLY AVAILABLE FOR HARPER CREEK AT ROAD CROSSING STATIONS DURING DECEMBER, JANUARY AND FEBRUARY.
2. ANY RECORDED MEAN MONTHLY TEMPERATURES LESS THAN ZERO ARE SHOWN TO BE ZERO.

Figure 5.4 Mean Monthly Stream Temperature at OP, TSFDS, HARPERUS and Harper Creek at Road Crossing Stations Compared to Optimum Temperature Range for Bull Trout

Lastly, an important difference exists between then stream temperature data collected and the stream temperatures likely experienced by resident fish. The temperature data collected represents near surface stream temperatures and trout will likely seek out areas of the creek bed where groundwater inflows are warmer than surface waters during the winter, particularly for key incubation sites. Our data does not capture temperatures near the stream bed that may be warmer during winter.

5.4.2 Predicted Temperature Change

5.4.2.1 Comparison of Collected Temperature Data

In order to assess the rate of temperature change seen at the Project site, a review of temperature change over stream length from the collected data was completed. Figure 5.5 shows the difference in monthly temperature recorded at TSFDS and TSFUS over the 2011 and 2012. Also shown on this figure is the rate of temperature change per kilometer for the roughly 3 km reach between the two stations. This results in an annual average temperature change rate of 0.26 °C/km in T-Creek. The rate of temperature change is highest during the spring and fall and lowest during the summer.

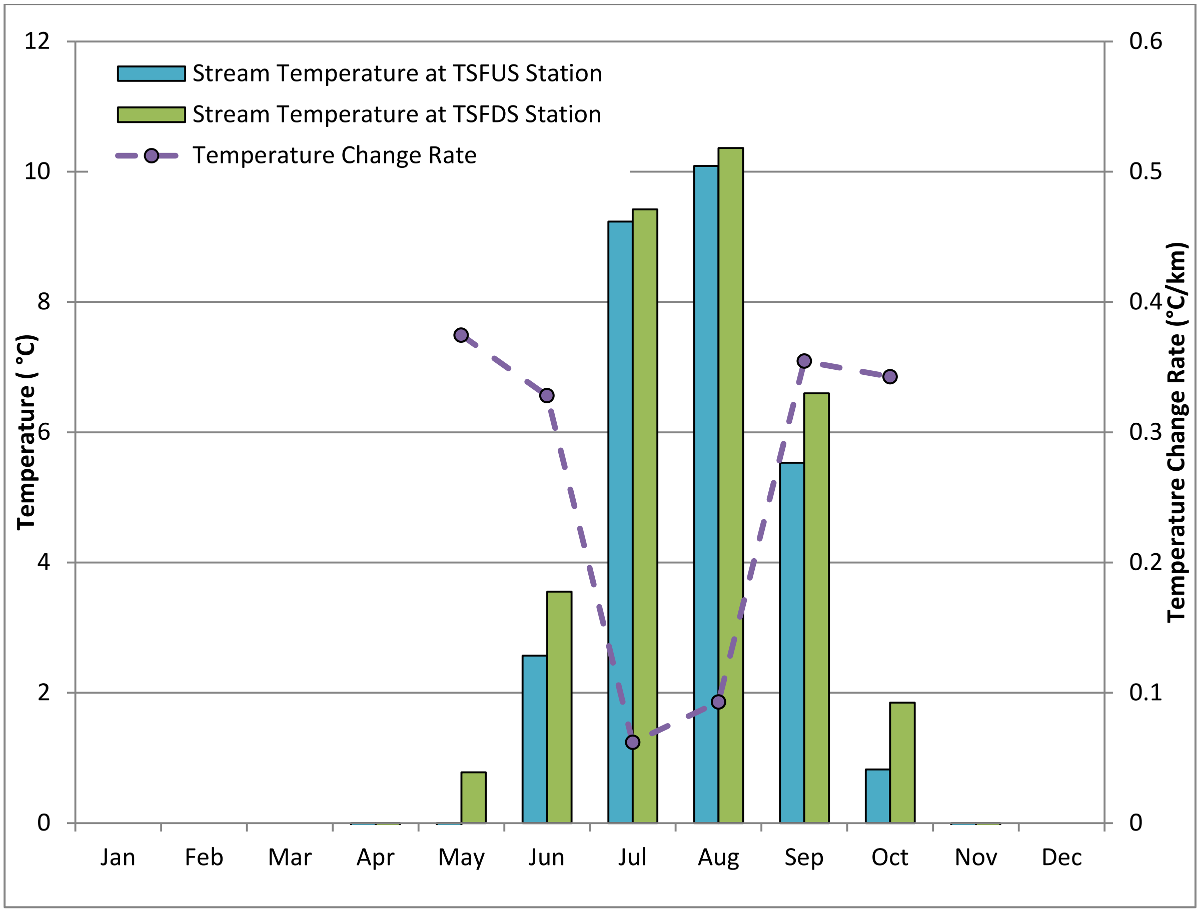


Figure 5.5 Concurrent Mean Monthly Temperature Data at TSFUS and TSFDS Stations

Similar results were developed for the reach between HARPERUS Station and Harper Creek at the road crossing for 2012 and shown in Figure 5.6. Also shown on this figure is the rate of temperature change per kilometer for the roughly 17 km reach between the two stations. The annual average temperature change rate in Harper Creek is 0.14 °C/km and this stream section includes the influence of T-Creek. Interestingly, the rate of temperature change shows the inverse relationship to T-Creek, with the greatest rate of change occurring in the warm summer months and lower rates of change occurring in the spring and fall.

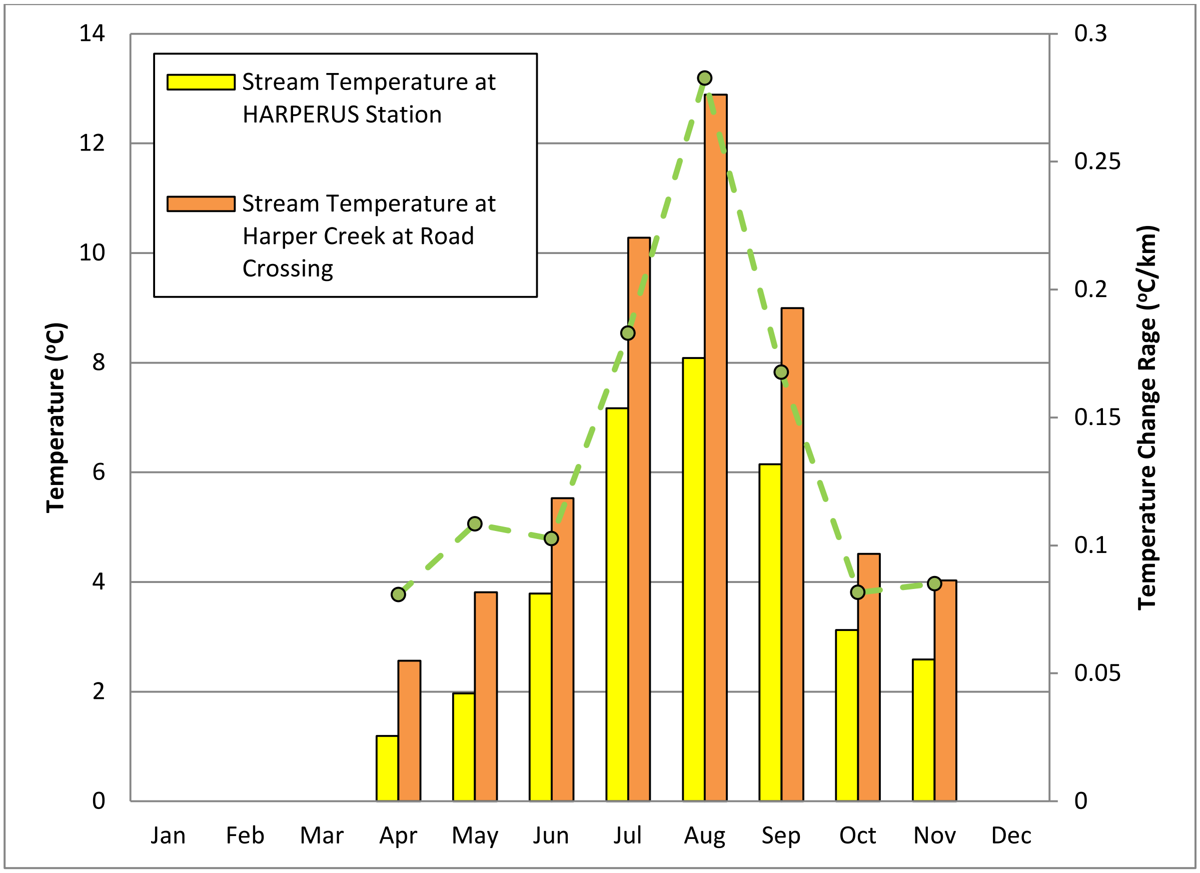


Figure 5.6 Concurrent Mean Monthly Temperature Data at HARPERUS and Harper Creek at Road Crossing Stations

5.4.2.2 SSTEMP Model Results

Using these hydrology values and other meteorology, geometry and stream shading parameters, STTEMP predicted a mean monthly outflow temperature for each stream segment for pre-mine conditions. These values show that water temperature generally increases over the modelled reaches year round. Stream temperature in Harper Creek increase between 0.01°C and 0.07°C over the modelled reach, while stream temperatures in the tributaries increase by roughly 0.2°C to 0.6°C over the 0.5 km modelled reach. These values give a rate of temperature change per kilometer of almost double those shown in Section 5.4.2.1. Table 5.3 presents results for Node 9, Harper Creek below T-Creek confluence. Results for all modelled nodes are presented in Appendix C2.

Table 5.3 Harper Creek Streamflow Temperature Model Summary at Node 9, Harper Creek Below T-Creek Confluence

Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	1.66	3.79	7.71	8.42	6.48	2.78
	Predicted Outflow Temperature (^oC)	1.70	3.83	7.76	8.49	6.53	2.79
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.65 - 1.75	3.72 - 3.93	7.52 - 7.99	8.25 - 8.74	6.35 - 6.72	2.70 - 2.88
	Temperature Increase over Reach (^oC/)	0.04	0.04	0.05	0.07	0.05	0.01
Operations - Year 22	Change in Flow from Pre-Mine (%)	-32%	-40%	-37%	-32%	-33%	-20%
	Inflow Temperature (^oC)	1.85	3.83	7.00	7.93	6.46	2.97
	Predicted Outflow Temperature (^oC)	1.90	3.88	7.07	8.02	6.51	2.97
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.84 - 1.96	3.76 - 3.99	6.87 - 7.27	7.77 - 8.27	6.29 - 6.72	2.89 - 3.05
	Temperature Increase over Reach (^oC)	0.05	0.05	0.07	0.09	0.05	0.00
Temperature Change Rate Due to Flow Changes (^oC/km)		0.02	0.02	0.04	0.04	0.00	-0.02

NOTES:

1. MODEL REACH IS 500 m IN LENGTH ENDING 500 m BELOW THE T-CREEK CONFLUENCE
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2011-2013.

The model was run again using Operations I, Year 22 parameters and mean monthly outflow temperatures were predicted. Generally, all modelled nodes saw an increase in the temperature change over the reach from pre-mine conditions, showing that a reduction in streamflow would increase the rate of warming. Most increases over pre-mine conditions are small, however, at Node 3, T-Creek at Harper Creek confluence, the increase in temperature change in the model reach from pre-mine to year 22 is almost 1.7 °C/km. We believe that this is likely a modelling anomaly and driven by an extreme increase in reach travel time due to the reduction in discharge in the reach and influence of the discharge-wetting width factors and manning's n. We believe that at these reduced flows, the model is over predicting travel time through the reach allowing the stream to be warmed by almost a degree in 0.5 km. Changing discharge, wetted width factors and manning's n to reflect flow conditions at all nodes would likely eliminate this error and refine the 95 percent confidence interval, currently we do not have enough site data to complete this modelling in that much detail.

The difference in temperature change per kilometer was calculated to assess the predicted temperature change due to change in streamflow over the creek length. These results indicate that typically the rate of change per kilometer is in the order of no change to 0.04°C/km in Harper Creek and less than 0.4°C/km in the tributaries. Again, Table 5.3 present results for Node 9, Harper Creek below T-Creek confluence, while similar results for all modelled nodes are in Appendix C2.

It should be noted that the predicted outflow temperatures should not be used as an absolute water temperature prediction. As these models looked at stream segments and not the stream network, cumulative effects have not been considered, nor have the effects on stream temperature of upstream water management facilities like the TMF or seepage ponds. These results are meant to present an estimate of the scale of temperature change expected in the streams due to the reduction in streamflow but not an absolute water temperature value.

6 – CONCLUSIONS

Three types of analyses have been completed to support the assessment of impacts to fish and fish habitat due to flow modifications. These analyses are:

1. Flow threshold calculations. These flow based methodologies characterise the magnitude and duration of flows under pre-mine and operational conditions and compare them to recommended conditions based on analogy with experience in other streams.
2. Physical habitat modelling. These methodologies are based on the premise that fish have preferred ranges of depth, velocity, substrate, and cover types, depending on the species and life stage. Habitat modelling aims to quantify the usable habitat available under Project modified flow conditions. This method assumes that physical habitat limits fish production.
3. Stream temperature modelling. Temperature is an important environmental factor in aquatic ecosystems as it plays a pivotal role over biological activity (development, growth and reproduction). Energy balance modelling was used to predict the change in stream temperature due to the modified flow conditions during Project operation.

On their own, the results of these analyses are not particularly informative. Rather, the results need to be interpreted with respect to their biological significance. This interpretation is outside the scope of this report. The following sections provide generalization and summary of key results.

6.1 FLOW THRESHOLDS

Changes in daily streamflow were quantified by comparison to three flow based habitat suitability methods. The three methods applied were the BC flow thresholds for fish bearing streams, BC modified Tennant method, and the indicators of hydrologic alteration methodology. These methods were applied at 13 locations (nodes) and six mine stages, including construction (year -1), operation 1 (year 10), operation 2 (year 22), operation 3 (year 27), closure (year 30), and post-closure (year 50). The results of this analysis are summarised as follows:

- Under operational conditions, the Project will reduce annual and monthly flows at many of the 13 nodes more than are recommended by the BC flow thresholds for fish bearing streams. However, this result is at least in part a result of the threshold methodology (and hydrologic regime of the Project streams), which calculates that only approximately 5% of the flow should be diverted, while the threshold authors suggest that this methodology should allow approximately 22% flow reduction.
- When comparing Project affected flows to the BC modified Tennant method recommendations for summer rearing (adults and juveniles) and overwintering, two general results are observed 1) if pre-mine flow exceeds the flow recommendation, operational flows typically exceed the flow recommendation, and 2) if pre-mine flow does not exceed the flow recommendation, operational flows do not exceed the flow recommendation.
- The indicators of hydrological alteration analysis aims to describe the range of variability (1 standard deviation from the mean) in many hydrologic parameters under pre-mine conditions and then compare this to the variability during operations conditions. Rather than calculating a flow recommendation, the results are more subjective and require interpretation as to whether variability has been materially changed.

6.2 PHYSICAL HABITAT MODELLING

Physical habitat modelling was conducted in the fish bearing reaches of P-Creek and T-Creek using PHABSIM and in Harper Creek below T-Creek using River2D. Project specific depth, velocity and cover bull trout habitat suitability criteria were developed based on fish observations in Harper, P and T-Creeks. Weighted usable area was calculated in each of the models for bull trout fry, rearing and spawning suitability. In P and T-Creeks, the modelling suggests that weighted usable area generally:

- Increases during operations for fry and rearing life stages during May, June and July as the reduced streamflow reduces depth and velocity to more suitable conditions.
- Decreases during operations for fry and rearing life stages during in September and October as the reduced streamflow reduces depth and velocity below preferred conditions.
- Decreases during operations for spawning life stages as the reduced streamflow reduces depth and velocity below preferred conditions.
- Similar to baseline conditions for all life stages during post closure, except in rearing P-Creek where flow conditions remain reduced.

6.3 TEMPERATURE MODELLING

Temperature is an important environmental factor in aquatic ecosystems as it plays a pivotal role over biological activity (development, growth and reproduction). Seasonal temperature differences strongly influence the biological activity of aquatic organisms. Increases in surface water temperature beyond diurnal or seasonal averages, have the potential to accelerate embryo development, alter the timing of emergence, growth and downstream migration of juveniles, reduce metabolic efficiencies of food conversion into growth, alter adult spawning migration and spawning timing, increase susceptibility to disease and shift the competitive advantage of salmonids over non-salmonid species. In order to assess the change in instream flows on the stream temperature, modelling was completed to calculate the magnitude of temperature change predicted. The difference in temperature change per kilometer between pre-mine and year 22 conditions was calculated to assess the predicted temperature change due to change in streamflow. These values show that typically the rate of change per kilometer is in the order of no change to 0.04°C/km in Harper Creek and no change to 0.40°C/km in the tributaries.

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8 – CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

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APPENDIX A

FLOW THRESHOLDS

APPENDIX A1

BC INSTREAM FLOW THRESHOLD RESULTS FOR NODES 1 TO 13

(Pages A1-1 to A1-26)

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TABLE A1-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

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Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.72	0.60	0.59	4.14	12.79	13.31	6.46	2.94	2.23	1.92	1.26	0.90	4.00
		%MAD	18%	15%	15%	104%	320%	333%	161%	73%	56%	48%	31%	23%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.70	0.59	0.56	3.43	12.79	13.31	6.46	2.41	1.89	1.72	1.21	0.88	3.84
		% Pre-Mine MAD	18%	15%	14%	86%	320%	333%	161%	60%	47%	43%	30%	22%	96%
-1	End of Construction	m^3/s	0.72	0.60	0.59	3.52	11.30	11.68	5.74	2.51	1.84	1.82	1.18	0.83	3.54
		% Pre-Mine MAD	18%	15%	15%	88%	283%	292%	143%	63%	46%	46%	29%	21%	88%
10	Operations I	m^3/s	0.67	0.55	0.56	3.69	10.85	10.46	5.05	2.40	1.83	1.71	1.18	0.85	3.33
		% Pre-Mine MAD	17%	14%	14%	92%	271%	262%	126%	60%	46%	43%	30%	21%	83%
22	Operations I	m^3/s	0.67	0.54	0.55	3.68	10.82	10.41	5.02	2.39	1.82	1.71	1.18	0.84	3.31
		% Pre-Mine MAD	17%	14%	14%	92%	271%	260%	126%	60%	45%	43%	29%	21%	83%
27	Operations II	m^3/s	0.67	0.54	0.54	3.69	10.84	10.47	5.07	2.41	1.84	1.72	1.19	0.85	3.33
		% Pre-Mine MAD	17%	14%	13%	92%	271%	262%	127%	60%	46%	43%	30%	21%	83%
30	Closure	m^3/s	0.72	0.60	0.61	3.97	11.81	11.62	5.43	2.50	1.95	1.88	1.26	0.92	3.62
		% Pre-Mine MAD	18%	15%	15%	99%	295%	291%	136%	63%	49%	47%	31%	23%	90%
50	Post-Closure	m^3/s	0.74	0.68	0.75	4.20	12.38	12.20	5.63	2.59	1.98	1.92	1.26	0.92	3.78
		% Pre-Mine MAD	19%	17%	19%	105%	310%	305%	141%	65%	50%	48%	32%	23%	95%

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NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A1-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

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Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.26	0.22	0.20	0.92	3.60	3.35	1.54	0.78	0.58	0.54	0.42	0.32	1.07
		%MAD	25%	21%	19%	86%	338%	315%	144%	73%	55%	51%	40%	30%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.26	0.22	0.19	0.92	3.60	3.35	1.54	0.66	0.52	0.50	0.40	0.31	1.04
		% Pre-Mine MAD	24%	21%	18%	86%	338%	315%	144%	62%	49%	47%	38%	29%	98%
-1	End of Construction	m^3/s	0.28	0.24	0.21	0.86	3.59	3.74	1.65	0.76	0.56	0.56	0.45	0.33	1.11
		% Pre-Mine MAD	27%	23%	20%	81%	337%	350%	154%	72%	52%	53%	42%	31%	104%
10	Operations I	m^3/s	0.24	0.20	0.18	0.85	3.11	2.87	1.43	0.74	0.53	0.51	0.41	0.30	0.95
		% Pre-Mine MAD	23%	19%	17%	80%	292%	269%	134%	69%	50%	47%	38%	28%	89%
22	Operations I	m^3/s	0.24	0.20	0.17	0.85	3.10	2.85	1.42	0.73	0.52	0.50	0.40	0.30	0.94
		% Pre-Mine MAD	22%	18%	16%	79%	290%	268%	133%	69%	49%	47%	38%	28%	88%
27	Operations II	m^3/s	0.24	0.20	0.17	0.85	3.11	2.88	1.42	0.74	0.52	0.50	0.40	0.30	0.95
		% Pre-Mine MAD	22%	18%	16%	79%	292%	270%	133%	69%	49%	47%	38%	28%	89%
30	Closure	m^3/s	0.24	0.20	0.17	0.85	3.12	2.89	1.42	0.73	0.52	0.50	0.40	0.29	0.95
		% Pre-Mine MAD	22%	18%	16%	79%	292%	271%	133%	69%	49%	47%	38%	28%	89%
50	Post-Closure	m^3/s	0.24	0.19	0.17	0.85	3.11	2.88	1.41	0.73	0.52	0.50	0.40	0.29	0.94
		% Pre-Mine MAD	22%	18%	16%	79%	292%	270%	133%	69%	49%	47%	38%	28%	89%

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NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET. AL. (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A1-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.02	0.02	0.01	0.27	1.75	2.32	1.04	0.34	0.23	0.10	0.05	0.03	0.52
		%MAD	5%	4%	3%	52%	339%	449%	201%	66%	44%	20%	9%	6%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.02	0.02	0.01	0.22	1.75	2.32	1.04	0.27	0.19	0.08	0.05	0.03	0.50
		% Pre-Mine MAD	4%	4%	3%	42%	339%	449%	201%	53%	36%	16%	9%	6%	97%
-1	End of Construction	m^3/s	0.03	0.00	0.00	0.09	0.59	0.78	0.34	0.10	0.08	0.03	0.00	0.00	0.17
		% Pre-Mine MAD	5%	0%	0%	18%	114%	151%	65%	19%	16%	6%	1%	0%	33%
10	Operations I	m^3/s	0.00	0.00	0.00	0.08	0.57	0.73	0.27	0.05	0.02	0.02	0.00	0.00	0.14
		% Pre-Mine MAD	0%	0%	0%	15%	110%	141%	51%	9%	4%	4%	1%	0%	28%
22	Operations I	m^3/s	0.00	0.00	0.00	0.08	0.55	0.70	0.24	0.04	0.02	0.02	0.00	0.00	0.14
		% Pre-Mine MAD	0%	0%	0%	15%	106%	135%	47%	8%	4%	3%	1%	0%	27%
27	Operations II	m^3/s	0.00	0.00	0.00	0.08	0.55	0.70	0.25	0.04	0.02	0.02	0.00	0.00	0.14
		% Pre-Mine MAD	0%	0%	0%	15%	106%	135%	48%	8%	4%	3%	1%	0%	27%
30	Closure	m^3/s	0.03	0.03	0.03	0.24	1.15	1.57	0.52	0.11	0.10	0.14	0.06	0.05	0.34
		% Pre-Mine MAD	6%	6%	6%	46%	223%	304%	101%	22%	20%	27%	12%	10%	65%
50	Post-Closure	m^3/s	0.07	0.13	0.19	0.54	2.01	2.60	0.83	0.21	0.16	0.21	0.08	0.07	0.59
		% Pre-Mine MAD	13%	26%	36%	104%	389%	503%	160%	41%	31%	42%	16%	14%	115%

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NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

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Knight Piésold CONSULTING

TABLE A1-4

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Print Oct/16/14 9:00:27

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.00	0.00	0.00	0.15	1.12	1.56	0.69	0.20	0.13	0.04	0.01	0.00	0.33
		%MAD	0%	0%	0%	46%	344%	478%	211%	62%	39%	14%	3%	0%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.00	0.00	0.00	0.12	1.12	1.56	0.69	0.16	0.10	0.03	0.01	0.00	0.32
		% Pre-Mine MAD	0%	0%	0%	36%	344%	478%	211%	50%	31%	10%	2%	0%	97%
-1	End of Construction	m^3/s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		% Pre-Mine MAD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10	Operations I	m^3/s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		% Pre-Mine MAD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
22	Operations I	m^3/s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		% Pre-Mine MAD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
27	Operations II	m^3/s	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		% Pre-Mine MAD	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%
30	Closure	m^3/s	0.03	0.03	0.04	0.18	0.68	0.91	0.27	0.09	0.09	0.14	0.06	0.06	0.21
		% Pre-Mine MAD	11%	10%	11%	56%	207%	278%	83%	26%	27%	44%	19%	17%	66%
50	Post-Closure	m^3/s	0.06	0.12	0.17	0.45	1.41	1.80	0.53	0.16	0.12	0.19	0.07	0.06	0.43
		% Pre-Mine MAD	17%	36%	53%	136%	432%	551%	163%	48%	37%	58%	21%	18%	131%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-5

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.01	0.01	0.01	0.11	0.62	0.60	0.19	0.07	0.04	0.03	0.02	0.02	0.15
		%MAD	10%	9%	10%	78%	427%	413%	130%	45%	26%	23%	14%	10%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.01	0.01	0.01	0.11	0.62	0.60	0.19	0.05	0.03	0.03	0.02	0.01	0.14
		% Pre-Mine MAD	9%	9%	9%	78%	427%	413%	130%	36%	21%	19%	13%	10%	98%
-1	End of Construction	m^3/s	0.02	0.02	0.02	0.09	0.65	0.63	0.12	0.04	0.02	0.02	0.01	0.02	0.14
		% Pre-Mine MAD	12%	11%	12%	61%	445%	435%	86%	25%	12%	13%	8%	11%	95%
10	Operations I	m^3/s	0.00	0.00	0.01	0.02	0.25	0.20	0.04	0.01	0.00	0.01	0.04	0.02	0.05
		% Pre-Mine MAD	2%	0%	6%	13%	171%	137%	28%	9%	3%	7%	27%	11%	35%
22	Operations I	m^3/s	0.00	0.00	0.01	0.02	0.24	0.19	0.04	0.01	0.00	0.01	0.04	0.02	0.05
		% Pre-Mine MAD	2%	0%	6%	13%	167%	129%	26%	9%	3%	7%	27%	11%	34%
27	Operations II	m^3/s	0.00	0.00	0.01	0.02	0.26	0.22	0.04	0.02	0.00	0.01	0.03	0.01	0.05
		% Pre-Mine MAD	1%	0%	5%	13%	180%	150%	31%	12%	3%	8%	21%	8%	36%
30	Closure	m^3/s	0.00	0.00	0.01	0.02	0.27	0.23	0.05	0.02	0.00	0.01	0.03	0.01	0.05
		% Pre-Mine MAD	1%	0%	4%	13%	186%	159%	33%	12%	3%	9%	21%	9%	38%
50	Post-Closure	m^3/s	0.00	0.00	0.01	0.02	0.27	0.23	0.05	0.02	0.00	0.02	0.03	0.01	0.05
		% Pre-Mine MAD	1%	0%	4%	13%	186%	159%	33%	12%	3%	11%	21%	9%	38%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-6

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Print Oct/15/14 10:53:05

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.02	0.01	0.02	0.31	0.84	0.96	0.56	0.22	0.11	0.13	0.11	0.04	0.28
		%MAD	6%	3%	9%	111%	303%	346%	203%	78%	39%	45%	39%	14%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.02	0.01	0.02	0.27	0.84	0.96	0.56	0.17	0.09	0.11	0.10	0.04	0.27
		% Pre-Mine MAD	5%	3%	7%	95%	303%	346%	203%	63%	31%	41%	36%	13%	96%
-1	End of Construction	m^3/s	0.01	0.00	0.00	0.32	0.90	1.01	0.52	0.13	0.04	0.09	0.10	0.03	0.26
		% Pre-Mine MAD	3%	0%	0%	114%	324%	364%	188%	46%	16%	33%	35%	12%	95%
10	Operations I	m^3/s	0.02	0.00	0.00	0.31	0.88	0.98	0.51	0.13	0.05	0.09	0.10	0.04	0.26
		% Pre-Mine MAD	6%	1%	0%	112%	315%	351%	183%	45%	17%	34%	36%	13%	93%
22	Operations I	m^3/s	0.02	0.00	0.00	0.31	0.90	1.02	0.53	0.13	0.05	0.09	0.10	0.04	0.27
		% Pre-Mine MAD	6%	2%	0%	113%	325%	367%	189%	45%	17%	34%	36%	13%	96%
27	Operations II	m^3/s	0.02	0.00	0.00	0.32	0.91	1.03	0.53	0.13	0.05	0.10	0.10	0.04	0.27
		% Pre-Mine MAD	6%	2%	0%	114%	327%	368%	190%	46%	17%	34%	37%	13%	96%
30	Closure	m^3/s	0.02	0.00	0.00	0.32	0.91	1.02	0.53	0.13	0.05	0.10	0.10	0.04	0.27
		% Pre-Mine MAD	6%	1%	0%	117%	326%	367%	190%	46%	17%	35%	38%	13%	97%
50	Post-Closure	m^3/s	0.01	0.00	0.00	0.32	0.91	1.03	0.53	0.13	0.05	0.10	0.10	0.04	0.27
		% Pre-Mine MAD	5%	1%	0%	114%	327%	369%	190%	46%	17%	35%	37%	13%	96%

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NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET. AL. (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-7

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Print Oct/15/14 10:54:24

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.01	0.00	0.05	0.32	0.64	0.70	0.39	0.14	0.07	0.10	0.08	0.02	0.21
		%MAD	4%	2%	23%	151%	305%	332%	187%	67%	32%	46%	39%	11%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.01	0.00	0.04	0.27	0.64	0.70	0.31	0.11	0.05	0.08	0.07	0.02	0.19
		% Pre-Mine MAD	3%	1%	18%	127%	305%	332%	149%	52%	25%	40%	35%	10%	92%
-1	End of Construction	m^3/s	0.00	0.00	0.03	0.30	0.60	0.65	0.37	0.12	0.03	0.07	0.07	0.02	0.19
		% Pre-Mine MAD	1%	0%	12%	142%	283%	311%	174%	55%	15%	35%	35%	9%	90%
10	Operations I	m^3/s	0.01	0.01	0.06	0.30	0.57	0.60	0.33	0.11	0.04	0.07	0.07	0.02	0.18
		% Pre-Mine MAD	3%	3%	27%	141%	271%	288%	158%	52%	17%	35%	35%	11%	87%
22	Operations I	m^3/s	0.01	0.01	0.06	0.29	0.54	0.57	0.30	0.10	0.04	0.07	0.07	0.02	0.17
		% Pre-Mine MAD	3%	3%	26%	139%	259%	269%	145%	47%	17%	33%	34%	10%	82%
27	Operations II	m^3/s	0.01	0.01	0.05	0.29	0.55	0.57	0.31	0.10	0.03	0.07	0.07	0.02	0.17
		% Pre-Mine MAD	3%	3%	26%	140%	260%	272%	146%	48%	17%	33%	34%	10%	83%
30	Closure	m^3/s	0.01	0.01	0.06	0.29	0.55	0.57	0.31	0.10	0.03	0.07	0.07	0.02	0.17
		% Pre-Mine MAD	3%	3%	26%	139%	261%	273%	147%	48%	17%	33%	34%	10%	83%
50	Post-Closure	m^3/s	0.01	0.01	0.06	0.29	0.55	0.58	0.31	0.10	0.03	0.07	0.07	0.02	0.17
		% Pre-Mine MAD	3%	3%	26%	139%	262%	274%	148%	48%	16%	33%	34%	10%	83%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node7_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET. AL. (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-8

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

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Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.04	0.04	0.03	0.30	1.29	1.00	0.32	0.13	0.09	0.10	0.07	0.05	0.29
		%MAD	14%	13%	12%	105%	445%	345%	110%	45%	30%	35%	24%	17%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.04	0.04	0.03	0.30	1.29	1.00	0.32	0.11	0.08	0.09	0.07	0.05	0.29
		% Pre-Mine MAD	14%	13%	11%	105%	445%	345%	110%	37%	27%	30%	23%	17%	98%
-1	End of Construction	m^3/s	0.05	0.05	0.04	0.34	1.28	0.95	0.32	0.14	0.08	0.10	0.08	0.05	0.29
		% Pre-Mine MAD	18%	16%	15%	119%	442%	325%	111%	47%	28%	34%	27%	19%	100%
10	Operations I	m^3/s	0.03	0.02	0.02	0.26	0.90	0.60	0.22	0.10	0.06	0.08	0.06	0.03	0.20
		% Pre-Mine MAD	10%	8%	8%	91%	311%	206%	76%	33%	20%	27%	19%	12%	69%
22	Operations I	m^3/s	0.03	0.02	0.02	0.26	0.90	0.59	0.21	0.09	0.06	0.08	0.06	0.03	0.20
		% Pre-Mine MAD	10%	8%	8%	91%	309%	202%	74%	33%	20%	27%	19%	12%	68%
27	Operations II	m^3/s	0.03	0.02	0.02	0.27	0.92	0.62	0.23	0.10	0.06	0.08	0.06	0.03	0.20
		% Pre-Mine MAD	10%	8%	7%	92%	316%	215%	78%	35%	21%	27%	19%	12%	70%
30	Closure	m^3/s	0.03	0.02	0.02	0.27	0.93	0.64	0.23	0.10	0.06	0.08	0.06	0.03	0.21
		% Pre-Mine MAD	10%	8%	8%	92%	319%	219%	81%	36%	21%	27%	19%	12%	71%
50	Post-Closure	m^3/s	0.03	0.02	0.02	0.27	0.93	0.64	0.23	0.10	0.06	0.08	0.06	0.03	0.21
		% Pre-Mine MAD	10%	8%	8%	92%	319%	219%	81%	35%	21%	27%	19%	12%	71%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A1-9

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Print Oct/16/14 9:00:27

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.29	0.24	0.21	1.19	5.35	5.67	2.58	1.12	0.81	0.65	0.47	0.35	1.58
		%MAD	18%	15%	13%	75%	338%	358%	163%	71%	51%	41%	30%	22%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.28	0.24	0.21	1.00	5.35	5.67	2.58	0.93	0.69	0.59	0.45	0.34	1.53
		% Pre-Mine MAD	18%	15%	13%	63%	338%	358%	163%	59%	43%	37%	29%	22%	97%
-1	End of Construction	m^3/s	0.31	0.26	0.23	1.13	4.43	4.35	1.85	0.87	0.63	0.60	0.46	0.34	1.29
		% Pre-Mine MAD	20%	17%	14%	71%	280%	275%	117%	55%	40%	38%	29%	21%	82%
10	Operations I	m^3/s	0.24	0.20	0.18	1.06	3.67	3.39	1.68	0.78	0.54	0.52	0.41	0.29	1.08
		% Pre-Mine MAD	15%	13%	11%	67%	232%	214%	106%	49%	34%	33%	26%	19%	68%
22	Operations I	m^3/s	0.23	0.19	0.17	1.05	3.64	3.34	1.65	0.76	0.53	0.51	0.40	0.29	1.07
		% Pre-Mine MAD	15%	12%	11%	67%	230%	211%	105%	48%	34%	32%	25%	18%	68%
27	Operations II	m^3/s	0.23	0.19	0.17	1.05	3.65	3.37	1.71	0.79	0.55	0.52	0.41	0.30	1.08
		% Pre-Mine MAD	15%	12%	11%	67%	231%	213%	108%	50%	35%	33%	26%	19%	68%
30	Closure	m^3/s	0.31	0.27	0.25	1.44	4.91	4.77	2.15	0.90	0.68	0.74	0.51	0.39	1.45
		% Pre-Mine MAD	19%	17%	16%	91%	310%	301%	136%	57%	43%	46%	32%	24%	91%
50	Post-Closure	m^3/s	0.31	0.33	0.37	1.60	5.18	4.98	2.28	0.93	0.68	0.73	0.49	0.37	1.52
		% Pre-Mine MAD	20%	21%	23%	101%	327%	315%	144%	59%	43%	46%	31%	23%	96%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-10

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Print Oct/16/14 9:00:27

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	0.77	0.65	0.76	4.99	13.67	13.66	6.54	3.03	2.29	2.13	1.37	0.98	4.25
		%MAD	18%	15%	18%	117%	322%	322%	154%	71%	54%	50%	32%	23%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	0.76	0.64	0.70	4.12	13.67	13.66	6.54	2.49	1.96	1.91	1.32	0.96	4.07
		% Pre-Mine MAD	18%	15%	17%	97%	322%	322%	154%	59%	46%	45%	31%	23%	96%
-1	End of Construction	m^3/s	0.78	0.65	0.78	4.98	12.67	12.22	5.70	2.70	2.07	2.07	1.31	0.91	3.91
		% Pre-Mine MAD	18%	15%	18%	117%	298%	288%	134%	64%	49%	49%	31%	21%	92%
10	Operations I	m^3/s	0.72	0.59	0.75	4.73	11.59	10.59	5.32	2.42	1.77	1.96	1.29	0.90	3.56
		% Pre-Mine MAD	17%	14%	18%	111%	273%	249%	125%	57%	42%	46%	30%	21%	84%
22	Operations I	m^3/s	0.72	0.58	0.74	4.73	11.56	10.54	5.29	2.41	1.77	1.95	1.29	0.90	3.55
		% Pre-Mine MAD	17%	14%	17%	111%	272%	248%	125%	57%	42%	46%	30%	21%	84%
27	Operations II	m^3/s	0.72	0.58	0.72	4.74	11.58	10.59	5.33	2.43	1.78	1.96	1.30	0.91	3.56
		% Pre-Mine MAD	17%	14%	17%	111%	272%	249%	125%	57%	42%	46%	31%	21%	84%
30	Closure	m^3/s	0.79	0.66	0.82	5.11	12.86	11.96	5.76	2.53	1.92	2.18	1.40	1.00	3.93
		% Pre-Mine MAD	19%	16%	19%	120%	303%	282%	136%	60%	45%	51%	33%	24%	92%
50	Post-Closure	m^3/s	0.79	0.72	0.94	5.25	13.11	12.15	5.88	2.57	1.90	2.16	1.37	0.98	4.00
		% Pre-Mine MAD	19%	17%	22%	124%	308%	286%	138%	60%	45%	51%	32%	23%	94%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-11

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 11
BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Print Oct/16/14 9:00:27

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	2.52	2.32	2.86	10.51	38.06	42.00	16.18	5.51	4.22	4.64	4.78	3.10	11.42
		%MAD	22%	20%	25%	92%	333%	368%	142%	48%	37%	41%	42%	27%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	2.29	2.12	2.70	8.82	38.06	42.00	16.18	4.77	3.78	4.11	4.41	2.95	11.04
		% Pre-Mine MAD	20%	19%	24%	77%	333%	368%	142%	42%	33%	36%	39%	26%	97%
-1	End of Construction	m^3/s	2.54	2.36	2.92	10.56	37.32	40.62	16.30	5.68	4.37	4.58	4.74	3.05	11.31
		% Pre-Mine MAD	22%	21%	26%	92%	327%	356%	143%	50%	38%	40%	41%	27%	99%
10	Operations I	m^3/s	2.48	2.29	2.88	10.63	36.24	39.05	15.97	5.31	4.09	4.58	4.72	3.05	11.01
		% Pre-Mine MAD	22%	20%	25%	93%	317%	342%	140%	47%	36%	40%	41%	27%	96%
22	Operations I	m^3/s	2.47	2.29	2.88	10.62	36.21	39.01	15.94	5.30	4.09	4.57	4.72	3.04	10.99
		% Pre-Mine MAD	22%	20%	25%	93%	317%	342%	140%	46%	36%	40%	41%	27%	96%
27	Operations II	m^3/s	2.47	2.29	2.86	10.63	36.23	39.05	15.98	5.32	4.11	4.59	4.72	3.05	11.01
		% Pre-Mine MAD	22%	20%	25%	93%	317%	342%	140%	47%	36%	40%	41%	27%	96%
30	Closure	m^3/s	2.55	2.37	2.95	10.99	37.52	40.42	16.43	5.43	4.23	4.80	4.82	3.14	11.37
		% Pre-Mine MAD	22%	21%	26%	96%	329%	354%	144%	48%	37%	42%	42%	28%	100%
50	Post-Closure	m^3/s	2.55	2.43	3.07	11.09	37.77	40.62	16.54	5.46	4.22	4.78	4.80	3.12	11.44
		% Pre-Mine MAD	22%	21%	27%	97%	331%	356%	145%	48%	37%	42%	42%	27%	100%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node11_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-12

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Print Oct/16/14 8:58:51

Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	3.62	3.47	4.52	15.49	48.41	50.36	19.72	6.91	5.29	5.64	6.18	4.23	14.52
		%MAD	25%	24%	31%	107%	333%	347%	136%	48%	36%	39%	43%	29%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	3.31	3.14	4.19	12.93	48.41	50.36	19.72	6.06	4.79	5.14	5.79	4.03	14.02
		% Pre-Mine MAD	23%	22%	29%	89%	333%	347%	136%	42%	33%	35%	40%	28%	97%
-1	End of Construction	m^3/s	3.63	3.48	4.54	15.49	47.41	48.92	19.74	7.05	5.40	5.59	6.12	4.15	14.36
		% Pre-Mine MAD	25%	24%	31%	107%	327%	337%	136%	49%	37%	39%	42%	29%	99%
10	Operations I	m^3/s	3.57	3.41	4.51	15.24	46.33	47.29	19.37	6.70	5.13	5.48	6.10	4.14	14.00
		% Pre-Mine MAD	25%	24%	31%	105%	319%	326%	133%	46%	35%	38%	42%	29%	96%
22	Operations I	m^3/s	3.57	3.41	4.50	15.23	46.30	47.24	19.35	6.69	5.12	5.47	6.10	4.14	13.99
		% Pre-Mine MAD	25%	23%	31%	105%	319%	325%	133%	46%	35%	38%	42%	29%	96%
27	Operations II	m^3/s	3.57	3.41	4.48	15.24	46.32	47.29	19.38	6.71	5.14	5.48	6.11	4.15	14.00
		% Pre-Mine MAD	25%	23%	31%	105%	319%	326%	134%	46%	35%	38%	42%	29%	96%
30	Closure	m^3/s	3.65	3.48	4.58	15.61	47.60	48.66	19.83	6.81	5.27	5.71	6.21	4.24	14.37
		% Pre-Mine MAD	25%	24%	32%	108%	328%	335%	137%	47%	36%	39%	43%	29%	99%
50	Post-Closure	m^3/s	3.64	3.55	4.70	15.75	47.85	48.85	19.94	6.84	5.26	5.68	6.18	4.22	14.44
		% Pre-Mine MAD	25%	24%	32%	109%	330%	337%	137%	47%	36%	39%	43%	29%	99%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node12_Flow Thresholds_20141015.xlsx]Mean Monthly

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET AL (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A1-13

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

RECOMMENDED INSTREAM FLOW THRESHOLD FOR NODE 13
NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Print Oct/15/14 11:08:52

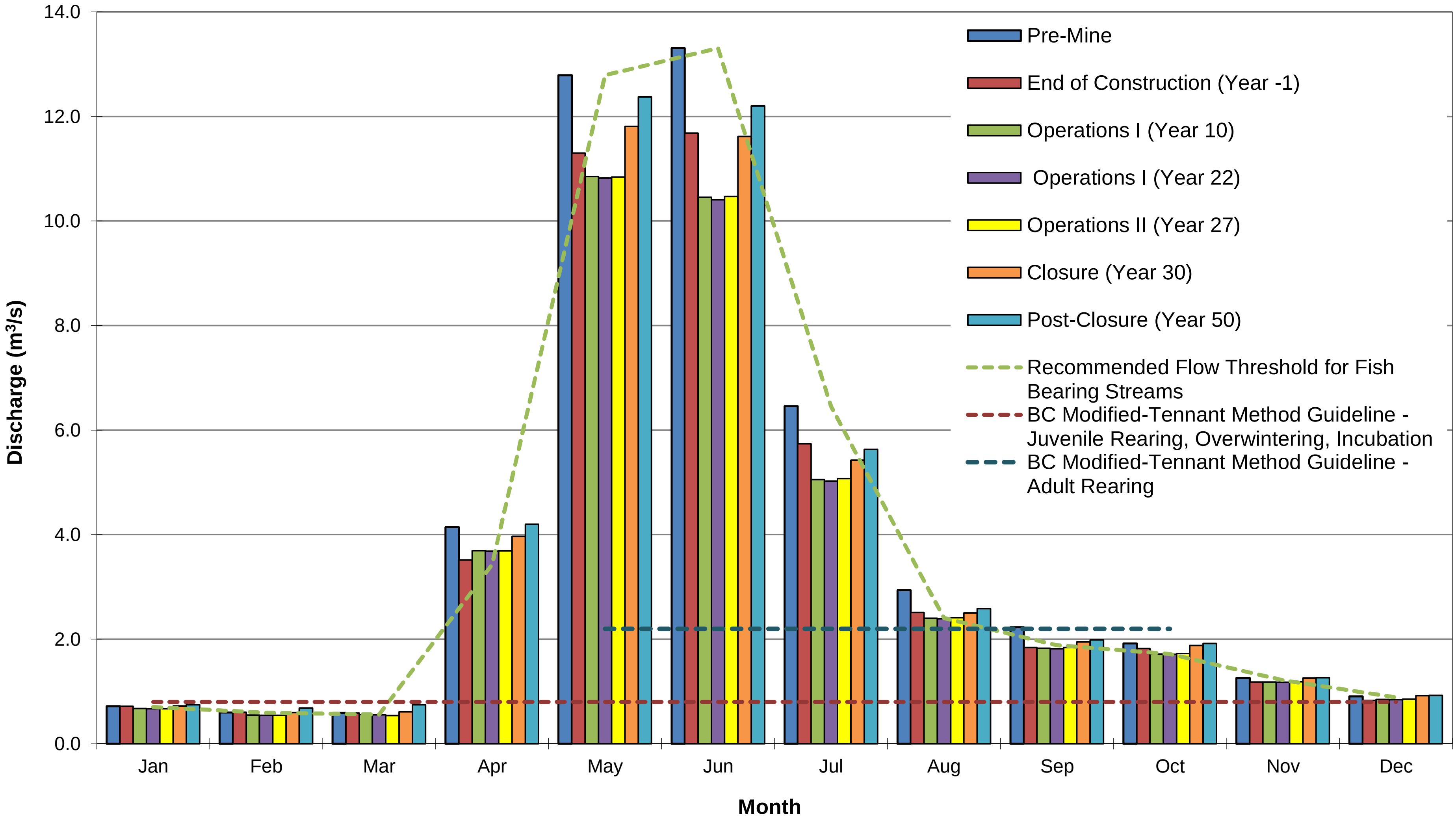
Mine Stage		Units	Mean Monthly Discharge												Average Annual
Year	Description		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-	Pre-Mine	m^3/s	30.05	28.16	33.87	97.19	296.82	422.99	340.78	214.71	131.45	91.95	65.28	34.78	149.58
		%MAD	20%	19%	23%	65%	198%	283%	228%	144%	88%	61%	44%	23%	100%
-	Recommended flow threshold for fish bearing streams[2]	m^3/s	27.13	26.33	32.39	84.96	223.90	422.99	340.78	185.71	115.76	80.01	59.82	33.37	136.54
		% Pre-Mine MAD	18%	18%	22%	57%	150%	283%	228%	124%	77%	53%	40%	22%	91%
-1	End of Construction	m^3/s	30.04	28.15	33.83	97.18	296.83	422.99	340.71	214.60	131.35	91.89	65.26	34.77	149.54
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%
10	Operations I	m^3/s	30.05	28.16	33.86	97.17	296.78	422.91	340.66	214.59	131.35	91.89	65.26	34.78	149.53
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%
22	Operations I	m^3/s	30.05	28.16	33.86	97.17	296.78	422.91	340.65	214.58	131.35	91.89	65.26	34.78	149.53
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%
27	Operations II	m^3/s	30.05	28.16	33.85	97.17	296.79	422.92	340.66	214.58	131.35	91.89	65.26	34.78	149.53
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%
30	Closure	m^3/s	30.05	28.16	33.86	97.18	296.79	422.92	340.66	214.58	131.35	91.89	65.26	34.78	149.53
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%
50	Post-Closure	m^3/s	30.05	28.15	33.86	97.17	296.79	422.93	340.66	214.59	131.35	91.89	65.26	34.78	149.53
		% Pre-Mine MAD	20%	19%	23%	65%	198%	283%	228%	143%	88%	61%	44%	23%	100%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node13_Flow Thresholds_20141015.xlsx]info

NOTE:

1. MEAN MONTHLY VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE SURFACE WATER WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. THRESHOLD CALCULATED AS PER HATFIELD ET. AL. (2003) AND VALUES REPRESENT FLOW THAT WOULD REMAIN IN THE CREEK IF THRESHOLD WAS MET.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

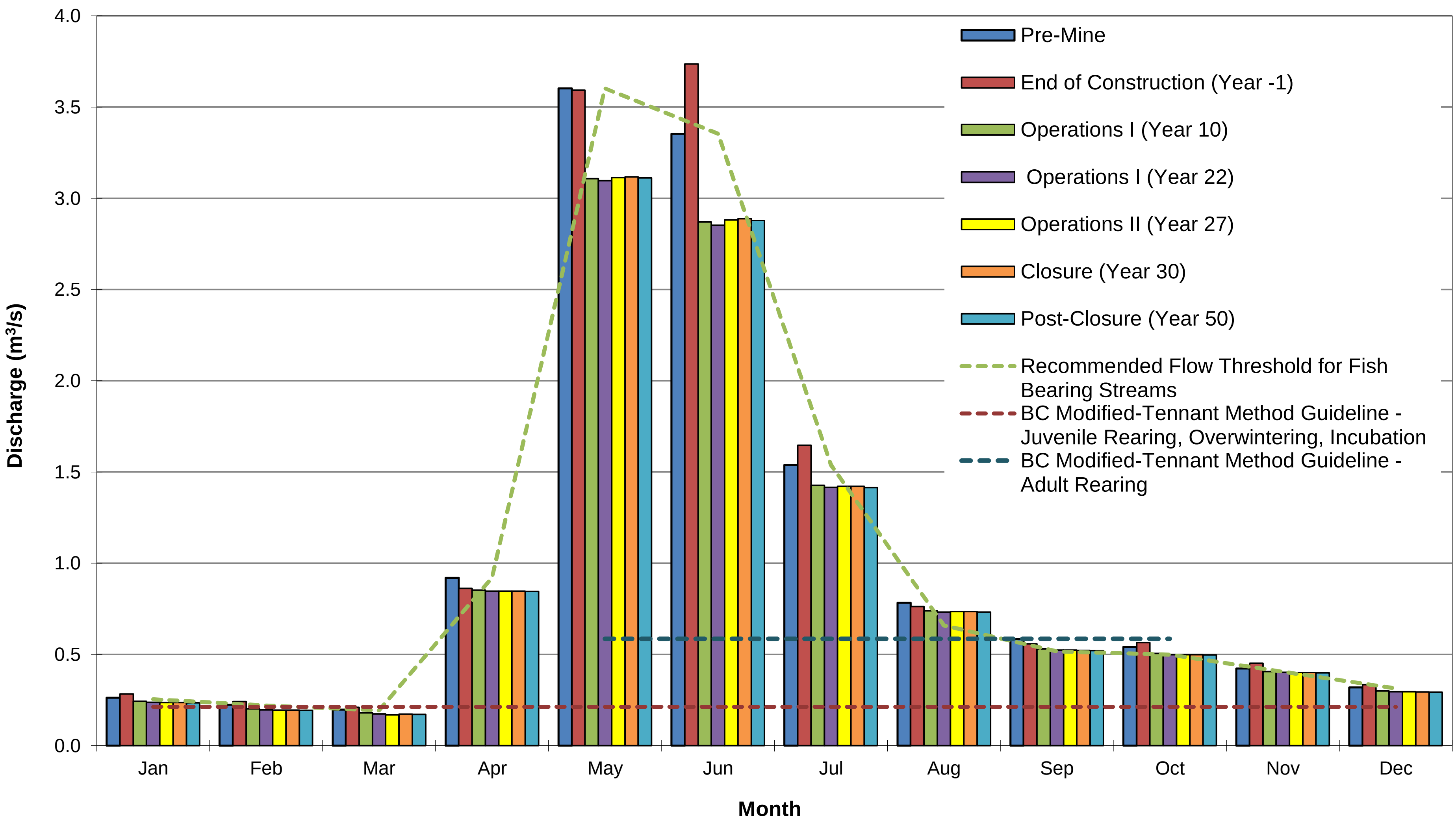
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-1

REV 0



NOTES:

1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

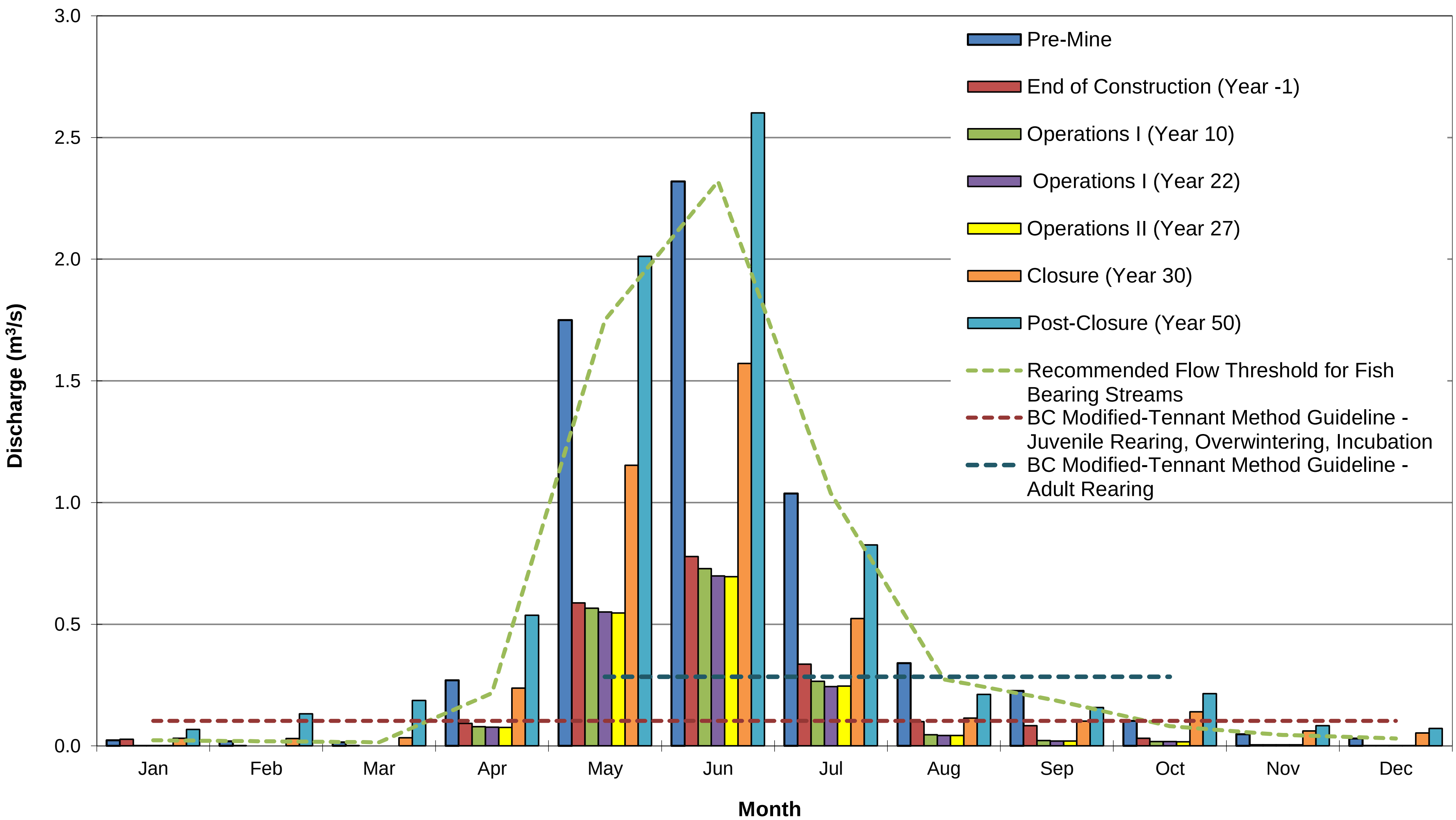
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A1-2		REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

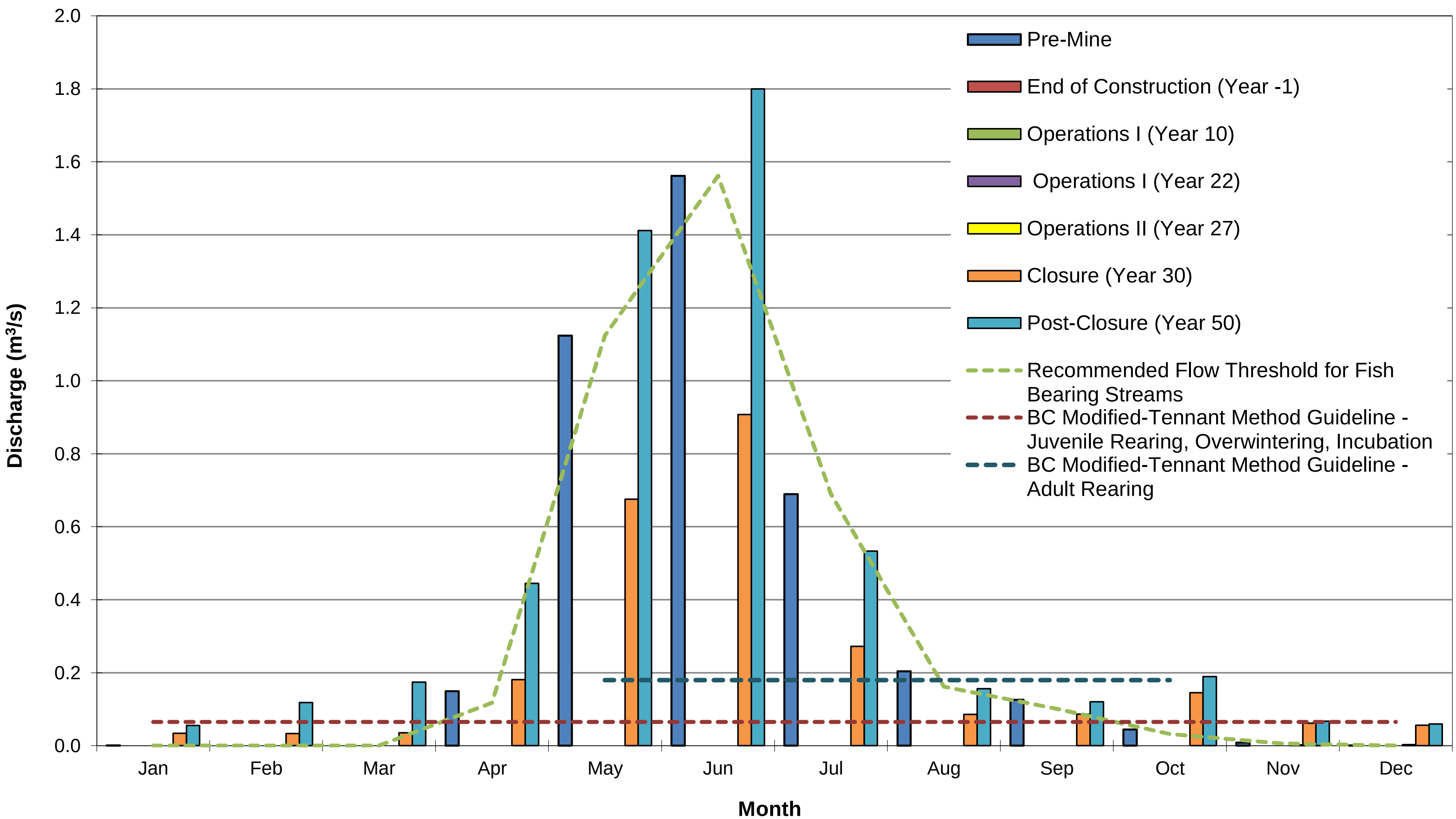
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-3

REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

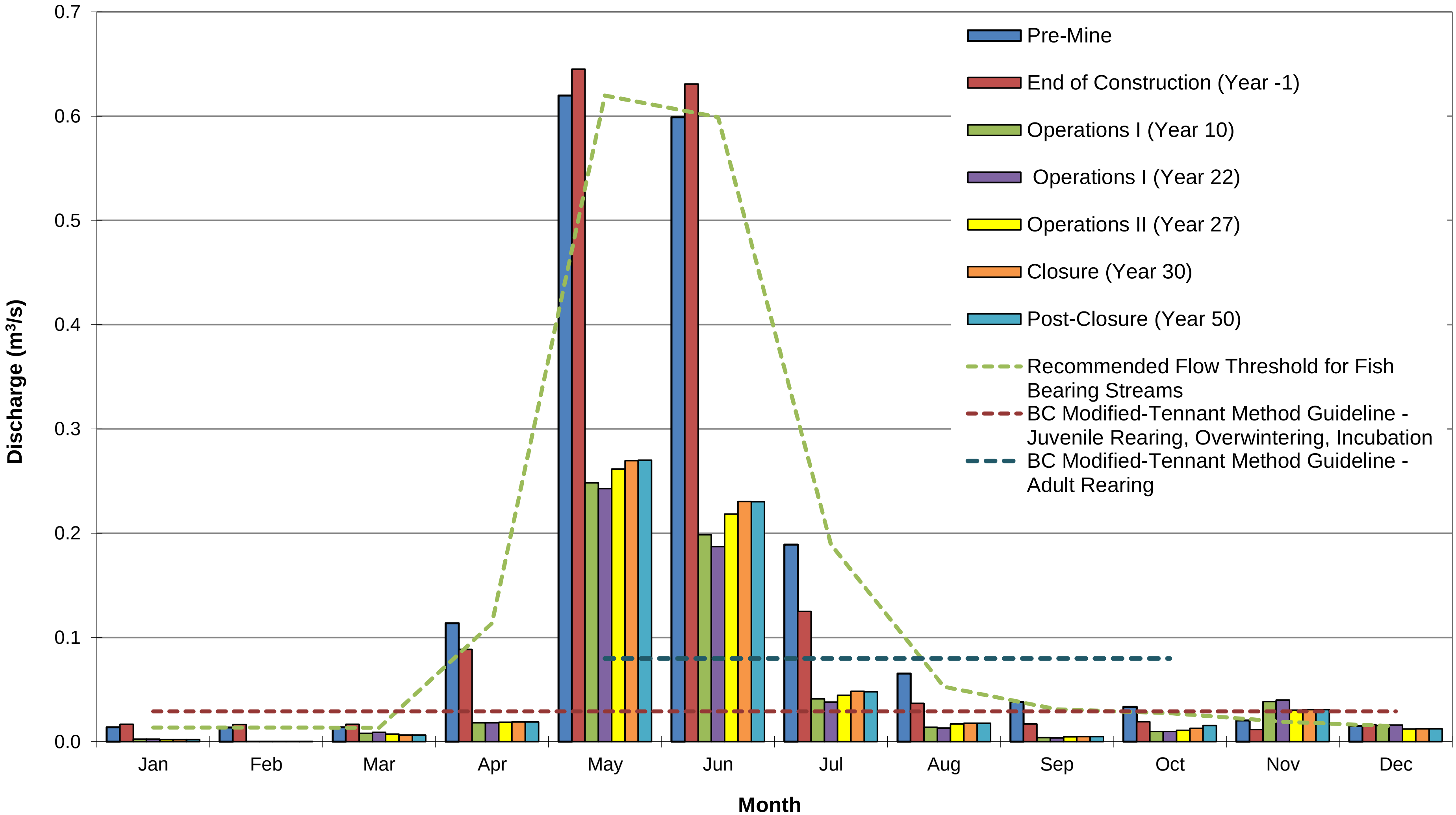
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A1-4		REV 0



NOTES:

1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

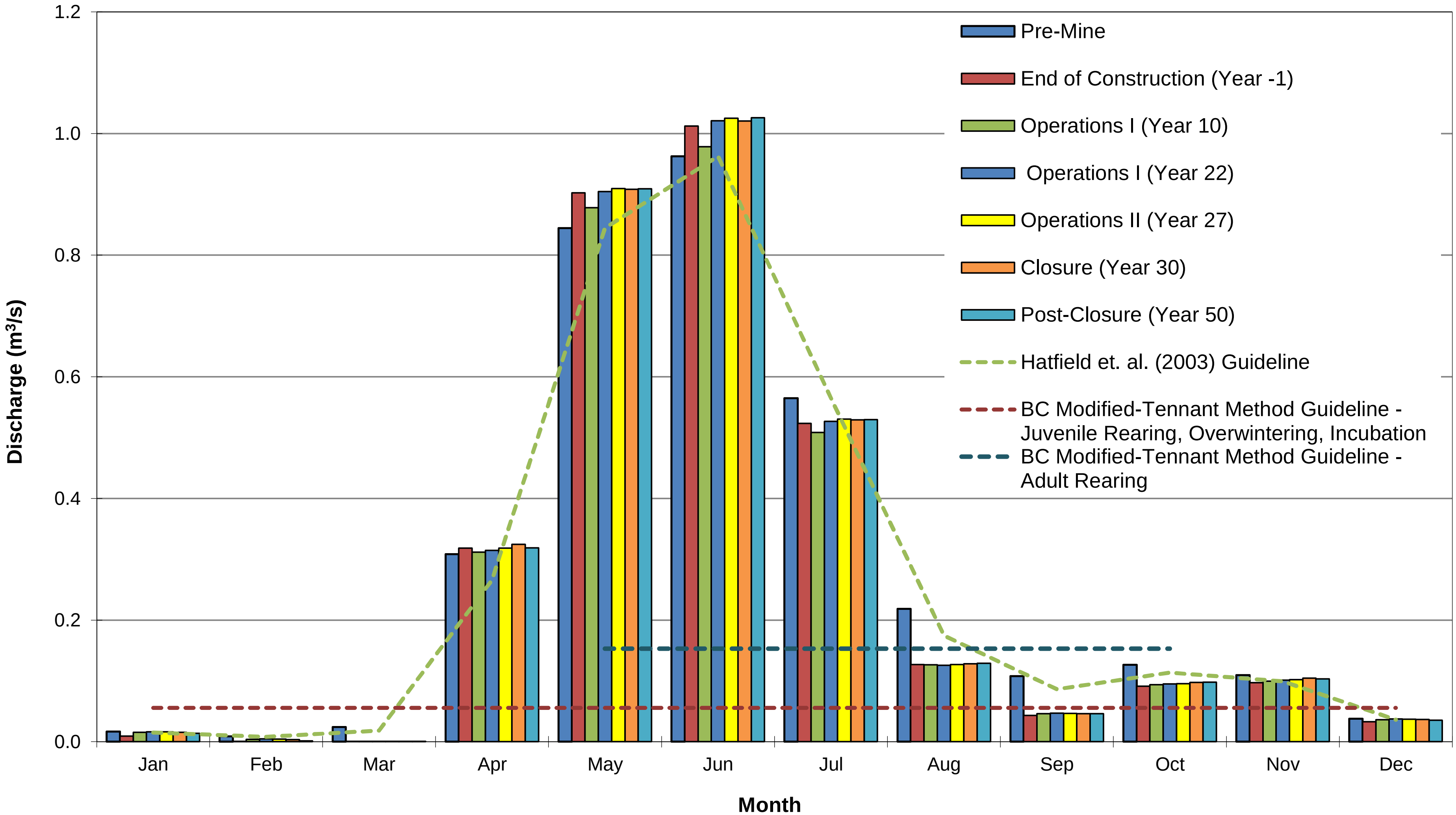
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-5

REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR RAINBOW TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

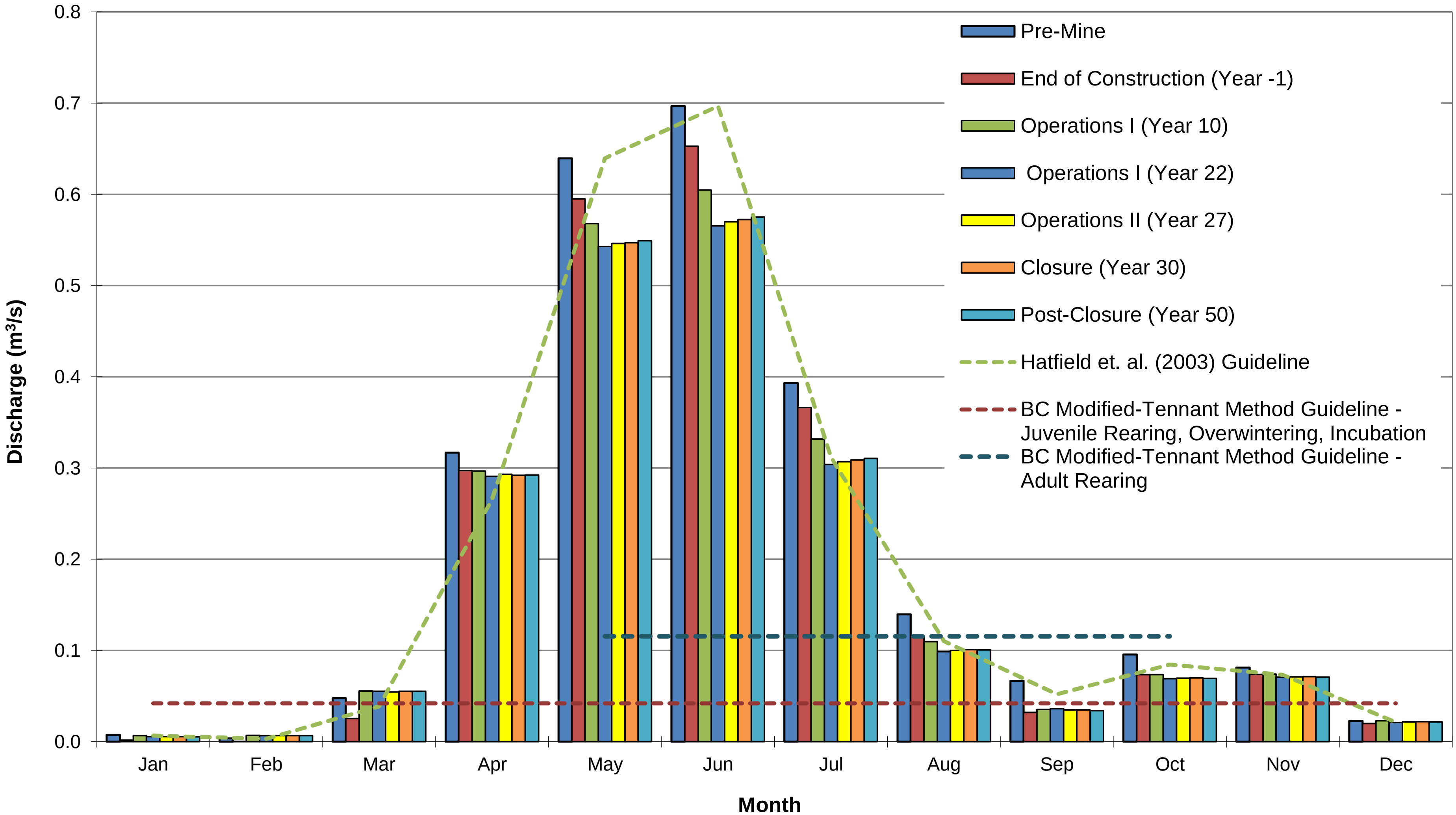
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-6

REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR RAINBOW TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

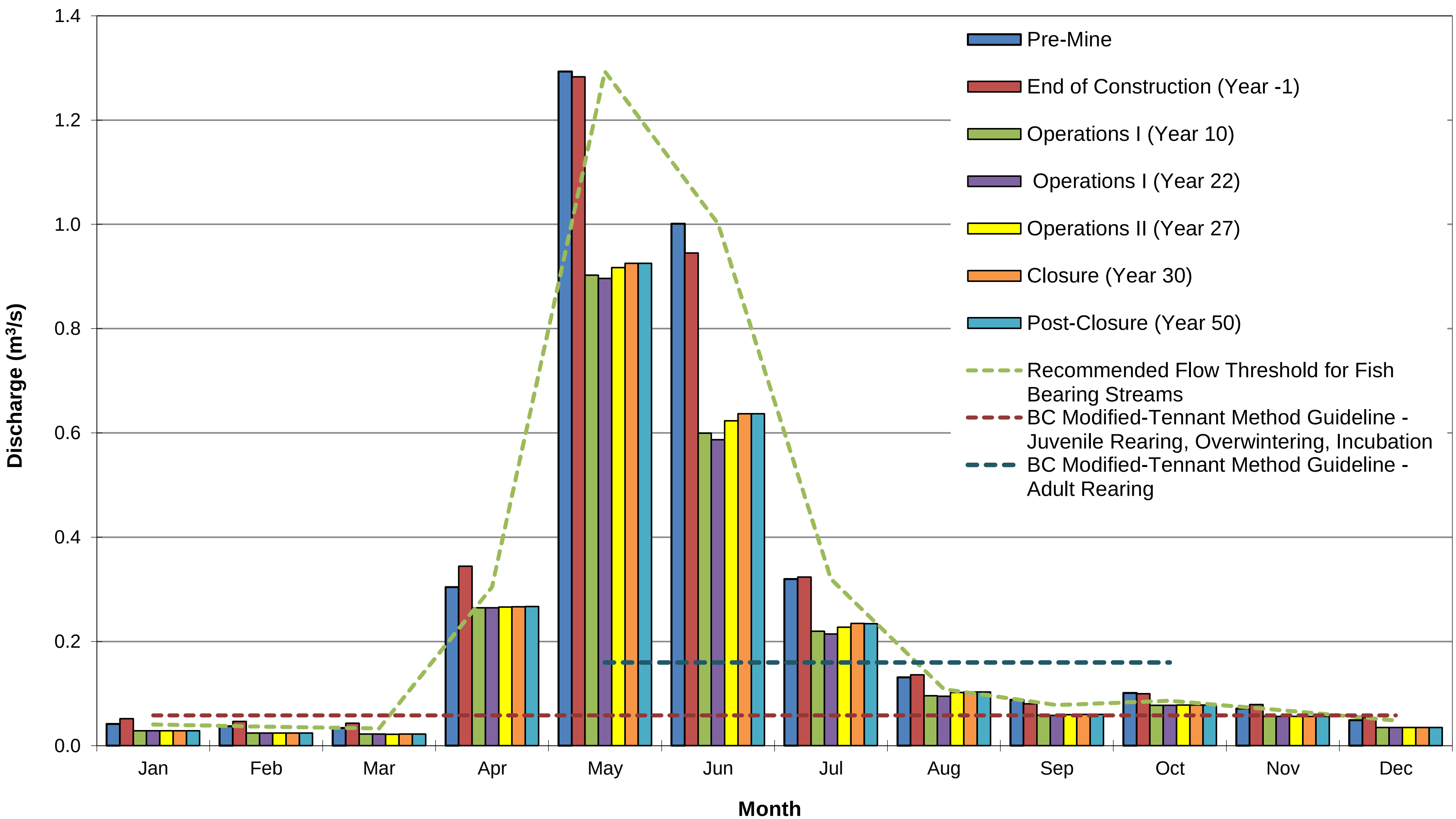
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.	
VA101-458/15	3	
FIGURE A1-7		REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

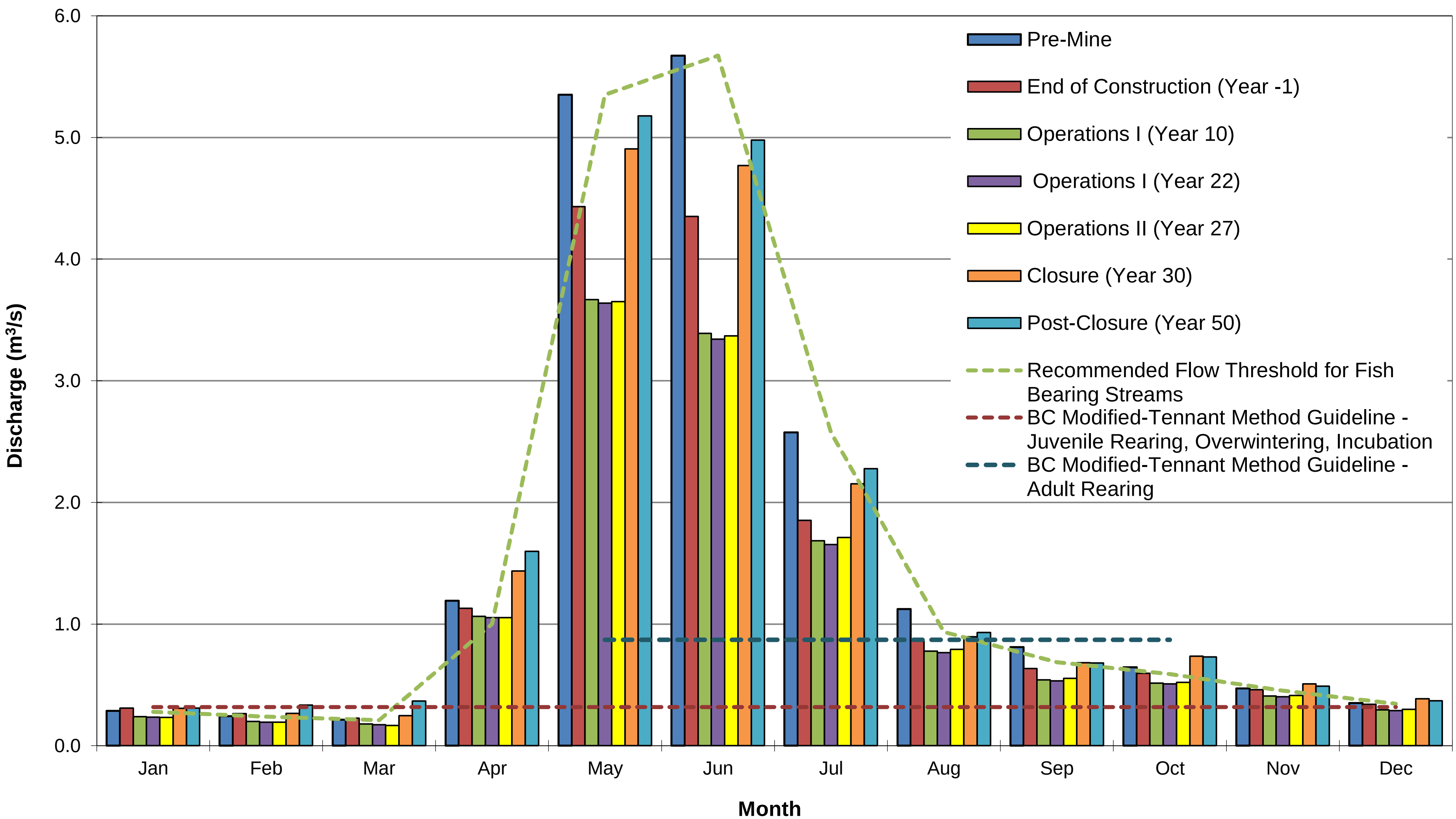
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A1-8		REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

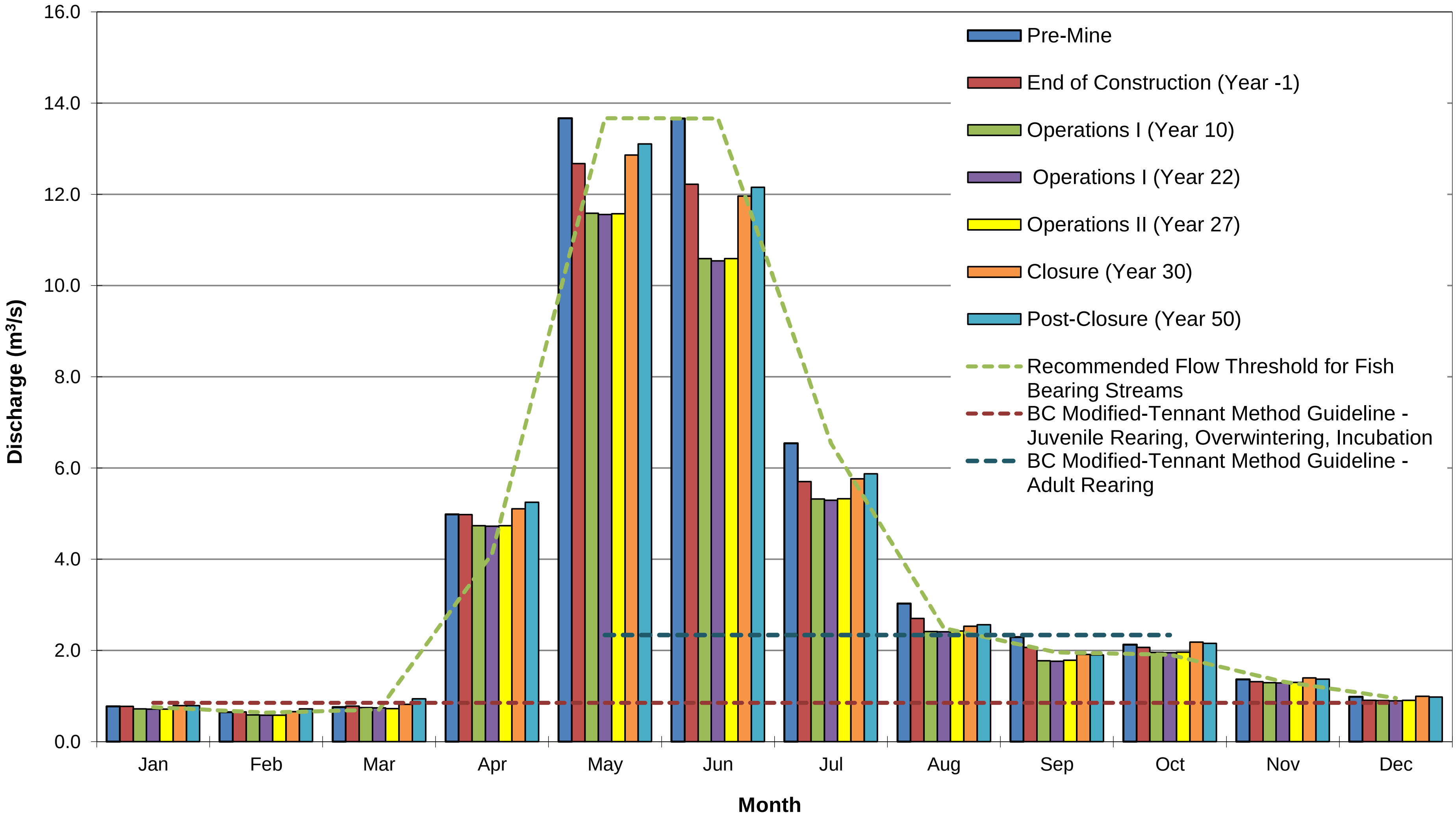
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A1-9		REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

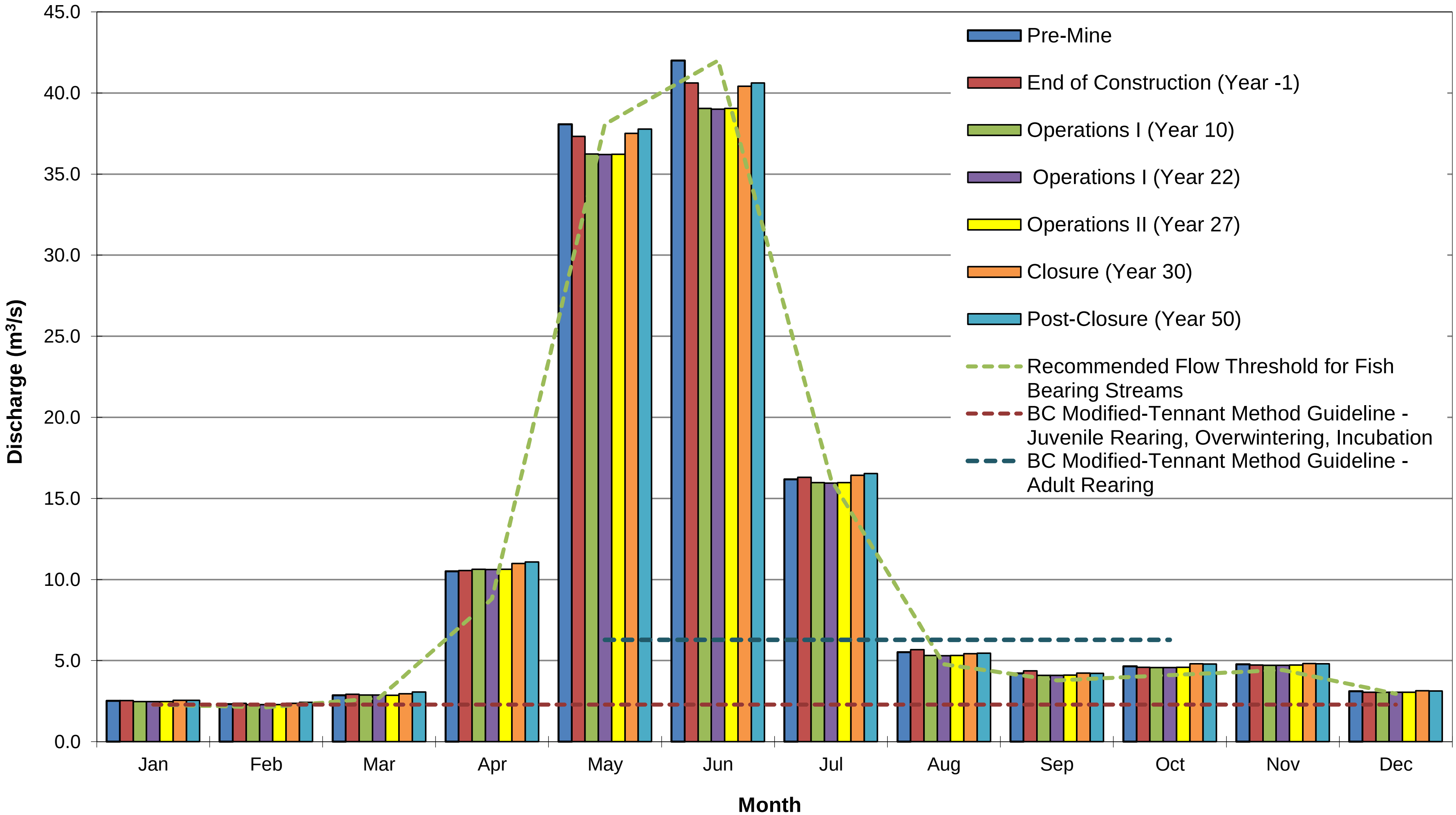
HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15 | REF NO. 3

FIGURE A1-10 | REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

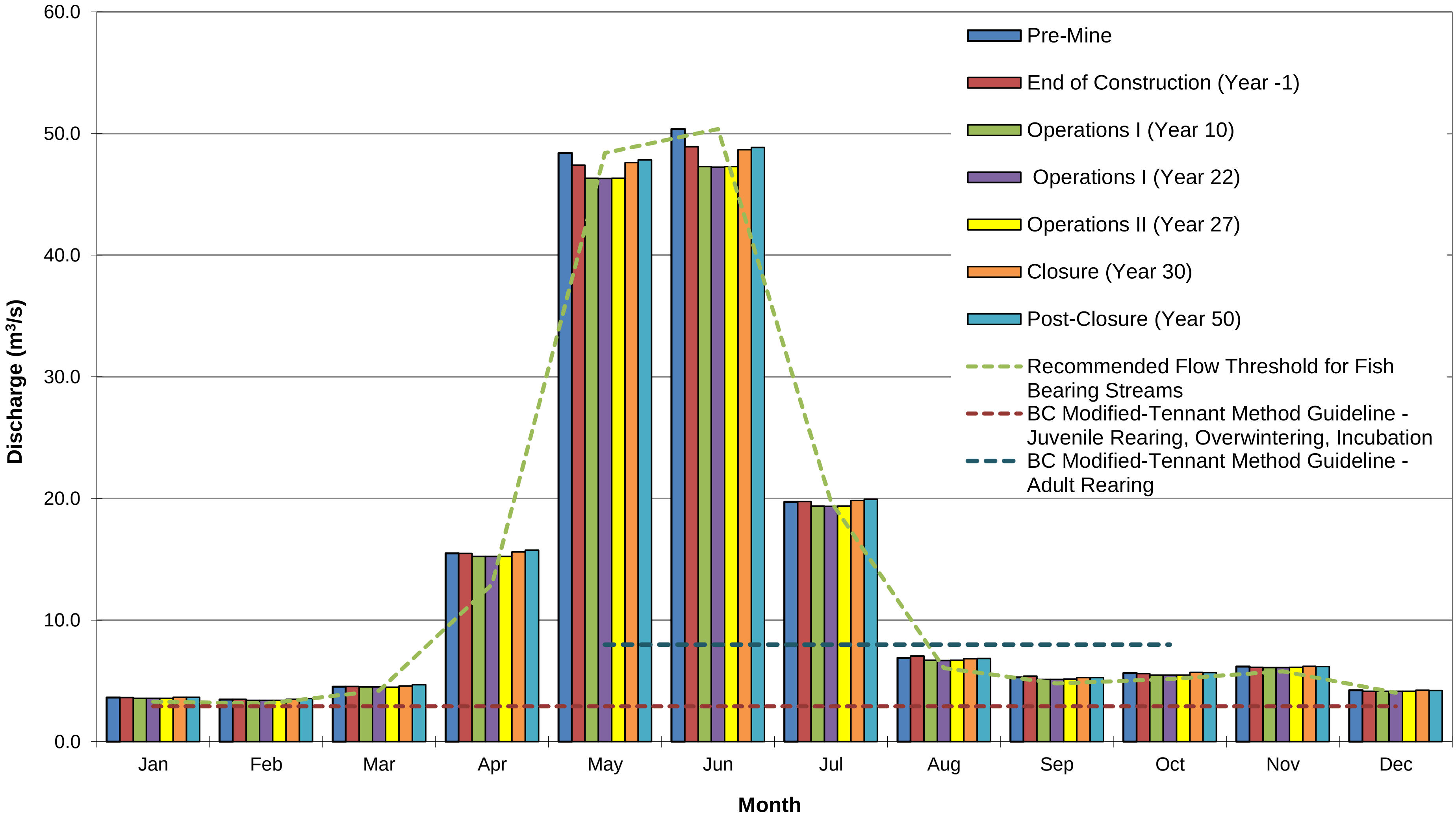
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-11

REV 0



NOTES:
1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR BULL TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

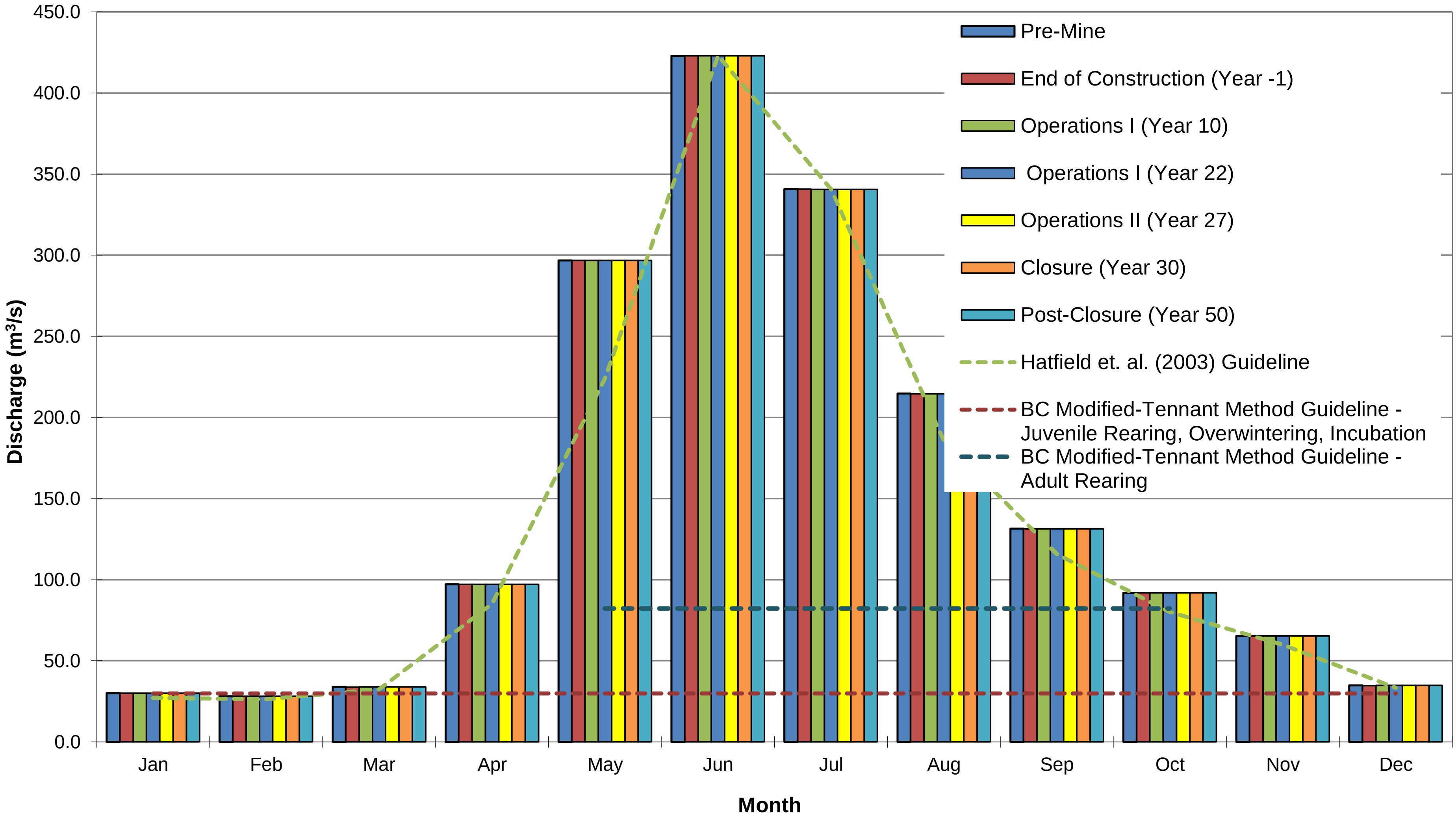
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A1-12		REV 0



NOTES:

1. HATFIELD ET. AL. GUIDELINE CALCULATED FOR FISH BEARING STREAMS.
2. MONTHLY DURATIONS FOR BIOLOGICAL REQUIRMENTS FOR BC MODIFIED-TENNANT METHOD GUIDELINE FLOW RECOMMENDATIONS ASSIGNED FOR RAINBOW TROUT LIFE STAGE.
3. MEAN MONTHLY DISCHARGE FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

GUIDELINE INSTREAM FLOWS FOR NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

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P/A NO. VA101-458/15

REF NO. 3

FIGURE A1-13

REV 0

APPENDIX A2

BC MODIFIED TENNANT GUIDELINES RESULTS FOR NODES 1 TO 13

(Pages A2-1 to A2-13)

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TABLE A2-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Print Oct/15/14 11:15:55

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.80
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>2.2
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.80
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	3.74
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.80
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.40
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>15.99
Wetland Linklage	Weeks	100% of Pre-Mine MAD	4.00

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB

TABLE A2-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Print Oct/15/14 11:14:35

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.21
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.59
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.21
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	1.62
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.21
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.11
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>4.26
Wetland Linklage	Weeks	100% of Pre-Mine MAD	1.07

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET. AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Print Oct/16/14 9:00:27

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.10
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.28
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.10
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	1.03
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.10
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.05
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>2.07
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.52

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE A2-4

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Print Oct/15/14 10:48:38

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.07
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.18
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.07
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	0.77
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.07
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.03
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>1.31
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.33

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NOTE:
1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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CONSULTING

TABLE A2-5

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Print Oct/15/14 10:50:51

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.03
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.08
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.03
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	0.46
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.03
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.01
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>0.58
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.15

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NOTE:
1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-6

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Print Oct/15/14 11:16:57

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.06
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.15
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.06
Spawning	May 16 to June 30	1.56 * Pre-Mine MAD $^{0.63}$	0.70
Egg Incubation	July 1 to August 31	20% of Pre-Mine MAD	0.06
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.03
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>1.11
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.28

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NOTE:

1. PERIOD/DURATION SELECTED FOR RAINBOW TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET. AL. (2003)
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-7

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Print Oct/15/14 10:55:07

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.04
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.12
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.04
Spawning	May 16 to June 30	1.56 * Pre-Mine MAD $^{0.63}$	0.58
Egg Incubation	July 1 to August 31	20% of Pre-Mine MAD	0.04
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.02
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>0.84
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.21

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NOTE:
1. PERIOD/DURATION SELECTED FOR RAINBOW TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET. AL. (2003)
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

TABLE A2-8

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Print Oct/15/14 10:56:52

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.06
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.16
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.06
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	0.72
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.06
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.03
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>1.16
Wetland Linklage	Weeks	100% of Pre-Mine MAD	0.29

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-9

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Print Oct/15/14 11:03:13

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.32
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>0.87
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.32
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	2.08
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.32
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.16
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>6.33
Wetland Linklage	Weeks	100% of Pre-Mine MAD	1.58

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NOTE:
1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-10

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Print Oct/15/14 11:05:17

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	0.85
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>2.34
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	0.85
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	3.88
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	0.85
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	0.42
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>17
Wetland Linklage	Weeks	100% of Pre-Mine MAD	4.25

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-11

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 11
BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Print Oct/15/14 10:59:08

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	2.28
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>6.28
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	2.28
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	7.23
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	2.28
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	1.14
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>45.67
Wetland Linklage	Weeks	100% of Pre-Mine MAD	11.42

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NOTE:
1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-12

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Print Oct/15/14 11:07:14

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	2.90
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>7.98
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	2.90
Spawning	August 16 to September 15	1.56 * Pre-Mine MAD $^{0.63}$	8.42
Egg Incubation	September 16 to February 28	20% of Pre-Mine MAD	2.90
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	1.45
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>58.07
Wetland Linklage	Weeks	100% of Pre-Mine MAD	14.52

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NOTE:

1. PERIOD/DURATION SELECTED FOR BULL TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET AL. (2003).
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A2-13

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BC MODIFIED-TENNANT GUIDELINE INSTREAM FLOWS FOR NODE 13
NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Print Oct/15/14 11:09:27

Biological or Physical Requirement	Period/Duration	Flow Recommendation	
		Recommendation	Node Discharge (m^3/s)
Juvenile Summer Rearing	May 1 to October 31	20% of Pre-Mine MAD	29.92
Adult Summer Rearing	May 1 to October 31	> 55% of Pre-Mine MAD	>82.27
Overwintering	November 1 to April 30	20% of Pre-Mine MAD	29.92
Spawning	May 16 to June 30	1.56 * Pre-Mine MAD $^{0.63}$	36.58
Egg Incubation	July 1 to August 31	20% of Pre-Mine MAD	29.92
Short-term Maintenance	Days to a Week	10% of Pre-Mine MAD	14.96
Channel Maintenance	Days to a Week	> 400% of Pre-Mine MAD	>598.31
Wetland Linklage	Weeks	100% of Pre-Mine MAD	149.58

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NOTE:
1. PERIOD/DURATION SELECTED FOR RAINBOW TROUT LIFE STAGE.
2. FLOW RECOMMENDATION CALCULATED AS OUTLINED IN HATFIELD ET. AL. (2003)
3. DISCHARGE VALUES CALCULATED FROM WATERSHED MODEL RESULTS FOR 1974-2000 AND 2003 TO 2010.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX A3

INDICATORS OF HYDROLOGIC ALTERATION RESULTS FOR NODES 1 TO 13

(Pages A3-1 to A3-13)

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TABLE A3-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Print Oct/15/14 9:59:42

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.72	0.13	0.39	0.97	0.67	0.08	0.51	0.77	0.58	0.85	29%	20%
February	(m^3/s)	0.60	0.11	0.33	0.80	0.54	0.06	0.42	0.63	0.49	0.71	29%	23%
March	(m^3/s)	0.59	0.21	0.34	1.54	0.55	0.30	0.35	2.11	0.38	0.80	11%	20%
April	(m^3/s)	4.14	2.39	0.61	10.11	3.68	2.13	0.42	8.56	1.75	6.53	34%	29%
May	(m^3/s)	12.79	2.98	7.56	19.17	10.82	1.88	7.45	14.74	9.81	15.77	34%	40%
June	(m^3/s)	13.31	4.29	5.00	21.14	10.41	2.82	5.76	18.34	9.01	17.60	40%	37%
July	(m^3/s)	6.46	4.65	2.20	23.26	5.02	2.17	2.22	10.62	2.20	11.10	11%	0%
August	(m^3/s)	2.94	2.40	1.38	11.48	2.39	0.99	1.51	5.83	1.38	5.34	11%	3%
September	(m^3/s)	2.23	1.58	0.95	8.73	1.82	0.65	1.05	4.32	0.95	3.81	14%	3%
October	(m^3/s)	1.92	1.05	0.79	5.99	1.71	0.71	0.88	3.82	0.87	2.97	20%	6%
November	(m^3/s)	1.26	0.32	0.68	1.84	1.18	0.25	0.71	1.60	0.94	1.58	31%	23%
December	(m^3/s)	0.90	0.16	0.56	1.22	0.84	0.11	0.58	0.99	0.75	1.06	29%	23%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.39	0.12	0.15	0.67	0.34	0.10	0.12	0.54	0.27	0.51	34%	26%
3-day Minimum	(m^3/s)	0.40	0.12	0.15	0.68	0.35	0.10	0.12	0.54	0.28	0.52	34%	26%
7-day Minimum	(m^3/s)	0.42	0.12	0.16	0.69	0.37	0.10	0.12	0.55	0.30	0.54	31%	20%
30-day Minimum	(m^3/s)	0.51	0.10	0.30	0.76	0.46	0.08	0.30	0.62	0.41	0.61	31%	34%
90-day Minimum	(m^3/s)	0.62	0.12	0.35	0.84	0.56	0.08	0.37	0.78	0.50	0.73	34%	23%
1-day Maximum	(m^3/s)	32.08	9.13	14.70	54.57	25.81	5.87	15.91	38.61	22.95	41.21	26%	37%
3-day Maximum	(m^3/s)	28.37	7.91	12.05	46.67	22.85	4.75	15.21	33.09	20.46	36.28	26%	31%
7-day Maximum	(m^3/s)	24.33	6.43	10.41	42.52	19.65	4.42	12.33	30.67	17.90	30.76	26%	37%
30-day Maximum	(m^3/s)	17.14	3.48	9.02	24.24	13.82	2.47	9.41	20.01	13.67	20.62	26%	57%
90-day Maximum	(m^3/s)	11.62	2.67	6.26	20.31	9.38	1.55	6.40	13.89	8.95	14.29	26%	40%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-10	55	January-14	October-5	March-14	55	January-14	October-5	January-15	May-4	9%	9%
Date of Annual Maximum	(day)	May-29	16	April-30	July-12	May-27	10	April-30	June-19	May-12	June-14	29%	14%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	29	35	162	91	28	31	155	62	120	23%	29%
High Pulse Count	(day)	91	22	50	151	91	12	68	122	69	113	26%	9%
Low Pulse Duration	(day)	32	27	8	110	29	19	9	87	8	59	11%	9%
High Pulse Duration	(day)	47	33	12	151	35	21	15	101	14	80	26%	9%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.41	0.11	-0.70	-0.24	-0.34	0.06	-0.44	-0.23	-0.52	-0.30	37%	26%
Rise Rate	(m^3/s)	0.62	0.19	0.36	1.20	0.51	0.09	0.37	0.73	0.44	0.81	29%	29%
Number of Flow Reversals	(No.)	102	15	65	135	102	15	67	137	88	117	31%	34%

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NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Print Oct/15/14 10:01:49

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.26	0.05	0.13	0.35	0.24	0.03	0.16	0.29	0.21	0.31	34%	23%
February	(m^3/s)	0.22	0.04	0.11	0.30	0.20	0.03	0.13	0.24	0.18	0.27	34%	26%
March	(m^3/s)	0.20	0.04	0.10	0.27	0.17	0.04	0.11	0.34	0.16	0.24	34%	31%
April	(m^3/s)	0.92	0.64	0.16	2.52	0.85	0.58	0.12	2.25	0.29	1.56	37%	31%
May	(m^3/s)	3.60	0.86	2.16	5.49	3.10	0.57	2.05	4.14	2.74	4.46	37%	31%
June	(m^3/s)	3.35	1.24	1.15	5.78	2.85	0.87	1.46	4.63	2.12	4.59	37%	29%
July	(m^3/s)	1.54	1.21	0.60	6.70	1.42	0.89	0.60	4.98	0.60	2.75	9%	9%
August	(m^3/s)	0.78	0.54	0.39	2.76	0.73	0.39	0.45	2.55	0.39	1.32	11%	6%
September	(m^3/s)	0.58	0.32	0.33	1.98	0.52	0.16	0.33	1.07	0.33	0.90	9%	6%
October	(m^3/s)	0.54	0.24	0.28	1.48	0.50	0.17	0.28	1.00	0.30	0.79	17%	9%
November	(m^3/s)	0.42	0.12	0.24	0.68	0.40	0.10	0.23	0.60	0.30	0.54	29%	29%
December	(m^3/s)	0.32	0.06	0.20	0.42	0.30	0.04	0.19	0.39	0.26	0.38	40%	26%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.13	0.04	0.05	0.23	0.12	0.03	0.05	0.18	0.09	0.18	37%	26%
3-day Minimum	(m^3/s)	0.14	0.04	0.05	0.23	0.12	0.03	0.05	0.18	0.09	0.18	34%	26%
7-day Minimum	(m^3/s)	0.15	0.04	0.05	0.23	0.13	0.03	0.06	0.18	0.10	0.19	31%	26%
30-day Minimum	(m^3/s)	0.18	0.04	0.09	0.26	0.16	0.03	0.10	0.24	0.14	0.22	43%	37%
90-day Minimum	(m^3/s)	0.22	0.05	0.11	0.30	0.20	0.03	0.12	0.28	0.18	0.27	31%	31%
1-day Maximum	(m^3/s)	10.33	3.38	4.30	18.32	8.53	2.52	4.27	15.52	6.94	13.71	26%	31%
3-day Maximum	(m^3/s)	8.65	2.69	3.41	15.46	7.16	2.01	3.78	14.43	5.96	11.34	23%	29%
7-day Maximum	(m^3/s)	7.16	2.17	2.95	14.06	6.02	1.94	3.16	14.02	4.99	9.34	26%	31%
30-day Maximum	(m^3/s)	4.69	0.99	2.52	6.85	4.00	0.93	2.44	6.81	3.70	5.68	31%	46%
90-day Maximum	(m^3/s)	3.01	0.74	1.55	5.51	2.61	0.53	1.63	4.26	2.27	3.75	23%	29%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-19	61	January-14	December-2	March-12	46	January-14	November-5	January-18	May-20	9%	6%
Date of Annual Maximum	(day)	May-26	13	May-1	July-7	May-26	10	May-1	June-19	May-13	June-8	29%	20%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	36	38	174	91	29	39	157	55	127	29%	29%
High Pulse Count	(day)	91	22	52	151	91	17	57	129	69	113	29%	20%
Low Pulse Duration	(day)	28	28	7	118	30	23	7	109	7	56	14%	9%
High Pulse Duration	(day)	43	30	10	151	36	24	10	101	13	74	17%	17%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.13	0.04	-0.22	-0.06	-0.11	0.02	-0.19	-0.07	-0.17	-0.09	31%	14%
Rise Rate	(m^3/s)	0.16	0.05	0.09	0.29	0.14	0.03	0.08	0.23	0.11	0.21	31%	20%
Number of Flow Reversals	(No.)	108	14	78	133	108	14	78	133	94	121	29%	31%

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NOTE:

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2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Print Oct/15/14 10:02:07

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.02	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.01	0.03	40%	100%
February	(m^3/s)	0.02	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.03	43%	100%
March	(m^3/s)	0.01	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.02	43%	100%
April	(m^3/s)	0.27	0.29	0.00	1.10	0.08	0.09	0.00	0.36	0.00	0.56	17%	23%
May	(m^3/s)	1.75	0.52	0.78	2.85	0.55	0.13	0.31	0.81	1.23	2.27	34%	100%
June	(m^3/s)	2.32	0.68	0.86	3.42	0.70	0.24	0.11	1.08	1.64	3.00	40%	100%
July	(m^3/s)	1.04	0.82	0.23	3.65	0.24	0.14	0.02	0.59	0.23	1.86	17%	49%
August	(m^3/s)	0.34	0.43	0.07	2.02	0.04	0.05	0.00	0.19	0.07	0.77	14%	83%
September	(m^3/s)	0.23	0.30	0.03	1.52	0.02	0.03	0.00	0.17	0.03	0.52	9%	83%
October	(m^3/s)	0.10	0.11	0.01	0.65	0.02	0.03	0.00	0.11	0.01	0.21	6%	66%
November	(m^3/s)	0.05	0.03	0.01	0.13	0.00	0.01	0.00	0.02	0.02	0.08	34%	100%
December	(m^3/s)	0.03	0.01	0.00	0.05	0.00	0.00	0.00	0.00	0.02	0.04	31%	100%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	37%	100%
3-day Minimum	(m^3/s)	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	46%	100%
7-day Minimum	(m^3/s)	0.01	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02	43%	100%
30-day Minimum	(m^3/s)	0.01	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.02	46%	100%
90-day Minimum	(m^3/s)	0.02	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.03	43%	100%
1-day Maximum	(m^3/s)	5.90	1.94	2.89	12.75	1.74	0.44	0.69	3.16	3.96	7.84	20%	100%
3-day Maximum	(m^3/s)	5.10	1.41	2.34	9.06	1.52	0.33	0.61	2.23	3.69	6.52	29%	100%
7-day Maximum	(m^3/s)	4.29	1.13	1.66	7.00	1.28	0.30	0.58	1.82	3.16	5.41	31%	100%
30-day Maximum	(m^3/s)	2.89	0.60	1.37	4.16	0.86	0.19	0.49	1.23	2.29	3.49	23%	100%
90-day Maximum	(m^3/s)	1.79	0.42	0.94	3.05	0.52	0.12	0.30	0.75	1.37	2.22	20%	100%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	May-15	97	January-14	October-29	March-29	63	March-1	December-1	February-8	August-20	34%	6%
Date of Annual Maximum	(day)	June-2	23	May-1	September-20	May-30	10	May-10	June-23	May-10	June-25	14%	3%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	57	2	217	91	32	34	166	35	148	34%	9%
High Pulse Count	(day)	91	20	52	130	91	15	48	128	71	111	37%	14%
Low Pulse Duration	(day)	24	23	1	95	63	33	11	120	1	47	17%	66%
High Pulse Duration	(day)	41	29	11	122	51	29	10	104	13	70	20%	34%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.09	0.04	-0.26	-0.05	-0.02	0.01	-0.03	-0.01	-0.12	-0.05	11%	100%
Rise Rate	(m^3/s)	0.10	0.04	0.05	0.28	0.03	0.01	0.01	0.05	0.06	0.13	11%	100%
Number of Flow Reversals	(No.)	105	15	77	134	103	15	75	136	91	120	34%	31%

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NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE A3-4

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Print Oct/15/14 10:02:26

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11%	0%
February	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11%	0%
March	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11%	0%
April	(m^3/s)	0.15	0.18	0.00	0.69	0.00	0.00	0.00	0.00	0.00	0.33	17%	0%
May	(m^3/s)	1.12	0.35	0.46	1.84	0.00	0.00	0.00	0.00	0.77	1.47	34%	100%
June	(m^3/s)	1.56	0.44	0.61	2.31	0.00	0.00	0.00	0.00	1.12	2.00	37%	100%
July	(m^3/s)	0.69	0.56	0.13	2.39	0.00	0.00	0.00	0.00	0.13	1.25	17%	100%
August	(m^3/s)	0.20	0.29	0.02	1.38	0.00	0.00	0.00	0.00	0.02	0.49	14%	100%
September	(m^3/s)	0.13	0.20	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.33	9%	0%
October	(m^3/s)	0.04	0.07	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.11	6%	0%
November	(m^3/s)	0.01	0.02	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.03	11%	0%
December	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11%	0%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9%	0%
3-day Minimum	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9%	0%
7-day Minimum	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9%	0%
30-day Minimum	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9%	0%
90-day Minimum	(m^3/s)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9%	0%
1-day Maximum	(m^3/s)	3.90	1.31	2.03	8.74	0.00	0.00	0.00	0.00	2.59	5.21	20%	100%
3-day Maximum	(m^3/s)	3.37	0.92	1.64	5.94	0.00	0.00	0.00	0.00	2.46	4.29	29%	100%
7-day Maximum	(m^3/s)	2.83	0.73	1.16	4.59	0.00	0.00	0.00	0.00	2.10	3.57	31%	100%
30-day Maximum	(m^3/s)	1.92	0.40	0.91	2.75	0.00	0.00	0.00	0.00	1.52	2.32	23%	100%
90-day Maximum	(m^3/s)	1.18	0.28	0.63	2.00	0.00	0.00	0.00	0.00	0.90	1.46	20%	100%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-14	12	March-1	April-3	-	0	-	-	March-2	March-27	46%	100%
Date of Annual Maximum	(day)	June-3	23	May-1	September-20	-	0	-	-	May-11	June-26	14%	100%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	30	37	163	0	0	0	0	62	121	31%	100%
High Pulse Count	(day)	91	20	52	129	0	0	0	0	71	111	34%	100%
Low Pulse Duration	(day)	65	32	9	121	0	0	0	0	33	97	31%	100%
High Pulse Duration	(day)	45	28	15	122	0	0	0	0	17	73	26%	100%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.06	0.03	-0.18	-0.03	0.00	0.00	0.00	0.00	-0.08	-0.03	9%	100%
Rise Rate	(m^3/s)	0.06	0.03	0.03	0.20	0.00	0.00	0.00	0.00	0.03	0.09	6%	100%
Number of Flow Reversals	(No.)	104	15	75	134	0	0	0	0	90	119	34%	100%

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NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-5

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Print Oct/15/14 10:02:42

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.01	0.01	0.02	46%	100%
February	(m^3/s)	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.02	49%	100%
March	(m^3/s)	0.01	0.00	0.01	0.02	0.01	0.05	0.00	0.31	0.01	0.02	46%	100%
April	(m^3/s)	0.11	0.10	0.01	0.39	0.02	0.02	0.00	0.07	0.01	0.22	20%	46%
May	(m^3/s)	0.62	0.17	0.30	0.98	0.24	0.06	0.14	0.34	0.45	0.79	29%	100%
June	(m^3/s)	0.60	0.26	0.16	1.05	0.19	0.07	0.05	0.32	0.34	0.86	43%	100%
July	(m^3/s)	0.19	0.23	0.04	1.28	0.04	0.04	0.01	0.17	0.04	0.42	6%	63%
August	(m^3/s)	0.07	0.09	0.02	0.43	0.01	0.02	0.00	0.10	0.02	0.15	9%	86%
September	(m^3/s)	0.04	0.04	0.01	0.24	0.00	0.00	0.00	0.02	0.01	0.08	9%	91%
October	(m^3/s)	0.03	0.03	0.01	0.19	0.01	0.01	0.00	0.04	0.01	0.07	9%	63%
November	(m^3/s)	0.02	0.01	0.01	0.06	0.04	0.04	0.00	0.11	0.01	0.03	14%	94%
December	(m^3/s)	0.02	0.00	0.01	0.02	0.02	0.02	0.00	0.04	0.01	0.02	26%	94%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	29%	100%
3-day Minimum	(m^3/s)	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	29%	100%
7-day Minimum	(m^3/s)	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	31%	100%
30-day Minimum	(m^3/s)	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.01	29%	100%
90-day Minimum	(m^3/s)	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.01	0.02	43%	100%
1-day Maximum	(m^3/s)	1.90	0.81	0.96	5.24	0.65	0.21	0.34	1.14	1.09	2.71	11%	97%
3-day Maximum	(m^3/s)	1.65	0.53	0.78	3.20	0.59	0.19	0.28	1.00	1.12	2.17	20%	100%
7-day Maximum	(m^3/s)	1.38	0.39	0.65	2.40	0.49	0.15	0.25	0.94	0.99	1.76	31%	100%
30-day Maximum	(m^3/s)	0.88	0.19	0.46	1.29	0.31	0.07	0.16	0.50	0.69	1.07	26%	100%
90-day Maximum	(m^3/s)	0.50	0.13	0.24	0.97	0.16	0.03	0.09	0.22	0.37	0.63	20%	100%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	May-18	128	January-10	December-8	April-2	81	March-1	December-26	January-11	September-23	34%	9%
Date of Annual Maximum	(day)	May-27	15	April-30	July-12	May-25	10	May-1	June-19	May-12	June-11	26%	17%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	55	9	224	91	40	31	199	36	147	23%	11%
High Pulse Count	(day)	91	22	49	143	91	29	51	184	69	113	34%	49%
Low Pulse Duration	(day)	14	9	6	42	45	30	9	121	6	23	14%	69%
High Pulse Duration	(day)	44	31	12	143	34	19	9	92	13	75	23%	11%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.02	0.01	-0.05	-0.01	-0.01	0.00	-0.01	0.00	-0.03	-0.02	29%	100%
Rise Rate	(m^3/s)	0.03	0.01	0.01	0.06	0.01	0.00	0.00	0.02	0.02	0.04	20%	100%
Number of Flow Reversals	(No.)	106	12	76	129	105	13	70	130	94	118	31%	37%

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NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-6

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

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Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.02	0.01	0.00	0.05	0.02	0.01	0.00	0.03	0.00	0.03	46%	3%
February	(m^3/s)	0.01	0.01	0.00	0.03	0.00	0.00	0.00	0.01	0.00	0.02	20%	0%
March	(m^3/s)	0.02	0.04	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.06	11%	0%
April	(m^3/s)	0.31	0.13	0.08	0.56	0.31	0.12	0.07	0.56	0.18	0.44	37%	31%
May	(m^3/s)	0.84	0.20	0.42	1.31	0.90	0.18	0.55	1.22	0.64	1.05	34%	40%
June	(m^3/s)	0.96	0.28	0.44	1.93	1.02	0.30	0.43	1.64	0.68	1.24	23%	43%
July	(m^3/s)	0.56	0.33	0.18	1.93	0.53	0.24	0.17	1.04	0.24	0.89	20%	26%
August	(m^3/s)	0.22	0.22	0.05	1.21	0.13	0.06	0.03	0.27	0.05	0.44	9%	6%
September	(m^3/s)	0.11	0.11	0.02	0.56	0.05	0.02	0.01	0.14	0.02	0.22	11%	3%
October	(m^3/s)	0.13	0.10	0.01	0.32	0.09	0.07	0.01	0.34	0.03	0.23	37%	14%
November	(m^3/s)	0.11	0.09	0.00	0.34	0.10	0.08	0.00	0.28	0.02	0.20	34%	20%
December	(m^3/s)	0.04	0.03	0.00	0.09	0.04	0.02	0.00	0.08	0.01	0.06	31%	20%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	17%	0%
3-day Minimum	(m^3/s)	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	17%	0%
7-day Minimum	(m^3/s)	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	17%	0%
30-day Minimum	(m^3/s)	0.01	0.01	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.01	17%	0%
90-day Minimum	(m^3/s)	0.01	0.01	0.00	0.05	0.01	0.00	0.00	0.02	0.00	0.02	34%	0%
1-day Maximum	(m^3/s)	2.06	0.61	0.85	3.83	2.19	0.61	1.22	3.89	1.45	2.66	29%	29%
3-day Maximum	(m^3/s)	1.82	0.55	0.70	3.55	1.94	0.49	1.17	3.01	1.28	2.37	26%	26%
7-day Maximum	(m^3/s)	1.58	0.46	0.62	2.98	1.69	0.40	0.93	2.51	1.12	2.03	17%	29%
30-day Maximum	(m^3/s)	1.14	0.28	0.52	2.03	1.21	0.28	0.71	1.75	0.86	1.43	23%	34%
90-day Maximum	(m^3/s)	0.83	0.24	0.42	1.76	0.85	0.19	0.51	1.26	0.59	1.06	23%	23%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	February-27	56	January-14	December-31	March-1	6	February-2	March-16	January-14	April-23	3%	0%
Date of Annual Maximum	(day)	May-28	12	May-1	July-1	May-28	10	May-6	June-16	May-15	June-9	26%	20%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	48	6	212	91	30	59	223	44	139	20%	9%
High Pulse Count	(day)	91	20	55	153	91	14	58	118	71	112	29%	17%
Low Pulse Duration	(day)	42	28	6	106	42	13	22	90	14	69	23%	3%
High Pulse Duration	(day)	52	32	6	153	61	30	16	113	19	84	34%	43%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.03	0.01	-0.05	-0.01	-0.03	0.01	-0.04	-0.01	-0.04	-0.02	29%	6%
Rise Rate	(m^3/s)	0.03	0.01	0.01	0.07	0.03	0.01	0.02	0.05	0.02	0.05	23%	9%
Number of Flow Reversals	(No.)	101	15	70	134	101	14	72	136	87	116	34%	26%

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NOTE:

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2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A3-7

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Print Oct/15/14 10:03:03

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.01	0.01	0.00	0.03	0.01	0.00	0.00	0.02	0.00	0.02	17%	3%
February	(m^3/s)	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.04	0.00	0.01	9%	14%
March	(m^3/s)	0.05	0.06	0.00	0.25	0.06	0.07	0.00	0.30	0.00	0.11	14%	20%
April	(m^3/s)	0.32	0.12	0.09	0.59	0.29	0.09	0.10	0.46	0.20	0.43	31%	23%
May	(m^3/s)	0.64	0.16	0.30	1.00	0.54	0.10	0.33	0.70	0.48	0.80	37%	31%
June	(m^3/s)	0.70	0.22	0.31	1.54	0.57	0.16	0.33	1.00	0.48	0.92	20%	34%
July	(m^3/s)	0.39	0.24	0.11	1.41	0.30	0.17	0.10	0.95	0.15	0.63	20%	20%
August	(m^3/s)	0.14	0.16	0.02	0.86	0.10	0.10	0.02	0.57	0.02	0.30	9%	6%
September	(m^3/s)	0.07	0.08	0.00	0.37	0.04	0.04	0.00	0.20	0.00	0.15	14%	3%
October	(m^3/s)	0.10	0.09	0.00	0.27	0.07	0.06	0.00	0.29	0.01	0.18	34%	14%
November	(m^3/s)	0.08	0.07	0.00	0.25	0.07	0.05	0.00	0.22	0.01	0.16	31%	17%
December	(m^3/s)	0.02	0.02	0.00	0.07	0.02	0.01	0.00	0.05	0.00	0.04	37%	6%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	20%	9%
3-day Minimum	(m^3/s)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	14%	11%
7-day Minimum	(m^3/s)	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	11%	11%
30-day Minimum	(m^3/s)	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.01	14%	11%
90-day Minimum	(m^3/s)	0.01	0.01	0.00	0.04	0.01	0.01	0.00	0.03	0.00	0.02	14%	9%
1-day Maximum	(m^3/s)	1.53	0.48	0.57	3.07	1.29	0.31	0.85	2.27	1.05	2.01	23%	26%
3-day Maximum	(m^3/s)	1.35	0.44	0.50	2.85	1.13	0.29	0.69	2.16	0.92	1.79	23%	31%
7-day Maximum	(m^3/s)	1.16	0.36	0.45	2.41	0.98	0.27	0.56	2.05	0.80	1.53	17%	29%
30-day Maximum	(m^3/s)	0.84	0.23	0.37	1.71	0.70	0.16	0.42	1.05	0.62	1.07	20%	29%
90-day Maximum	(m^3/s)	0.61	0.18	0.33	1.36	0.51	0.12	0.27	0.88	0.43	0.80	20%	31%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	February-27	78	February-1	December-31	March-3	92	January-6	December-31	February-1	May-15	6%	23%
Date of Annual Maximum	(day)	May-26	13	April-30	July-1	May-24	14	March-31	June-16	May-13	June-9	31%	20%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	53	6	212	91	51	18	215	39	144	31%	29%
High Pulse Count	(day)	91	23	46	150	91	21	37	132	68	114	29%	26%
Low Pulse Duration	(day)	48	27	6	106	49	26	4	106	21	75	40%	26%
High Pulse Duration	(day)	47	27	7	107	50	30	12	121	20	74	37%	46%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.02	0.01	-0.04	-0.01	-0.02	0.00	-0.04	-0.01	-0.03	-0.01	29%	20%
Rise Rate	(m^3/s)	0.03	0.01	0.01	0.06	0.02	0.01	0.01	0.04	0.02	0.04	23%	51%
Number of Flow Reversals	(No.)	101	14	70	135	101	15	70	136	87	115	26%	31%

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NOTE:
1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB

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TABLE A3-8

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Print Oct/15/14 10:04:41

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.04	0.01	0.02	0.06	0.03	0.01	0.01	0.05	0.03	0.05	37%	60%
February	(m^3/s)	0.04	0.01	0.01	0.05	0.02	0.01	0.01	0.04	0.03	0.05	37%	63%
March	(m^3/s)	0.03	0.01	0.01	0.05	0.02	0.01	0.01	0.07	0.02	0.04	43%	71%
April	(m^3/s)	0.30	0.24	0.02	0.88	0.26	0.20	0.01	0.74	0.07	0.54	37%	31%
May	(m^3/s)	1.29	0.31	0.76	1.97	0.90	0.18	0.60	1.18	0.98	1.60	37%	66%
June	(m^3/s)	1.00	0.51	0.24	2.07	0.59	0.36	0.14	1.34	0.49	1.51	37%	51%
July	(m^3/s)	0.32	0.41	0.08	2.44	0.21	0.26	0.04	1.44	0.08	0.73	6%	23%
August	(m^3/s)	0.13	0.14	0.05	0.65	0.09	0.12	0.02	0.72	0.05	0.27	11%	40%
September	(m^3/s)	0.09	0.06	0.04	0.34	0.06	0.03	0.02	0.18	0.04	0.15	9%	37%
October	(m^3/s)	0.10	0.08	0.03	0.46	0.08	0.06	0.02	0.25	0.03	0.18	9%	26%
November	(m^3/s)	0.07	0.03	0.03	0.14	0.06	0.03	0.02	0.11	0.04	0.10	37%	49%
December	(m^3/s)	0.05	0.01	0.02	0.07	0.03	0.01	0.01	0.06	0.04	0.06	40%	57%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.02	0.01	0.01	0.04	0.01	0.01	0.00	0.03	0.01	0.03	29%	54%
3-day Minimum	(m^3/s)	0.02	0.01	0.01	0.04	0.01	0.01	0.00	0.03	0.01	0.03	29%	54%
7-day Minimum	(m^3/s)	0.02	0.01	0.01	0.04	0.01	0.01	0.00	0.03	0.02	0.03	31%	54%
30-day Minimum	(m^3/s)	0.03	0.01	0.01	0.05	0.02	0.01	0.01	0.03	0.02	0.04	37%	63%
90-day Minimum	(m^3/s)	0.04	0.01	0.01	0.05	0.02	0.01	0.01	0.04	0.03	0.05	40%	60%
1-day Maximum	(m^3/s)	3.76	1.63	1.96	9.95	2.59	0.83	1.26	5.16	2.13	5.40	11%	34%
3-day Maximum	(m^3/s)	3.26	1.15	1.59	6.95	2.29	0.73	1.02	4.23	2.11	4.41	20%	46%
7-day Maximum	(m^3/s)	2.71	0.81	1.32	5.09	1.86	0.53	0.85	3.67	1.90	3.52	26%	71%
30-day Maximum	(m^3/s)	1.67	0.37	0.94	2.57	1.13	0.29	0.61	1.70	1.30	2.04	26%	69%
90-day Maximum	(m^3/s)	0.95	0.26	0.45	1.95	0.63	0.18	0.32	1.13	0.69	1.22	17%	66%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	April-13	99	January-14	December-2	April-21	97	February-1	November-25	January-14	July-21	23%	26%
Date of Annual Maximum	(day)	May-25	16	April-27	July-12	May-23	11	April-30	June-13	May-10	June-10	20%	14%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	56	5	240	91	55	8	217	35	147	37%	40%
High Pulse Count	(day)	91	23	48	143	91	29	37	165	68	115	40%	37%
Low Pulse Duration	(day)	22	25	2	121	21	23	3	120	2	47	14%	9%
High Pulse Duration	(day)	36	26	8	143	24	9	9	47	10	63	14%	3%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.05	0.01	-0.09	-0.02	-0.03	0.01	-0.05	-0.02	-0.06	-0.03	23%	57%
Rise Rate	(m^3/s)	0.06	0.02	0.03	0.12	0.04	0.01	0.02	0.07	0.04	0.07	26%	60%
Number of Flow Reversals	(No.)	106	12	74	129	106	12	76	131	94	118	29%	29%

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NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A3-9

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Print Oct/15/14 10:06:40

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
				Range Limits				Range Limits					
Parameter	**Unit**	**Mean**	**Standard Deviation**	**Low**	**High**	**Mean**	**Standard Deviation**	**Low**	**High**	**Low**	**High**	**Pre-Mine**	**Operations I (Year 22)**
Group 1: Monthly Magnitude													
January	(m^3/s)	0.29	0.06	0.13	0.39	0.23	0.04	0.14	0.32	0.22	0.35	31%	37%
February	(m^3/s)	0.24	0.05	0.11	0.33	0.19	0.03	0.11	0.26	0.19	0.30	31%	40%
March	(m^3/s)	0.21	0.05	0.10	0.30	0.17	0.04	0.10	0.34	0.17	0.26	37%	40%
April	(m^3/s)	1.19	0.92	0.16	3.62	1.05	0.71	0.14	2.61	0.27	2.11	31%	23%
May	(m^3/s)	5.35	1.36	2.95	8.33	3.64	0.71	1.78	4.99	3.99	6.71	31%	60%
June	(m^3/s)	5.67	1.88	2.01	8.63	3.34	1.14	1.07	5.62	3.79	7.56	40%	69%
July	(m^3/s)	2.58	2.01	0.86	10.34	1.65	1.11	0.51	5.92	0.86	4.59	11%	29%
August	(m^3/s)	1.12	0.96	0.46	4.78	0.76	0.46	0.32	3.05	0.46	2.08	11%	6%
September	(m^3/s)	0.81	0.61	0.36	3.50	0.53	0.21	0.27	1.22	0.36	1.42	9%	20%
October	(m^3/s)	0.65	0.35	0.30	2.13	0.51	0.19	0.24	1.11	0.30	0.99	11%	9%
November	(m^3/s)	0.47	0.14	0.25	0.80	0.40	0.11	0.20	0.62	0.33	0.61	29%	29%
December	(m^3/s)	0.35	0.07	0.21	0.47	0.29	0.05	0.17	0.39	0.28	0.42	31%	40%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.14	0.05	0.05	0.26	0.12	0.03	0.06	0.20	0.10	0.19	29%	29%
3-day Minimum	(m^3/s)	0.15	0.05	0.05	0.26	0.12	0.03	0.06	0.20	0.10	0.20	26%	26%
7-day Minimum	(m^3/s)	0.16	0.05	0.05	0.26	0.13	0.03	0.08	0.21	0.11	0.21	31%	29%
30-day Minimum	(m^3/s)	0.20	0.05	0.09	0.29	0.16	0.03	0.10	0.23	0.15	0.25	34%	29%
90-day Minimum	(m^3/s)	0.24	0.05	0.11	0.33	0.19	0.04	0.11	0.28	0.19	0.30	34%	37%
1-day Maximum	(m^3/s)	16.02	4.98	6.53	27.82	10.21	3.16	5.19	16.37	11.04	21.00	23%	54%
3-day Maximum	(m^3/s)	13.48	3.89	5.17	22.61	8.54	2.58	4.72	15.90	9.59	17.37	26%	69%
7-day Maximum	(m^3/s)	11.18	3.23	4.47	21.26	7.02	2.05	4.01	14.21	7.95	14.40	23%	69%
30-day Maximum	(m^3/s)	7.45	1.57	3.83	10.93	4.68	0.96	2.38	6.58	5.88	9.02	29%	86%
90-day Maximum	(m^3/s)	4.78	1.14	2.47	8.35	3.09	0.70	1.68	5.09	3.64	5.91	23%	80%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-19	61	January-14	December-2	March-4	20	January-14	April-5	January-18	May-20	9%	3%
Date of Annual Maximum	(day)	May-26	13	May-1	July-7	May-26	13	April-30	July-1	May-13	June-8	29%	26%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	37	37	174	91	31	47	202	54	129	34%	17%
High Pulse Count	(day)	91	22	50	151	91	20	46	149	69	114	31%	23%
Low Pulse Duration	(day)	30	28	7	116	25	20	6	111	7	58	17%	9%
High Pulse Duration	(day)	49	29	16	151	38	28	9	121	20	78	31%	46%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.20	0.06	-0.35	-0.09	-0.13	0.03	-0.18	-0.08	-0.26	-0.13	34%	63%
Rise Rate	(m^3/s)	0.25	0.08	0.13	0.44	0.16	0.04	0.09	0.24	0.17	0.32	31%	54%
Number of Flow Reversals	(No.)	107	14	80	131	107	14	78	133	94	121	31%	34%

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NOTE:

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2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A3-10

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Print Oct/15/14 10:05:06

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	0.77	0.14	0.42	1.05	0.72	0.11	0.41	0.89	0.63	0.92	29%	17%
February	(m^3/s)	0.65	0.12	0.36	0.87	0.58	0.09	0.33	0.72	0.53	0.76	26%	26%
March	(m^3/s)	0.76	0.37	0.39	2.25	0.74	0.48	0.30	3.01	0.39	1.13	11%	14%
April	(m^3/s)	4.99	2.62	1.03	11.66	4.73	2.29	0.94	9.97	2.37	7.61	31%	26%
May	(m^3/s)	13.67	3.15	8.19	20.25	11.56	2.20	6.14	15.83	10.52	16.81	34%	31%
June	(m^3/s)	13.66	4.62	5.04	23.44	10.54	3.17	3.95	16.94	9.04	18.29	40%	34%
July	(m^3/s)	6.54	4.81	2.24	24.52	5.29	2.65	1.71	11.87	2.24	11.35	11%	6%
August	(m^3/s)	3.03	2.44	1.45	11.56	2.41	0.93	1.22	4.73	1.45	5.47	11%	9%
September	(m^3/s)	2.29	1.57	1.01	8.72	1.77	0.73	0.94	4.71	1.01	3.87	14%	11%
October	(m^3/s)	2.13	1.19	0.87	6.46	1.95	0.90	0.78	4.51	0.94	3.31	20%	20%
November	(m^3/s)	1.37	0.35	0.73	2.07	1.29	0.30	0.63	1.76	1.01	1.72	31%	20%
December	(m^3/s)	0.98	0.18	0.61	1.37	0.90	0.15	0.50	1.12	0.81	1.16	26%	20%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	0.44	0.13	0.16	0.73	0.40	0.11	0.18	0.65	0.31	0.57	31%	29%
3-day Minimum	(m^3/s)	0.45	0.13	0.16	0.73	0.41	0.11	0.19	0.66	0.32	0.58	31%	29%
7-day Minimum	(m^3/s)	0.47	0.13	0.17	0.74	0.44	0.11	0.21	0.67	0.34	0.60	31%	29%
30-day Minimum	(m^3/s)	0.57	0.12	0.33	0.86	0.52	0.10	0.30	0.70	0.45	0.69	34%	26%
90-day Minimum	(m^3/s)	0.69	0.13	0.44	0.97	0.64	0.11	0.34	0.86	0.56	0.83	34%	31%
1-day Maximum	(m^3/s)	33.79	9.82	15.44	57.53	28.51	7.62	16.18	54.59	23.97	43.61	23%	29%
3-day Maximum	(m^3/s)	29.89	8.53	12.66	49.78	25.20	6.64	14.87	52.54	21.36	38.42	26%	29%
7-day Maximum	(m^3/s)	25.53	6.89	10.93	44.95	21.21	5.46	12.52	44.20	18.63	32.42	31%	23%
30-day Maximum	(m^3/s)	17.95	3.75	9.47	27.25	14.32	2.60	7.25	19.82	14.21	21.70	29%	40%
90-day Maximum	(m^3/s)	12.23	2.88	6.53	22.01	9.95	1.99	5.26	13.30	9.35	15.11	23%	34%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-14	76	January-14	December-31	March-6	60	January-10	November-5	January-14	May-29	9%	9%
Date of Annual Maximum	(day)	May-29	16	April-30	July-12	May-25	13	April-27	July-5	May-12	June-14	29%	17%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	32	15	165	91	33	40	174	60	123	29%	31%
High Pulse Count	(day)	91	22	49	151	91	17	51	119	69	113	23%	17%
Low Pulse Duration	(day)	28	23	7	106	25	12	6	59	7	51	9%	6%
High Pulse Duration	(day)	44	32	11	151	28	12	9	54	12	77	23%	11%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.44	0.12	-0.75	-0.25	-0.37	0.07	-0.50	-0.19	-0.56	-0.32	37%	26%
Rise Rate	(m^3/s)	0.66	0.20	0.37	1.30	0.55	0.12	0.30	0.77	0.46	0.86	29%	23%
Number of Flow Reversals	(No.)	103	15	67	135	103	15	67	137	88	117	29%	34%

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NOTE:

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0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE A3-11

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 11
BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Print Oct/15/14 10:05:26

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	2.52	1.37	1.15	8.01	2.40	1.34	0.00	7.59	1.15	3.88	11%	14%
February	(m^3/s)	2.32	1.42	1.15	8.98	2.20	1.41	0.00	8.62	1.15	3.73	6%	11%
March	(m^3/s)	2.86	1.50	1.30	6.98	2.77	1.61	0.05	7.01	1.37	4.36	17%	29%
April	(m^3/s)	10.51	4.43	2.65	21.14	10.04	5.32	0.27	19.11	6.08	14.93	34%	49%
May	(m^3/s)	38.06	8.99	17.12	56.45	36.69	9.08	10.54	59.10	29.08	47.05	37%	23%
June	(m^3/s)	42.00	15.06	18.99	81.70	40.36	15.09	9.87	74.25	26.95	57.06	37%	29%
July	(m^3/s)	16.18	10.97	5.32	54.79	16.49	10.07	2.35	49.26	5.32	27.14	14%	26%
August	(m^3/s)	5.51	4.66	1.62	28.42	5.64	3.62	0.73	19.32	1.62	10.18	6%	14%
September	(m^3/s)	4.22	2.56	1.13	13.39	4.10	2.49	0.55	13.19	1.66	6.77	20%	20%
October	(m^3/s)	4.64	2.84	1.02	14.12	4.50	3.06	0.21	14.95	1.81	7.48	20%	26%
November	(m^3/s)	4.78	2.44	1.76	9.62	4.62	2.46	0.00	9.63	2.34	7.21	34%	37%
December	(m^3/s)	3.10	1.51	1.52	8.51	2.98	1.52	0.00	8.23	1.59	4.62	17%	17%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	1.46	0.46	0.68	2.80	0.96	0.67	0.00	2.42	1.00	1.93	20%	51%
3-day Minimum	(m^3/s)	1.49	0.47	0.73	2.96	1.06	0.69	0.00	2.65	1.02	1.97	20%	46%
7-day Minimum	(m^3/s)	1.56	0.52	0.87	3.44	1.15	0.70	0.00	2.87	1.04	2.08	20%	40%
30-day Minimum	(m^3/s)	1.78	0.64	1.02	4.23	1.40	0.79	0.00	3.99	1.13	2.42	14%	37%
90-day Minimum	(m^3/s)	2.14	0.88	1.28	4.91	1.93	0.89	0.00	4.73	1.28	3.02	9%	23%
1-day Maximum	(m^3/s)	81.12	22.17	39.60	143.00	80.45	21.10	41.32	144.65	58.94	103.29	29%	26%
3-day Maximum	(m^3/s)	78.00	20.88	37.27	129.33	76.99	19.47	40.23	123.42	57.12	98.88	31%	26%
7-day Maximum	(m^3/s)	71.39	19.15	32.01	116.57	70.00	17.71	36.72	115.84	52.24	90.53	31%	29%
30-day Maximum	(m^3/s)	53.50	12.19	26.76	81.90	51.94	11.46	32.91	75.03	41.31	65.69	29%	29%
90-day Maximum	(m^3/s)	33.71	7.79	20.21	59.29	32.82	6.84	21.31	52.57	25.92	41.50	26%	26%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	April-30	137	January-1	December-31	June-12	124	January-4	December-31	January-1	September-14	31%	31%
Date of Annual Maximum	(day)	June-2	18	May-7	August-21	May-28	13	April-29	June-17	May-14	June-20	17%	17%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	60	0	229	91	55	0	217	31	151	31%	31%
High Pulse Count	(day)	91	21	65	146	93	20	58	155	70	112	31%	17%
Low Pulse Duration	(day)	31	18	2	65	22	15	0	72	13	50	40%	43%
High Pulse Duration	(day)	51	26	20	106	38	20	16	107	25	77	23%	31%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.70	0.21	-1.35	-0.38	-0.75	0.20	-1.37	-0.45	-0.91	-0.49	23%	17%
Rise Rate	(m^3/s)	1.06	0.35	0.55	2.12	1.14	0.35	0.60	2.18	0.71	1.41	20%	17%
Number of Flow Reversals	(No.)	71	22	42	141	87	19	60	141	49	94	17%	34%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node 11_IHA.xlsx]info

NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-12

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Print Oct/15/14 10:05:53

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	Unit			Low	High			Low	High	Low	High	Pre-Mine	Operations I (Year 22)
Group 1: Monthly Magnitude													
January	(m^3/s)	3.62	2.00	1.49	11.60	3.57	1.91	1.74	11.17	1.62	5.63	14%	11%
February	(m^3/s)	3.47	2.28	1.66	14.63	3.41	2.22	1.78	14.27	1.66	5.76	6%	6%
March	(m^3/s)	4.52	2.49	1.95	11.99	4.50	2.47	1.65	11.36	2.03	7.01	17%	23%
April	(m^3/s)	15.49	6.18	3.75	30.52	15.23	6.79	1.53	26.63	9.31	21.67	26%	40%
May	(m^3/s)	48.41	10.48	27.69	76.19	46.30	11.33	21.11	78.84	37.92	58.89	31%	29%
June	(m^3/s)	50.36	20.12	24.00	107.19	47.24	19.14	14.88	98.51	30.25	70.48	34%	29%
July	(m^3/s)	19.72	14.17	5.87	70.65	19.35	12.86	3.44	65.12	5.87	33.90	14%	11%
August	(m^3/s)	6.91	5.41	2.19	32.32	6.69	4.40	1.55	23.21	2.19	12.32	9%	14%
September	(m^3/s)	5.29	3.16	1.62	15.78	5.08	3.06	0.86	15.58	2.12	8.45	26%	17%
October	(m^3/s)	5.64	3.45	1.16	16.92	5.47	3.54	1.19	17.74	2.20	9.09	20%	26%
November	(m^3/s)	6.18	3.40	1.80	13.35	6.10	3.30	1.97	13.39	2.78	9.57	29%	34%
December	(m^3/s)	4.23	2.12	1.78	10.93	4.14	2.05	1.63	10.65	2.11	6.34	23%	23%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	2.04	0.71	0.90	4.08	1.65	0.84	0.05	3.72	1.33	2.75	26%	46%
3-day Minimum	(m^3/s)	2.09	0.72	0.91	4.20	1.79	0.82	0.05	4.24	1.37	2.82	26%	40%
7-day Minimum	(m^3/s)	2.18	0.76	0.94	4.37	1.93	0.87	0.06	4.78	1.42	2.94	26%	31%
30-day Minimum	(m^3/s)	2.54	1.00	1.15	6.10	2.32	1.01	0.73	6.22	1.54	3.55	17%	20%
90-day Minimum	(m^3/s)	3.03	1.29	1.56	7.01	2.90	1.18	1.62	6.79	1.74	4.32	20%	17%
1-day Maximum	(m^3/s)	96.84	26.11	41.90	171.00	93.03	23.82	48.53	151.62	70.73	122.95	26%	26%
3-day Maximum	(m^3/s)	93.04	24.59	39.27	153.33	89.24	23.43	46.99	145.33	68.45	117.63	26%	34%
7-day Maximum	(m^3/s)	85.89	23.67	35.21	141.00	82.16	22.32	43.36	130.10	62.22	109.56	26%	31%
30-day Maximum	(m^3/s)	65.27	16.20	32.14	107.43	62.10	15.80	32.47	100.67	49.07	81.46	23%	29%
90-day Maximum	(m^3/s)	41.89	11.14	23.76	78.19	40.03	10.11	25.39	71.56	30.75	53.03	23%	26%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	April-20	115	January-9	December-29	June-27	124	January-10	December-31	January-9	August-13	26%	51%
Date of Annual Maximum	(day)	May-31	14	May-4	July-3	May-27	13	April-29	June-22	May-17	June-14	37%	34%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	65	0	221	91	62	0	211	26	156	34%	34%
High Pulse Count	(day)	91	22	61	149	94	23	65	149	69	114	26%	26%
Low Pulse Duration	(day)	30	24	2	95	25	22	0	111	7	54	34%	26%
High Pulse Duration	(day)	63	33	17	141	53	27	16	109	30	95	43%	37%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-0.85	0.25	-1.53	-0.45	-0.90	0.24	-1.56	-0.52	-1.10	-0.61	29%	34%
Rise Rate	(m^3/s)	1.22	0.42	0.69	2.46	1.22	0.39	0.76	2.55	0.79	1.64	26%	14%
Number of Flow Reversals	(No.)	77	25	39	135	100	25	60	145	52	102	43%	49%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Flow Thresholds\[Node 12_IHA.xlsx]Table

NOTE:

1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE A3-13

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

SUMMARY OF INDICATORS OF HYDROLOGIC ALTERATION FOR NODE 13
NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Print Oct/15/14 10:06:11

Indicators of Hydrological Alteration		Pre-Mine				Operations I (Year 22)				Range of Variability Approach (RVA) Targets		Rate of Non-attainment of RVA Targets	
		Mean	Standard Deviation	Range Limits		Mean	Standard Deviation	Range Limits					
Parameter	**Unit**			**Low**	**High**			**Low**	**High**	**Low**	**High**	**Pre-Mine**	**Operations I (Year 22)**
Group 1: Monthly Magnitude													
January	(m^3/s)	30.05	14.58	12.39	79.06	30.05	14.57	12.41	79.03	15.47	44.64	14%	14%
February	(m^3/s)	28.17	11.12	14.73	76.58	28.16	11.12	14.74	76.58	17.04	39.29	14%	14%
March	(m^3/s)	33.87	12.04	18.46	63.45	33.86	12.04	18.16	63.43	21.83	45.91	26%	26%
April	(m^3/s)	97.19	31.42	38.33	164.09	97.17	31.36	38.26	163.90	65.77	128.60	37%	37%
May	(m^3/s)	296.82	62.92	155.70	442.39	296.78	62.97	154.88	442.69	233.89	359.74	31%	31%
June	(m^3/s)	422.99	70.27	302.77	587.47	422.91	70.20	303.14	586.58	352.71	493.26	31%	31%
July	(m^3/s)	340.78	77.97	206.06	549.19	340.65	77.76	206.47	548.13	262.81	418.75	23%	23%
August	(m^3/s)	214.71	54.59	145.15	379.03	214.58	54.39	145.28	378.15	160.12	269.30	23%	23%
September	(m^3/s)	131.45	38.32	80.30	248.10	131.35	38.26	80.05	248.07	93.13	169.76	17%	17%
October	(m^3/s)	91.95	40.11	46.88	262.77	91.89	40.06	47.00	262.56	51.84	132.05	14%	14%
November	(m^3/s)	65.28	25.97	30.24	114.58	65.26	25.90	30.36	114.44	39.30	91.25	43%	43%
December	(m^3/s)	34.78	11.57	19.59	71.74	34.78	11.55	19.59	71.72	23.21	46.35	23%	23%
Group 2: Magnitude and Duration of Annual Extreme													
1-day Minimum	(m^3/s)	18.87	5.20	10.70	33.00	18.86	5.20	10.73	32.95	13.67	24.07	26%	29%
3-day Minimum	(m^3/s)	19.15	5.25	10.73	33.67	19.14	5.24	10.77	33.61	13.91	24.40	29%	29%
7-day Minimum	(m^3/s)	19.78	5.42	10.80	35.43	19.77	5.42	10.83	35.38	14.36	25.21	23%	23%
30-day Minimum	(m^3/s)	23.00	5.82	11.89	37.19	22.99	5.82	11.91	37.22	17.17	28.82	26%	26%
90-day Minimum	(m^3/s)	28.13	9.67	16.34	63.18	28.11	9.64	16.36	62.93	18.45	37.80	17%	17%
1-day Maximum	(m^3/s)	678.40	124.77	494.00	956.00	678.26	124.64	493.20	955.10	553.63	803.17	29%	29%
3-day Maximum	(m^3/s)	638.90	121.95	452.33	916.67	638.80	121.79	451.50	915.59	516.95	760.86	29%	29%
7-day Maximum	(m^3/s)	584.02	115.74	414.43	844.29	583.90	115.69	413.63	843.15	468.28	699.76	34%	34%
30-day Maximum	(m^3/s)	465.82	69.60	341.63	643.03	465.74	69.47	343.15	641.82	396.22	535.43	29%	29%
90-day Maximum	(m^3/s)	367.08	51.26	284.78	516.67	366.96	51.14	285.81	515.80	315.83	418.34	31%	31%
Group 3: Timing of Annual Extremes													
Date of Annual Minimum	(day)	March-13	106	January-2	December-30	May-5	146	January-1	December-31	January-2	June-26	11%	31%
Date of Annual Maximum	(day)	June-11	17	May-7	July-13	June-6	16	May-7	July-13	May-25	June-28	34%	37%
Group 4: Frequency and Duration of High and Low Pulses													
Low Pulse Count	(day)	91	36	1	153	91	36	1	153	55	127	31%	31%
High Pulse Count	(day)	91	15	58	124	91	15	58	124	76	106	31%	31%
Low Pulse Duration	(day)	38	24	1	105	39	25	1	105	14	62	37%	40%
High Pulse Duration	(day)	21	12	7	54	22	12	7	54	9	33	29%	29%
Group 5: Rate and Frequency of Change in Conditions													
Fall Rate	(m^3/s)	-13.13	2.33	-18.68	-8.17	-13.19	2.37	-18.67	-8.17	-15.46	-10.79	29%	31%
Rise Rate	(m^3/s)	15.89	3.27	9.72	24.38	15.66	3.24	9.72	24.22	12.63	19.16	26%	29%
Number of Flow Reversals	(No.)	98	13	79	128	107	12	84	132	84	111	37%	43%

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NOTE:

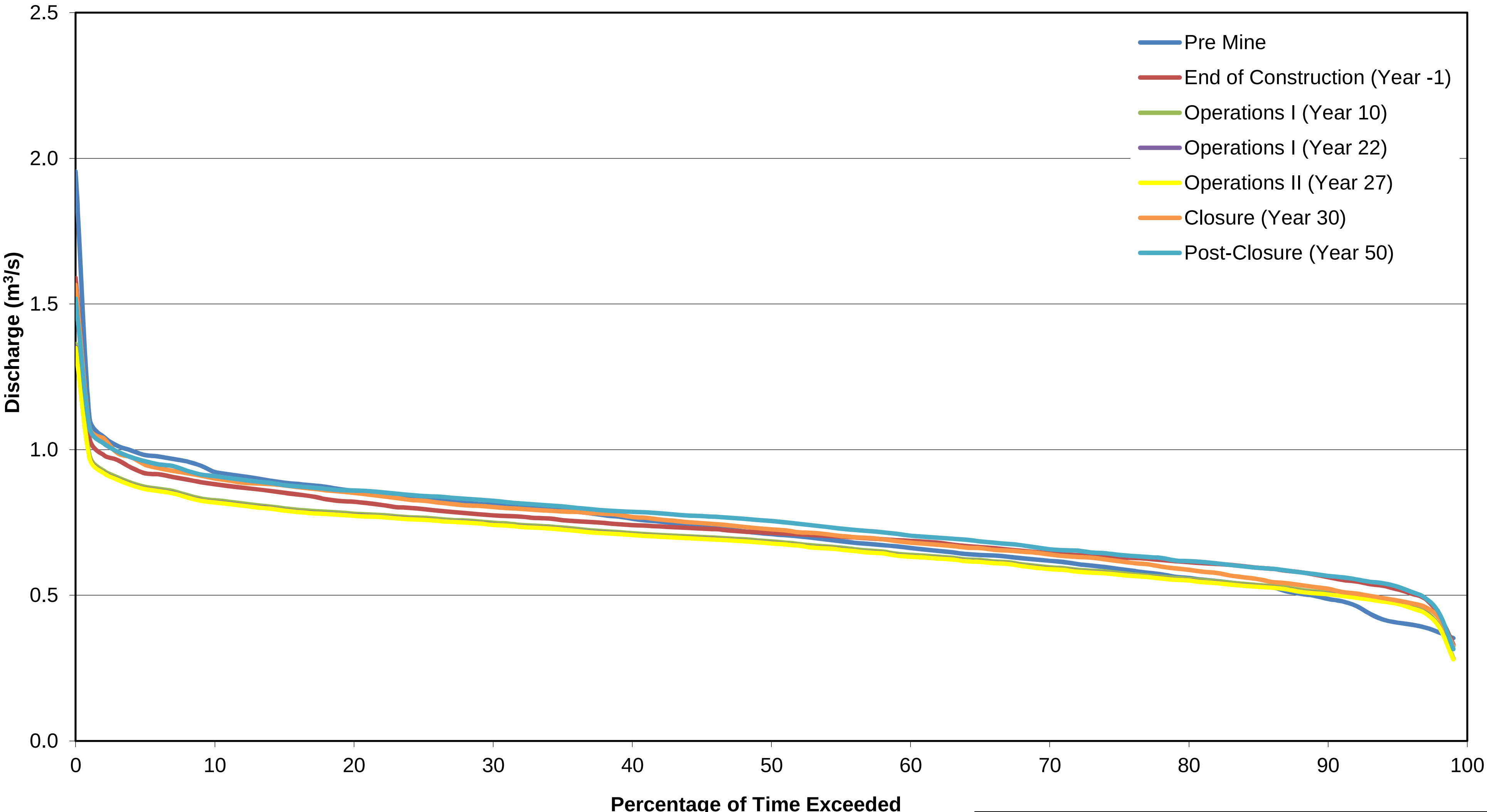
1. DAILY DISCHARGE SERIES WERE CREATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS FOR THE PERIOD 1974-2000 AND 2003-2010.
2. RVA TARGETS ARE BASED ON MEAN +/- 1 STANDARD DEVIATION, EXCEPT WHEN SUCH A TARGET WOULD FALL OUTSIDE OF PRE-MINE RANGE LIMITS AND THEN RANGE LIMIT WAS USED.
3. LOW PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH DAILY MEAN FLOWS DROP BELOW THE 25TH PERCENTILE OF ALL DAILY FLOWS. HIGH PULSES ARE DEFINED AS THOSE PERIODS DURING WHICH THE 75TH PERCENTILE IS EXCEEDED.

0	14OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX A4

MONTHLY FLOW DURATION CURVES FOR NODES 1 TO 13

(Pages A4-1 to A4-156)



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

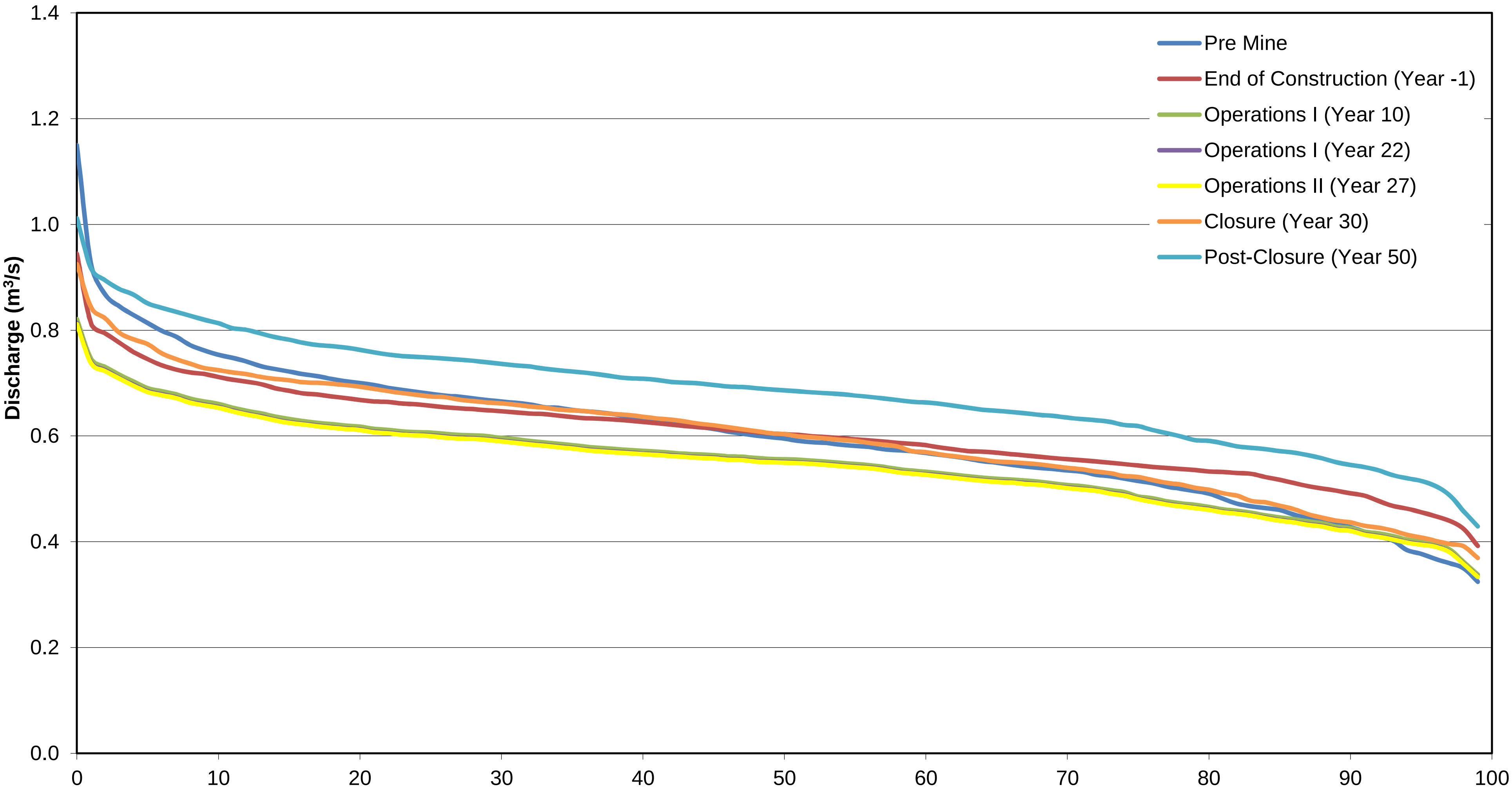
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-1

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

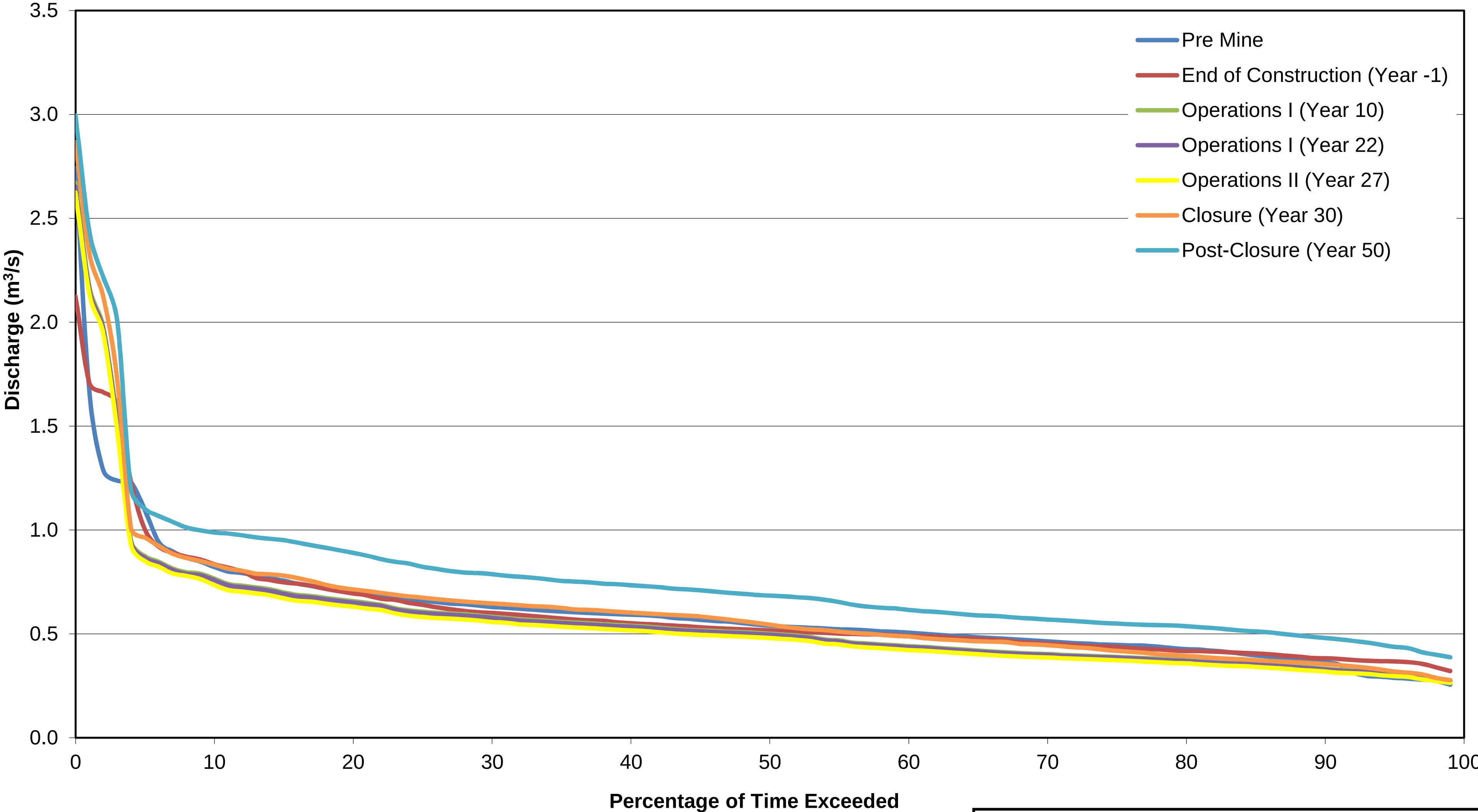
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-2

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

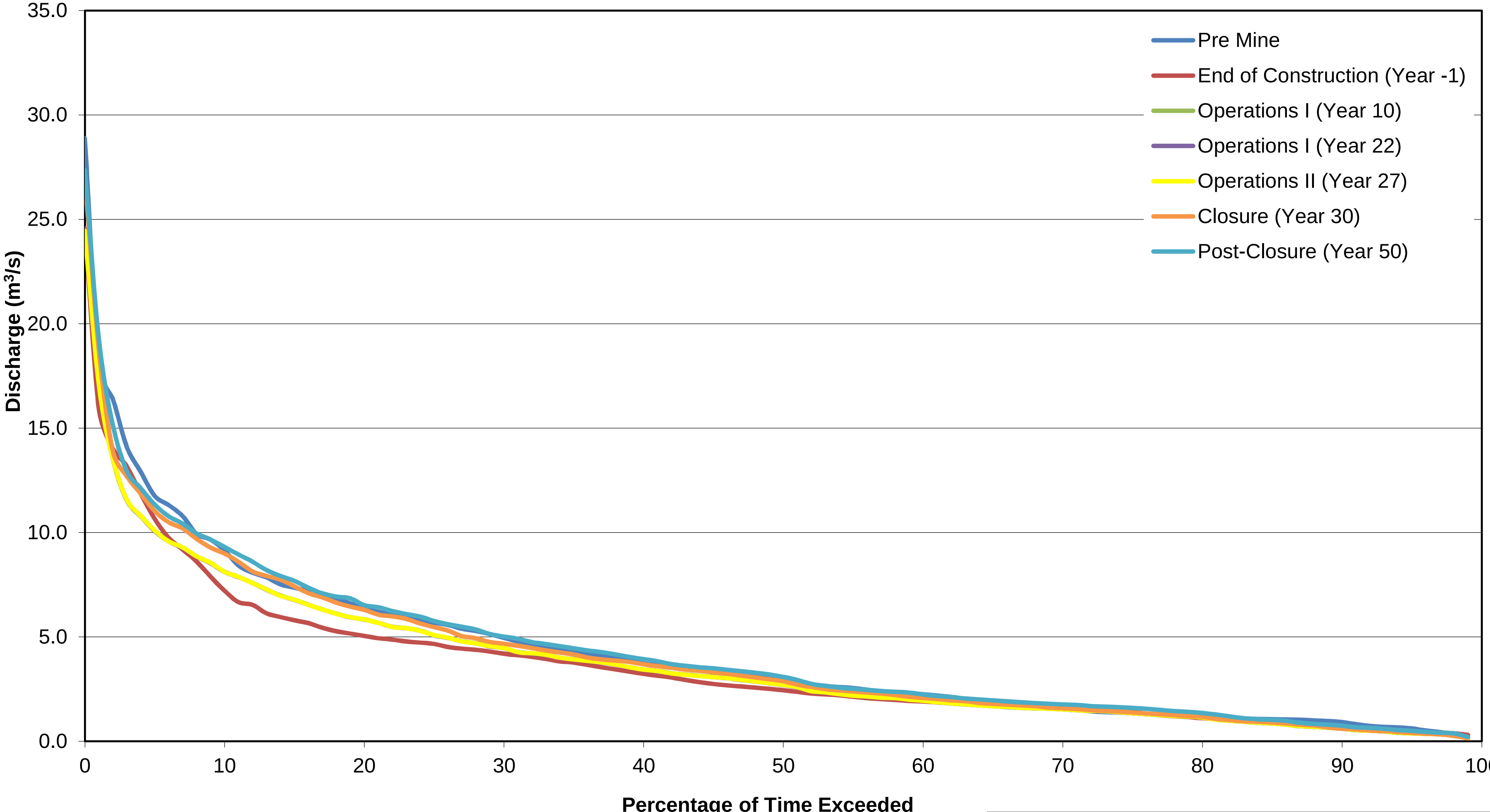
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-3

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

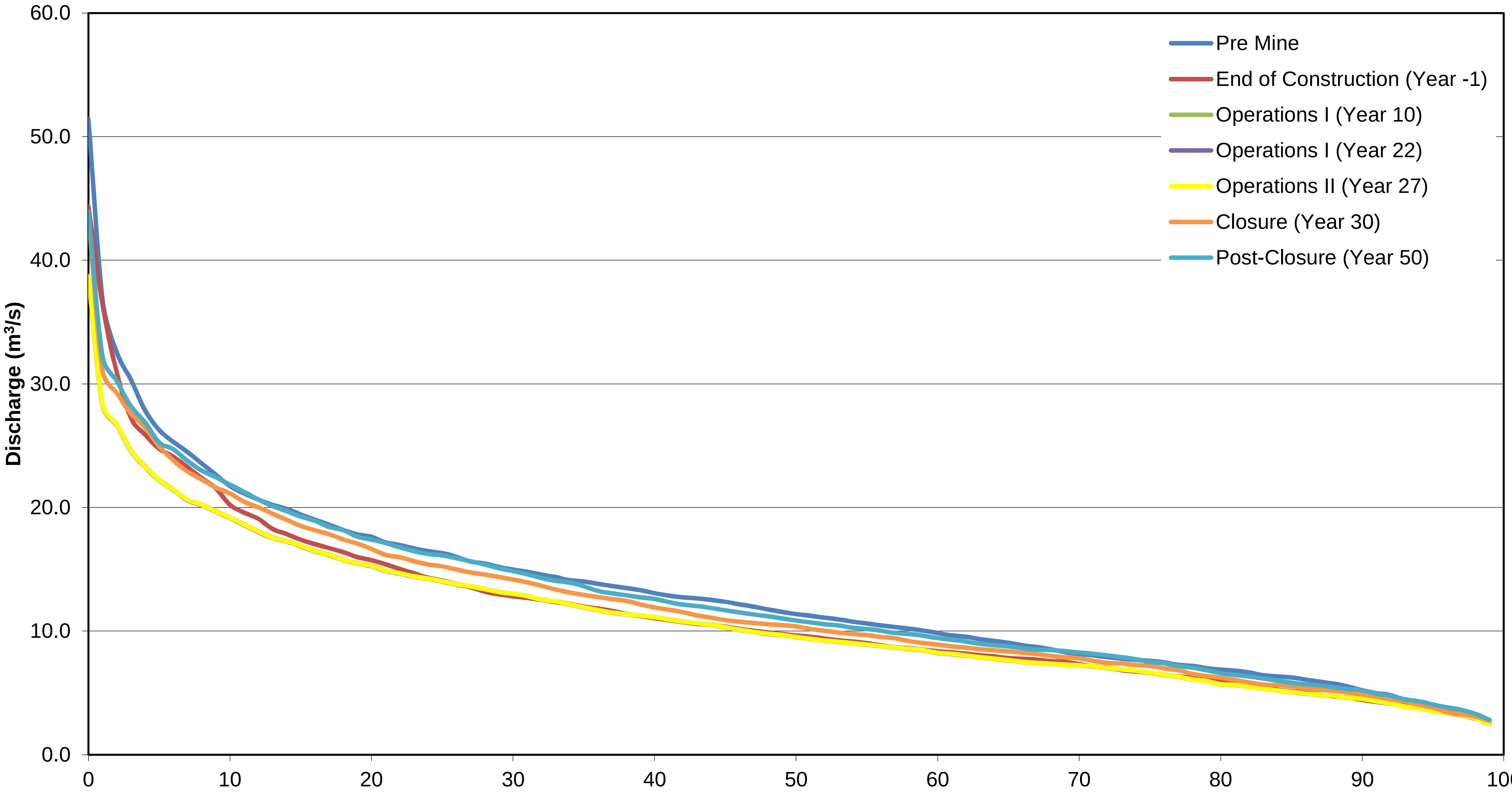
HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-4	REV 0

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-5

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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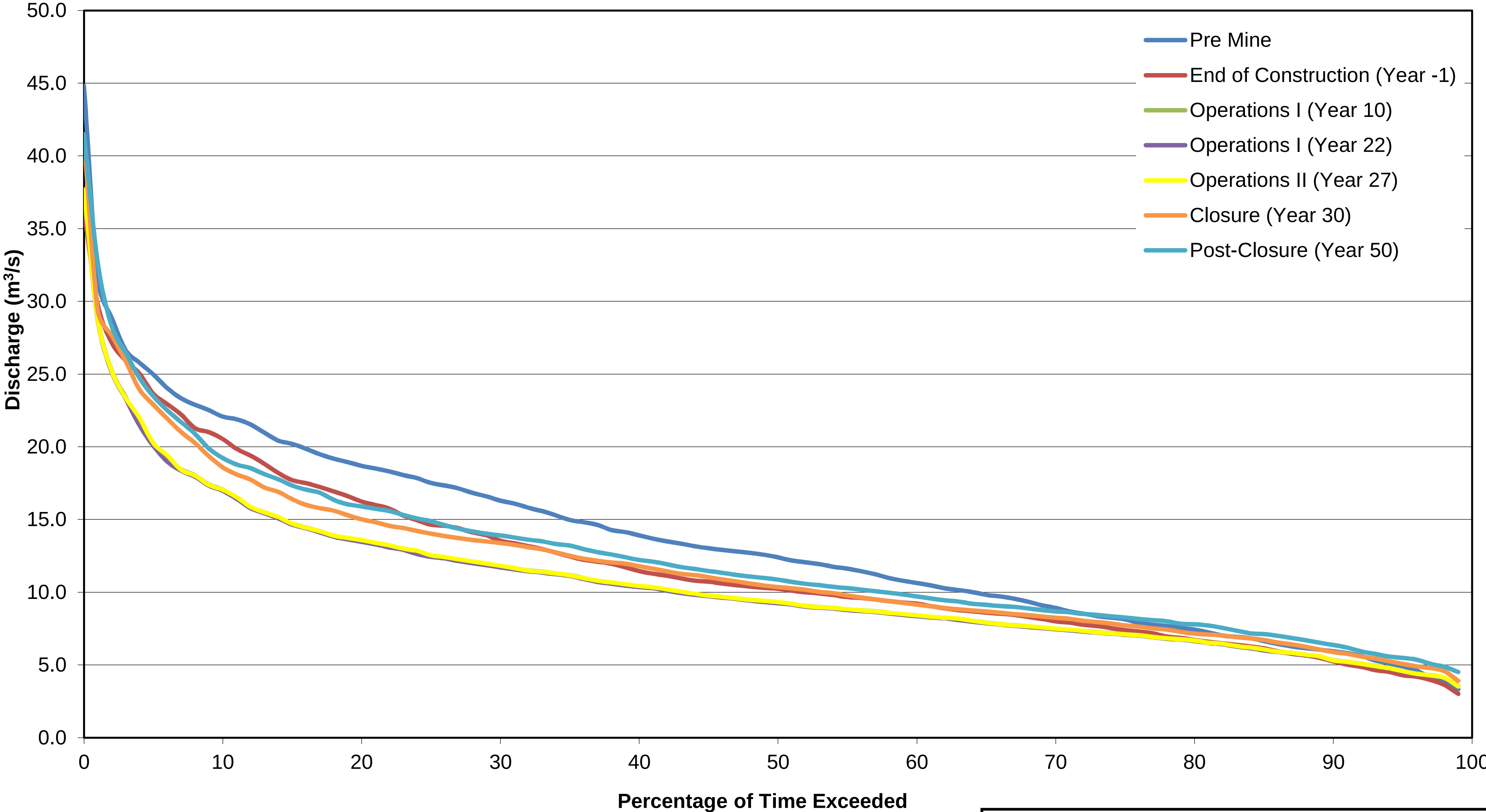


NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

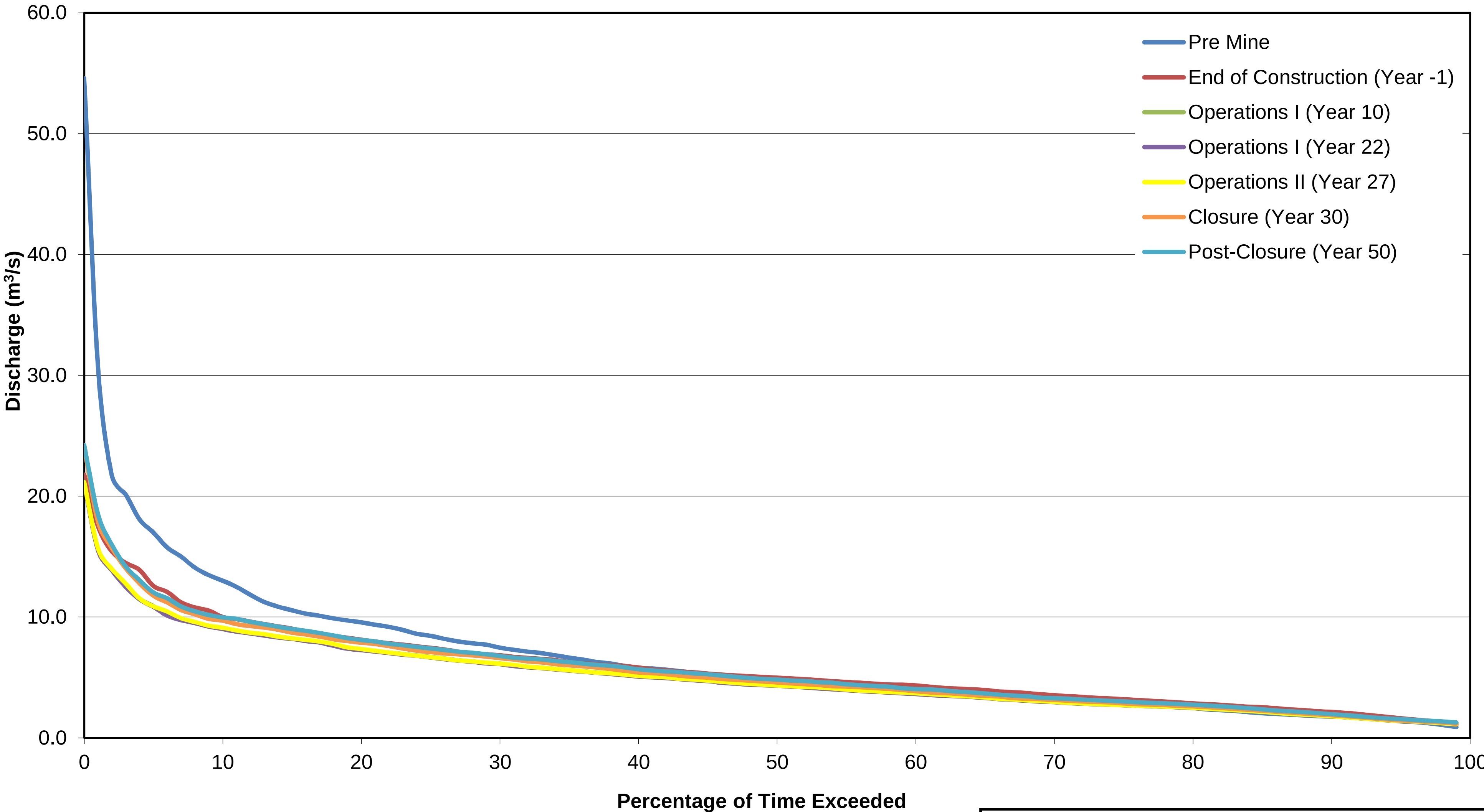
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-6

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

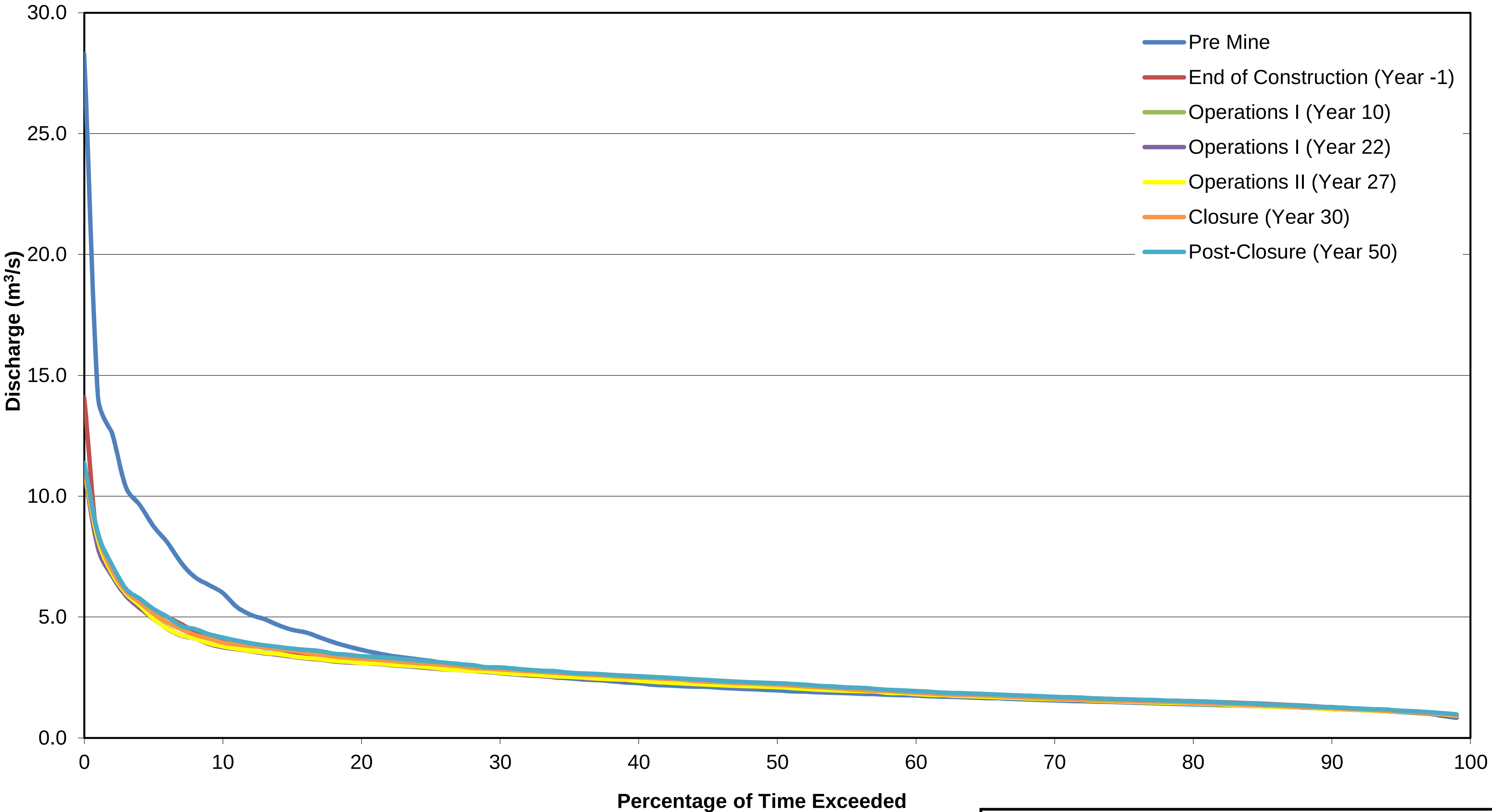
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-7

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

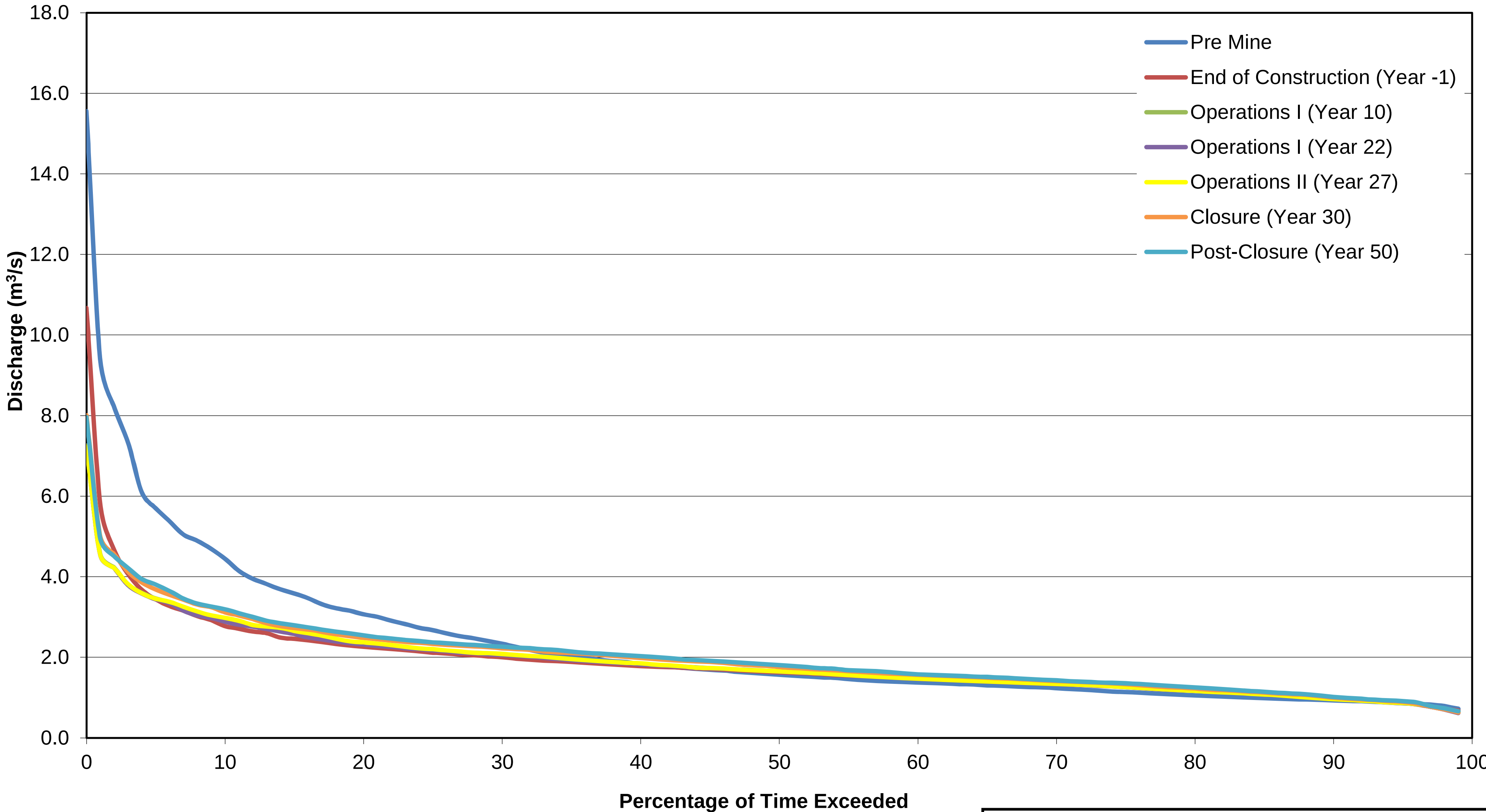
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-8

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

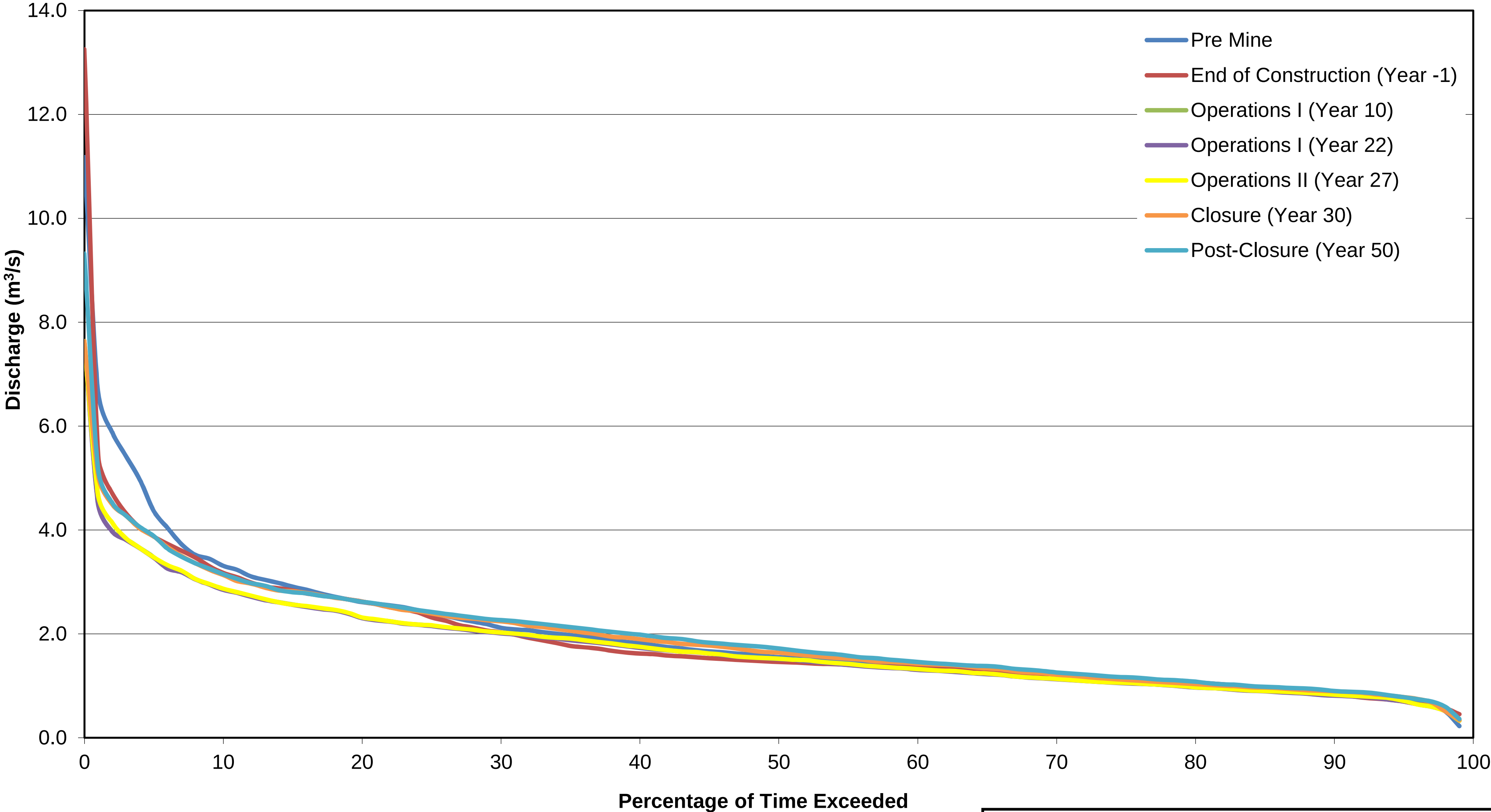
HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-9	REV 0

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

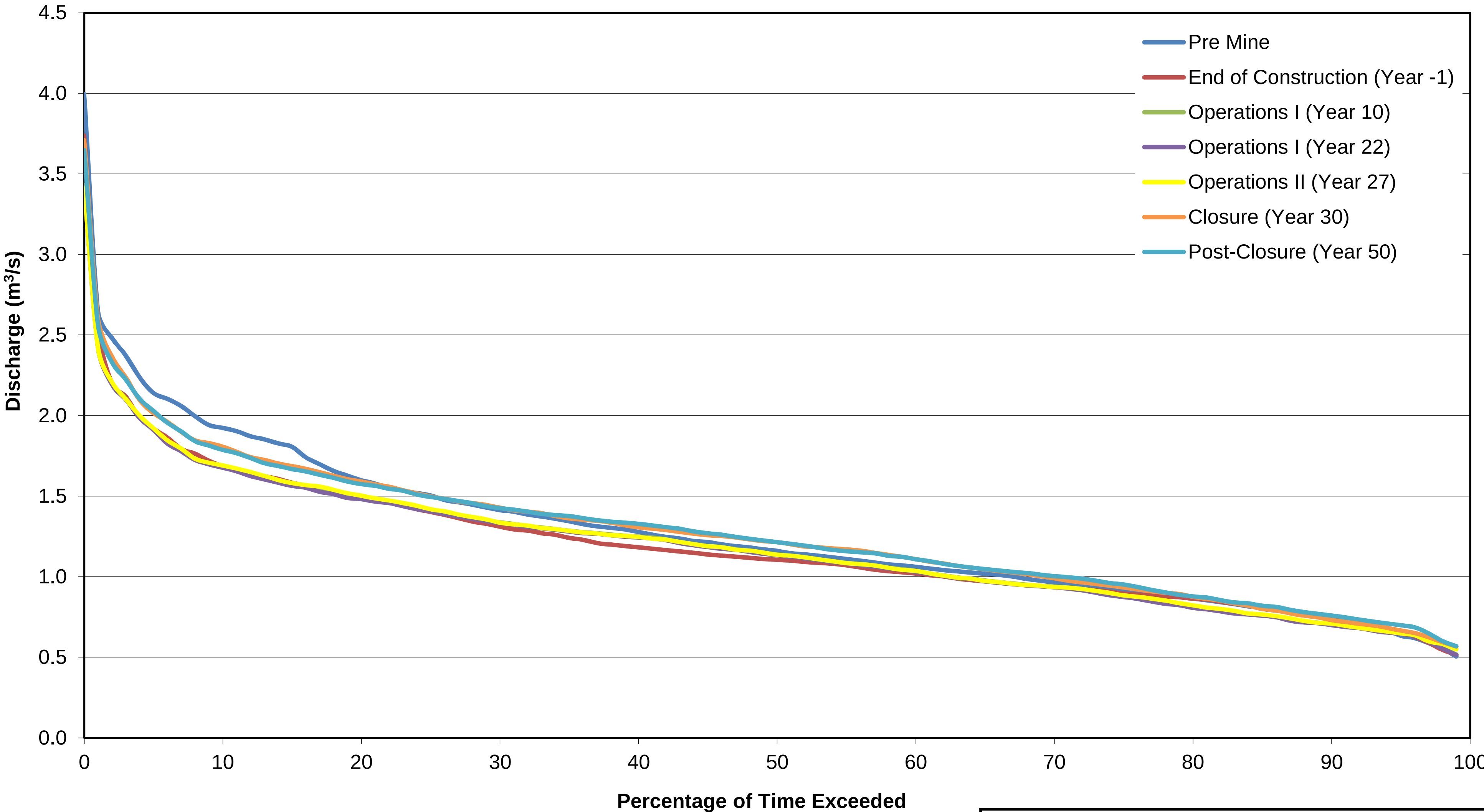
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-10

REV 0

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

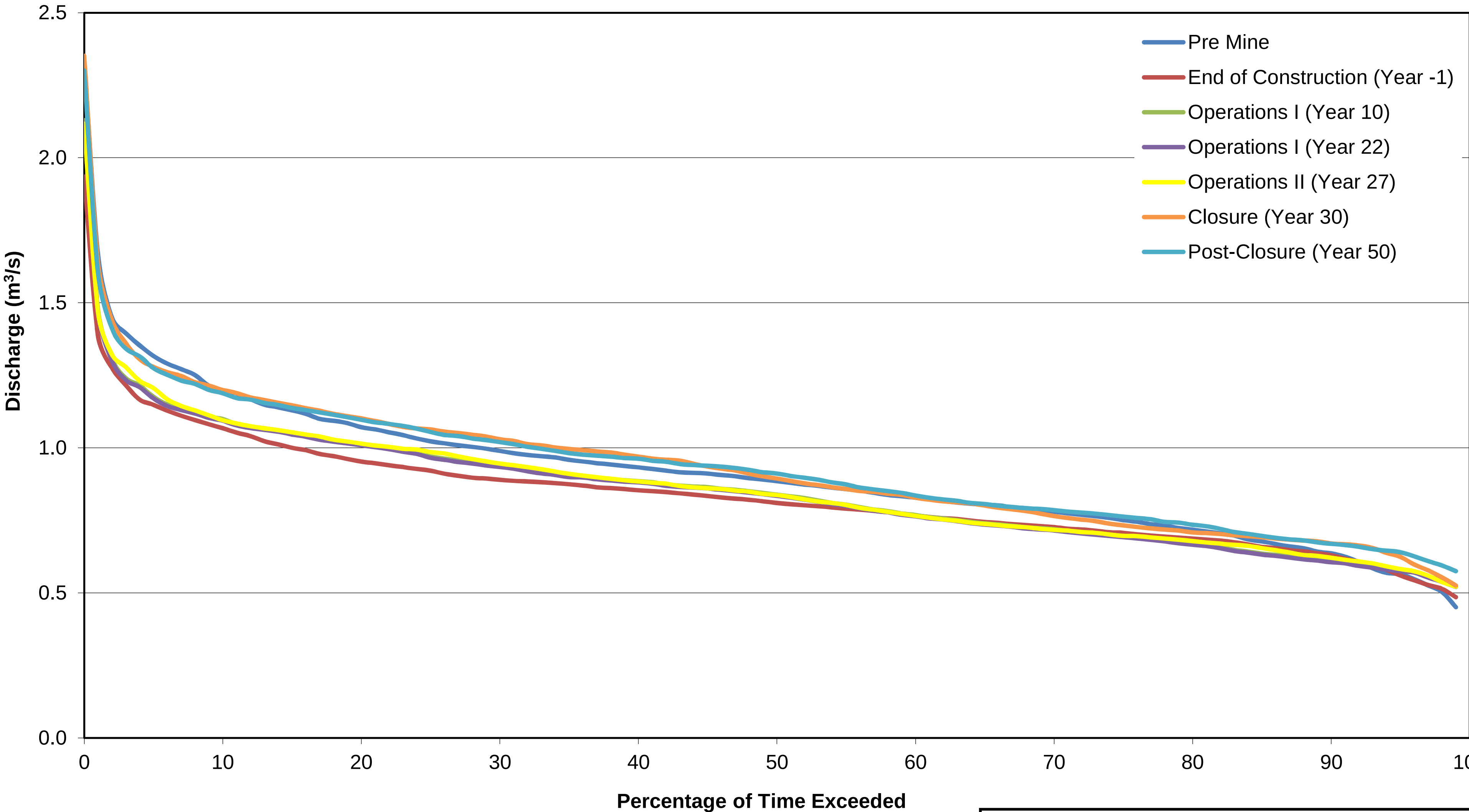
NOVEMBER FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-11 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

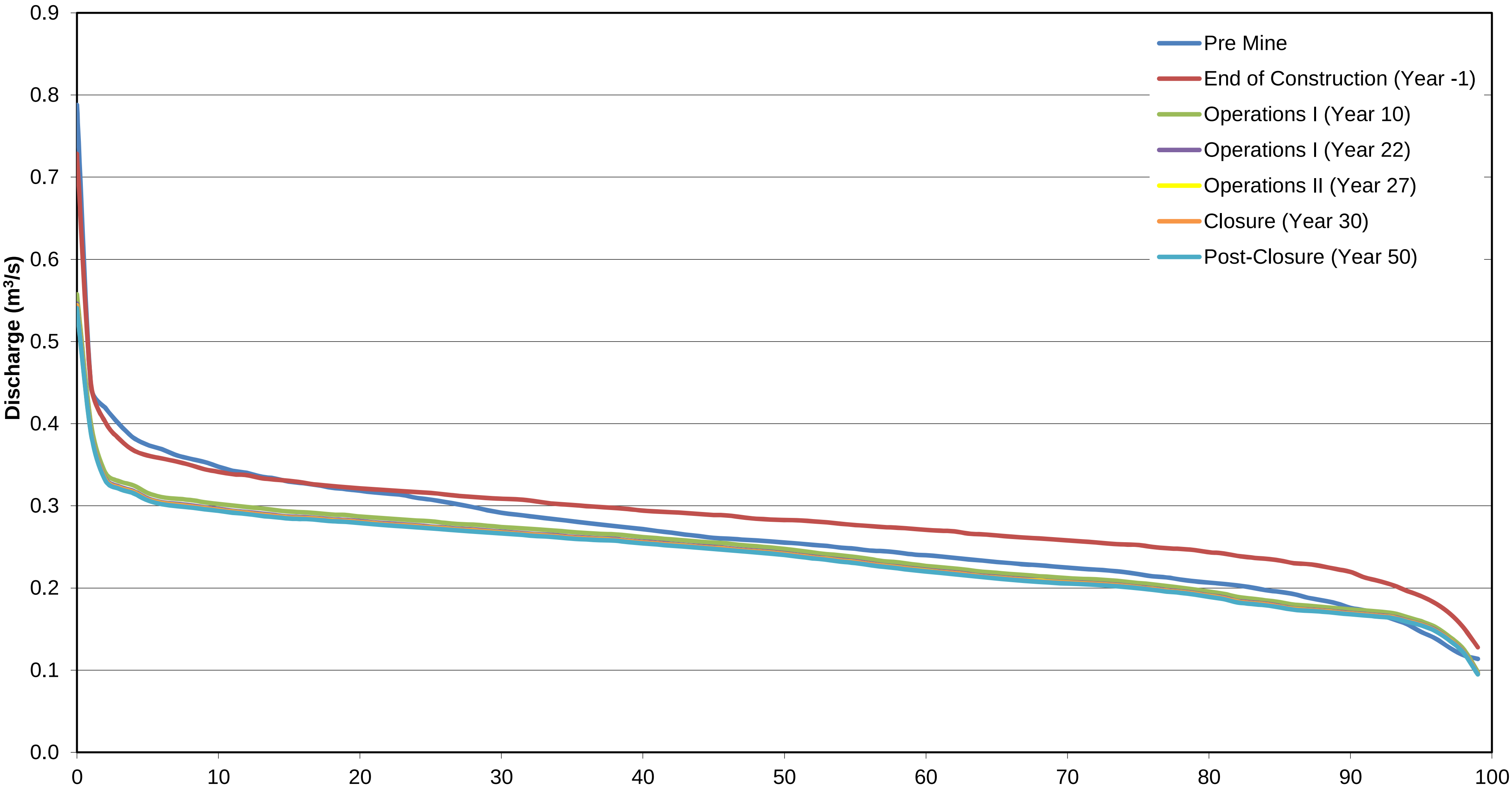
DECEMBER FLOW DURATION CURVES AT NODE 1
HARPER CREEK NEAR THE MOUTH (WSC 08LB076)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-12 REV 0

0	08OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

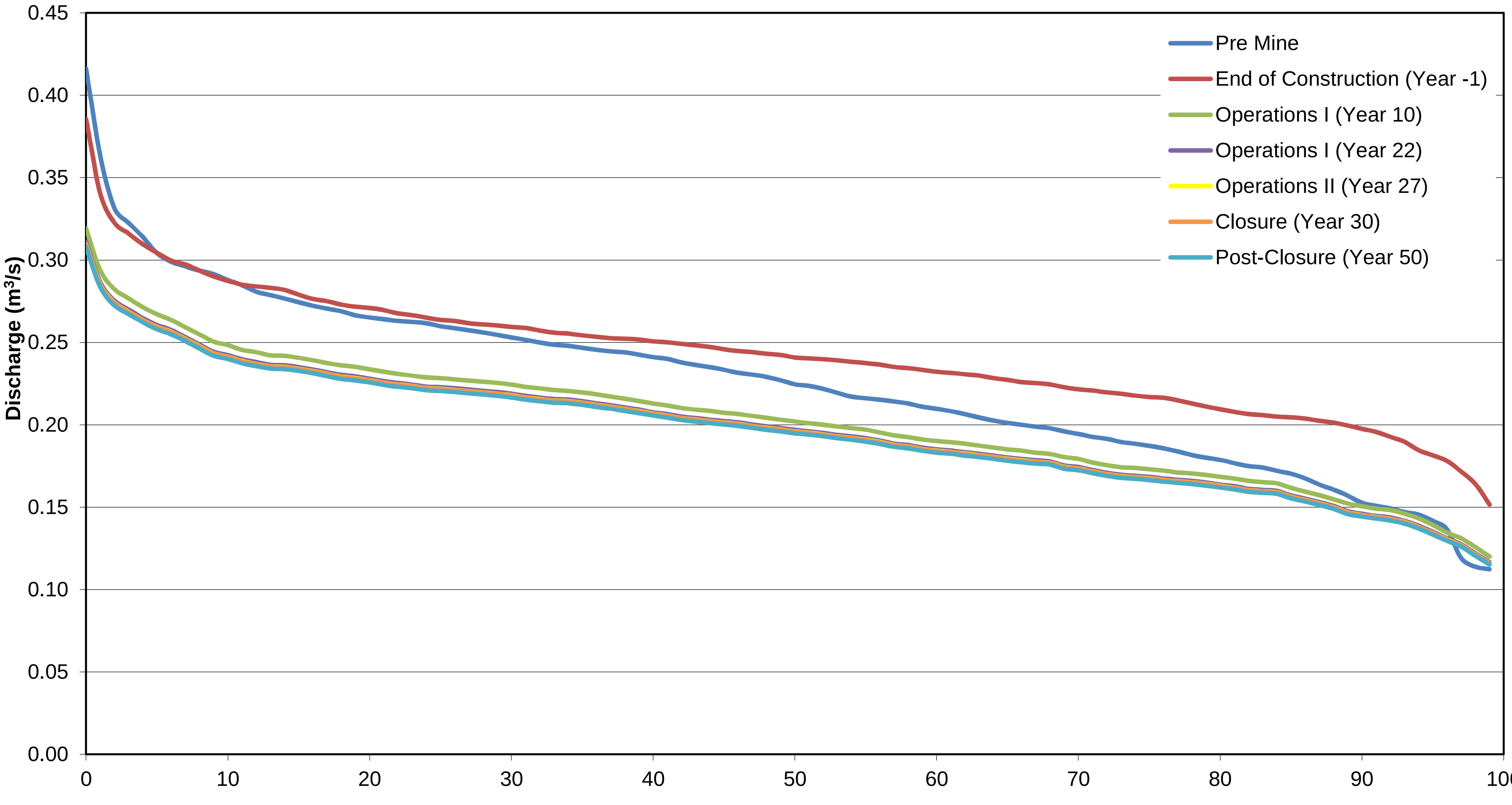
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-13

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

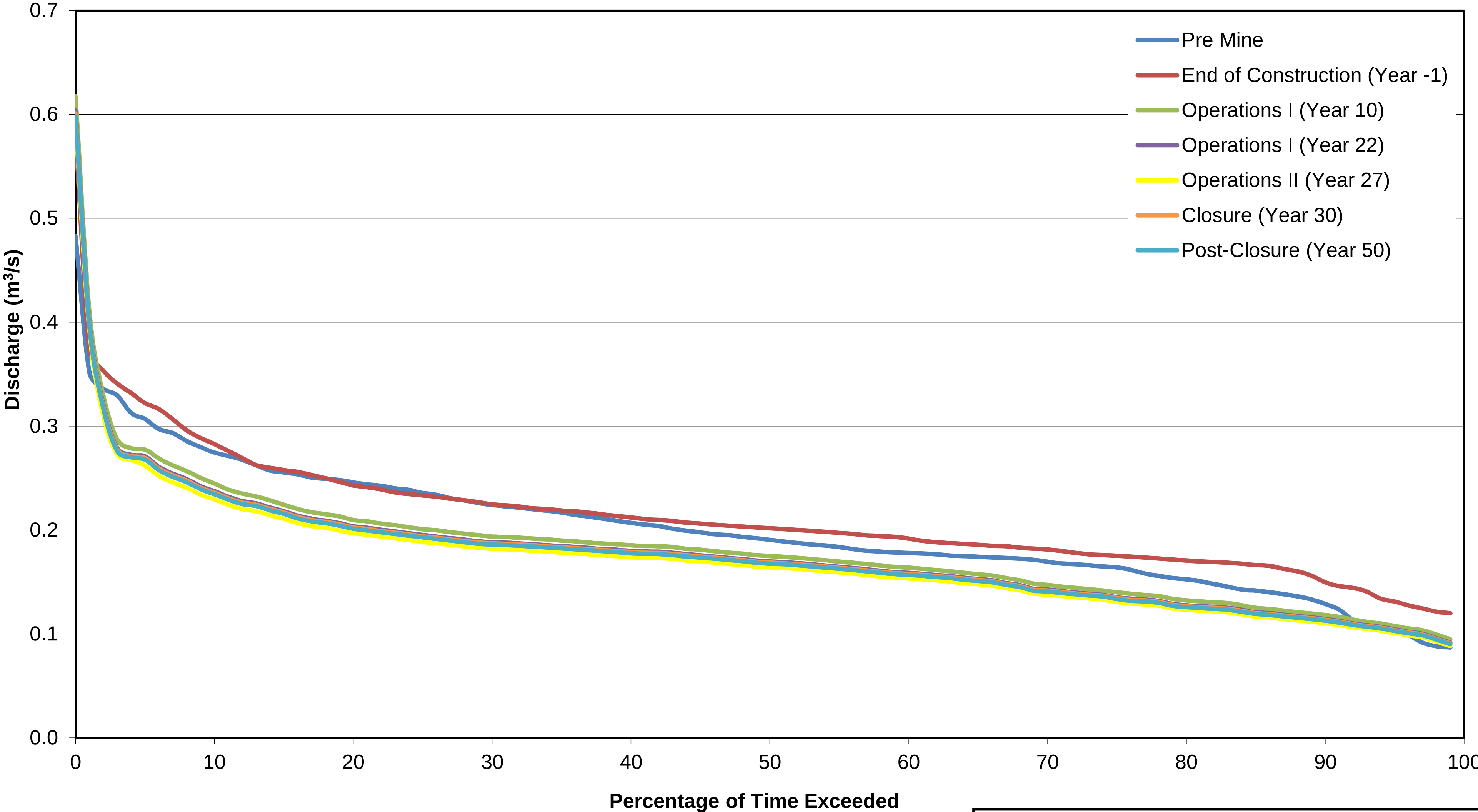
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-14

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

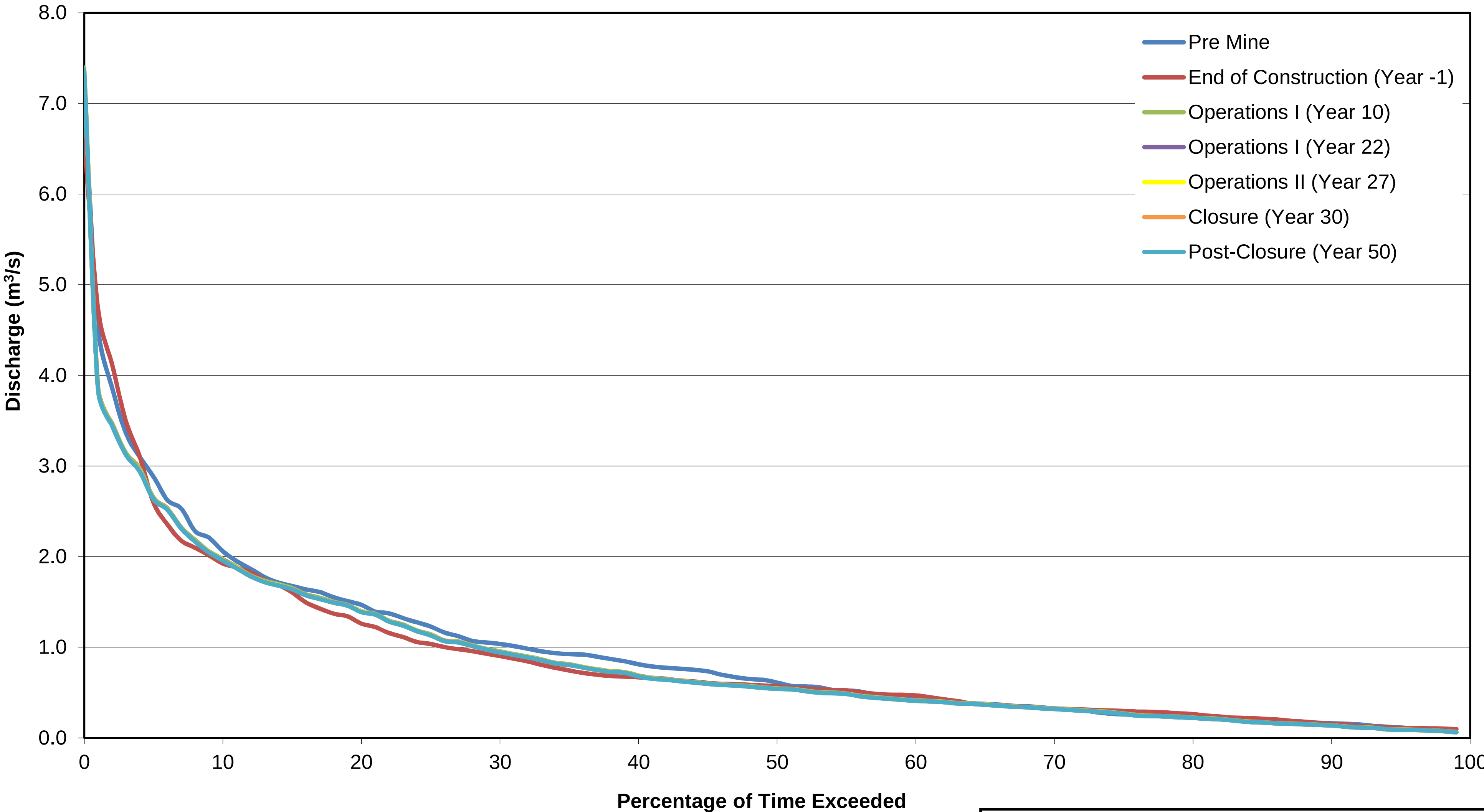
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-15

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

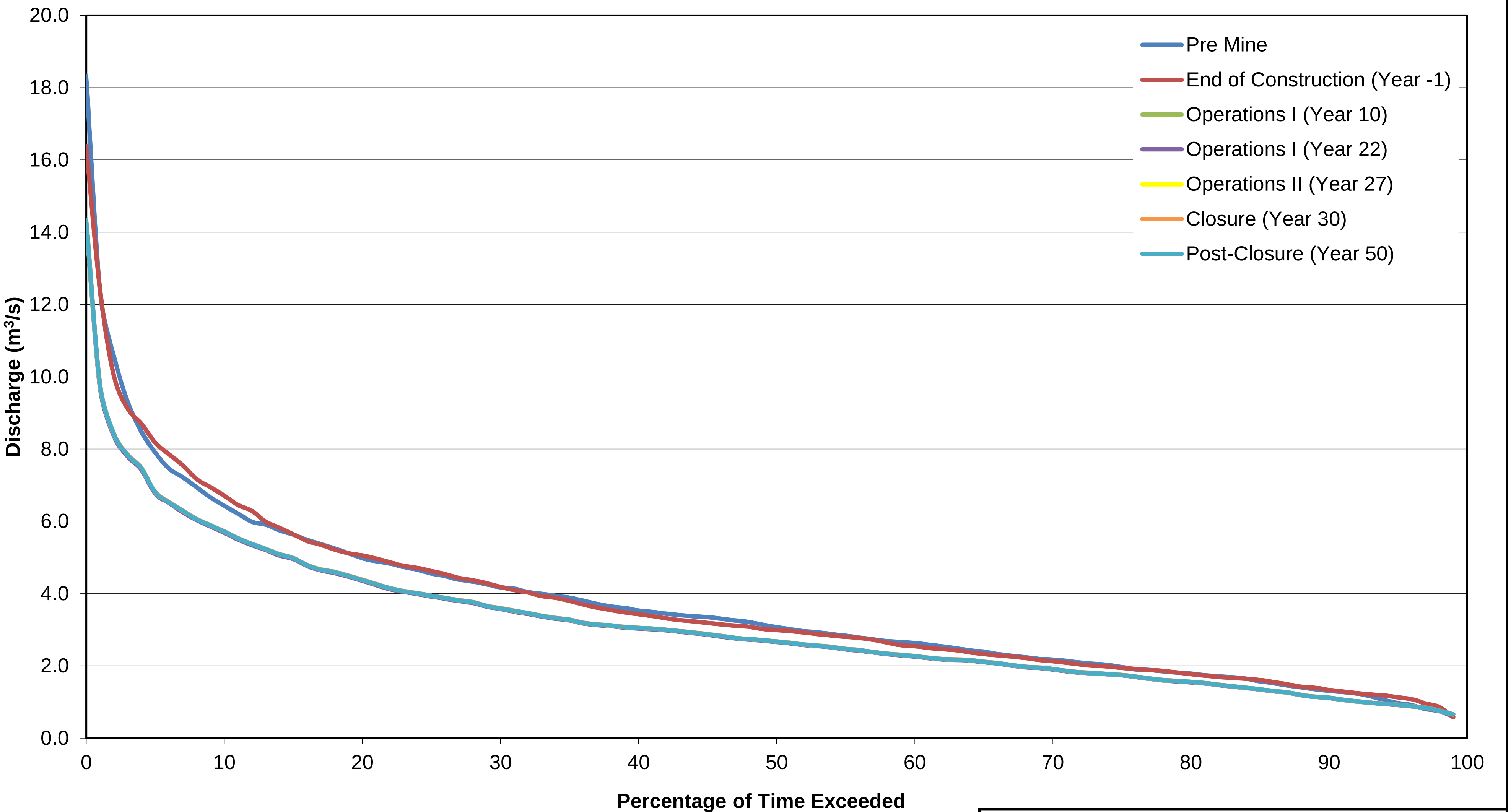
HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15 | REF NO. 3

FIGURE A4-16 | REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

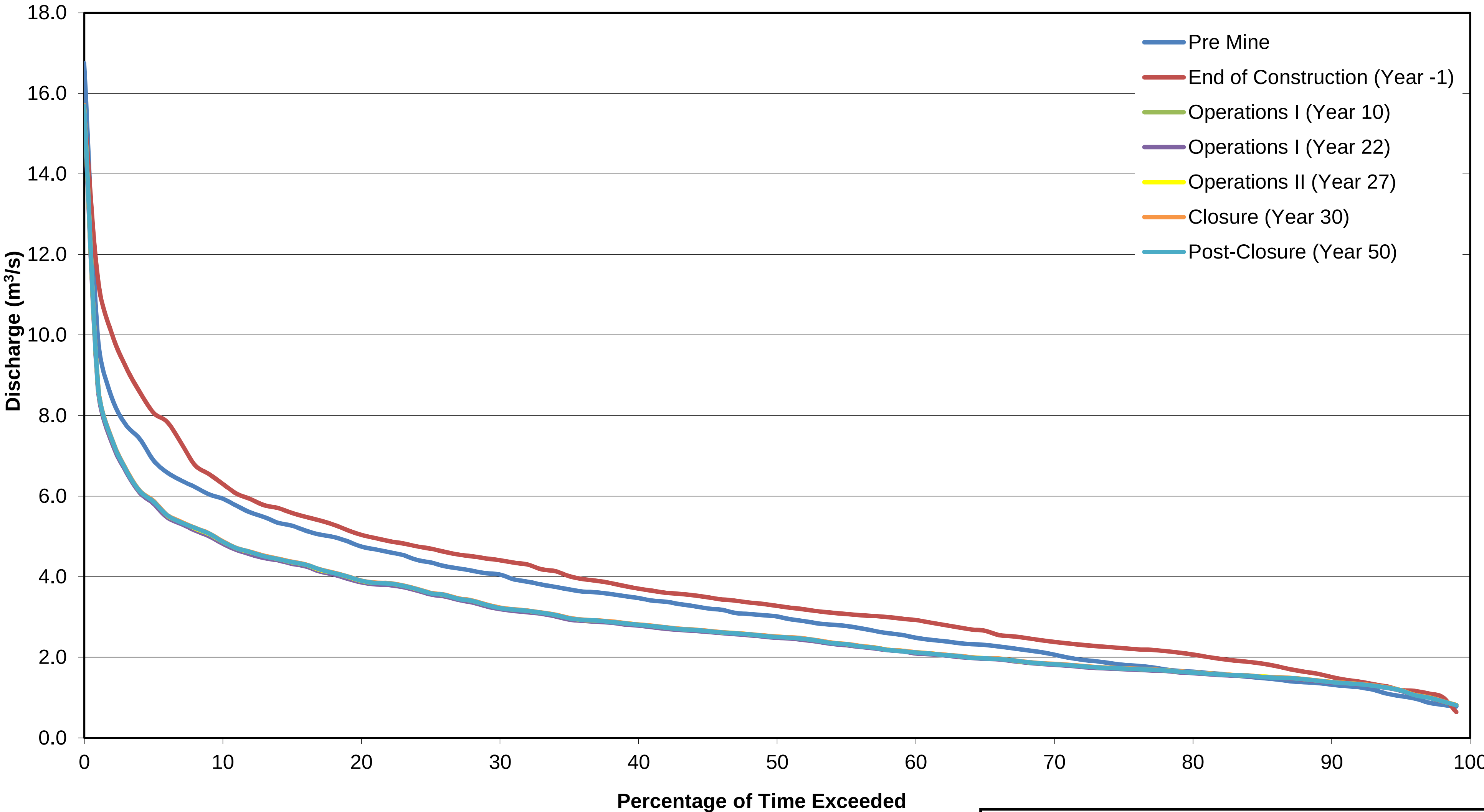
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-17

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

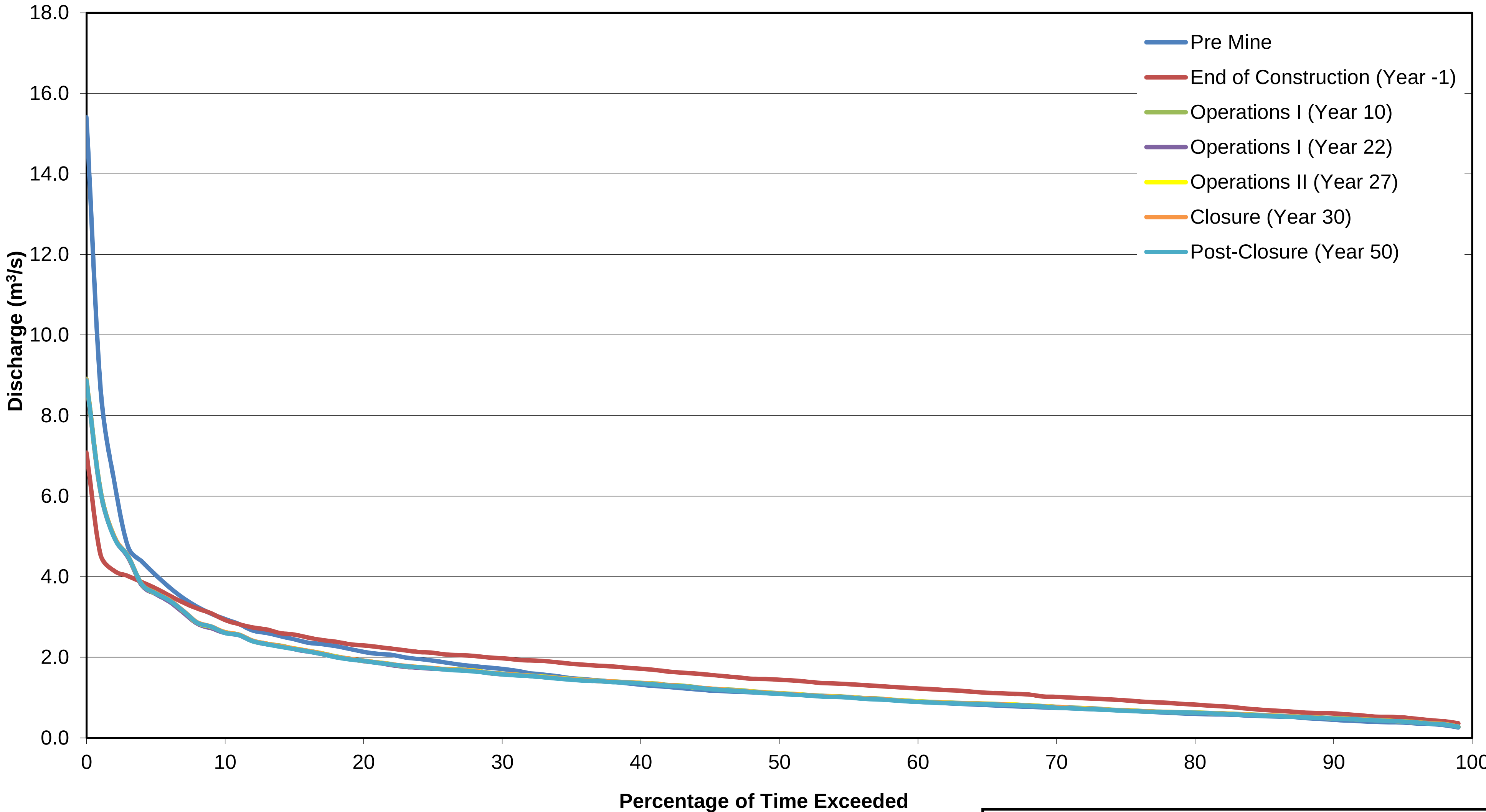
HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-18 REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

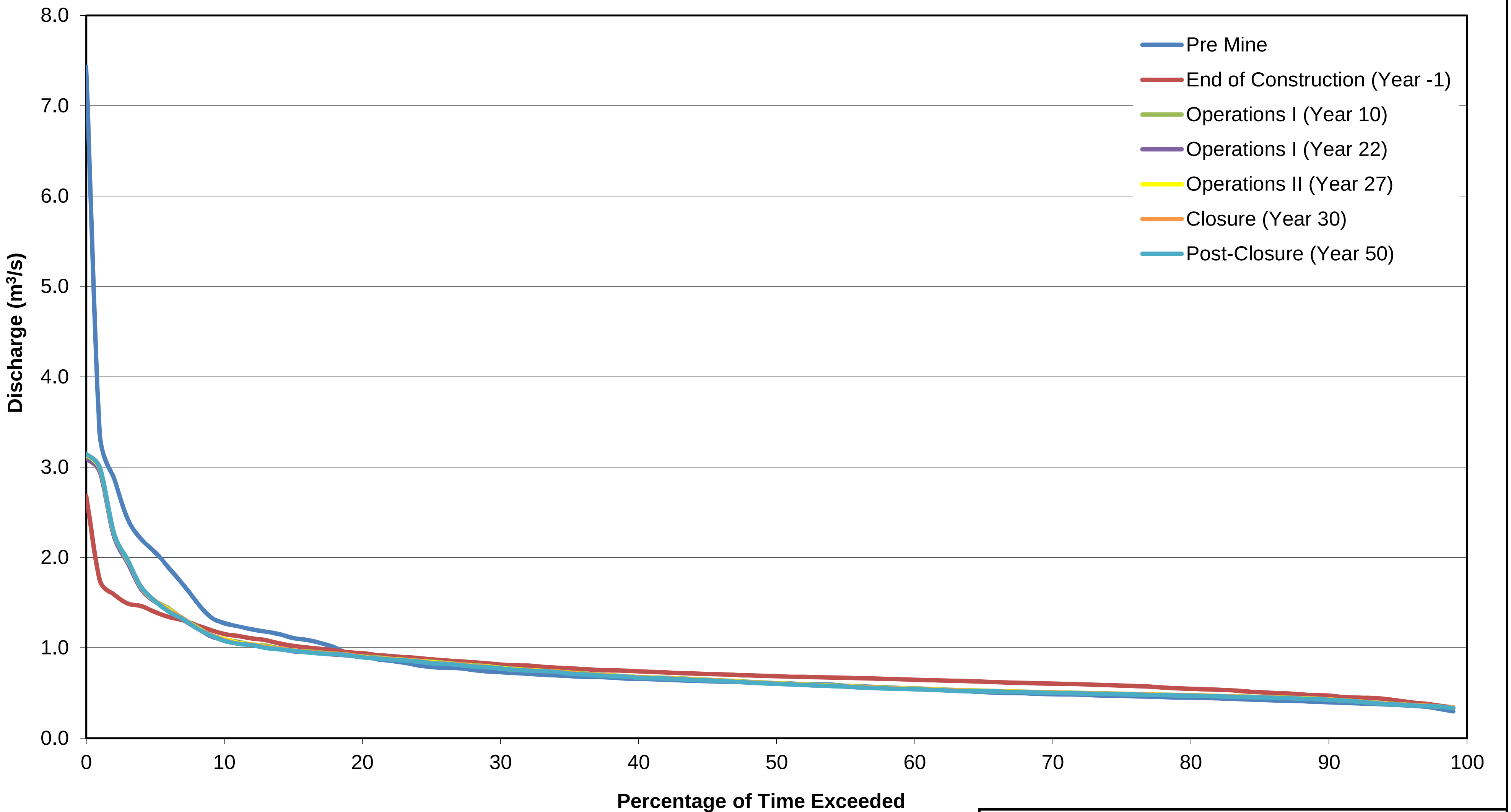
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-19

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

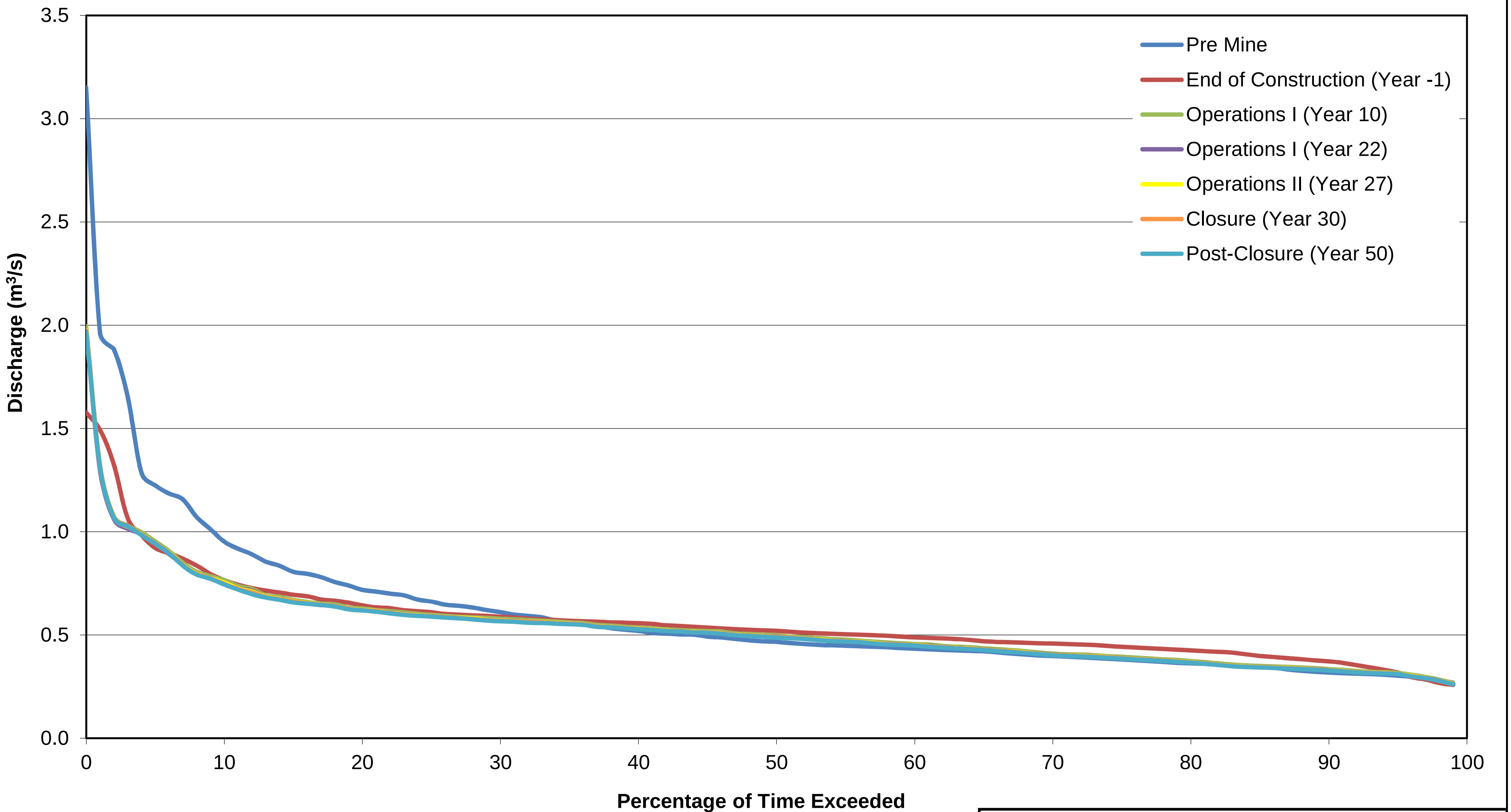
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-20

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

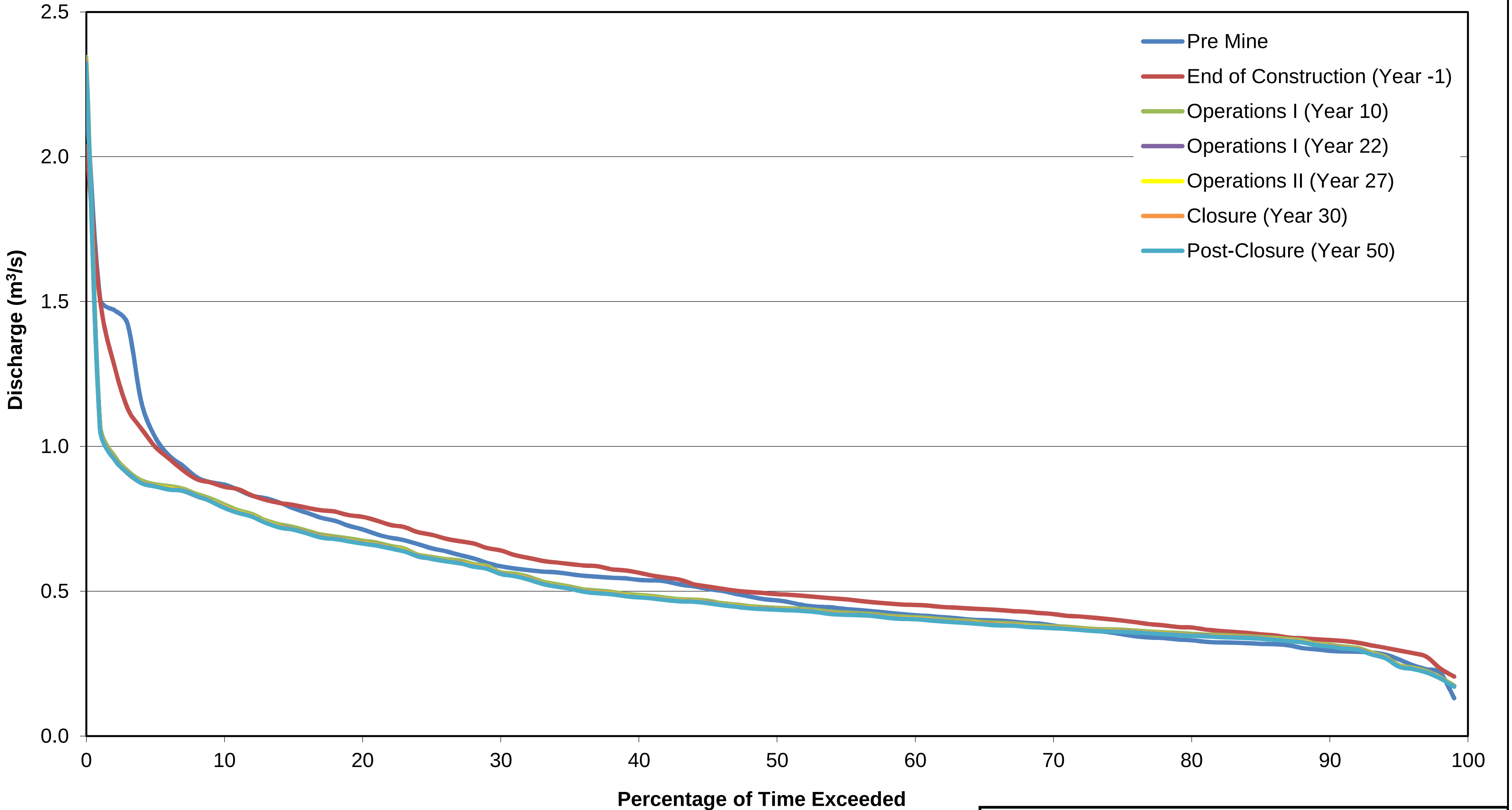
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-21

REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

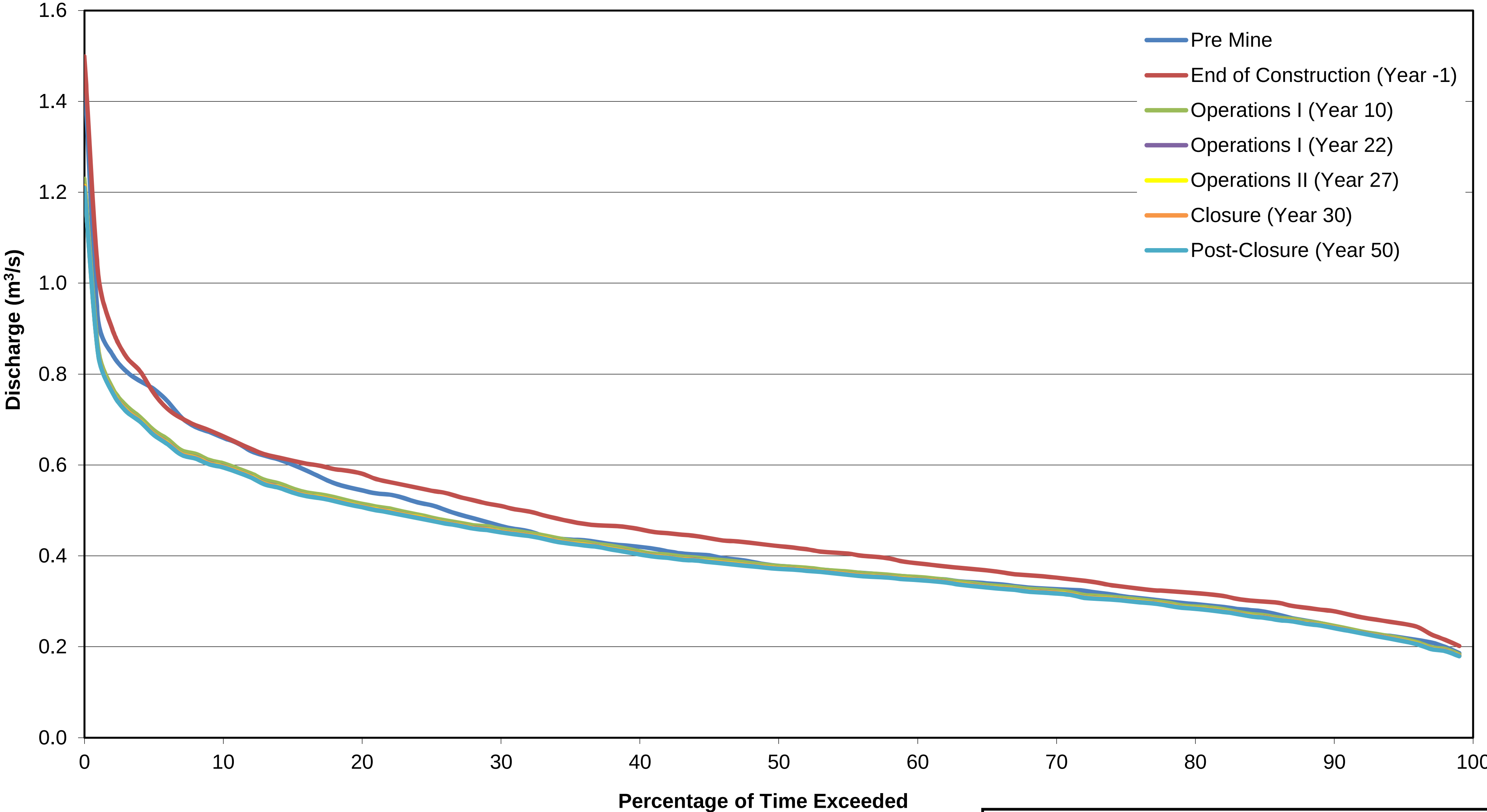
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-22

REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

Knight Piésold CONSULTING

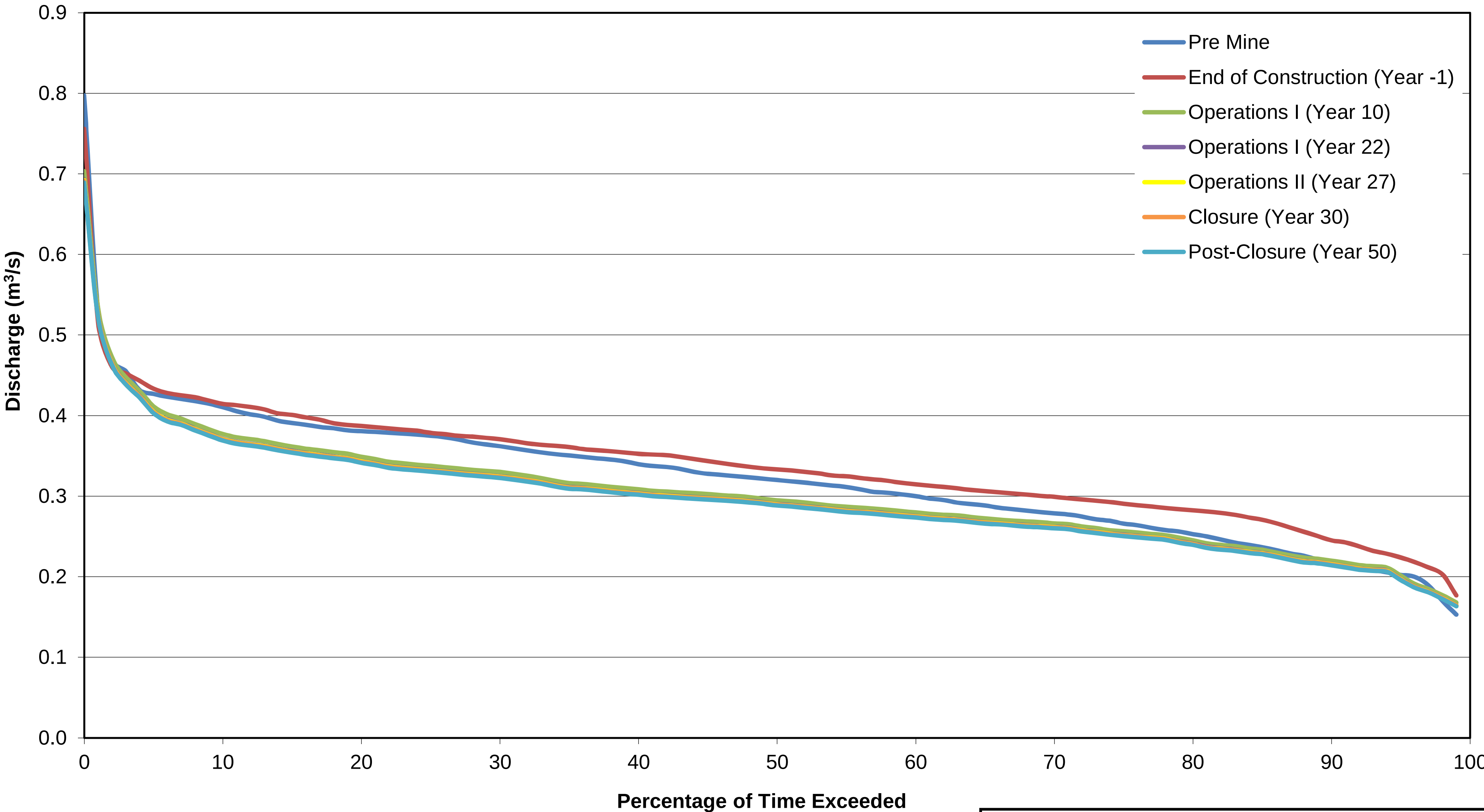
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-23

REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 2
HARPER CREEK ABOVE T-CREEK CONFLUENCE

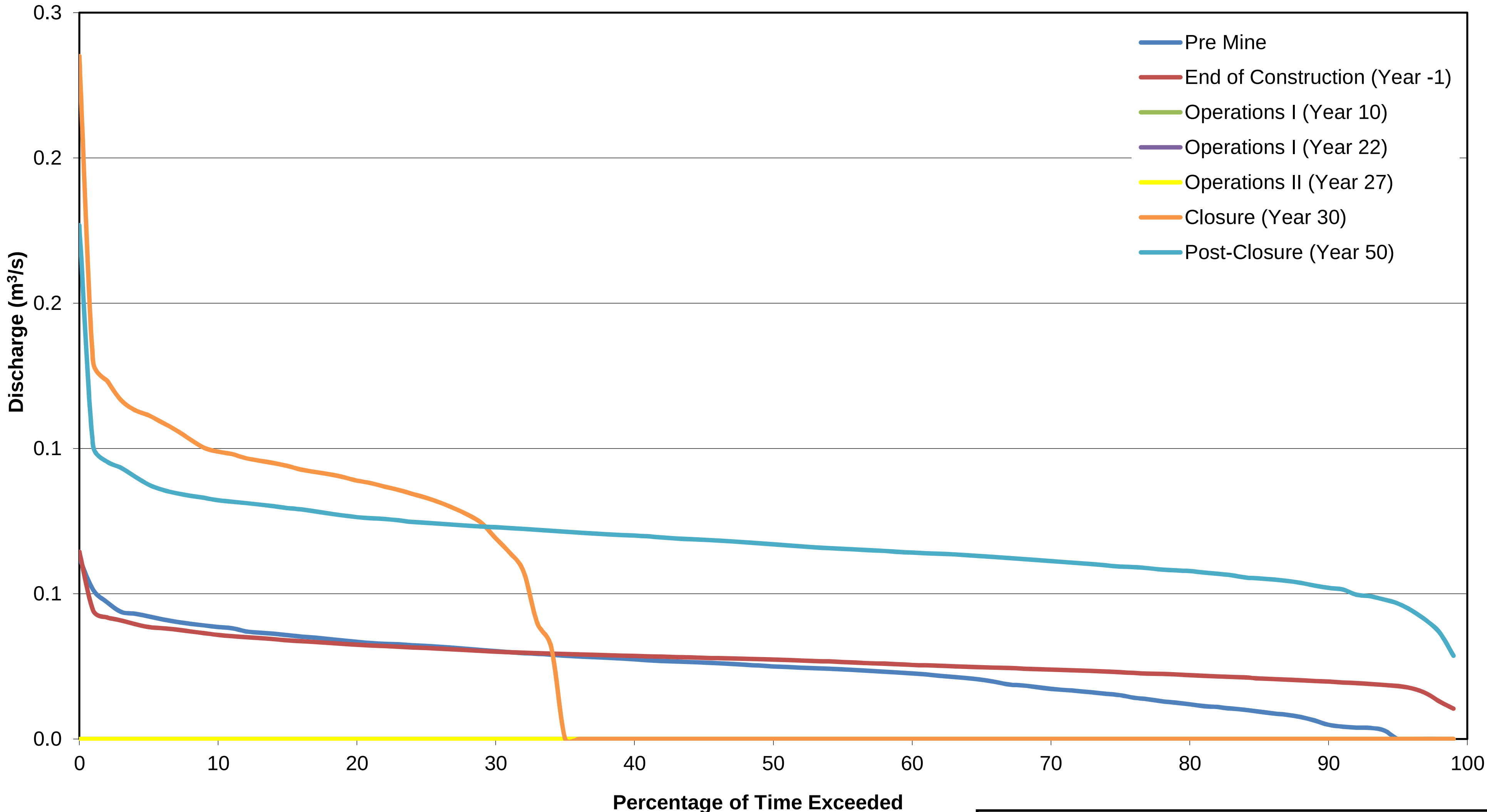
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-24

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

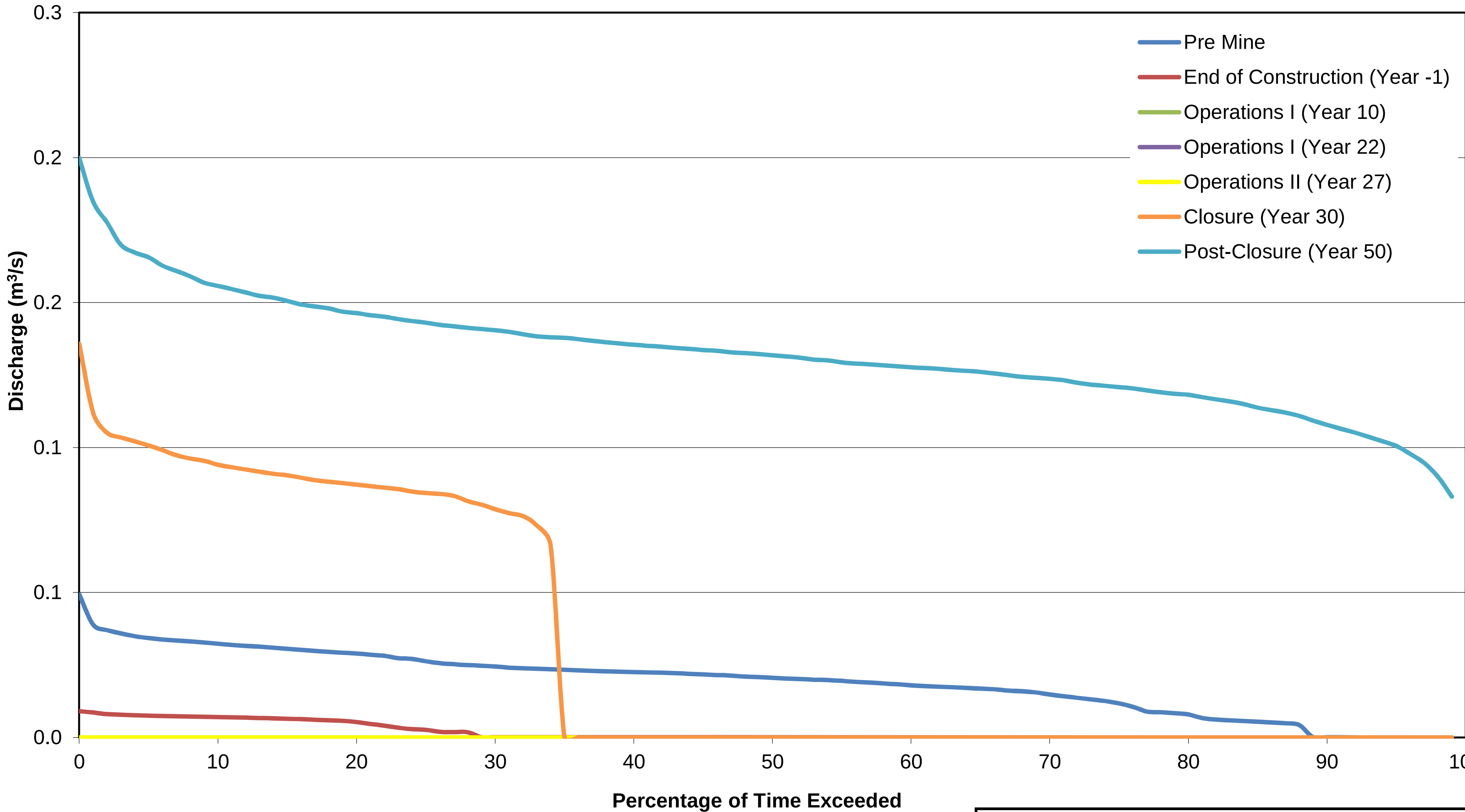
JANUARY FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-25 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

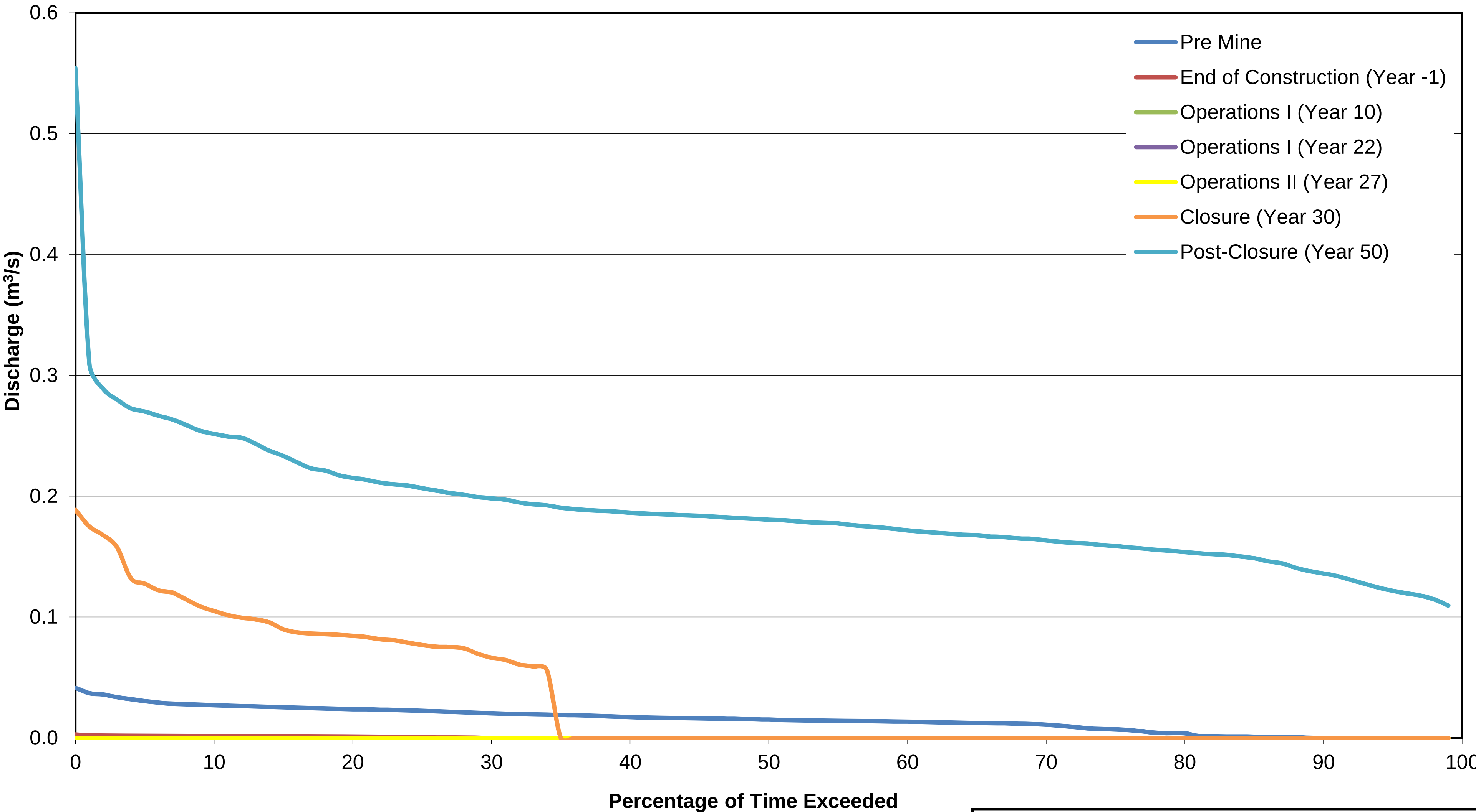
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-26		REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

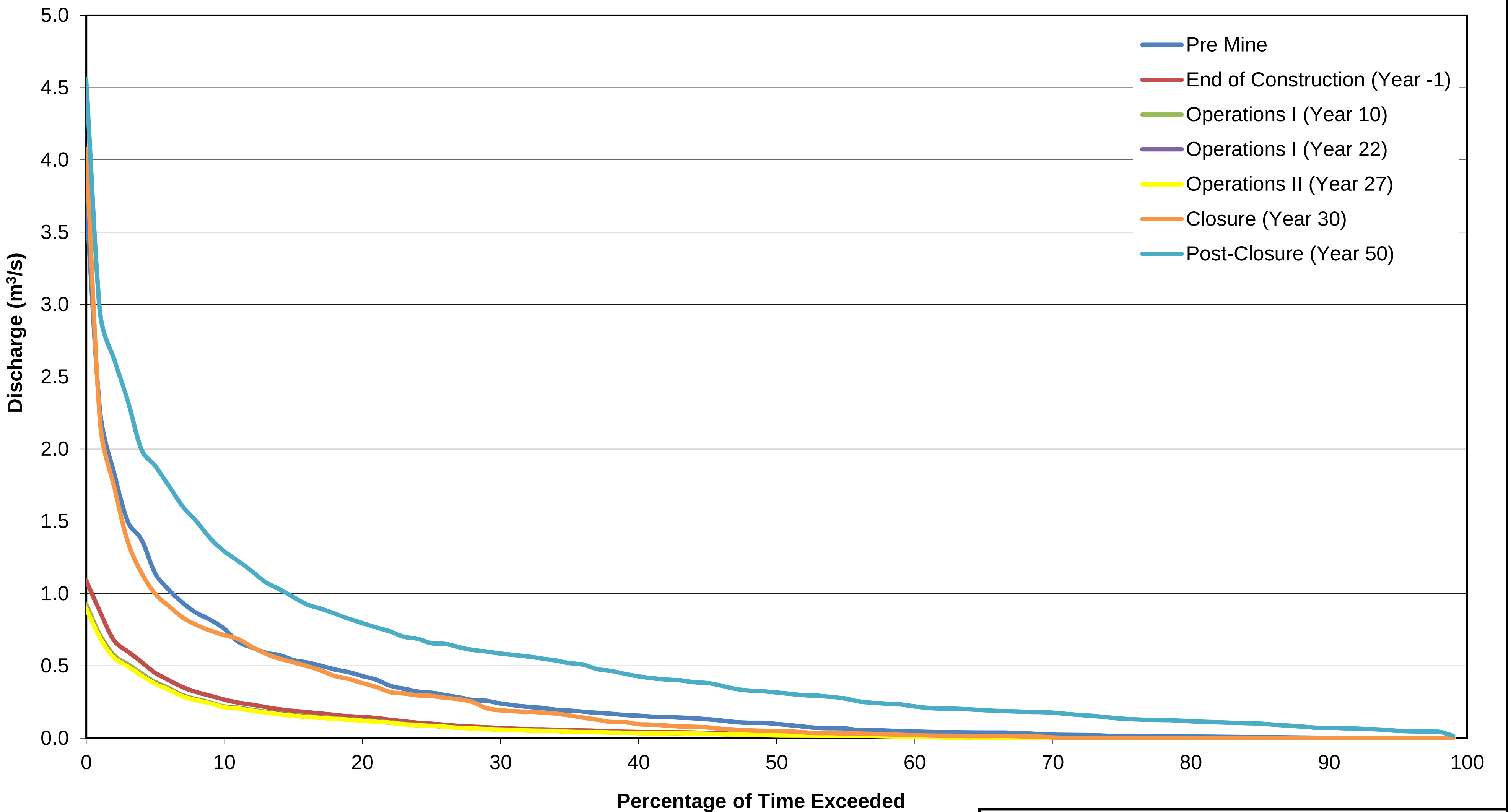
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.	
VA101-458/15	3	
FIGURE A4-27		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

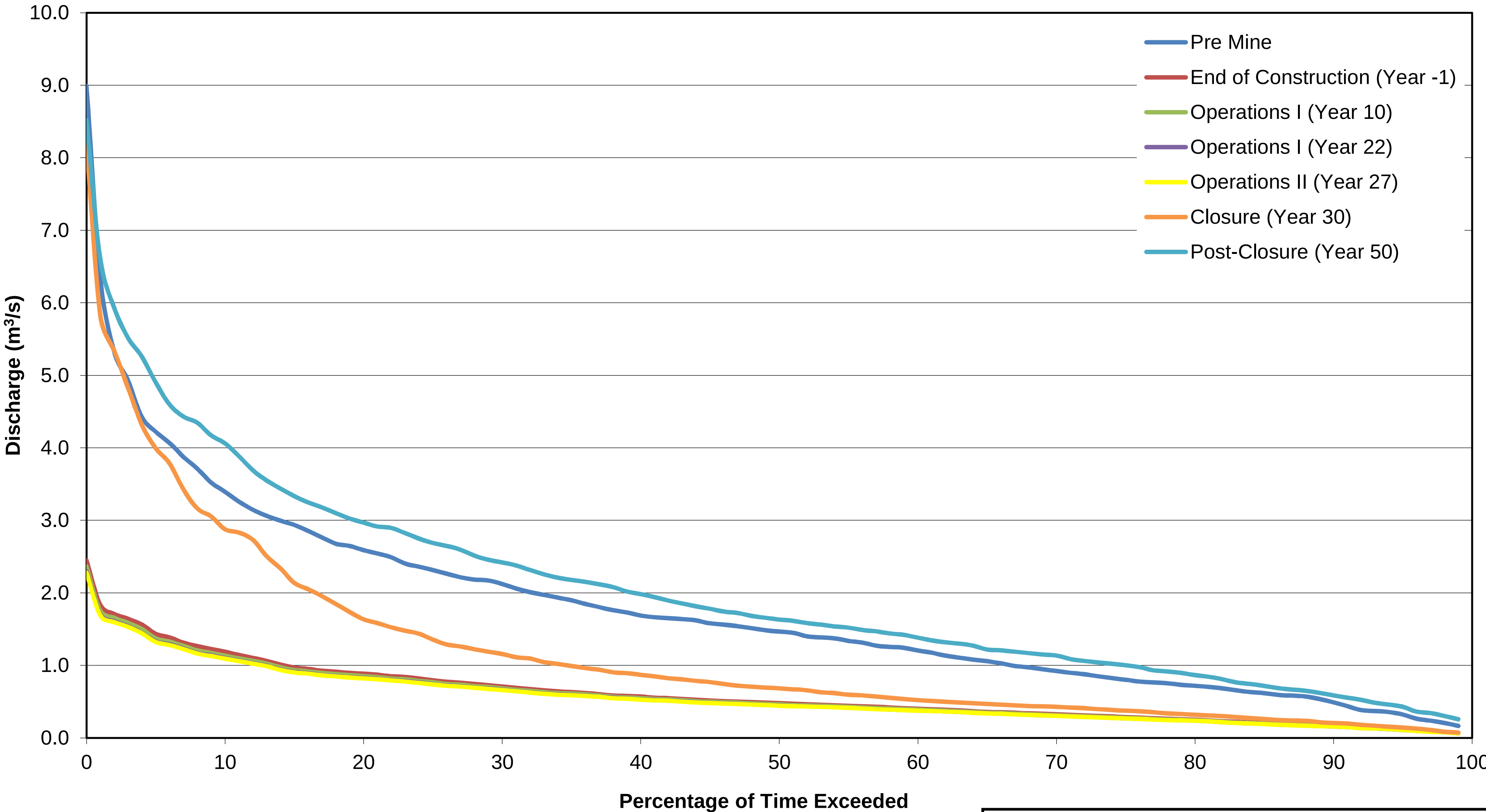
APRIL FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-28 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

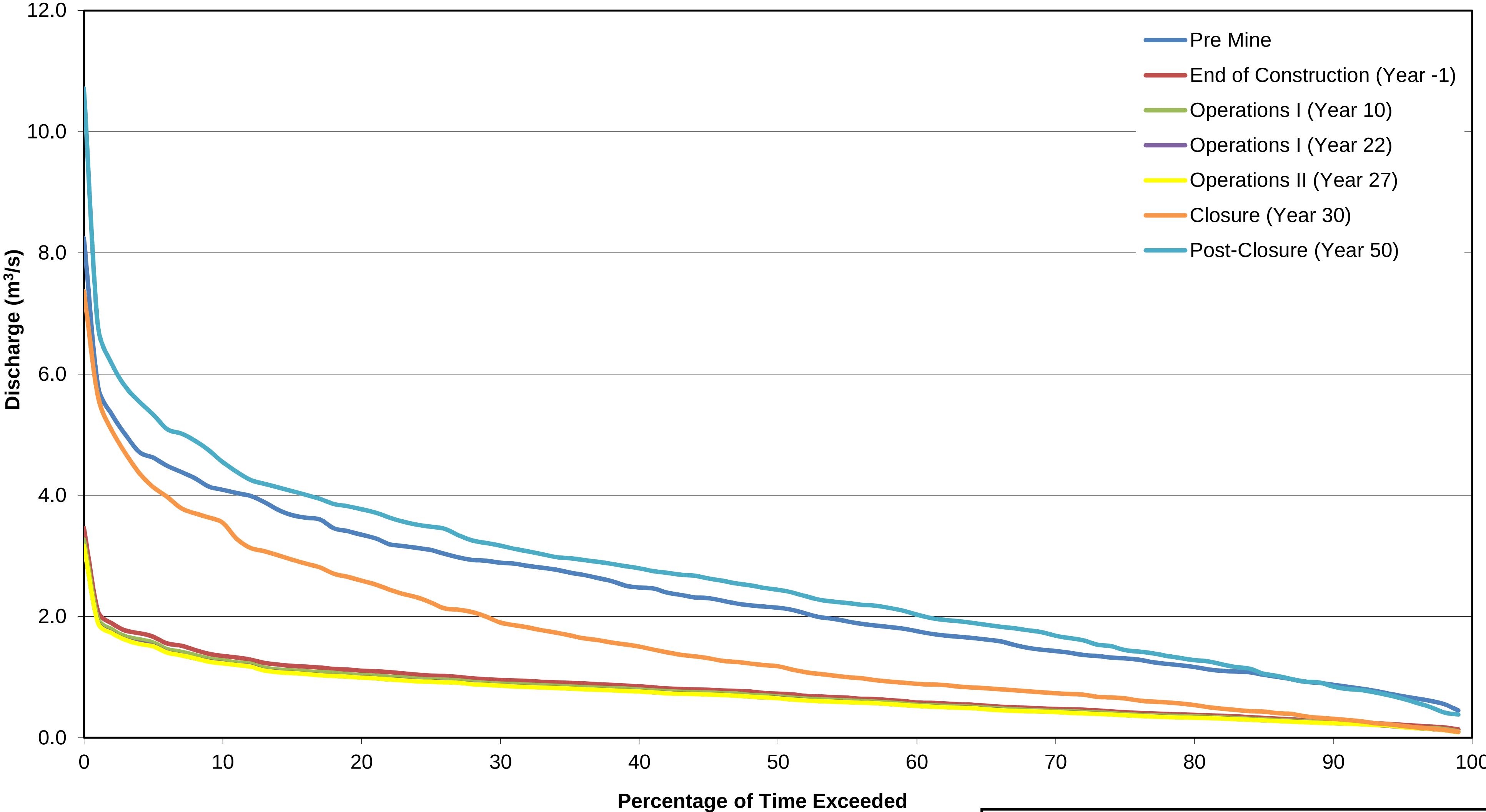
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-29

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

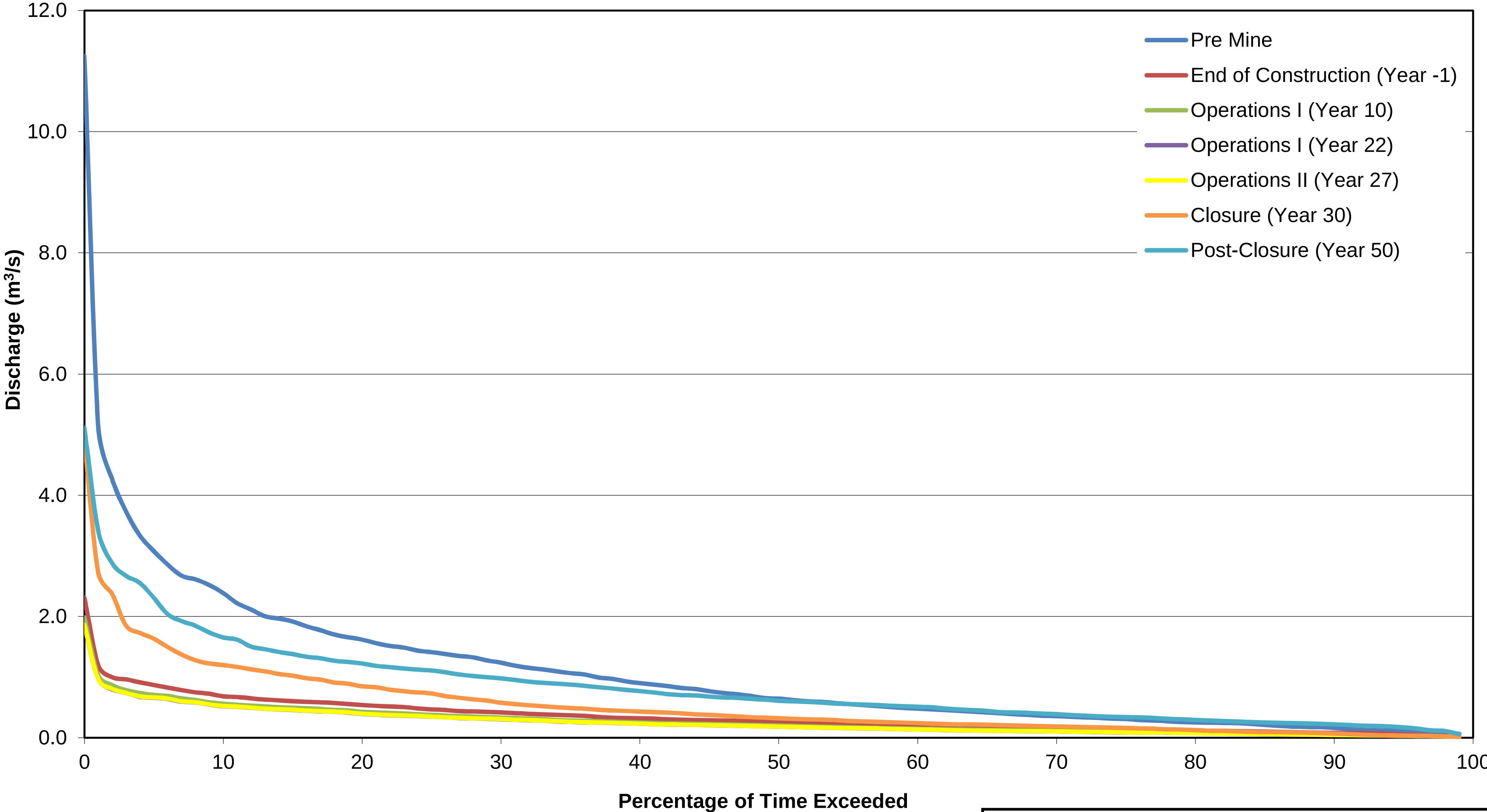
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-30

REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

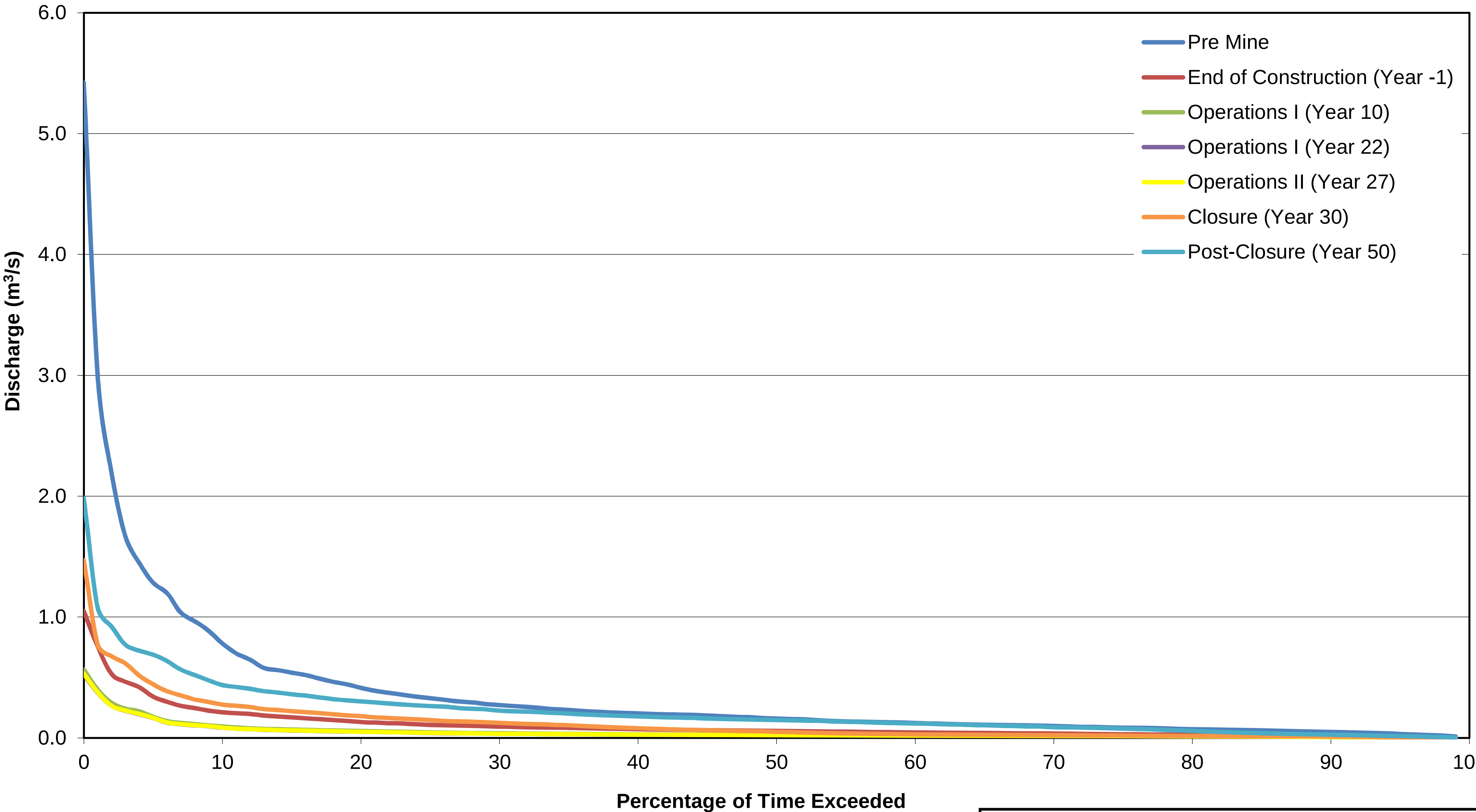
HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-31		REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

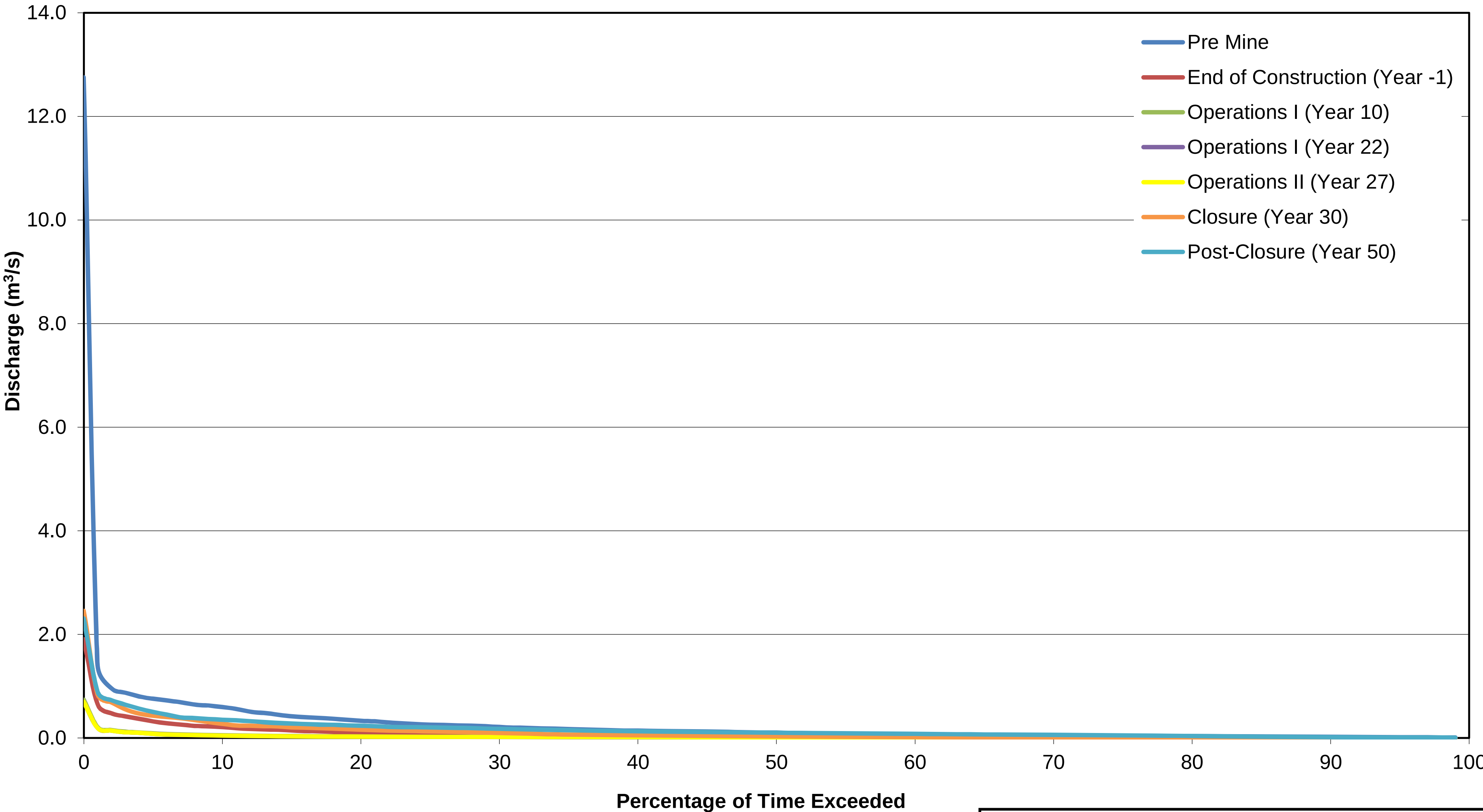
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-32

REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

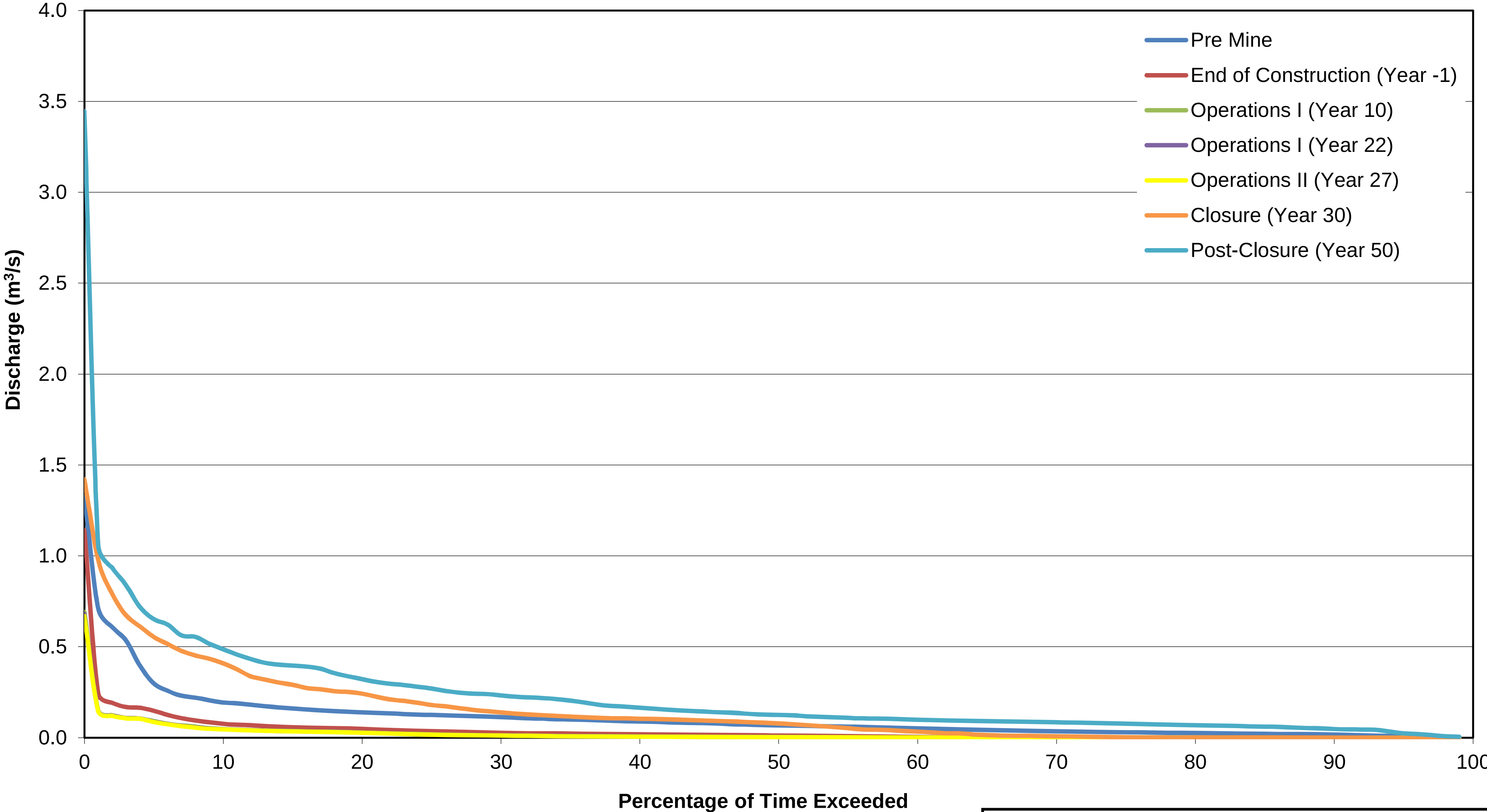
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-33

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

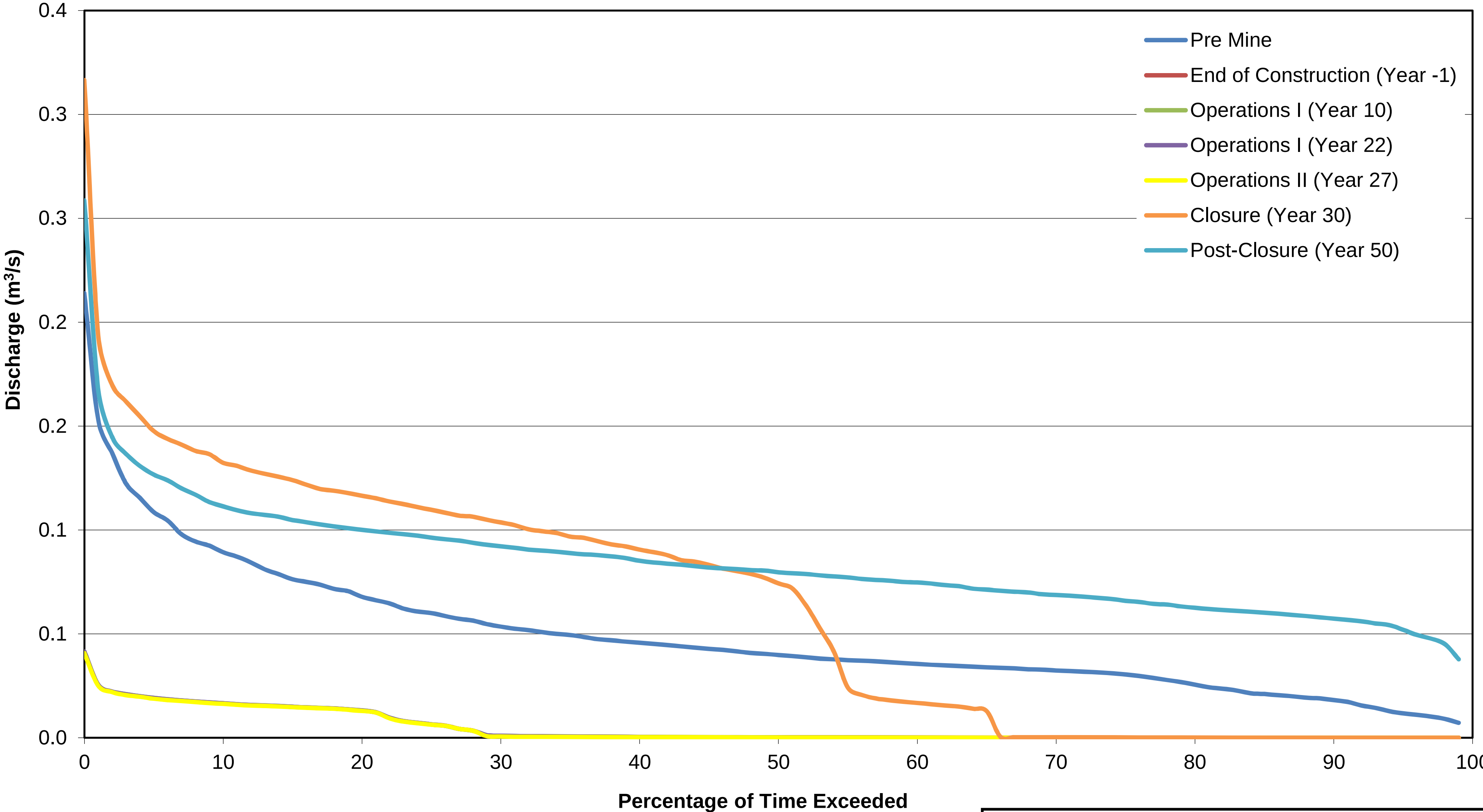
HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-34	REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

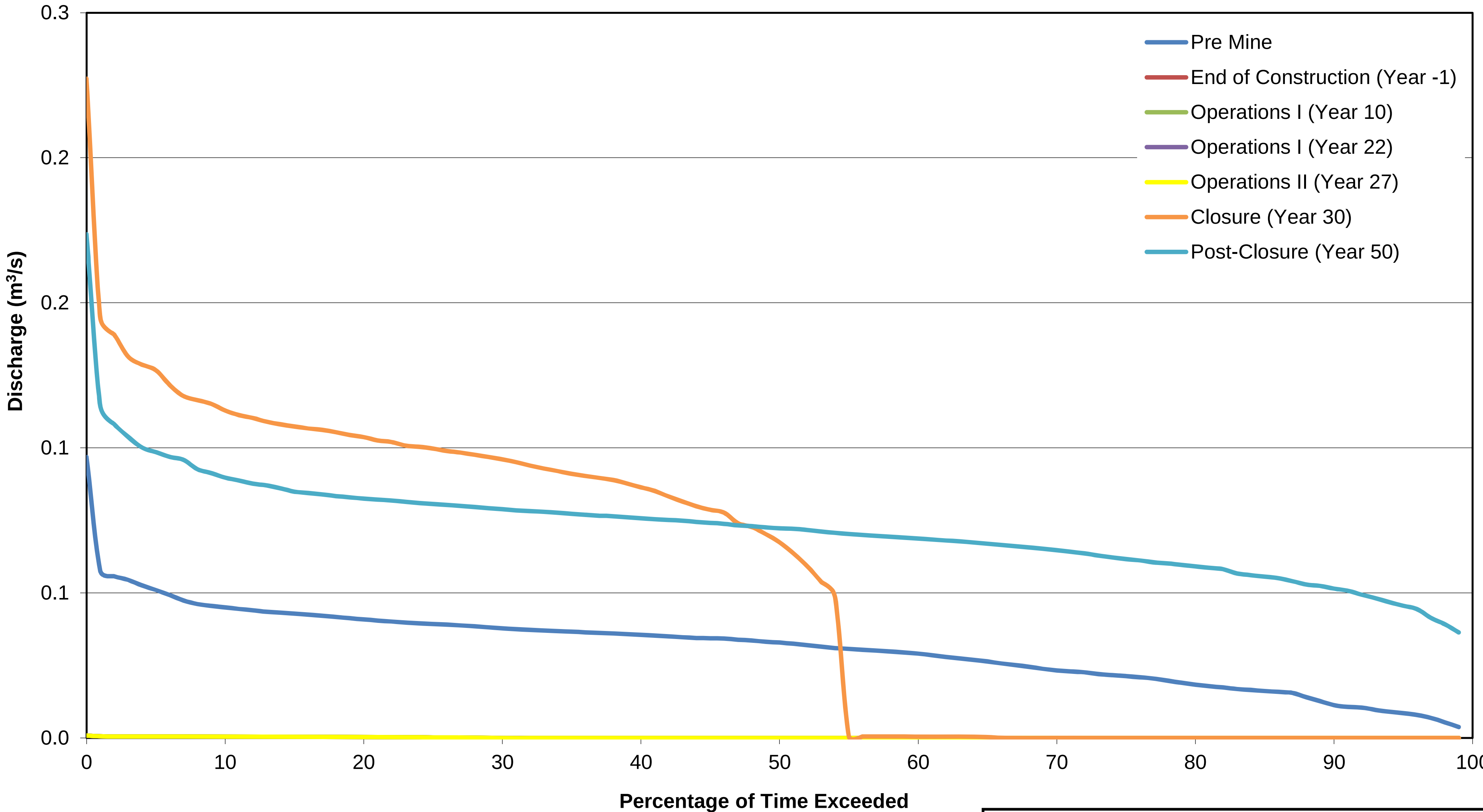
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-35

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

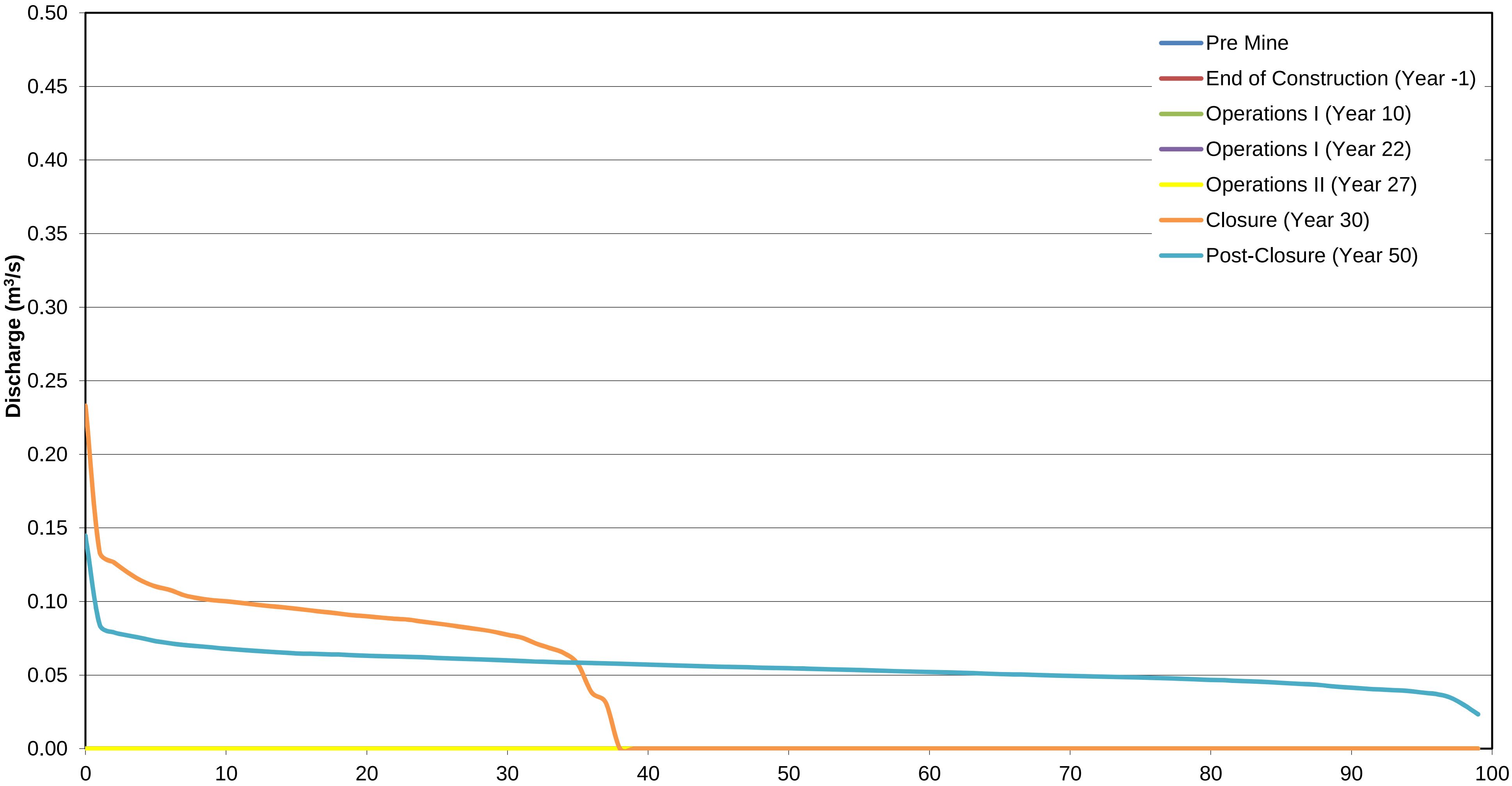
DECEMBER FLOW DURATION CURVES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-36 REV 0

0	09OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

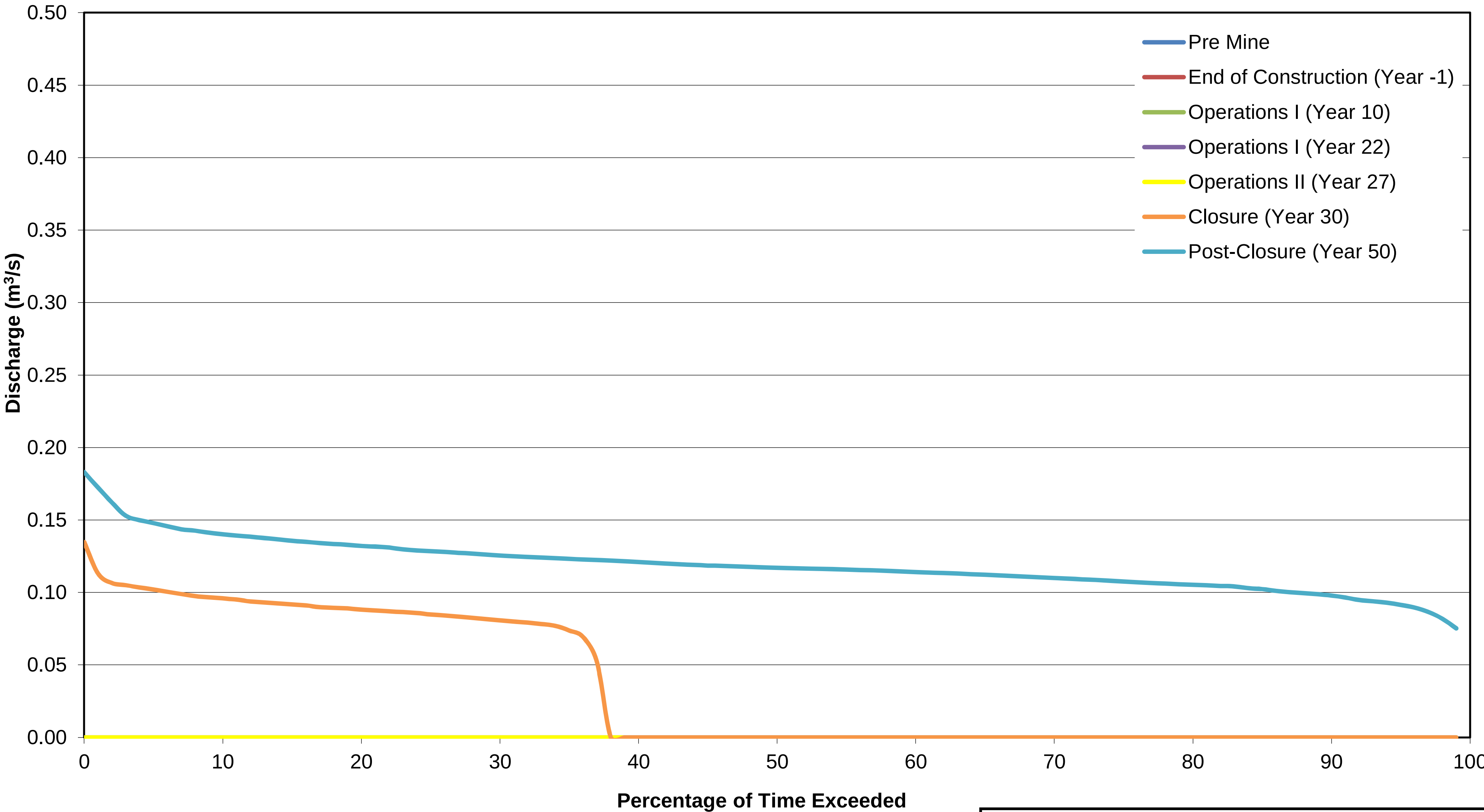
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-37

REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

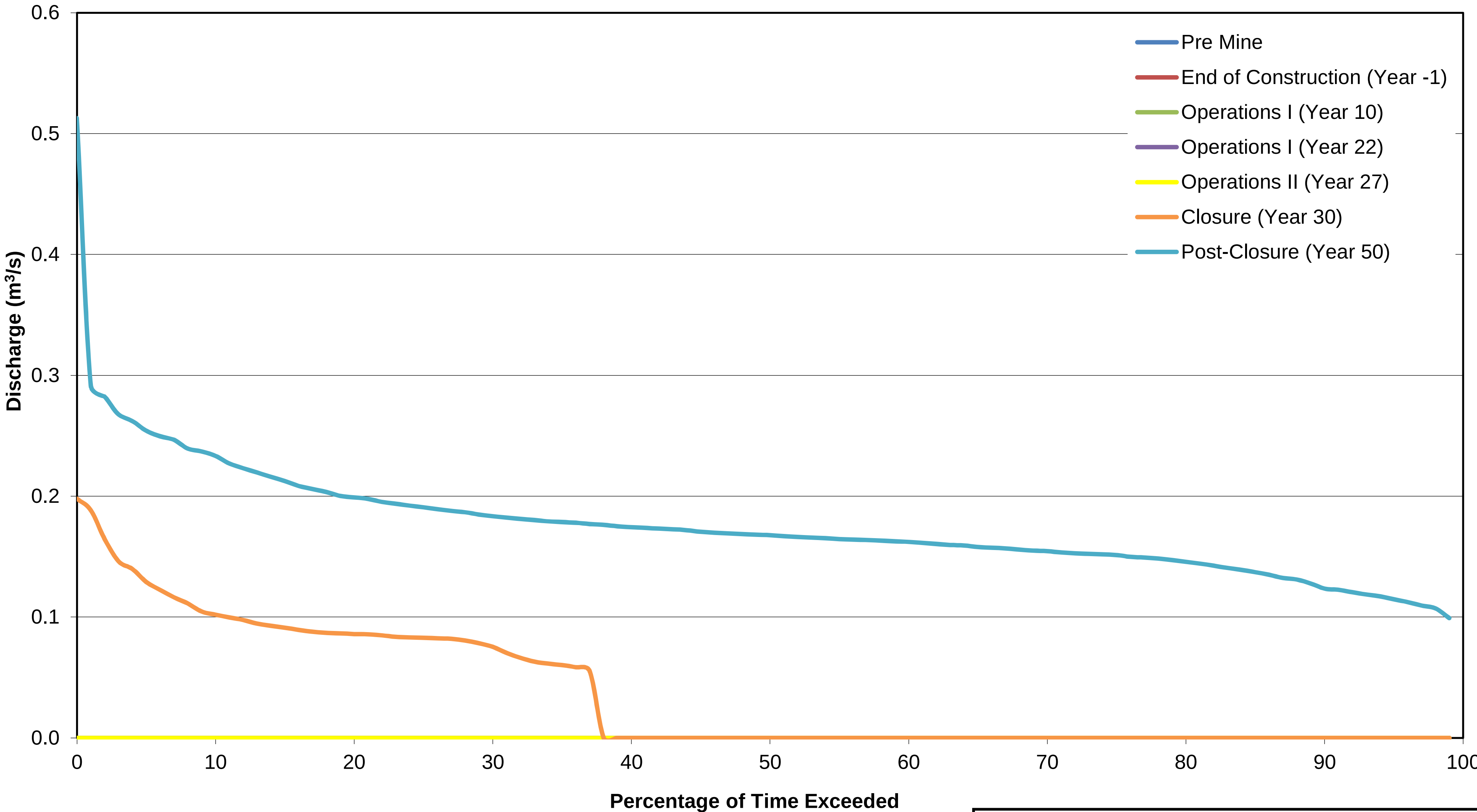
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-38	REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

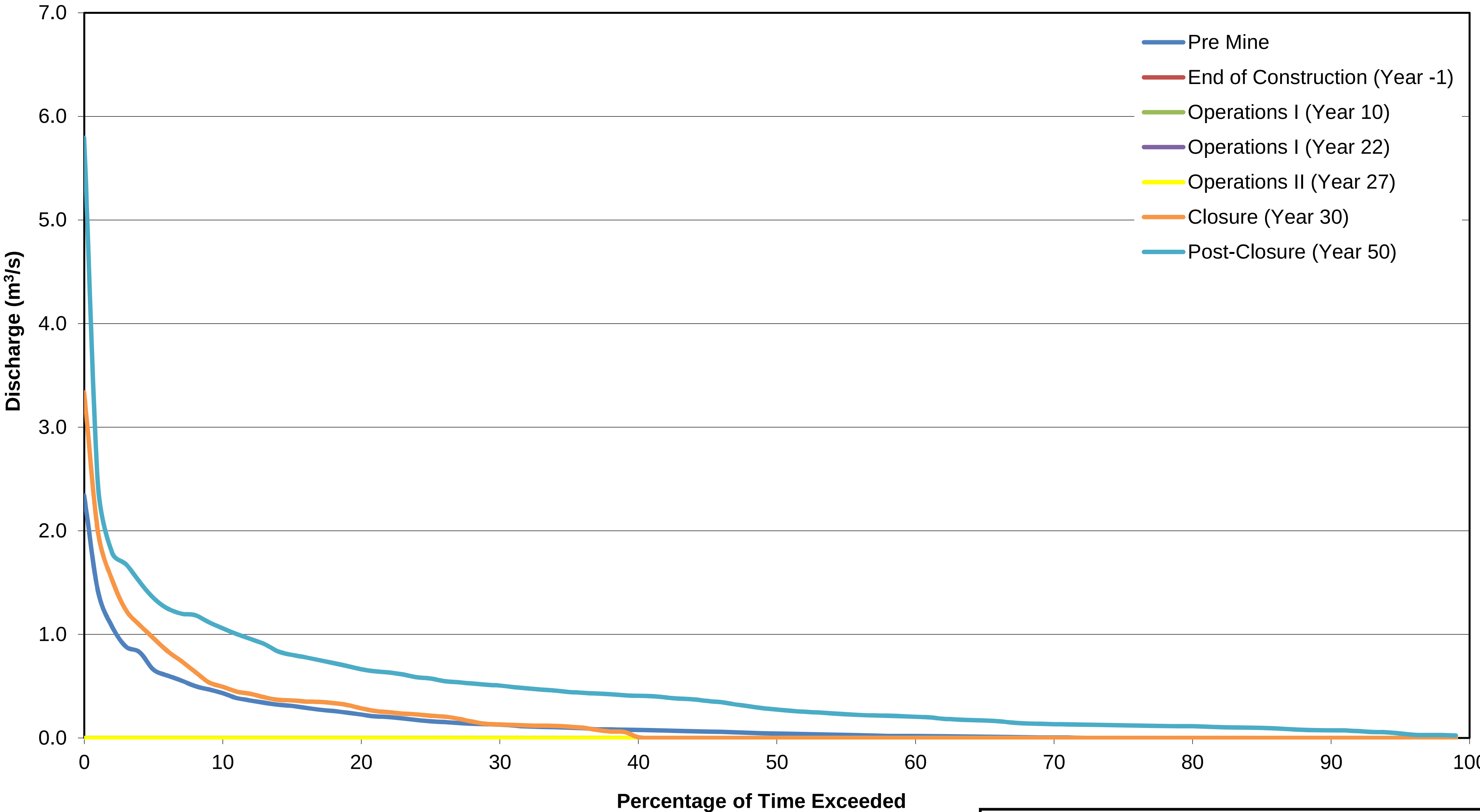
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-39

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

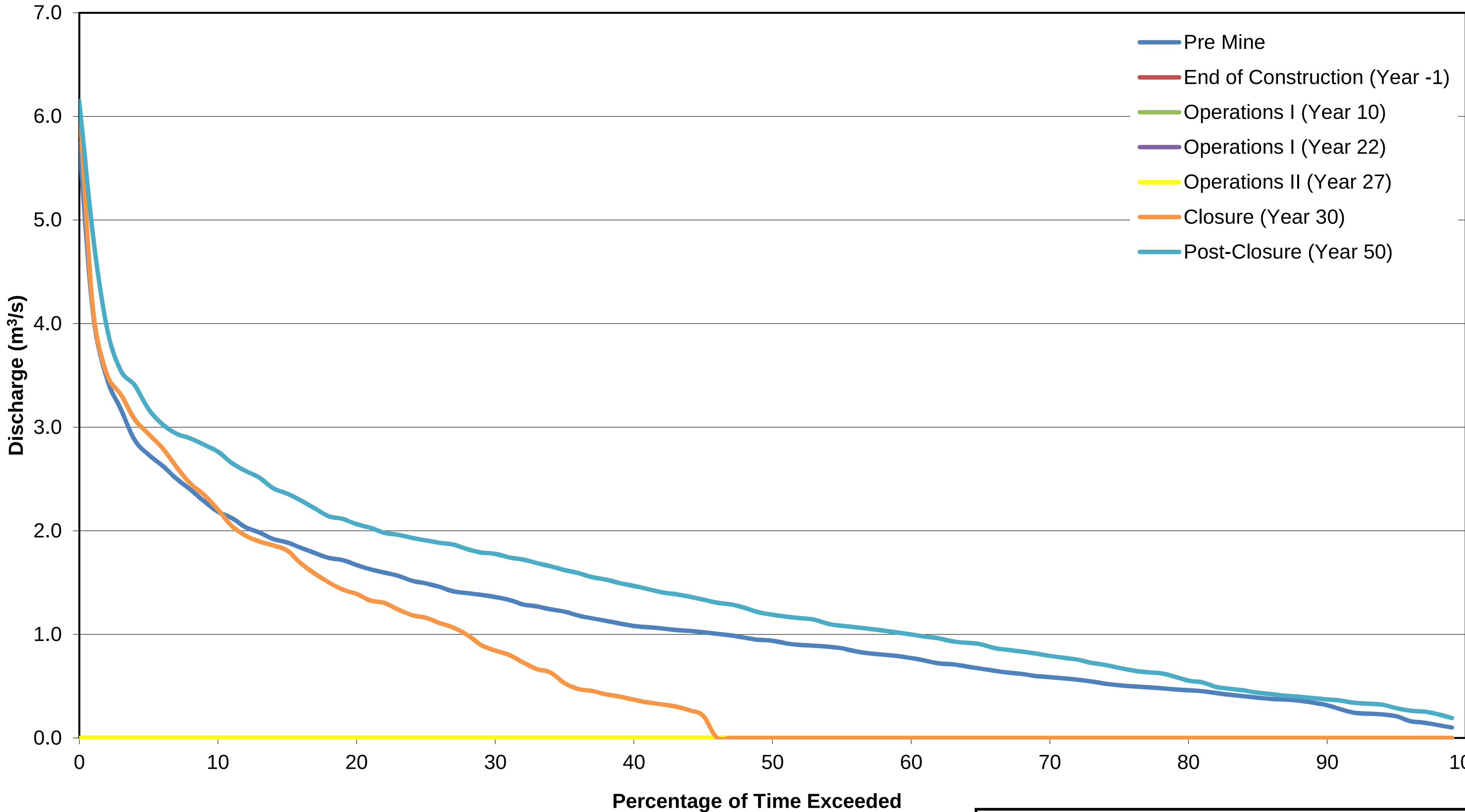
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-40

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

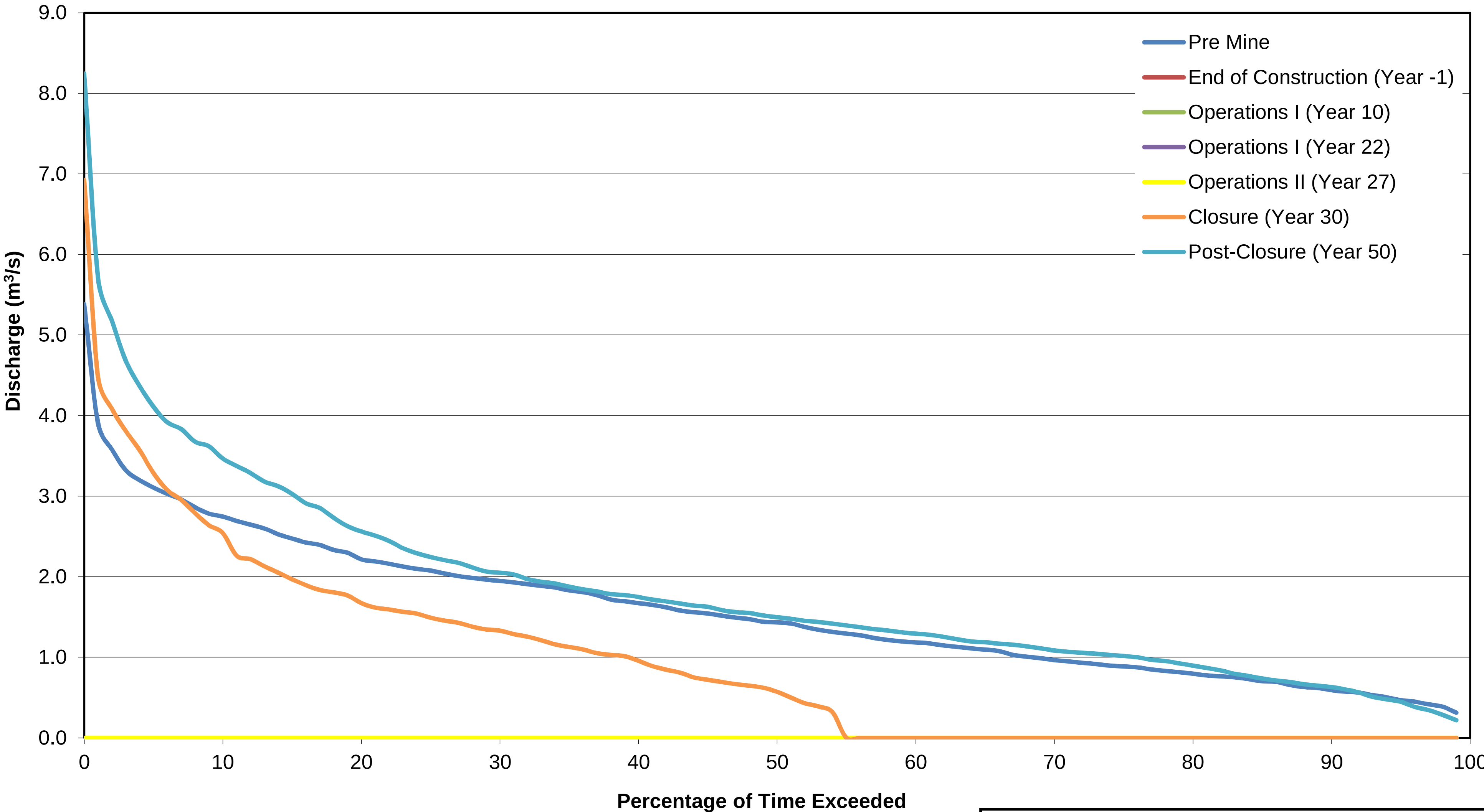
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-41

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

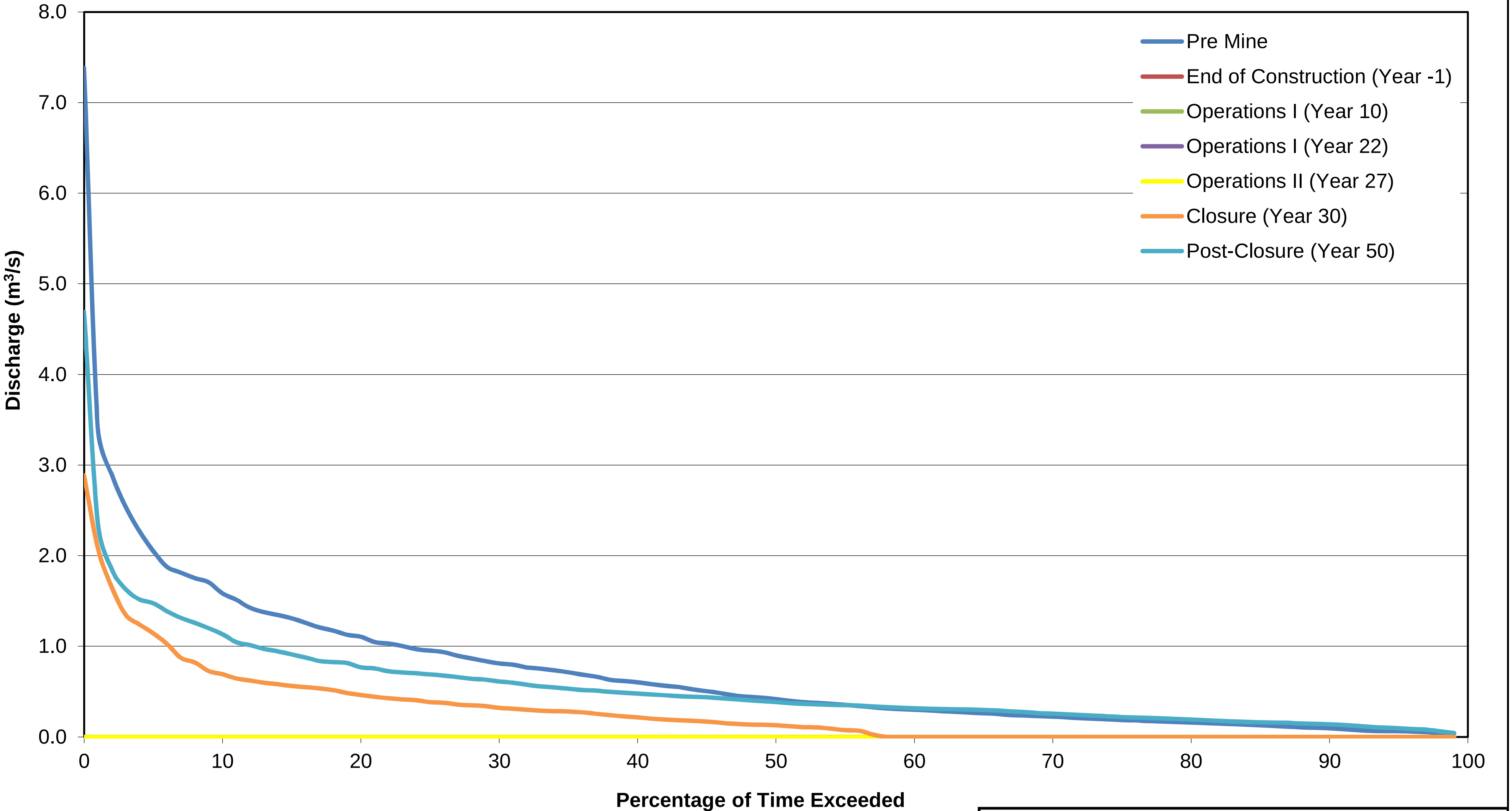
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-42

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

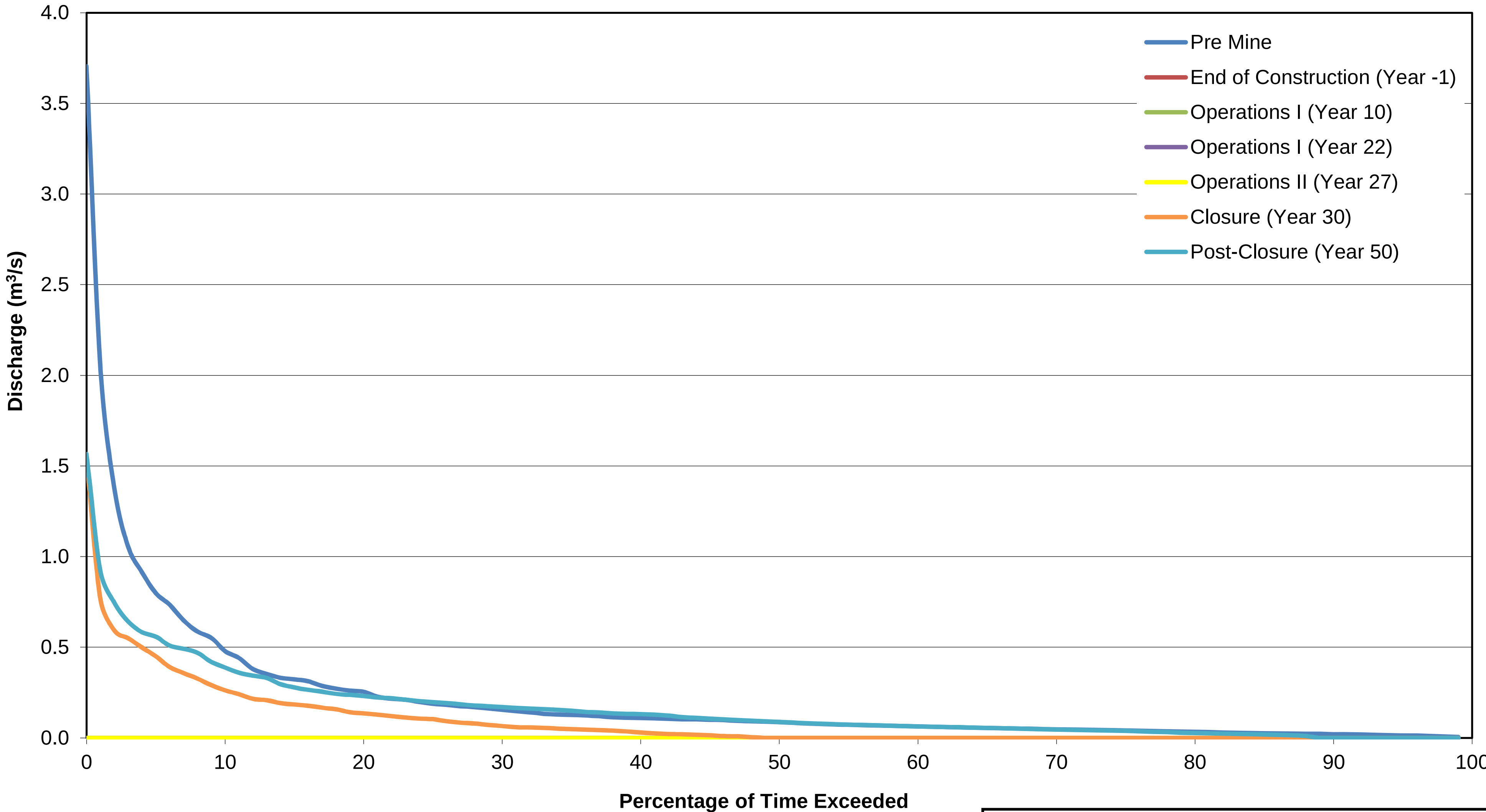
JULY FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-43 REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

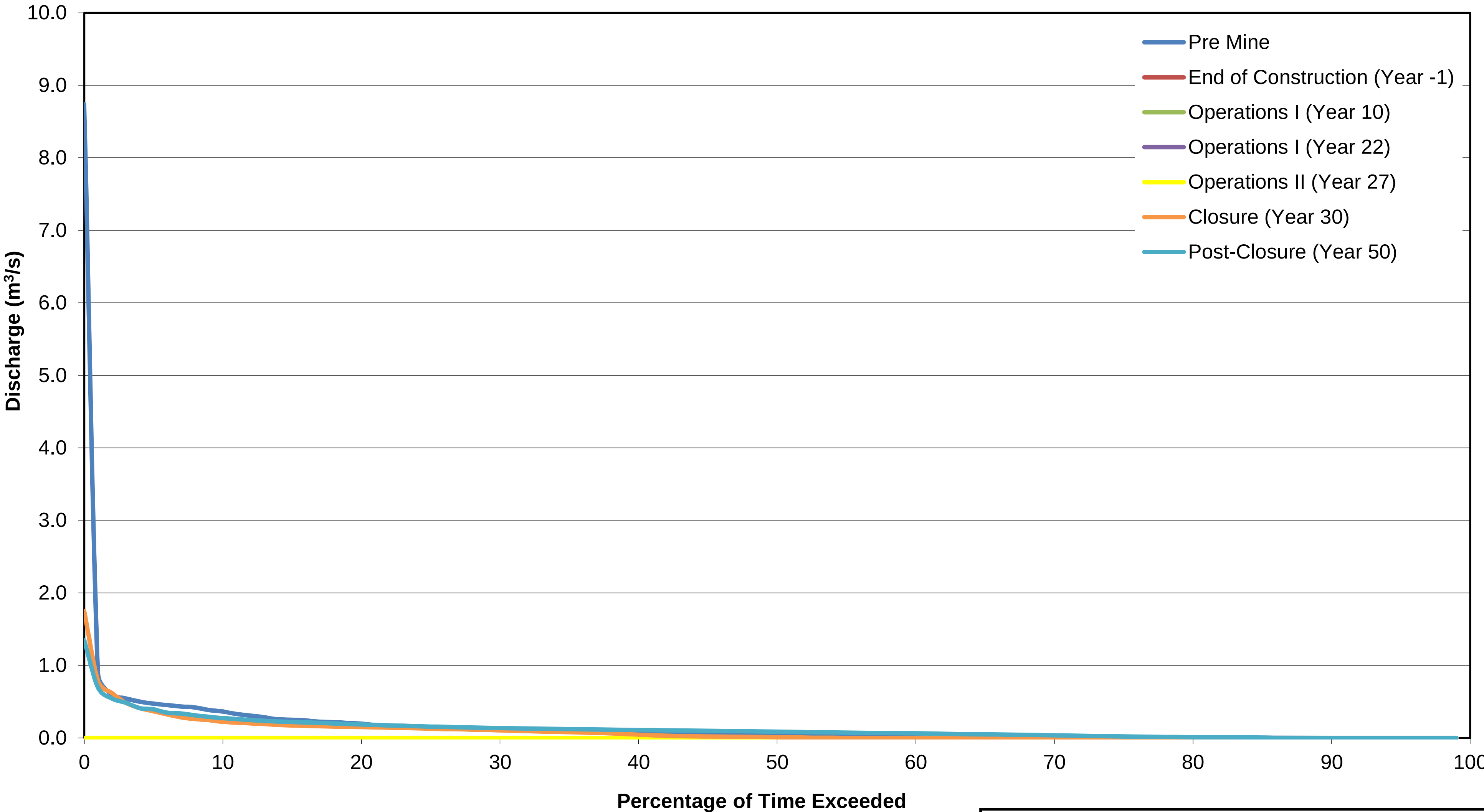
AUGUST FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-44 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

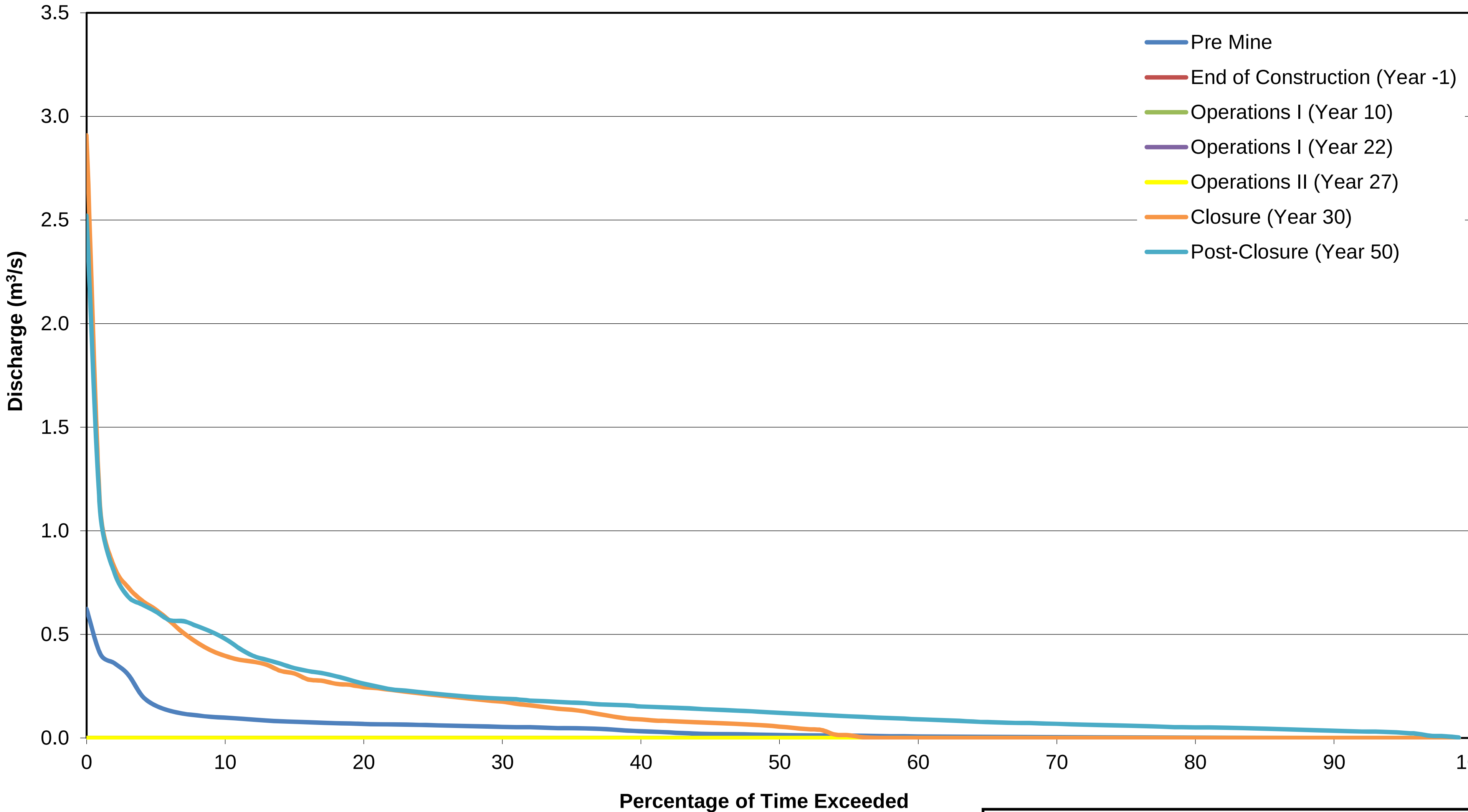
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-45

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

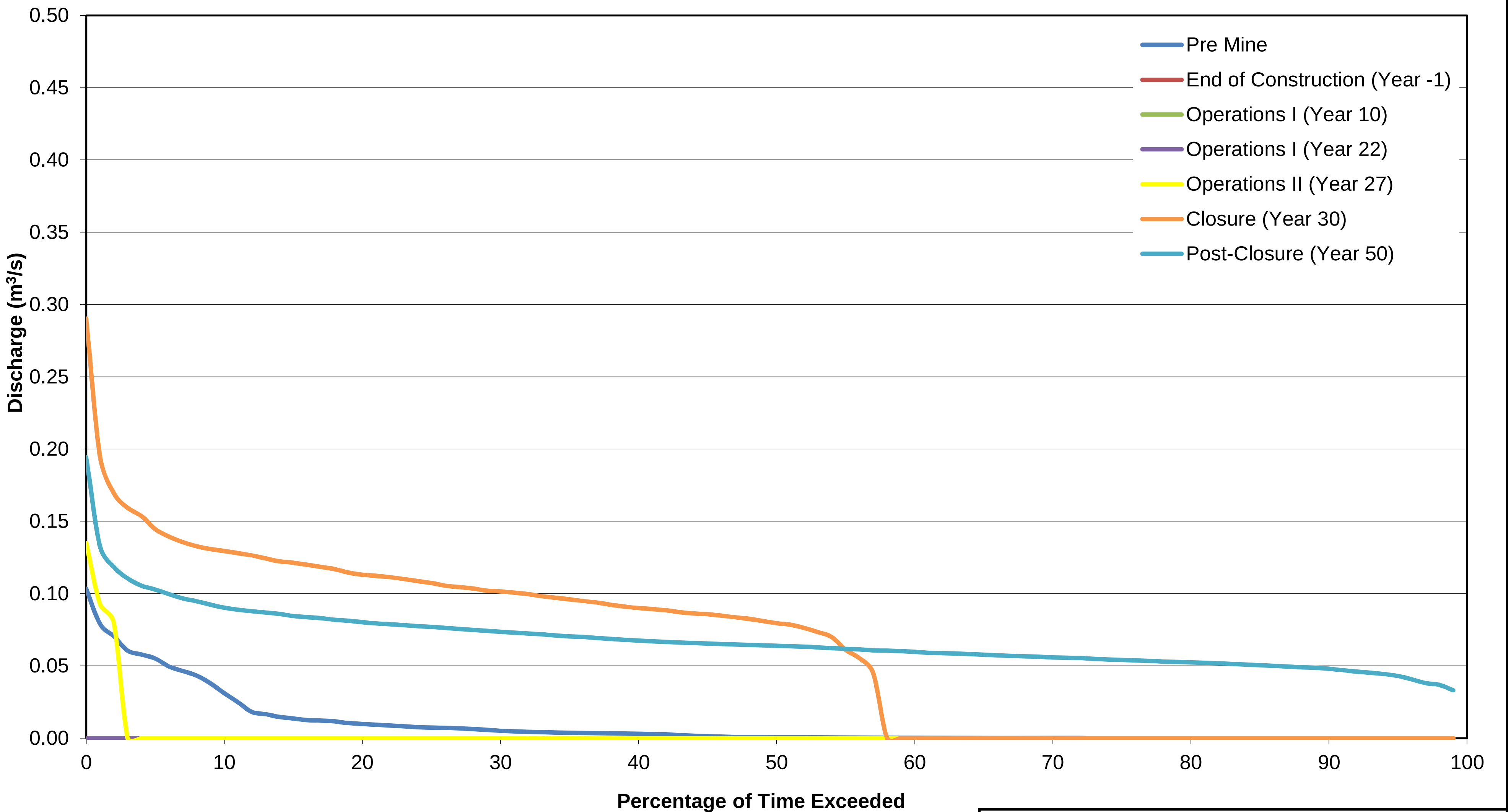
OCTOBER FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-46 REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

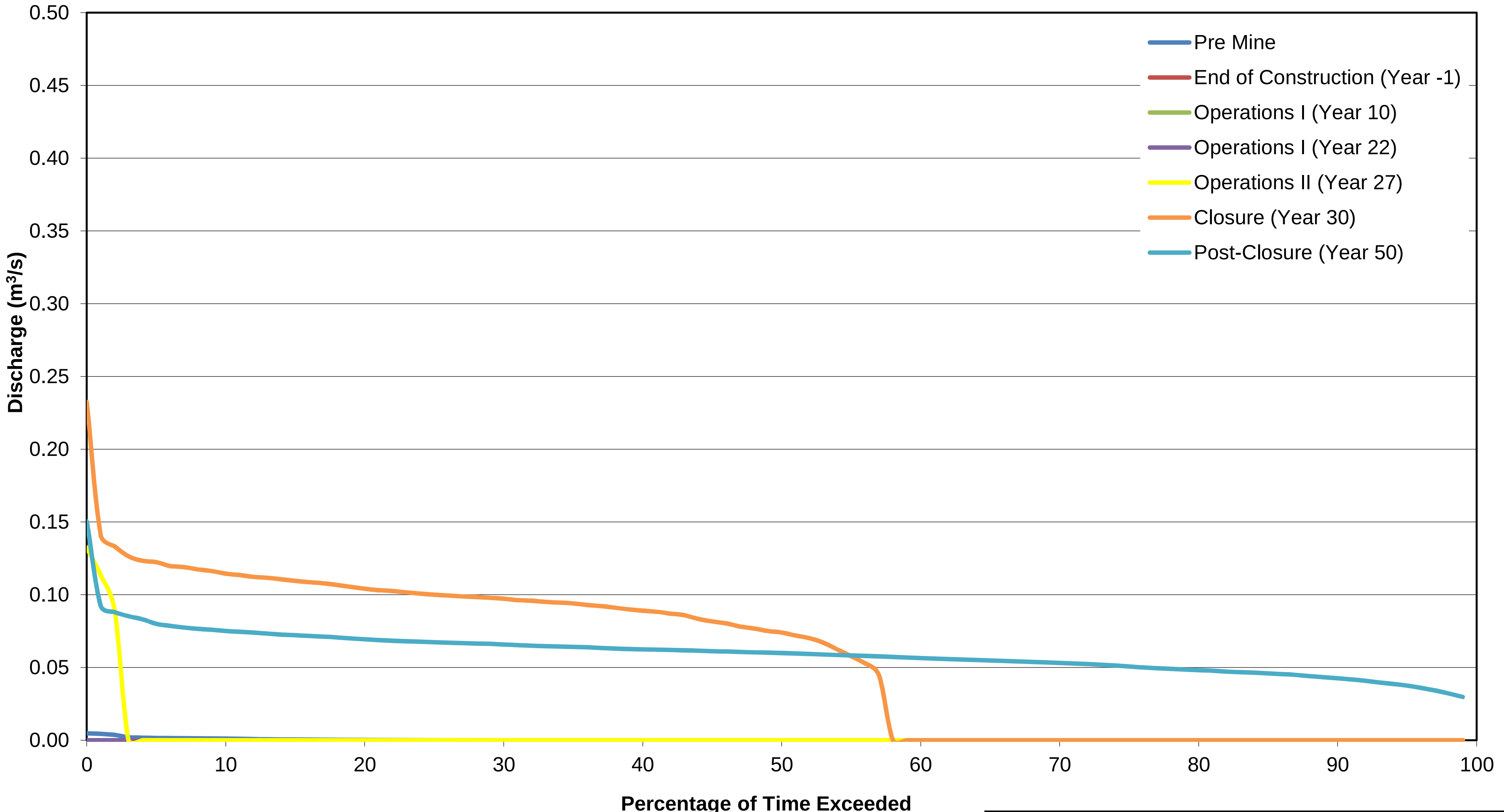
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-47

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 4
T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

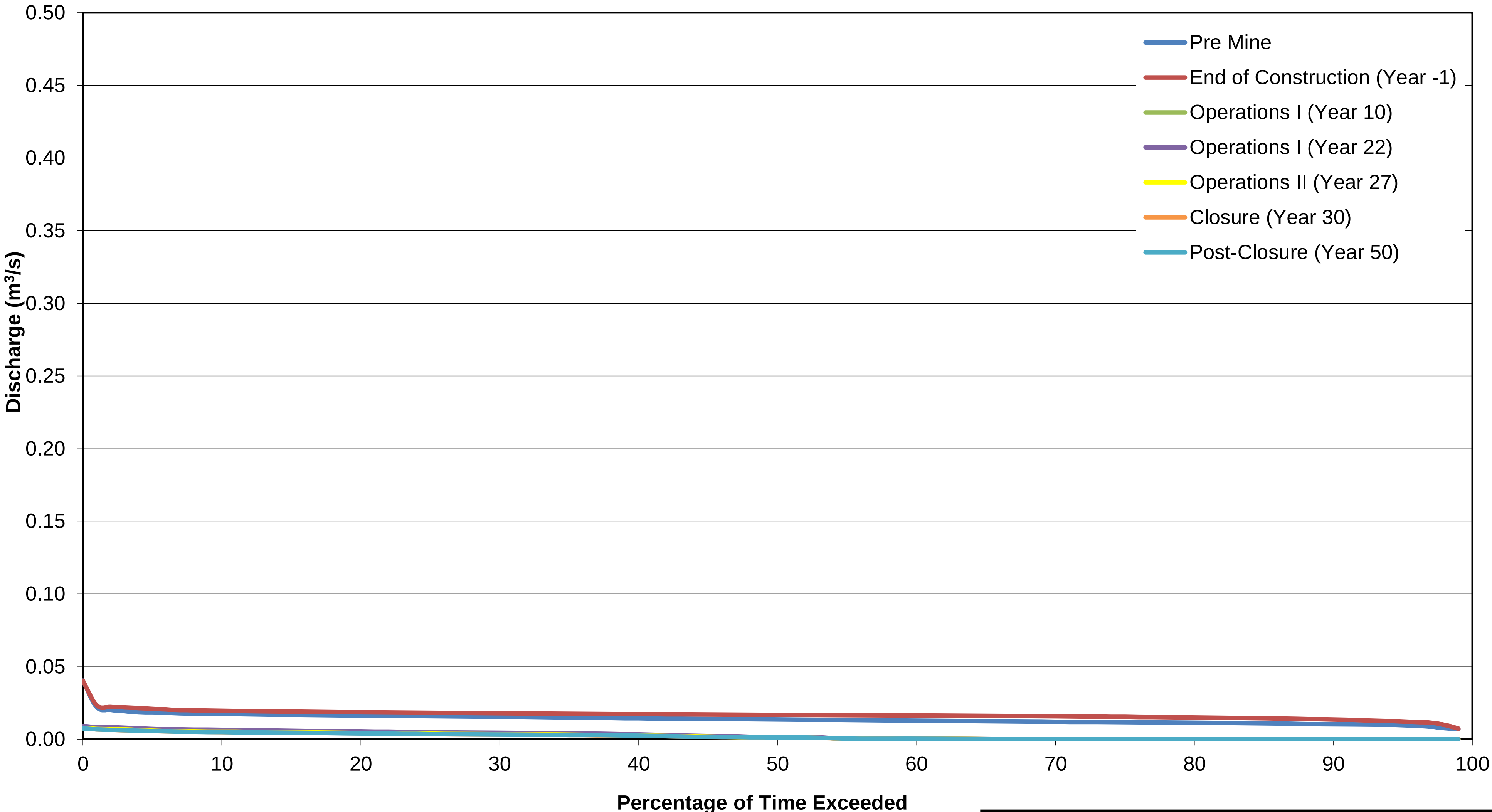
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-48

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

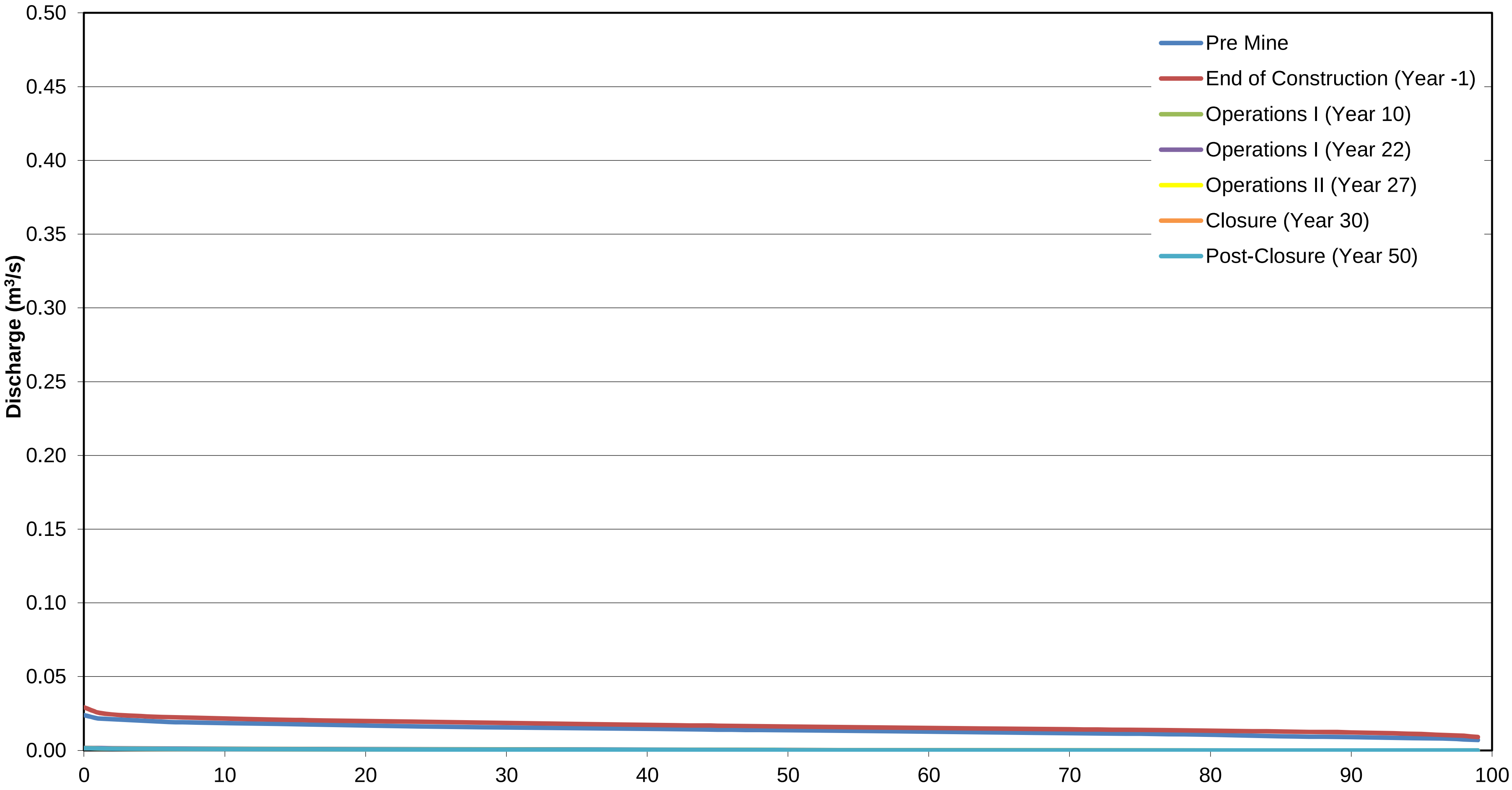
JANUARY FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-49 REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

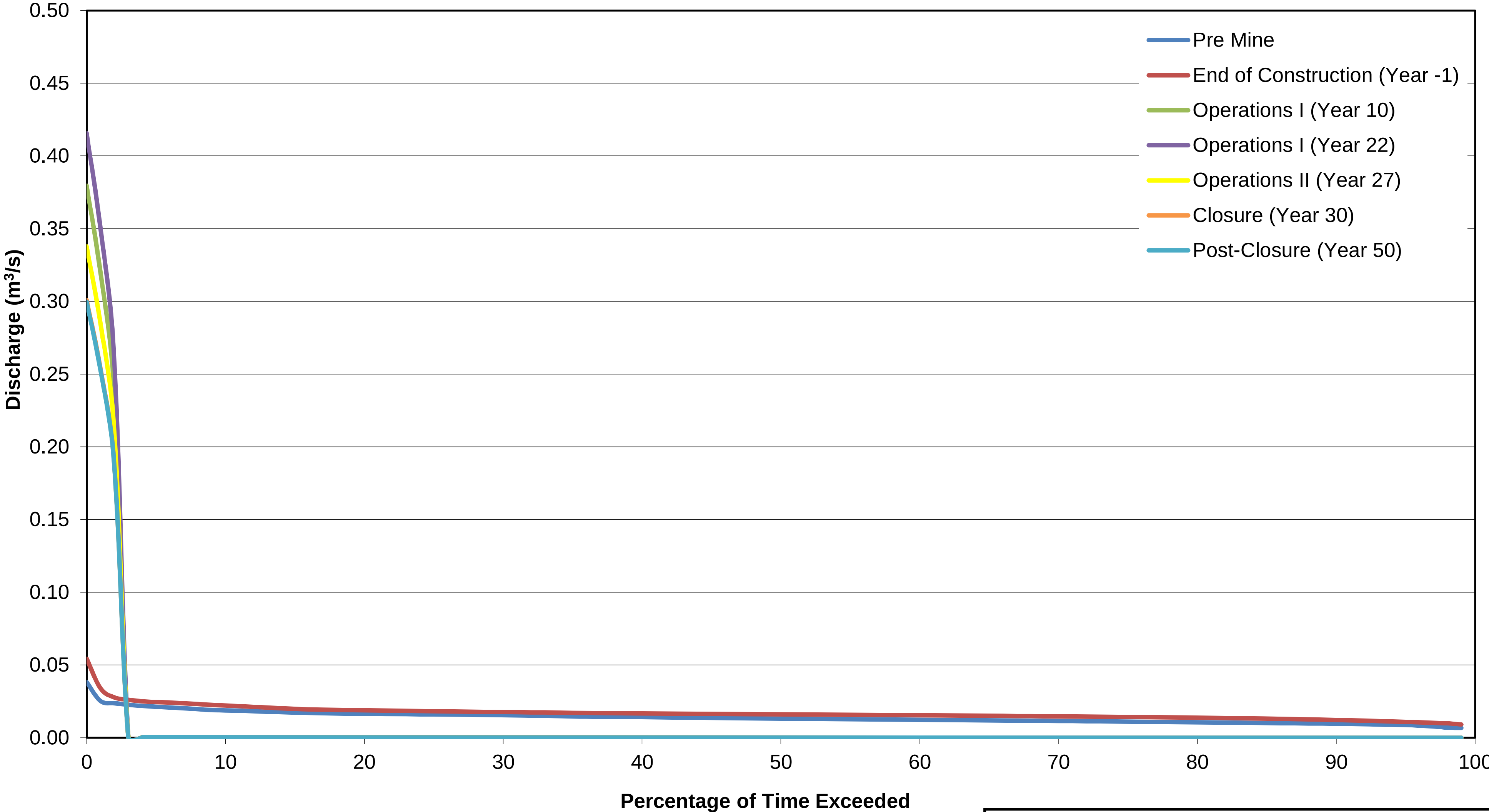
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-50

REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

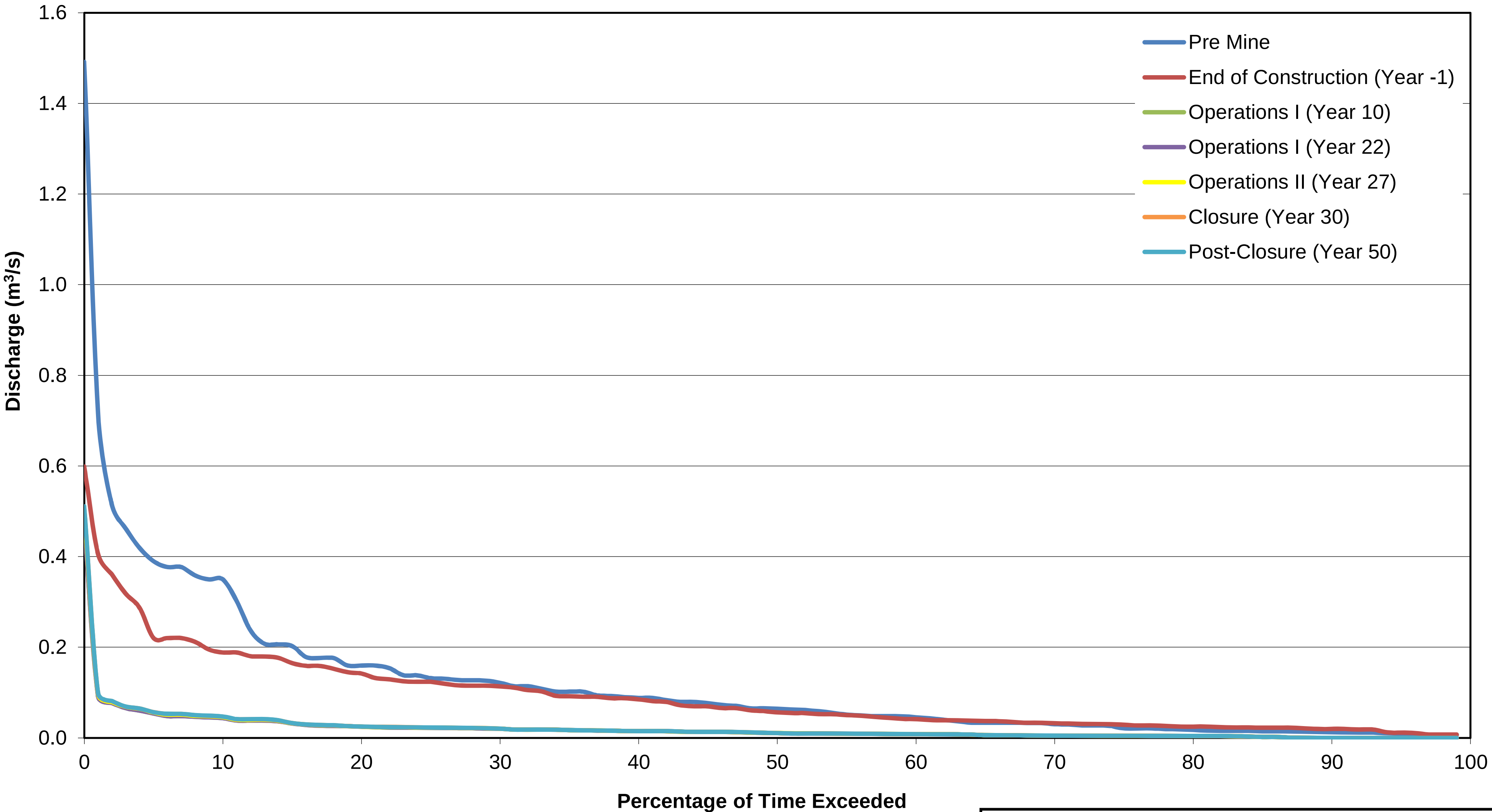
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-51

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

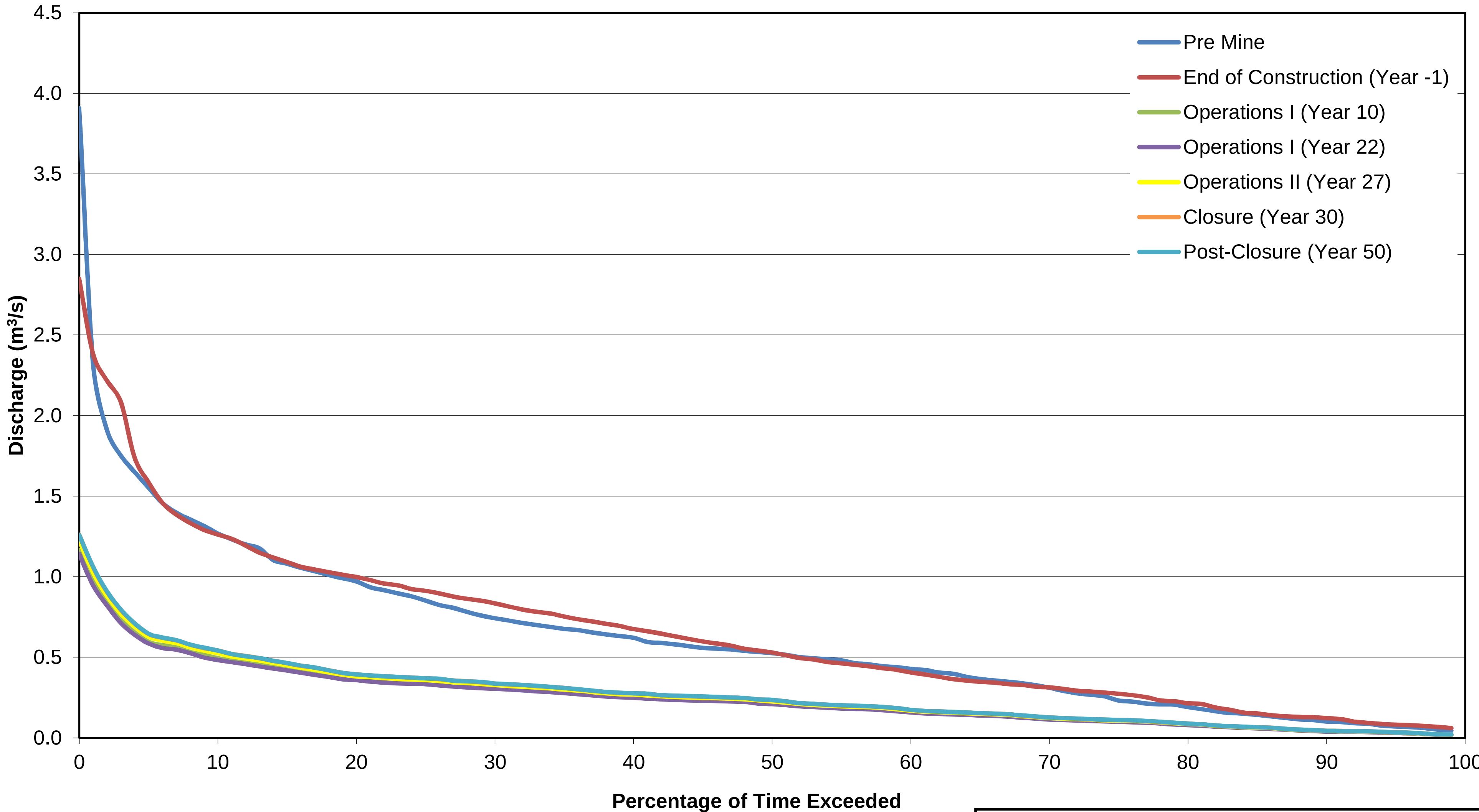
HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-52	REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

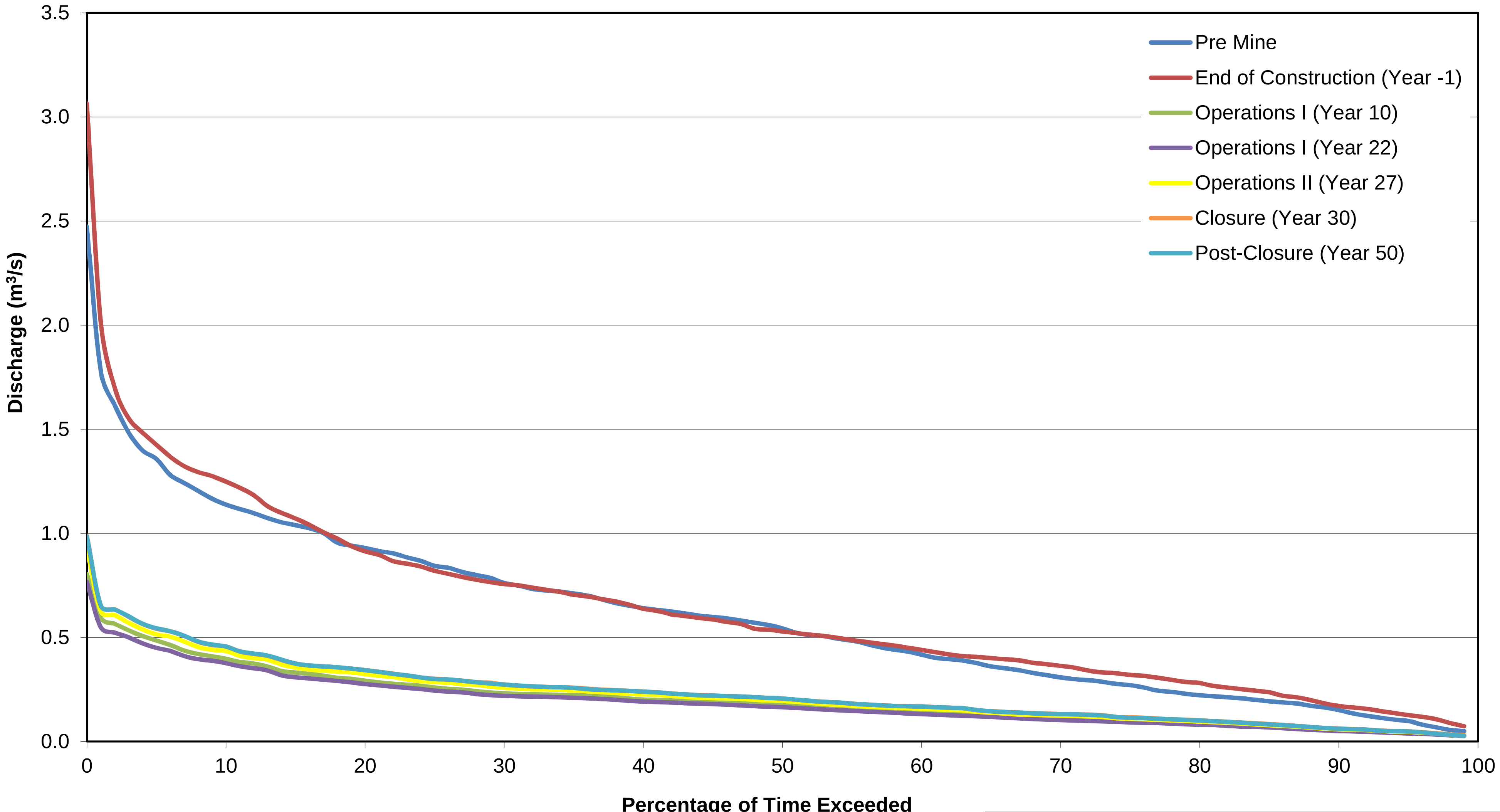
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-53

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

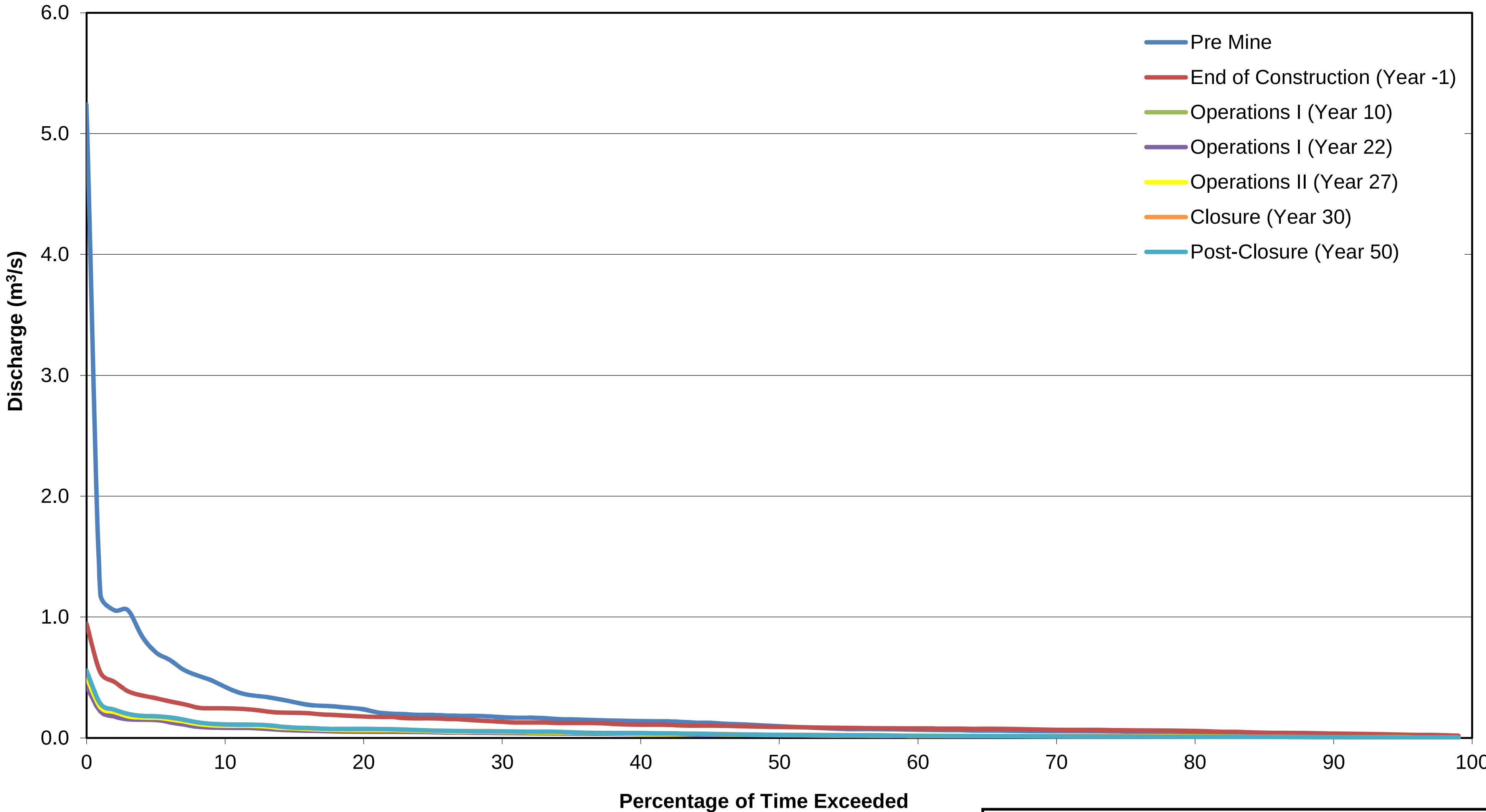
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-54

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

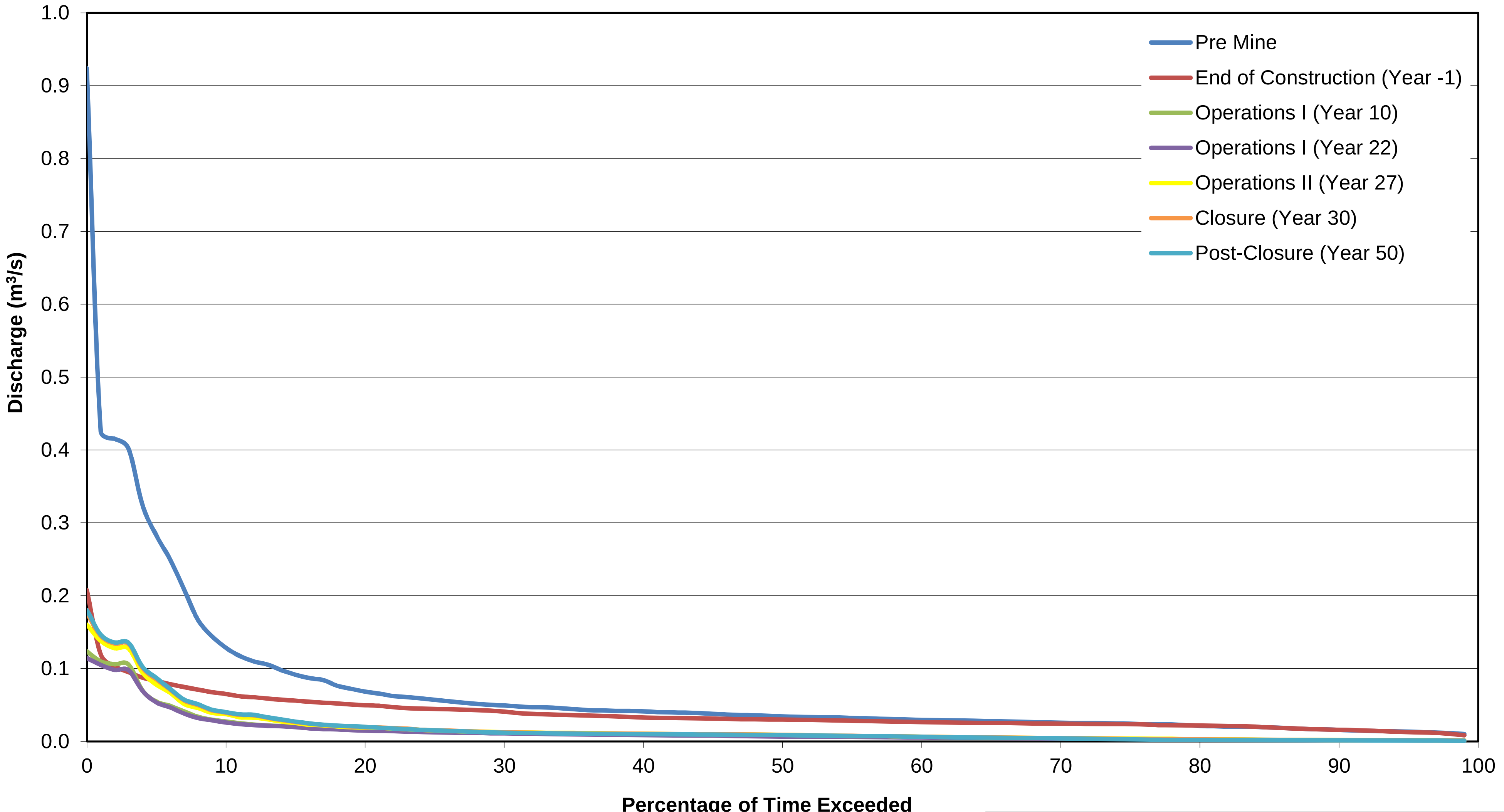
JULY FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-55 REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

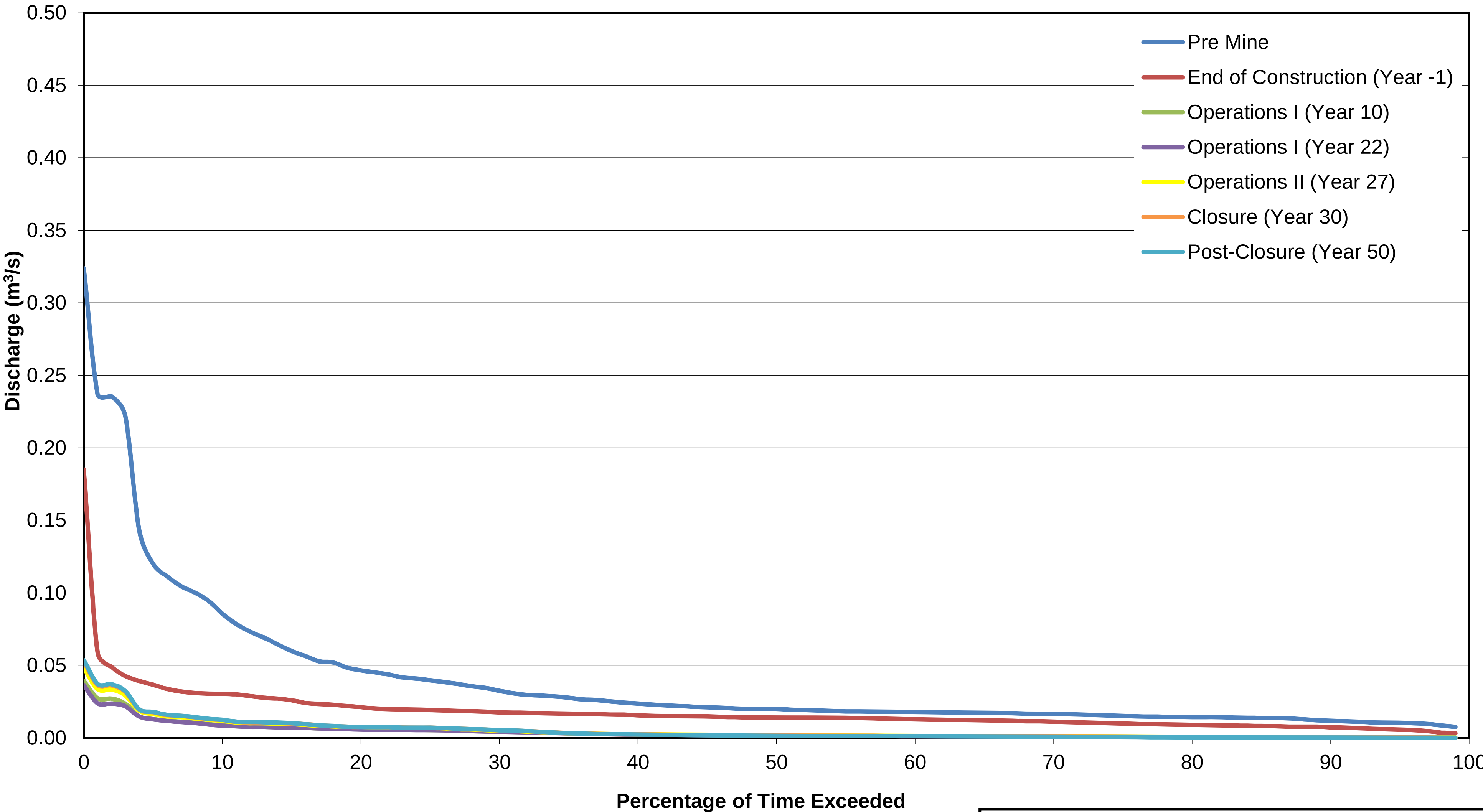
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-56

REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

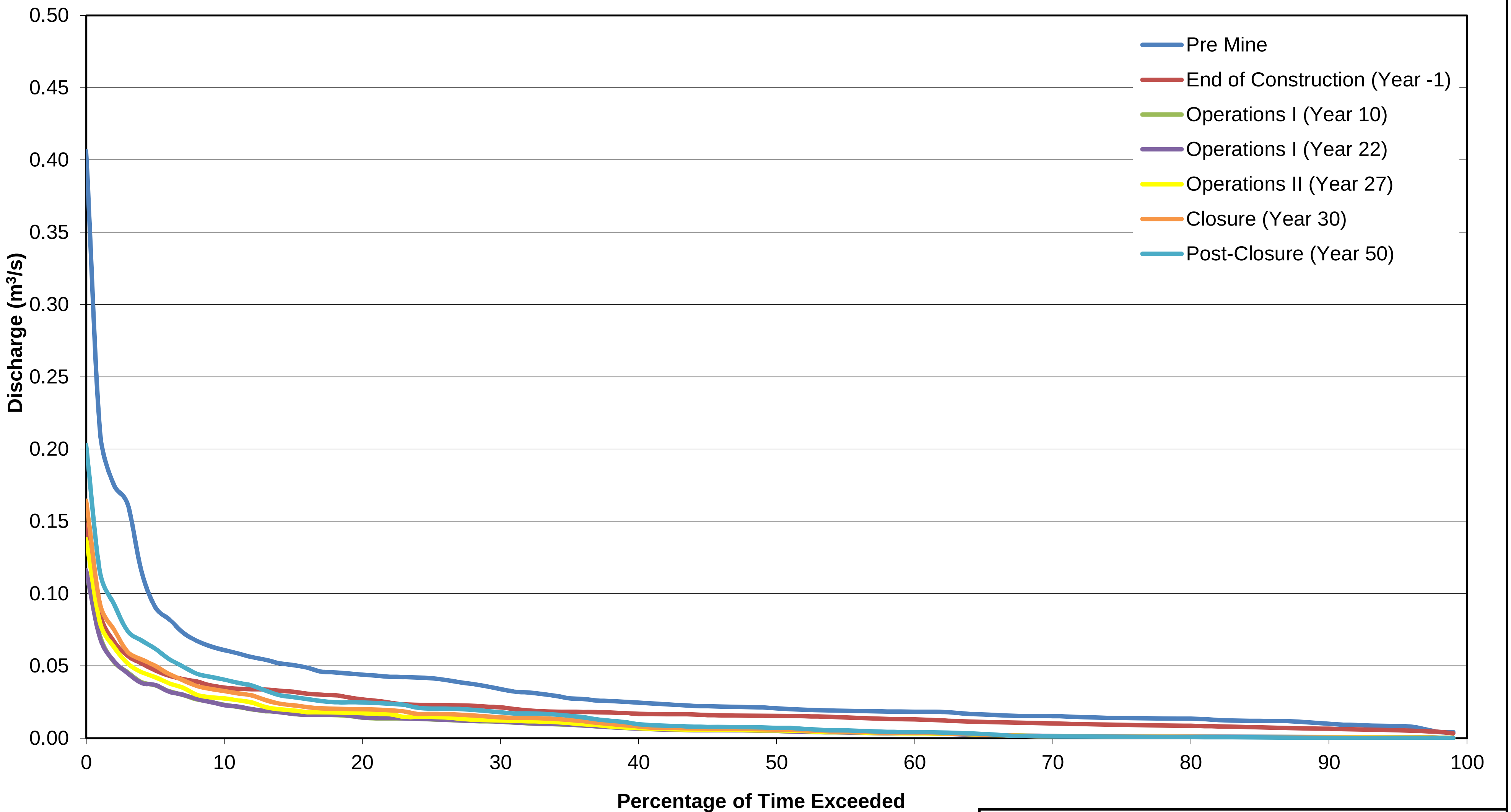
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-57

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

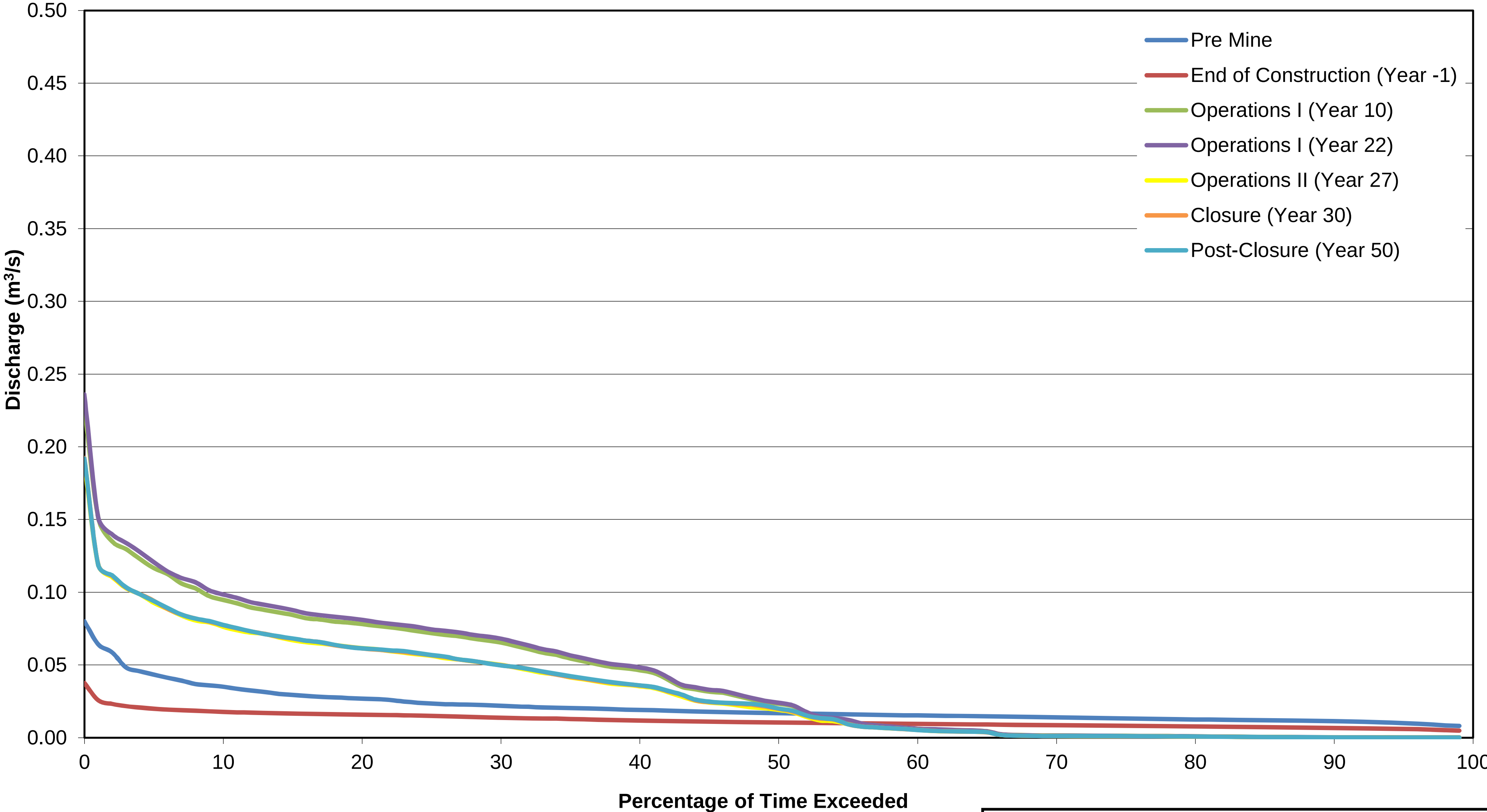
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-58

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

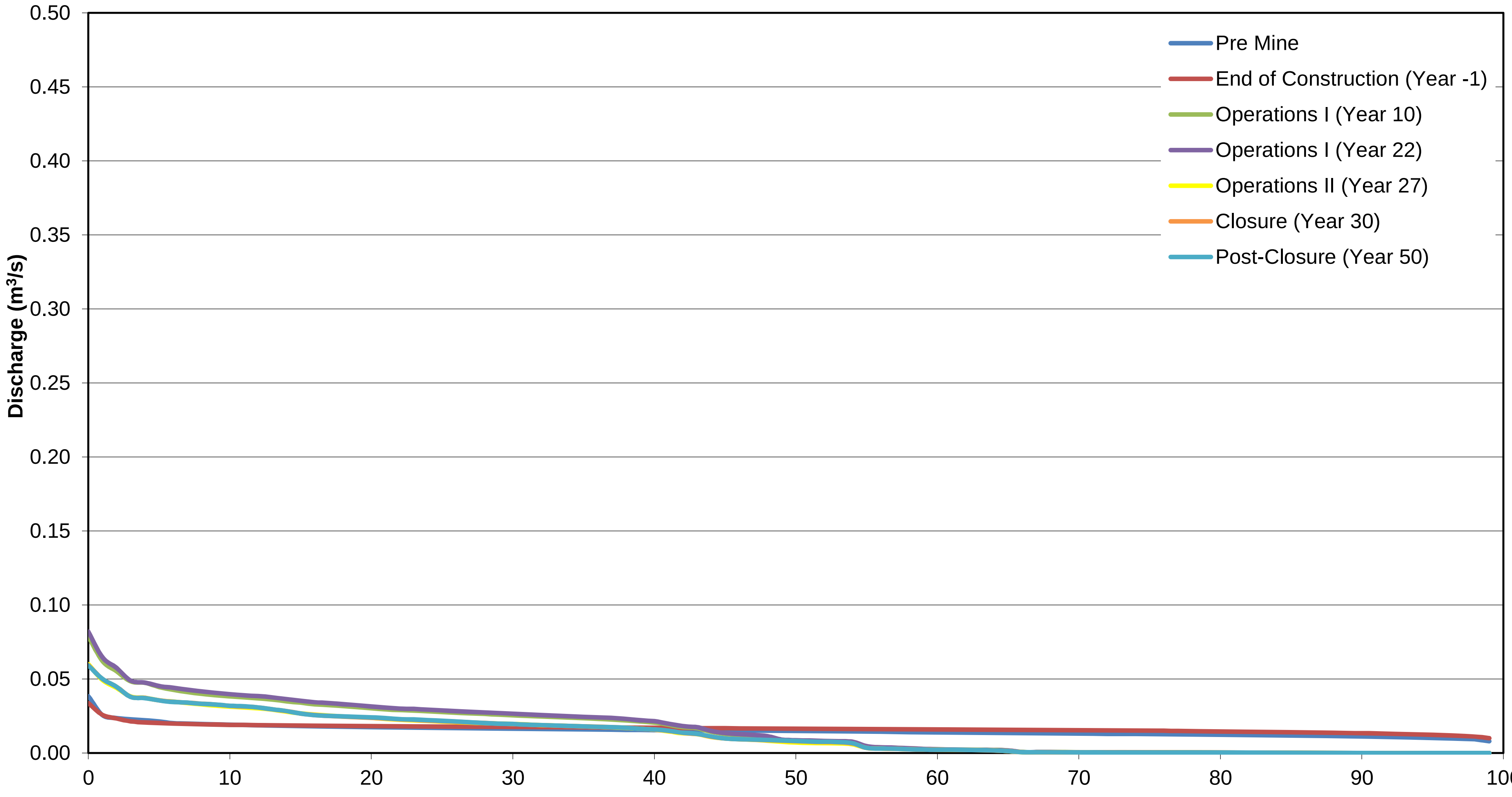
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-59

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

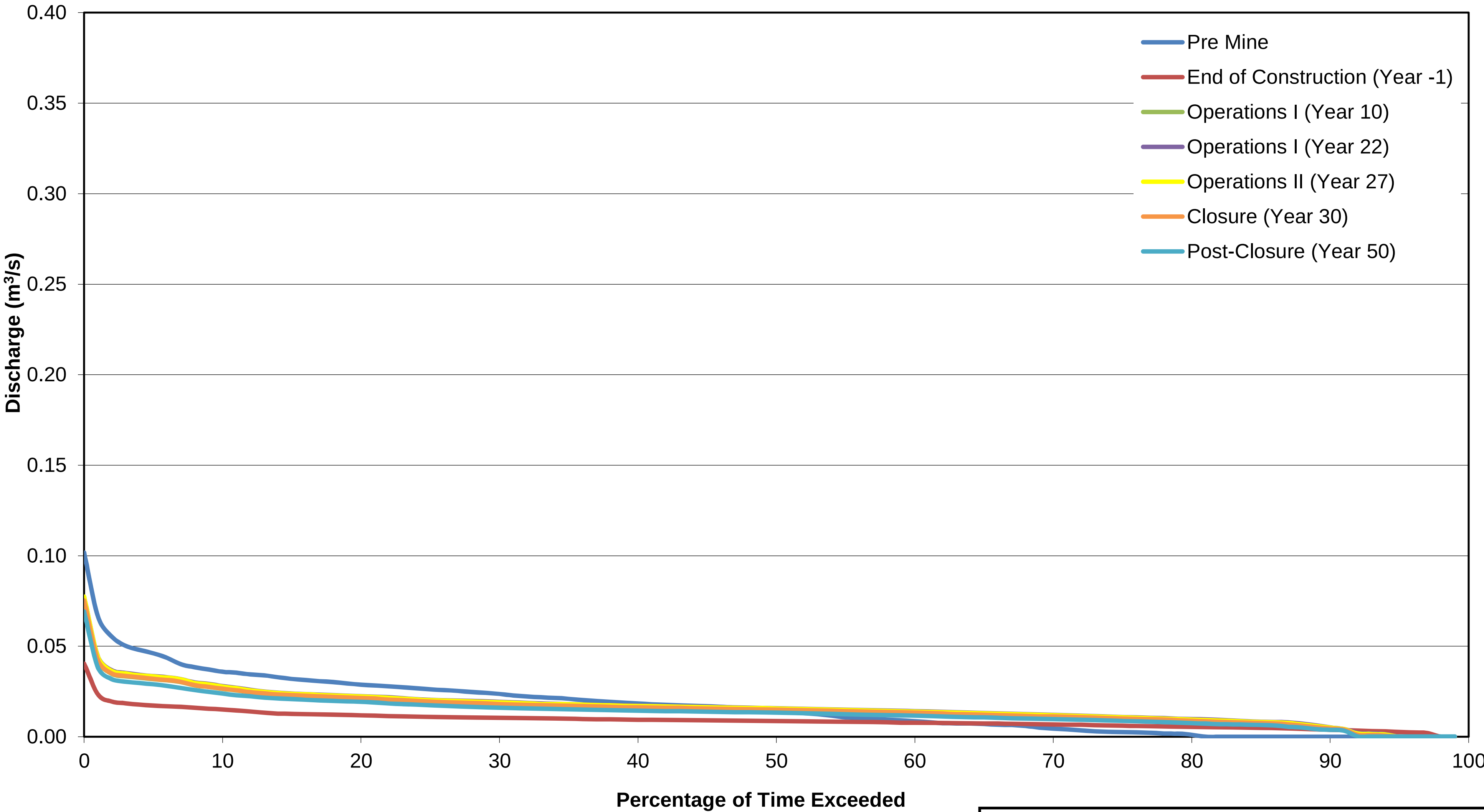
HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-60	REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

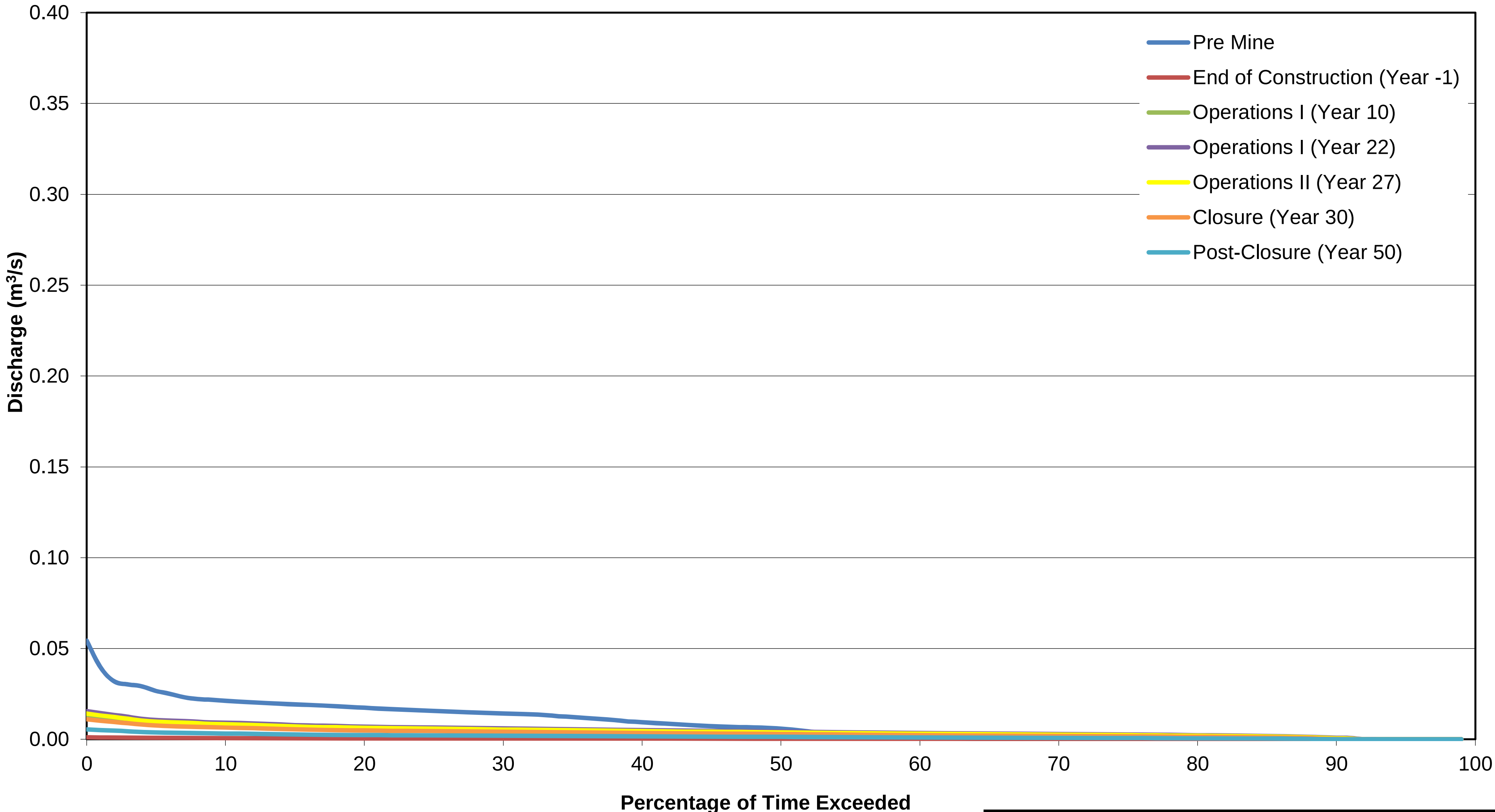
JANUARY FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-61 REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

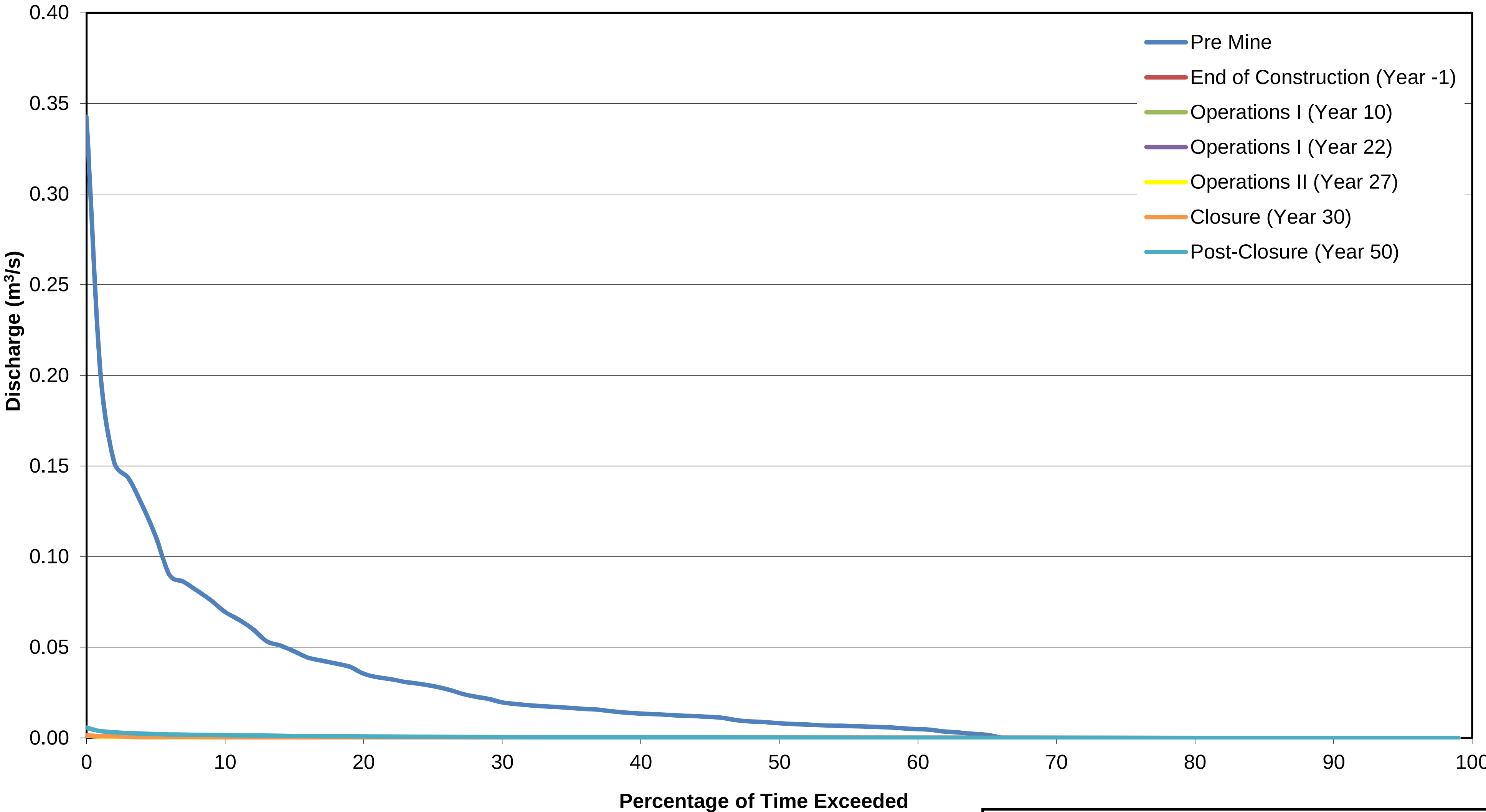
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-62

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

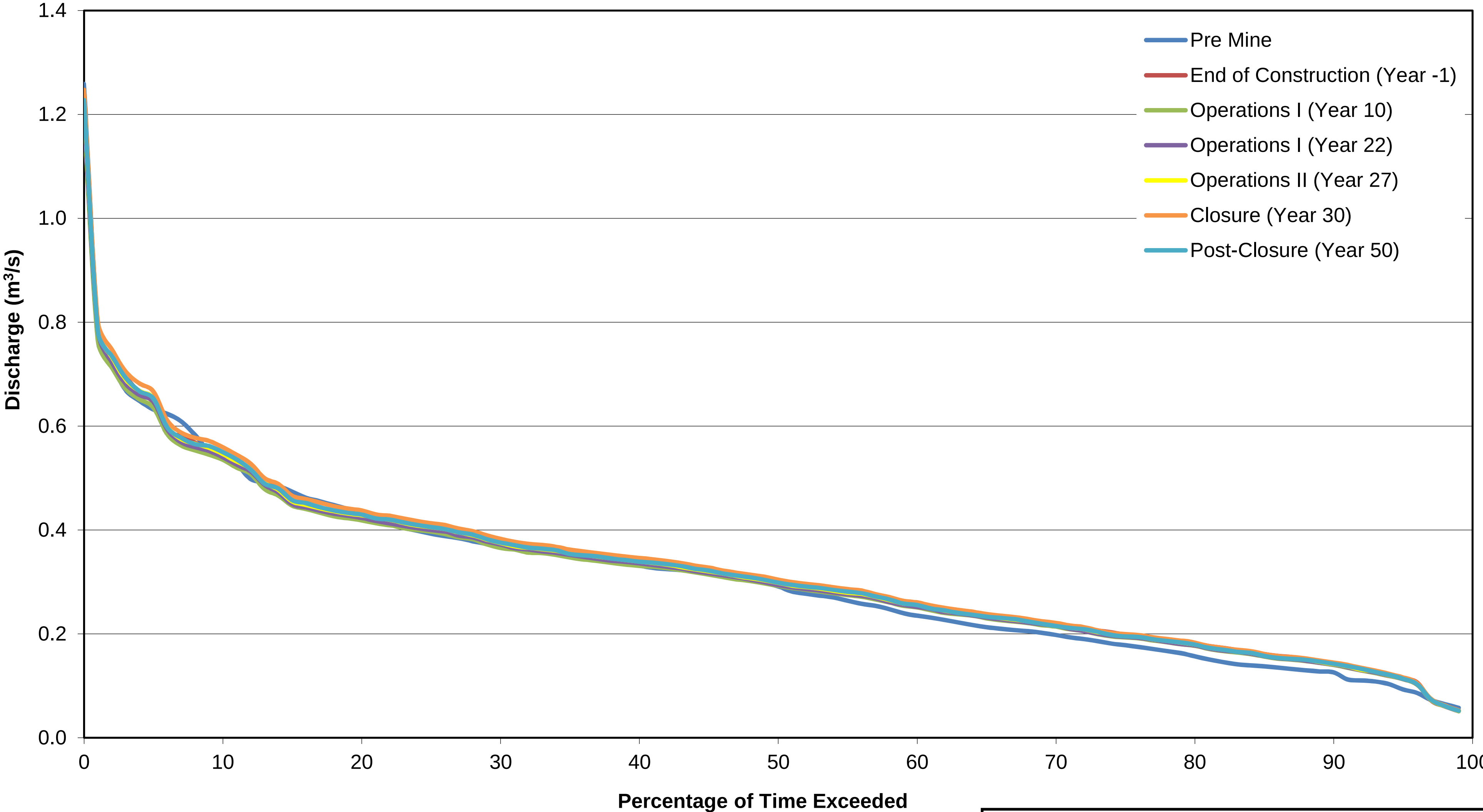
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-63

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

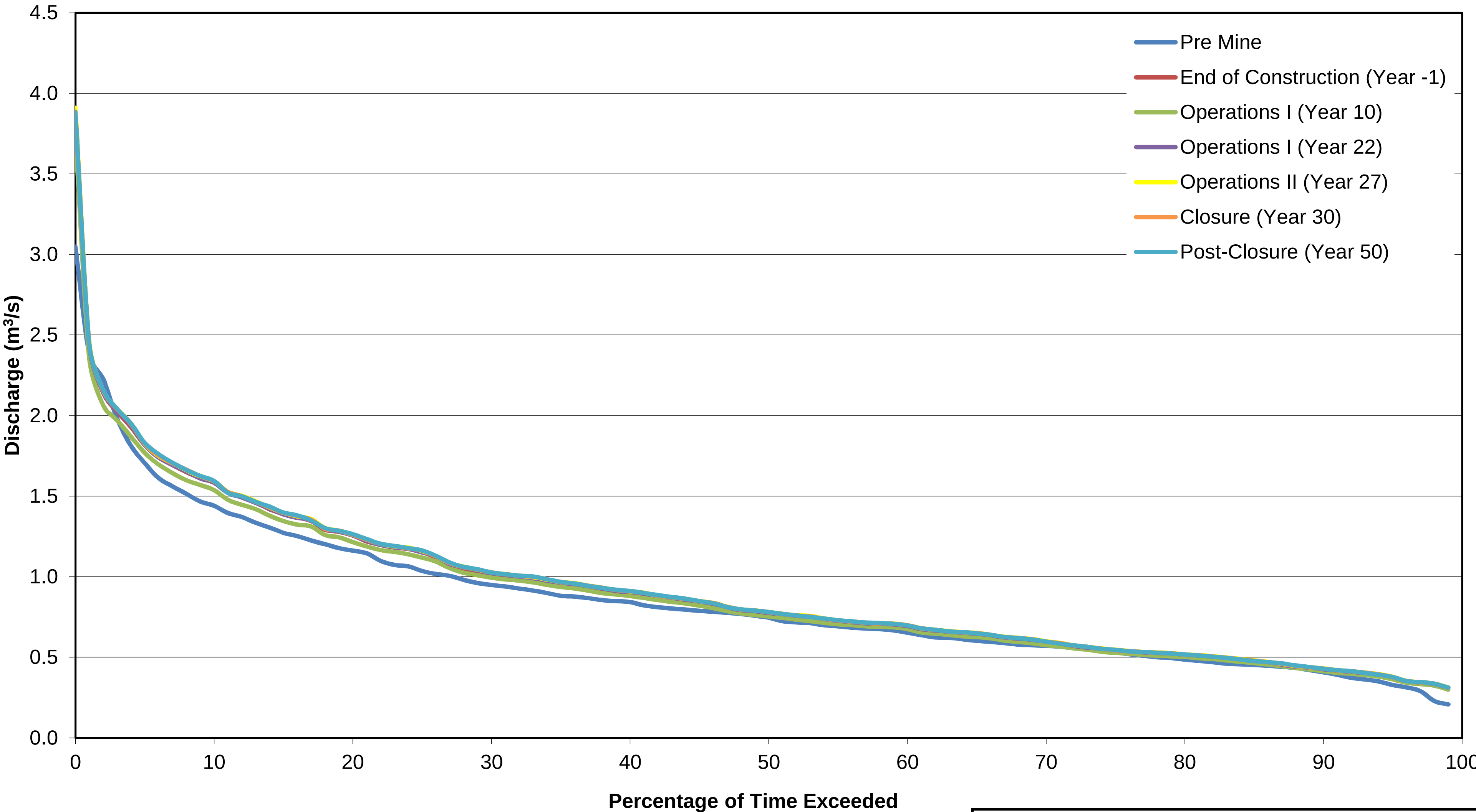
APRIL FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-64 REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

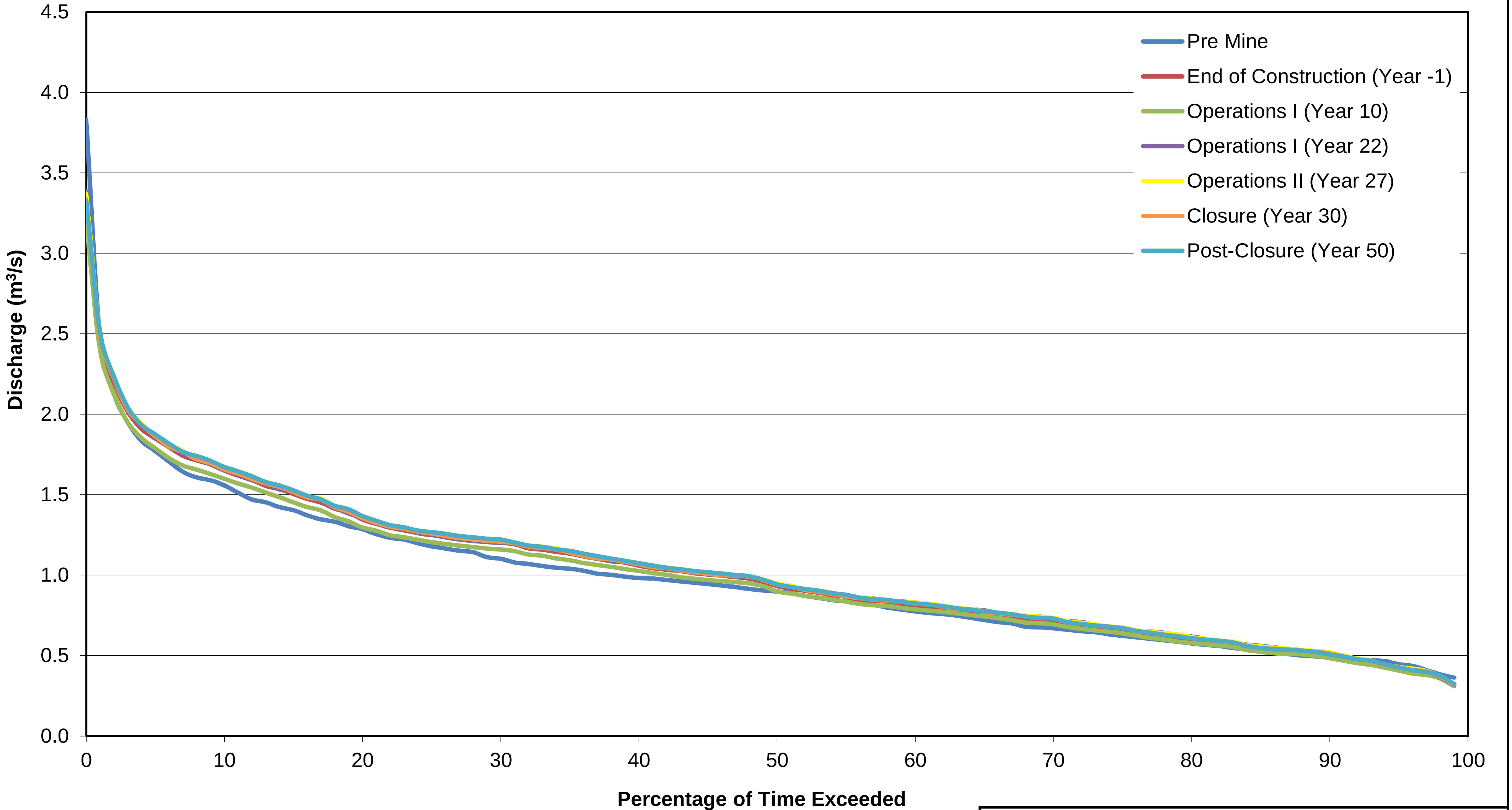
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-65

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

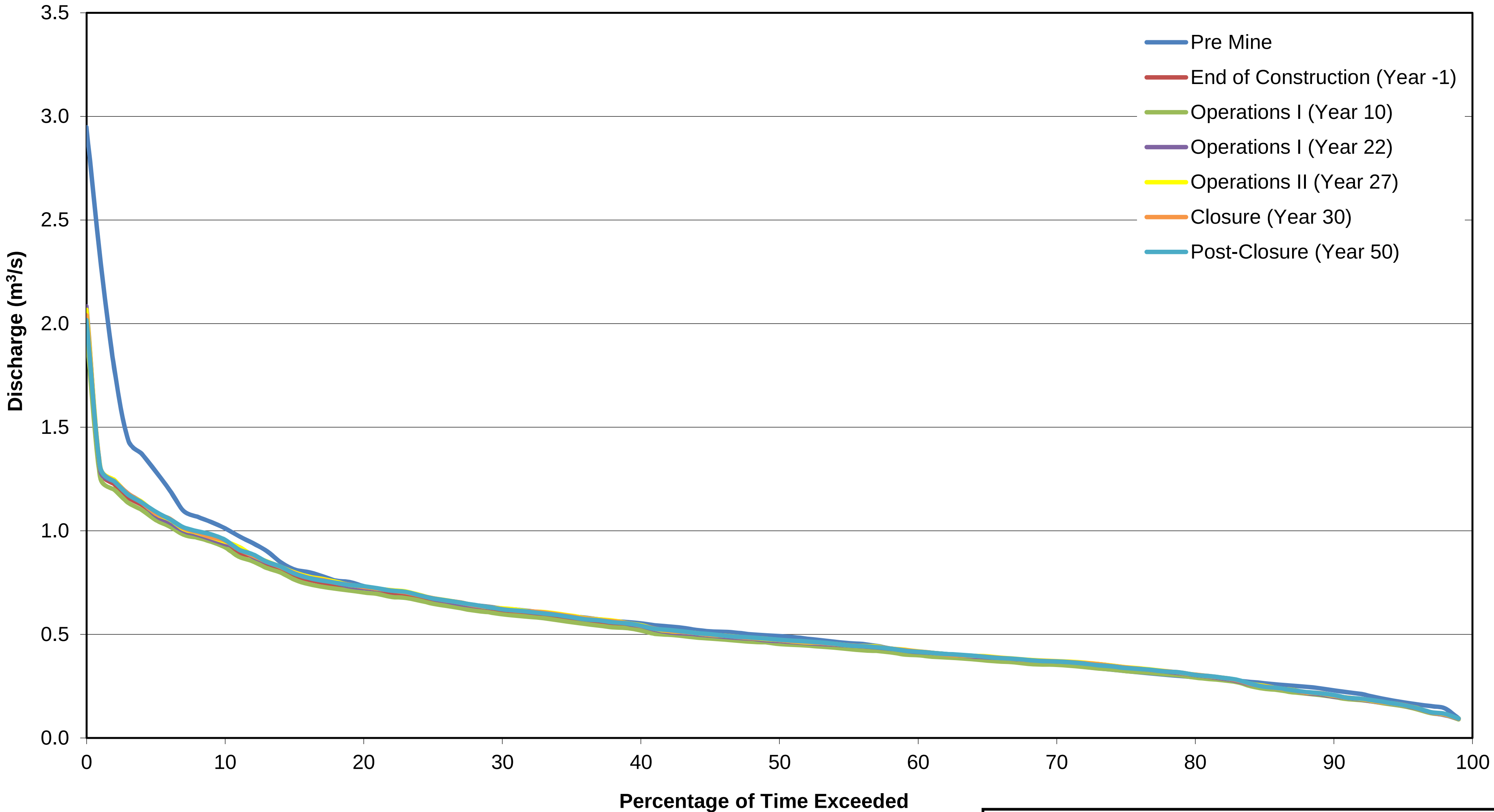
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-66

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

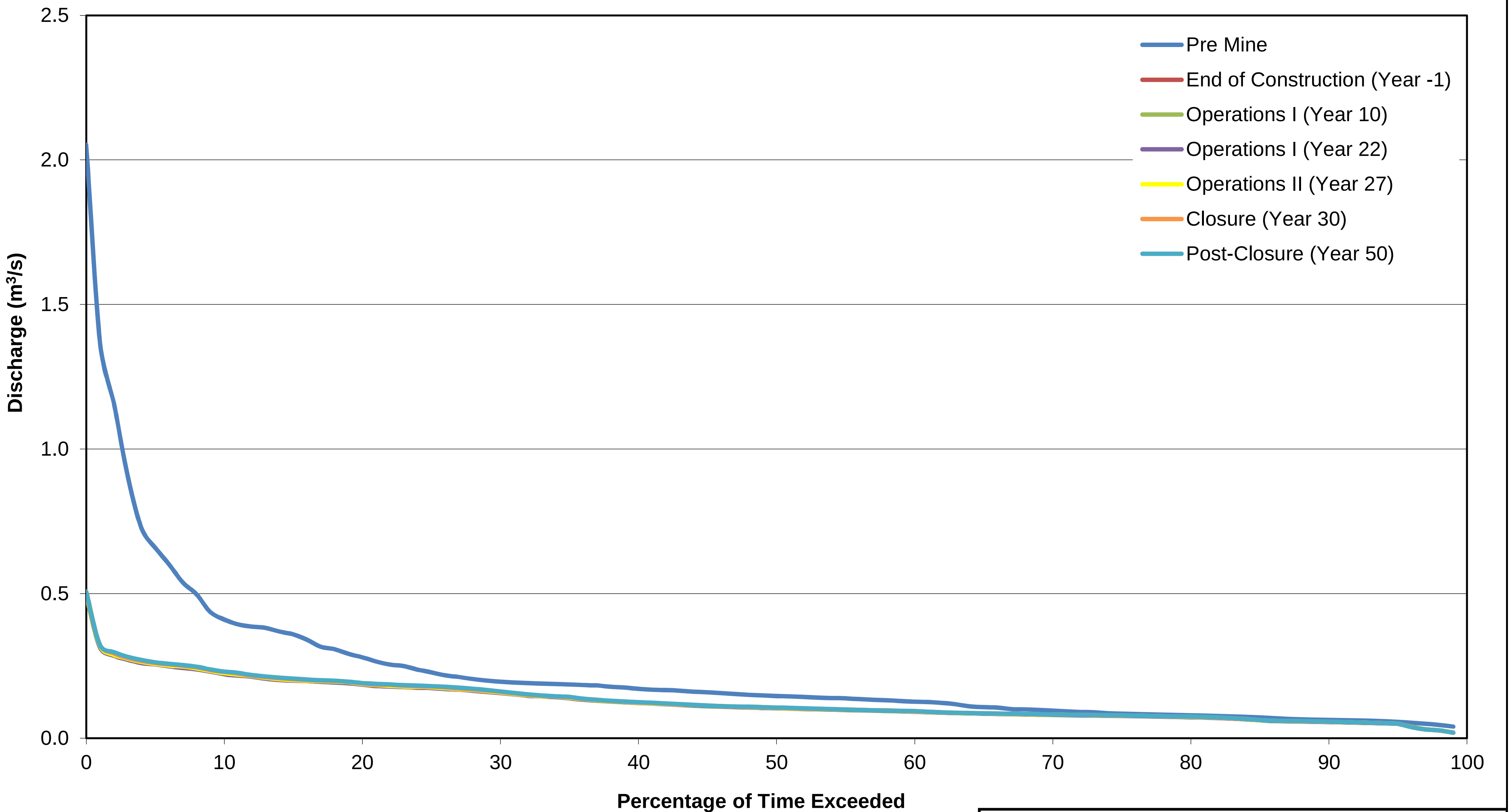
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-67

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

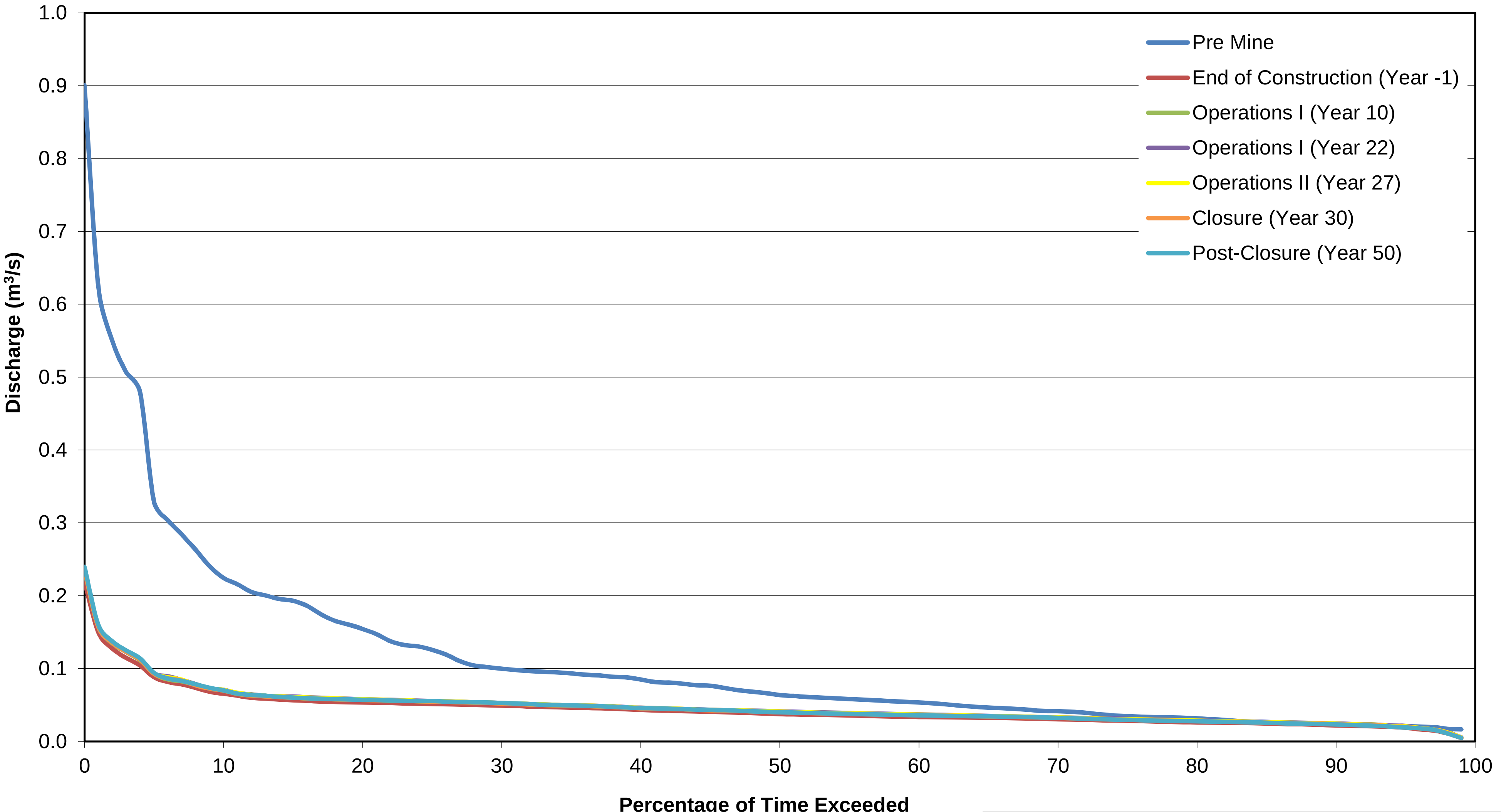
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-68

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

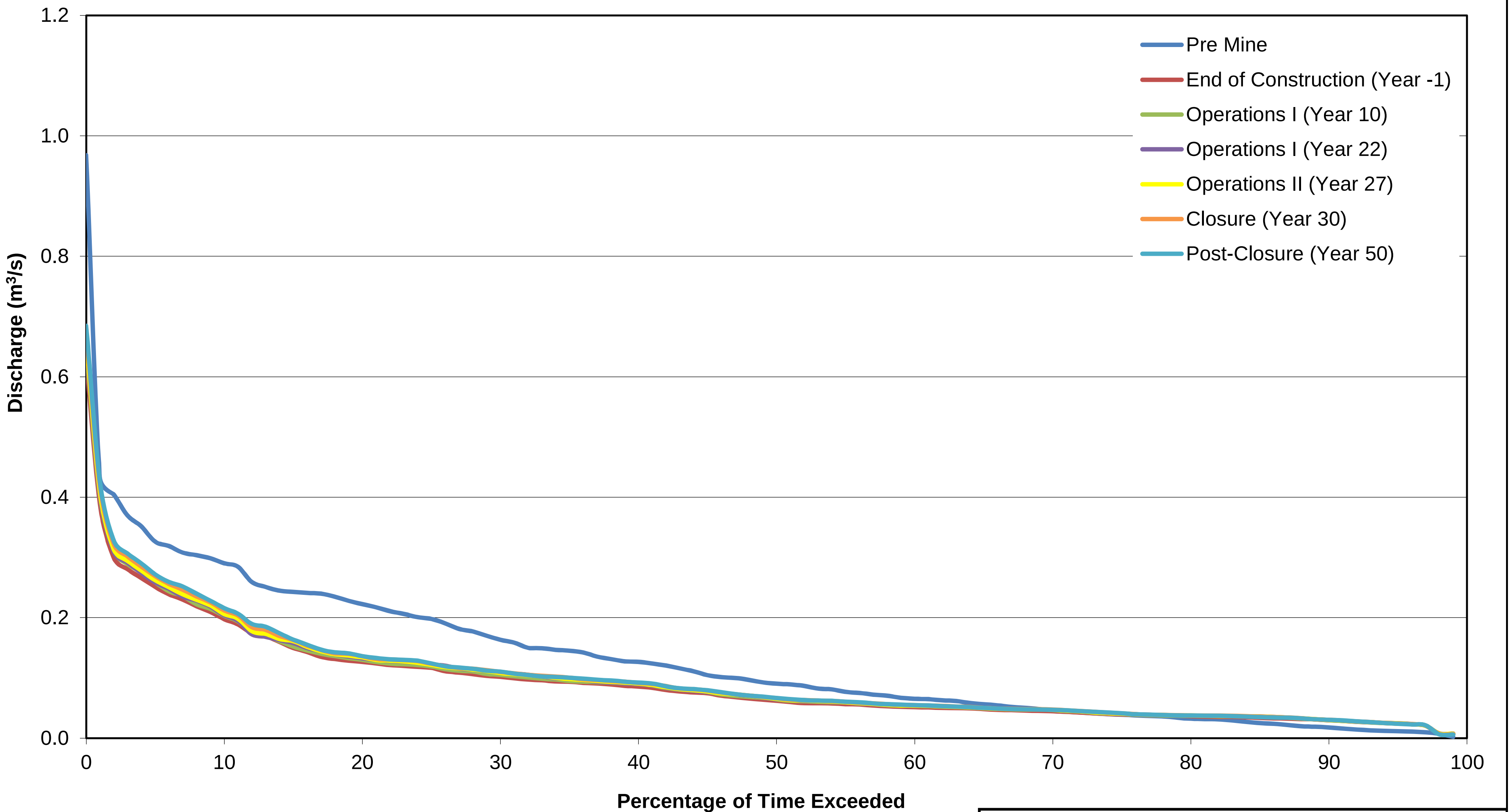
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-69

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

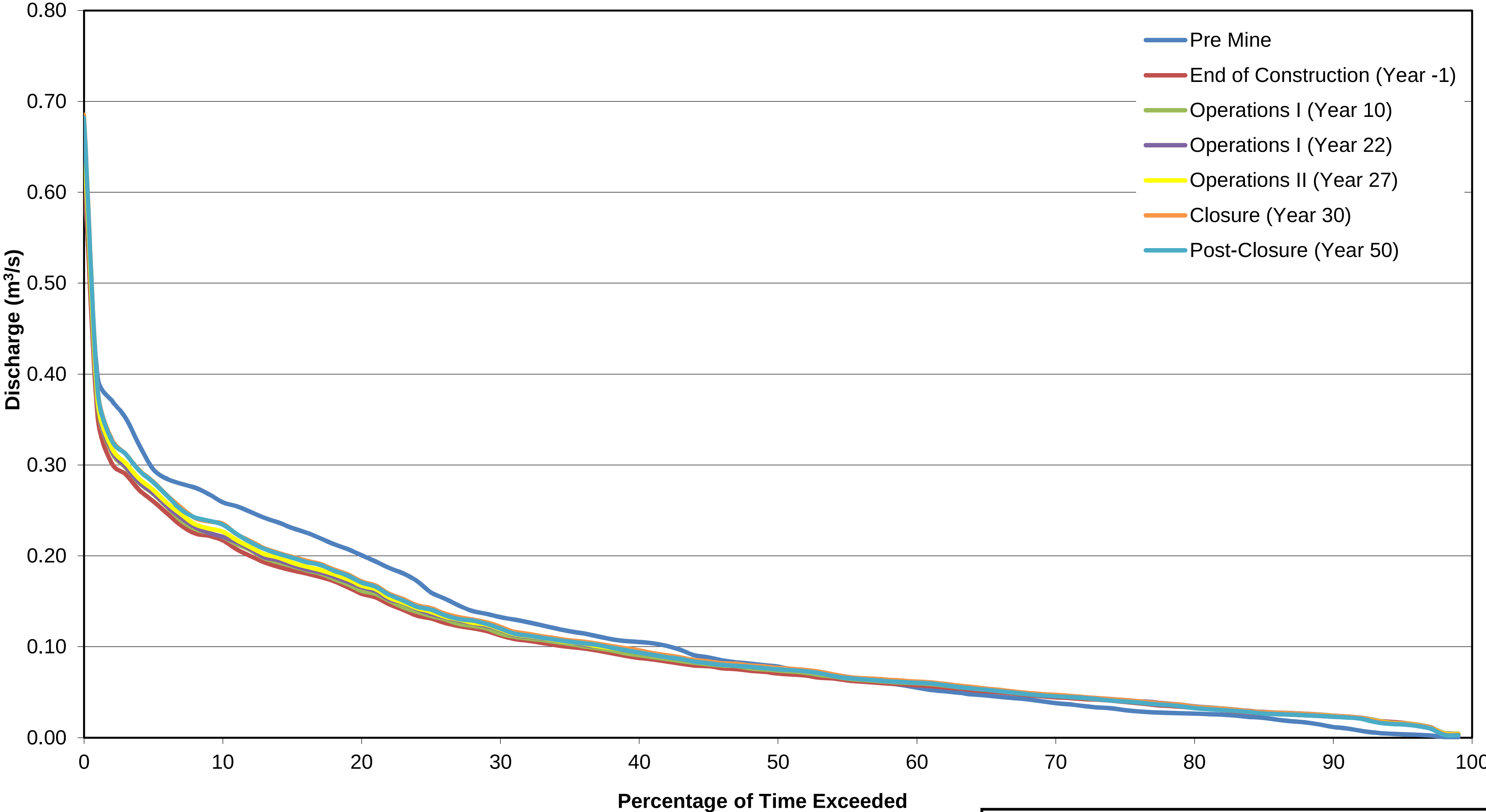
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-70

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 6 JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

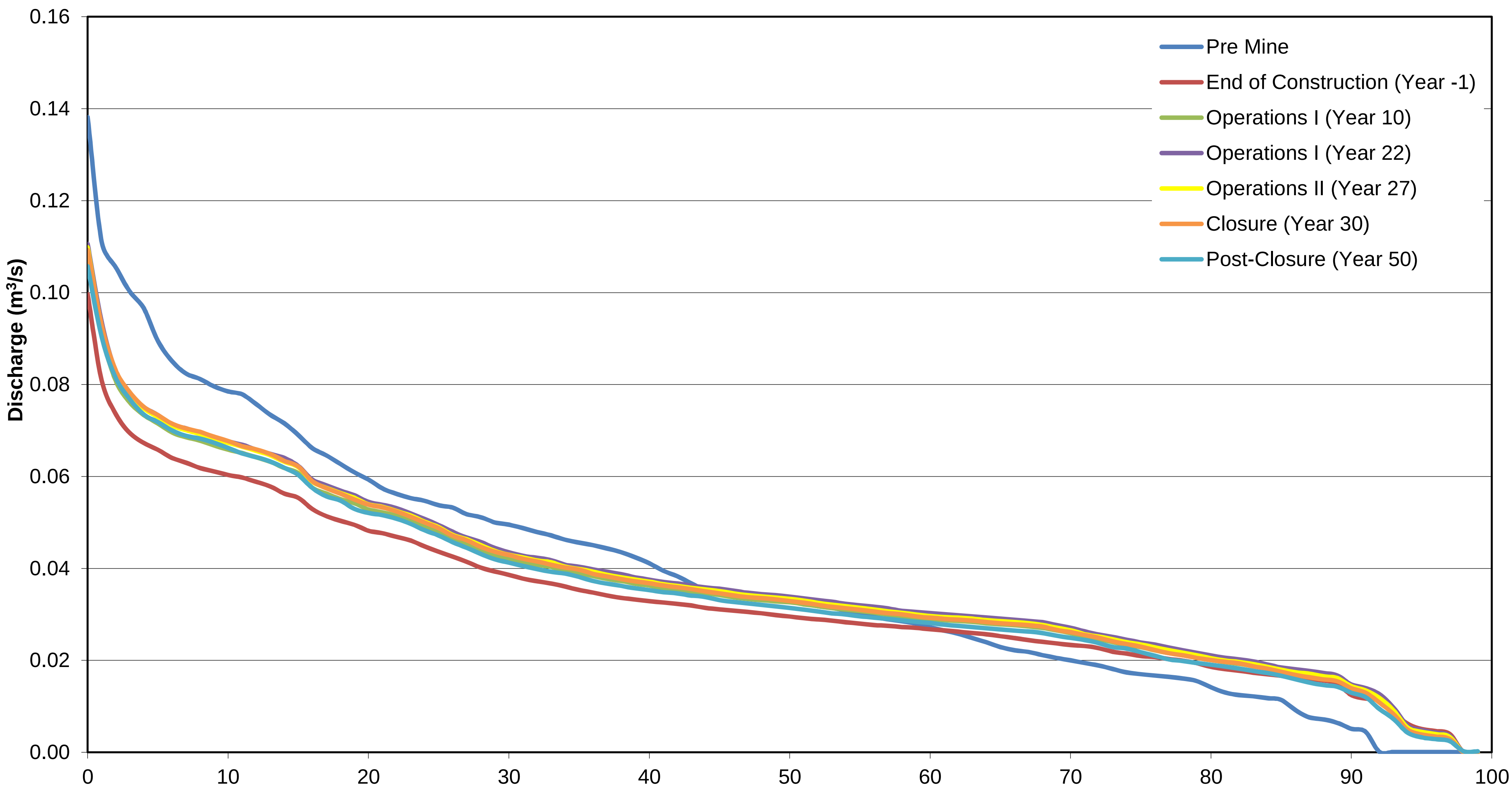
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-71

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

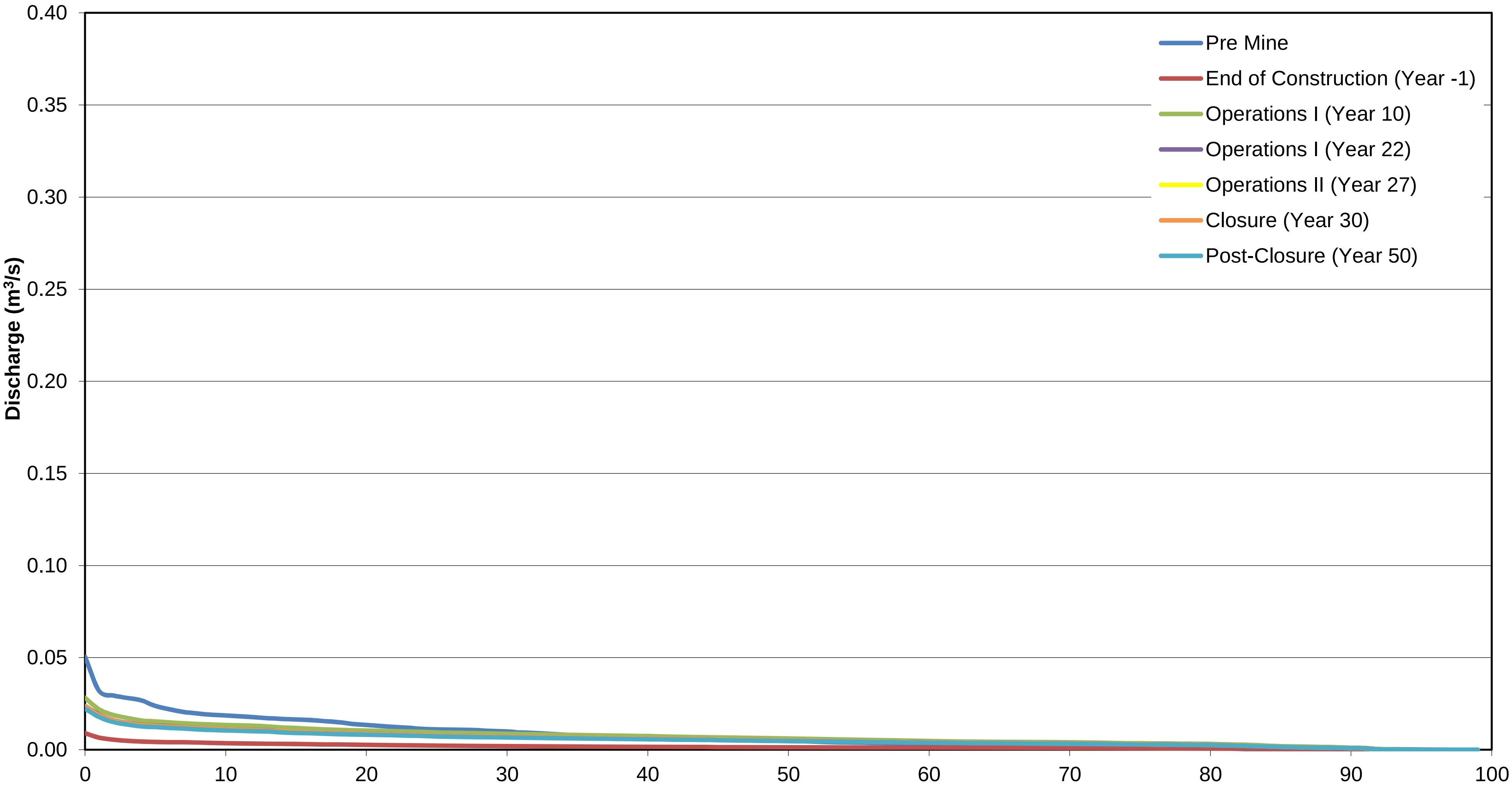
HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 6
JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-72 REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

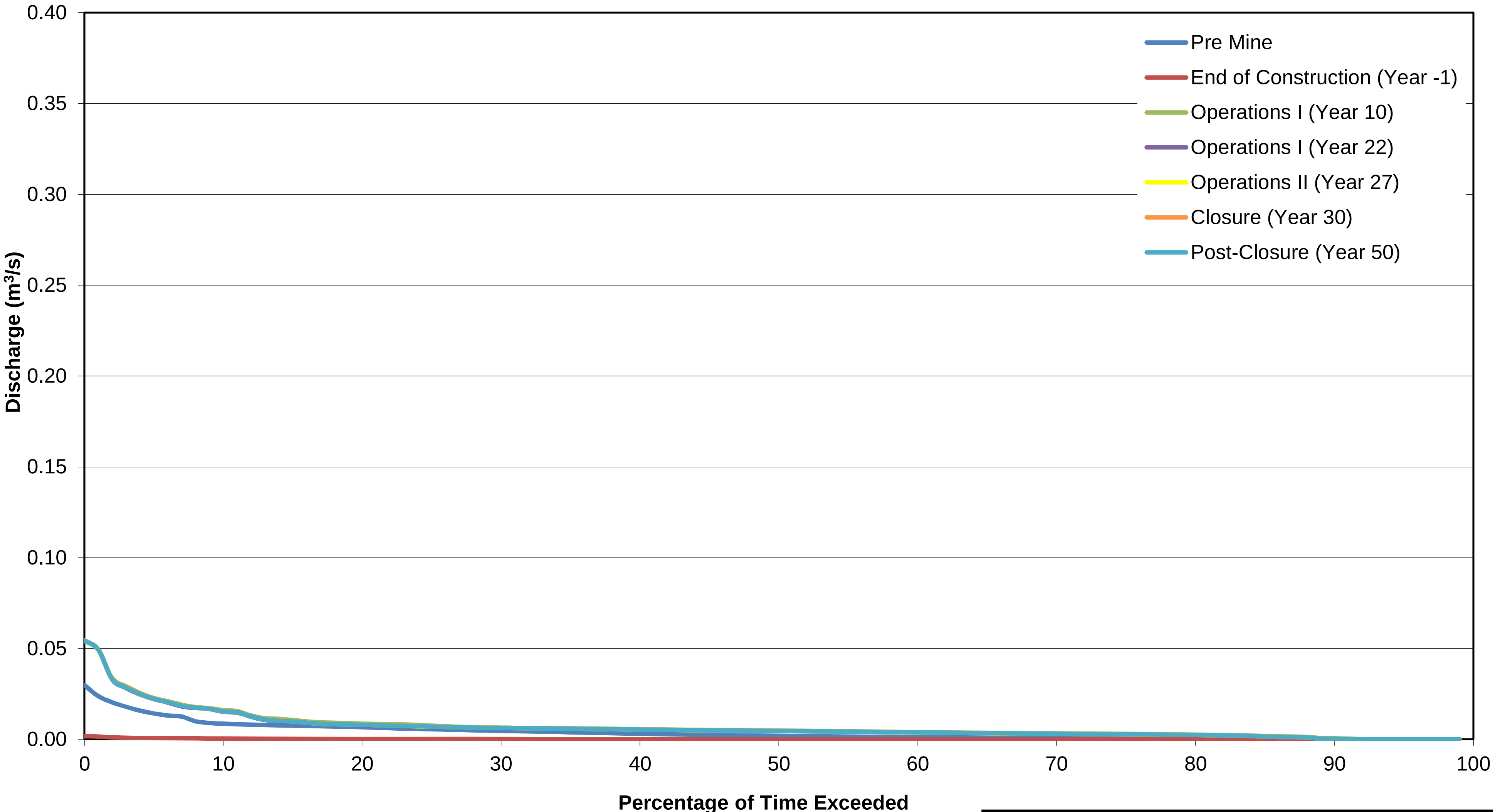
JANUARY FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-73 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

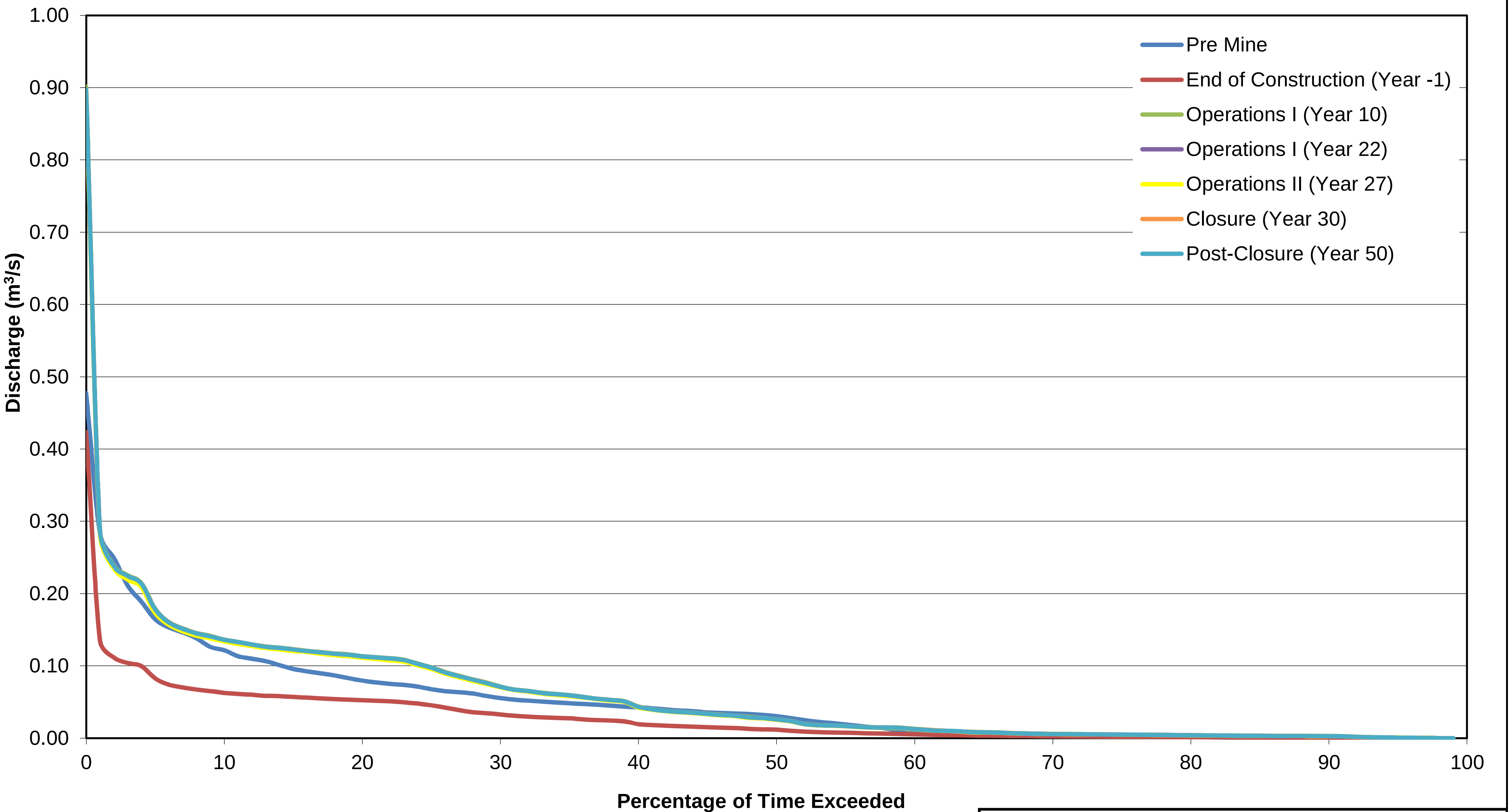
FEBRUARY FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-74 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

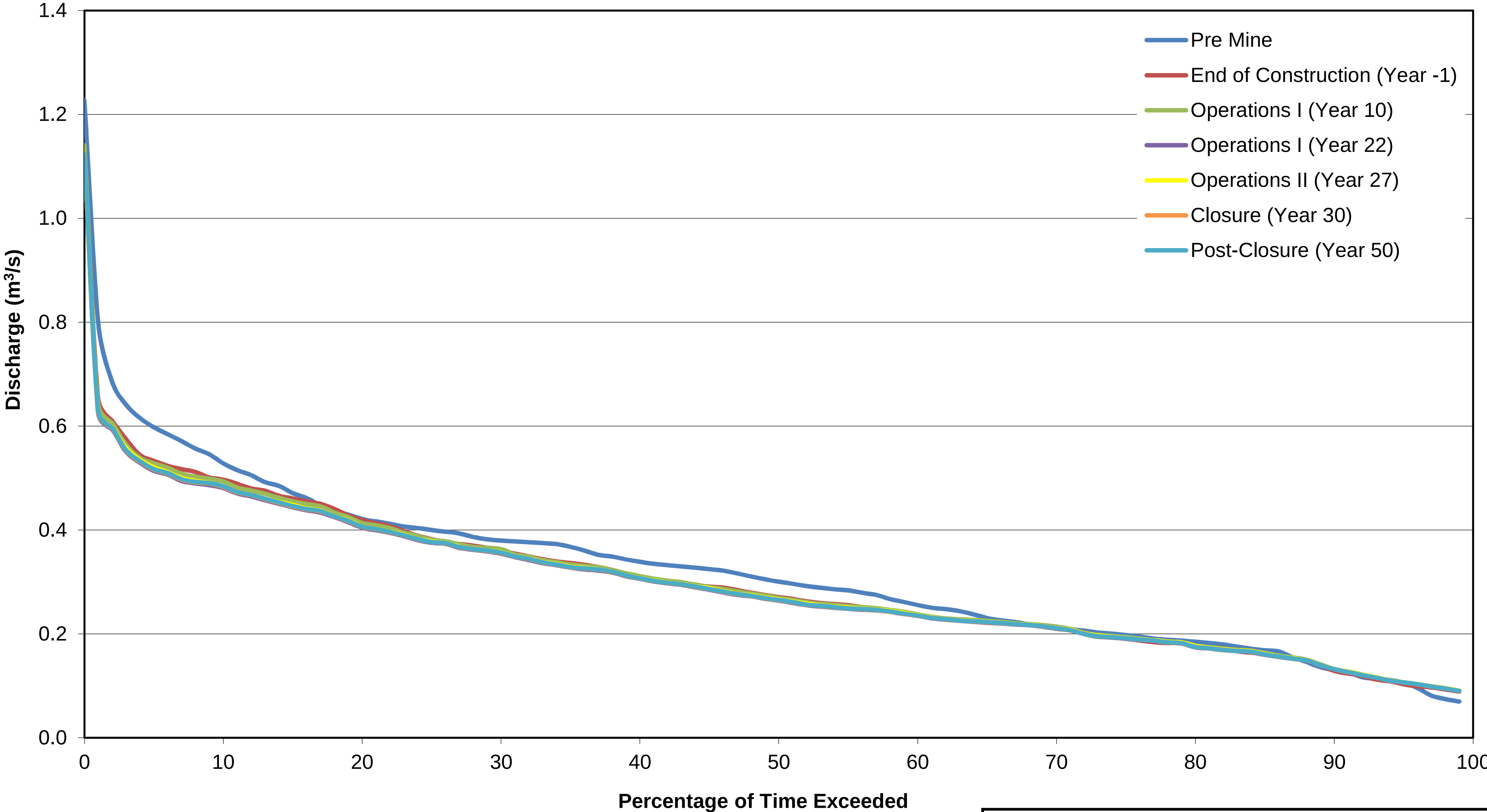
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-75

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

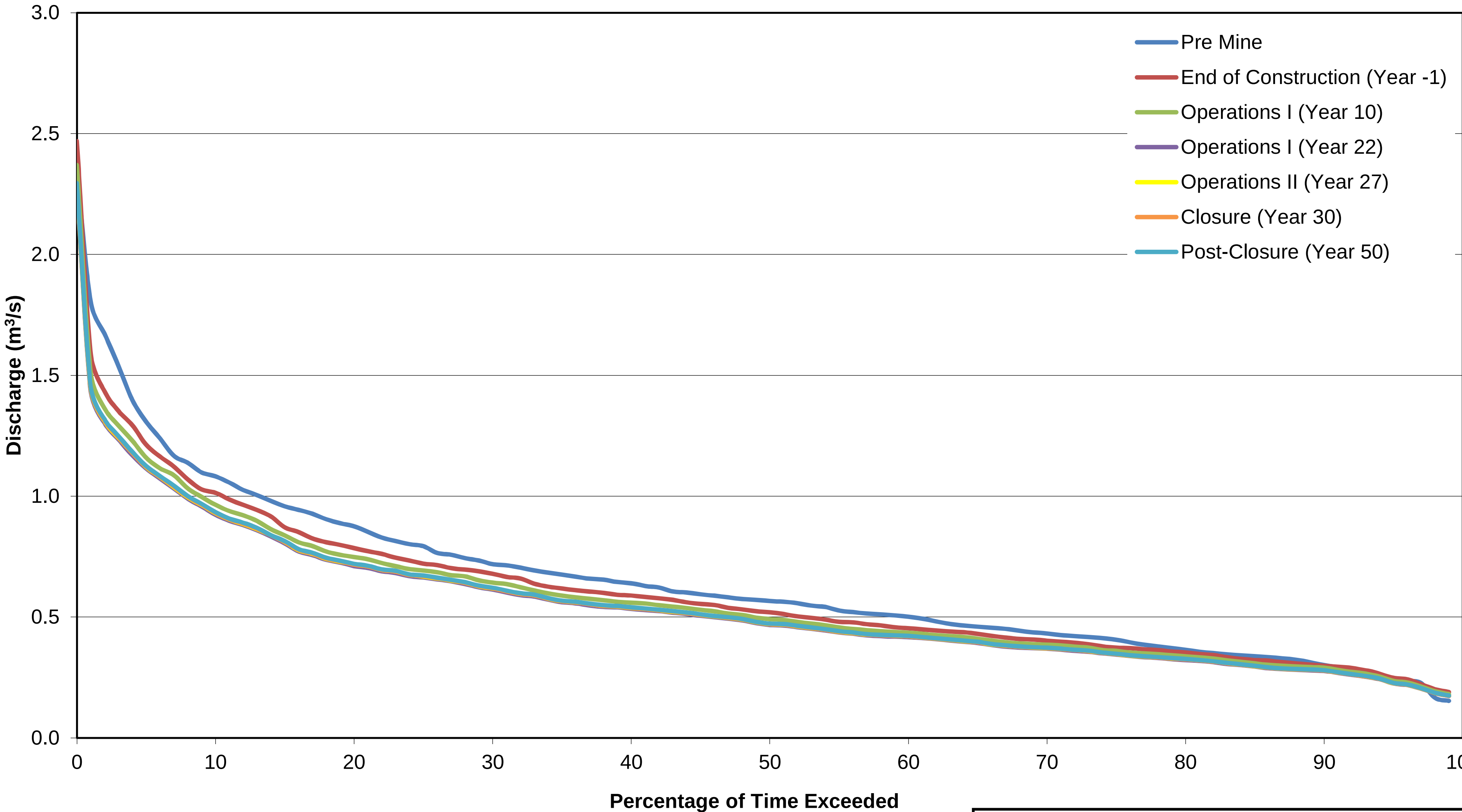
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-76

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

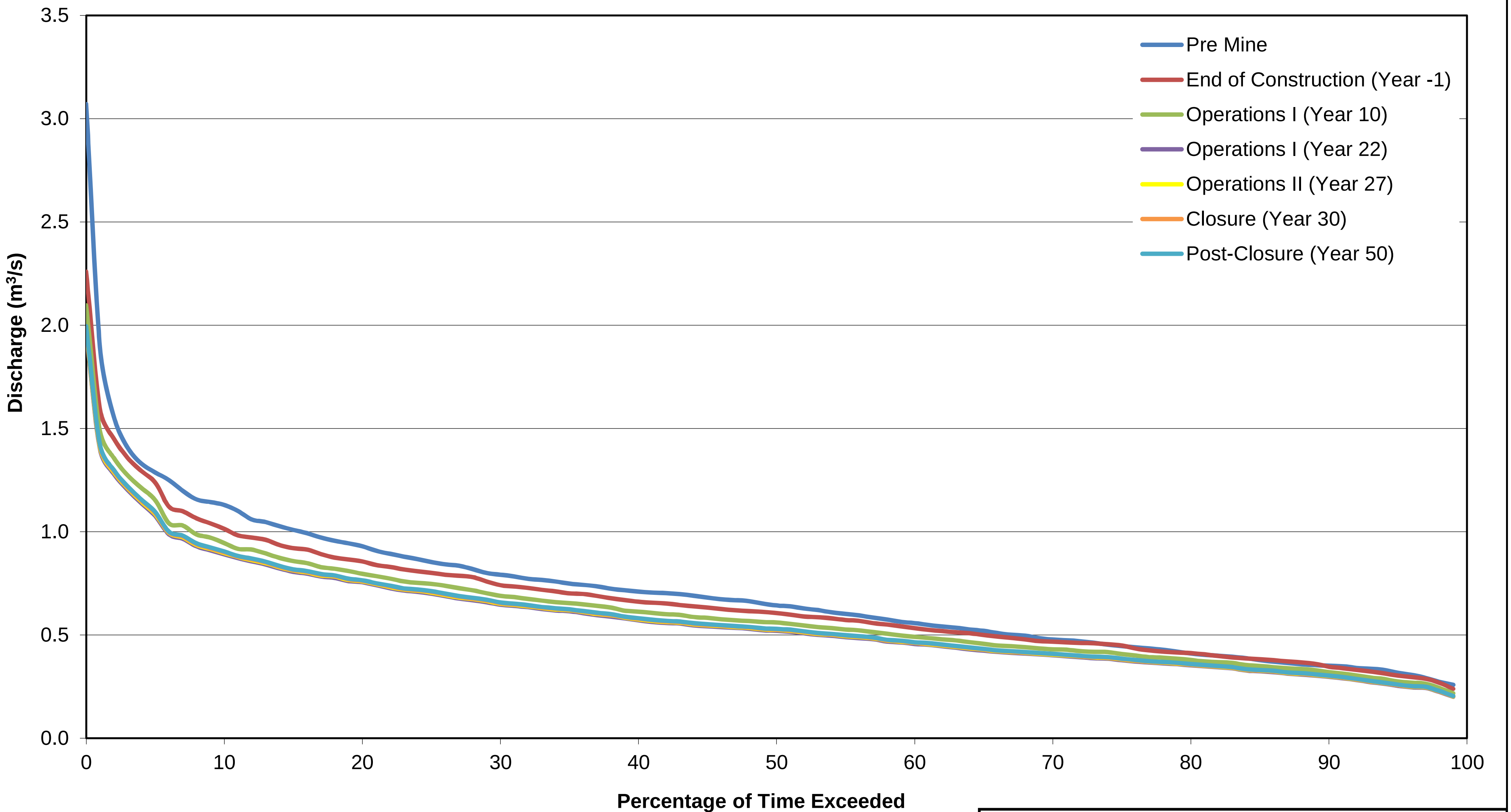
MAY FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-77 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

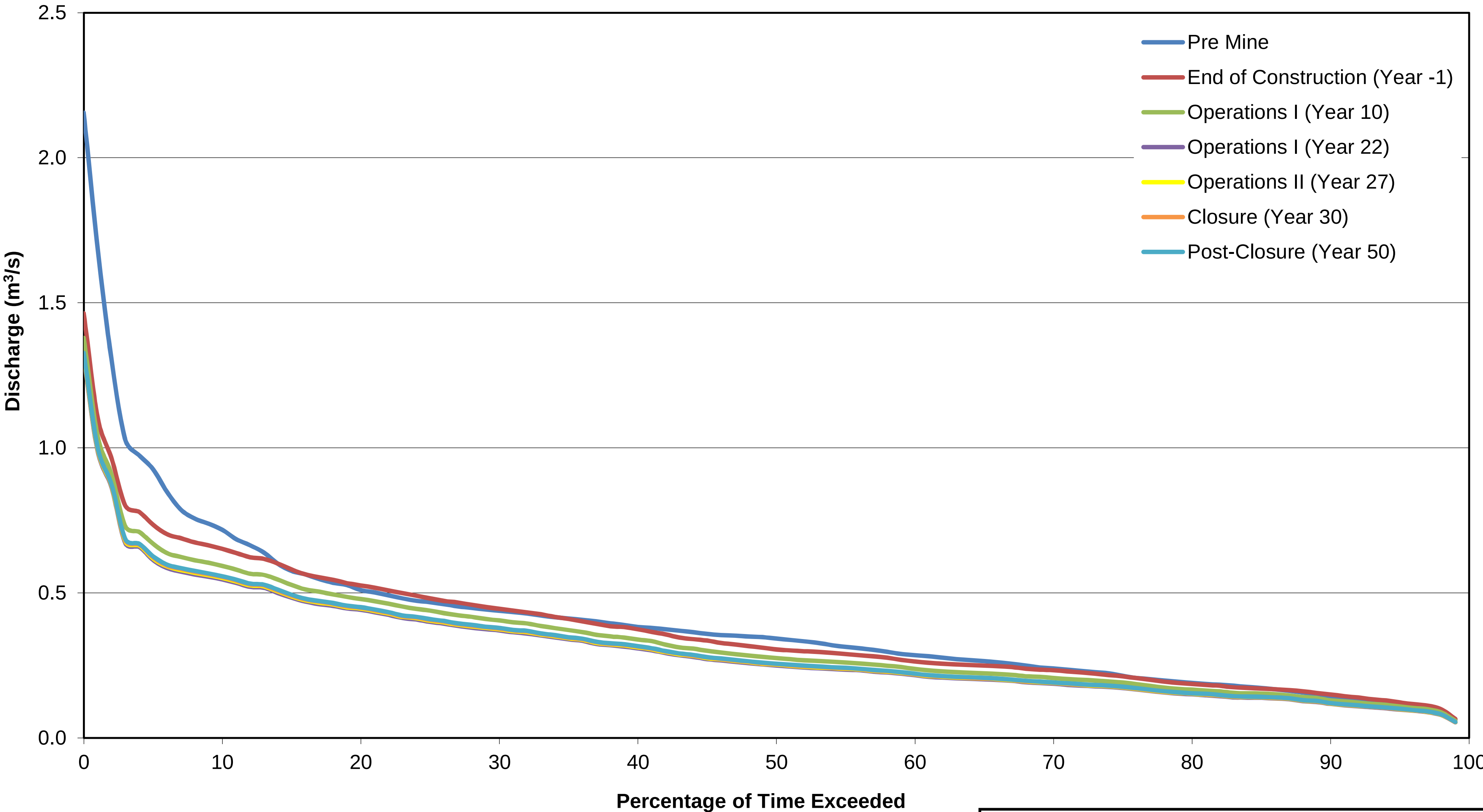
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-78

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

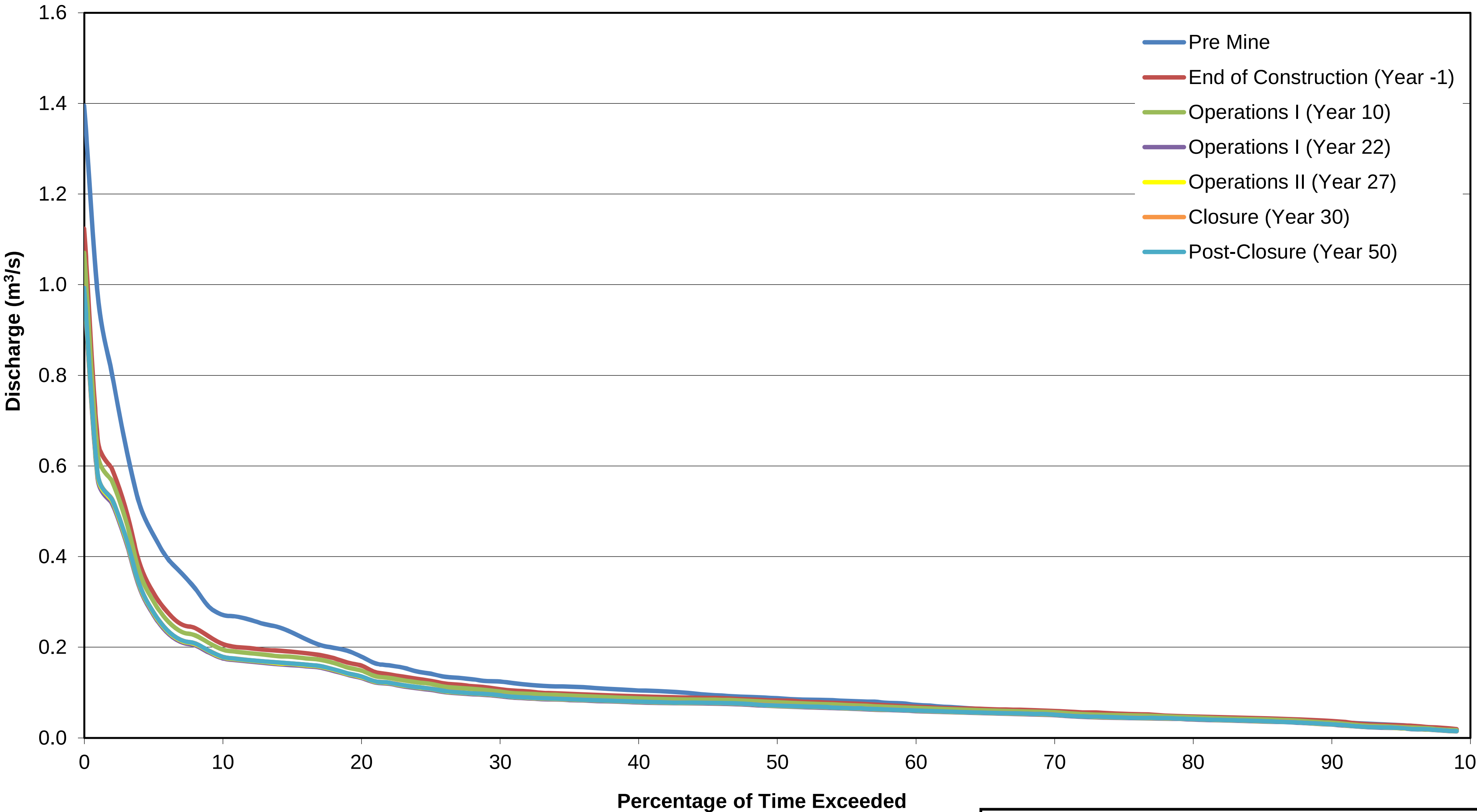
JULY FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-79 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

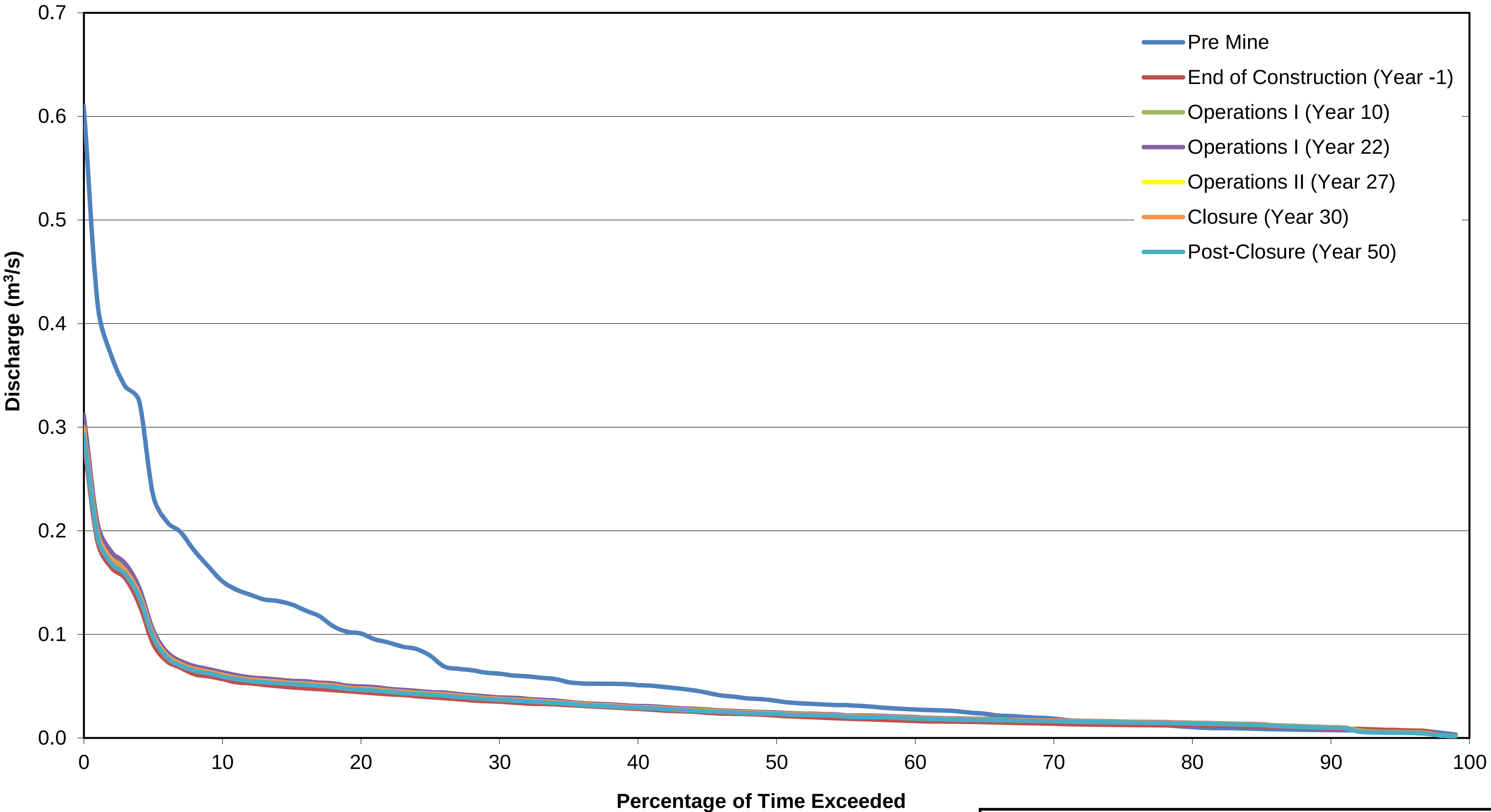
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-80

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

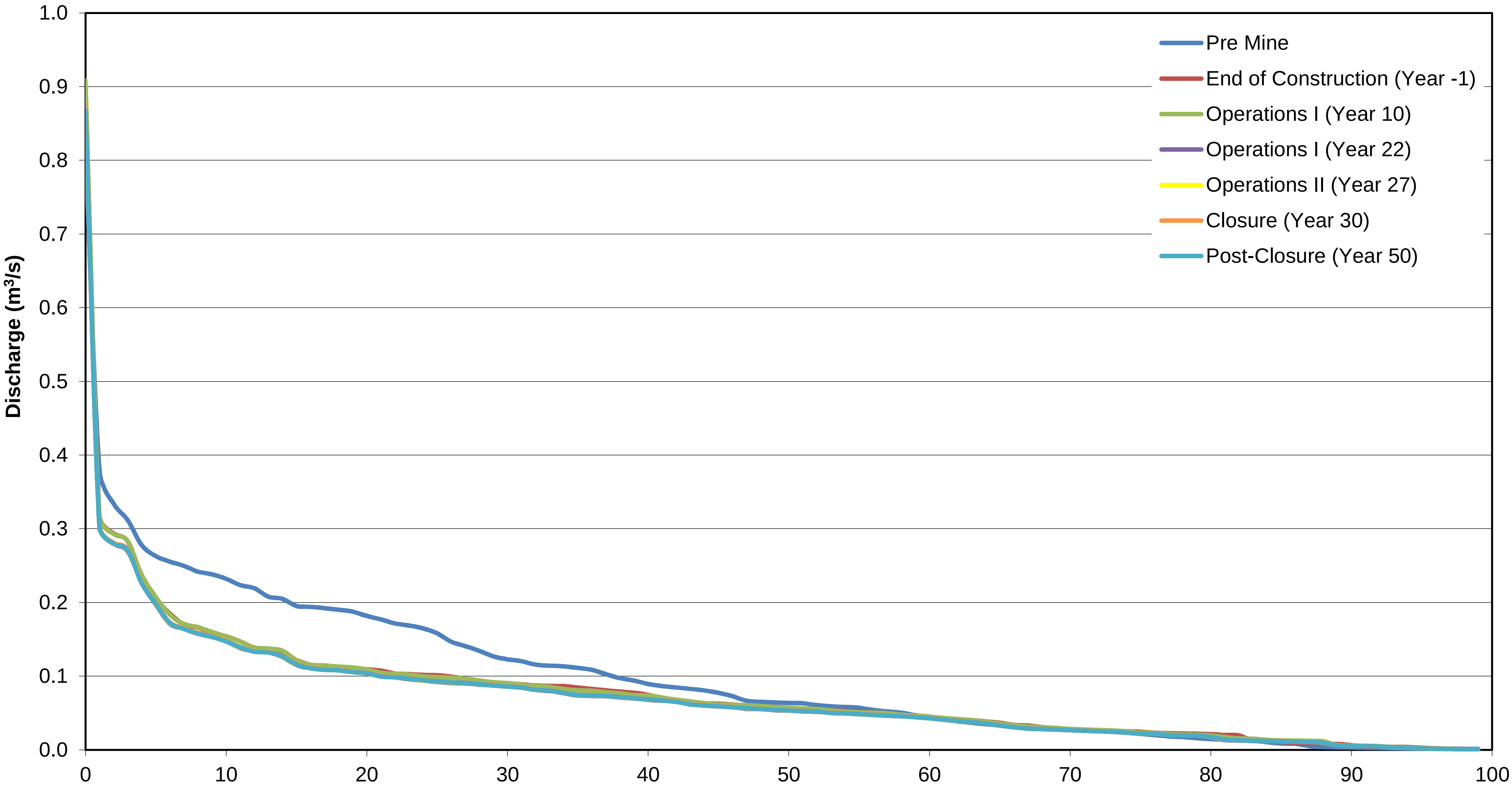
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-81

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

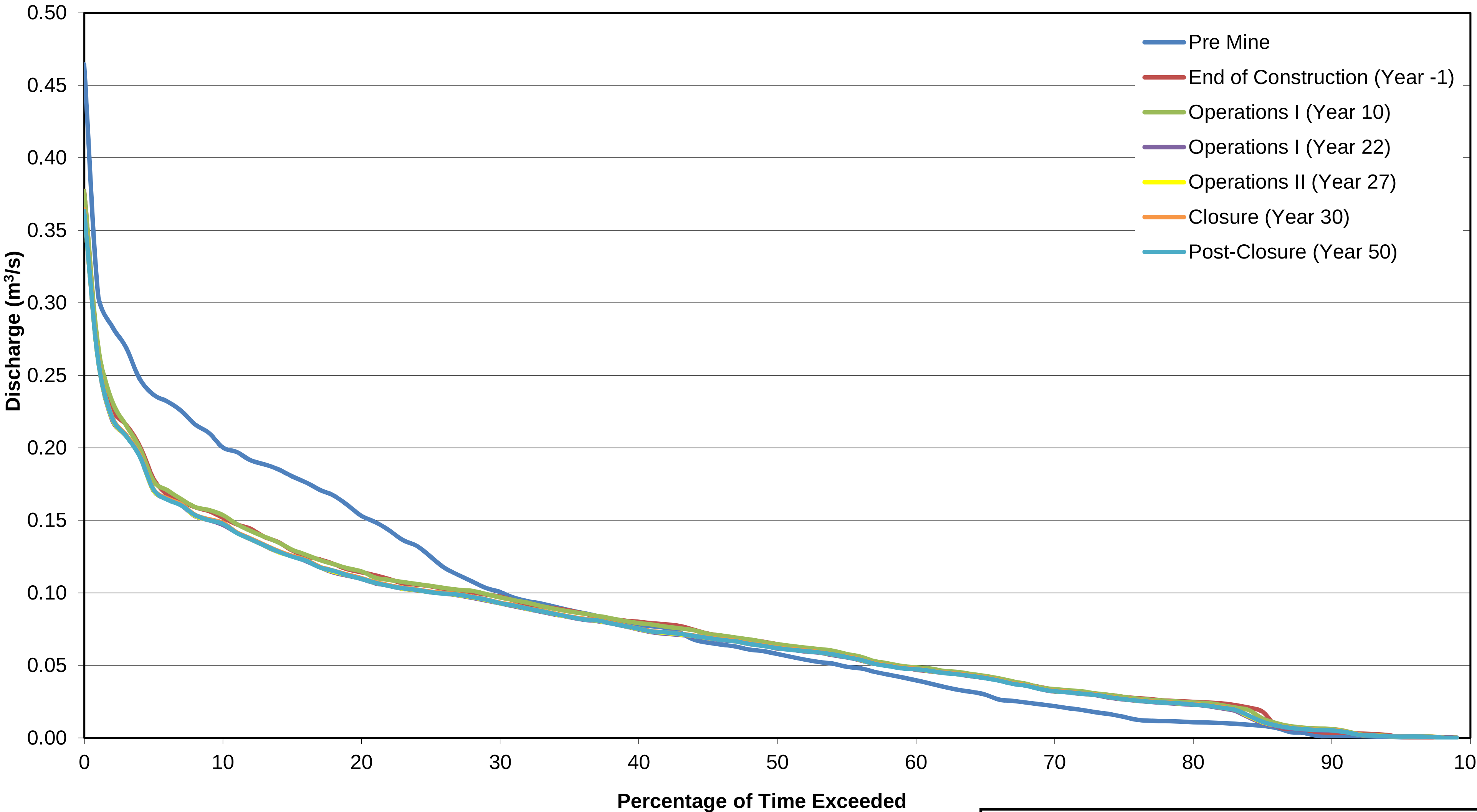
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-82	REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

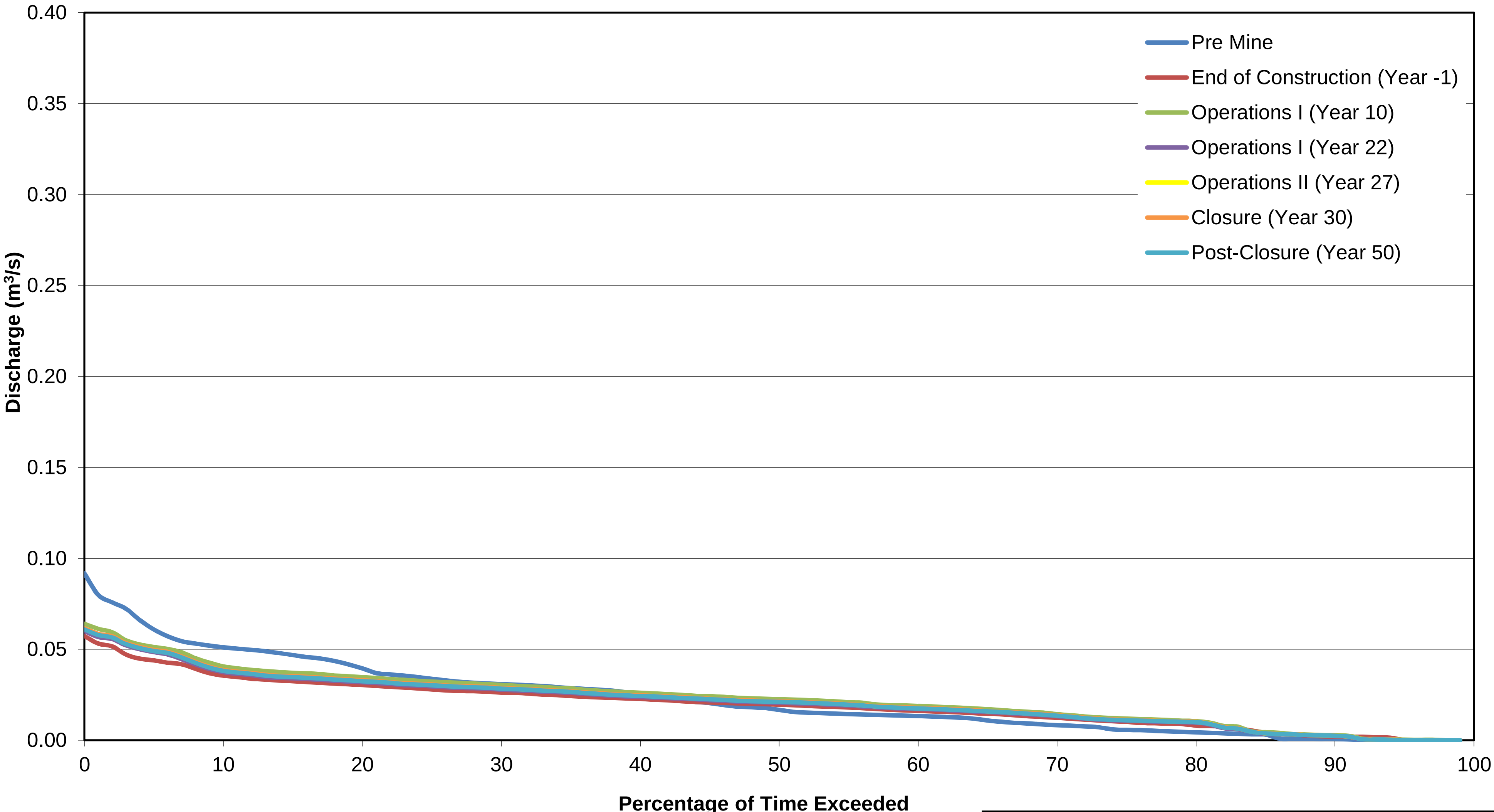
HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-83		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

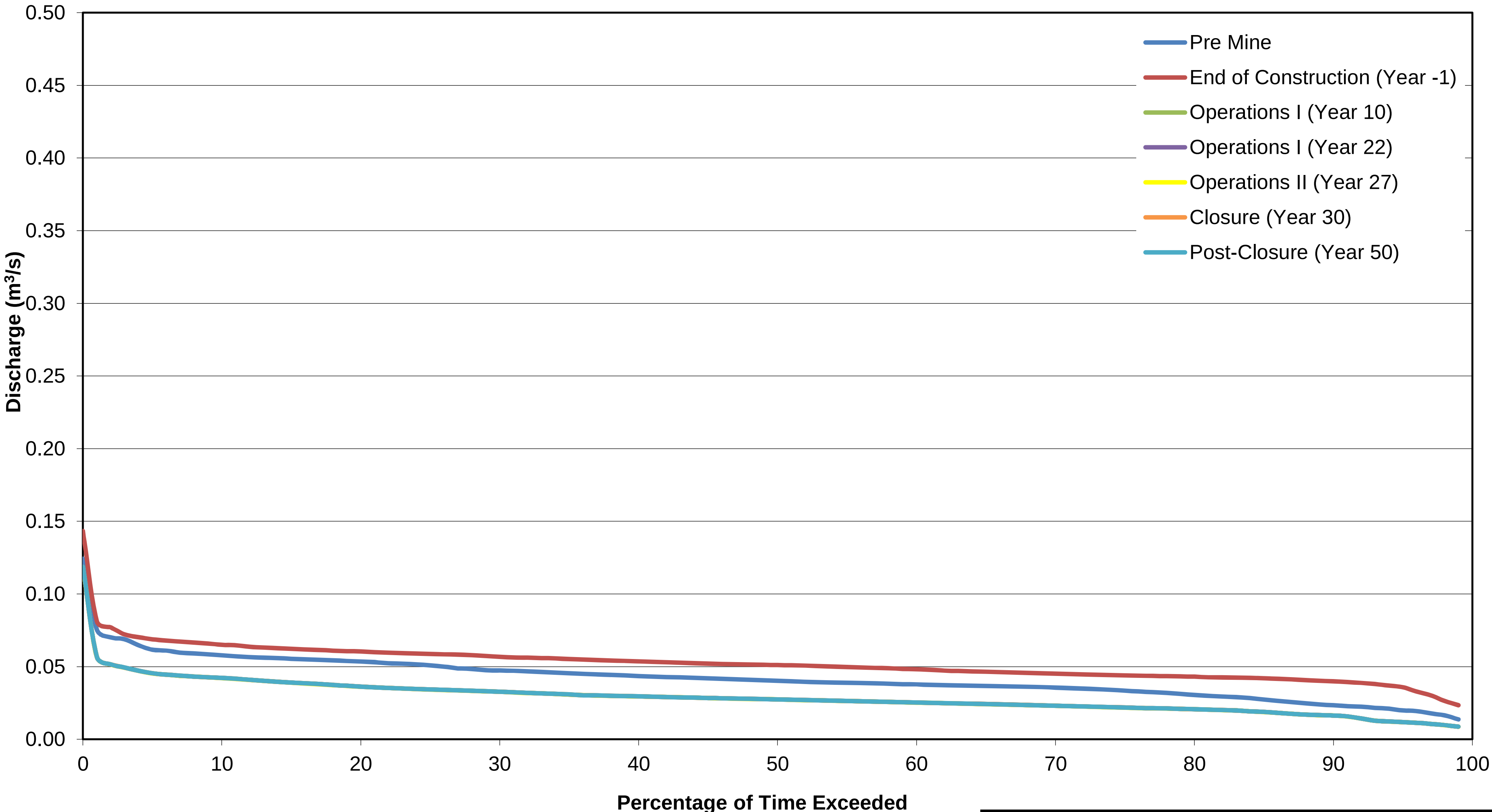
DECEMBER FLOW DURATION CURVES AT NODE 7 BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-84 REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

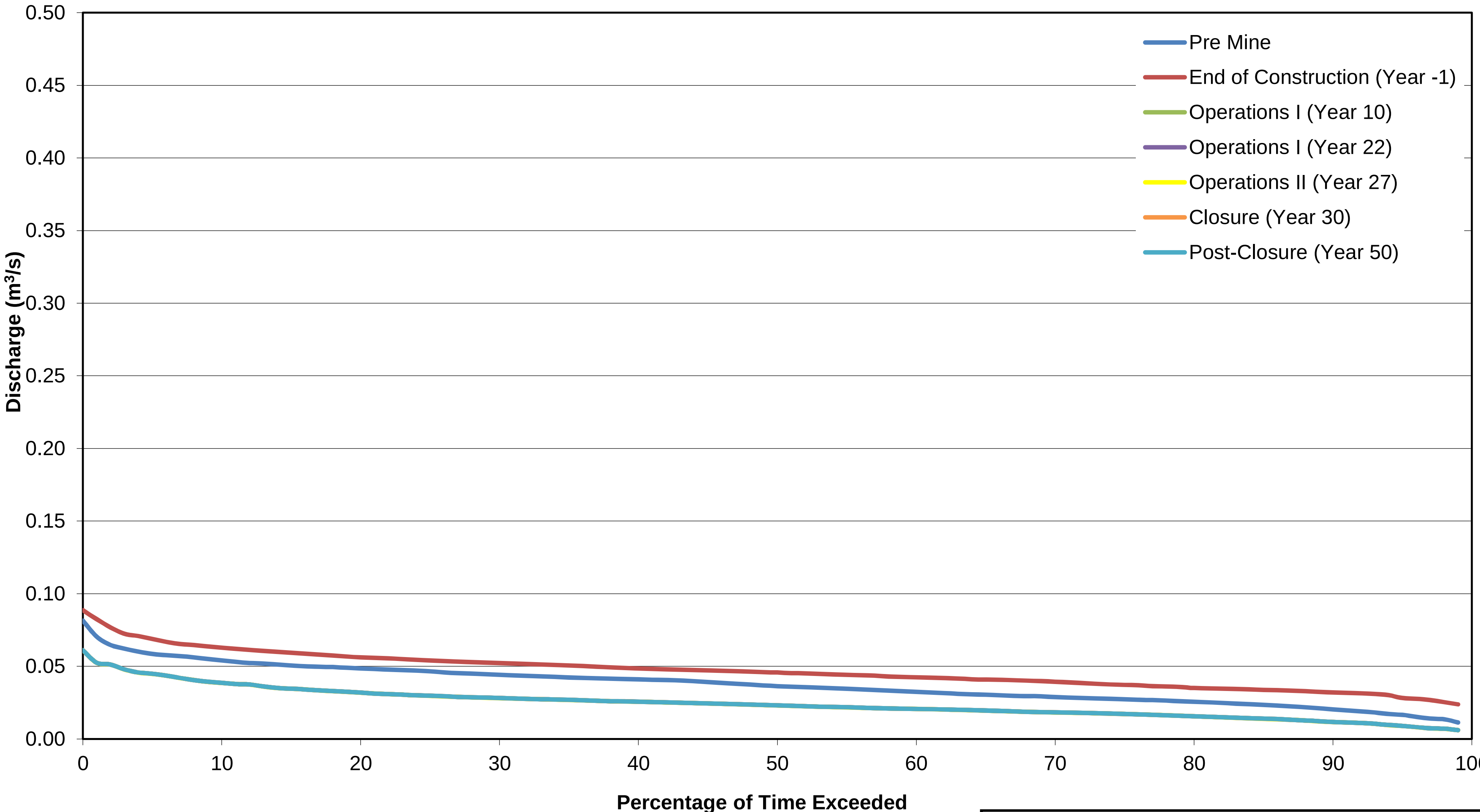
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-85		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

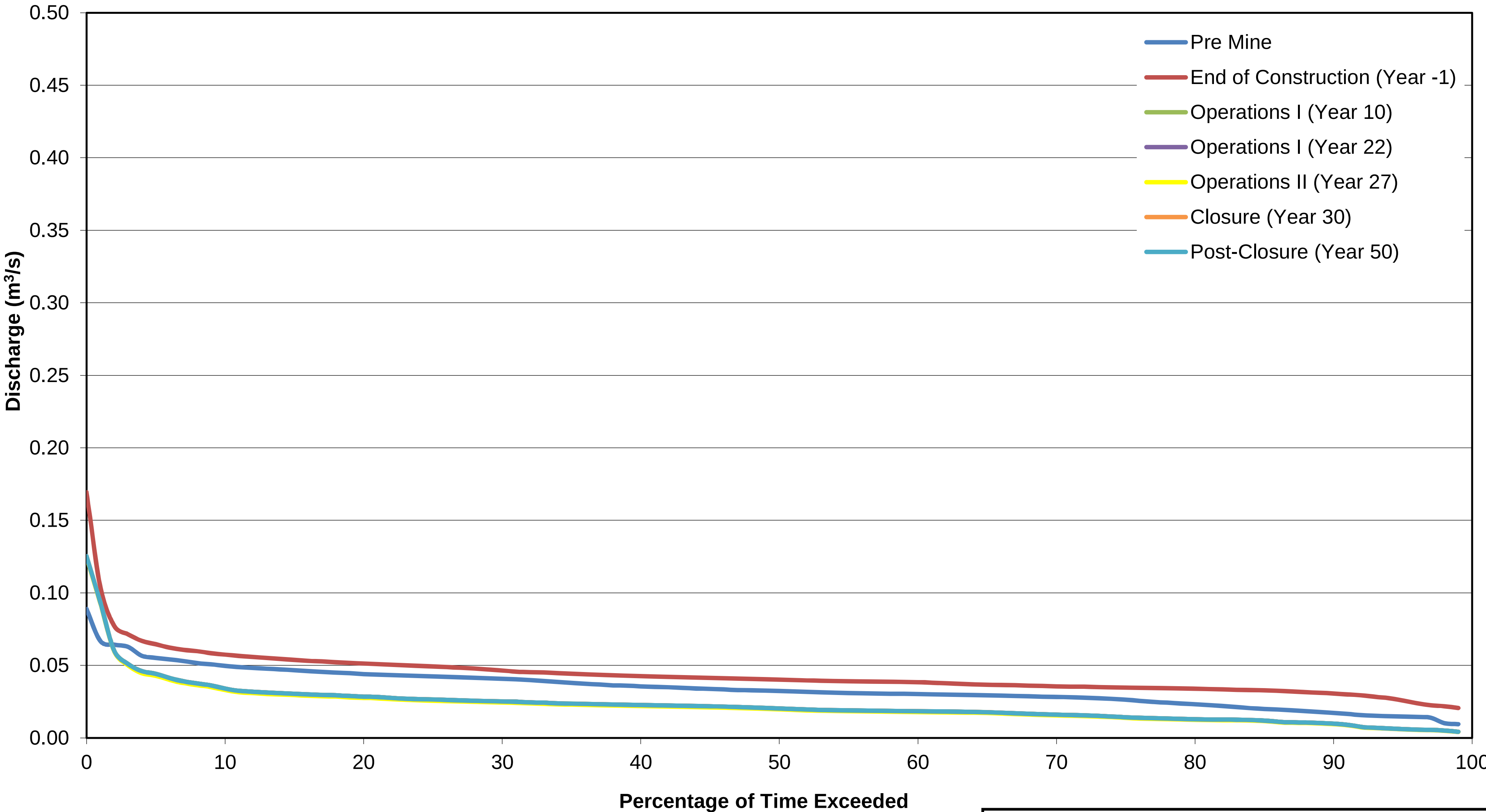
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-86

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

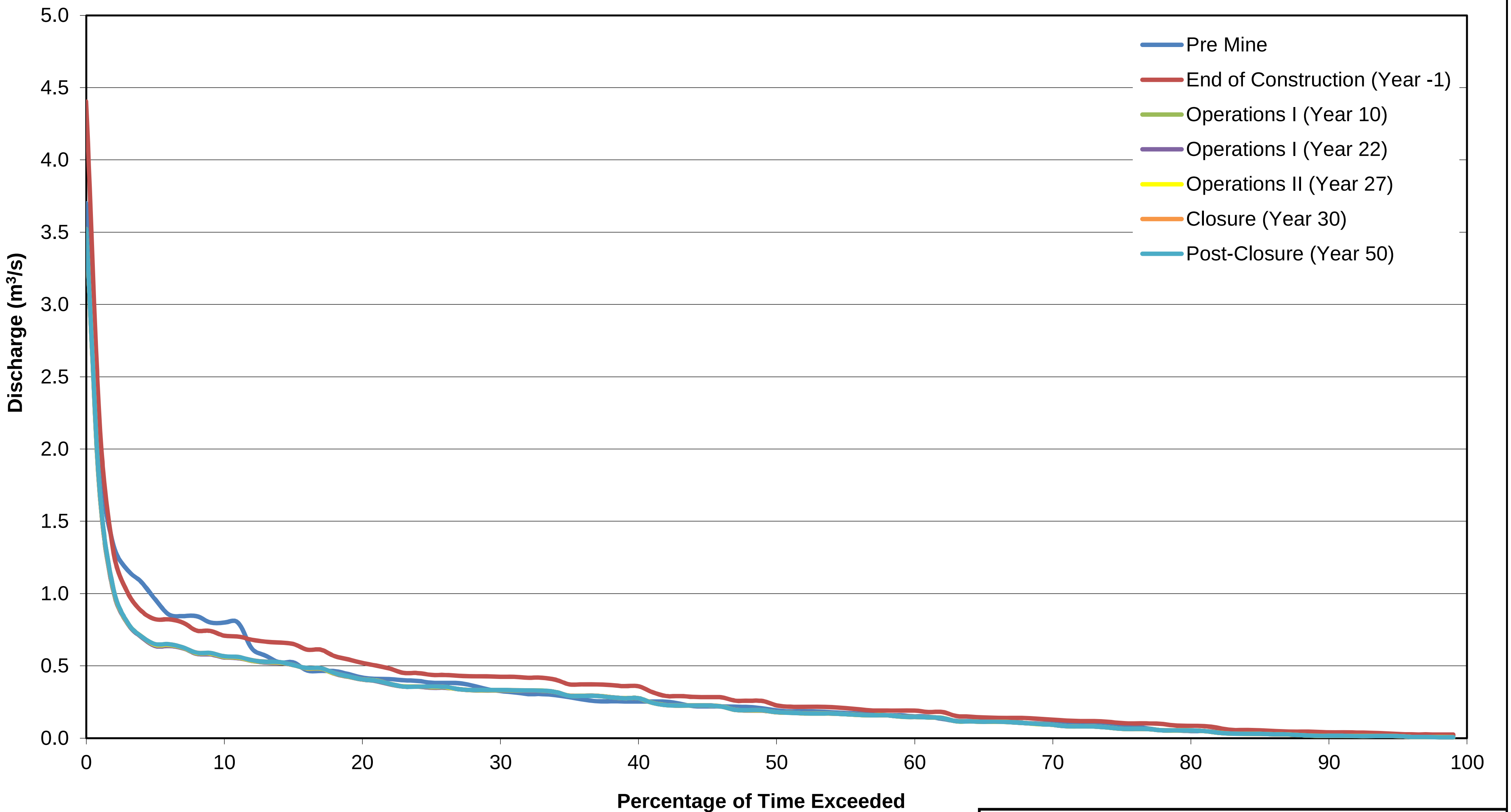
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-87

REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

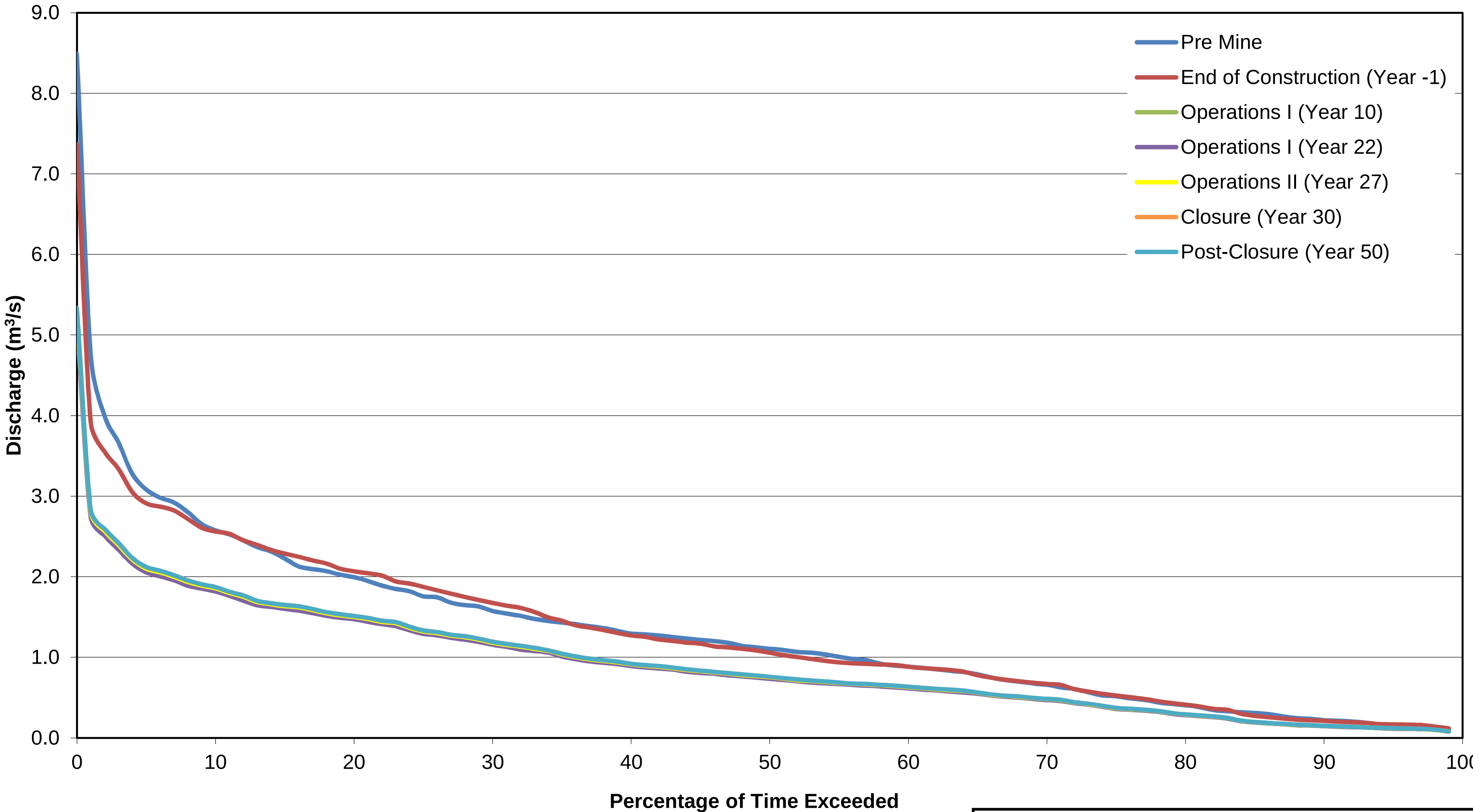
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-88

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

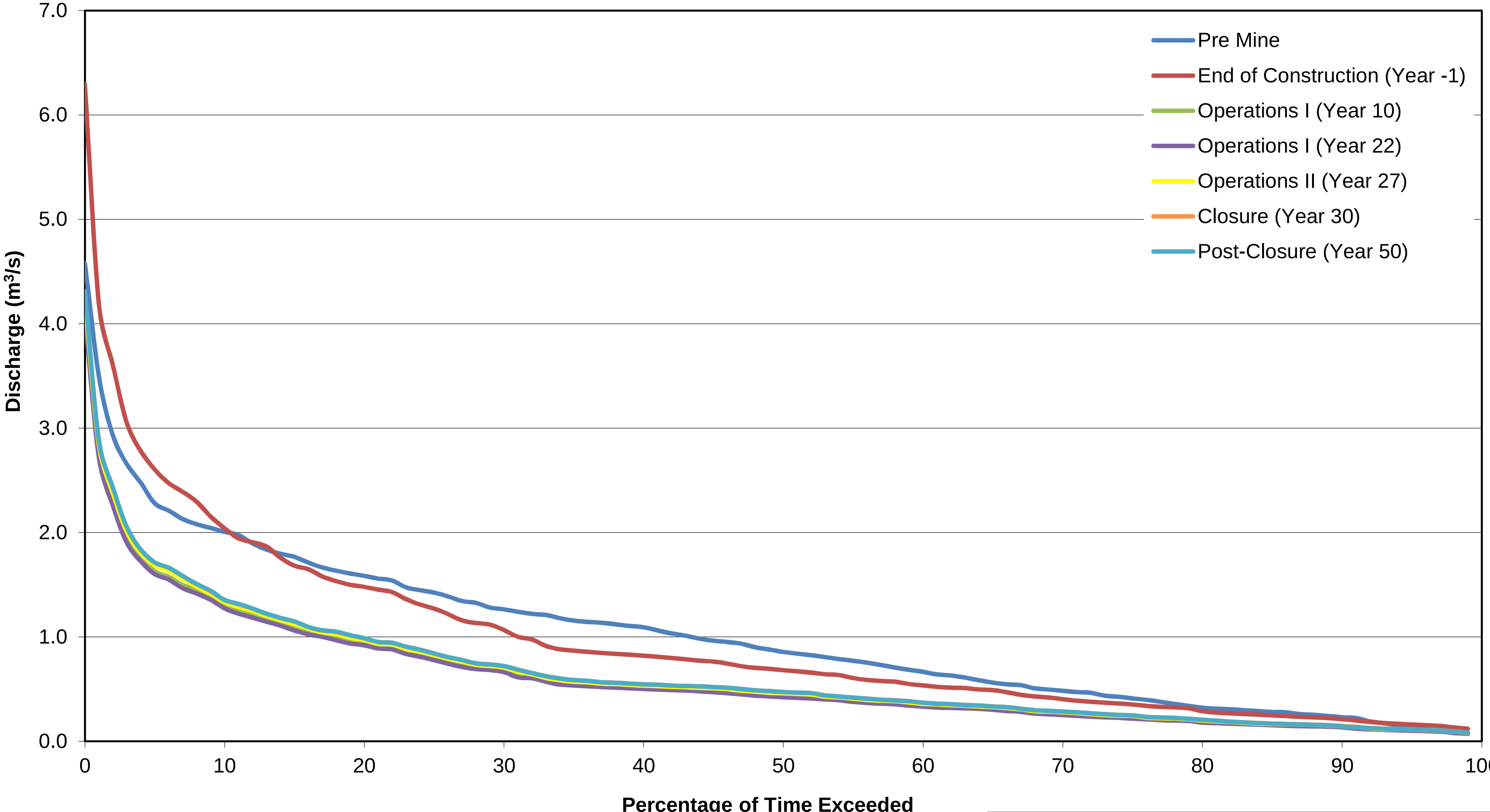
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-89

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

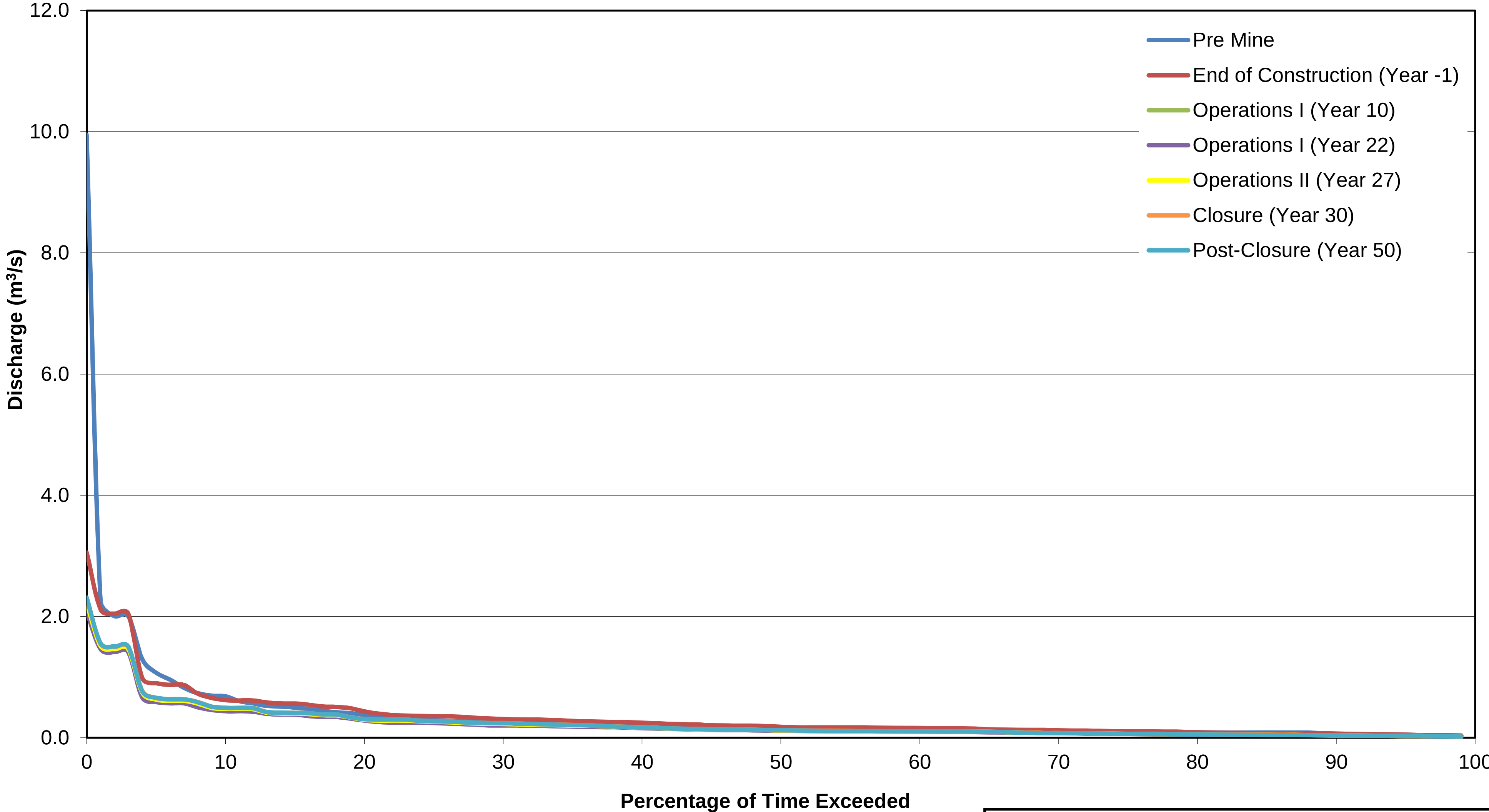
JUNE FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-90 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

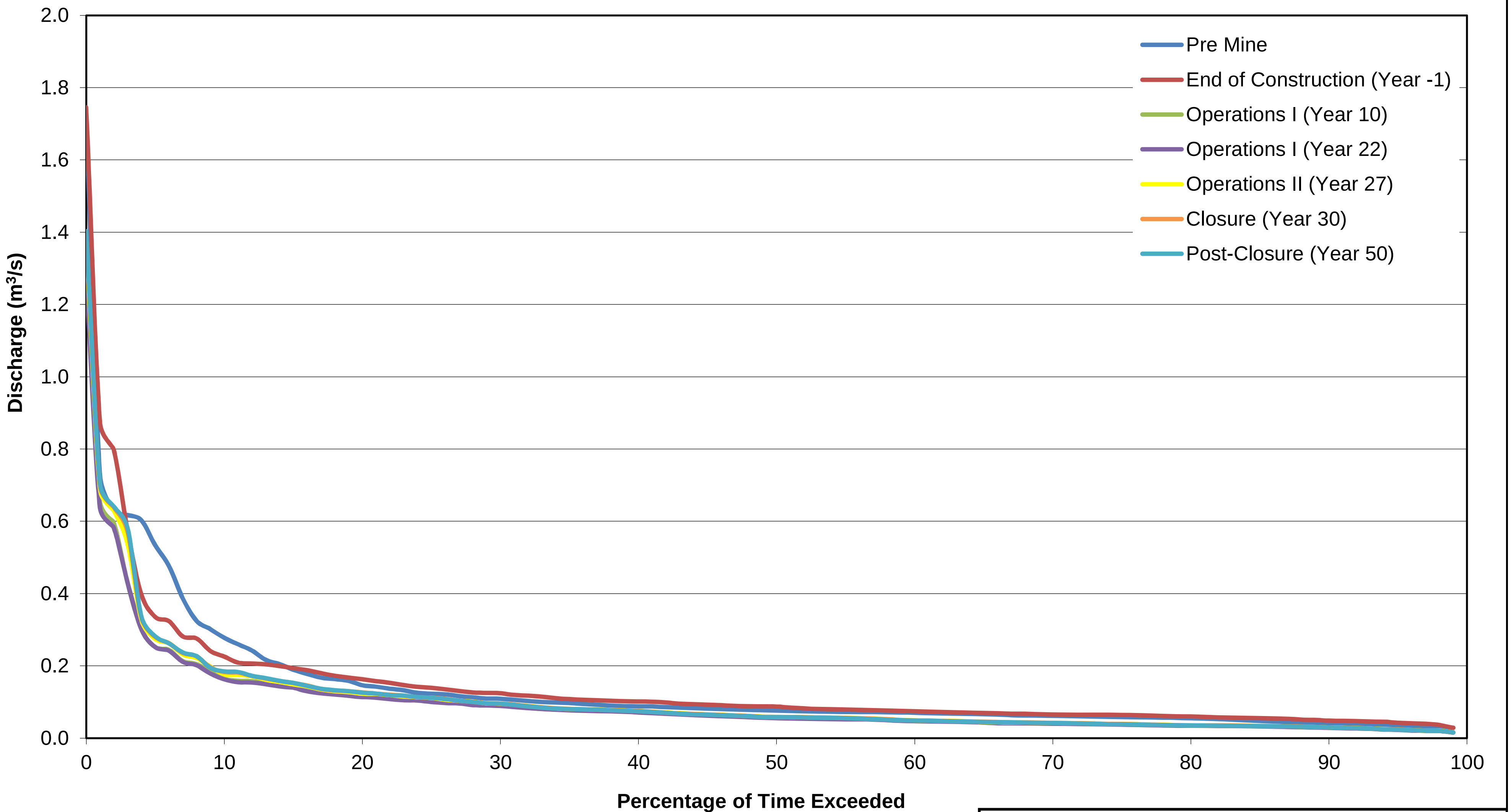
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-91

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

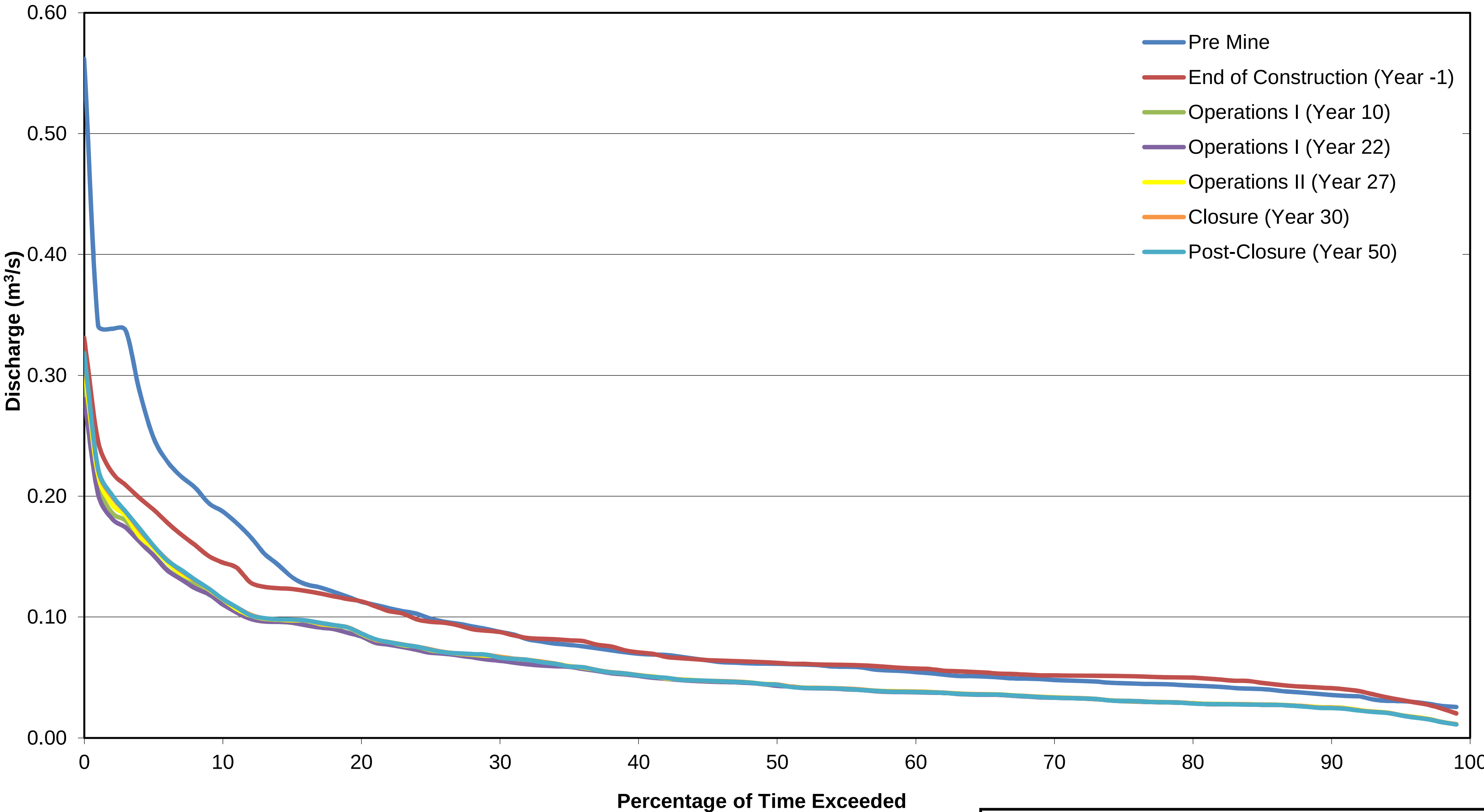
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-92

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

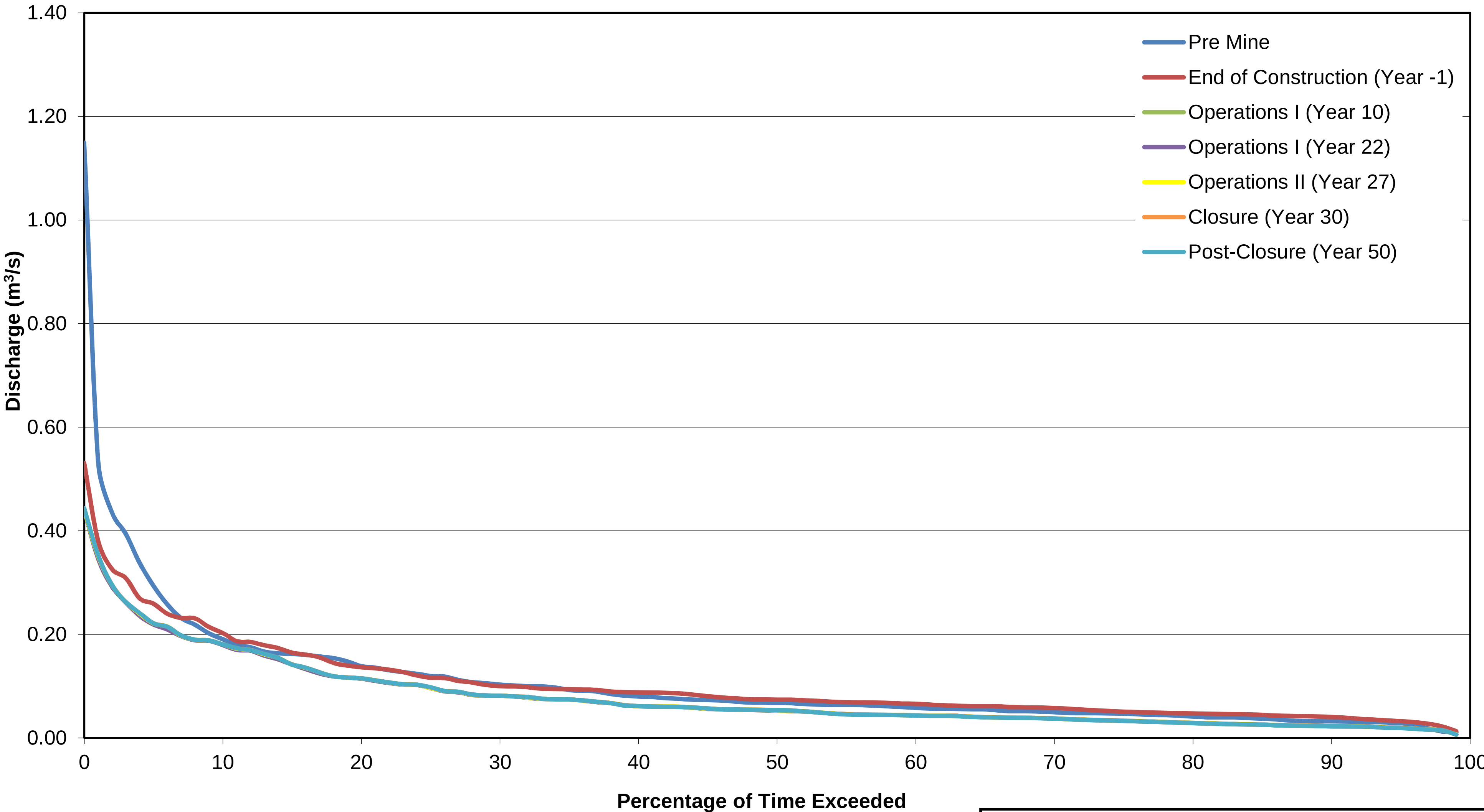
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-93

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

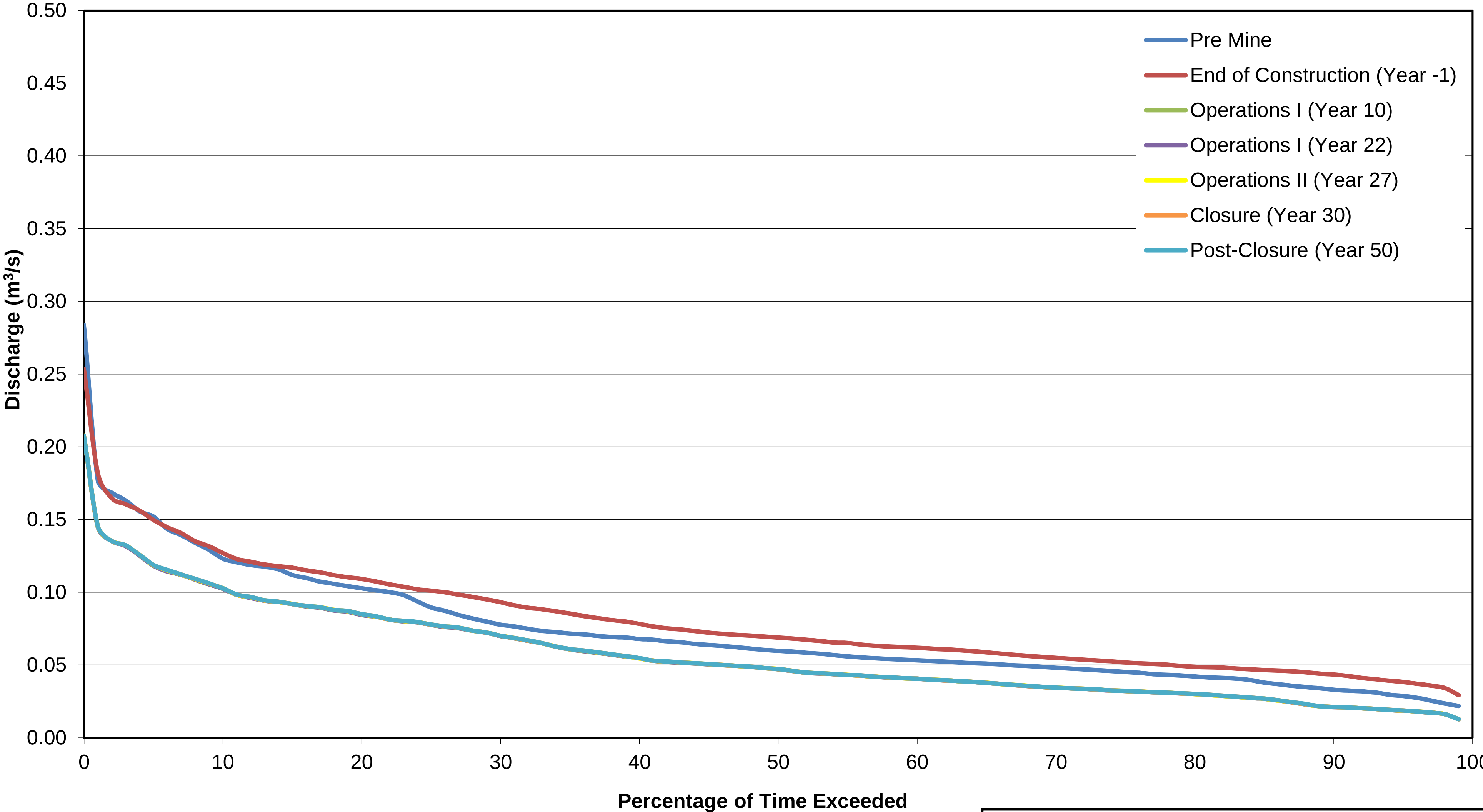
OCTOBER FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-94 REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

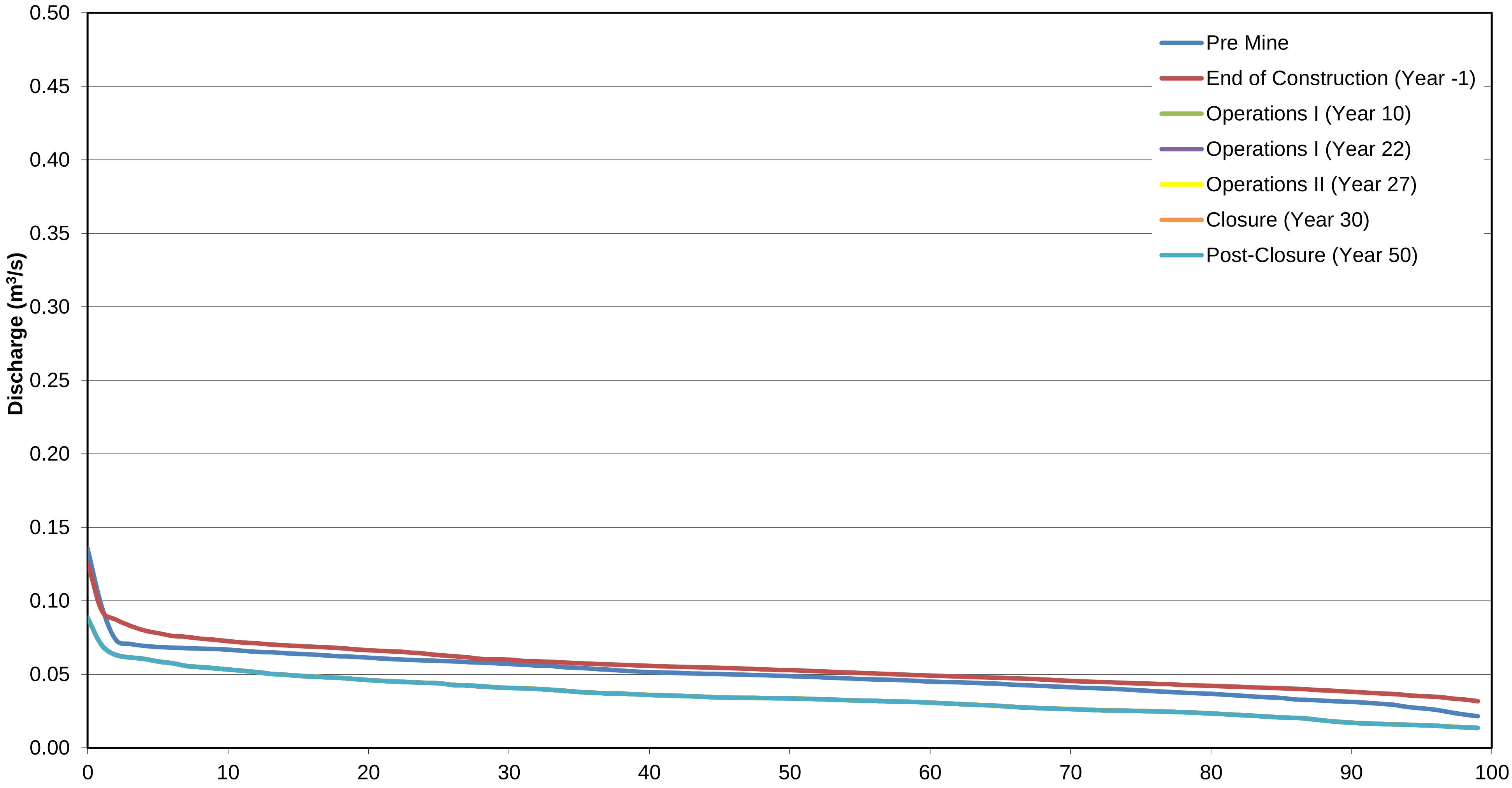
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-95

REV 0

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	14OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

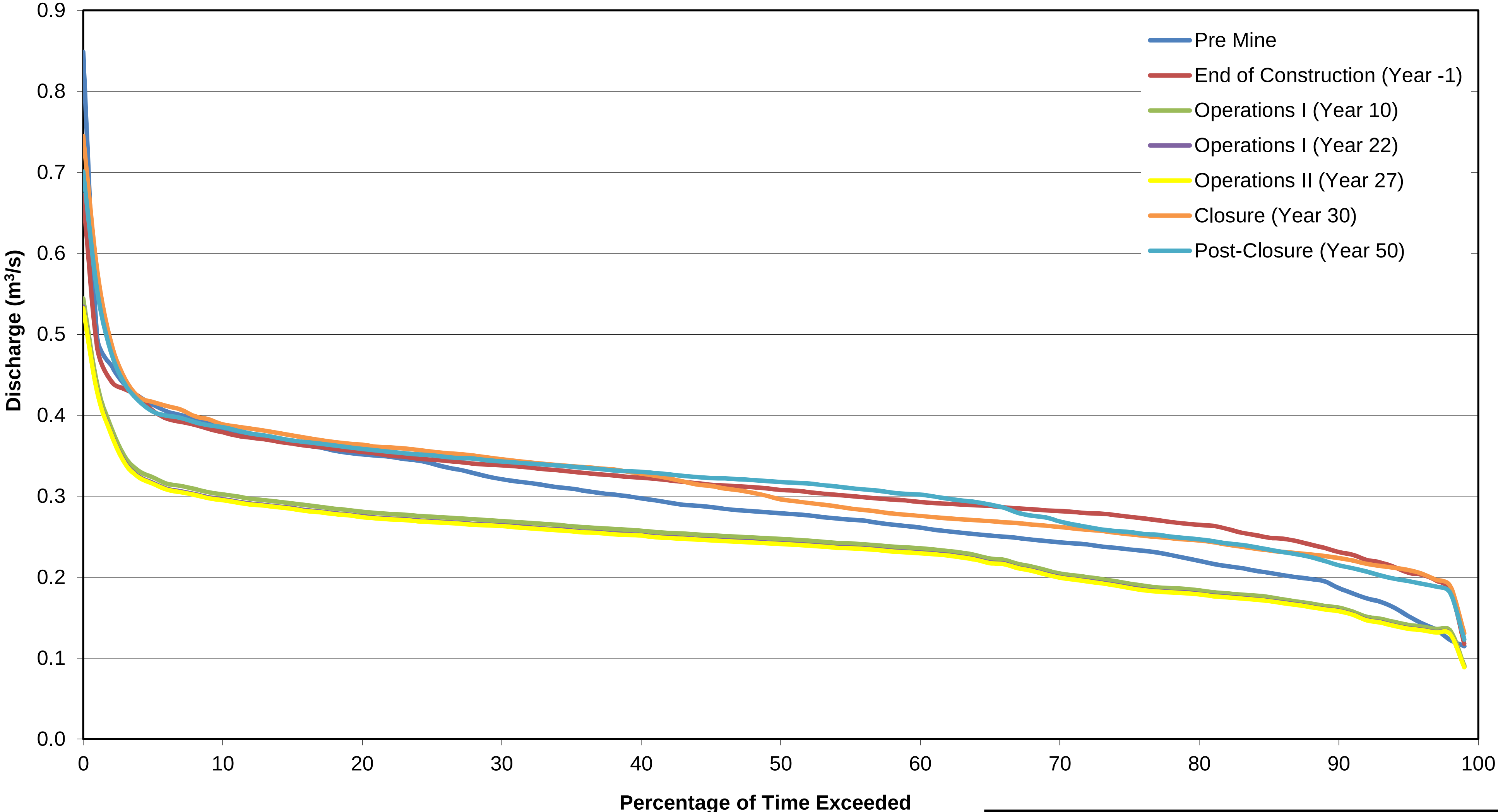
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 8
HARPER CREEK BELOW P-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-96		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

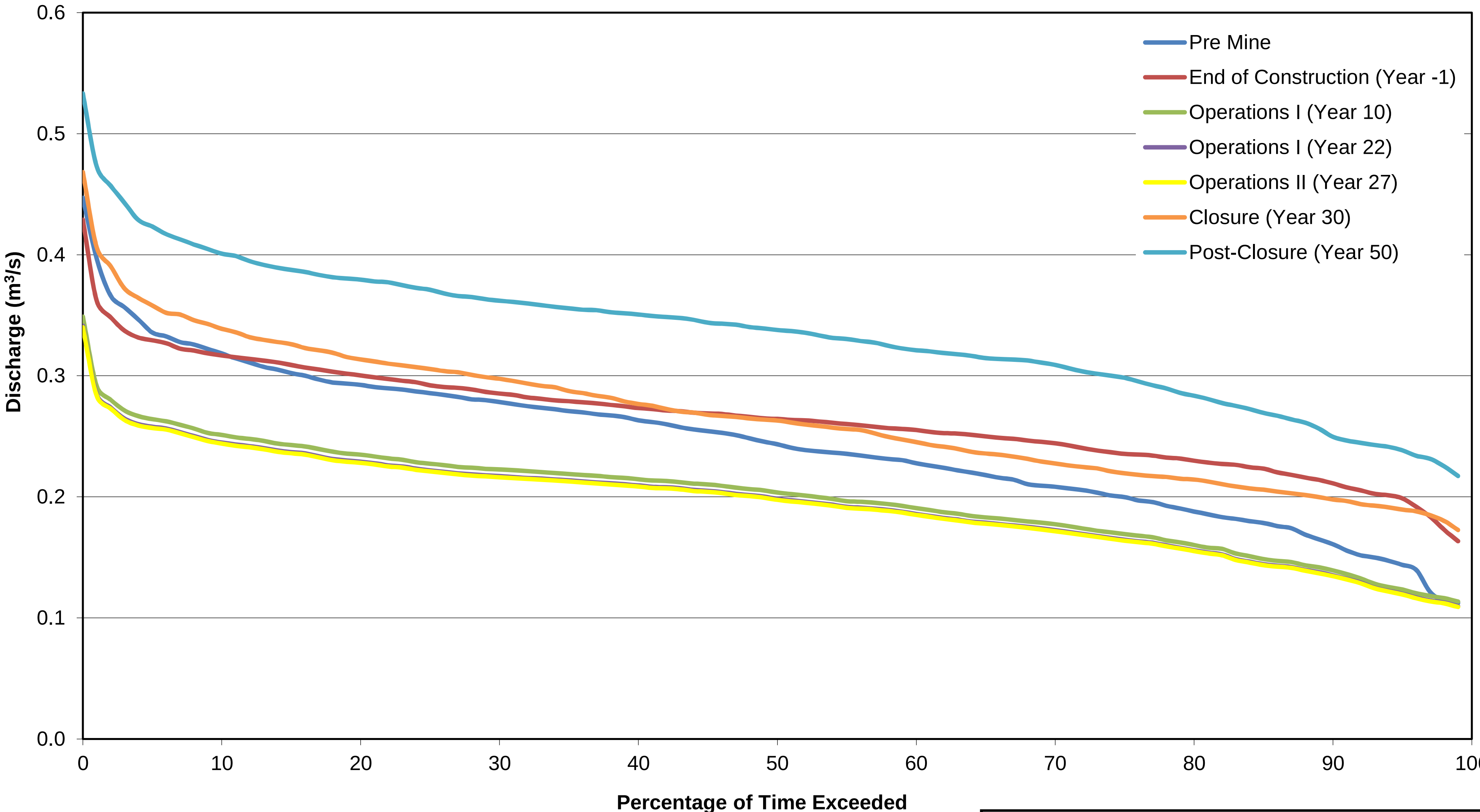
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-97

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

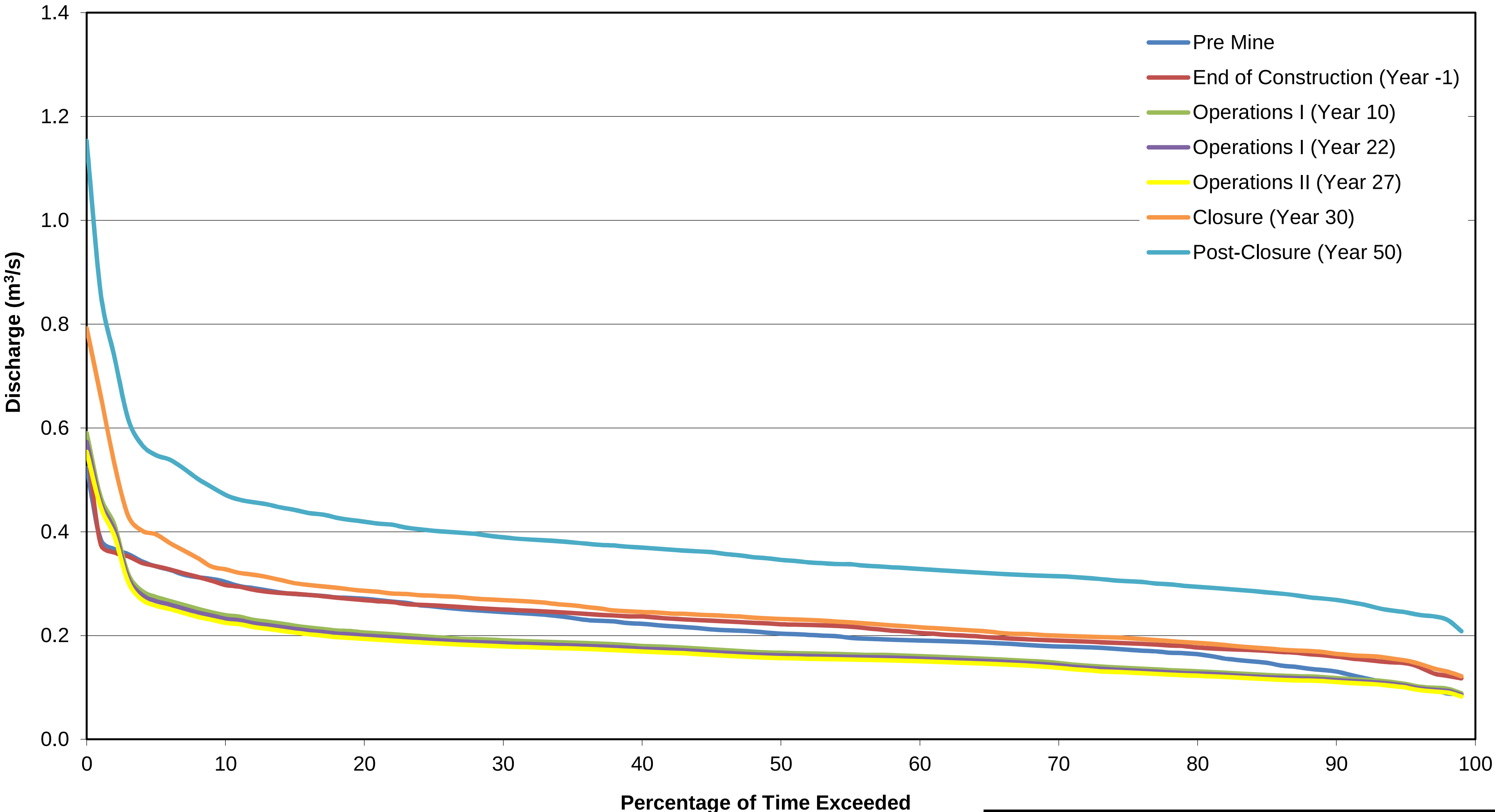
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-98

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

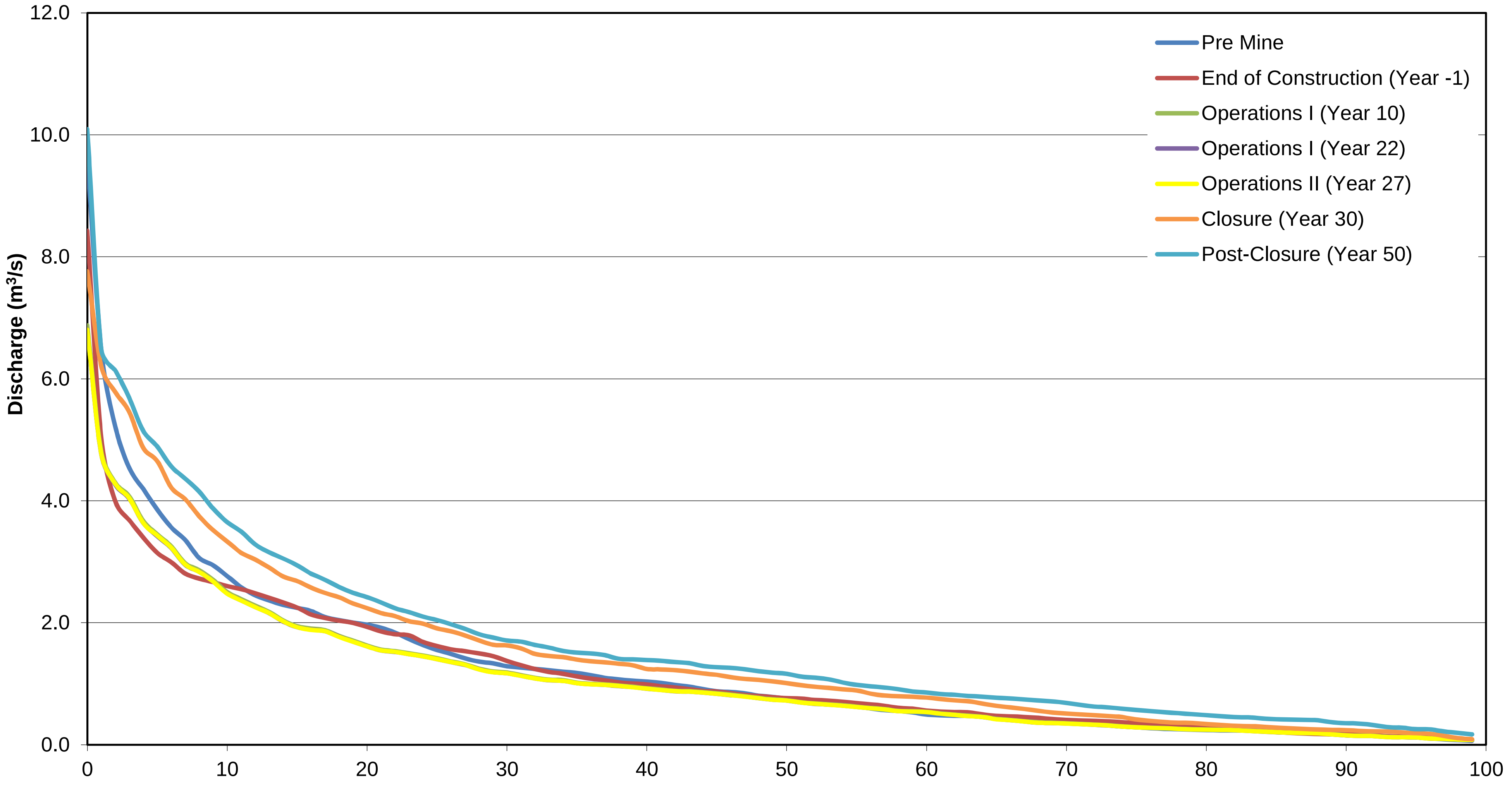
MARCH FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15 | REF NO. 3

FIGURE A4-99 | REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Knight Piésold CONSULTING

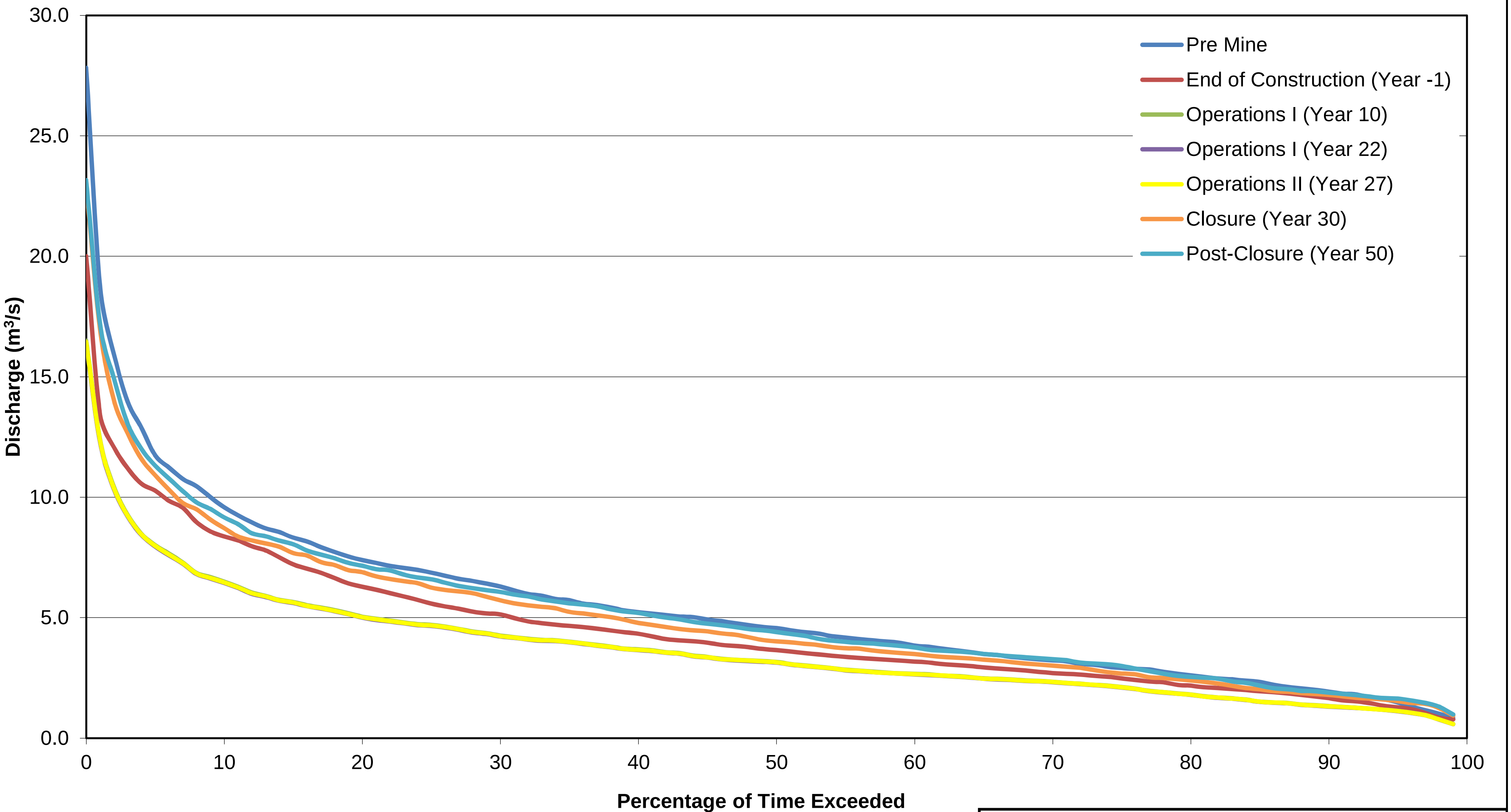
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-100

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

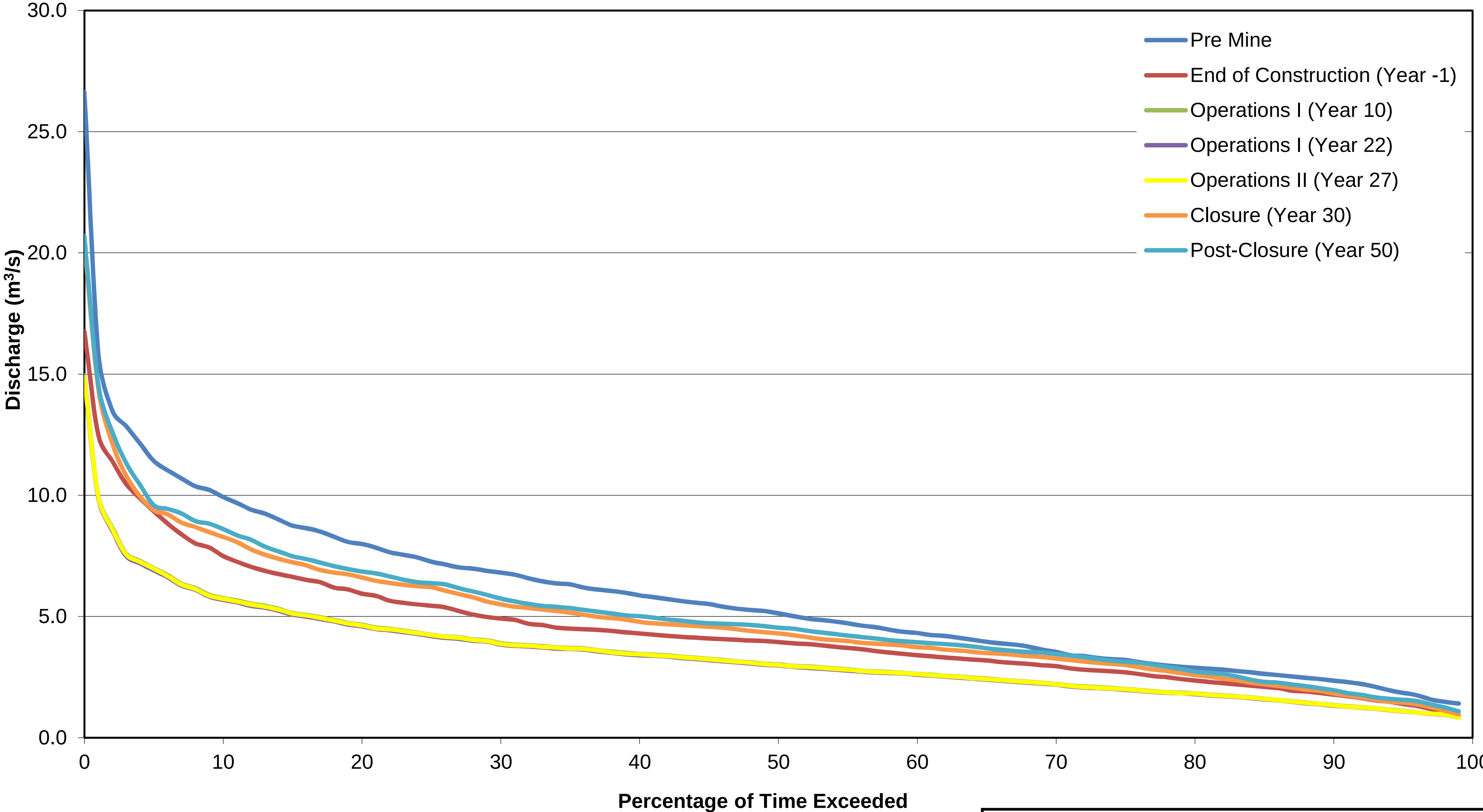
HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-101 REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

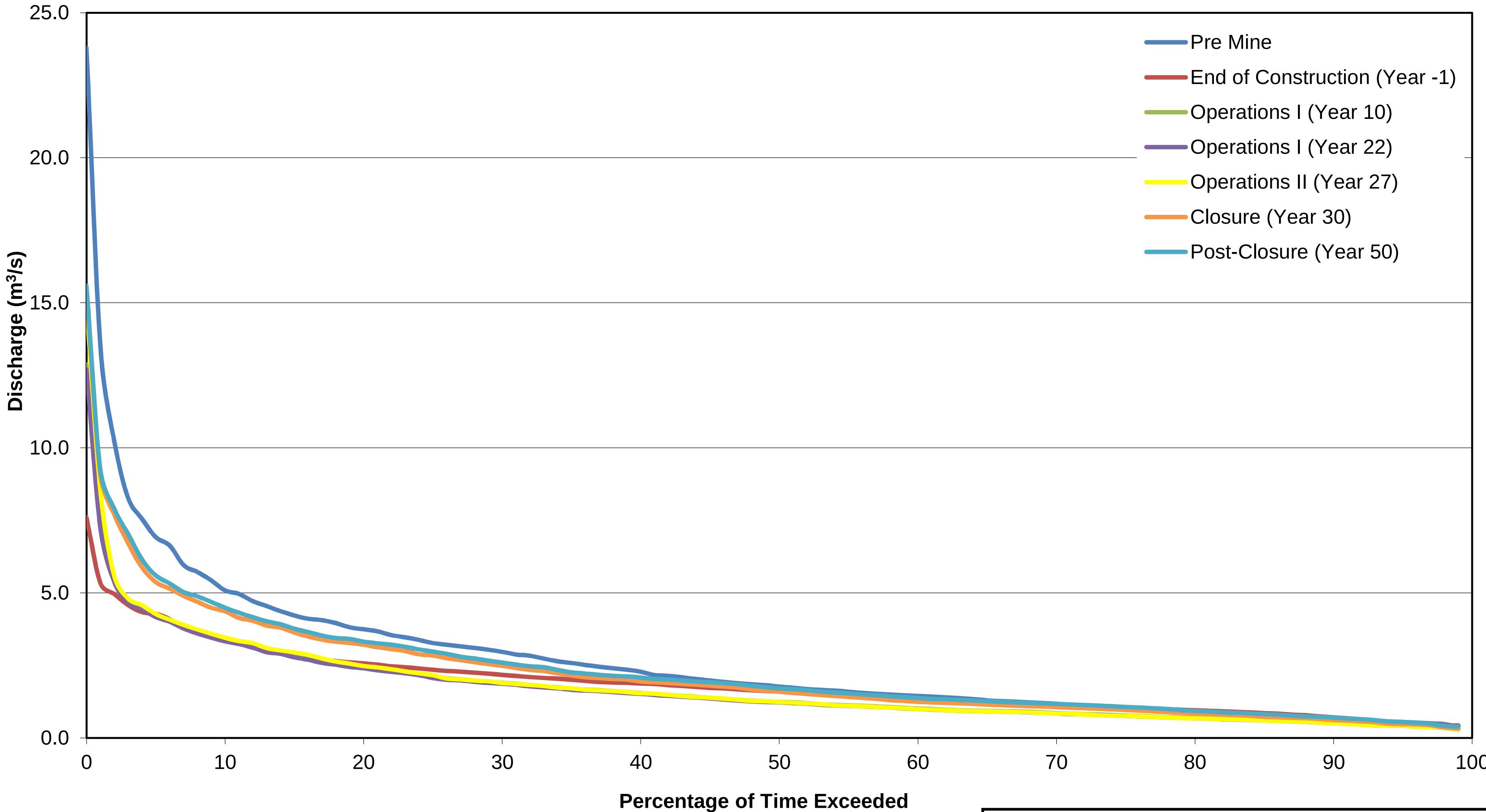
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-102

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

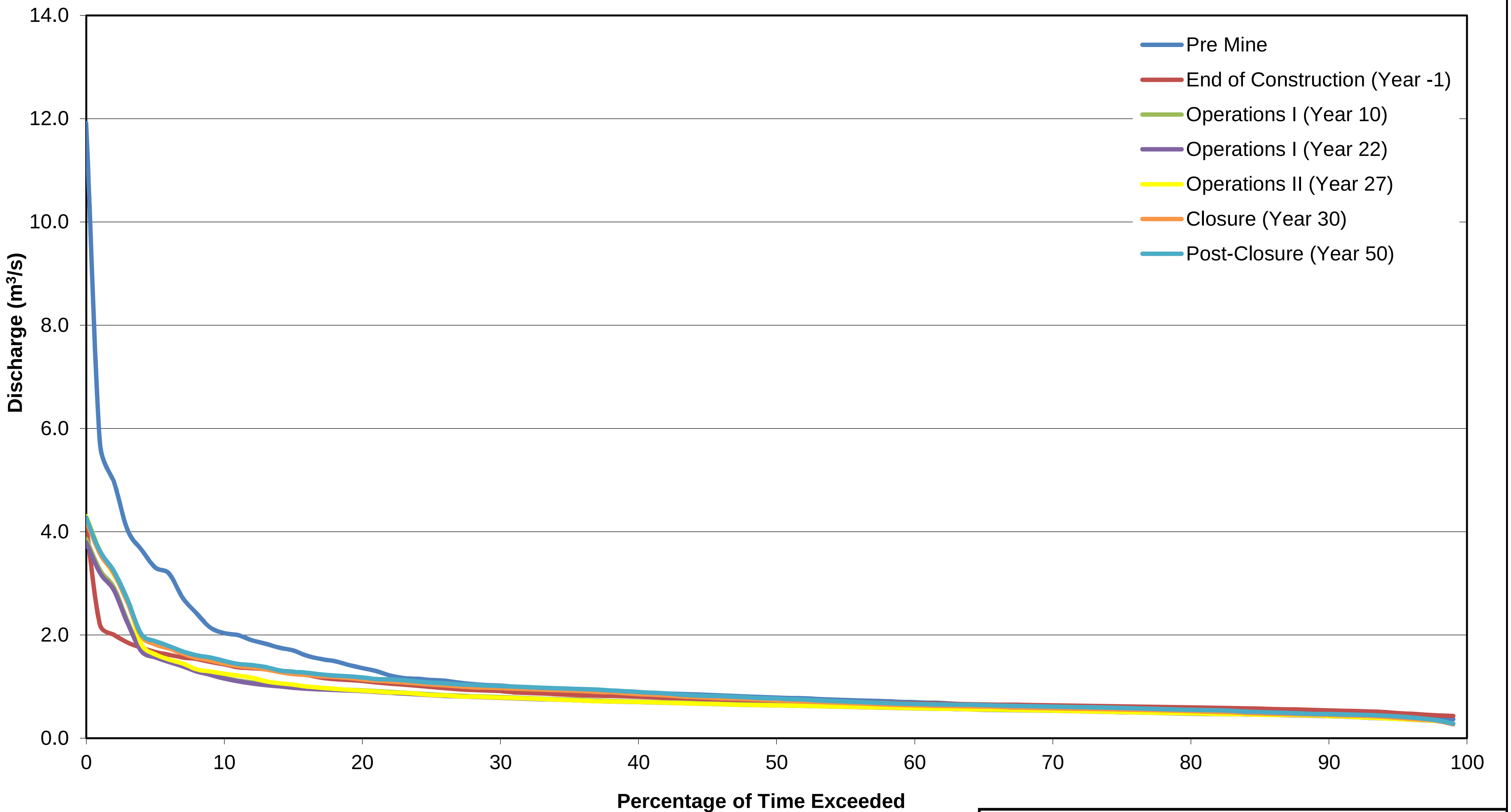
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-103

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

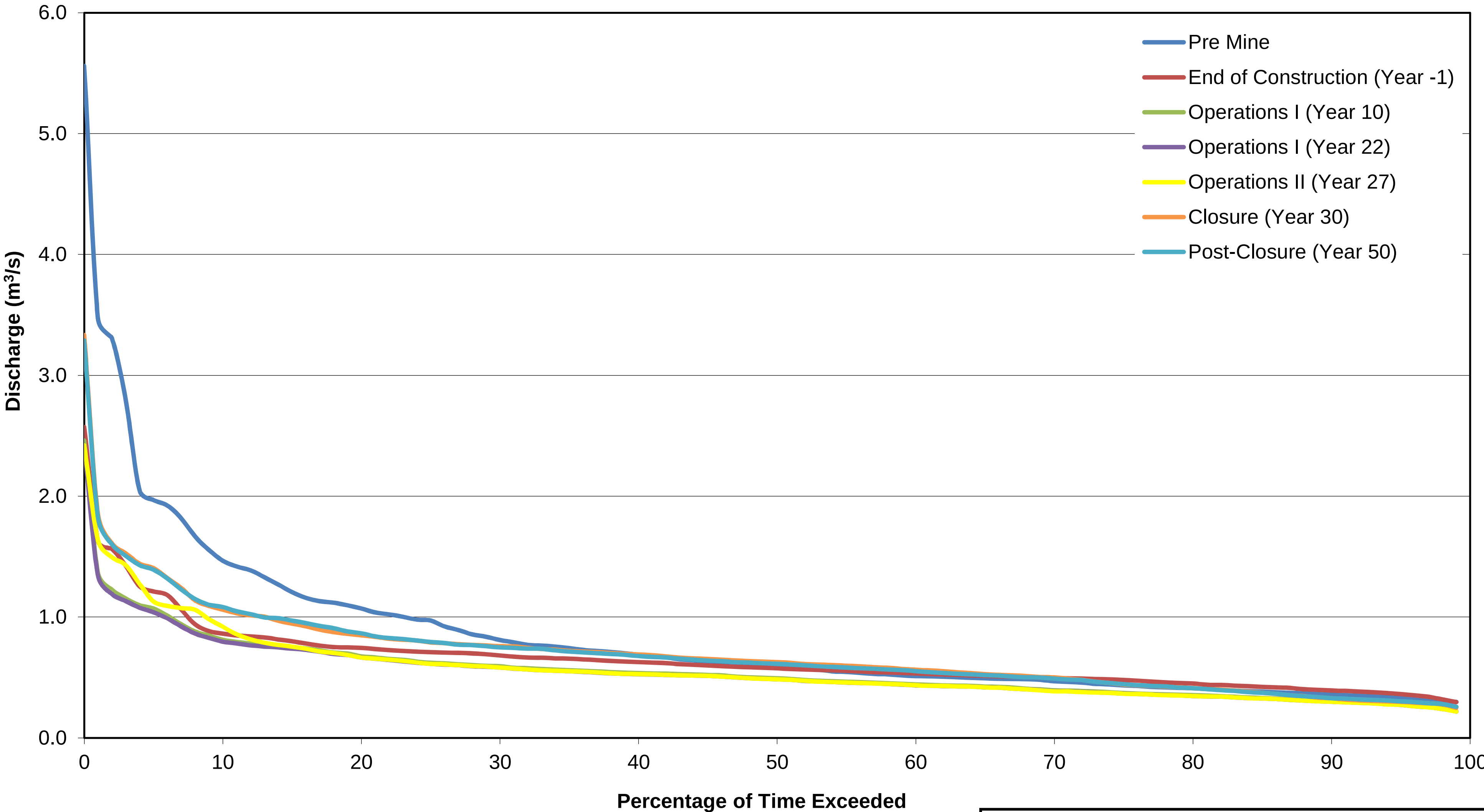
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-104

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

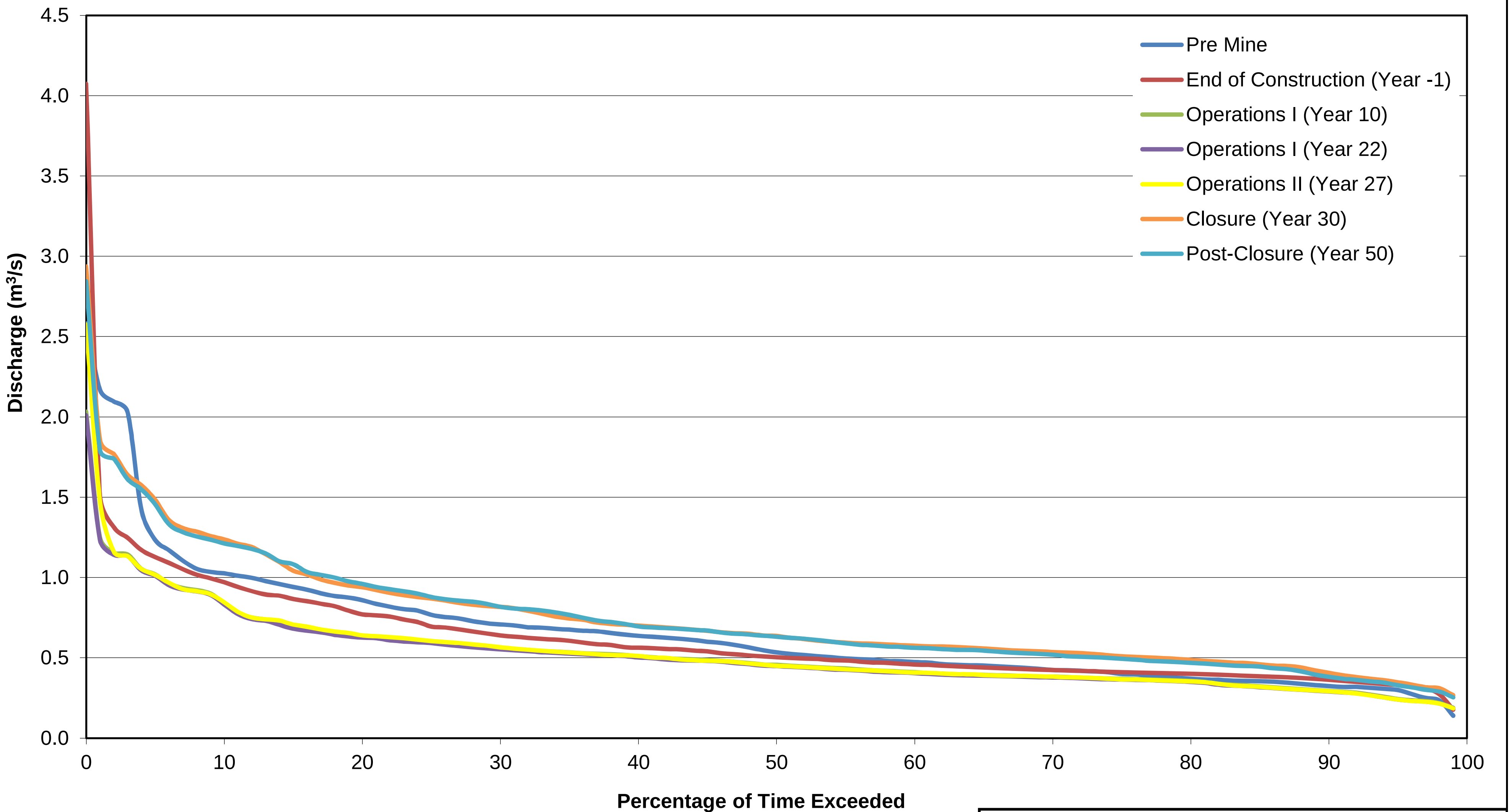
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-105

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

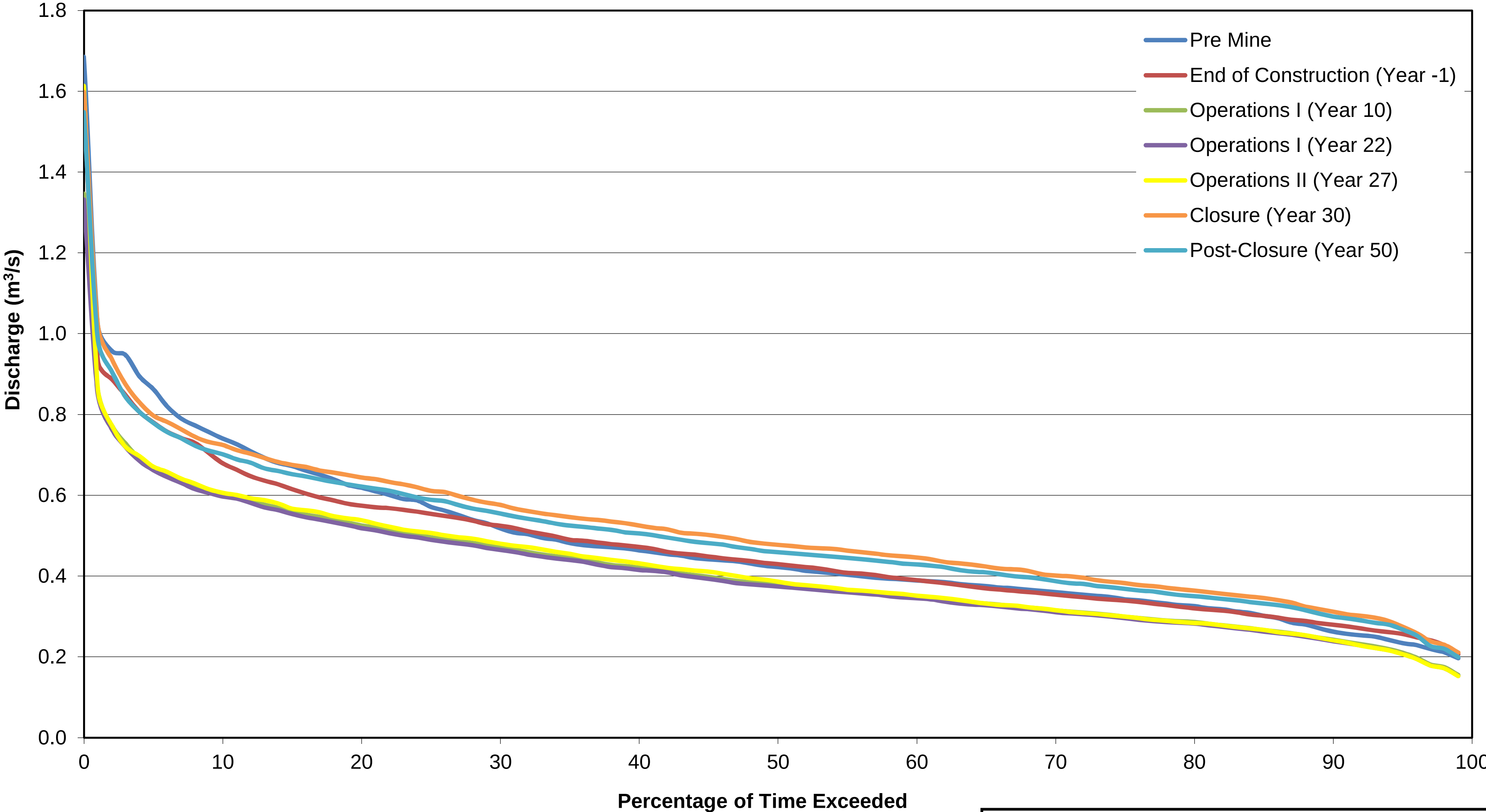
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-106

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

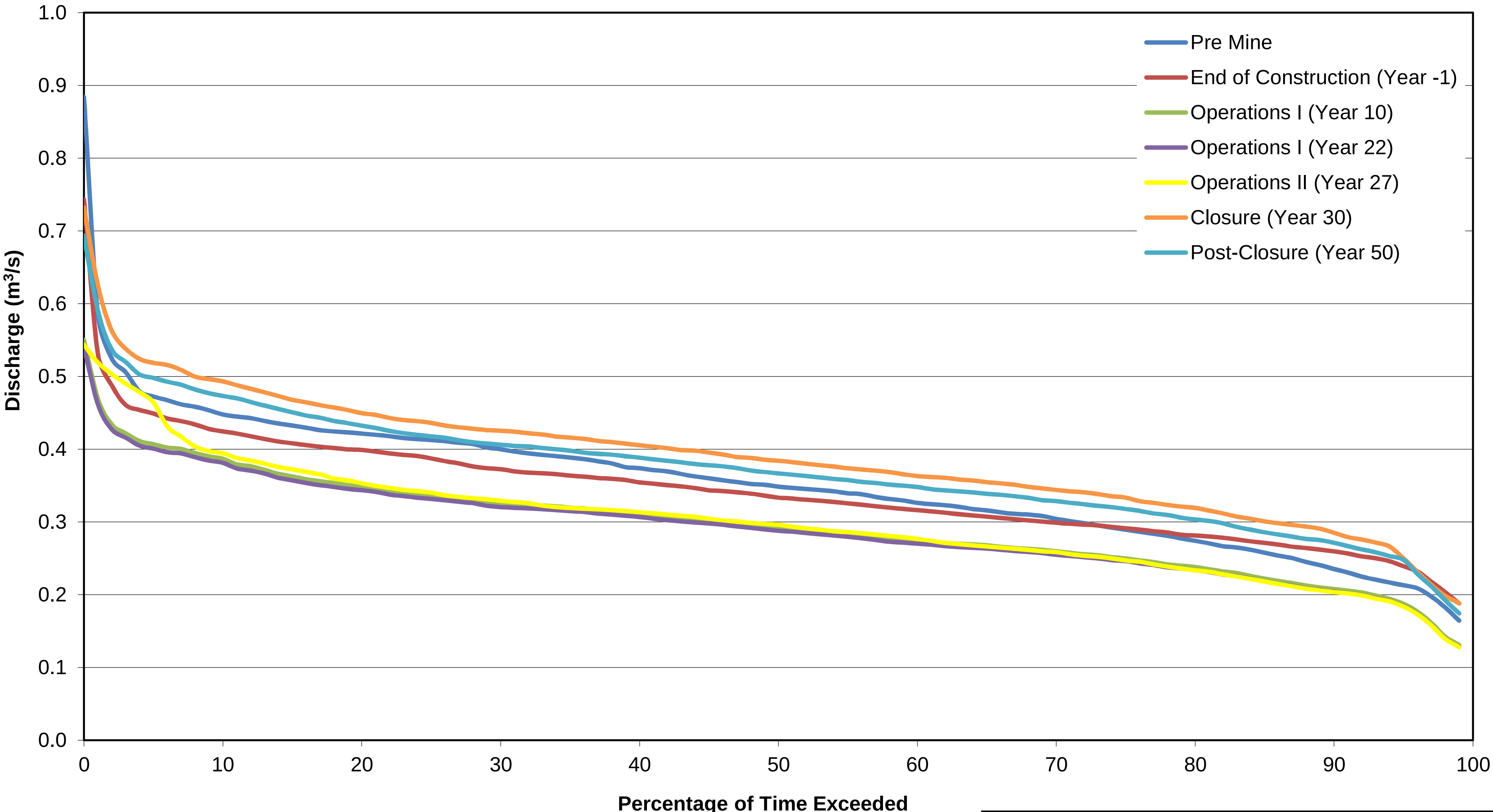
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-107

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

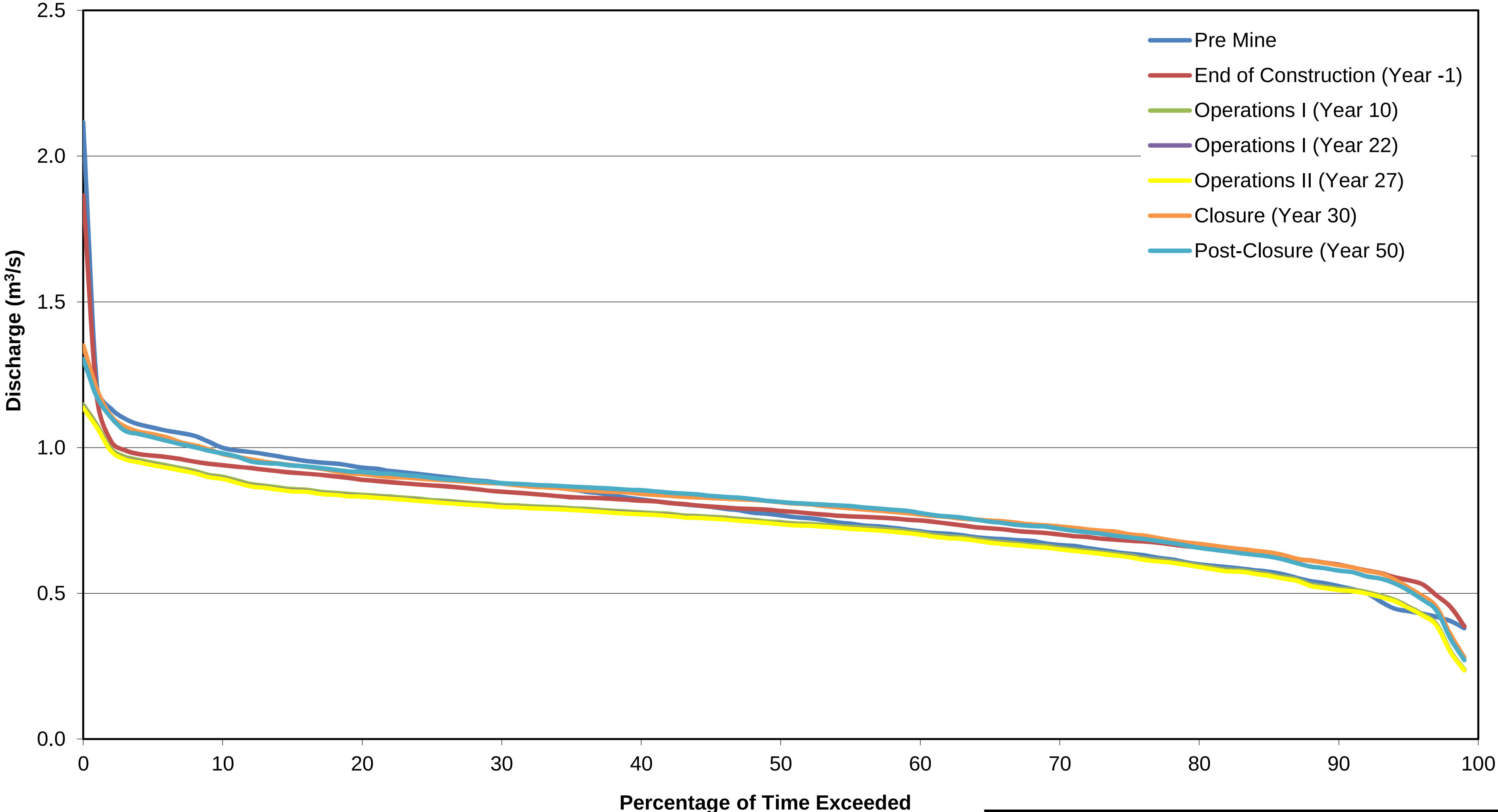
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-108

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

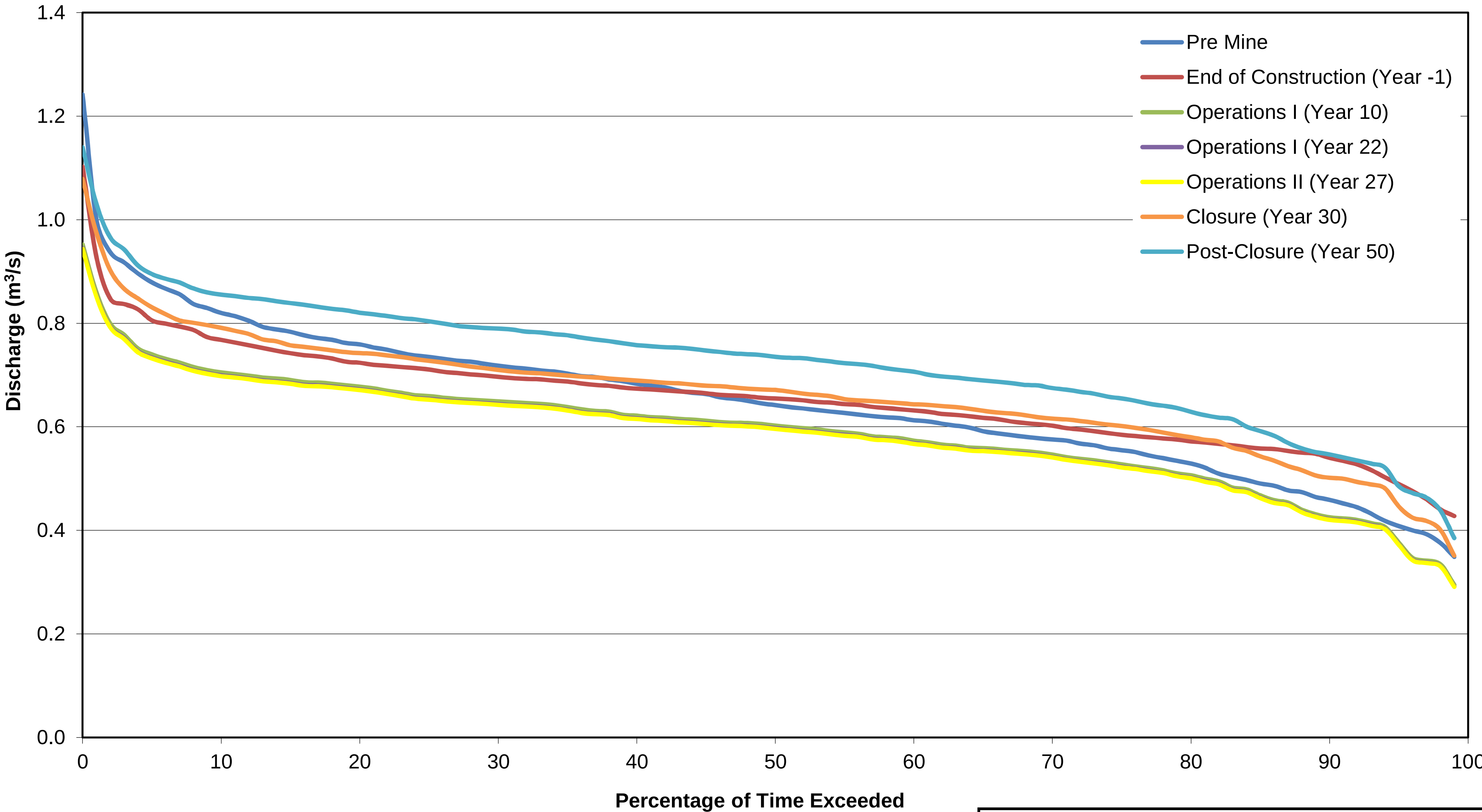
JANUARY FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-109 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

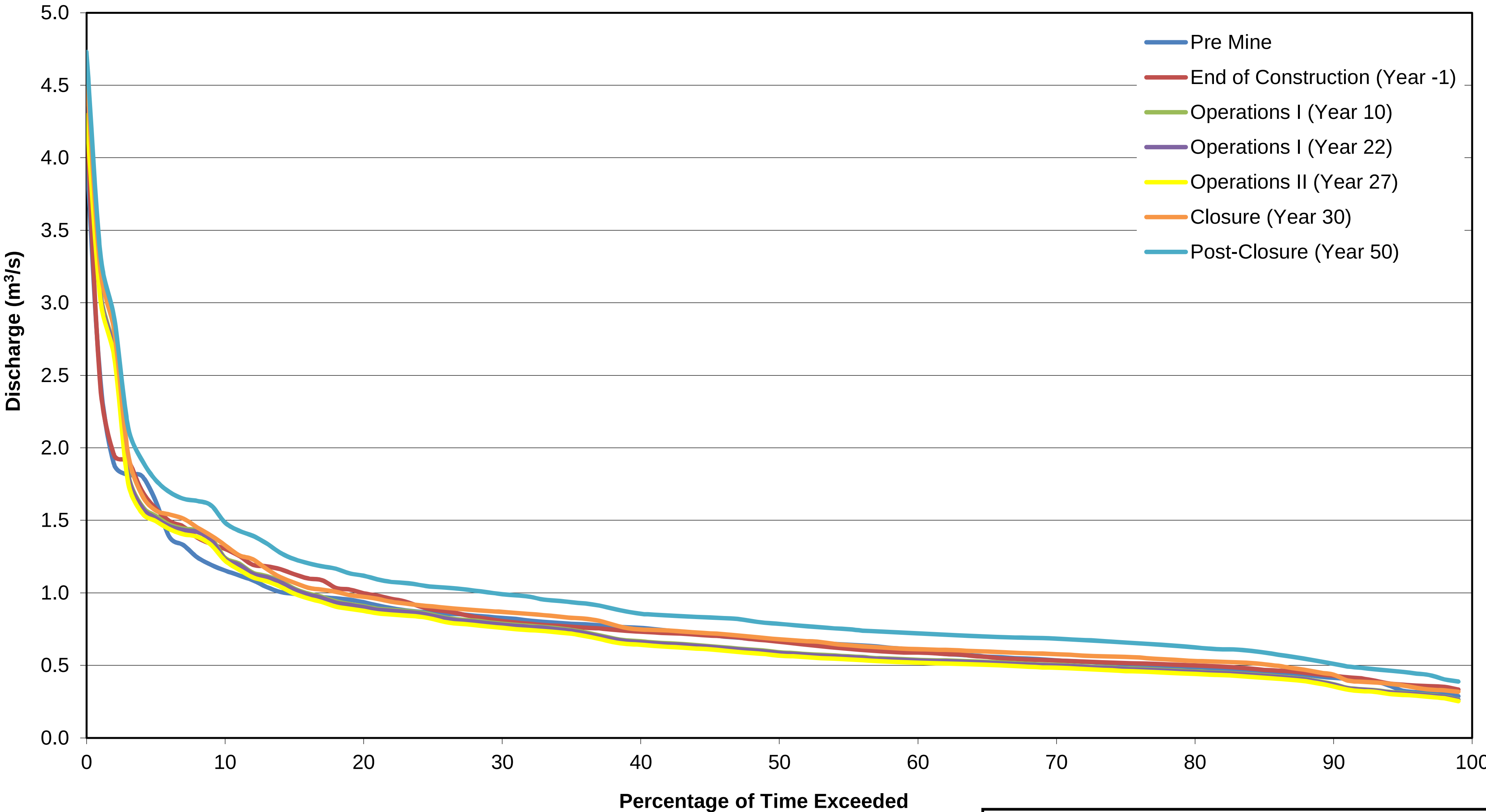
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-110

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

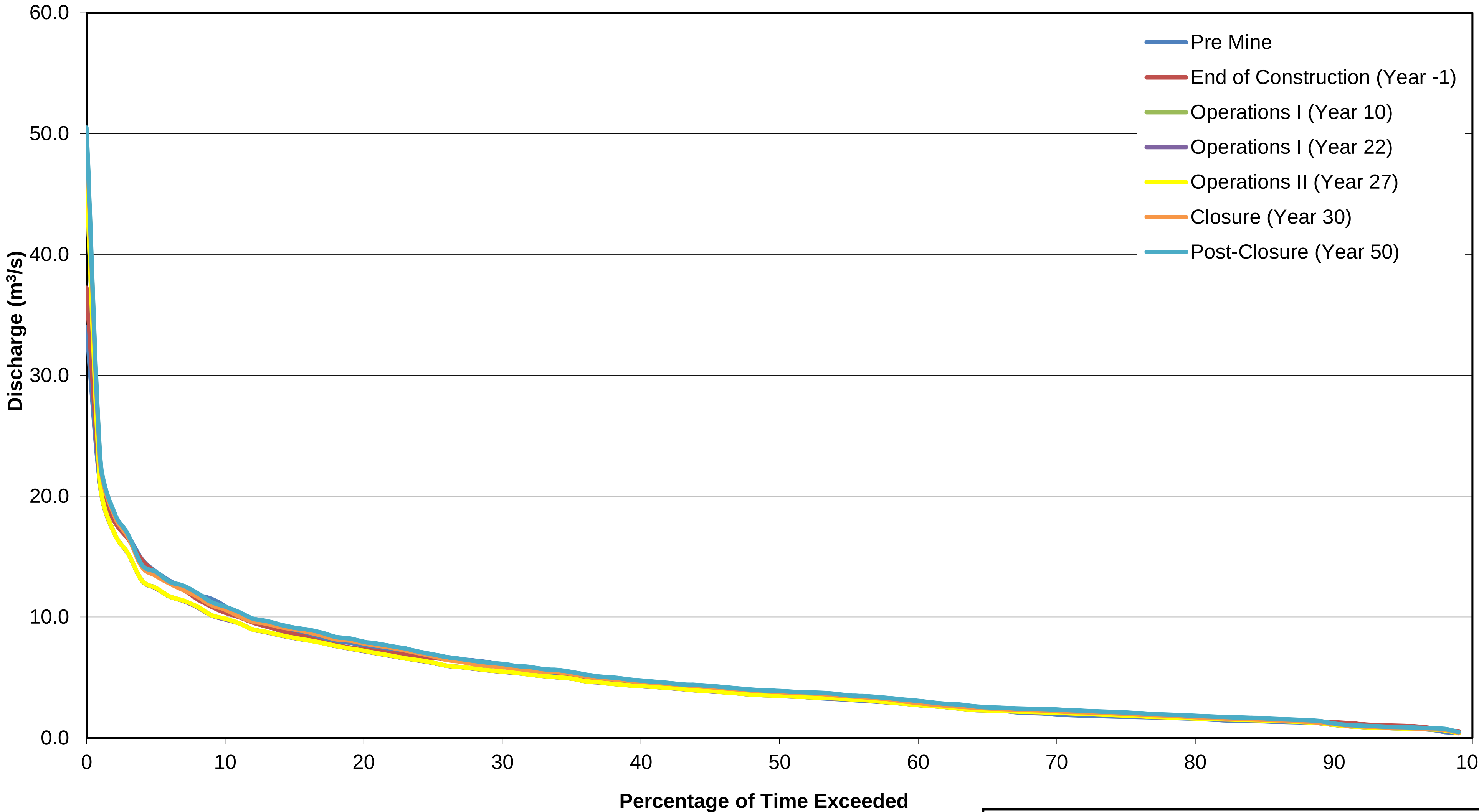
MARCH FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-111 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

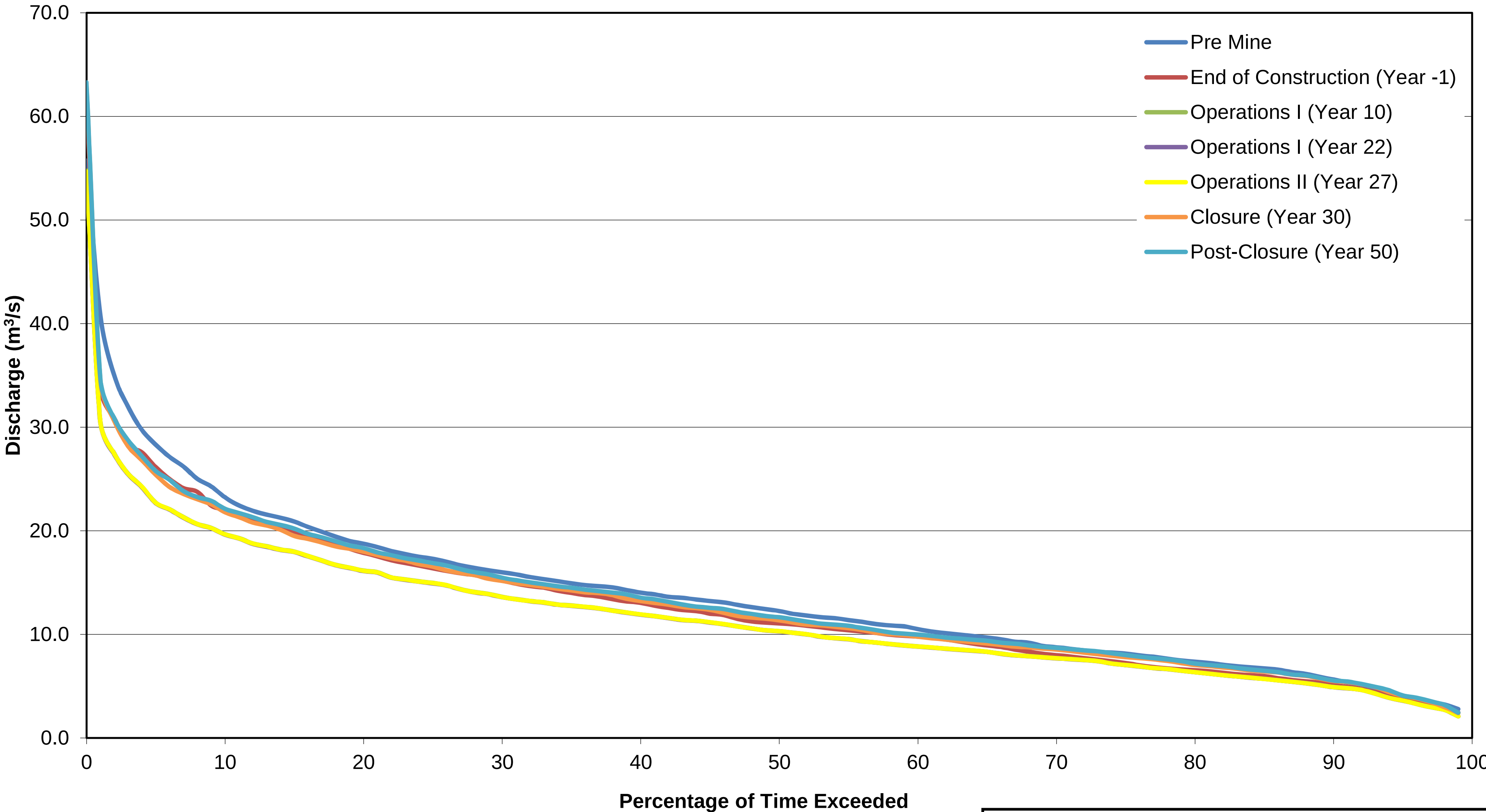
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-112

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

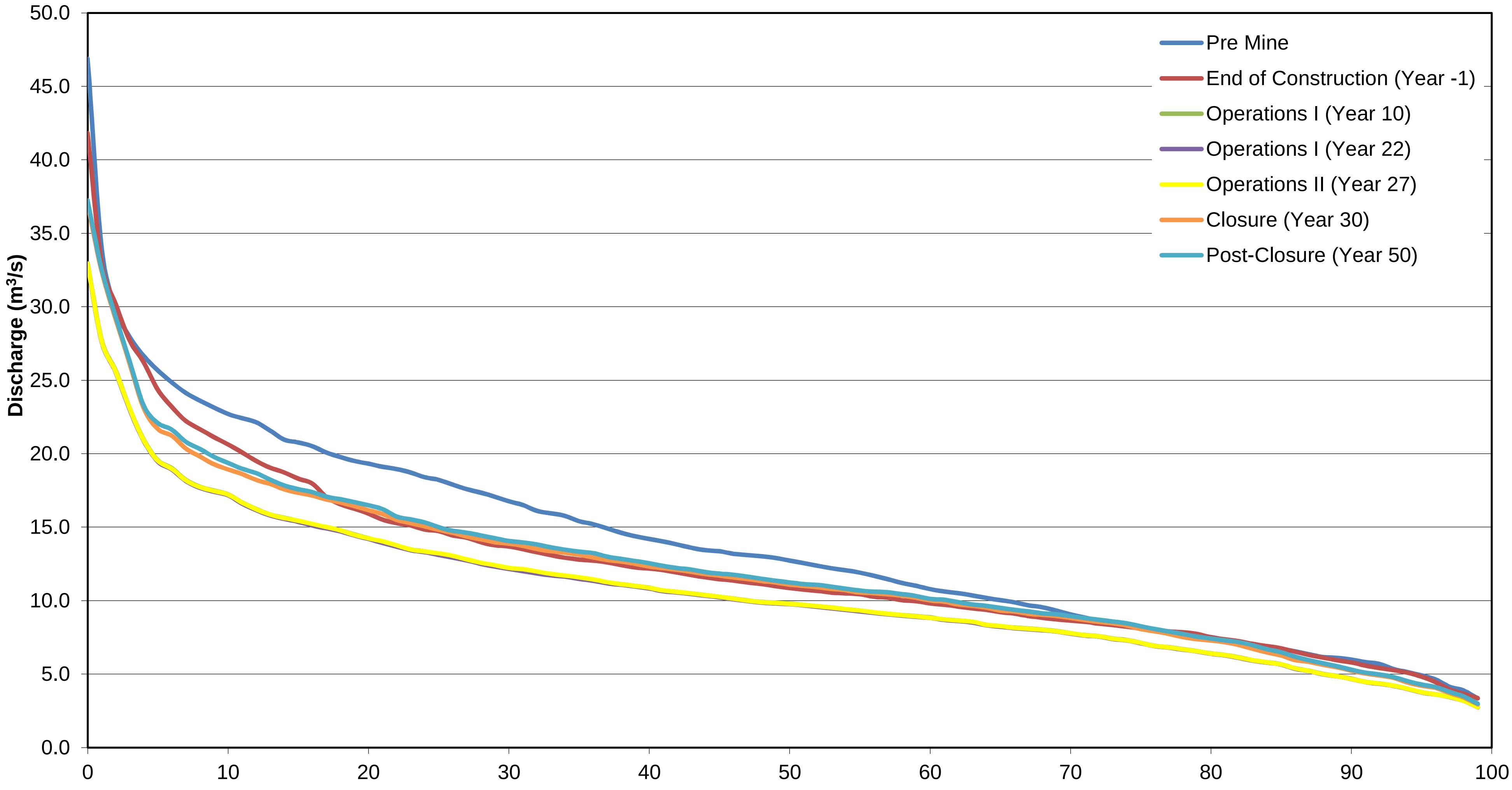
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-113

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

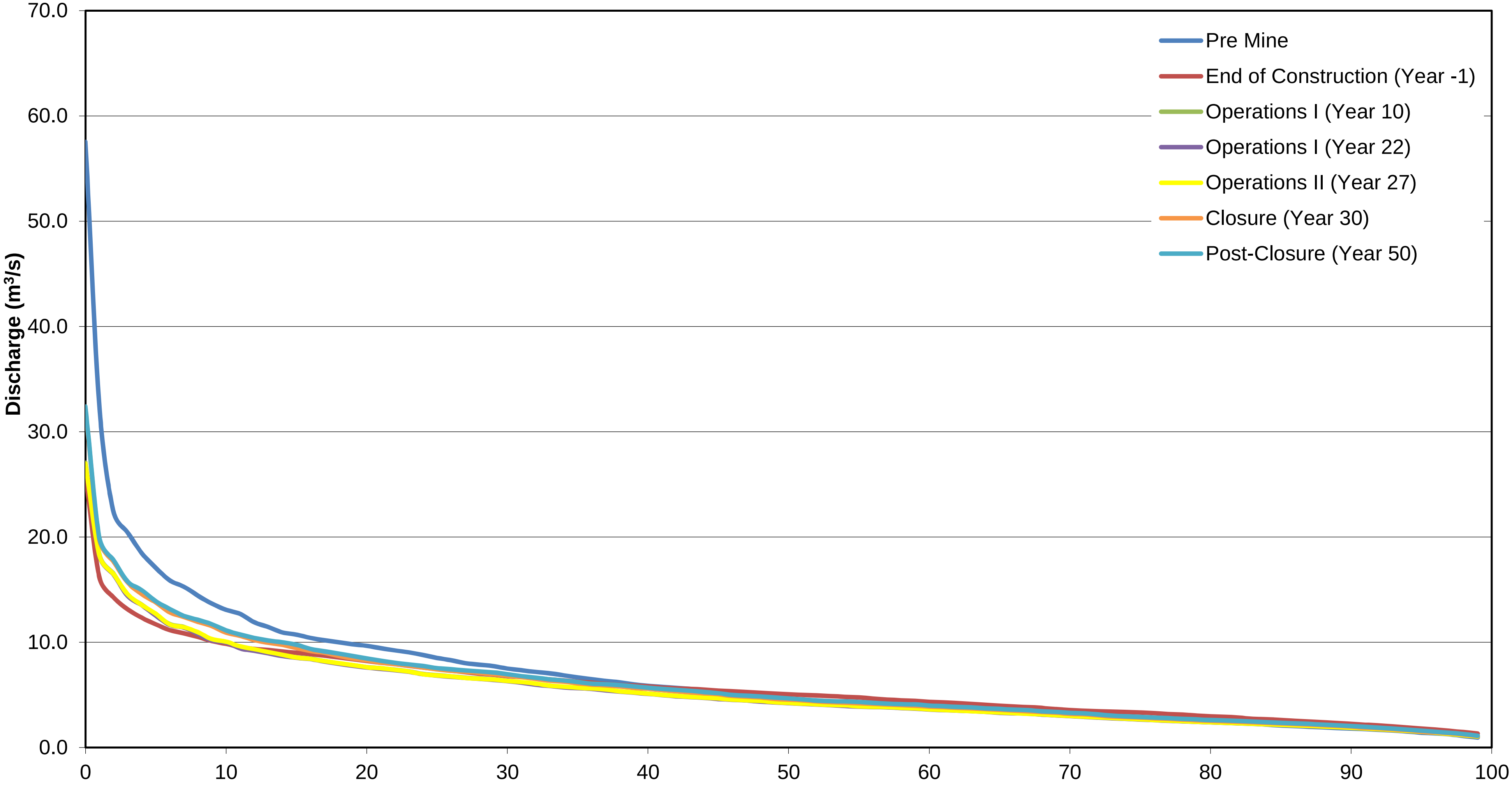
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-114

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

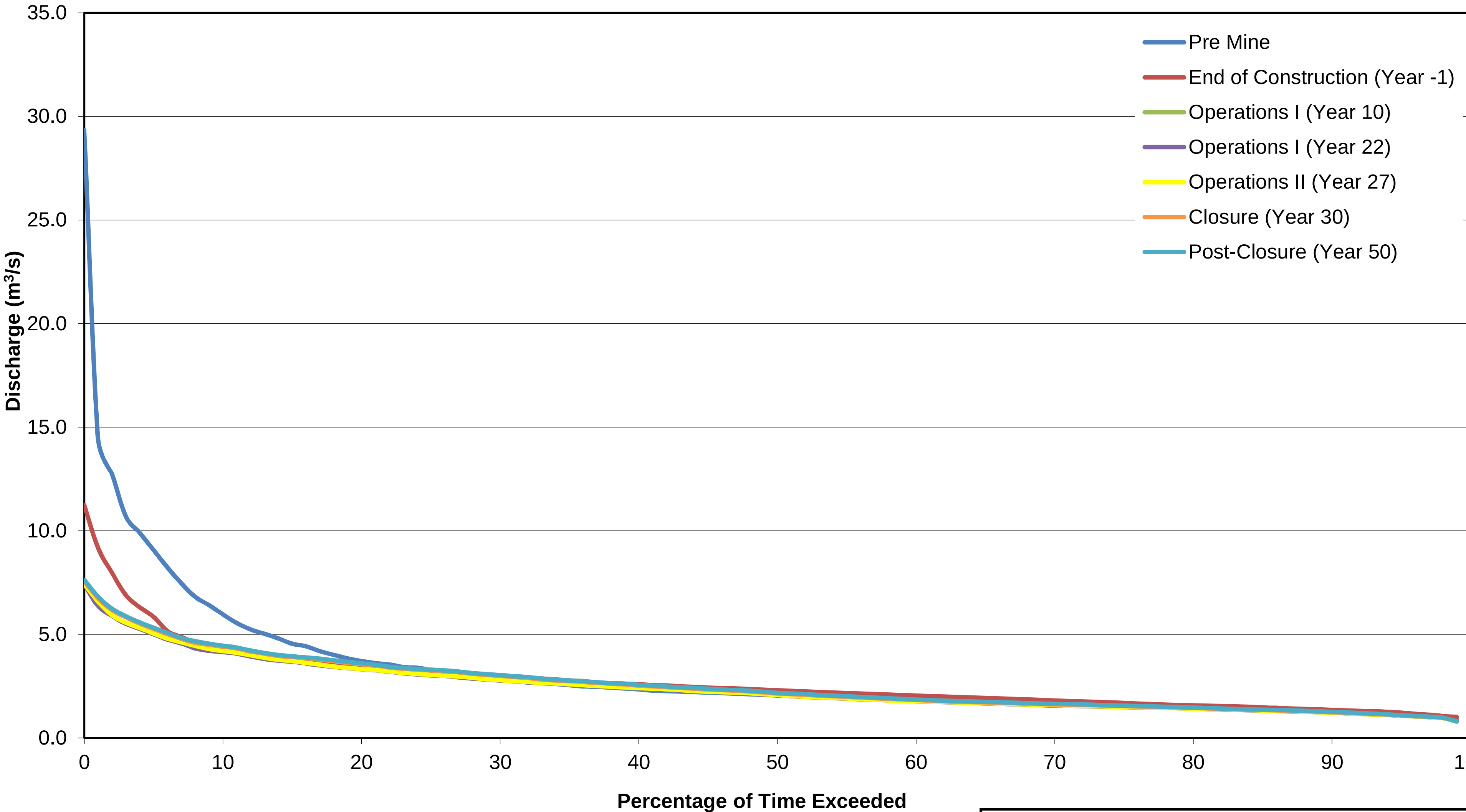
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-115

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

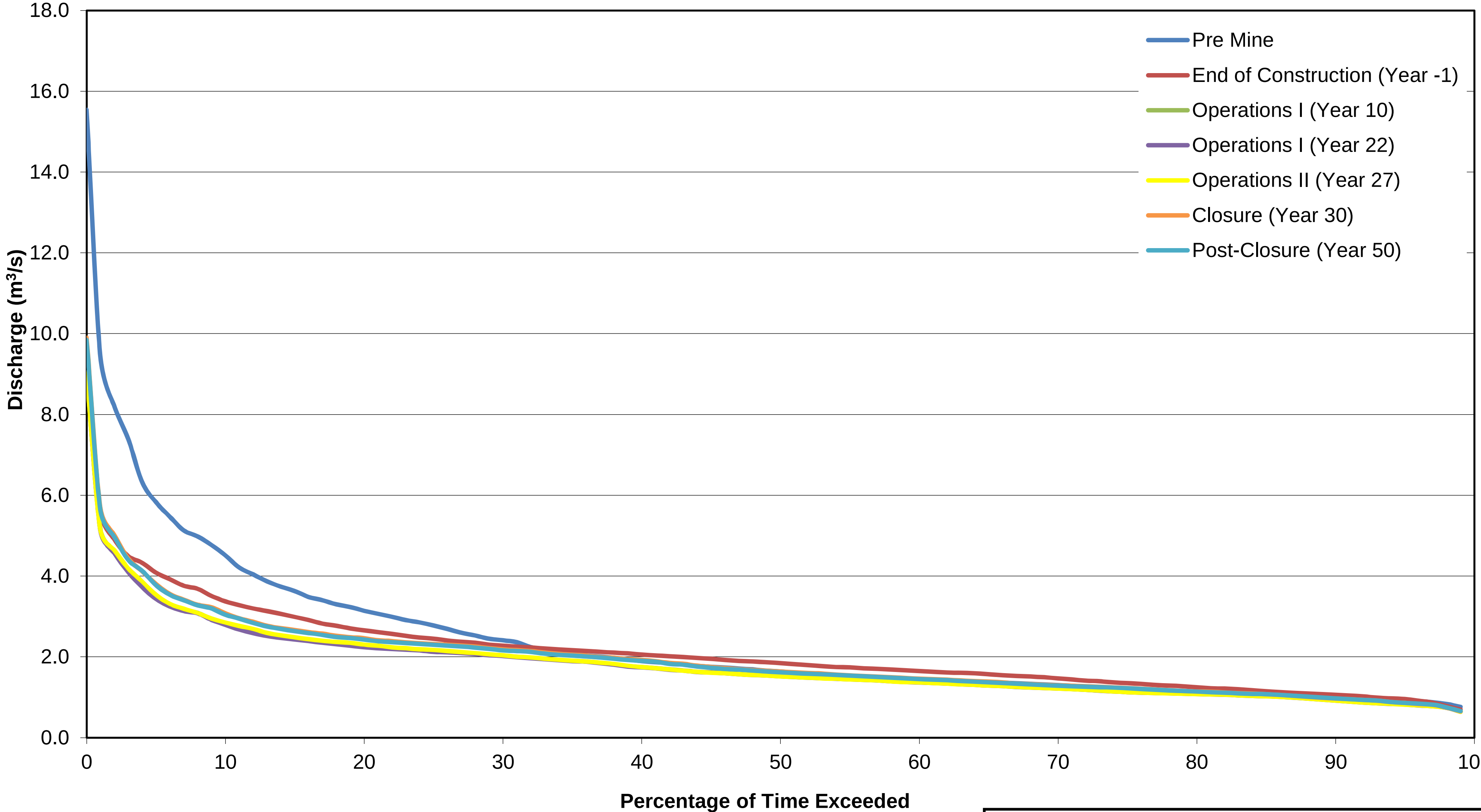
AUGUST FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-116 REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

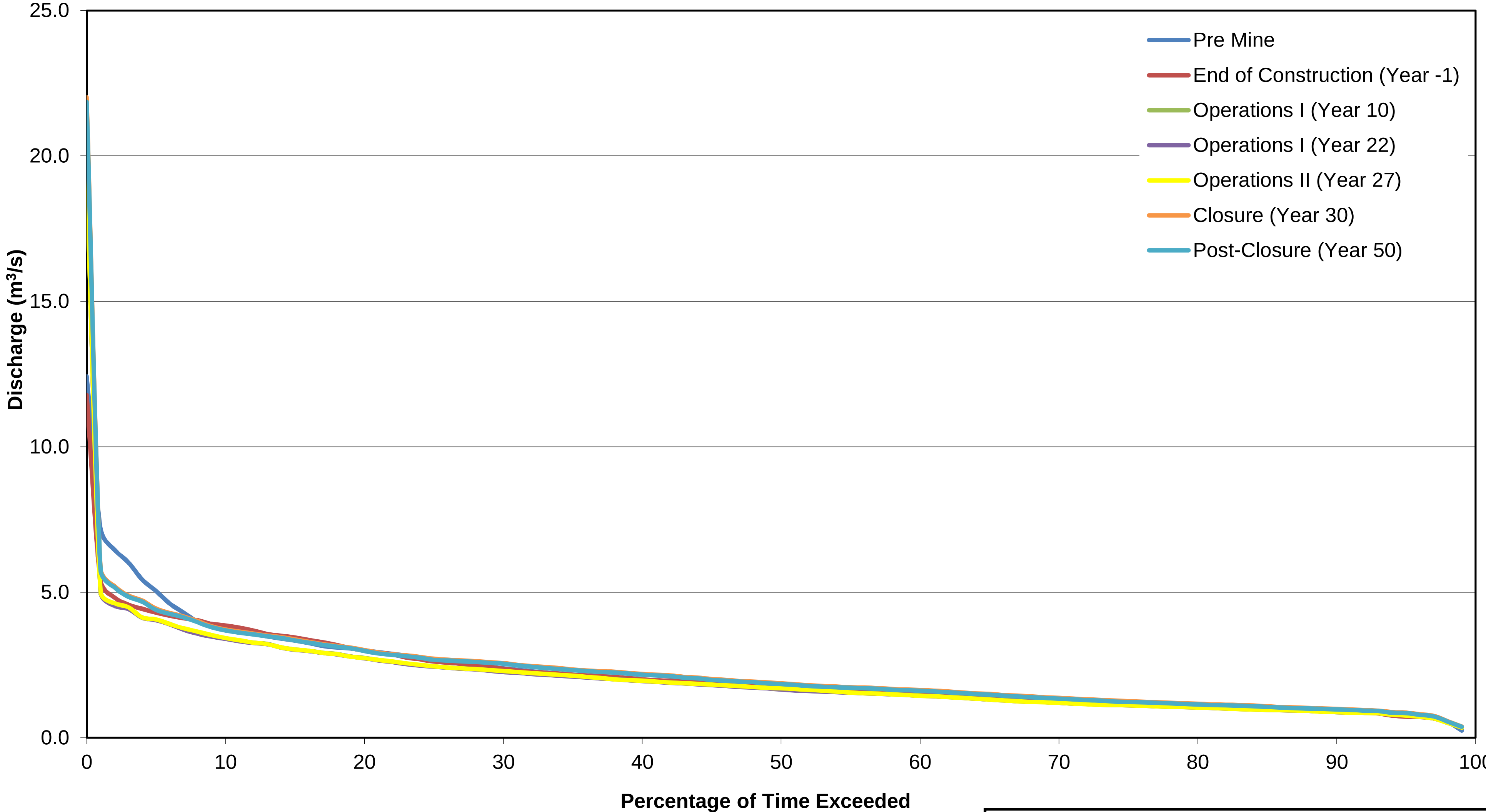
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-117

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

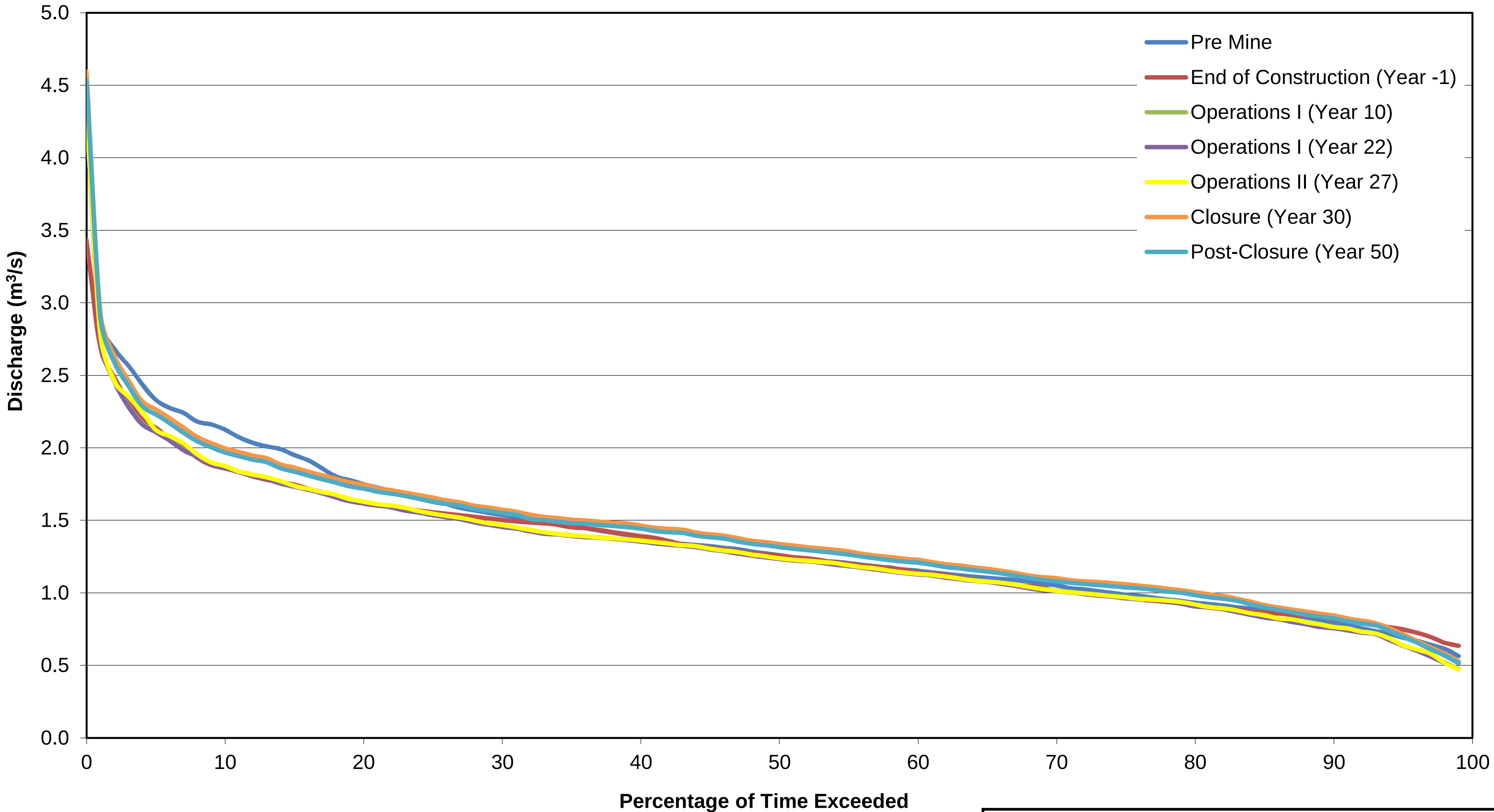
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-118

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

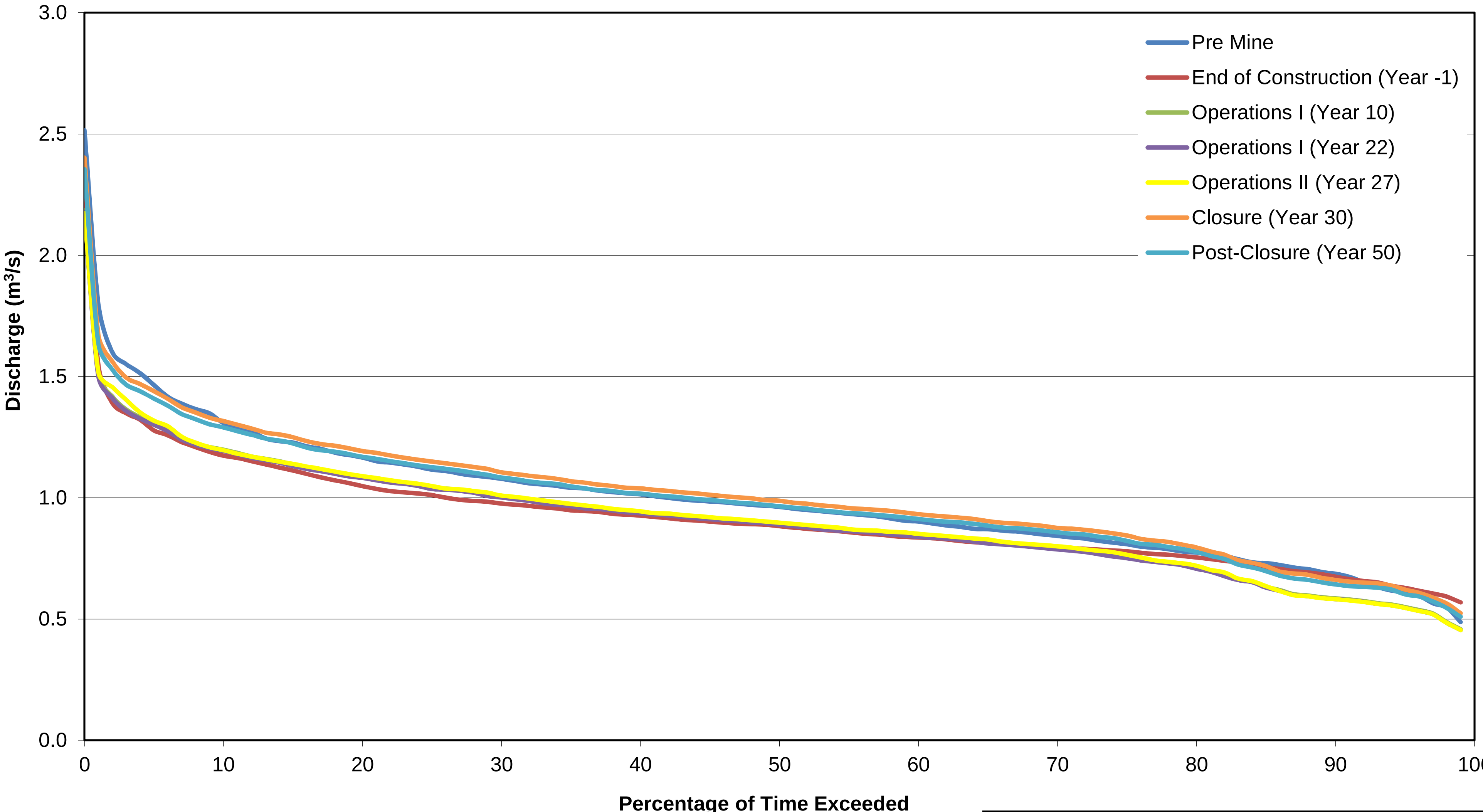
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-119

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

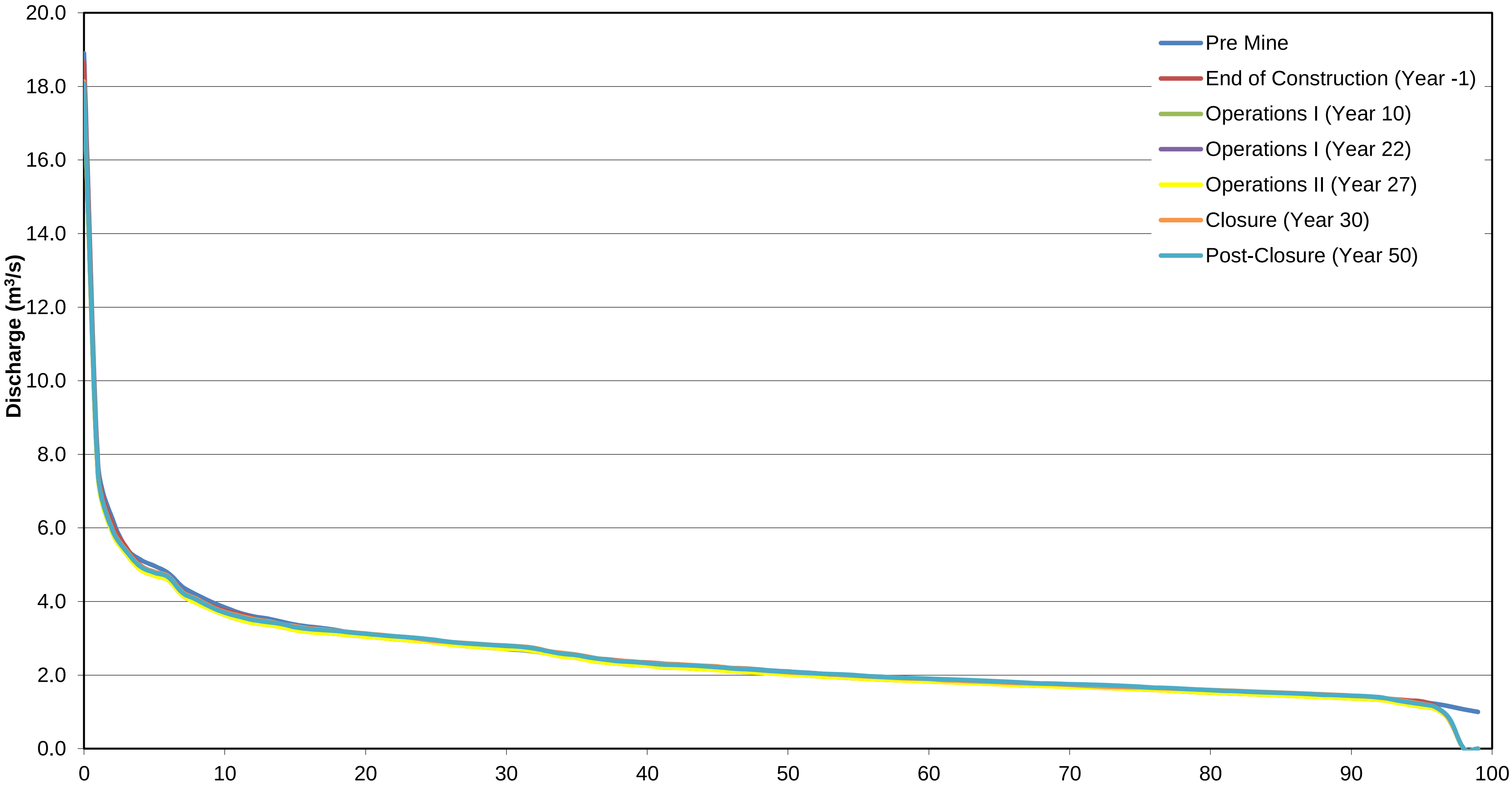
HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 10
HARPER CREEK AT BARRIERE RIVER CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-120	REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

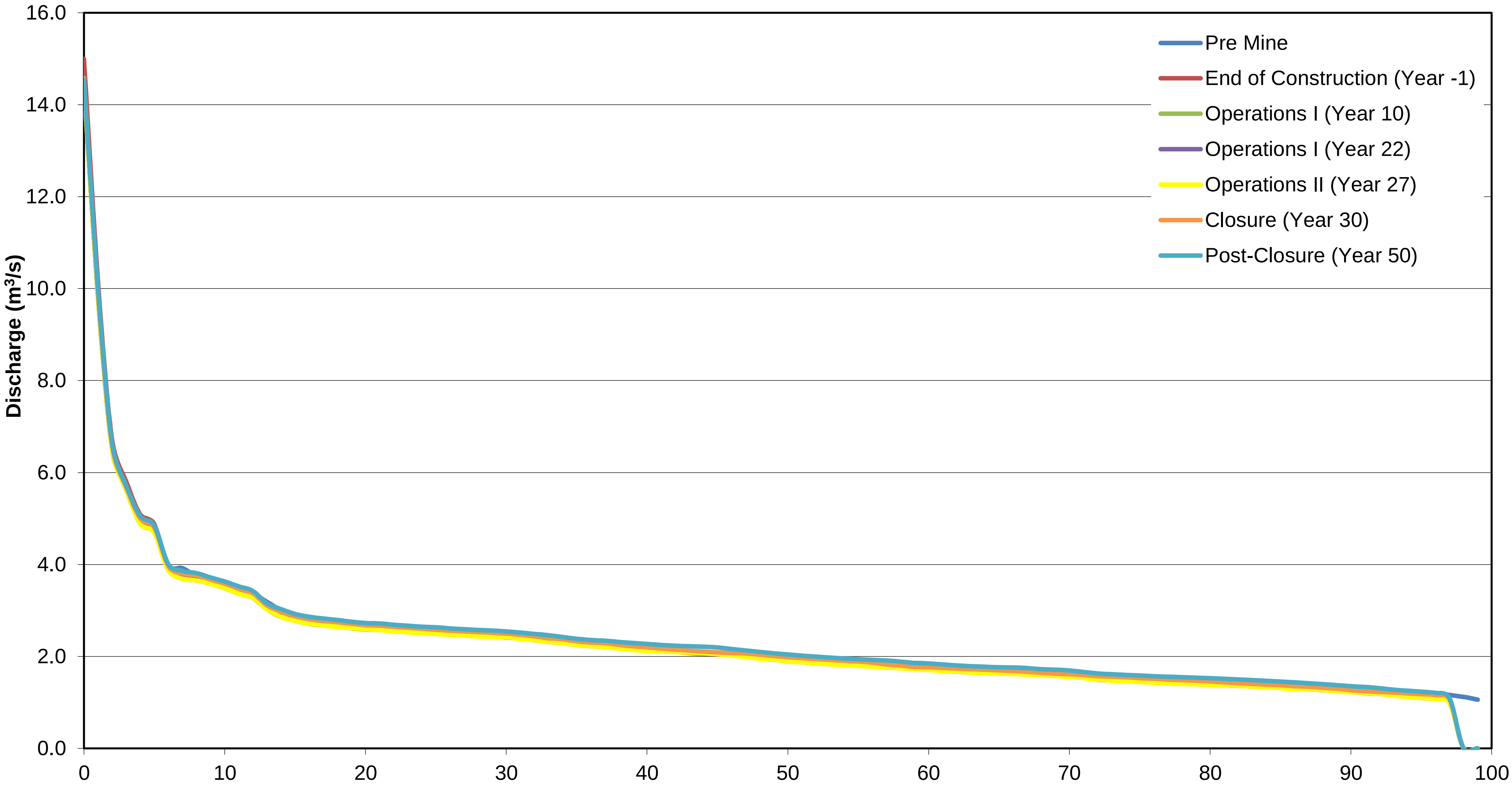
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-121

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

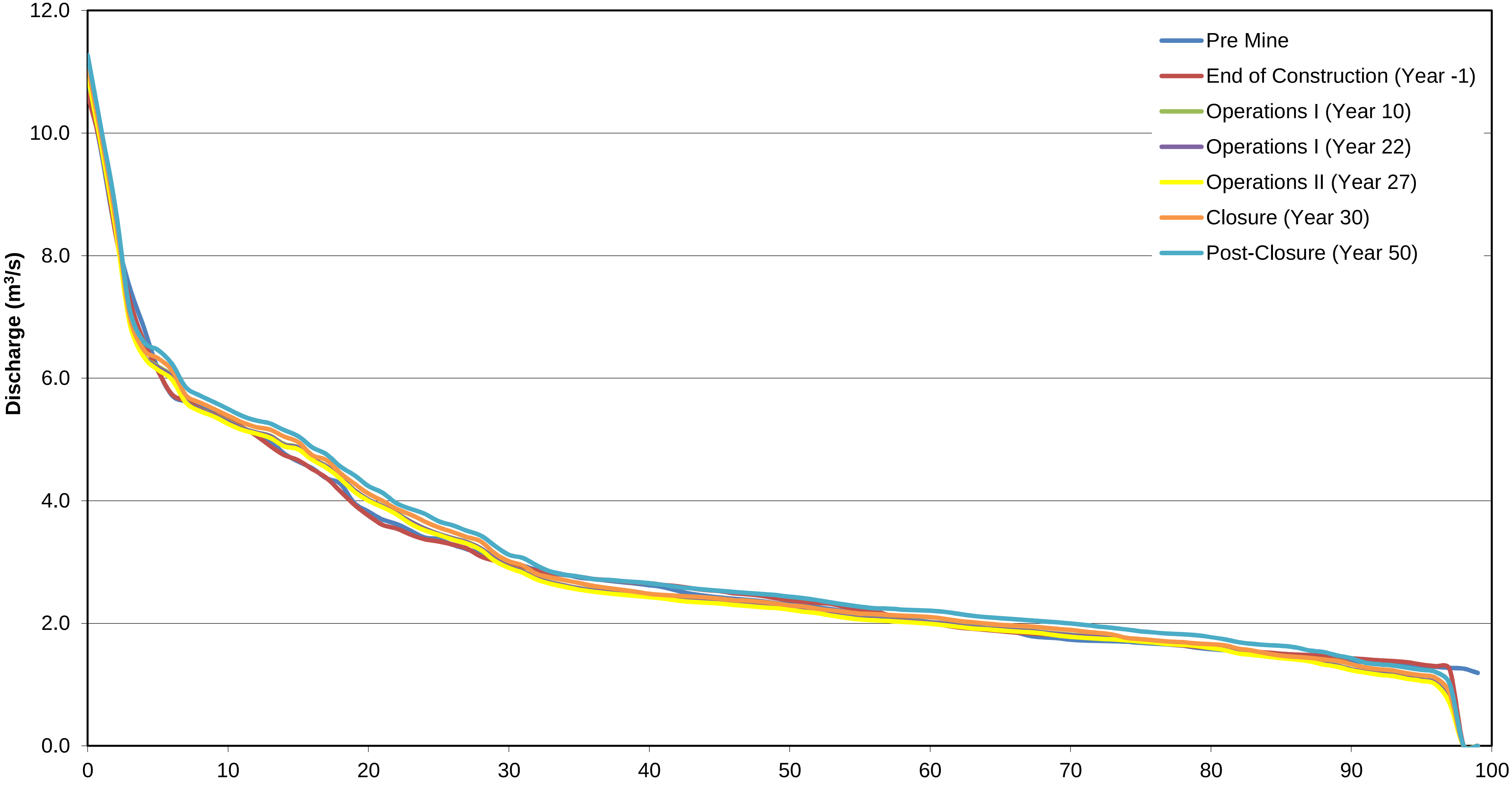
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-122

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

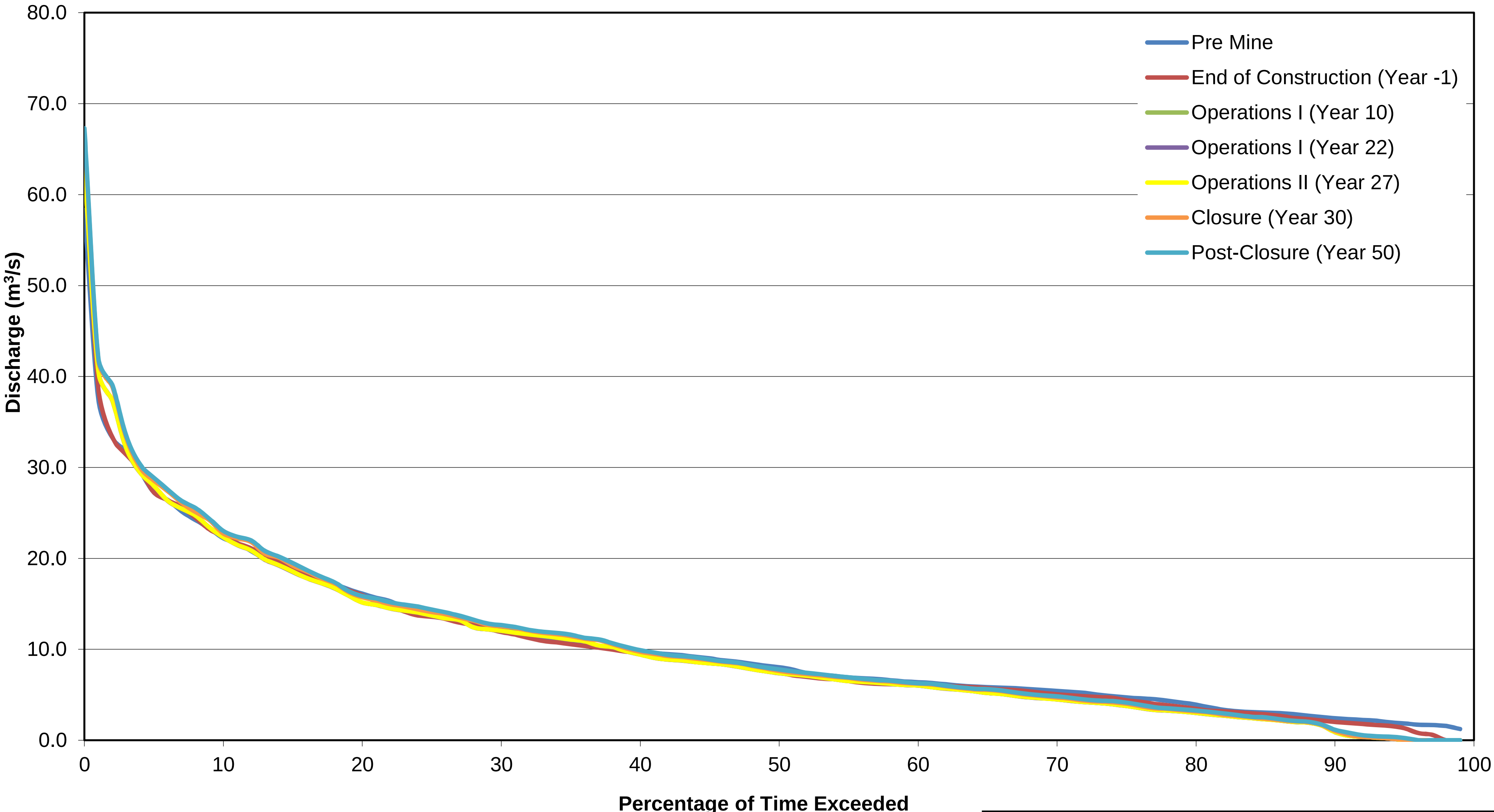
HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-123 REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

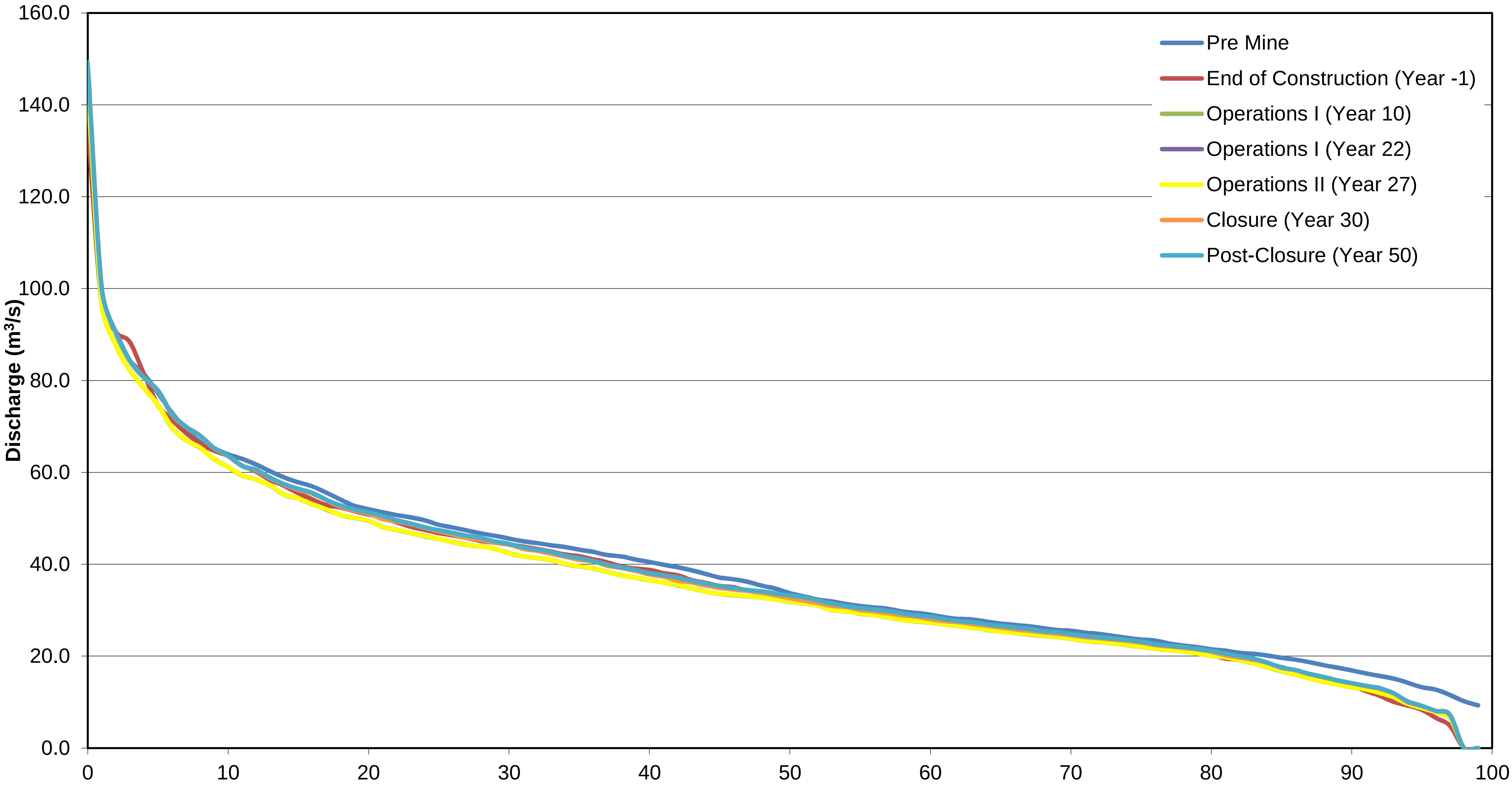
APRIL FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-124 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

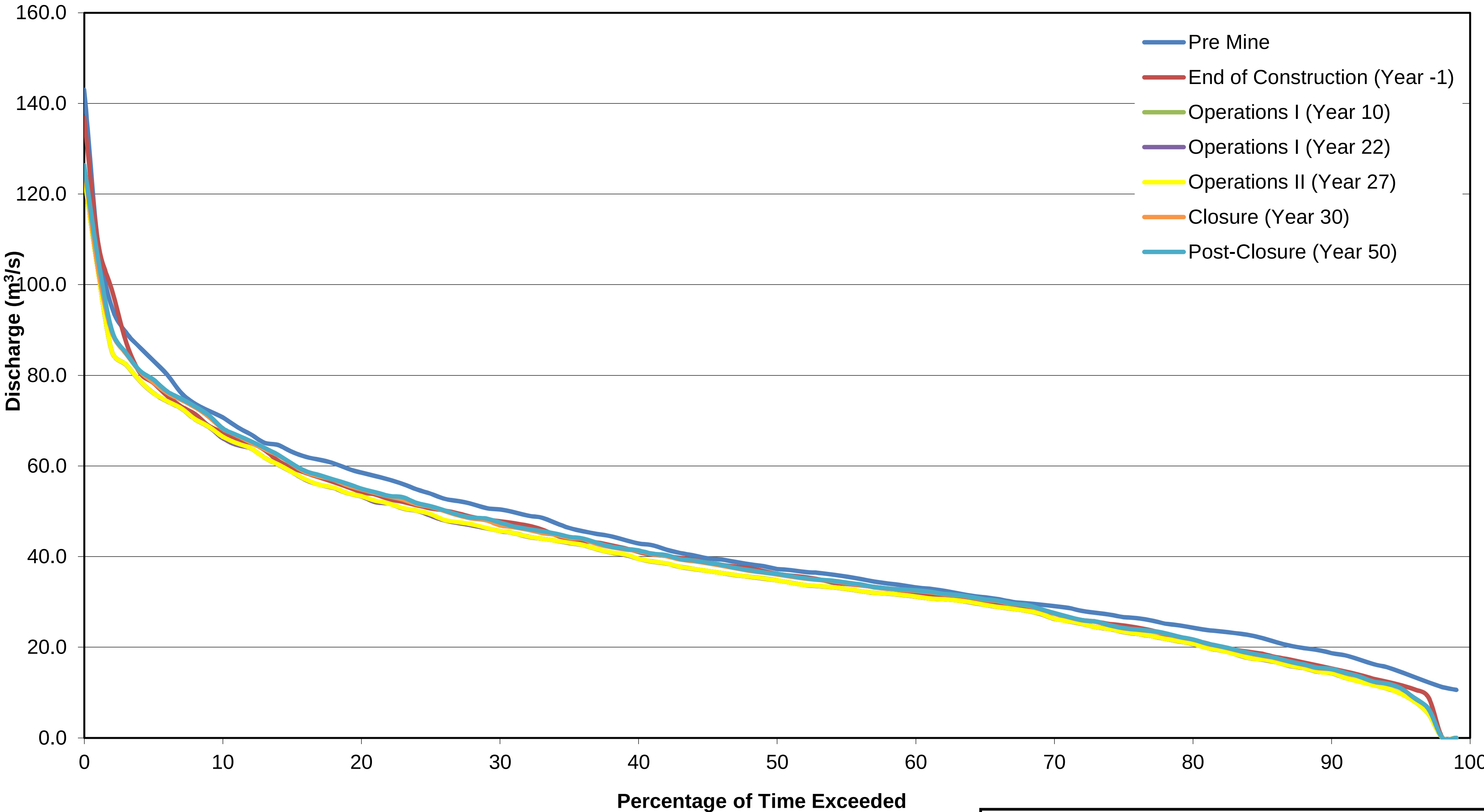
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-125

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

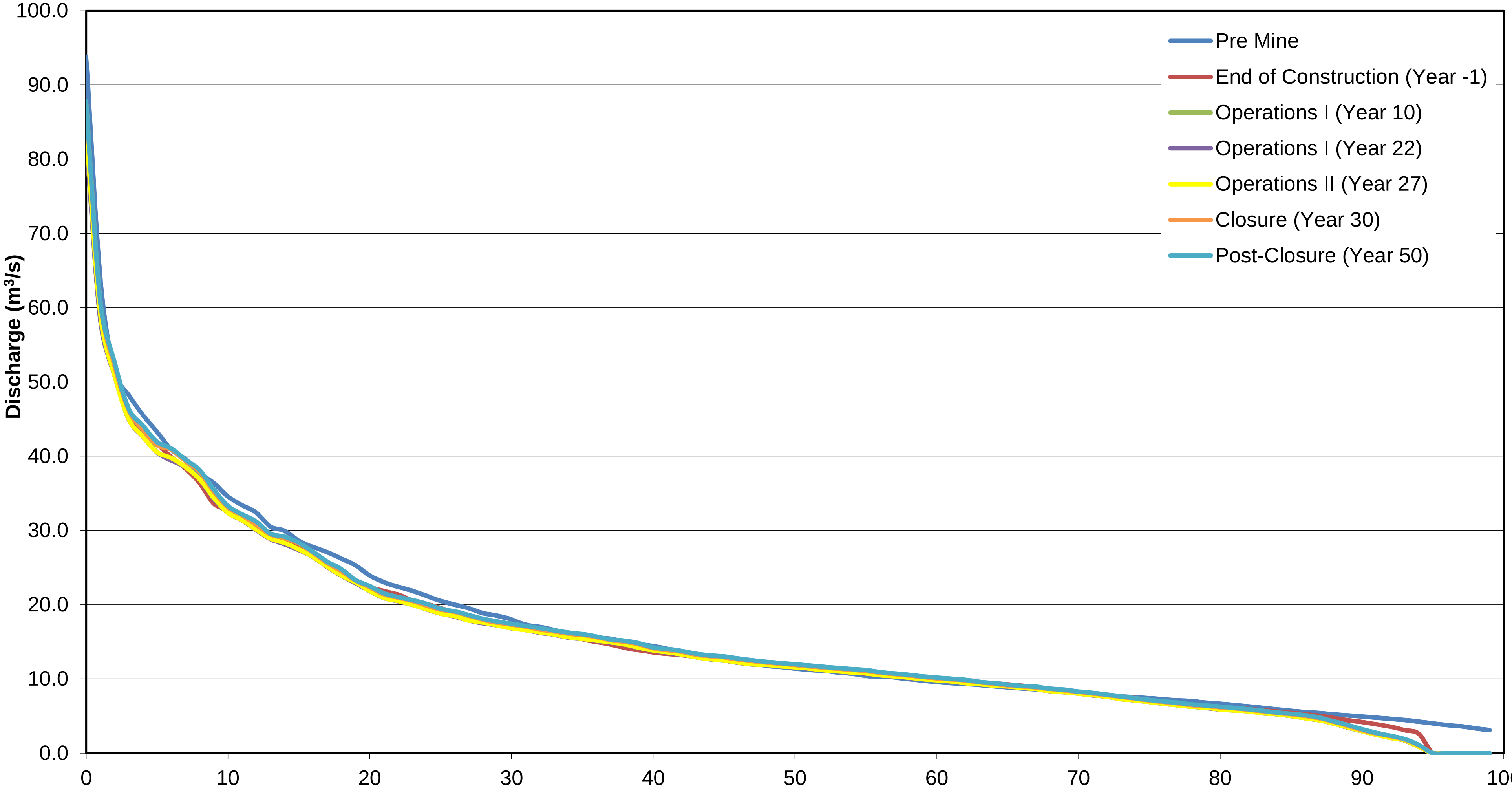
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-126

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

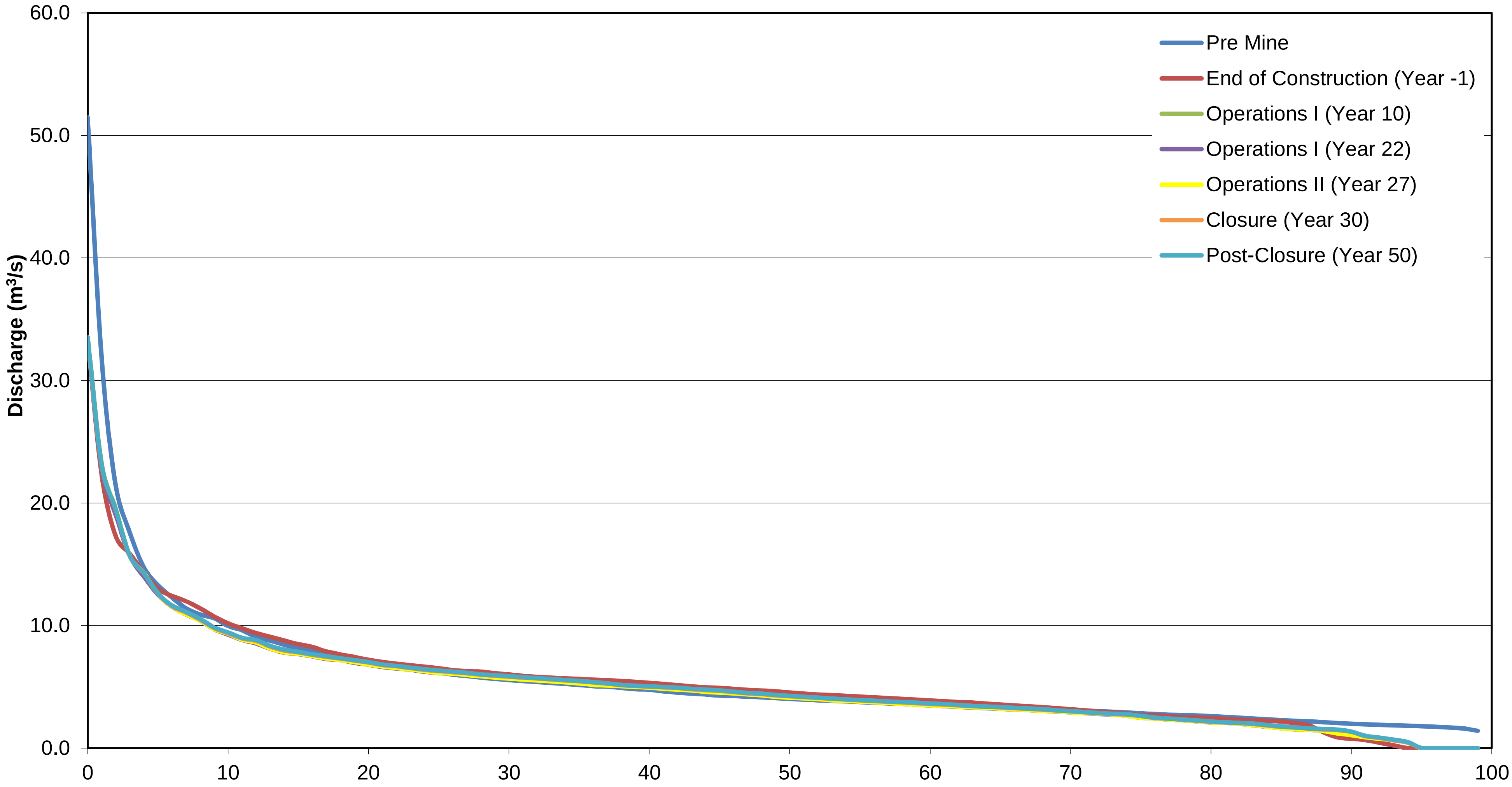
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-127

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

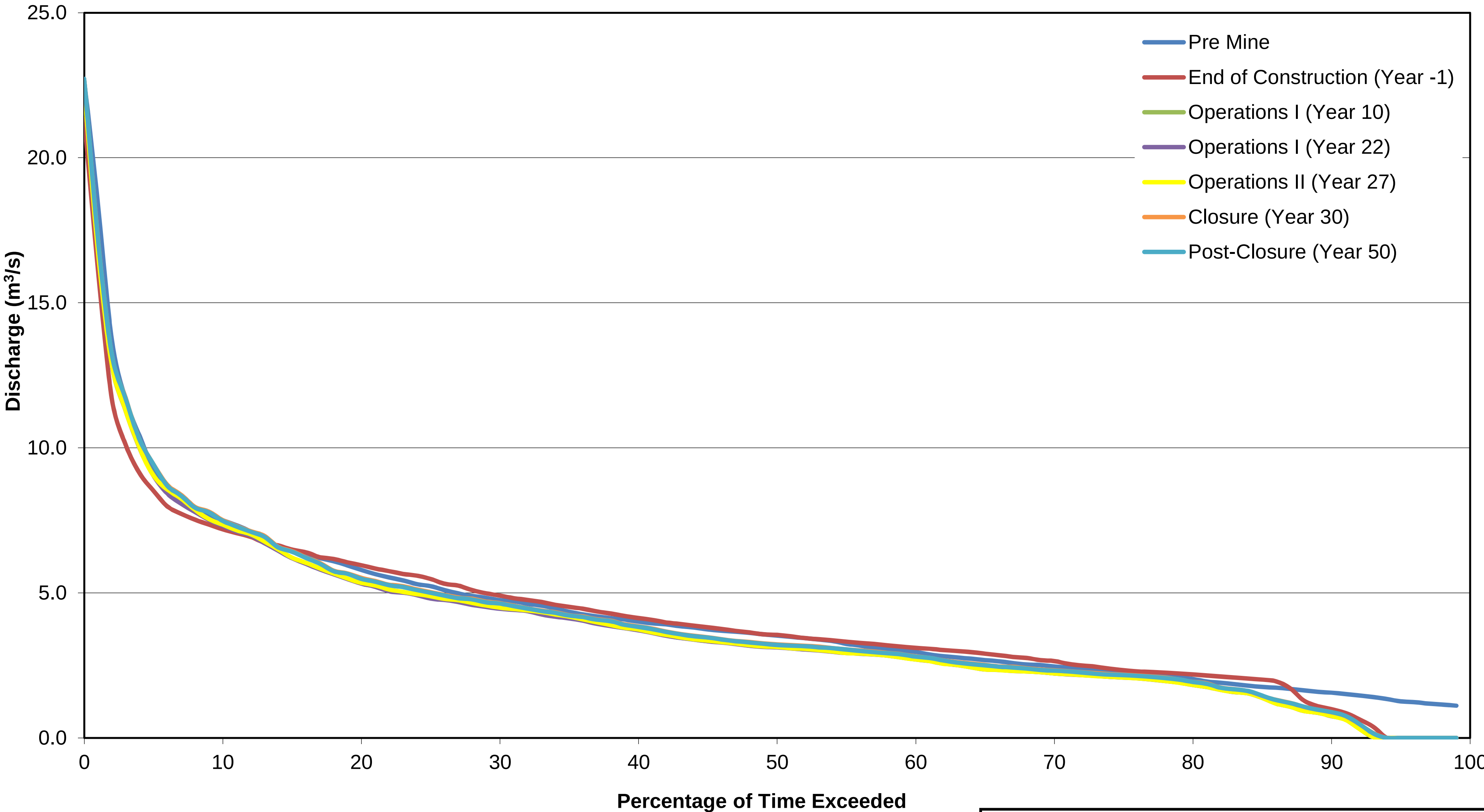
AUGUST FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-128 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

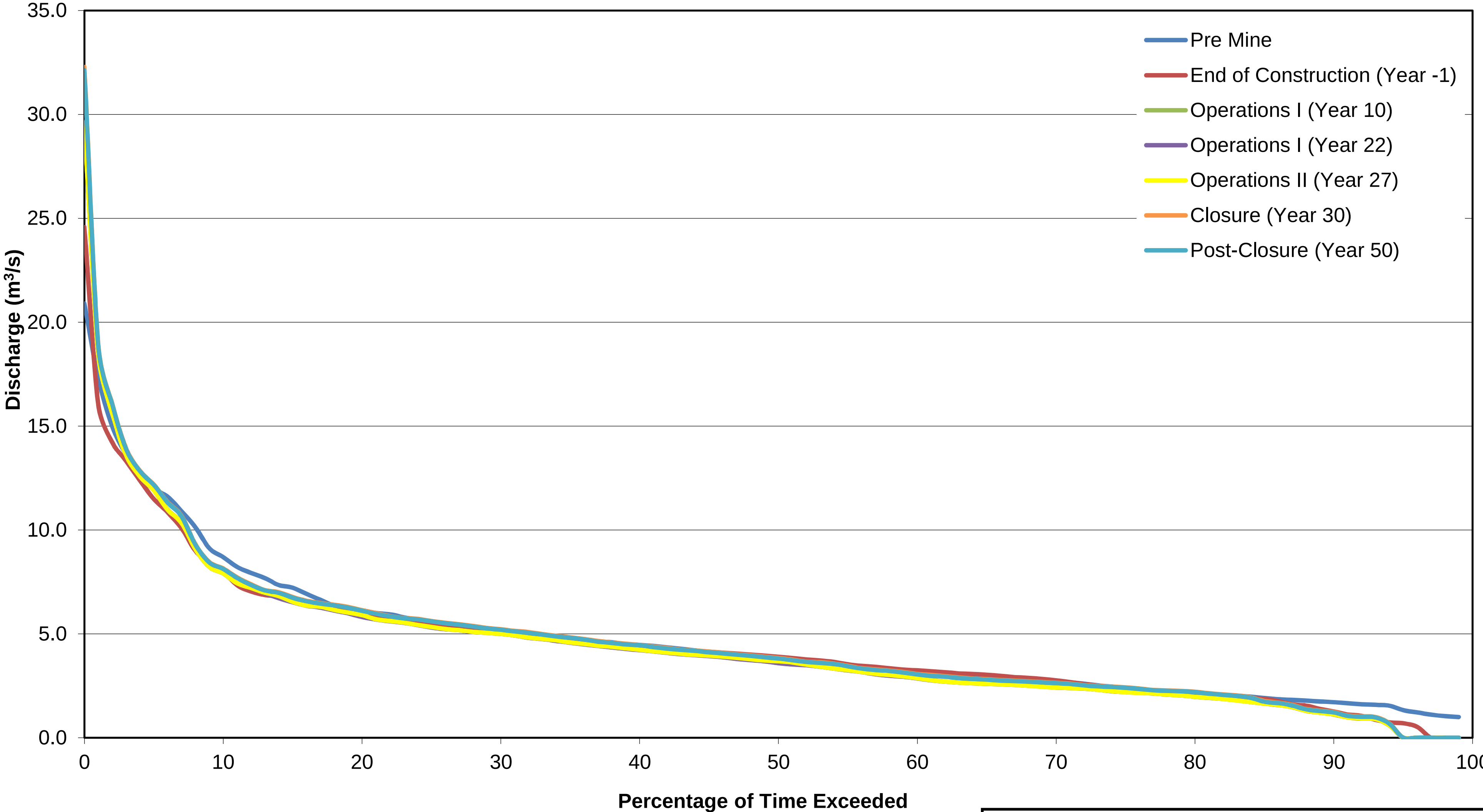
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-129		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

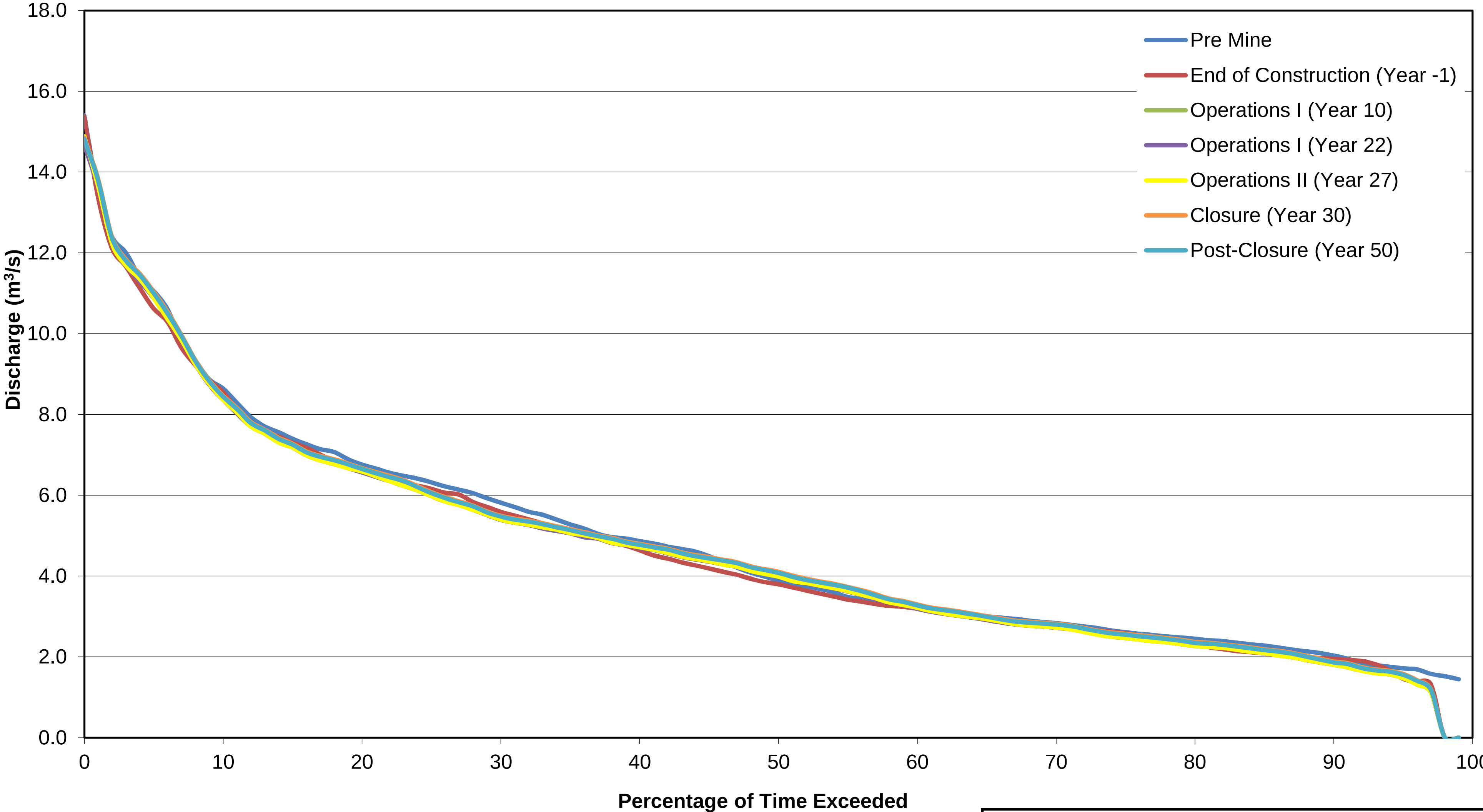
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-130

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

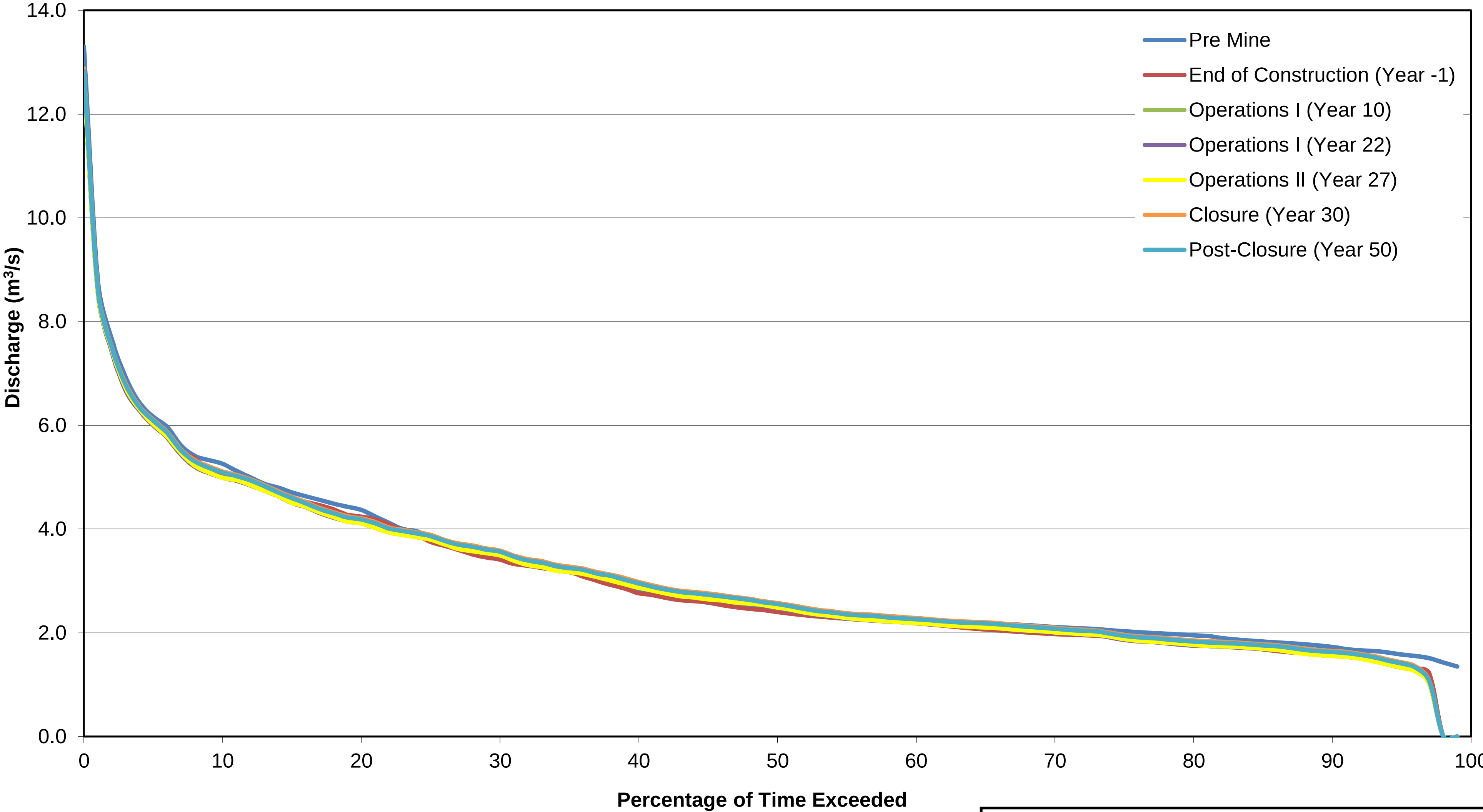
HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-131		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 11 BARRIERE RIVER BELOW SPRAGUE CREEK (WSC 08LB069)

Knight Piésold CONSULTING

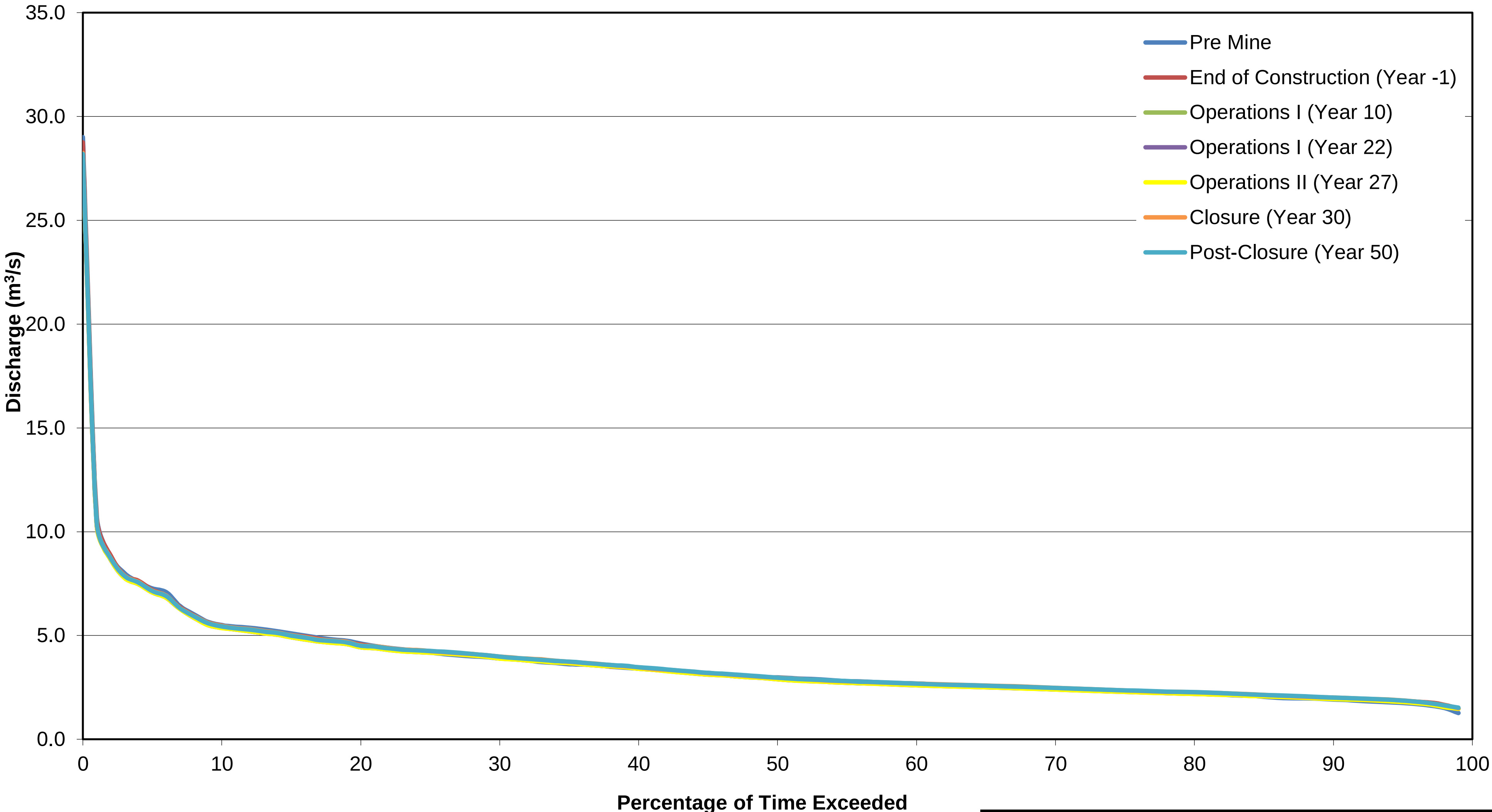
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-132

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

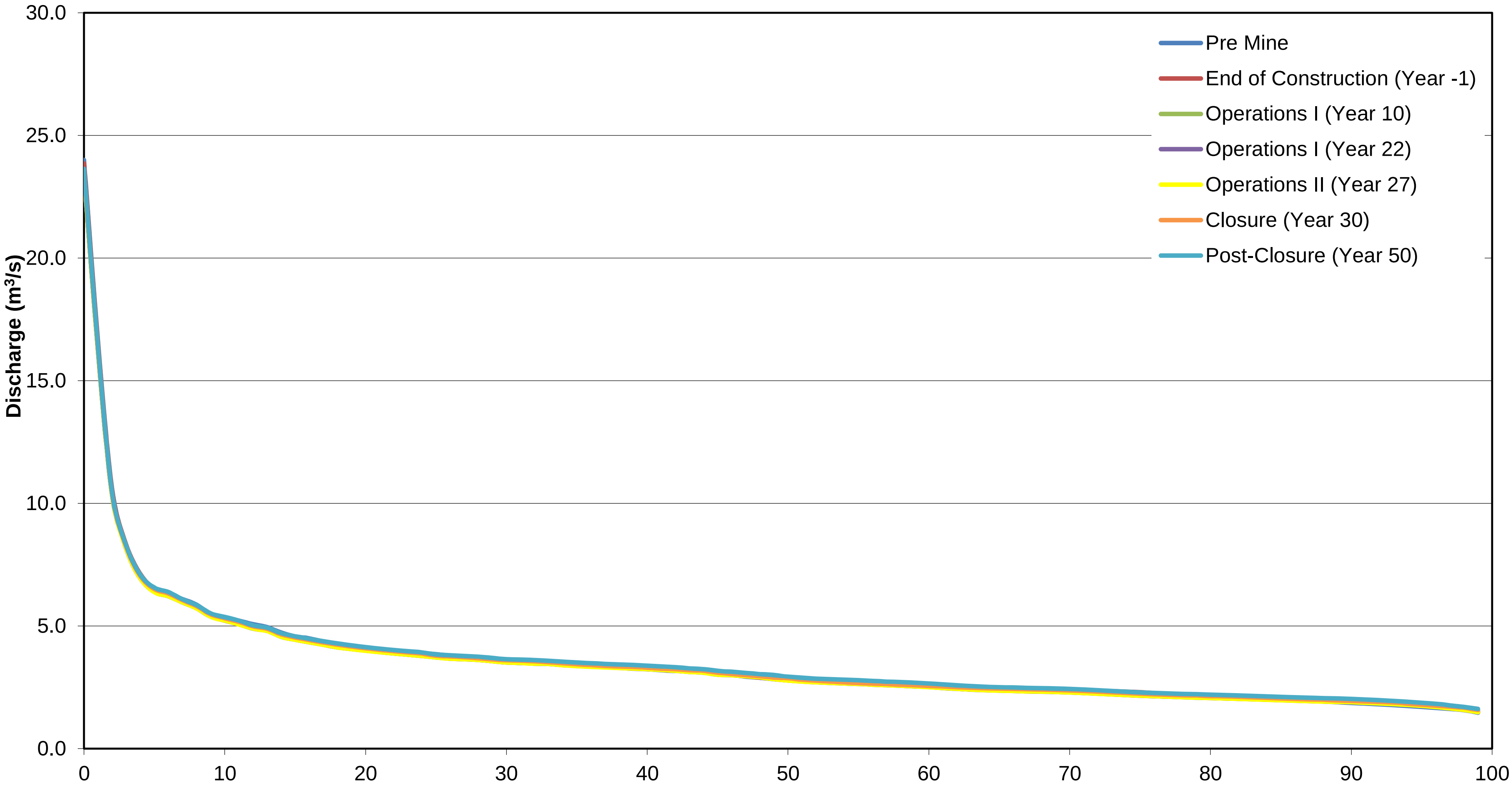
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-133

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

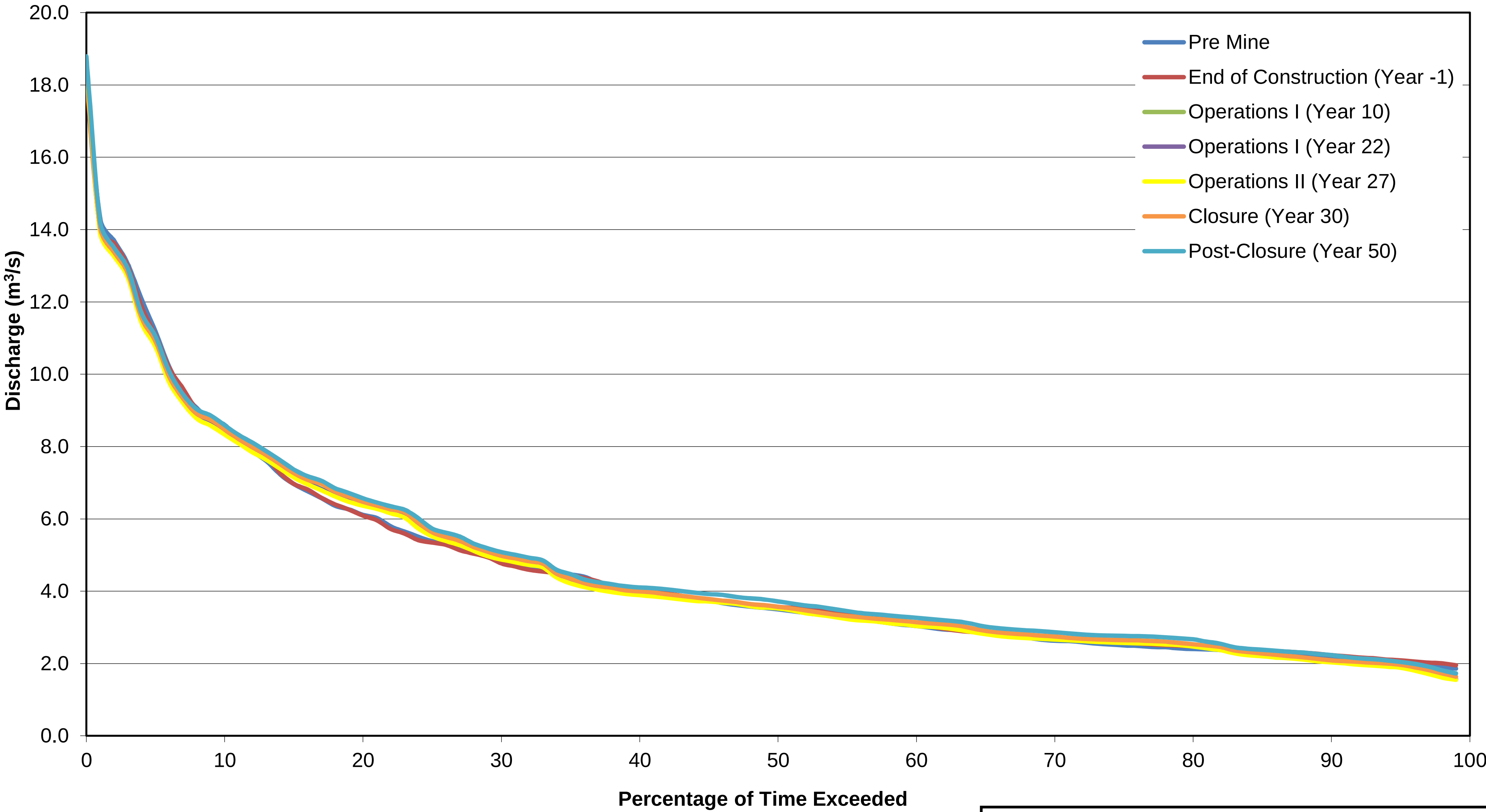
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-134

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

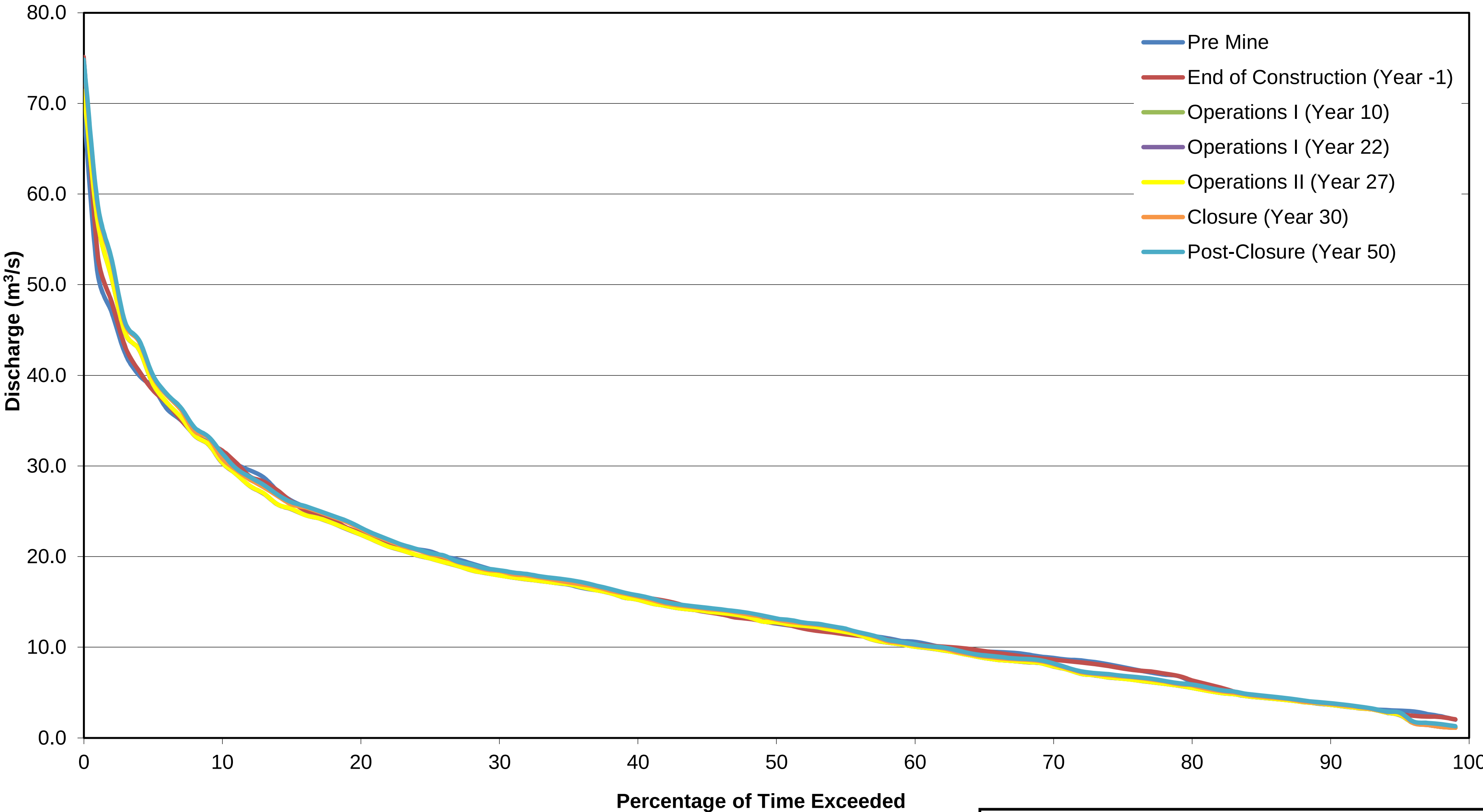
MARCH FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-458/15	3

FIGURE A4-135 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

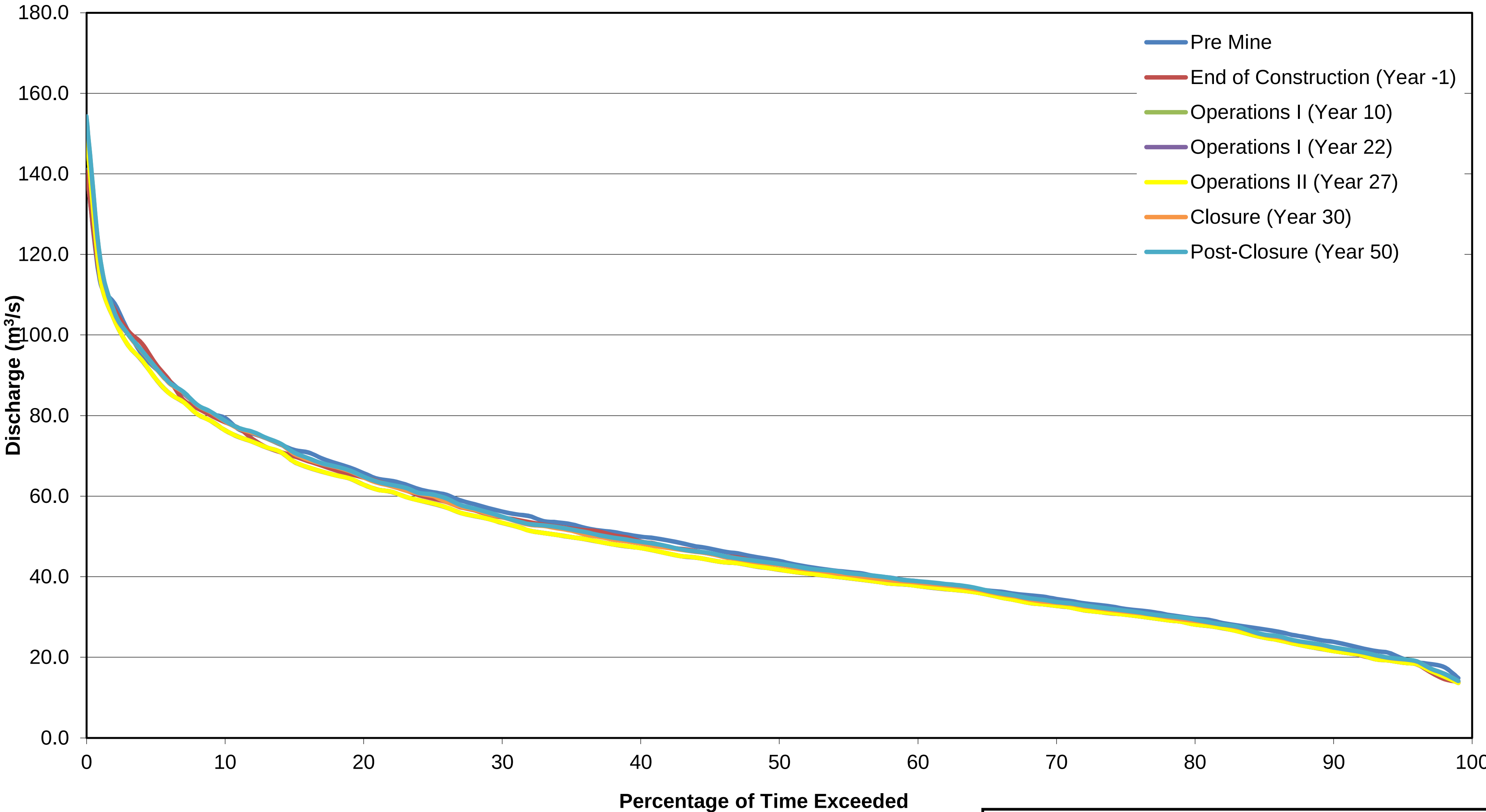
HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-136	REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

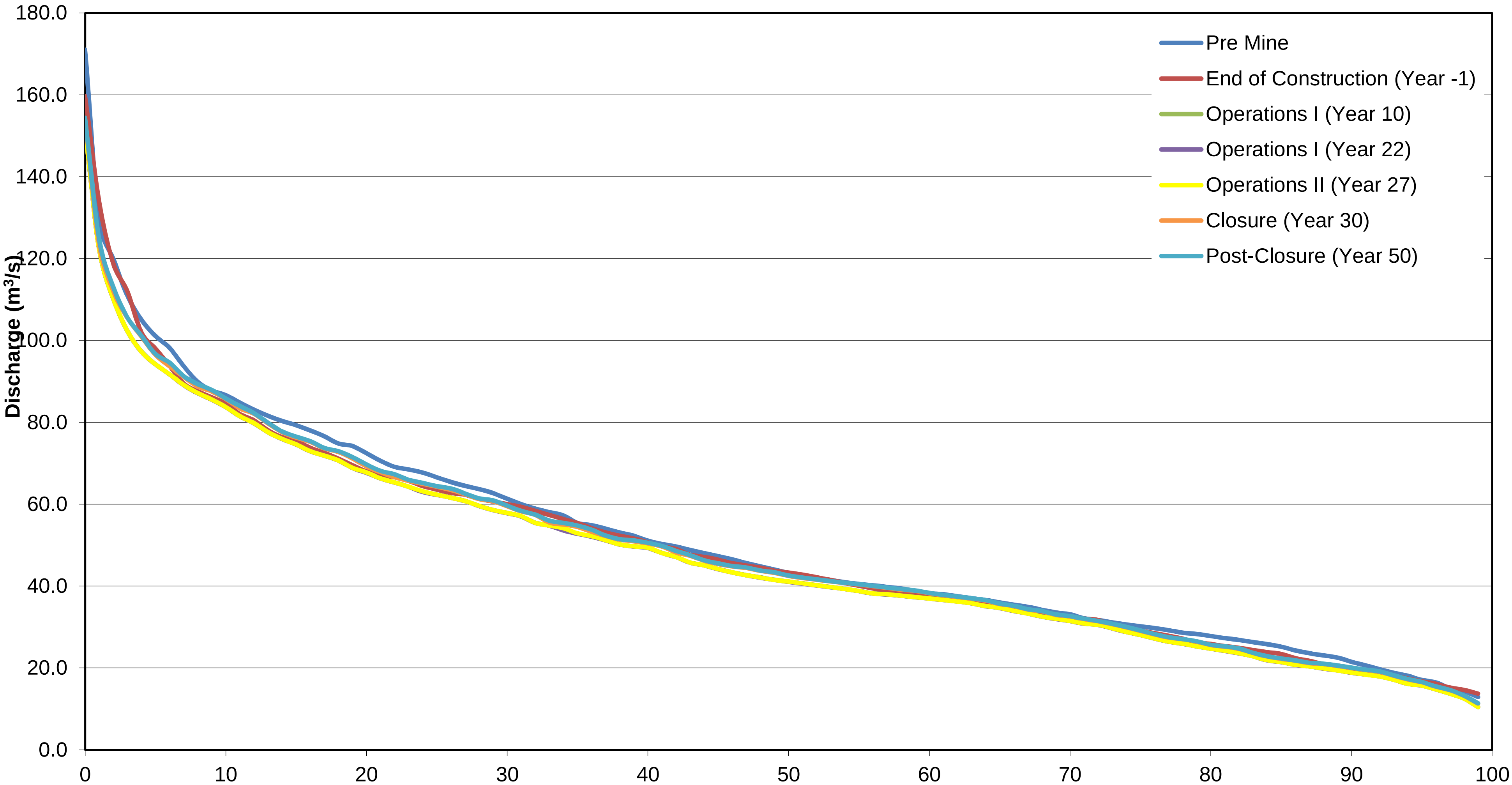
HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3
FIGURE A4-137	REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

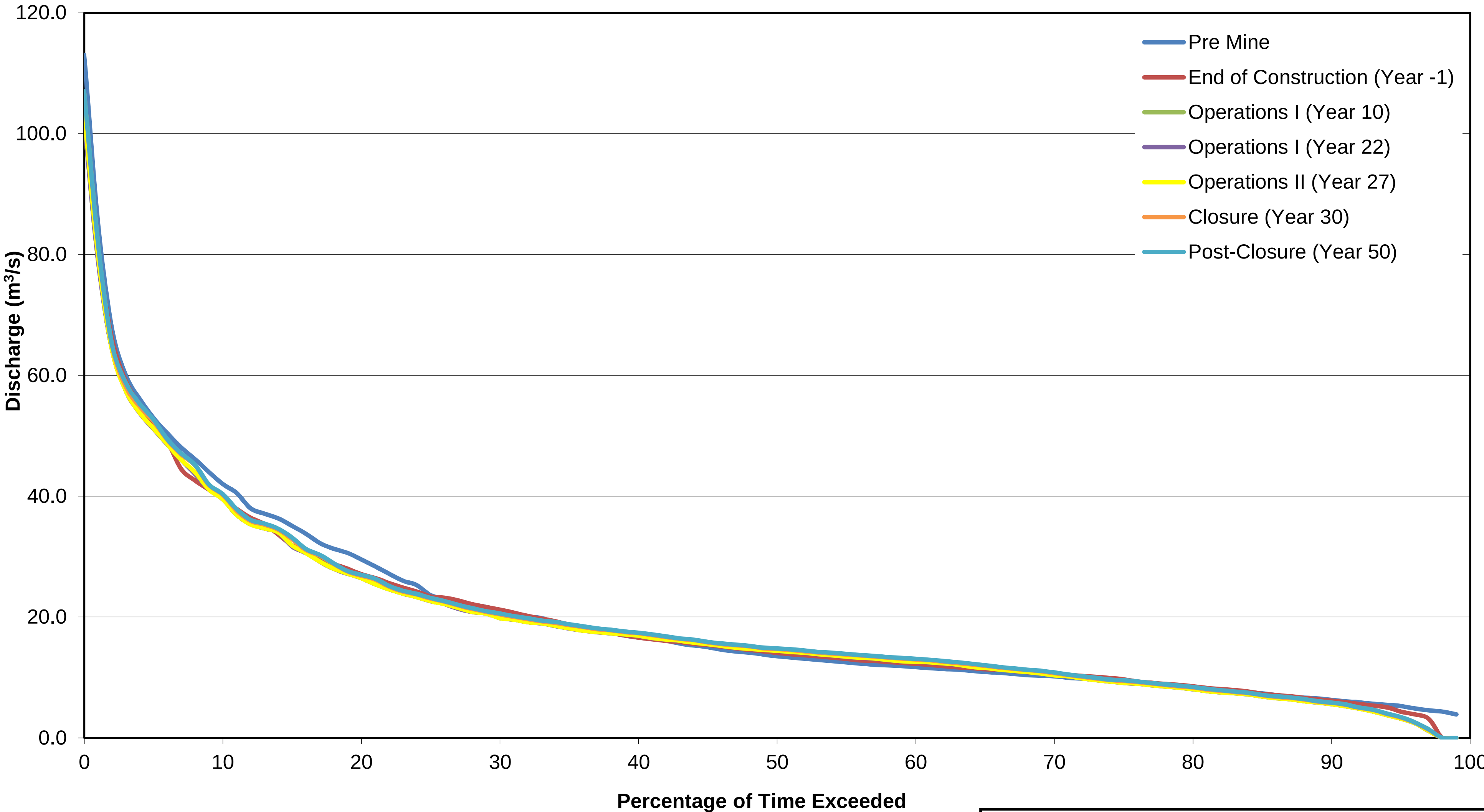
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-138

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

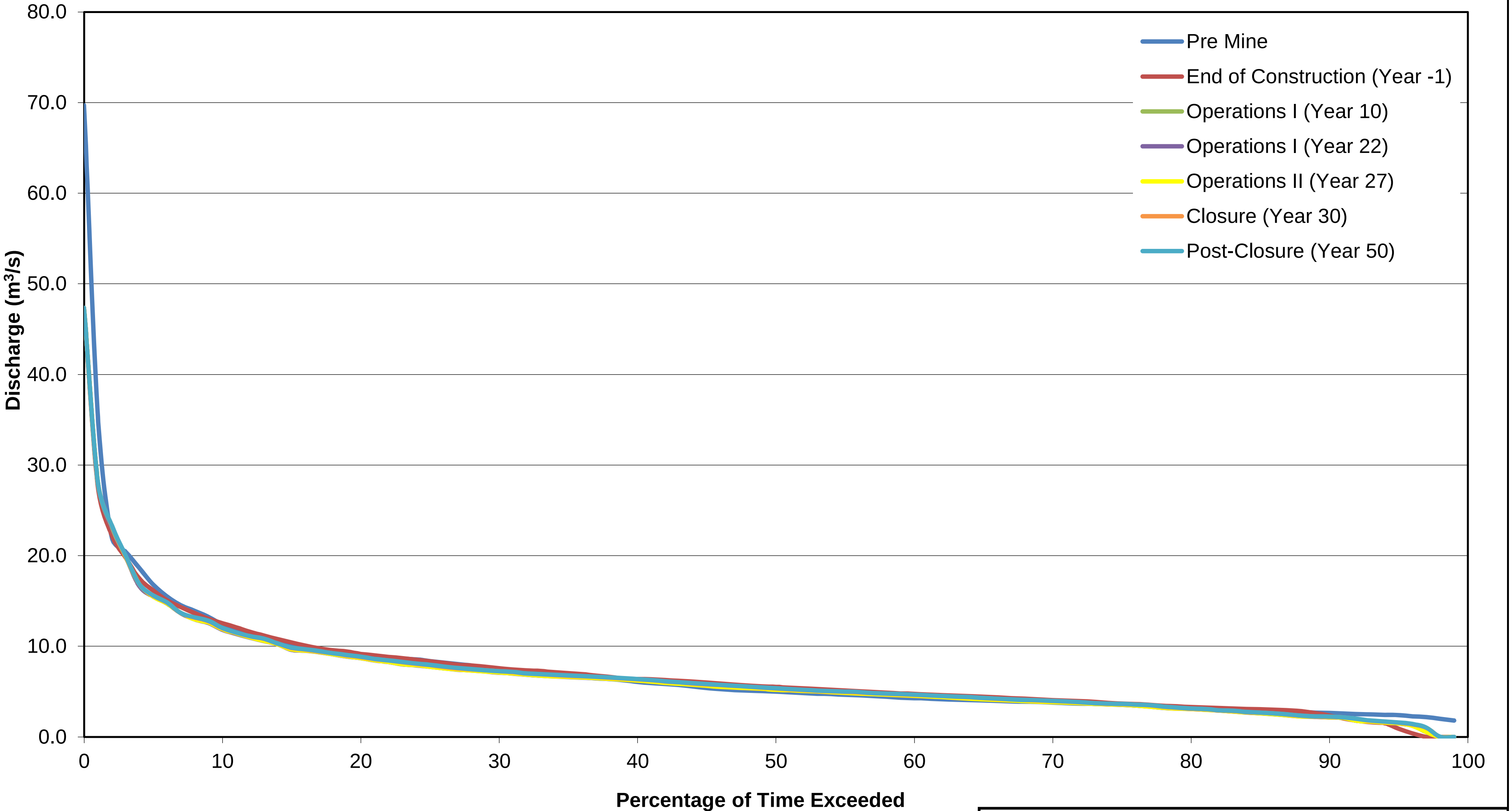
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-139

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

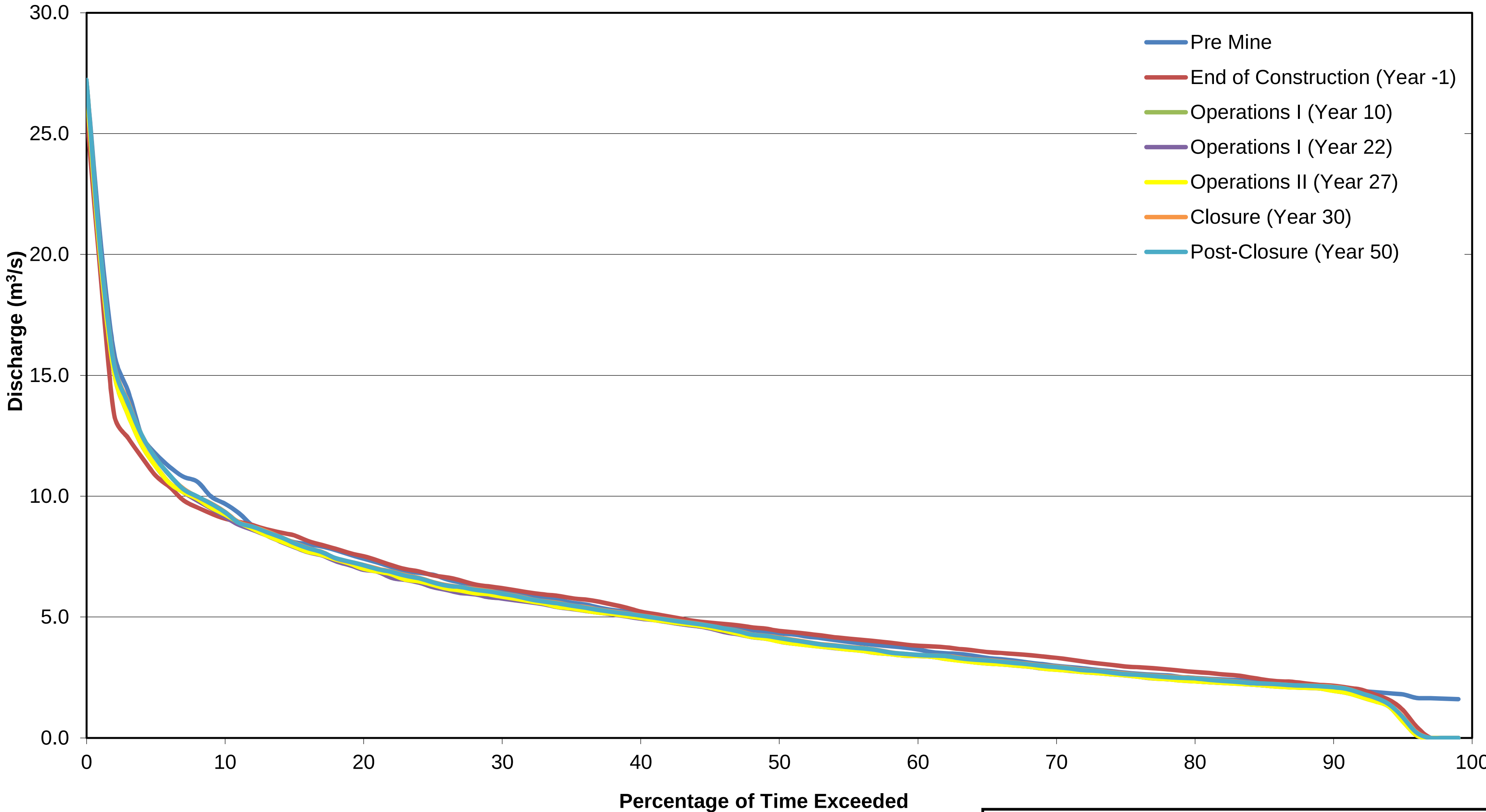
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-140

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

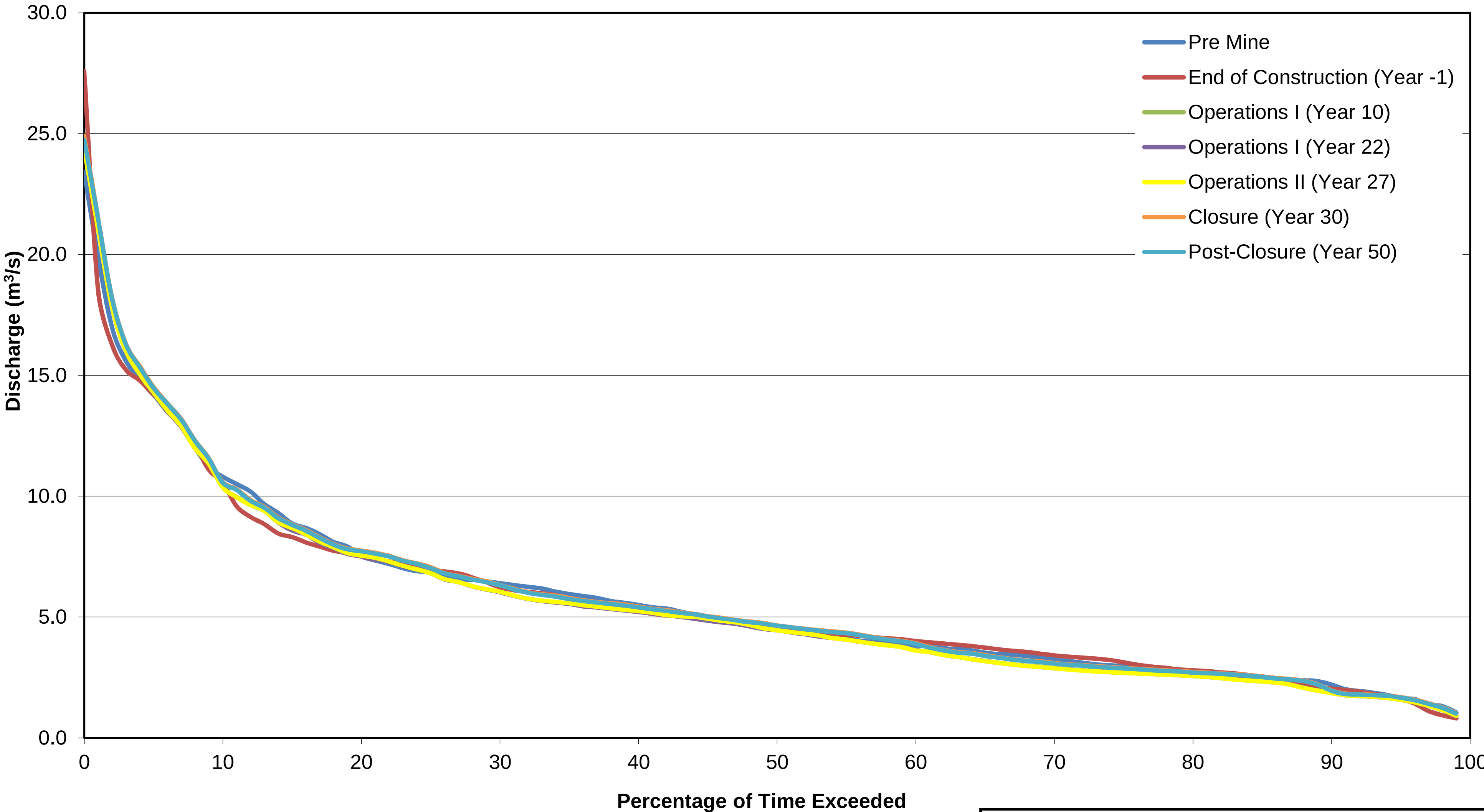
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-141

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

Knight Piésold CONSULTING

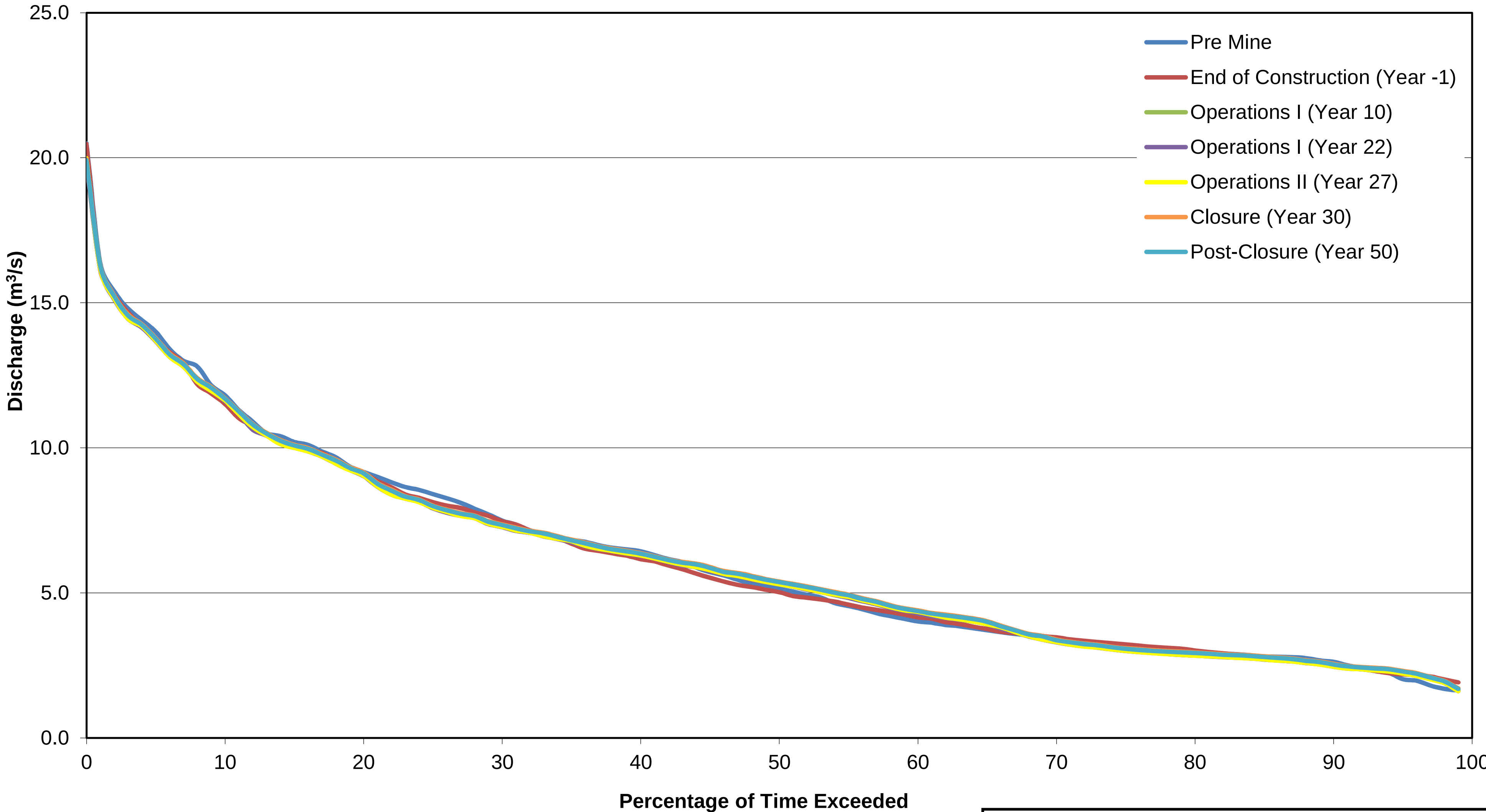
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-142

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

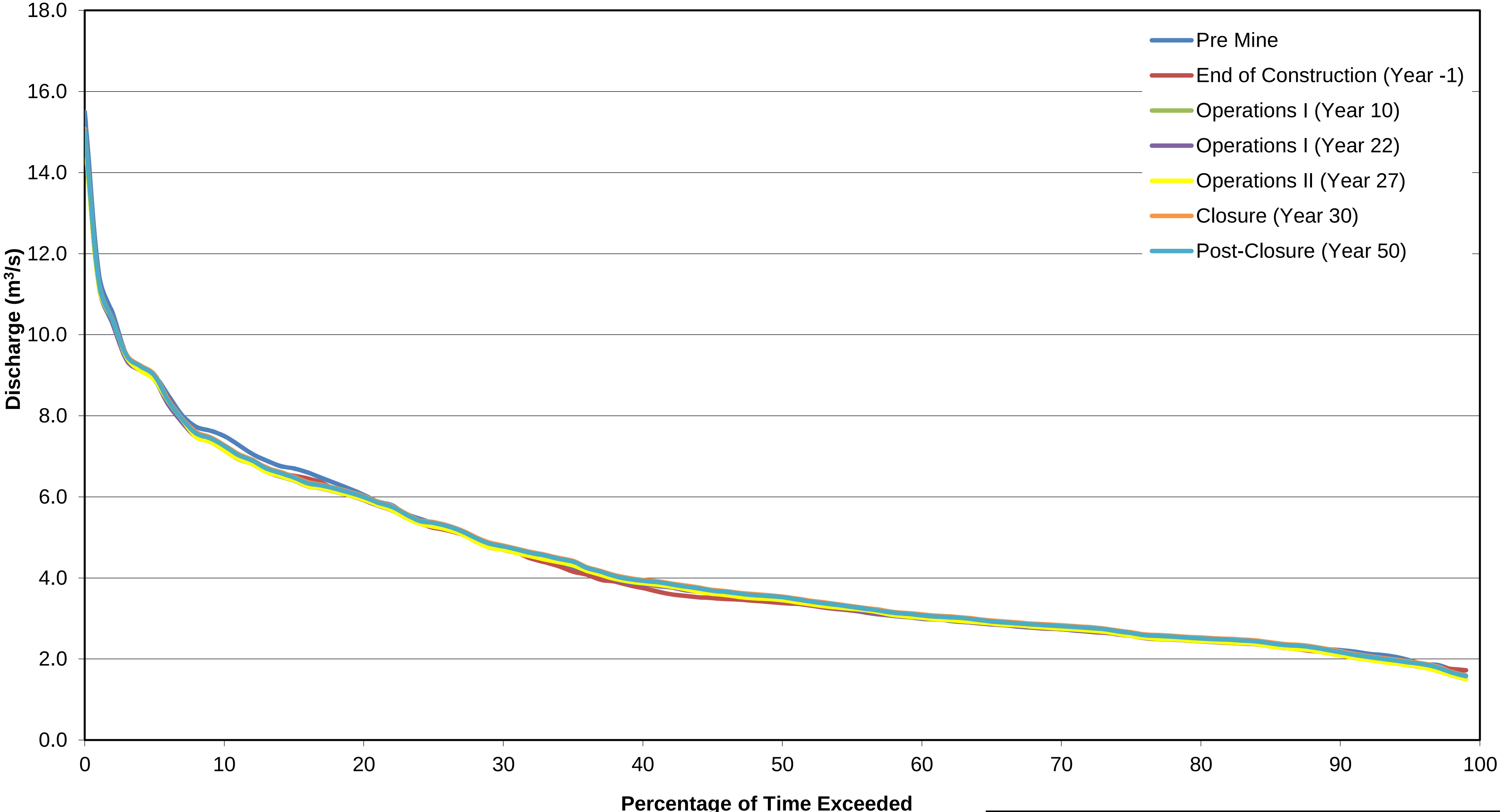
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-143

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 12
BARRIERE RIVER AT THE MOUTH (WSC 08LB020)

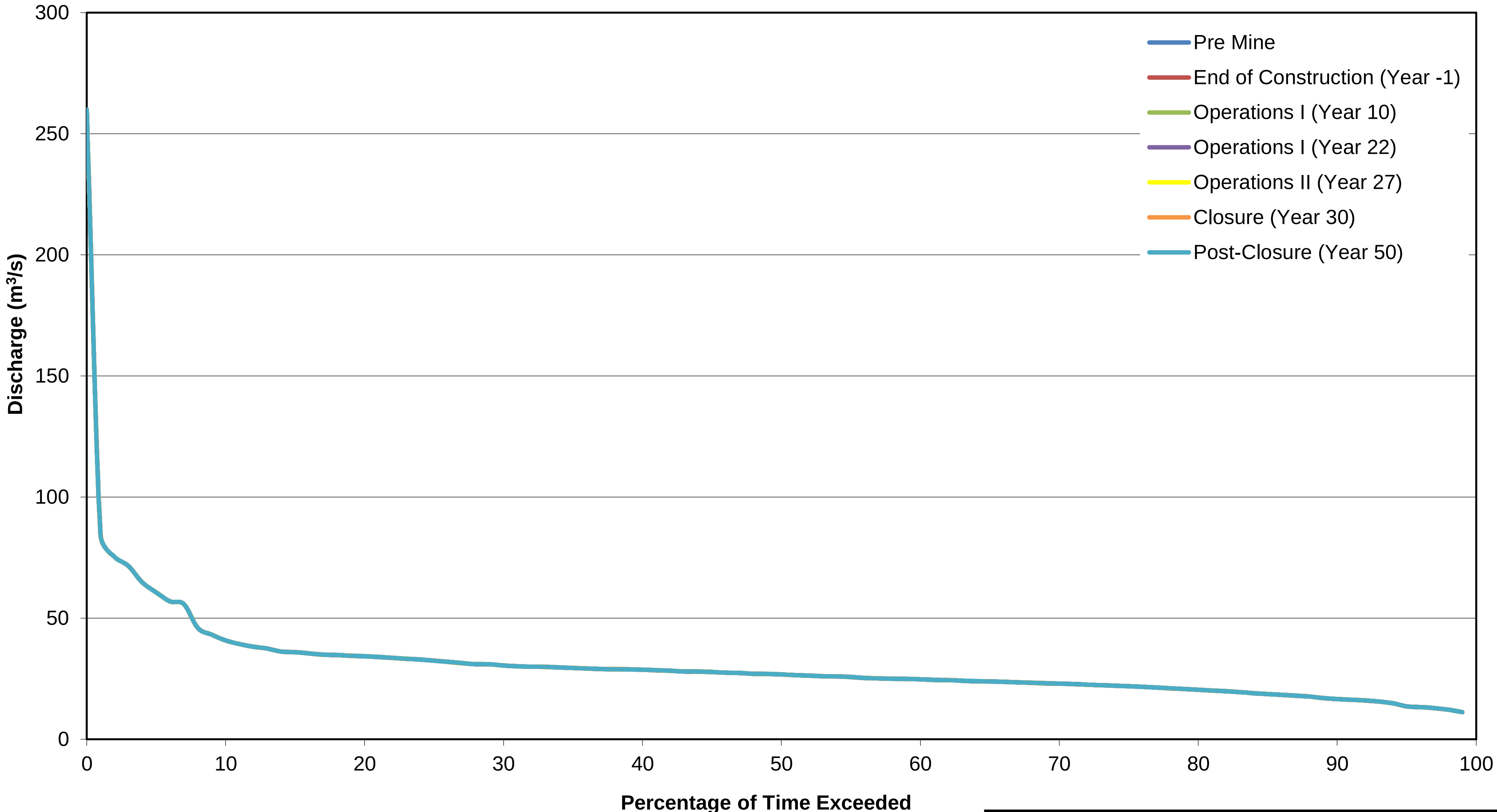
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-144

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JANUARY FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

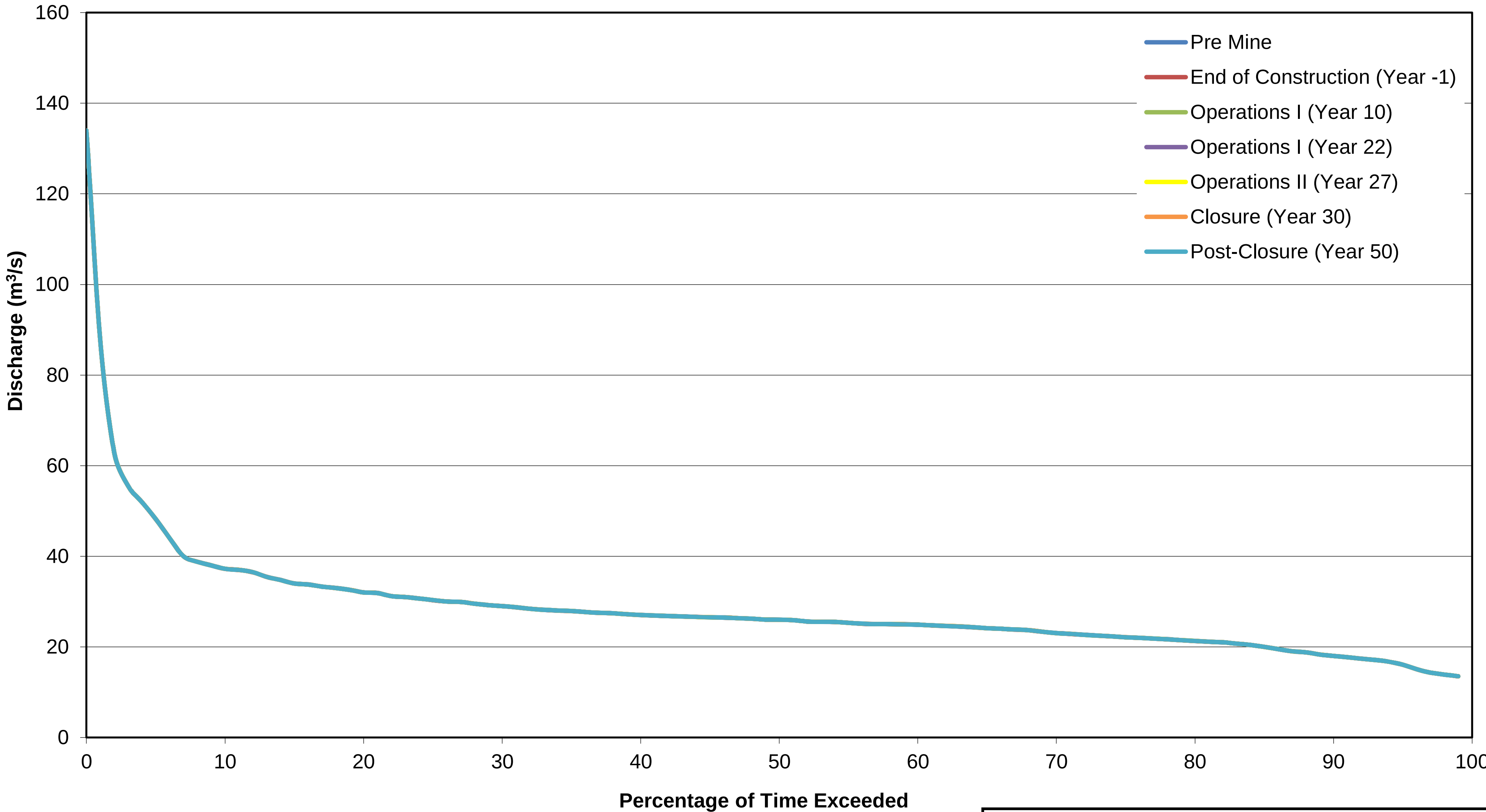
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-145

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

FEBRUARY FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

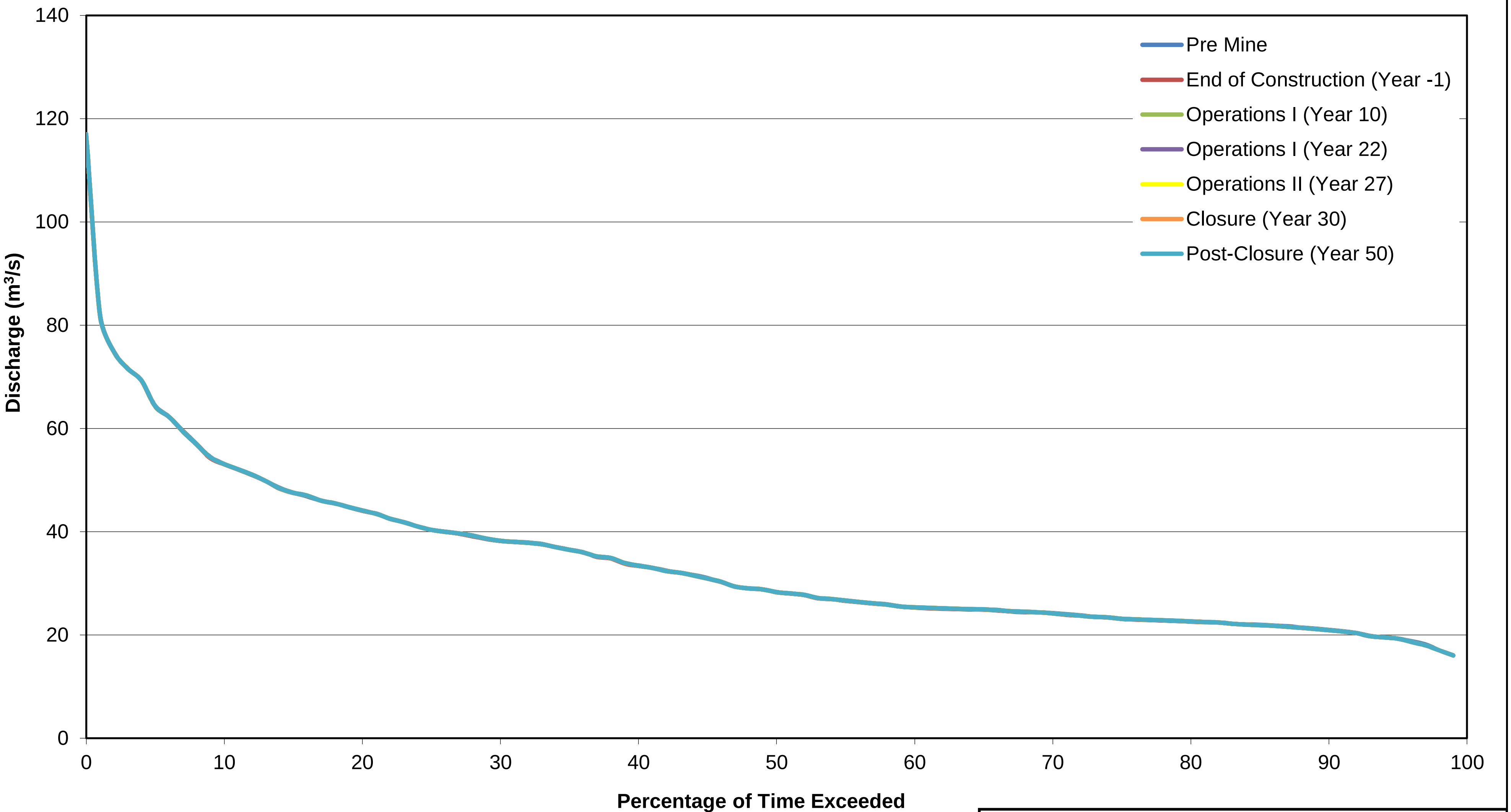
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-146

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MARCH FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

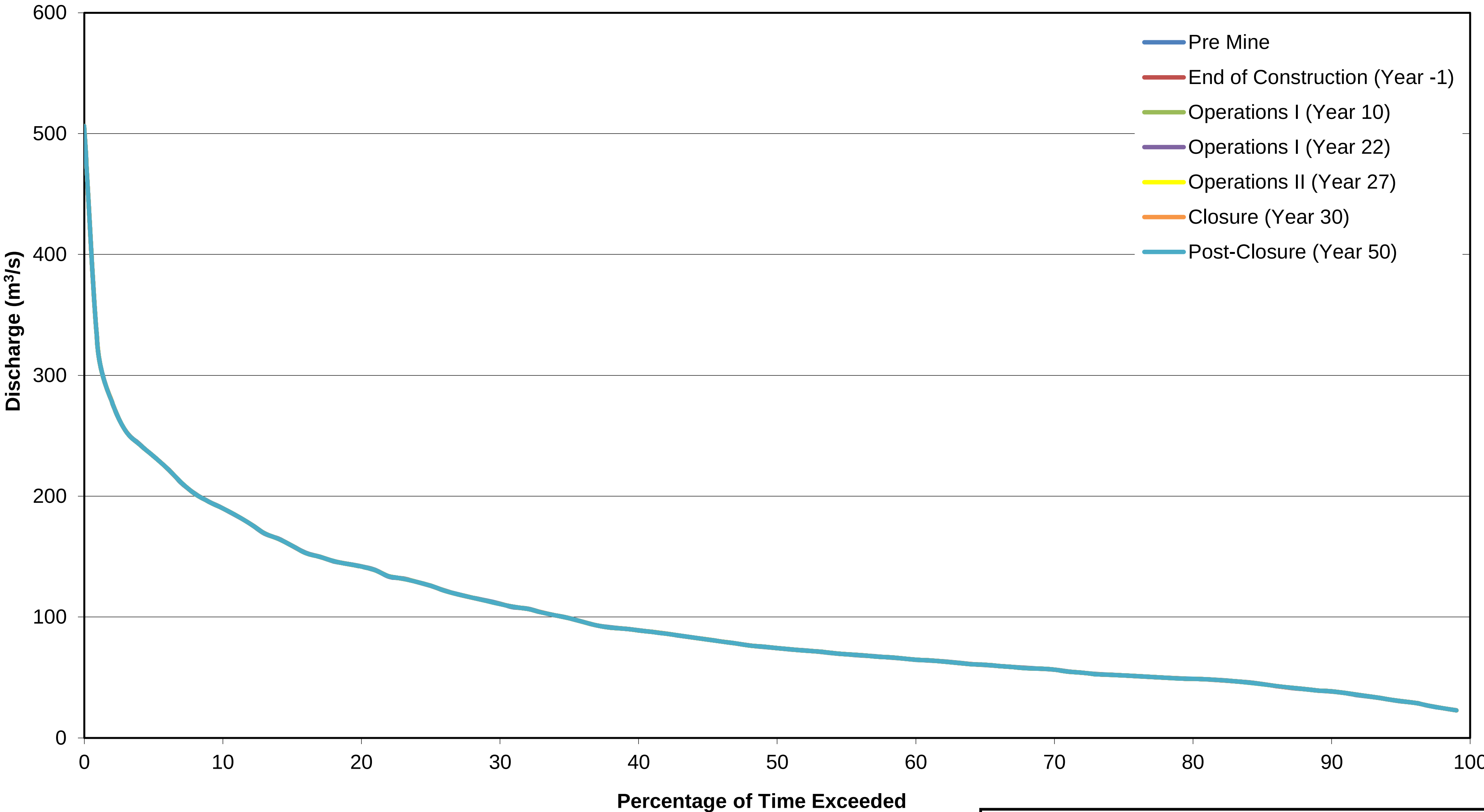
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-147

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

APRIL FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

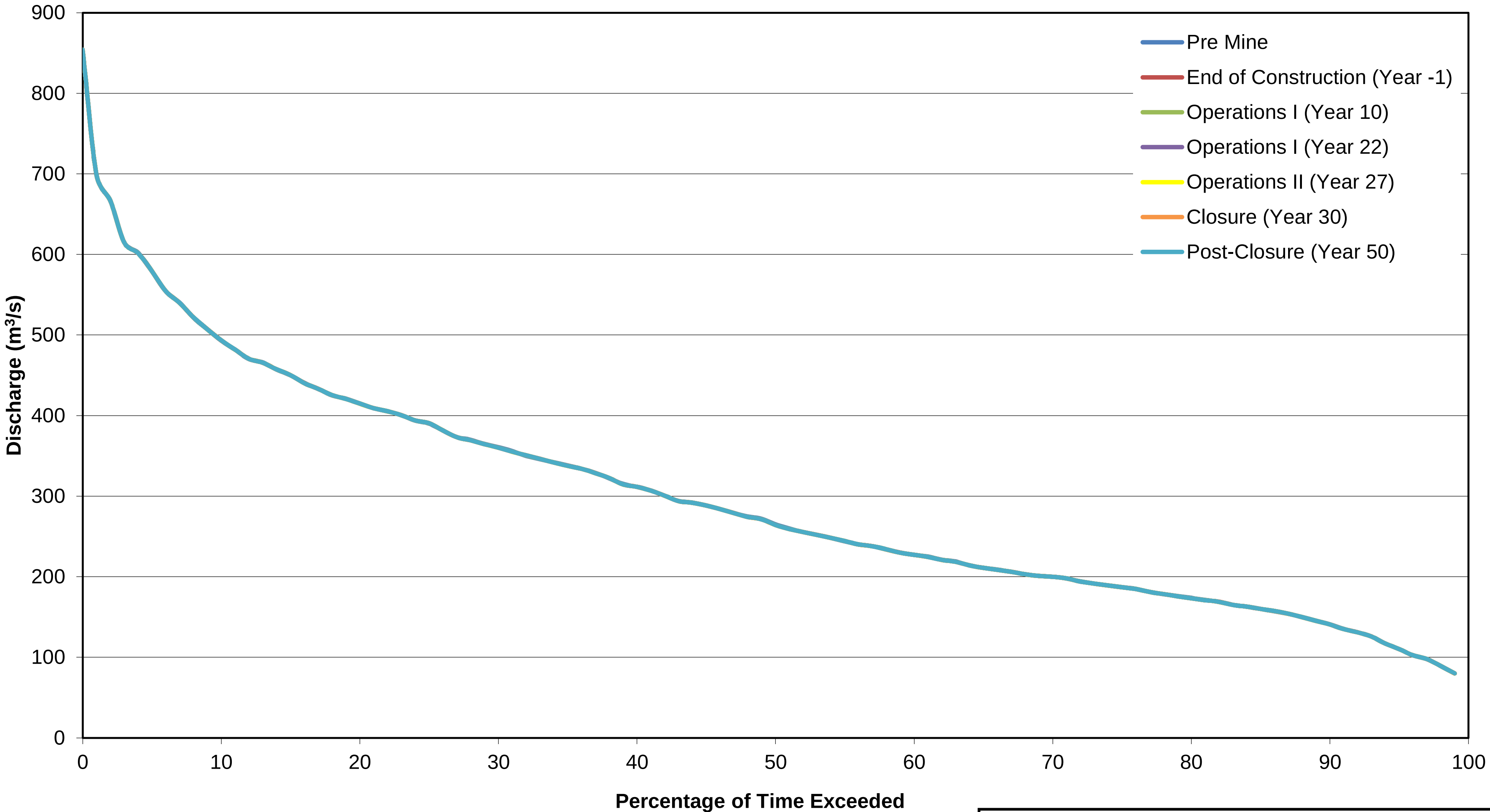
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-148

REV 0

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

MAY FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

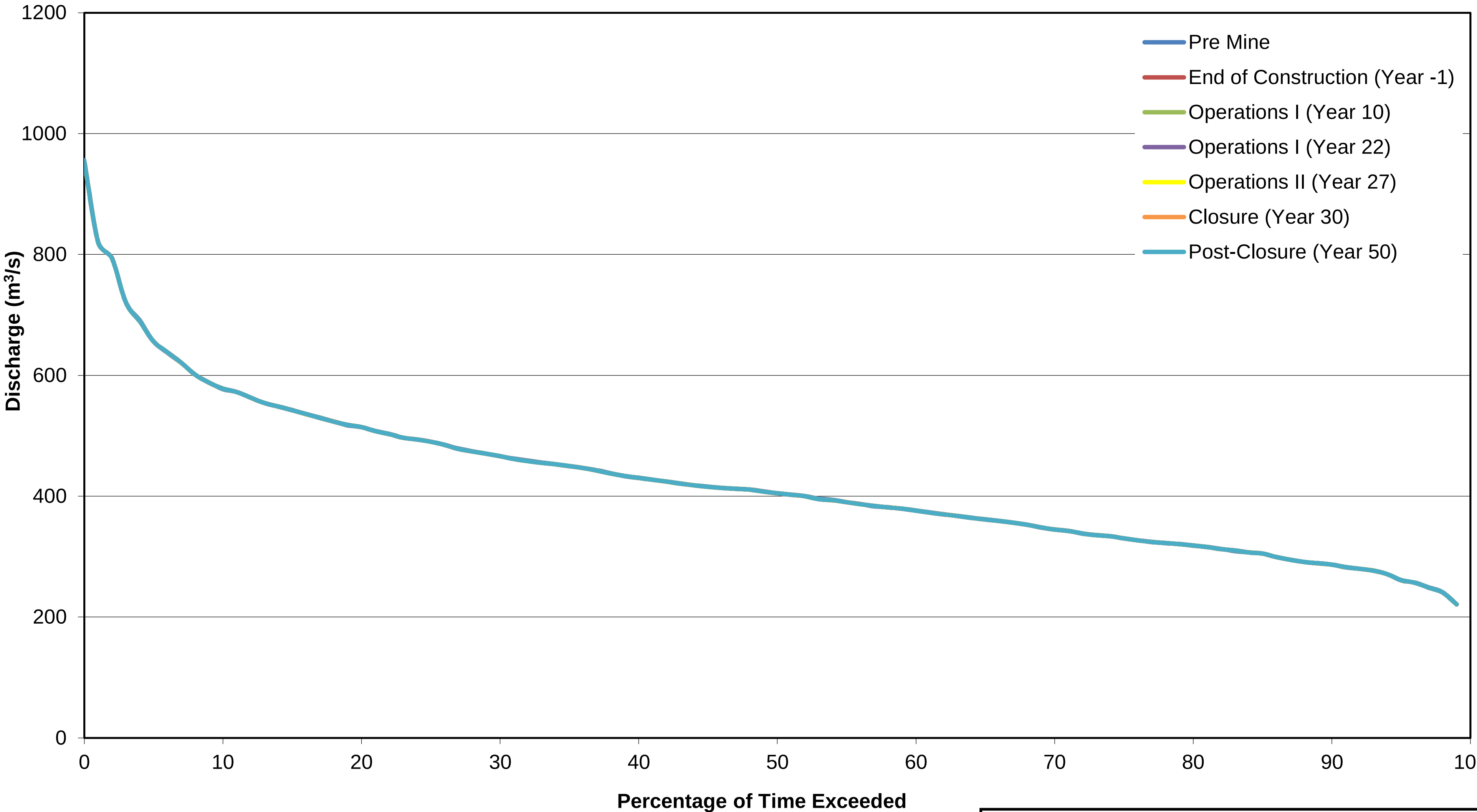
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-149

REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

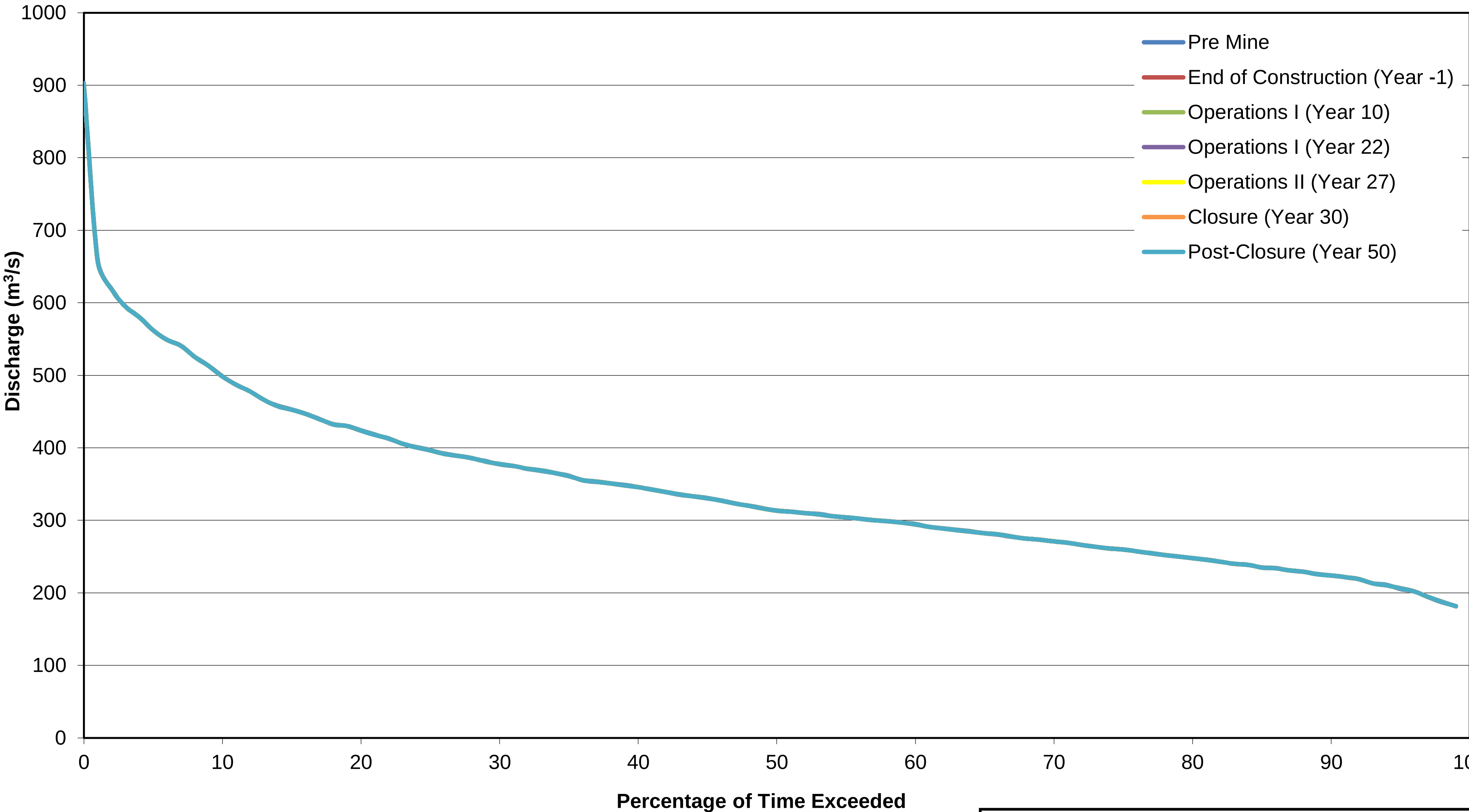
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JUNE FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-150		REV 0



NOTES:
1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

JULY FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

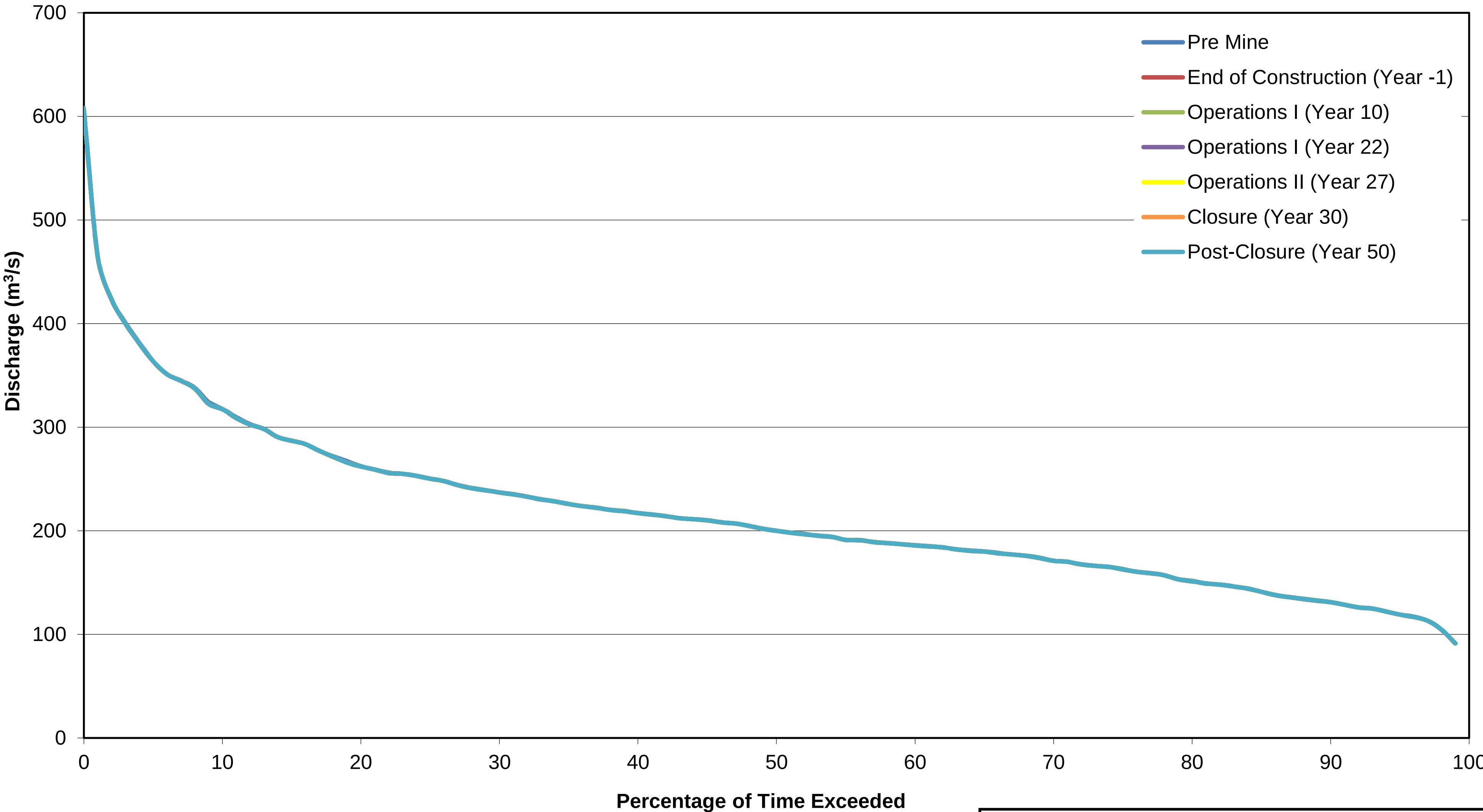
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-151

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

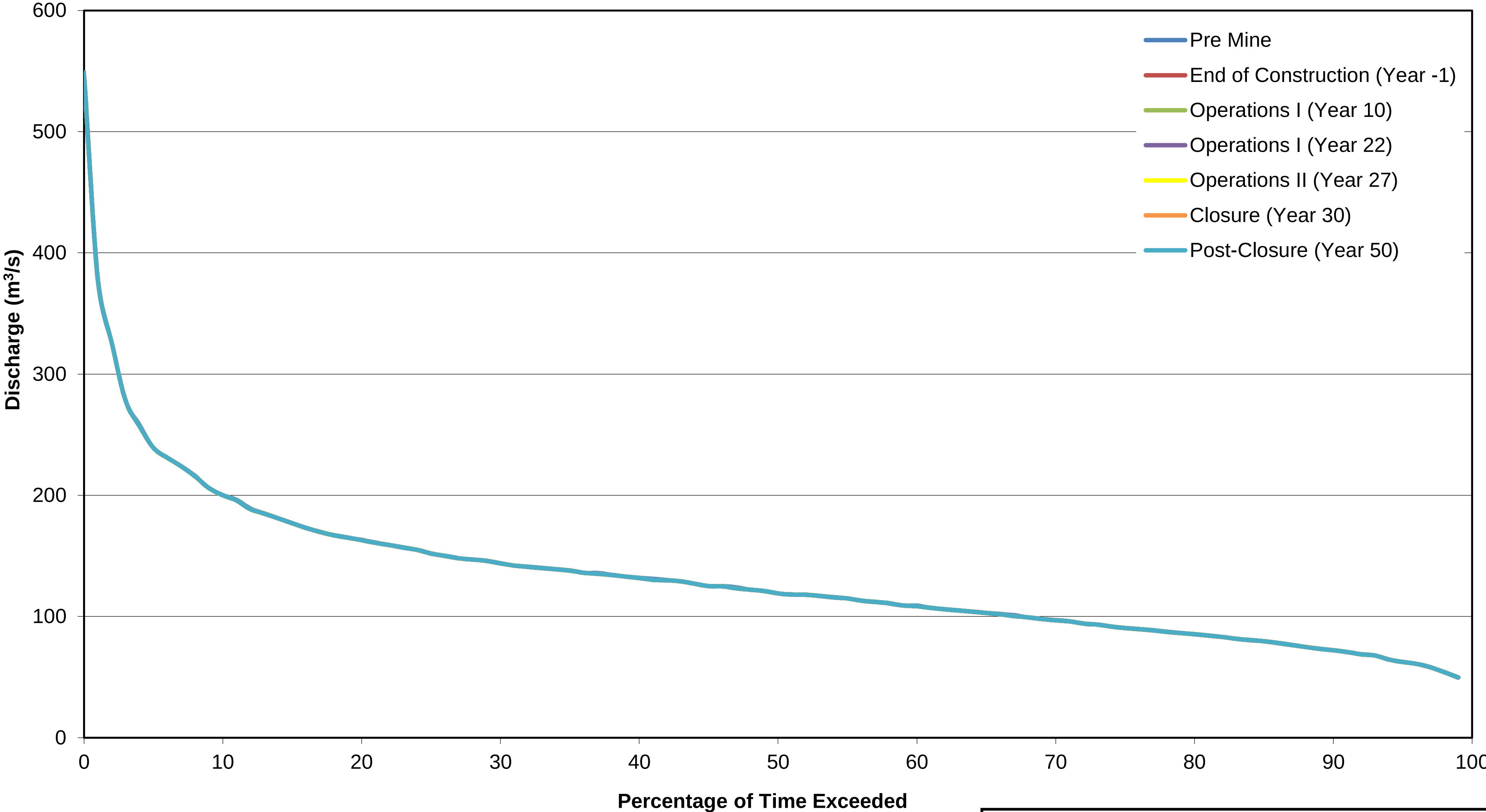
HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

AUGUST FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

P/A NO. VA101-458/15	REF NO. 3	
FIGURE A4-152		REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

SEPTEMBER FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

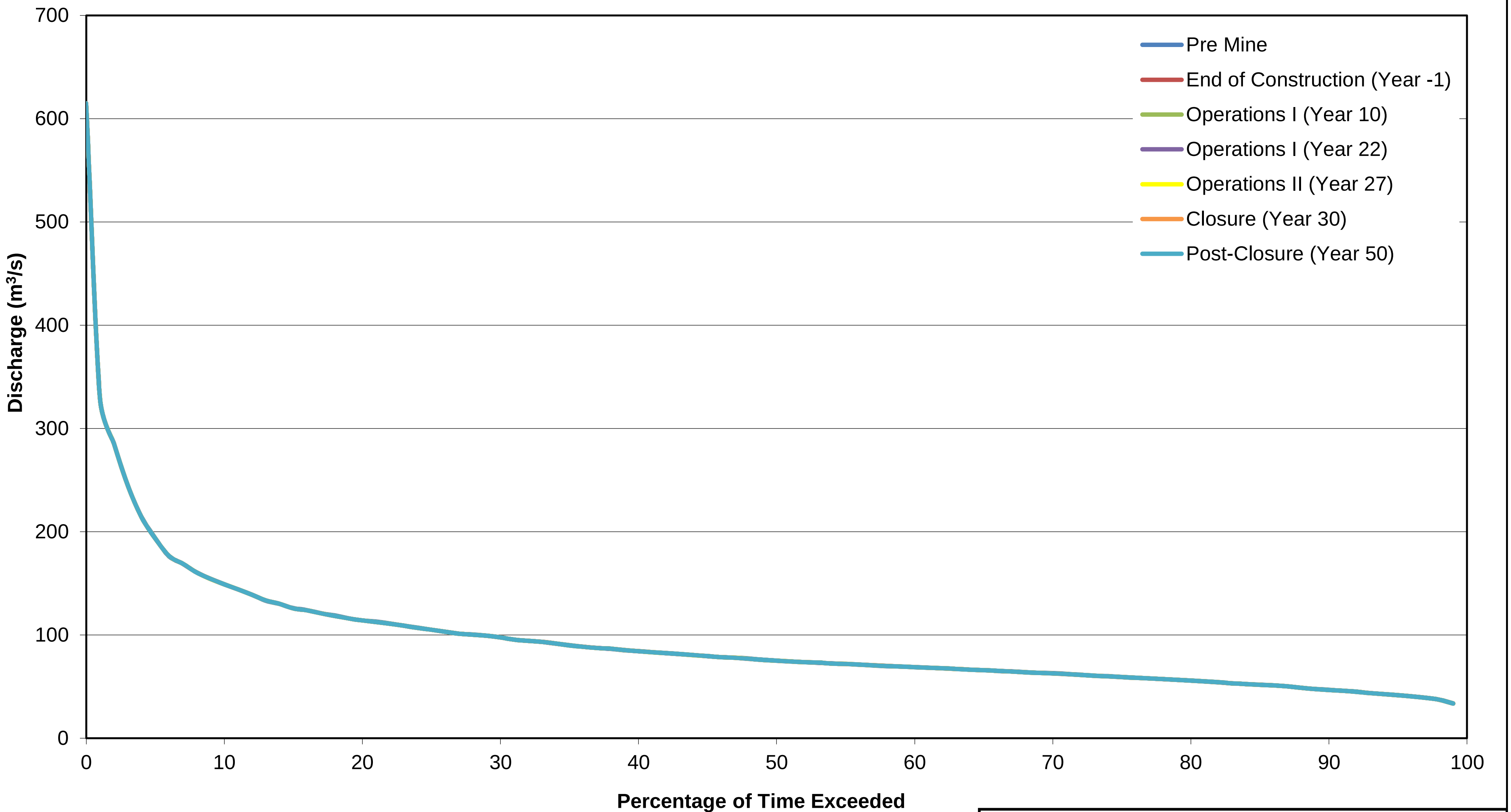
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-153

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

OCTOBER FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

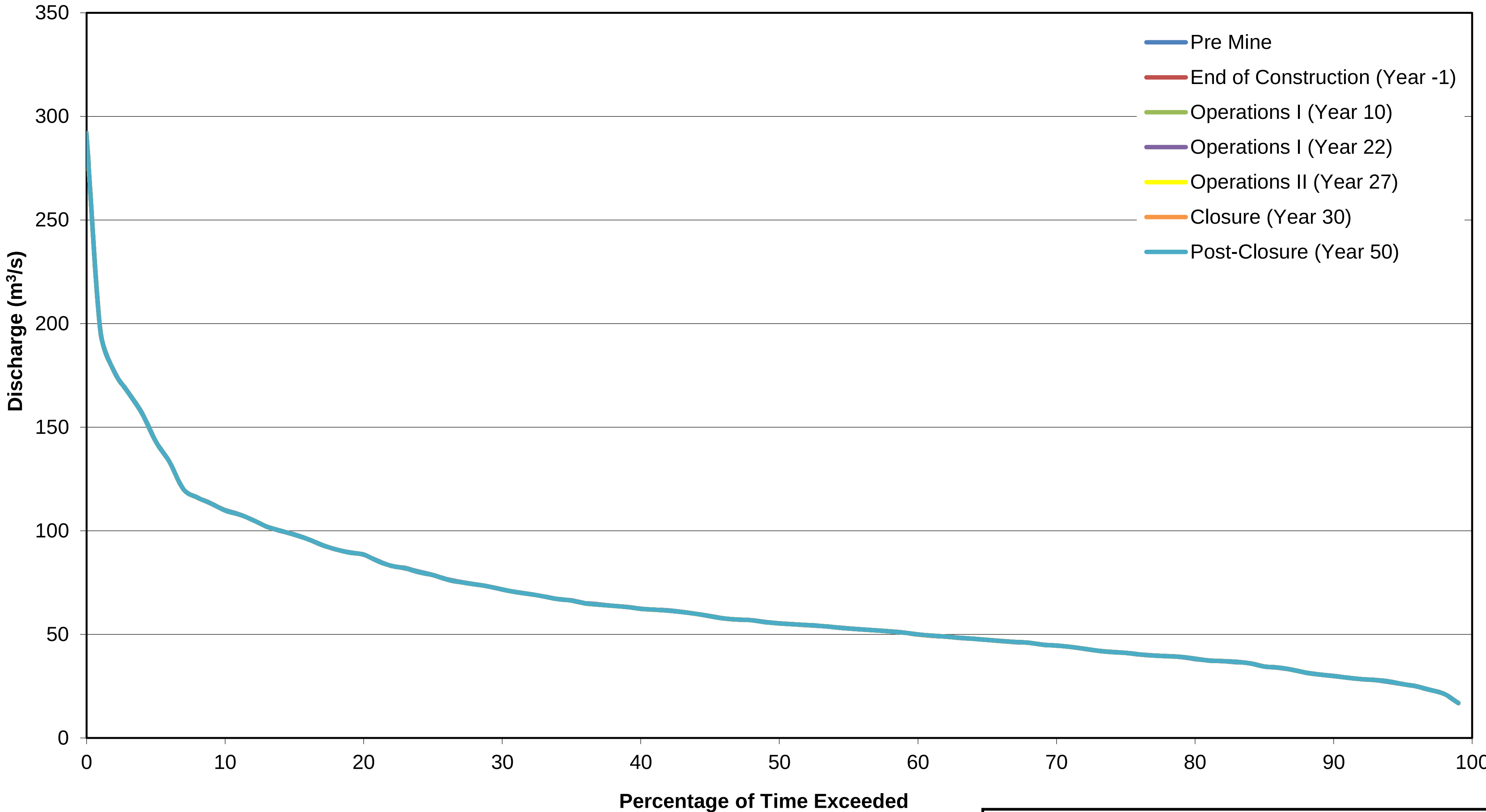
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-154

REV 0



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

NOVEMBER FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

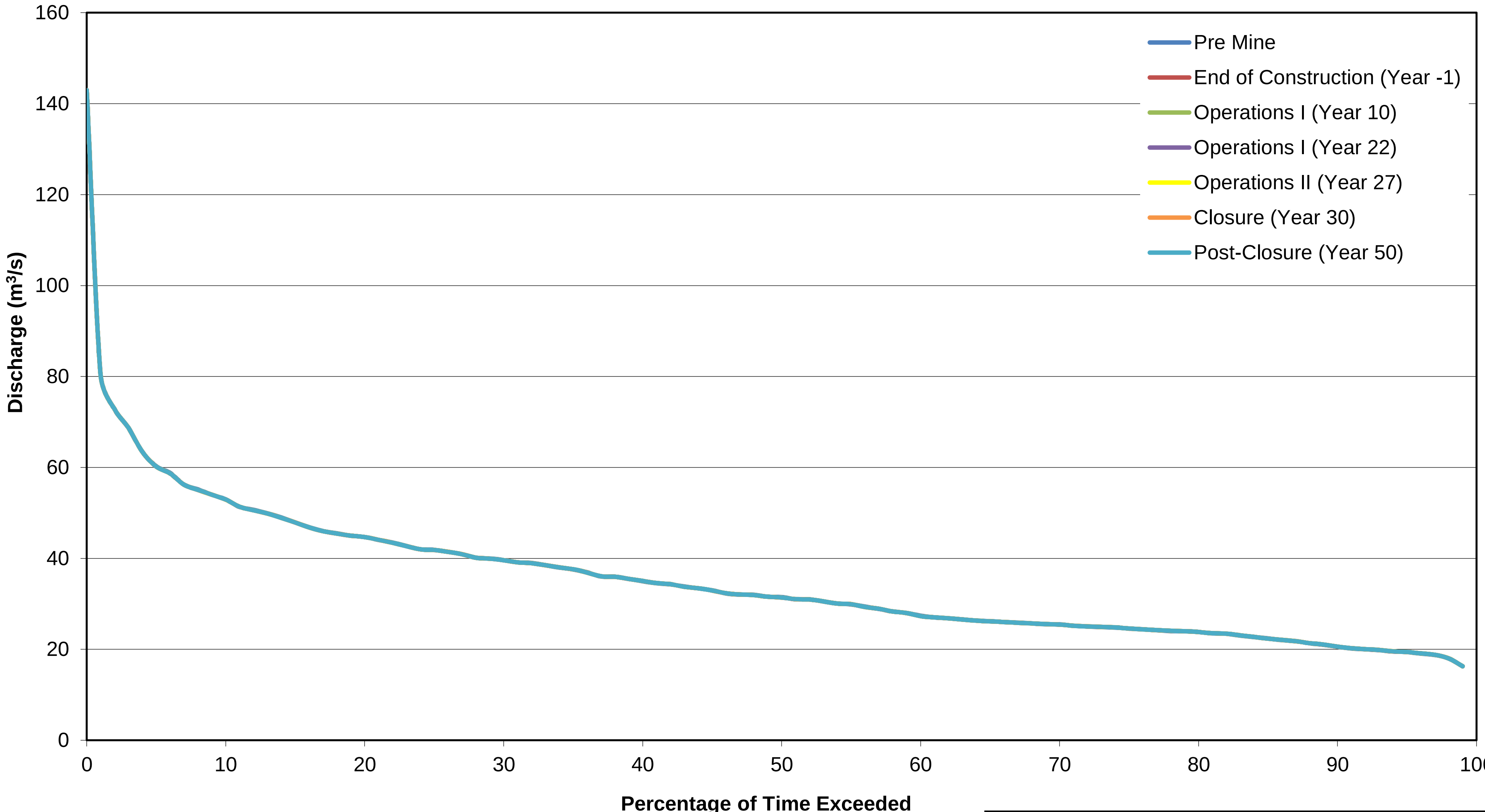
P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-155

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB



NOTES:

1. FLOW DURATION CURVES BASED ON DAILY FLOWS FROM WATERSHED MODEL RESULTS FOR 1974-2000, AND 2003-2010.

0	15OCT'14	ISSUED WITH REPORT	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DECEMBER FLOW DURATION CURVES AT NODE 13 NORTH THOMPSON RIVER AT BIRCH ISLAND (WSC 08LB047)

Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF NO. 3

FIGURE A4-156

REV 0

APPENDIX B

HABITAT IMPACTS

APPENDIX B1

SURVEY REPORT OF THE TOPOGRAPHIC SURVEY ON PORTIONS OF HARPER CREEK – BRITISH COLUMBIA – 2012

(Pages B1-1 to B1-4)

SURVEY REPORT OF THE
TOPOGRAPHIC SURVEY ON PORTIONS OF HARPER CREEK -
BRITISH COLUMBIA – 2012

INTRODUCTION

The purpose of this survey was to characterise channel conditions and model areas for environmental assessment. The survey consisted of a topographic survey over creek beds and the upland banks in select locations along Harper Creek. The survey consisted of two areas: directly downstream of T creek and midway between P and T creeks.

METHODOLOGY

The topographic survey was performed using a Leica Viva GNSS dual frequency RTK GPS System and a Leica TCR 1203 total station. The RTK GPS was used to set survey control points in order to geo-reference the survey and to collect data in areas where the sky view permitted. In the areas of dense vegetation the total station was used.

(Figure 1 - Harper Creek)

GPS NETWORK

An RTK base station was established just north of where T creek flows into Harper Creek in an old cut block. From this base station the rover received differential corrections. A spike was set in a stone mound as the reference point for the base station. The initial position of the reference point was established using a Code only GPS solution and pseudo range data was recorded for the duration of the survey (approximately 9-10 hours per day) for post processing.

The final adjusted position for the base station was established by post processing the data with the Geodetic Survey of Canada's Precise Point Positioning (PPP) service. The base was set up on multiple days, so separate data sets were collected and submitted to the PPP service to independently confirm the position of the base station.

The horizontal datum is NAD83 (CSRS) and the vertical datum is CGVD28.

(Figure 2 – Base Station 8666)

Using the adjusted position for base station 8666 all vectors between the base station and rover were processed using StarNet V6 with a minimally constraint network.

RTK GPS SURVEY

Discrete RTK points were measured in areas where the tree canopy permitted at approximately a 2-3 metre spacing. These points were measured by placing the "pogo" tip on the ground and measuring an "instantaneous" RTK position.

The RTK GPS was also used to tie spikes set for use with the total station. For these points, an average of 30 "instantaneous" positions were measured and averaged to calculate a position.

CONVENTIONAL TOTAL STATION SURVEY

In areas where conventional topography was required the Leica TCR 1203 was set up over control points established from the RTK GPS and a traverse was run along the creek beds. Spikes were used as survey control points and the angles between them were doubled. The traverse was closed onto points also tied with the GPS. From each setup, points were measured at a 2-3 metre spacing using a combination of the prism and the reflectorless capability of the total station. All data was collected using the on-board Leica software.

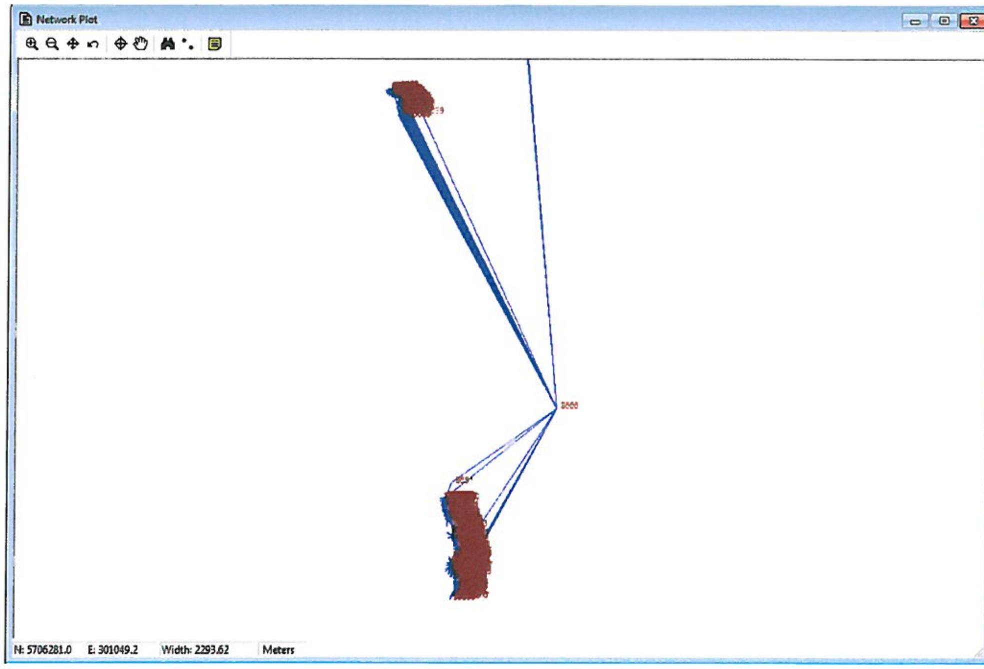
The habitat units mapped were recorded with the following codes:

Habitat Unit 1 (HAB1) = Pool
Habitat Unit 2 (HAB2) = Ripples
Habitat Unit 3 (HAB3) = Run/Slide
Habitat Unit 4 (HAB4) = Cobble
Habitat Unit 5 (HAB5) = Gravel
Habitat Unit 6 (HAB6) = Sand
Habitat Unit 7 (HAB7) = Overhanging vegetation
Habitat Unit 8 (HAB8) = Large Woody Debris
Habitat Unit 9 (HAB9) = Undercut Bank

(Figure 4 –Leica TCR 1203 - Measuring to the target in thick vegetation)

OFFICE PROCESSING

All RTK GPS vectors and conventional measurements were adjusted using StarNet V6. After the Least Squares Adjustment was complete and the network passed the Chi Squared Test the points were imported to AutoCAD Civil 3D 2012 and a surface was generated to take a quick look to see the shot coverage.



A detailed surface was not built (ie. no break lines were added or triangles manipulated) since the model being used at Knight-Piesold only inputs points.

The final delivery for this survey included:

1. Civil 3D 2012 drawing file with points and surfaces
2. A coordinate transformation spreadsheet showing the conversion between UTM and Local coordinate systems
3. Comma separated points files in Ground and UTM systems (sorted PNEZD)

The field survey was performed between July 30th – August 2nd, 2012 by

Justin Petras (Bazett Land Surveying Inc.)

Toby Perkins, M.A.Sc., P.Eng. (Knight-Piesold Consulting)

This survey report was written and prepared by Justin Petras

This survey report was reviewed by Dave Bazett, CLS, BCLS

APPENDIX B2

ONE DIMENSIONAL MODEL RESULTS FOR NODE 3, T-CREEK AT HARPER CREEK CONFLUENCE

(Pages B2-1 to B2-3)

Knight Piésold
CONSULTING

TABLE B2-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR BULL TROUT FRY AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	1.75	2.30	1.04	0.33	0.22	0.10
		Mean Weighted Useable Area	m^2	90	66	130	189	193	202
		10th Percentile Weighted Useable Area	m^2	28	24	51	125	131	135
		90th Percentile Weighted Useable Area	m^2	144	117	210	222	230	232
-1	End of Construction	Mean Discharge	m^3/s	0.60	0.76	0.33	0.10	0.08	0.03
		Mean Weighted Useable Area	m^2	150	133	181	200	184	115
		10th Percentile Weighted Useable Area	m^2	88	84	132	135	0	0
		90th Percentile Weighted Useable Area	m^2	212	199	215	231	232	231
		Mean Percent Change	%	67%	102%	39%	6%	-5%	-43%
		10th Percentile Percent Change	%	215%	242%	159%	9%	-100%	-100%
		90th Percentile Percent Change	%	47%	69%	3%	4%	1%	0%
10	Operations I	Mean Discharge	m^3/s	0.58	0.71	0.26	0.05	0.02	0.02
		Mean Weighted Useable Area	m^2	152	138	189	187	116	79
		10th Percentile Weighted Useable Area	m^2	92	86	134	82	0	0
		90th Percentile Weighted Useable Area	m^2	212	207	224	233	232	229
		Mean Percent Change	%	69%	109%	46%	-1%	-40%	-61%
		10th Percentile Percent Change	%	227%	251%	164%	-34%	-100%	-100%
		90th Percentile Percent Change	%	47%	76%	7%	5%	1%	-1%
22	Operations I	Mean Discharge	m^3/s	0.56	0.68	0.23	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	154	140	192	183	108	76
		10th Percentile Weighted Useable Area	m^2	94	89	135	70	0	0
		90th Percentile Weighted Useable Area	m^2	212	209	225	233	231	229
		Mean Percent Change	%	70%	113%	48%	-3%	-44%	-62%
		10th Percentile Percent Change	%	235%	264%	166%	-44%	-100%	-100%
		90th Percentile Percent Change	%	47%	78%	7%	5%	0%	-1%
27	Operations II	Mean Discharge	m^3/s	0.56	0.68	0.24	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	154	141	192	184	108	74
		10th Percentile Weighted Useable Area	m^2	95	89	135	70	0	0
		90th Percentile Weighted Useable Area	m^2	212	208	225	233	231	229
		Mean Percent Change	%	71%	114%	48%	-3%	-44%	-64%
		10th Percentile Percent Change	%	240%	264%	165%	-44%	-100%	-100%
		90th Percentile Percent Change	%	47%	78%	7%	5%	0%	-1%
30	Closure	Mean Discharge	m^3/s	1.25	1.56	0.51	0.13	0.11	0.14
		Mean Weighted Useable Area	m^2	122	100	166	188	147	140
		10th Percentile Weighted Useable Area	m^2	36	31	90	125	0	0
		90th Percentile Weighted Useable Area	m^2	209	180	215	232	229	222
		Mean Percent Change	%	36%	52%	28%	-1%	-24%	-30%
		10th Percentile Percent Change	%	28%	26%	76%	0%	-100%	-100%
		90th Percentile Percent Change	%	44%	53%	3%	4%	0%	-4%
50	Post-Closure	Mean Discharge	m^3/s	2.06	2.54	0.80	0.22	0.16	0.21
		Mean Weighted Useable Area	m^2	79	62	138	192	193	194
		10th Percentile Weighted Useable Area	m^2	25	23	80	133	129	135
		90th Percentile Weighted Useable Area	m^2	134	127	210	226	226	222
		Mean Percent Change	%	-12%	-5%	6%	2%	0%	-4%
		10th Percentile Percent Change	%	-11%	-6%	57%	6%	-2%	0%
		90th Percentile Percent Change	%	-7%	9%	0%	2%	-2%	-4%

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	8OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE B2-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR REARING BULL TROUT AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	1.75	2.30	1.04	0.33	0.22	0.10
		Mean Weighted Useable Area	m^2	153	132	194	292	320	349
		10th Percentile Weighted Useable Area	m^2	73	67	94	174	174	153
		90th Percentile Weighted Useable Area	m^2	188	182	285	419	439	439
-1	End of Construction	Mean Discharge	m^3/s	0.60	0.76	0.33	0.10	0.08	0.03
		Mean Weighted Useable Area	m^2	207	188	258	350	328	210
		10th Percentile Weighted Useable Area	m^2	174	174	176	182	0	0
		90th Percentile Weighted Useable Area	m^2	285	225	390	439	440	438
		Mean Percent Change	%	35%	43%	33%	20%	3%	-40%
		10th Percentile Percent Change	%	136%	160%	87%	5%	-100%	-100%
		90th Percentile Percent Change	%	52%	24%	37%	5%	0%	0%
10	Operations I	Mean Discharge	m^3/s	0.58	0.71	0.26	0.05	0.02	0.02
		Mean Weighted Useable Area	m^2	209	192	283	343	215	146
		10th Percentile Weighted Useable Area	m^2	174	174	179	153	0	0
		90th Percentile Weighted Useable Area	m^2	285	229	426	440	438	438
		Mean Percent Change	%	37%	46%	46%	18%	-33%	-58%
		10th Percentile Percent Change	%	136%	161%	90%	-12%	-100%	-100%
		90th Percentile Percent Change	%	52%	26%	49%	5%	0%	0%
22	Operations I	Mean Discharge	m^3/s	0.56	0.68	0.23	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	211	194	291	337	199	141
		10th Percentile Weighted Useable Area	m^2	174	174	180	131	0	0
		90th Percentile Weighted Useable Area	m^2	298	230	430	439	438	438
		Mean Percent Change	%	38%	47%	50%	15%	-38%	-60%
		10th Percentile Percent Change	%	137%	161%	91%	-24%	-100%	-100%
		90th Percentile Percent Change	%	59%	27%	51%	5%	0%	0%
27	Operations II	Mean Discharge	m^3/s	0.56	0.68	0.24	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	211	195	290	337	199	136
		10th Percentile Weighted Useable Area	m^2	174	174	180	131	0	0
		90th Percentile Weighted Useable Area	m^2	298	230	430	439	438	438
		Mean Percent Change	%	38%	47%	49%	15%	-38%	-61%
		10th Percentile Percent Change	%	137%	161%	91%	-24%	-100%	-100%
		90th Percentile Percent Change	%	59%	27%	51%	5%	0%	0%
30	Closure	Mean Discharge	m^3/s	1.25	1.56	0.51	0.13	0.11	0.14
		Mean Weighted Useable Area	m^2	180	163	243	316	243	222
		10th Percentile Weighted Useable Area	m^2	94	93	174	175	0	0
		90th Percentile Weighted Useable Area	m^2	232	212	394	438	438	417
		Mean Percent Change	%	18%	23%	25%	8%	-24%	-37%
		10th Percentile Percent Change	%	28%	40%	84%	1%	-100%	-100%
		90th Percentile Percent Change	%	23%	16%	38%	5%	0%	-5%
50	Post-Closure	Mean Discharge	m^3/s	2.06	2.54	0.80	0.22	0.16	0.21
		Mean Weighted Useable Area	m^2	143	125	195	293	309	303
		10th Percentile Weighted Useable Area	m^2	78	70	158	181	183	181
		90th Percentile Weighted Useable Area	m^2	185	181	233	433	433	417
		Mean Percent Change	%	-7%	-5%	1%	0%	-3%	-13%
		10th Percentile Percent Change	%	6%	5%	68%	4%	6%	18%
		90th Percentile Percent Change	%	-2%	0%	-18%	3%	-1%	-5%

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NOTES:

1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	8OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE B2-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR SPAWNING BULL TROUT AT NODE 3 T-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Time Period	
Year	Description			Aug 16th - 31st	Sep 1st - 15th
-	Pre-Mine	Mean Discharge	m^3/s	0.26	0.21
		Mean Weighted Useable Area	m^2	107	118
		10th Percentile Weighted Useable Area	m^2	54	14
		90th Percentile Weighted Useable Area	m^2	205	187
-1	End of Construction	Mean Discharge	m^3/s	0.08	0.09
		Mean Weighted Useable Area	m^2	73	71
		10th Percentile Weighted Useable Area	m^2	1	0
		90th Percentile Weighted Useable Area	m^2	156	140
		Mean Percent Change	%	-31%	-40%
		10th Percentile Percent Change	%	-97%	-100%
		90th Percentile Percent Change	%	-24%	-25%
10	Operations I	Mean Discharge	m^3/s	0.04	0.03
		Mean Weighted Useable Area	m^2	30	22
		10th Percentile Weighted Useable Area	m^2	1	0
		90th Percentile Weighted Useable Area	m^2	96	81
		Mean Percent Change	%	-72%	-82%
		10th Percentile Percent Change	%	-98%	-100%
		90th Percentile Percent Change	%	-53%	-57%
22	Operations I	Mean Discharge	m^3/s	0.03	0.02
		Mean Weighted Useable Area	m^2	26	20
		10th Percentile Weighted Useable Area	m^2	1	0
		90th Percentile Weighted Useable Area	m^2	90	77
		Mean Percent Change	%	-75%	-83%
		10th Percentile Percent Change	%	-98%	-100%
		90th Percentile Percent Change	%	-56%	-59%
27	Operations II	Mean Discharge	m^3/s	0.03	0.02
		Mean Weighted Useable Area	m^2	26	20
		10th Percentile Weighted Useable Area	m^2	1	0
		90th Percentile Weighted Useable Area	m^2	90	77
		Mean Percent Change	%	-75%	-83%
		10th Percentile Percent Change	%	-98%	-100%
		90th Percentile Percent Change	%	-56%	-59%
30	Closure	Mean Discharge	m^3/s	0.09	0.12
		Mean Weighted Useable Area	m^2	70	70
		10th Percentile Weighted Useable Area	m^2	2	0
		90th Percentile Weighted Useable Area	m^2	168	196
		Mean Percent Change	%	-34%	-41%
		10th Percentile Percent Change	%	-97%	-100%
		90th Percentile Percent Change	%	-18%	5%
50	Post-Closure	Mean Discharge	m^3/s	0.16	0.17
		Mean Weighted Useable Area	m^2	120	119
		10th Percentile Weighted Useable Area	m^2	4	3
		90th Percentile Weighted Useable Area	m^2	196	205
		Mean Percent Change	%	12%	1%
		10th Percentile Percent Change	%	-92%	-82%
		90th Percentile Percent Change	%	-5%	10%

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NOTES:

1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	8OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX B3

ONE DIMENSIONAL MODEL RESULTS FOR NODE 5, P-CREEK AT HARPER CREEK CONFLUENCE

(Pages B3-1 to B3-3)

Knight Piésold
CONSULTING

TABLE B3-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR BULL TROUT FRY AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	0.62	0.59	0.19	0.06	0.04	0.03
		Mean Weighted Useable Area	m^2	70	58	201	349	407	407
		10th Percentile Weighted Useable Area	m^2	22	21	49	126	206	258
		90th Percentile Weighted Useable Area	m^2	150	100	386	483	500	500
-1	End of Construction	Mean Discharge	m^3/s	0.64	0.63	0.13	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	64	51	201	384	439	418
		10th Percentile Weighted Useable Area	m^2	21	22	55	257	315	294
		90th Percentile Weighted Useable Area	m^2	134	85	385	483	505	505
		Mean Percent Change	%	-8%	-11%	0%	10%	8%	3%
		10th Percentile Percent Change	%	-4%	7%	13%	105%	53%	14%
		90th Percentile Percent Change	%	-10%	-16%	0%	0%	1%	1%
10	Operations I	Mean Discharge	m^3/s	0.25	0.19	0.04	0.01	0.00	0.01
		Mean Weighted Useable Area	m^2	133	130	350	286	134	248
		10th Percentile Weighted Useable Area	m^2	48	49	134	52	0	0
		90th Percentile Weighted Useable Area	m^2	367	314	494	500	413	500
		Mean Percent Change	%	90%	126%	74%	-18%	-67%	-39%
		10th Percentile Percent Change	%	120%	136%	174%	-59%	-100%	-100%
		90th Percentile Percent Change	%	145%	213%	28%	4%	-17%	0%
22	Operations I	Mean Discharge	m^3/s	0.25	0.18	0.04	0.01	0.00	0.01
		Mean Weighted Useable Area	m^2	134	137	354	276	132	247
		10th Percentile Weighted Useable Area	m^2	48	50	134	52	0	0
		90th Percentile Weighted Useable Area	m^2	370	325	494	500	413	500
		Mean Percent Change	%	93%	137%	76%	-21%	-68%	-39%
		10th Percentile Percent Change	%	120%	139%	174%	-59%	-100%	-100%
		90th Percentile Percent Change	%	147%	224%	28%	4%	-17%	0%
27	Operations II	Mean Discharge	m^3/s	0.26	0.21	0.04	0.02	0.00	0.01
		Mean Weighted Useable Area	m^2	128	118	340	298	152	246
		10th Percentile Weighted Useable Area	m^2	47	49	126	52	0	0
		90th Percentile Weighted Useable Area	m^2	359	295	500	511	465	494
		Mean Percent Change	%	83%	105%	69%	-15%	-63%	-40%
		10th Percentile Percent Change	%	112%	135%	157%	-59%	-100%	-100%
		90th Percentile Percent Change	%	140%	194%	30%	6%	-7%	-1%
30	Closure	Mean Discharge	m^3/s	0.27	0.23	0.05	0.02	0.00	0.01
		Mean Weighted Useable Area	m^2	125	113	331	295	154	247
		10th Percentile Weighted Useable Area	m^2	46	49	109	52	0	0
		90th Percentile Weighted Useable Area	m^2	355	280	500	511	471	483
		Mean Percent Change	%	80%	96%	64%	-15%	-62%	-39%
		10th Percentile Percent Change	%	108%	133%	124%	-59%	-100%	-100%
		90th Percentile Percent Change	%	137%	179%	30%	6%	-6%	-3%
50	Post-Closure	Mean Discharge	m^3/s	0.27	0.23	0.05	0.02	0.00	0.02
		Mean Weighted Useable Area	m^2	125	114	326	283	150	249
		10th Percentile Weighted Useable Area	m^2	46	49	103	52	0	0
		90th Percentile Weighted Useable Area	m^2	355	284	500	505	471	471
		Mean Percent Change	%	80%	97%	62%	-19%	-63%	-39%
		10th Percentile Percent Change	%	108%	134%	111%	-59%	-100%	-100%
		90th Percentile Percent Change	%	137%	183%	30%	5%	-6%	-6%

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE B3-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR REARING BULL TROUT AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	0.62	0.59	0.19	0.06	0.04	0.03
		Mean Weighted Useable Area	m^2	32	30	53	47	37	35
		10th Percentile Weighted Useable Area	m^2	13	13	17	19	14	11
		90th Percentile Weighted Useable Area	m^2	65	59	67	64	61	59
-1	End of Construction	Mean Discharge	m^3/s	0.64	0.63	0.13	0.04	0.02	0.02
		Mean Weighted Useable Area	m^2	32	28	58	46	24	26
		10th Percentile Weighted Useable Area	m^2	14	13	36	25	10	8
		90th Percentile Weighted Useable Area	m^2	66	59	70	63	51	52
		Mean Percent Change	%	-1%	-7%	10%	-2%	-35%	-26%
		10th Percentile Percent Change	%	6%	4%	110%	29%	-30%	-25%
		90th Percentile Percent Change	%	1%	0%	4%	-2%	-16%	-11%
10	Operations I	Mean Discharge	m^3/s	0.25	0.19	0.04	0.01	0.00	0.01
		Mean Weighted Useable Area	m^2	47	54	36	15	5	14
		10th Percentile Weighted Useable Area	m^2	20	32	7	1	0	0
		90th Percentile Weighted Useable Area	m^2	68	70	62	42	11	46
		Mean Percent Change	%	46%	80%	-31%	-68%	-87%	-61%
		10th Percentile Percent Change	%	57%	152%	-60%	-93%	-100%	-100%
		90th Percentile Percent Change	%	5%	19%	-7%	-34%	-82%	-22%
22	Operations I	Mean Discharge	m^3/s	0.25	0.18	0.04	0.01	0.00	0.01
		Mean Weighted Useable Area	m^2	47	55	35	14	5	14
		10th Percentile Weighted Useable Area	m^2	22	32	5	1	0	0
		90th Percentile Weighted Useable Area	m^2	68	70	64	40	11	48
		Mean Percent Change	%	47%	82%	-33%	-69%	-88%	-61%
		10th Percentile Percent Change	%	72%	154%	-68%	-93%	-100%	-100%
		90th Percentile Percent Change	%	4%	19%	-5%	-37%	-82%	-19%
27	Operations II	Mean Discharge	m^3/s	0.26	0.21	0.04	0.02	0.00	0.01
		Mean Weighted Useable Area	m^2	46	52	37	17	6	15
		10th Percentile Weighted Useable Area	m^2	19	30	7	1	0	0
		90th Percentile Weighted Useable Area	m^2	69	69	63	52	16	51
		Mean Percent Change	%	43%	73%	-31%	-63%	-84%	-57%
		10th Percentile Percent Change	%	48%	135%	-60%	-93%	-100%	-100%
		90th Percentile Percent Change	%	5%	18%	-5%	-18%	-75%	-13%
30	Closure	Mean Discharge	m^3/s	0.27	0.23	0.05	0.02	0.00	0.01
		Mean Weighted Useable Area	m^2	46	51	37	17	6	17
		10th Percentile Weighted Useable Area	m^2	18	28	5	1	0	0
		90th Percentile Weighted Useable Area	m^2	69	69	64	53	16	52
		Mean Percent Change	%	42%	69%	-30%	-63%	-83%	-51%
		10th Percentile Percent Change	%	38%	119%	-68%	-93%	-100%	-100%
		90th Percentile Percent Change	%	5%	17%	-4%	-17%	-75%	-11%
50	Post-Closure	Mean Discharge	m^3/s	0.27	0.23	0.05	0.02	0.00	0.02
		Mean Weighted Useable Area	m^2	46	51	36	17	6	20
		10th Percentile Weighted Useable Area	m^2	18	28	5	1	0	0
		90th Percentile Weighted Useable Area	m^2	69	69	64	53	17	55
		Mean Percent Change	%	41%	69%	-32%	-64%	-83%	-43%
		10th Percentile Percent Change	%	38%	119%	-68%	-93%	-100%	-100%
		90th Percentile Percent Change	%	5%	17%	-4%	-16%	-72%	-7%

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE B3-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR SPAWNING BULL TROUT AT NODE 5 P-CREEK AT HARPER CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Time Period	
Year	Description			Aug 16th - 31st	Sep 1st - 15th
-	Pre-Mine	Mean Discharge	m^3/s	0.06	0.04
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
-1	End of Construction	Mean Discharge	m^3/s	0.03	0.02
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-
10	Operations I	Mean Discharge	m^3/s	0.01	0.00
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-
22	Operations I	Mean Discharge	m^3/s	0.01	0.00
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-
27	Operations II	Mean Discharge	m^3/s	0.01	0.00
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-
30	Closure	Mean Discharge	m^3/s	0.01	0.01
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-
50	Post-Closure	Mean Discharge	m^3/s	0.01	0.01
		Mean Weighted Useable Area	m^2	0	0
		10th Percentile Weighted Useable Area	m^2	0	0
		90th Percentile Weighted Useable Area	m^2	0	0
		Mean Percent Change	%	-	-
		10th Percentile Percent Change	%	-	-
		90th Percentile Percent Change	%	-	-

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH PHABSIM MODELS.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX B4

TWO DIMENSIONAL MODEL RESULTS FOR NODE 9, HARPER CREEK BELOW T-CREEK CONFLUENCE

(Pages B4-1 to B4-3)

Knight Piésold CONSULTING

TABLE B4-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR BULL TROUT FRY AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	5.41	5.72	2.62	1.13	0.81	0.65
		Mean Weighted Useable Area	m^2	160	153	206	232	231	233
		10th Percentile Weighted Useable Area	m^2	111	110	161	200	224	224
		90th Percentile Weighted Useable Area	m^2	207	181	258	258	258	257
-1	End of Construction	Mean Discharge	m^3/s	4.06	4.11	1.76	0.80	0.57	0.56
		Mean Weighted Useable Area	m^2	178	175	219	238	231	231
		10th Percentile Weighted Useable Area	m^2	111	120	176	225	224	224
		90th Percentile Weighted Useable Area	m^2	248	235	258	258	247	255
		Mean Percent Change	%	11%	14%	6%	2%	0%	-1%
		10th Percentile Percent Change	%	0%	9%	9%	12%	0%	0%
		90th Percentile Percent Change	%	20%	30%	0%	0%	-4%	-1%
10	Operations I	Mean Discharge	m^3/s	3.66	3.39	1.53	0.68	0.51	0.52
		Mean Weighted Useable Area	m^2	183	184	224	236	230	231
		10th Percentile Weighted Useable Area	m^2	129	144	176	225	224	224
		90th Percentile Weighted Useable Area	m^2	250	246	258	257	247	252
		Mean Percent Change	%	14%	21%	9%	2%	0%	-1%
		10th Percentile Percent Change	%	17%	30%	10%	12%	0%	0%
		90th Percentile Percent Change	%	21%	36%	0%	0%	-4%	-2%
22	Operations I	Mean Discharge	m^3/s	3.63	3.34	1.50	0.67	0.51	0.51
		Mean Weighted Useable Area	m^2	184	185	225	235	230	231
		10th Percentile Weighted Useable Area	m^2	130	145	176	225	224	224
		90th Percentile Weighted Useable Area	m^2	251	248	258	257	245	252
		Mean Percent Change	%	14%	21%	9%	1%	-1%	-1%
		10th Percentile Percent Change	%	17%	32%	10%	12%	0%	0%
		90th Percentile Percent Change	%	21%	37%	0%	-1%	-5%	-2%
27	Operations II	Mean Discharge	m^3/s	3.64	3.38	1.53	0.68	0.52	0.52
		Mean Weighted Useable Area	m^2	183	185	224	235	231	232
		10th Percentile Weighted Useable Area	m^2	129	144	176	225	224	224
		90th Percentile Weighted Useable Area	m^2	250	247	258	257	250	256
		Mean Percent Change	%	14%	21%	9%	1%	0%	-1%
		10th Percentile Percent Change	%	17%	31%	9%	12%	0%	0%
		90th Percentile Percent Change	%	21%	36%	0%	0%	-3%	-1%
30	Closure	Mean Discharge	m^3/s	4.61	4.50	1.90	0.78	0.64	0.68
		Mean Weighted Useable Area	m^2	171	169	217	238	235	236
		10th Percentile Weighted Useable Area	m^2	111	111	175	225	225	225
		90th Percentile Weighted Useable Area	m^2	234	224	258	258	257	258
		Mean Percent Change	%	7%	11%	5%	3%	2%	1%
		10th Percentile Percent Change	%	0%	1%	9%	12%	0%	0%
		90th Percentile Percent Change	%	13%	24%	0%	0%	-1%	0%
50	Post-Closure	Mean Discharge	m^3/s	5.15	4.99	2.08	0.83	0.66	0.74
		Mean Weighted Useable Area	m^2	163	162	213	240	235	237
		10th Percentile Weighted Useable Area	m^2	111	111	175	225	224	224
		90th Percentile Weighted Useable Area	m^2	210	200	258	258	258	258
		Mean Percent Change	%	1%	6%	4%	3%	2%	2%
		10th Percentile Percent Change	%	0%	0%	9%	12%	0%	0%
		90th Percentile Percent Change	%	1%	11%	0%	0%	0%	0%

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH RIVER2D HABITAT MODEL.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB

TABLE B4-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR REARING BULL TROUT AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

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Mine Stage		Parameter	Units	Monthly					
Year	Description			May	Jun	Jul	Aug	Sep	Oct
-	Pre-Mine	Mean Discharge	m^3/s	5.41	5.72	2.62	1.13	0.81	0.65
		Mean Weighted Useable Area	m^2	159	154	178	168	169	168
		10th Percentile Weighted Useable Area	m^2	99	99	134	155	156	156
		90th Percentile Weighted Useable Area	m^2	213	209	216	197	187	180
-1	End of Construction	Mean Discharge	m^3/s	4.06	4.11	1.76	0.80	0.57	0.56
		Mean Weighted Useable Area	m^2	171	170	186	165	165	167
		10th Percentile Weighted Useable Area	m^2	126	131	157	156	156	156
		90th Percentile Weighted Useable Area	m^2	216	215	216	186	176	176
		Mean Percent Change	%	8%	10%	5%	-2%	-3%	-1%
		10th Percentile Percent Change	%	27%	32%	17%	0%	0%	0%
		90th Percentile Percent Change	%	1%	3%	0%	-6%	-6%	-2%
10	Operations I	Mean Discharge	m^3/s	3.66	3.39	1.53	0.68	0.51	0.52
		Mean Weighted Useable Area	m^2	176	180	179	164	166	168
		10th Percentile Weighted Useable Area	m^2	136	144	157	156	156	156
		90th Percentile Weighted Useable Area	m^2	216	216	216	177	178	180
		Mean Percent Change	%	11%	17%	1%	-2%	-2%	0%
		10th Percentile Percent Change	%	37%	44%	17%	0%	0%	1%
		90th Percentile Percent Change	%	2%	3%	0%	-10%	-4%	0%
22	Operations I	Mean Discharge	m^3/s	3.63	3.34	1.50	0.67	0.51	0.51
		Mean Weighted Useable Area	m^2	176	181	179	164	167	168
		10th Percentile Weighted Useable Area	m^2	136	144	157	156	156	157
		90th Percentile Weighted Useable Area	m^2	216	216	215	176	179	180
		Mean Percent Change	%	11%	17%	1%	-2%	-1%	0%
		10th Percentile Percent Change	%	38%	45%	17%	0%	0%	1%
		90th Percentile Percent Change	%	2%	3%	0%	-11%	-4%	0%
27	Operations II	Mean Discharge	m^3/s	3.64	3.38	1.53	0.68	0.52	0.52
		Mean Weighted Useable Area	m^2	176	180	179	164	167	168
		10th Percentile Weighted Useable Area	m^2	136	144	157	156	156	156
		90th Percentile Weighted Useable Area	m^2	216	216	215	180	179	180
		Mean Percent Change	%	11%	17%	1%	-2%	-1%	0%
		10th Percentile Percent Change	%	38%	45%	17%	0%	0%	1%
		90th Percentile Percent Change	%	2%	3%	0%	-9%	-4%	0%
30	Closure	Mean Discharge	m^3/s	4.61	4.50	1.90	0.78	0.64	0.68
		Mean Weighted Useable Area	m^2	166	165	180	167	166	167
		10th Percentile Weighted Useable Area	m^2	121	126	156	156	156	156
		90th Percentile Weighted Useable Area	m^2	215	212	215	185	181	181
		Mean Percent Change	%	5%	7%	1%	-1%	-2%	-1%
		10th Percentile Percent Change	%	22%	26%	17%	0%	0%	0%
		90th Percentile Percent Change	%	1%	1%	0%	-6%	-3%	1%
50	Post-Closure	Mean Discharge	m^3/s	5.15	4.99	2.08	0.83	0.66	0.74
		Mean Weighted Useable Area	m^2	162	160	181	167	164	166
		10th Percentile Weighted Useable Area	m^2	111	120	156	156	156	156
		90th Percentile Weighted Useable Area	m^2	214	210	216	183	176	178
		Mean Percent Change	%	2%	4%	2%	-1%	-3%	-1%
		10th Percentile Percent Change	%	12%	20%	17%	0%	0%	0%
		90th Percentile Percent Change	%	1%	0%	0%	-7%	-6%	-1%

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NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH RIVER2D HABITAT MODEL.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE B4-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

LIFE OF MINE MONTHLY WEIGHTED USEABLE AREA FOR SPAWNING BULL TROUT AT NODE 9 HARPER CREEK BELOW T-CREEK CONFLUENCE

Print Oct/15/14 13:33:27

Mine Stage		Parameter	Units	Time Period	
Year	Description			Aug 16th - 31st	Sep 1st - 15th
-	Pre-Mine	Mean Discharge	m^3/s	1.06	0.83
		Mean Weighted Useable Area	m^2	101	97
		10th Percentile Weighted Useable Area	m^2	79	75
		90th Percentile Weighted Useable Area	m^2	117	124
-1	End of Construction	Mean Discharge	m^3/s	0.74	0.59
		Mean Weighted Useable Area	m^2	99	107
		10th Percentile Weighted Useable Area	m^2	79	84
		90th Percentile Weighted Useable Area	m^2	116	131
		Mean Percent Change	%	-2%	10%
		10th Percentile Percent Change	%	-1%	13%
		90th Percentile Percent Change	%	-1%	5%
10	Operations I	Mean Discharge	m^3/s	0.63	0.54
		Mean Weighted Useable Area	m^2	106	111
		10th Percentile Weighted Useable Area	m^2	81	85
		90th Percentile Weighted Useable Area	m^2	125	132
		Mean Percent Change	%	4%	15%
		10th Percentile Percent Change	%	2%	13%
		90th Percentile Percent Change	%	8%	6%
22	Operations I	Mean Discharge	m^3/s	0.62	0.54
		Mean Weighted Useable Area	m^2	106	112
		10th Percentile Weighted Useable Area	m^2	81	85
		90th Percentile Weighted Useable Area	m^2	125	132
		Mean Percent Change	%	5%	15%
		10th Percentile Percent Change	%	2%	14%
		90th Percentile Percent Change	%	8%	6%
27	Operations II	Mean Discharge	m^3/s	0.64	0.55
		Mean Weighted Useable Area	m^2	106	111
		10th Percentile Weighted Useable Area	m^2	79	82
		90th Percentile Weighted Useable Area	m^2	125	132
		Mean Percent Change	%	4%	14%
		10th Percentile Percent Change	%	-1%	10%
		90th Percentile Percent Change	%	8%	6%
30	Closure	Mean Discharge	m^3/s	0.73	0.67
		Mean Weighted Useable Area	m^2	101	104
		10th Percentile Weighted Useable Area	m^2	78	80
		90th Percentile Weighted Useable Area	m^2	124	132
		Mean Percent Change	%	0%	7%
		10th Percentile Percent Change	%	-2%	7%
		90th Percentile Percent Change	%	6%	6%
50	Post-Closure	Mean Discharge	m^3/s	0.78	0.69
		Mean Weighted Useable Area	m^2	99	102
		10th Percentile Weighted Useable Area	m^2	77	79
		90th Percentile Weighted Useable Area	m^2	118	127
		Mean Percent Change	%	-3%	5%
		10th Percentile Percent Change	%	-2%	6%
		90th Percentile Percent Change	%	1%	2%

M:\1\01\00458\15\A\Data\Task 480 Fish Habitat Modelling\Rev 0\Habitat Modeling\[Node 9_Habitat Modeling_20141008.xlsx]Table Spawning

NOTES:
1. MEAN MONTHLY DISCHARGE VALUES CALCULATED FROM THE PRE-MINE AND LIFE OF MINE WATERSHED MODELS.
2. WEIGHTED USEABLE AREA (WUA) CALCULATED BASED ON DISCHARGE - WUA RELATIONSHIP DEVELOPED WITH RIVER2D HABITAT MODEL.

0	08OCT'14	ISSUED WITH REPORT VA101-00458/15-3	ACA	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

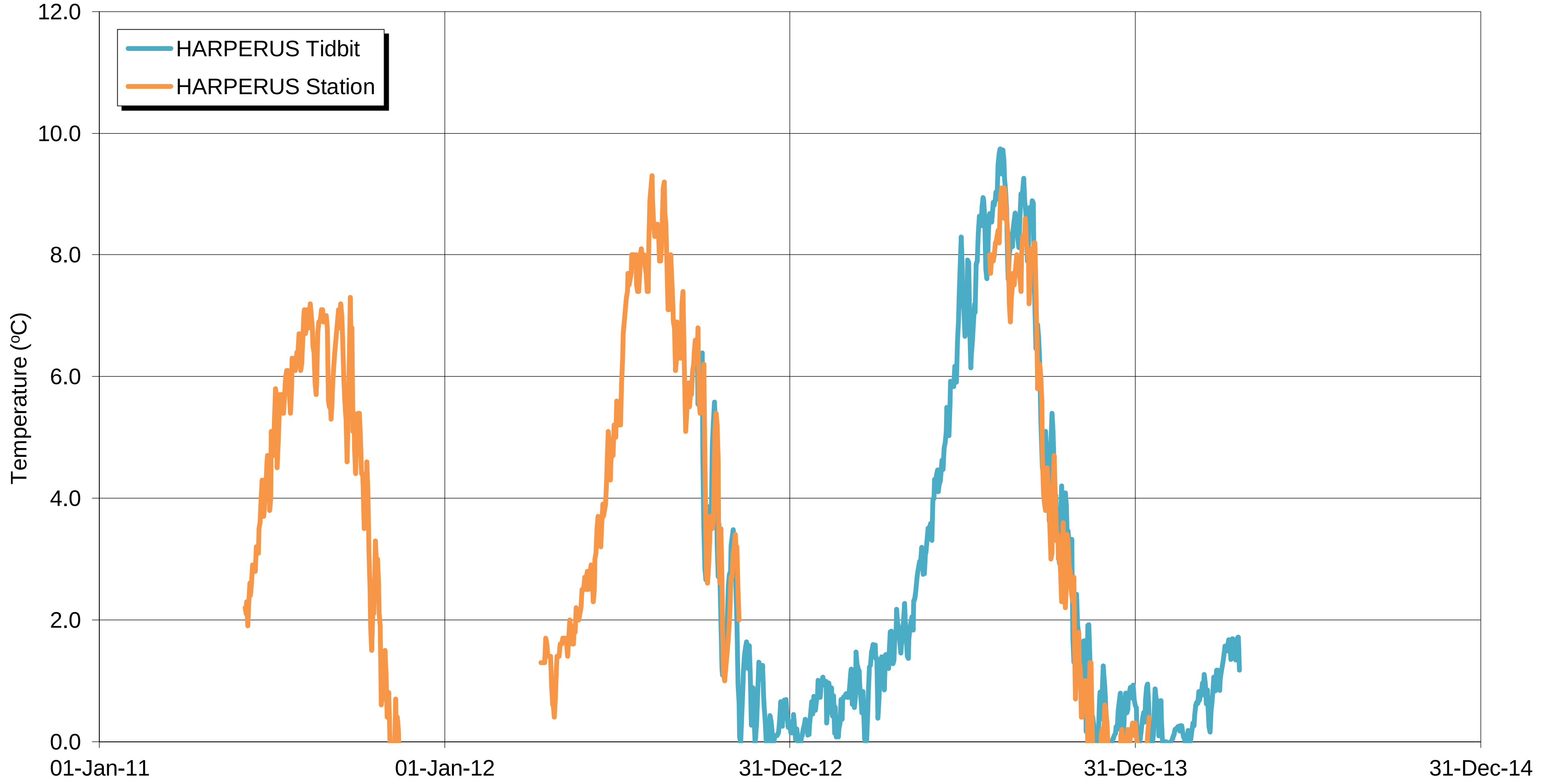
APPENDIX C

STREAM TEMPERATURE MODELLING

APPENDIX C1

DAILY STREAM TEMPERATURE AT HCMC STATIONS

(Pages C1-1 to C1-7)



REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT HARPERUS STATION
HARPER CREEK UPSTREAM OF T-CREEK CONFLUENCE

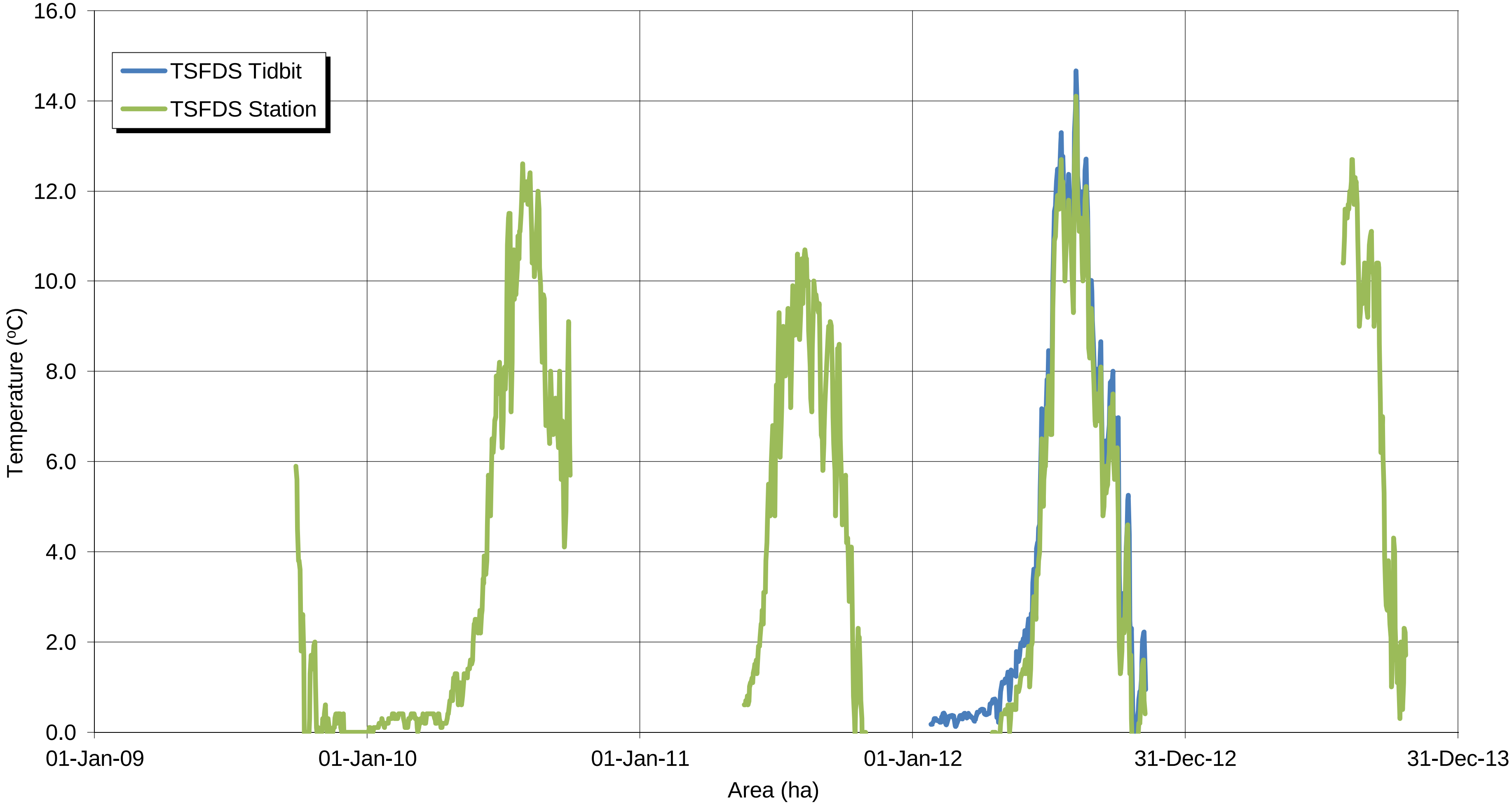
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-1

REV 0



HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT TSFDS STATION T-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

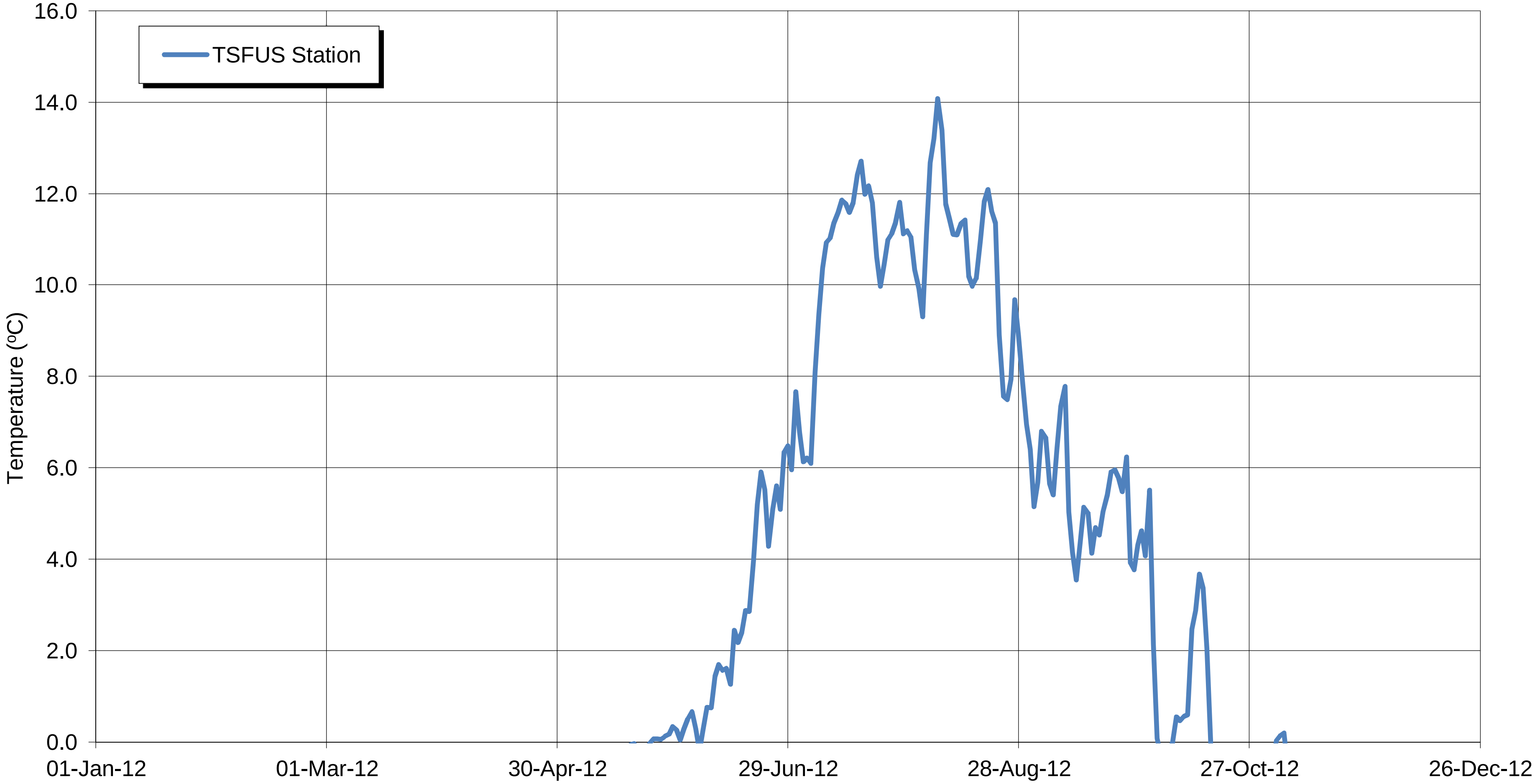
P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-2

REV 0

0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT TSFUS STATION T-CREEK UPSTREAM OF HARPER CREEK CONFLUENCE

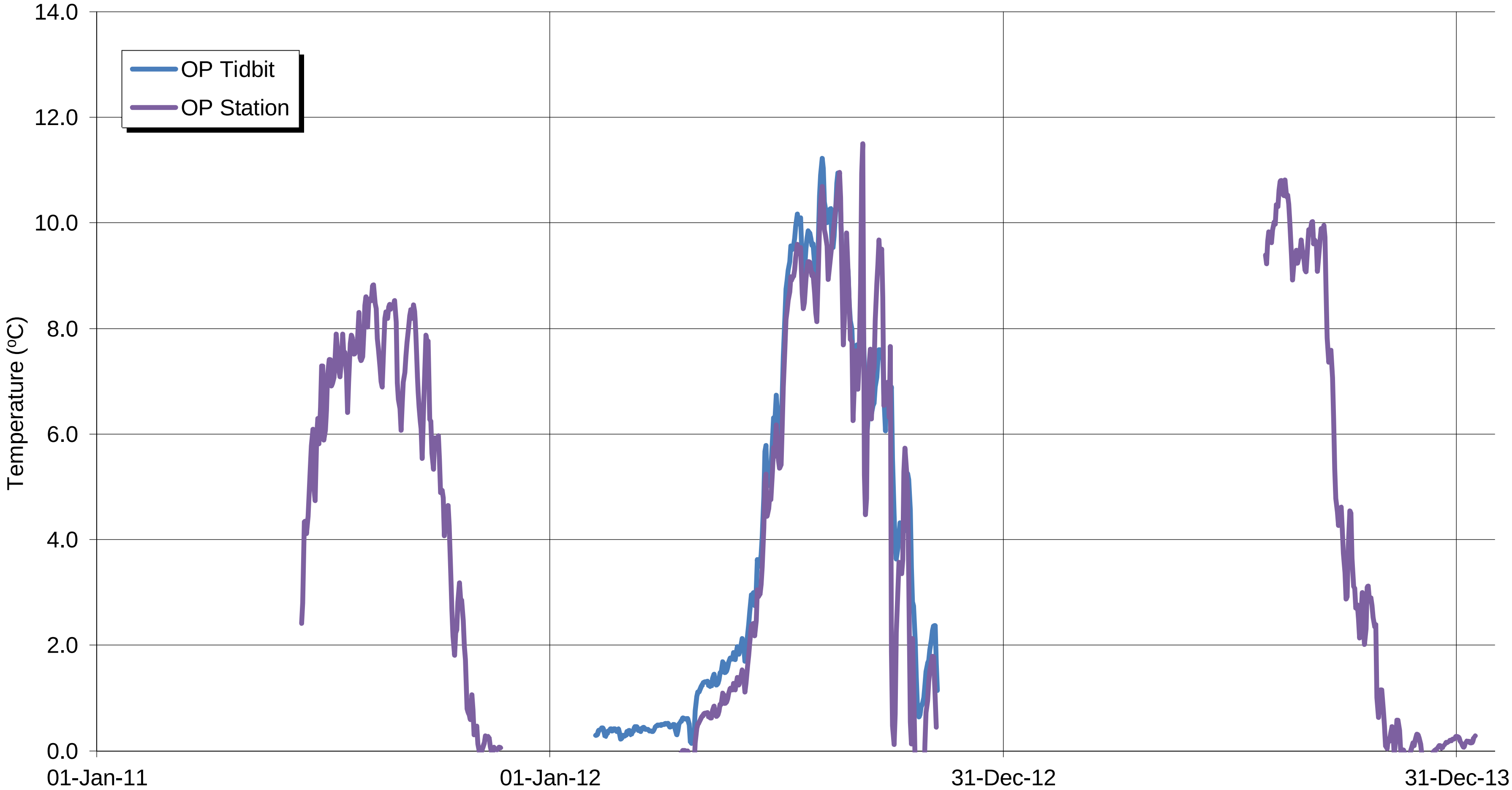
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-3

REV 0



0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT OP STATION P-CREEK AT HARPER CREEK CONFLUENCE

Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-4

REV 0

0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT JONESUS STATION JONES CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

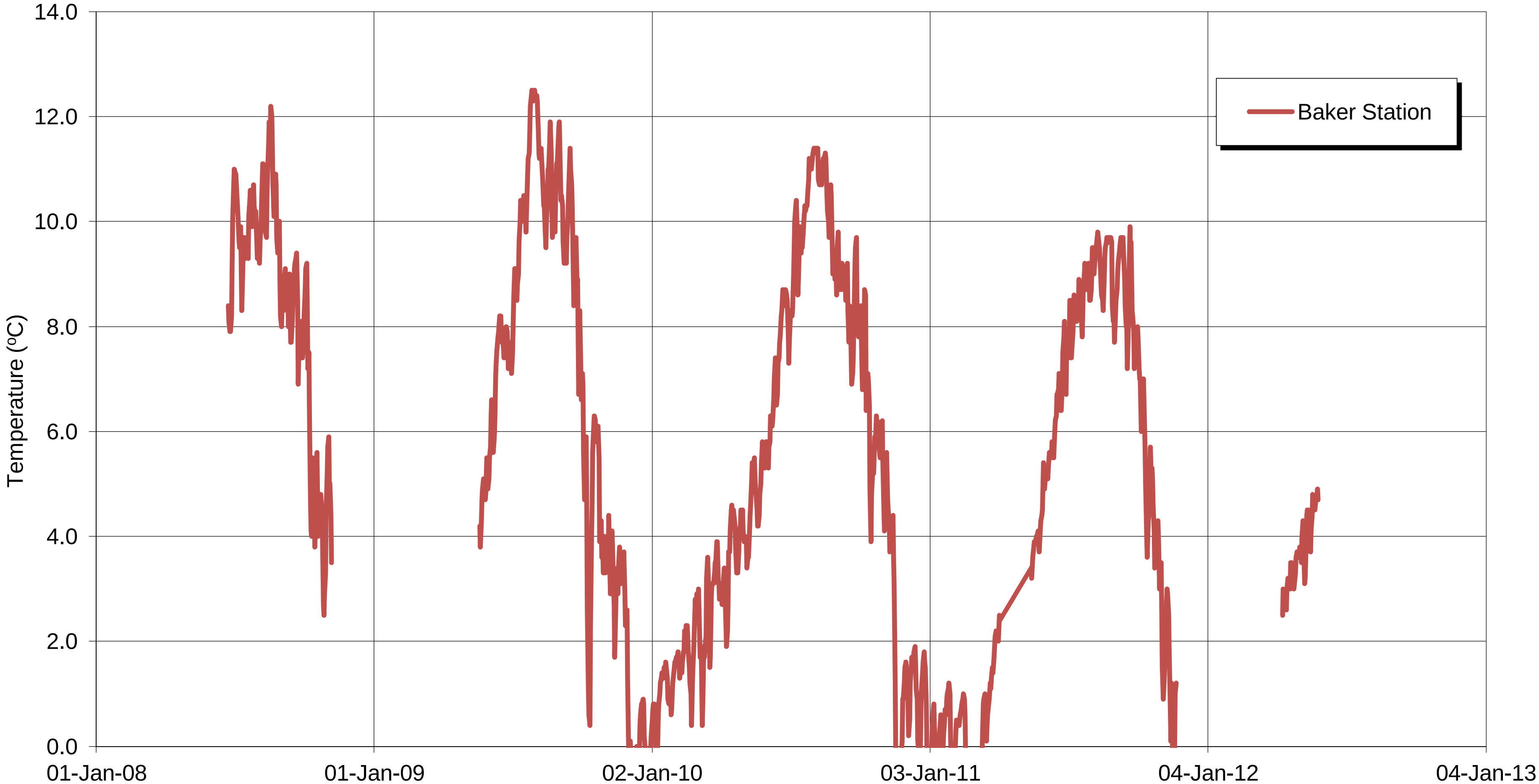
Knight Piésold CONSULTING

P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-5

REV 0



0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE AT BAKER STATION
BAKER CREEK ABOVE NORTH THOMPSON RIVER CONFLUENCE

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P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-6

REV 0

HARPER CREEK MINING CORP.

HARPER CREEK PROJECT

DAILY AVERAGE TEMPERATURE
HARPER CREEK AT ROAD CROSSING

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P/A NO. VA101-458/15

REF. NO. 3

FIGURE C1-7

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	29JUL'14	ISSUED WITH REPORT	BW	TJP	KJB

APPENDIX C2

STREAM TEMPERATURE MODELLING RESULTS

(Pages C2-1 to C2-6)

Knight Piésold CONSULTING

TABLE C2-1

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

HARPER CREEK STREAMFLOW TEMPERATURE CHANGES AT NODE 2
HARPER CREEK UPSTREAM OF T-CREEK

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	1.97	3.52	6.42	7.62	6.29	2.99
	Predicted Outflow Temperature (^oC)	2.03	3.60	6.53	7.72	6.37	3.01
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.97 - 2.10	3.49 - 3.71	6.36 - 6.71	7.45 - 7.99	6.21 - 6.54	2.92 - 3.10
	Temperature Increase over Reach (^oC)	0.06	0.08	0.11	0.10	0.08	0.02
Operations - Year 22	Change in Flow from Pre-Mine (%)	-14%	-14%	-7%	-6%	-9%	-7%
	Inflow Temperature (^oC)	1.97	3.52	6.42	7.62	6.29	2.99
	Predicted Outflow Temperature (^oC)	2.05	3.60	6.53	7.72	6.38	3.02
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.99 - 2.10	3.49 - 3.72	6.33 - 6.73	7.49 - 7.95	6.19 - 6.56	2.91 - 3.12
	Temperature Increase over Reach (^oC)	0.08	0.08	0.11	0.10	0.09	0.03
Temperature Change Rate Due to Flow Changes (^oC/km)		0.04	0.00	0.00	0.00	0.02	0.02

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NOTES:

1. MODEL REACH IS 500m IN LENGTH, ENDING AT THE HARPER US GAUGE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2011-2013
3. INFLOWS AND OUTFLOWS BASED ON DAILY DATA FROM 1974 - 2010.
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	10OCT'14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE C2-2

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

T-CREEK STREAMFLOW TEMPERATURE CHANGES AT NODE 3
T-CREEK AT HARPER CREEK CONFLUENCE

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	1.03	4.18	9.63	10.31	7.00	1.65
	Predicted Outflow Temperature (^oC)	1.44	4.59	9.98	10.60	7.26	2.35
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.40 - 1.47	4.46 - 4.71	9.70 - 10.26	10.31 - 10.88	7.06 - 7.47	2.24 - 2.47
	Temperature Increase over Reach (^oC)	0.41	0.41	0.35	0.29	0.26	0.70
Operations - Year 22	Change in Flow from Pre-Mine (%)	-68%	-70%	-77%	-87%	-91%	-83%
	Inflow Temperature (^oC)	1.03	4.18	9.63	10.31	7.00	1.65
	Predicted Outflow Temperature (^oC)	1.46	4.59	10.04	11.44	8.09	2.75
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.42 - 1.49	4.46 - 4.73	9.72 - 10.36	11.10 - 11.78	7.85 - 8.34	2.66 - 2.84
	Temperature Increase over Reach (^oC)	0.43	0.41	0.41	1.13	1.09	1.10
Temperature Change Rate Due to Flow Changes (^oC/km)		0.04	0.00	0.12	1.68	1.66	0.80

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NOTES:

1. MODEL REACH IS 500m IN LENGTH, ENDING AT THE TSFDS GAUGE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2009-2013
3. INFLOW AND OUTFLOW DATA CALCULATED USING DAILY FLOW DATA FROM 1974-2010.
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	15OCT'14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE C2-3

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

P-CREEK STREAMFLOW TEMPERATURE CHANGES AT NODE 5
P-CREEK AT HARPER CREEK CONFLUENCE

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^{o}C)	0.88	4.00	7.77	9.06	7.52	2.49
	Predicted Outflow Temperature (^{o}C)	1.12	4.24	8.09	9.52	7.92	2.78
	95 Percent Confidence Interval of Outflow Temperature (^{o}C)	1.09 - 1.15	4.12 - 4.36	7.85 - 8.33	9.23 - 9.81	7.66 - 8.17	2.78 - 2.93
	Temperature Increase over Reach (^{o}C)	0.24	0.24	0.32	0.46	0.40	0.29
Operations - Year 22	Change in Flow from Pre-Mine (%)	-60%	-69%	-81%	-81%	-90%	-68%
	Inflow Temperature (^{o}C)	0.88	4.00	7.77	9.06	7.52	2.49
	Predicted Outflow Temperature (^{o}C)	1.24	4.44	8.29	9.61	8.13	2.88
	95 Percent Confidence Interval of Outflow Temperature (^{o}C)	1.22 - 1.27	4.31 - 4.56	8.04 - 8.53	9.33 - 9.89	7.88 -8.38	2.88 - 3.06
	Temperature Increase over Reach (^{o}C)	0.36	0.44	0.52	0.55	0.61	0.39
Temperature change rate due to flow changes ($^{o}C/km$)		0.24	0.40	0.40	0.18	0.42	0.20

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NOTES:

1. MODEL REACH IS 500m IN LENGTH, ENDING AT THE OP GAUGE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2011-2013
3. INFLOWS AND OUTFLOWS BASED ON DAILY DATA FROM 1974-2010.
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	10OCT]14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE C2-4

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

JONES CREEK STREAMFLOW TEMPERATURE CHANGES AT NODE 6
JONES CREEK ABOVE NORTH THOMPSON CONFLUENCE

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	3.64	6.15	10.09	11.15	9.03	4.61
	Predicted Outflow Temperature (^oC)	3.95	6.48	10.37	11.37	9.32	4.79
	95 Percent Confidence Interval of Outflow Temperature (^oC)	3.84 - 4.05	6.30 - 6.66	10.09 - 10.65	11.05 - 11.70	9.04 - 9.61	4.65 - 4.92
	Temperature Increase over Reach (^oC)	0.31	0.33	0.28	0.22	0.29	0.18
Operations - Year 22	Change in Flow from Pre-Mine (%)	8.2%	7.6%	-4.1%	-39.7%	-53.9%	-22.8%
	Inflow Temperature (^oC)	3.64	6.15	10.09	11.15	9.03	4.61
	Predicted Outflow Temperature (^oC)	3.94	6.45	10.39	11.41	9.43	4.91
	95 Percent Confidence Interval of Outflow Temperature (^oC)	3.83 - 4.05	6.25 - 6.66	10.09 - 10.69	11.06 - 11.75	9.12 - 9.75	4.78 - 5.04
	Temperature Increase over Reach (^oC)	0.30	0.30	0.30	0.26	0.40	0.30
Temperature change rate due to flow changes (^oC/km)		-0.02	-0.06	0.04	0.08	0.22	0.24

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NOTES:

1. MODEL REACH IS 500m IN LENGTH, ENDING AT THE JONESUS GAUGE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2012-2013
3. INFLOW AND OUTFLOW DATA BASED ON DAILY DATA FROM 1974-2010.
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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TABLE C2-5

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

BAKER CREEK STREAMFLOW TEMPERATURE CHANGES AT NODE 7
BAKER CREEK AT NORTH THOMPSON RIVER CONFLUENCE

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	4.37	6.81	9.52	10.3	8.82	5.47
	Predicted Outflow Temperature (^oC)	4.59	7.00	9.70	10.59	9.23	5.78
	95 Percent Confidence Interval of Outflow Temperature (^oC)	4.42 - 4.69	6.80 - 7.20	9.44 - 9.95	10.29 - 10.88	8.92 - 9.54	5.62 - 5.93
	Temperature Increase over Reach (^oC)	0.22	0.19	0.18	0.29	0.41	0.31
Operations - Year 22	Change in Flow from Pre-Mine (%)	-14%	-18%	-21%	-27%	-42%	-23%
	Inflow Temperature (^oC)	4.37	6.81	9.52	10.3	8.82	5.47
	Predicted Outflow Temperature (^oC)	4.62	7.00	9.74	10.66	9.23	5.86
	95 Percent Confidence Interval of Outflow Temperature (^oC)	4.45 - 4.65	6.81 - 7.19	9.45 - 10.02	10.30 - 11.02	8.92 - 9.55	5.67 - 6.04
	Temperature Increase over Reach (^oC)	0.25	0.19	0.22	0.36	0.41	0.39
Temperature Change Rate Due to Flow Changes (^oC/km)		0.06	0.00	0.08	0.14	0.00	0.16

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NOTES:

1. MODEL REACH IS 500m IN LENGTH, ENDING AT THE BAKER GAUGE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2008-2012.
3. INFLOWS AND OUTFLOWS CALCULATED USING DAILY DATA FROM 1974-2010.
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	09OCT'14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE C2-6

HARPER CREEK MINING CORP.
HARPER CREEK PROJECT

HARPER CREEK STREAMFLOW TEMPERATURE MODEL SUMMARY AT NODE 9
HARPER CREEK BELOW T-CREEK CONFLUENCE

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Life of Mine	Parameter	May	June	July	August	September	October
Pre-Mine	Inflow Temperature (^oC)	1.66	3.79	7.71	8.42	6.48	2.78
	Predicted Outflow Temperature (^oC)	1.70	3.83	7.76	8.49	6.53	2.79
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.65 - 1.75	3.72 - 3.93	7.52 - 7.99	8.25 - 8.74	6.35 - 6.72	2.70 - 2.88
	Temperature Increase over Reach (^oC/)	0.04	0.04	0.05	0.07	0.05	0.01
Operations - Year 22	Change in Flow from Pre-Mine (%)	-32%	-40%	-37%	-32%	-33%	-20%
	Inflow Temperature (^oC)	1.85	3.83	7.00	7.93	6.46	2.97
	Predicted Outflow Temperature (^oC)	1.90	3.88	7.07	8.02	6.51	2.97
	95 Percent Confidence Interval of Outflow Temperature (^oC)	1.84 - 1.96	3.76 - 3.99	6.87 - 7.27	7.77 - 8.27	6.29 - 6.72	2.89 - 3.05
	Temperature Increase over Reach (^oC)	0.05	0.05	0.07	0.09	0.05	0.00
Temperature Change Rate Due to Flow Changes (^oC/km)		0.02	0.02	0.04	0.04	0.00	-0.02

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NOTES:

1. MODEL REACH IS 500m IN LENGTH ENDING 500m BELOW THE T-CREEK CONFLUENCE.
2. INFLOW TEMPERATURE BASED ON RECORDED TEMPERATURE DATA 2011-2013.
3. INFLOW AND OUTFLOW BASED ON DAILY DATA FROM 1974-2010
4. TEMPERATURE CHANGE RATE DUE TO FLOW CHANGES IS CALCULATED AS THE DIFFERENCE BETWEEN THE TEMPERATURE INCREASE IN OPERATIONS AND PRE-MINE DIVIDED BY THE MODELED REACH LENGTH.

0	10OCT'14	ISSUED WITH REPORT VA101-00458/15-3	BW	TJP	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D