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**KENO HILL SILVER DISTRICT STREAM DISCHARGE MONITORING  
AND AUTOMATED STREAM DISCHARGE MONITORING 2016 REPORT**

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Prepared for:

**ELSA RECLAMATION AND DEVELOPMENT COMPANY LTD.**



**ALEXCO ENVIRONMENTAL GROUP SIGNATURES**

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## **EXECUTIVE SUMMARY**

This report meets the requirements for deliverables as specified in the workplans for tasks ERDC 009-7 and ERDC 009-8 through the provision of the hydrometric monitoring results from the 2016 field season. In accordance with the work plans eight hydrometric monitoring stations were maintained through semi-annual visits including winterizing and surveys. Monthly monitoring was carried out by Alexco Environmental Group Inc. (AEG) Whitehorse personnel with assistance from Na-Cho Nyak Dun First Nation.



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## 1 INTRODUCTION

This report presents the surface water discharge data collected in the Keno Hill Silver District (KHSD) during 2016 as part of a site wide hydrometric and water quality program. Table 1 lists the discharge site names and their descriptions as well as the monitoring type and sampling schedule. Most sites require discharge to be measured whenever possible during monthly water quality sampling events, though conditions may occasionally not permit discharge measurements during the ice covered season.

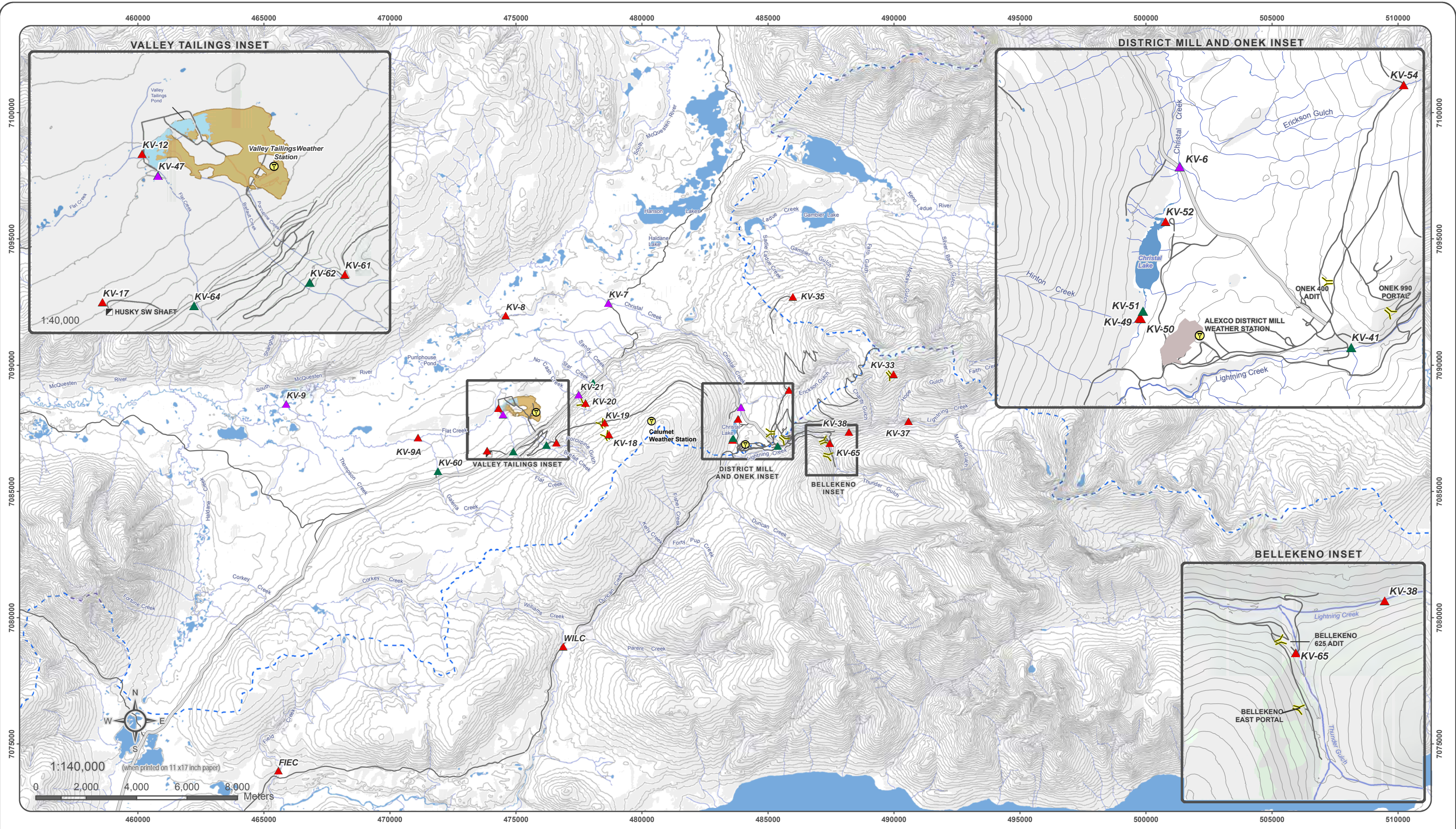
There are eight hydrometric monitoring stations with stilling wells and staff gauges. Formerly there were ten stations, but two stations, KV-62 and KV-47, were not providing reliable data due to unfavourable stream conditions and were decommissioned in 2016. At the eight operational stations, automated water level recorders are deployed in stilling wells to provide a continuous water level record during the ice-free season with interpolated winter data. Alexco Environmental Group Inc. (AEG) personnel from Whitehorse conducted sampling of these sites, with assistance from Nacho Nyak Dun First Nation (NNDFN) environmental monitors. Historic data are included in this report for completeness.

The following is a brief overview of the field program followed by results sections describing the continuously monitored hydrometric stations in more detail. There are four appendices to present that data including: Appendix A, 2016 discrete measurements; Appendix B, Historic discrete measurements; Appendix C, Hydrographs; and Appendix D, Photographs. Figure 1 provides an overview of the hydrometric sampling network.



**Table 1 – Surface water sites sampling schedule and type.**

Site	Description	Sampling Schedule	Continuous (Y/N)
KV-6	Christal Creek at Silver Trail Highway	monthly	Y
KV-7	Christal Creek at Hanson Road	monthly	Y
KV-8	Christal Creek at mouth	monthly	N
KV-9	Flat Creek upstream of South McQuesten River	monthly	Y
KV-9A	Flat Creek between Valley Tailings & KV-9	monthly	N
KV-12	Valley Tailings Pond #3 Decant	monthly	N
KV-17	Husky Southwest Adit	monthly	N
KV-18	Birmingham Adit	monthly	N
KV-19	Ruby Adit	monthly	N
KV-20	No Cash 500 Adit	monthly	N
KV-21	No Cash Creek at Silver Trail Highway	monthly	Y
KV-33	Keno 700 Adit	monthly	N
KV-35	Sadie Ladue Adit	monthly	N
KV-37	Lightning Creek upstream of Hope Gulch	monthly	N
KV-38	Lightning Creek upstream of Thunder Gulch	quarterly	N
KV-41	Lightning Creek upstream of bridge at Keno City	monthly	Y
KV-47	Porcupine Diversion Ditch downstream of Upper Flat Creek	quarterly	N
KV-49	Hinton Creek upstream of Christal Creek	monthly	N
KV-50	Christal Creek upstream of Hinton Creek	monthly	N
KV-51	Christal Creek downstream of Hinton Creek	monthly	Y
KV-52	Natural Spring to Christal Lake at Old Mackeno Pump house	monthly	N
KV-53	UN Adit	quarterly	N
KV-55	Sandy Creek at Silver Trail Highway	quarterly + winter months	N
KV-56	Star Creek at Silver Trail Highway	quarterly + winter months	N
KV-60	Galena Creek upstream of Silver King Adit	monthly	Y
KV-61	Porcupine Gulch at Calumet Road Crossing	monthly	N
KV-62	Befault Creek upstream of Porcupine diversion ditch	quarterly	N
KV-64	Flat Creek at Silver Trail Highway	monthly	Y
KV-65	Thunder Gulch upstream of Bellekeno 625	monthly	N
KV-66	Klondike Keno Adit	quarterly	N
KV-72	South McQuesten River at McQuesten Lake	monthly	N
WILC	Williams Creek downstream of Duncan Creek Road	monthly	N
FIEC	Field Creek upstream of Duncan Creek Road	monthly	N



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Datum: NAD 83; Map Projection: UTM Zone 8N

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- ▲ Hydrometric Monitoring Station
- ▲ Automatic Hydrometric Monitoring Station with Barologger
- ▲ Automatic Hydrometric Monitoring Stations
- ⊙ Weather Station
- Shaft
- Y Adit
- Watercourse
- Contour (100 feet)
- Watershed Divide
- Keno District Mill Site
- Valley Tailings
- Valley Tailings Ponds



**KENO HILL MINING DISTRICT**

**FIGURE 1**

**KENO HILL SILVER DISTRICT**

**DISCHARGE MONITORING LOCATIONS**

DECEMBER 2015

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## 2 METHODS

### 2.1 DATA COLLECTION OVERVIEW

Discharge measurements and staff gauge observations, if applicable, are taken during scheduled visits to the stations identified in Table 1. The velocity-area method is used for discharge measurements and taken with an electromagnetic current meter where and when suitable. Salt slug dilution gauging is used where a current meter is not suitable. These data are used to develop rating curves for computation of continuous water level data into derived continuous discharge records for the open water season. Discrete measurements during the winter allow the estimation of continuous winter low flows by drawing a recession curve through the observations. Continuous water levels are recorded at thirty minute or one hour intervals using Solinst Levellogger water level recorders in conjunction with Solinst Barologgers.

A typical hydrometric station installation consists of a cribbing structure (wood or metal) at least one graduated staff gauge, a stilling well (ABS or PVC), a pressure transducer (Solinst Levellogger), and bench marks (large spikes in tree bases or 6+ foot angle iron driven into the ground). Solinst Barologgers are used to compensate the Levelloggers and are shared between multiple stations. An example installation is shown in Figure 2.

Since 2012, all continuous hydrometric data have been processed using Aquatic Informatics' Aquarius time-series software; previous time-series and rating curve development was done in Microsoft Excel and, prior to 2011, by Clearwater Consultants Ltd.

More detailed methodology can be found in the AEG's *Standard Operating Protocol – Surface Water Hydrology – Data Collection and Management*.



**Figure 2 – KV-64 hydrometric monitoring station, installed in September 2015, below the Silver Trail Highway**

## **2.2 FIELD ACTIVITIES SUMMARY**

AEG and NDNFN monitors conducted monthly site visits in 2016. Data are recorded manually in field books and transcribed into Excel templates for discharge calculation. AEG Whitehorse personnel provide data management and QA/QC for all data collected.

Hydrometric stations were de-winterized in May 2016 and winterized in September 2016. Continuous data are provided to late September 2016 as loggers are not routinely downloaded in winter due to weather conditions and complications with electronic equipment. The hydrometric stations are also surveyed during the two bi-annual maintenance trips. All stations remain in good condition. Data loggers were removed from stations KV-47 and KV-62 and these stations are now monitored quarterly during routine water quality data collection.

There was a greater emphasis in 2016 on gathering discharge from some historic adits which have few measurements and on gathering winter low flow discharge measurements on Sandy and Star creeks to better understand winter baseflow and groundwater. However, it became apparent that these sites lack



measurements because they go dry or flows are so low measurement is not possible (i.e. less than 1-2 L/s).  
Visits to all sites in 2016 are recorded in Appendix A.

## 3 RESULTS

### 3.1 DISCRETE MEASUREMENTS

Appendix A lists discrete discharge measurements taken in 2016 for all sites listed in Table 1. Appendix B includes all discrete discharge observations to date at those same sites. Site visits in 2016 where no measurement was taken have also been included in Appendix B when relevant comments on hydrological conditions are included. Climatic conditions in the region present an exceptional challenge to gathering discharge measurements year around which can result in no observations during winter months.

### 3.2 HYDROMETRIC STATIONS AND CONTINUOUS MONITORING

There were eight hydrometric stations active during the 2016 monitoring season including: KV-6, KV-7, KV-9, KV-21, KV-41, KV-51, KV-60, and KV-64. KV-51 and KV-64 have fewer rating measurements than other longer term sites and therefore there is greater uncertainty in the rating curves and derived discharge records at these sites.

All stations remain stable and did not require maintenance beyond surveys and stilling well de-silting. KV-21 requires removal of built up sediment on a monthly basis to ensure the weir pond does not fill up. KV-60, Galena Creek above Silver King, was relocated in 2014 and though the gradient of the stream lends some uncertainty to the rating curve it continues to provide a continuous derived discharge record. KV-7 and KV-41 are both older stations with wooden cribbing structures. These stations should be replaced with metal cribbing and new stilling wells and staff gauges in the next 2-3 years to bring them up to the standard of quality of the other stations and ensure continued stability.

All hydrometric stations now yield year round continuous data; although the winter is estimated based on monthly discrete measurements. In 2016 continuous discharge data are available for all eight hydrometric stations.

#### 3.2.1 KV-6 CHRISTAL CREEK ABOVE SILVER TRAIL HIGHWAY

The hydrometric station on Christal Creek at KV-6 is above the Silver Trail highway and several hundred metres downstream of Christal Lake. The catchment area is ~6.1 km<sup>2</sup> with a median elevation of ~1002 metres above sea level (masl). Instantaneous discharge measurements have been collected since June 2008 on a monthly basis where possible.

A Solinst water level recorder was deployed at KV-6 in a stilling well on July 20<sup>th</sup> 2011 and retrieved on October 23<sup>rd</sup> 2011. There was one discharge measurement taken during the continuous water level record but no staff gauge was installed.

The 2012 Solinst Levellogger record begins May 1<sup>st</sup> and extends till mid-October. Ice begins to affect the pressure readings on October 10<sup>th</sup> making water levels and derived discharge following that unreliable (Figure C1, Appendix C). A staff gauge was installed along with the Levellogger on May 1<sup>st</sup> with a corresponding BaroLogger (barometric pressure data logger). After mid-July the record becomes unreliable due to a ponding effect (Figure C1, Appendix C).

In 2013, the KV-6 station was moved upstream due to the ponding encountered from the road culvert in 2012, but due to infrequent measurements a continuous record could not be produced. Furthermore, the station was moved again in September 2013 to a more stable reach with a better control section more favourable to measuring flow. The current location remains relatively stable and free of backwater effects.

Reliable stage records began at the new location in late May 2014 (Figure C2, Appendix C) and a derived discharge record has been produced continuously since that time. Winter records are approximated by drawing a line through discrete measurements as appropriate or manipulation of the record relative to the discrete measurements, taking into consideration higher winter measurement uncertainty. The peak annual discharge in 2015 at KV-6 was 0.353 m<sup>3</sup>/s on May 11<sup>th</sup>, 2015 (Figure C3, Appendix C). Figure C4 (Appendix C) shows the 2016 hydrograph including the peak, 0.280 m<sup>3</sup>/s, on April 27<sup>th</sup>, 2016.

Table 2 shows instantaneous discharge measurements taken since 2008 at KV-6, while Table 3 shows all monthly means where continuous data are available. Discrete measurements are included in Appendix A (2016) and Appendix B (all years).

**Table 2 - Instantaneous discharge measurements at KV-6, Christal Creek below Christal Lake (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008						0.064	0.130	0.119	0.080	0.161		
2009						0.124	0.101	0.114	0.103	0.033		
2010					0.071		0.094	0.061	0.141	0.094		
2011					0.136	0.080	0.091		0.127	0.088	0.075	0.107
2012		0.077		0.062	0.126	0.089	0.095	0.091	0.089	0.076		
2013						0.123	0.082	0.079	0.091	0.093	0.080	
2014			0.050	0.052	0.143	0.059	0.100	0.063	0.110	0.102	0.080	
2015	0.104		0.07	0.056	0.324	0.106	0.100	0.125	0.137	0.092	0.147	0.142
2016	0.130	0.067	0.086	0.071	0.170	0.104	0.098	0.180	0.122	0.094	0.087	
Mean	0.058	0.077	0.060	0.057	0.160	0.092	0.099	0.093	0.110	0.092	0.096	0.068
95% Confidence limit	0.025	0.010	0.020	0.008	0.069	0.017	0.009	0.027	0.014	0.021	0.026	0.034

**Table 3 – Mean Monthly Discharge at KV-6, Christal Creek below Christal Lake, for months where continuous data are available (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012					0.123	0.089	0.102					
2013												
2014					0.063	0.096	0.073	0.117	0.115	0.107	0.081	0.077
2015	0.092	0.078	0.066	0.084	0.185	0.110	0.119	0.123	0.128	0.116	0.115	0.107
2016	0.101	0.09	0.072	0.115	0.127	0.110	0.136	0.154	0.127			
Mean	0.097	0.084	0.069	0.100	0.125	0.101	0.108	0.131	0.123	0.112	0.098	0.092
95% Confidence limit	0.009	0.012	0.006	0.030	0.049	0.010	0.026	0.022	0.008	0.009	0.033	0.029

### 3.2.2 KV-7 CHRISTAL CREEK AT HANSON-MCQUESTEN LAKES ROAD BRIDGE

Christal Creek at KV-7 drains an area of ~35.8 km<sup>2</sup> with a median elevation of ~970 masl and includes KV-6, KV-51 and Christal Lake. There are a number of old workings within the watershed including Galkeno 300, Galkeno 900, Brewis Red Lake, Lucky Queen, Klondike Keno and, at least partially, Onek 400. Additionally, the Alexco District Mill, the Silver Trail Highway and parts of Keno City including the Keno City dump are at least partially within the watershed. It includes both a major east facing slope of Galena hill and west facing aspects of Sourdough hill.

Clearwater Consultants Ltd. (CCL) processed and summarized the data for 2004 - 2009 (CCL 2008; 2010). Data for 2010 and 2011 were processed by AEG following the same methodology as CCL. AEG has utilized Aquarius time series software since 2012 to manage the hydrometric data at KV-7. Mean monthly discharge is shown since 2003 at KV-7 in Table 4. Figure C55 to Figure C1011 (Appendix C) show the hydrographs for 2010, 2011, 2012, 2013, 2014, 2015, and 2016, respectively. Discrete measurements are included in Appendix A (2016) and Appendix B (all years).

The 2016 hydrograph shows a substantial peak in late April associated with freshet as well as a several peaks throughout the summer and fall associated with storm events. The peak annual discharge was 2.026 m<sup>3</sup>/s captured on July 26<sup>th</sup>, 2016 as a result of summer rain storms (Figure C10, Appendix C). KV-6 did not show the same peak, which is assumed to be as a result of the dampening effect of the lake.

**Table 4 – Mean Monthly Discharge at KV-7, Christal Creek at Hanson-McQuesten Road Bridge (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003								0.42	0.51			
2004			0.15	0.166	1.153	0.314	0.119	0.112	0.163	0.135	0.103	0.101
2005		0.122	0.112	0.391	1.54	0.264	0.294	0.398	0.335	0.259	0.189	0.150
2006	0.166	0.138	0.117	0.124	1.089	0.519	0.397	0.278	0.415	0.368	0.203	0.142
2007	0.151	0.12			0.757	0.327	0.54	0.218	0.335	0.154		
2008								0.43	0.333	0.352		0.134
2009	0.079	0.068	0.048	0.074	1.123	0.338	0.102	0.183	0.368			
2010					0.309	0.24	0.359	0.23	0.232	0.186		
2011					1.26	0.142	0.503	0.419	0.268	0.173	0.126	
2012	0.154	0.078			0.730	0.258	0.400	0.217	0.267	0.200		
2013	0.075	0.066				0.285	0.126	0.08	0.332	0.227	0.140	0.110
2014	0.097	0.103	0.086	0.077	0.740	0.430	0.195	0.573	0.351	0.220	0.176	0.140
2015	0.089	0.072	0.059	0.165	1.091	0.192	0.368	0.517	0.614	0.271	0.165	0.137
2016	0.125	0.125	0.081	0.268	0.580	0.266	0.560	0.692	0.541			
Mean	0.117	0.099	0.093	0.181	0.943	0.298	0.330	0.341	0.362	0.231	0.157	0.131
95% Confidence limit	0.025	0.018	0.026	0.084	0.207	0.057	0.093	0.095	0.065	0.045	0.027	0.013

Note: Grey numbers are discrete discharge measurements (included in means Oct-Apr).

### 3.2.3 KV-9 FLAT CREEK NEAR THE MOUTH

The Flat Creek headwaters originate on the Northwest face of Galena Hill above the former Elsa town site. Flat Creek at KV-9 also includes Thompson, Galena, Porcupine and Brefault Creeks. Flowing adits and shafts within the Flat creek watershed include, but are not limited to, Silver King and Husky Southwest. The former Elsa town site and the Valley Tailings Facility are also situated within the Flat Creek watershed making it one of the more heavily anthropogenically modified watersheds in the district. The total drainage area of Flat Creek is ~56.5 km<sup>2</sup> with a median elevation of ~830 masl. Station KV-9 is located just above the confluence of Flat Creek with the South McQuesten River approximately 10 km east of Elsa. In recent years, Flat Creek at KV-9 has remained open all winter allowing for accurate low flow measurements with a velocity meter and applicable stage observations. This is an extremely valuable site because of this feature.

Mean monthly discharge values from derived continuous discharge records for KV-9 are presented in Table 5 with some spot flows included as estimates where noted. Figure C122 to Figure C178 (Appendix C) show the discharge time series for 2010, 2011, 2012, 2013, 2014, 2015, and 2016, respectively. The 2016 hydrograph captured the freshet flow with a maximum observed flow of 2.370 m<sup>3</sup>/s on May 4<sup>th</sup>, 2016 (Figure C168, Appendix C). Discrete measurements are included in Appendix A (2016) and Appendix B (all years).

**Table 5 – Mean Monthly Discharge at KV-9, Flat Creek near the Mouth (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004								0.116	0.099	0.11	0.046	0.034
2005	0.03	0.028	0.126	0.273	2.077	1.017	0.282	0.34	0.33	0.28		
2008								0.545	0.375	0.448	0.129	0.09
2009	0.053	0.029	0.02	0.01	2.155	0.51	0.088	0.092	0.364			
2010						0.133	0.171	0.086	0.118	0.099		
2011					1.97	0.349	0.927	0.756	0.364	0.299		
2012				0.014	1.574	0.430		0.208	0.361	0.276		
2013					2.825	0.636	0.159	0.084	0.102	0.411	0.081	
2014					1.856	0.520	0.204	0.786	0.535	0.559	0.06	0.015
2015	0.009	0.007	0.01	0.102	1.927	0.178	0.31	0.511	0.873	0.423	0.131	0.057
2016	0.021	0.009	0.001	0.538	1.011	0.202	0.402	0.758				
Mean	0.028	0.018	0.039	0.187	1.924	0.442	0.318	0.389	0.352	0.312	0.092	0.049
95% Confidence limit	0.018	0.012	0.057	0.196	0.356	0.180	0.184	0.172	0.144	0.111	0.044	0.032

Note: Grey numbers are discrete discharge measurements (included in means Oct-Apr).

### 3.2.4 KV-21 NO CASH CREEK AT THE SILVER TRAIL HIGHWAY

No Cash Creek flows just northeast of Elsa and has a catchment area of ~1.4 km<sup>2</sup> at the Silver Trail Highway (KV-21). The median elevation is ~1212 masl and includes the No Cash 500 adit (KV-20), which is free draining. Calumet Drive (Galkeno 300 Road) bisects the catchment and two culverts convey water at different locations. The physical area of the catchment is a product of the road cut and associated culverts. It is possible that freshet flows may be reduced as a result of water bypassing frozen culverts and being directed into Porcupine Creek.



However, direct observations during this period are absent, but frozen culverts during freshet have been observed at other sites in and around Elsa (e.g. Porcupine diversion along Calumet Drive). Table 6 shows the discrete measurements gathered to date at KV-21.

Previous attempts at continuous gauging at KV-21 have not been successful due to heavy icing and a steep dynamic channel near the Silver Trail Highway. High water velocities, ice and machinery have all contributed to damage to the stilling wells and general channel instability. In September 2013, AEG and AKHM personnel installed a new station approximately 150 m below the Silver Trail Highway where the channel has a lower gradient. An artificial control was installed to create a step pool and provide a convenient place to measure water level. However, flows were so low in 2014 that stage changes were insufficient to establish a reliable rating curve. In June of 2015, AEG Whitehorse personnel installed a V-notch weir to garner reliable continuous data (Figure 3). The weir has provided a high confidence rating curve and continuous discharge has been successfully derived since installation. The highest discharge measured with the logger was 0.081 m<sup>3</sup>/s on August 11<sup>th</sup> as the weir was not installed until after freshet. Figure C19 (Appendix C) shows the 2015 hydrograph but the freshet peak was not captured; however, a discrete measurement of 0.244 m<sup>3</sup>/s was measured on May 14<sup>th</sup>, 2016 during freshet. Freshet was not as large in 2016 but peaked at 0.164 m<sup>3</sup>/s on May 2<sup>nd</sup>, 2016 (Figure C20, Appendix C). Discrete measurements are also included in Appendix A (2016) and Appendix B (all years).

**Table 6 – Discrete Discharge measurements at KV-21, No Cash Creek at the Silver Trail Highway (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007							0.015					
2008								0.007				
2009							0.003			0.006		
2010					0.010	0.008	0.007			0.008		
2011					0.020		0.005	0.011				
2012		0.002					0.012					
2013									0.016	0.017	0.004	
2014					0.058	0.005	0.005	0.011	0.026	0.013	0.007	
2015	0.003			0.002	0.244	0.011			0.035	0.017	0.002	0.010
2016	0.005	0.004	0.006	0.003	0.049	0.016	0.022	0.045	0.025	0.010	0.006	0.006
<b>Mean</b>	0.004	0.003	0.006	0.002	0.076	0.010	0.010	0.019	0.026	0.012	0.005	0.008
<b>95% Confidence limit</b>	0.002	0.002	N/A	0.001	0.084	0.005	0.005	0.018	0.008	0.004	0.002	0.004





Figure 3 – Weir at KV-21, June 2015

Table 7 – Mean Monthly Discharge at KV-21, No Cash Creek at the Silver Trail Highway (m<sup>3</sup>/s)

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015						0.010	0.017	0.020	0.027	0.016	0.004	0.008
2016	0.005	0.004	0.005	0.01	0.044	0.017	0.019	0.019	0.019			
Mean	0.005	0.004	0.005	0.010	0.044	0.014	0.018	0.020	0.023	0.016	0.004	0.008

### 3.2.5 KV-41 LIGHTNING CREEK AT KENO CITY BRIDGE

Lightning Creek at KV-41 has a catchment area of ~59 km<sup>2</sup> and a median catchment elevation of approximately ~1400 masl. Lightning Creek originates east of Keno City and drains the southern aspect of Keno Hill and the northern aspect of Mount Hinton. Lightning Creek flows to the south of Galena Hill into Duncan Creek. Within the Lightning Creek watershed are multiple adits including Keno 200 and 700, multiple old surface workings, Bellekeno workings and active placer mining on Thunder Gulch.

Hydrometric station KV-41 is located above the Keno City Bridge, and downstream of the Bellekeno Mine and local placer mining activity. Figure C2121 through Figure C256 (Appendix C) show the discharge time series for 2010, 2011, 2012, 2014, 2015, and 2016, respectively. Due to a logger failure in 2013 no continuous discharge was available.

Figure C256 (Appendix C) shows the 2016 hydrograph at KV-41 which includes the peak annual discharge 6.334 m<sup>3</sup>/s captured June 7<sup>th</sup>, 2016. As with previous years the peak occurred later on Lightning Creek, presumably due to a lag in snowmelt associated with the higher median elevation of the Lightning Creek Catchment.

Table 8 presents mean monthly data gathered since continuous data collection began and includes discrete discharge measurements in grey in lieu of monthly means where data are unavailable. Discrete measurements are included in Appendix A (2016) and Appendix B (all years).

**Table 8 – Mean Monthly Discharge at KV-41, Lightning Creek above Keno City Bridge (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2004</b>								0.433	0.315	0.24	0.153	0.125
<b>2005</b>	0.098	0.067	0.056	0.13	1.802	1.418	0.989	1.111	0.958	0.637	0.452	0.299
<b>2006</b>	0.219	0.192	0.194	0.272	0.793	1.994	1.326	0.921	1.083	0.889	0.554	0.447
<b>2007</b>					1.231	1.926	1.193					
<b>2008</b>								1.136	0.77	1.03		
<b>2009</b>		0.11	0.128	0.069	1.595	1.628						
<b>2010</b>					1.172	1.383	1.007	0.76	0.57	0.457		
<b>2011</b>						1.206	1.826	1.542	0.926			0.268
<b>2012</b>	0.251	0.159	0.182			2.096	1.404	0.707	0.869	0.566		
<b>2013</b>						1.901	0.71	0.437	0.774	0.766	0.421	0.174
<b>2014</b>	0.149	0.126	0.096		1.25	1.746	0.703	1.264	0.851	0.614	0.336	0.212
<b>2015</b>	0.198	0.198	0.197	0.195	2.487	1.178	1.035	1.377	1.544	0.735	0.388	0.217
<b>2016</b>	0.201	0.211	0.21	0.217	1.27	1.862	0.924	1.246	0.785			
<b>Mean</b>	0.183	0.142	0.142	0.167	1.513	1.619	1.185	1.028	0.876	0.659	0.384	0.249
<b>95% Confidence limit</b>	0.044	0.039	0.044	0.069	0.356	0.192	0.211	0.220	0.181	0.152	0.108	0.077

Note: Grey numbers are discrete discharge measurements (Included in means Oct-Apr).

### 3.2.6 KV-51 CHRISTAL CREEK DOWNSTREAM OF HINTON CREEK

In 2015, a new hydrometric station was commissioned above Christal Lake to better quantify the water balance of Christal Lake. Provisional data were provided in 2015 and the rating curve was updated for 2016. The 2015 hydrograph begins in early June when the station was established and shows similar event peaks to lower Christal Creek sites, but unfortunately did not capture freshet. However, a discrete measurement of 0.116 m<sup>3</sup>/s was taken May 12<sup>th</sup> during the freshet period (Figure C27, Appendix C). As at KV-7 freshet did not produce the peak annual flow at KV-51; peak discharge occurred on July 25<sup>th</sup>, 2016 at 0.136 m<sup>3</sup>/s (Figure C28, Appendix C). Table 9 summarizes the continuous data collected to date as mean monthly discharge while discrete measurements are included in Appendix A (2016) and B (historic).

**Table 9 – Mean Monthly Discharge at KV-51, Christal Creek downstream of Hinton Creek (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2015</b>						0.024	0.029	0.034	0.045	0.038	0.035	0.034
<b>2016</b>	0.033	0.031	0.031	0.036	0.053	0.043	0.052	0.067	0.053			
<b>Mean</b>	0.033	0.031	0.031	0.036	0.053	0.034	0.041	0.051	0.049	0.038	0.035	0.034

### 3.2.7 KV-60 GALENA CREEK ABOVE SILVER KING ADIT

Galena Creek is southwest of Elsa and the upper reaches of the watershed border those of Flat Creek with northwest aspect. KV-60 is located below the Silver Trail Highway and adjacent to the Silver King 100 Adit. Treatment water from Silver King does not influence KV-60. The catchment at KV-60 is ~9.4 km<sup>2</sup> with a median elevation of ~997 masl. The channel is deeply incised and flows through a rocky canyon just above the Silver Trail Highway and is characterized by large boulders and step pools, not dissimilar to Flat Creek. The historic Silver King 75 adit is located in the canyon above the highway.

Continuous hydrometric monitoring at KV-60 has been challenging due to the high gradient and flow velocity of the site. Large gravel and cobbles are frequently transported at this. The stream morphology can change each season during freshet compounding data collection challenges. KV-60 was re-established and resurveyed in September 2013 in conjunction with some channel modifications in an attempt to establish a stable control using large rocks in the channel. In September 2014 the channel was modified in an effort to minimize deposition of gravel around the staff gauge, once again altering the stage-discharge relationship. In June 2015 it was found that these efforts had ultimately failed to create favourable conditions for the reach and a decision was made in the field to establish a new staff gauge in the pool just above without any modifications to the natural arrangement of the channel as it was observed that this pool seemed to be stable over the preceding years.

Hydrographs for 2012, 2013, 2014, 2015 and 2016 are included in Appendix C; Figure C29 to Figure C33 respectively. The 2015 hydrograph peaks on May 13<sup>th</sup> at 4.40 m<sup>3</sup>/s which is the highest reliable data point measured to date (Figure C32, Appendix C). Freshet peaked much lower in 2016 at 0.725 m<sup>3</sup>/s on April 2<sup>nd</sup>, 2016 (Figure C33, Appendix C). One discrete measurement in August of 2016 appears to disagree with the derived record, but the measurement showed high uncertainty (45%) so can be disregarded. Table 10 presents the mean monthly discharge since continuous data gathering began in 2012. Discrete measurements are included in Appendix A (2016) and Appendix B (all years).

**Table 10 - Monthly Discharge at KV-60, Galena Creek above Silver King Adit (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2012</b>	0.007	0.004			0.386	0.039	0.095	0.046	0.065	0.025		
<b>2013</b>				0.994	0.891	0.315	0.018		0.045	0.078		
<b>2014</b>					0.039	0.144	0.017	0.234	0.104	0.112	0.026	0.016
<b>2015</b>	0.010	0.006	0.037	0.149	0.354	0.055	0.143	0.206	0.185	0.084	0.035	0.017



<b>2016</b>	0.013	0.009	0.012	0.117	0.268	0.058	0.094	0.116	0.113			
<b>Mean</b>	0.009	0.005	0.037	0.572	0.388	0.122	0.073	0.151	0.102	0.075	0.031	0.017
<b>95% Confidence limit</b>	0.003	0.003	0.024	0.563	0.274	0.101	0.048	0.084	0.047	0.036	0.009	0.001

Note: Grey numbers are discrete discharge measurements (Included in means Oct-Apr).

### 3.2.8 KV-64 FLAT CREEK AT SILVER TRAIL HIGHWAY

Flat Creek at the Silver Trail Highway is steep, rocky, and unstable. Water Quality measurements are gathered above the highway, but there is no suitable location for continuous gauging above the highway. Attenuation of peak flows occurs at the highway where significant deposition has covered older culverts and it is clear that water levels rise above the top of the culvert during freshet. Perhaps due to this effect or due to lessened anthropogenic influence the reaches below appear more stable and ultimately a station was established below the highway in September 2015 (Figure 2). The deposition above the highway was excavated and repairs were made to the culverts in 2016 to mitigate ponding above the highway during freshet. Continuous discharge was derived for 2016 and shows a peak on 0.334 m<sup>3</sup>/s on May 9<sup>th</sup>, 2016 (Figure C34, Appendix C). However, due to the lower number of rating measurements there is still greater uncertainty at this site compared to other long term stations in the district. Table 11 presents the mean monthly discharge from the period of the derived discharge record. Discrete measurements are included in Appendix A (2016) and Appendix B (all available)

**Table 11 – Mean Monthly Discharge at KV-64, Flat Creek below the Silver Trail Highway (m<sup>3</sup>/s)**

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>2015</b>									0.077	0.037	0.043	0.017
<b>2016</b>	0.007	0.004	0.003	0.029	0.115	0.037	0.047	0.065	0.048			



#### **4 REFERENCES**

Clearwater Consultants Ltd. 2008. Memorandum CCL-UKHM-1 United Keno Hill Mines – Hydrological Update and Assessment.

Clearwater Consultants Ltd. 2010. Memorandum CCL-UKHM-3 United Keno Hill Mines – Hydrological Update and Assessment.

# **APPENDIX A**

## **DISCRETE DISCHARGE MEASUREMENTS 2016**

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-6	Christal Creek u/s Silver Trail Highway	06/01/2016	14:45	129.6	0.1	
		02/02/2016	12:40	66.5	38.1	
		05/03/2016	15:13	86.1	2.6	
		06/04/2016	12:22	71.3	0.2	
		03/05/2016	5:18	169.5	4.4	0.265
		15/06/2016	10:37	103.5	7.1	0.215
		14/07/2016	14:20	98.1	4.4	0.226
		07/08/2016	9:21	180.3	1.1	0.294
		23/09/2016	10:00	112	2.6	0.248
		22/10/2016	14:50	93.7	5.1	0.314
		09/11/2016	17:45	86.7	4.1	
		03/12/2016	Entire staff gauge is under ice, overflow backed up from highway, could not find second location with flowing			
KV-7	Christal Creek at Hanson Road	09/01/2016	12:09	163.3	14.5	
		01/02/2016	12:10	144.9	1.6	
		03/03/2016	12:18	110.7	3.1	
		06/04/2016	11:01	100.1	9.6	
		03/05/2016	14:05	1006.1	0.3	0.695
		15/06/2016	9:03	256.5	3.8	0.425
		14/07/2016	12:56	518.7	1.2	0.54
		06/08/2016	16:07	574.8	16.7	0.602
		22/09/2016	12:32	473.4	0.5	0.549
		22/10/2016	13:41	207.2	3.9	
		09/11/2016	13:45	188.7	0.7	
		03/12/2016	10:54	236.5	0.9	
KV-8	Christal Creek at mouth	09/01/2016	10:58			
		01/02/2016	10:48			
		03/03/2016	11:09	166.1		
		06/04/2016	9:59	106.8		
		03/05/2016	12:36	1009.4		
		13/06/2016	15:34	330	10.2	
KV-8	Christal Creek at mouth	14/07/2016	11:39	501.7		
		06/08/2016	13:57	748.6		
		22/09/2016	10:05	465.7		
		22/10/2016	12:09	310.3		
		09/11/2016	11:28	141.6		

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)	
KV-9	Flat Creek upstream of South McQuesten River	08/01/2016	11:13	47.4	17.7		
		02/02/2016	14:26	19.9	7.5	0.296	
		04/03/2016					
		07/04/2016	9:35	20	19.2	0.282	
		02/05/2016	13:37	1740.1	3.2	0.85	
		13/06/2016	11:50	269.2	2.2	0.459	
		13/07/2016	13:45	263	1.6	0.451	
		05/08/2016	12:18	543.6	4.6	0.554	
		22/09/2016	3:10	551.6	1.6	0.584	
		21/10/2016	13:46	93	0.8	0.46	
		08/11/2016	13:08	73.5	4.8		
		02/12/2016	9:35	30.7	4.5	0.299	
KV-9A	Flat Creek u/s Galena Creek	08/01/2016					
		04/02/2016					
		04/03/2016					
		07/04/2016					
		05/05/2016	10:01	296.8			
		14/06/2016	9:55	148	7.6		
		15/07/2016	9:58	146.2			
		05/08/2016	14:34	204.6			
		24/09/2016	9:21	162.3			
		23/10/2016					
		08/11/2016	15:12	78.3			
02/12/2016							
KV-12	Valley Tailings Pond #3 Decant	21/06/2016		21.80			
		19/07/2016		16.86			
		16/08/2016		7.87			
		25/09/2016		13.37			
		20/10/2016		12.55			
		31/10/2016		11.92			
KV-17	Husky South West Shaft	05/01/2016					
		03/02/2016		0			
		04/03/2016					
		02/05/2016		0			
		14/07/2016					
		21/10/2016					



Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-18	Bermingham 200 Adit	05/01/2016	14:38	2		
		03/02/2016	10:04	2.4		
		05/03/2016	14:01	1.3		
		07/04/2016	15:54	1.1		
		05/05/2016	16:09	1.3		
		15/06/2016	14:10	2.8	6.3	
		14/07/2016	16:18	2.9		
		08/08/2016	13:18	9.9		
		24/09/2016	15:30	3.8		
		20/10/2016	13:12	2.7		
		11/11/2016	9:30	1.8		
03/12/2016	13:42	6.9				
KV-19	Ruby 400 Adit	05/01/2016	15:26	4		
		03/02/2016	10:53	2.8		
		05/03/2016	13:25	2.7		
		07/04/2016	15:06	2.1		
		04/05/2016				
		05/05/2016	17:19	2.8		
KV-19	Ruby 400 Adit	15/06/2016	13:24	1.3	0.9	
		15/07/2016	9:24	2.3		
		08/08/2016	12:33	2.8		
		24/09/2016	14:12	3.1		
		20/10/2016	12:35	2.9		
		11/11/2016	8:54	2.9		
		01/12/2016	15:02	9.2		
KV-20	No Cash 500 Adit	09/01/2016	15:27	10.3		
		03/02/2016	13:02	4.9		
		05/03/2016	12:44	4.1		
		07/04/2016	14:12	3		
		05/05/2016	14:00	4.4		
		14/06/2016	14:56	10	10.3	
		17/07/2016	9:02	10.7		
		05/08/2016	16:13	13.5		
		23/09/2016	13:35	11.5		
		23/10/2016	14:27	8.8		
		11/11/2016	11:15	5.5		
		03/12/2016				

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-21	No Cash Creek u/s Silver Trail Highway	09/01/2016	14:12	5.4	5.1	
		01/02/2016	13:24	3.6	9.2	
		06/03/2016	11:01	5.8		
		05/04/2016	16:26	2.7	6.7	
		04/05/2016	12:50	48.9	10.4	0.546
		16/06/2016	11:30	16.2	1.5	
		15/07/2016	13:55	21.6	2.8	0.458
		06/08/2016	17:18	45.2	9.1	0.503
		23/09/2016	11:59	25.1	13.7	0.45
		23/10/2016	11:30	10.2	3.7	
		10/11/2016	17:40	5.8	0	
		01/12/2016	12:24	6.2	3.5	
KV-33	Keno 700 Adit	07/01/2016	12:30	3.2		
		03/02/2016	15:25	0.42		
		05/03/2016		2.3		
		08/04/2016		2.3		
		19/05/2016	9:30	8.9		
		16/06/2016	10:47	5.8	9.4	0.156
		17/07/2016	11:02	6	5.6	
		08/08/2016	15:11	7.2	15.7	
		21/09/2016	19:49	6.6	3.3	
		20/10/2016	9:27	3.9	17.3	
		11/11/2016	13:22	4.3	4.2	
		04/12/2016	11:17	2.5	25	
KV-35	Sadie Ladue 600 Adit	07/01/2016	14:09	3.3		
		30/01/2016	10:51	3.9	0.5	
		05/03/2016	10:29	2.8		
		08/04/2016	9:54	2.8		
		18/05/2016	17:36	29.2	18.07	
		14/06/2016	17:39	15.8	2.5	
		17/07/2016	15:19	22.7	3.1	
		18/08/2016	16:23	47.3	0.4	
		24/09/2016	15:38	29.7	3	
		19/10/2016	17:36	13.9	3.1	
		09/11/2016	15:56	13	5.2	
		04/12/2016	12:37	11.1	1.6	

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-37	Lightning Creek u/s Hope Gulch	06/01/2016				
		08/02/2016	11:18	112.2	3.5	
		02/03/2016	10:24	102.5		
		08/04/2016	11:46	78		
		01/05/2016	13:20	92.8		
		16/06/2016	12:31	1180.2	0.5	
KV-37	Lightning Creek u/s Hope Gulch	12/07/2016	12:27	440.5		
		07/08/2016	Large beaver dam immediately above site, and small dam below, flooding banks and making poor conditions for measuring discharge, good spot for Q just d/s of sign			
		22/09/2016	14:01	489.6		
		20/10/2016	12:42	211.8		
		11/11/2016	14:31	187.8		
		04/12/2016	15:15	186.6		
KV-38	Lightning Creek u/s Thunder Gulch	08/02/2016	9:28	93.9		
		01/05/2016	11:32	156.4		
		12/07/2016	10:35	688.6		
		22/09/2016	13:09	702.3		
		20/10/2016	10:59	342.3		
KV-41	Lightning Creek u/s Keno City bridge	05/01/2016	12:03	200.3	2.6	
		02/02/2016	11:45	213		
		02/03/2016	9:38	228.8	4	
		06/04/2016	14:46	175.7	1	
		01/05/2016	10:19	236	0.9	0.065
		16/06/2016	9:33	1801.7	1.1	
		12/07/2016	9:45	884.1	5.7	0.144
		07/08/2016	12:58	1365.8	0.8	0.193
		22/09/2016	11:15	1049.5	4.6	0.159
		20/10/2016	10:10	521.5	2.2	
		08/11/2016	18:23	282.2	6.1	
04/12/2016	14:36	320.7	2.2			
KV-47	Porcupine Diversion Ditch d/s Upper Flat Creek	04/02/2016				
		05/05/2016				0.208
		16/07/2016				0.282
		21/10/2016				

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-49	Hinton Creek upstream Christal Creek	03/02/2016		0		
		04/05/2016				
		15/07/2016				
		23/10/2016				
KV-50	Christal Creek upstream Hinton Creek	03/02/2016	13:48	24.7	1.7	
		04/05/2016	11:30	28.5	4.6	
		15/07/2016	14:38	33.1	20.3	
		23/10/2016	9:47	43.3		
KV-51	Christal Creek d/s Hinton Creek	06/01/2016	15:30	37		
		03/02/2016	13:17	25.3	2.3	
		02/03/2016	16:13	25.8	9.6	
		06/04/2016	16:11	19.2	16.6	
		04/05/2016	10:55	47	6	0.451
		15/06/2016	15:48	46.7	2.5	0.406
		15/07/2016	13:52	41.4	10.9	0.461
		07/08/2016	10:36	78.9	3.2	0.513
		23/09/2016	14:48	53.2	1.7	0.428
		23/10/2016	9:12	41.5	4.7	
		11/11/2016	16:59	29.7		
05/12/2016	10:01	37.1	1.5			
KV-52	Natural spring to Christal Lake at old pumphouse	07/01/2016	15:09	70.7		
		03/02/2016	11:06	47	0.1	
		05/03/2016	15:53	41.4		
		06/04/2016	13:08	34.5		
		04/05/2016	9:02	29.4		
		15/06/2016	12:40	36.9		
		14/07/2016	15:37	40.4		
		07/08/2016	10:01	33		
		23/09/2016	15:19	41.9		
KV-52	Natural spring to Christal Lake	10/11/2016	18:33	41.2		
		03/12/2016	16:33	53.3		
KV-53	UN Adit	05/01/2016				
		05/02/2016				
		02/03/2016				
		01/05/2016		0		
		15/07/2016				
		20/10/2016				

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-55	Sandy Creek at Silver Trail Highway	01/02/2016	Conditions not suitable for salt slug, could only find what appears to be overflow water, large ice jam present at			
		02/03/2016				
		03/05/2016				
		13/07/2016	15:47	5.3		
		23/10/2016				
KV-56	Star Creek at Silver Trail Highway	01/02/2016	Creek appears to be frozen to the ground, moved up from culvert but could find water, only stagnant pools near			
		03/05/2016	16:28	95.3		
		13/07/2016	16:26	20.6		
		23/10/2016				
KV-60	Galena Creek upstream of Silver King 100 adit	08/01/2016	15:19	13.9	2.4	
		04/02/2016	12:06	10.1	2.2	
		04/03/2016	12:44	10.6		
		07/04/2016	12:07	5	1.6	
		05/05/2016	11:13	418.6	11.4	0.359
		14/06/2016	11:58	58.4	2.6	0.253
		15/07/2016	11:10	49.3	0.2	0.248
		06/08/2016	9:15	279.6		0.3065
		24/09/2016	11:06	82.9	0.9	0.26
KV-60	Galena Creek upstream of	10/11/2016	10:10	17.2	1.4	
		02/12/2016	12:31	12.6	7.2	
KV-61	Porcupine Gulch at Calumet Road Crossing	03/02/2016	11:41	5.4		
		04/05/2016	15:41	26.8	8.4	
		15/07/2016	10:11	10.4		
		20/10/2016	11:05	14		
KV-62	Brefalt Creek upstream of Porcupine Diversion	07/02/2016				
		06/05/2016	12:54	65.7	2.7	
		16/06/2016	12:23	1.9		
		15/07/2016	12:51	1.7	3.0	0.259
		20/10/2016				

Station ID	Description	Sample Date	Measurement Time	Discharge (L/s)	Discharge RPD (%)	Stage (m)
KV-64	Flat Creek at Silver Trail Highway	09/01/2016	16:28	8.8	8.9	
		01/02/2016	10:12	4.2	37.6	
		03/03/2016	15:56	3.4	2.3	
		08/04/2016	11:22	2.7	21.8	
		06/05/2016	10:06	142.9	4.7	0.29
		16/06/2016	15:07	44.5	0.2	0.425
		15/07/2016	11:30	38.6	26.1	0.412
		08/08/2016	10:26	130.8	3.6	0.485
		23/09/2016	13:29	64.3	9.4	0.474
		23/10/2016	14:38	21.9	5.5	
		10/11/2016	16:25	15	0.2	
02/12/2016	14:57	11.4	1.4			
KV-65	Thunder Gulch upstream of Bellekeno	06/01/2016	13:06	62.5		
		08/02/2016	13:34	47.6	2.9	
		06/03/2016	13:10	45.7		
		07/04/2016	16:30	35.9		
		01/05/2016	14:53	44.8		
		16/06/2016	14:35	223.3	0.2	
KV-65	Thunder Gulch upstream of Bellekeno	12/07/2016	13:48	75.4		
		09/08/2016	8:49	136.6		
		22/09/2016	14:58	97.8		
		20/10/2016	14:01	134		
		24/10/2016				
		11/11/2016	15:17	90.9		
05/12/2016	8:54	75.6				
KV-66	Klondike Keno Adit	01/02/2016				
		05/05/2016	11:03	2	3.1	
		16/07/2016	16:11	1.2		
		21/10/2016	14:11	1.6		
KV-72	South McQuesten River at McQuesten	07/02/2016				
		03/05/2016	9:51	527.1		
		14/07/2016	9:42	724.4		
		22/10/2016	9:49	357.4		
FIEC	Field Creek upstream of Duncan Creek Road	10/01/2016	10:55	34.3		
		09/02/2016				
		06/03/2016				
		08/04/2016				
		06/05/2016	8:36	931		
		16/06/2016	13:41	126.5		
		16/07/2016	11:46	467.9		
		08/08/2016	8:23	1077.2		
		25/09/2016	14:16	222.2		
		23/10/2016	13:12	84.6		
		12/11/2016	9:13	53		
04/12/2016	9:29	43.1				

## **APPENDIX B**

### **DISCRETE DISCHARGE MEASUREMENTS HISTORIC**

**Discharge (Flow) (L/s)**

Sample Date	KV-6	KV-7	KV-8	KV-9	KV-9A	KV-12	KV-17	KV-18
01/01/1994								
27/01/1994						0.1	3	2
01/02/1994								
24/02/1994						0.1	3	2
01/03/1994								
28/03/1994						0.1	3	0.5
23/04/1994						1.5	3	1
10/05/1994							2	
13/05/1994						2		
31/05/1994								12
01/06/1994							2	12
27/06/1994						0.8	2.8	1.5
28/06/1994								
27/07/1994							2	
28/07/1994								
29/07/1994							2	0.4
17/08/1994						0.1	2	0.4
07/09/1994		116						
29/09/1994						0.1	2	0.4
27/10/1994								
31/10/1994						0.1	2	0.5
29/11/1994						0.1	2	0.5
05/01/1995						0.1	2	0.5
06/02/1995							2	0.5
01/03/1995								
29/03/1995							2	0.2
27/04/1995						0.1	1.5	0.5
03/05/1995		298.6					1.3	1.5
06/06/1995								0.7
06/07/1995	18	220				2	2	0.7
11/07/1995								0.5
05/08/1995		236						
11/08/1995						0.1	2.5	2
04/09/1995						0.1	25.3	0.2
05/09/1995								
11/10/1995						0.1	14.5	0.6
05/11/1995						0.7	3	1
12/12/1995						0.1		
01/01/1996						0.1		
09/02/1996						0.1		
05/03/1996						0.1		
07/04/1996						0.1		
28/04/1996								
24/06/1996						9		
18/07/1996						18		



**Discharge (Flow) (L/s)**

Sample Date	KV-6	KV-7	KV-8	KV-9	KV-9A	KV-12	KV-17	KV-18
02/08/1996						4.9		
16/09/1996						0.1		
03/10/1996						0.1		
30/10/1996						0.1		
30/11/1996						0.1		
28/01/1997						0.1		
26/02/1997						0.1		
27/03/1997								2
12/05/1997						30		
25/06/1997							0.8	6.7
30/06/1997						2.8	1	2.5
31/07/1997						27		
20/08/1997						15		
13/09/1997						10.5		
10/10/1997		92		40		6	3	2.5
21/12/1997						0.33		
15/01/1998				30			1.5	1
13/03/1998				20				1
25/04/1998						0.08		
11/05/1998								
14/05/1998								1
23/05/1998						10.3		
30/05/1998						5.6		
06/06/2000						17		
07/11/2000						5.3		
10/07/2001						32	1.0	7.0
11/07/2001		872						
02/08/2003		165.7		109.2		1.4	0.1	0.5
24/01/2004		127	302	28				
19/02/2004		180						
23/03/2004		150						
24/04/2004		150						
15/06/2004		247	268					
20/07/2004		108						
29/07/2004	85							
30/07/2004		323	347	293				
25/08/2004		121						
21/09/2004		149						
21/10/2004		104						
29/11/2004		102						
17/12/2004		259						
25/01/2005		351.685439	383	24.6				
26/02/2005				28				
27/02/2005		233.065736	302					
22/03/2005		290						

**Discharge (Flow) (L/s)**

Sample Date	KV-6	KV-7	KV-8	KV-9	KV-9A	KV-12	KV-17	KV-18
21/04/2005		62.099477	357					
22/04/2005	48							
27/05/2005		657.269274						
30/06/2005	73.7	136	268			1.26		
19/07/2005				282				
20/07/2005	93	204						
22/08/2005				245				
23/08/2005		237						
22/09/2005		149						
25/10/2005	73	186	282					
25/01/2006		188	336	117				
22/02/2006		117						
14/03/2006				23				
15/03/2006		159.453969	332					
27/04/2006			313					
28/06/2006	130	858	221			8.4	0.4	
31/08/2006	108.987092	251.196066	263.1					
21/09/2006	112	374						
25/10/2006							0.5	2
15/06/2007						>20		
11/07/2007						>20		3.5
12/07/2007							0.3	
13/07/2007				1092.9				
15/07/2007								
16/07/2007								
17/07/2007								
18/08/2007						7.5		
31/08/2007			159.145					
05/09/2007	60.63	189.2	200.28					
06/09/2007				166.2				
08/09/2007								
10/09/2007							1.6	1.5
11/09/2007						2.6		
13/09/2007								
28/10/2007						3.2		
13/03/2008								2
16/05/2008				1137.0				
18/05/2008 11:45								
03/07/2008		159.4	210	152.2				
05/07/2008								
06/07/2008	129.6							
13/08/2008		437.6	488.35	1020.195				
14/08/2008	119.385					15		
15/09/2008	80.18							
18/09/2008		518.43	412.38	320.64				





**Discharge (Flow) (L/s)**

Sample Date	KV-6	KV-7	KV-8	KV-9	KV-9A	KV-12	KV-17	KV-18
16/02/2012 13:00					0			
09/03/2012 10:50								
10/03/2012 12:50			90.4					
11/03/2012 10:00	77.3							
12/03/2012 08:45								
14/03/2012 13:30					0			
15/03/2012 12:00						0		
07/04/2012 14:10								
08/04/2012 09:25	61.7			11.7				
09/04/2012 13:50						0		
01/05/2012 11:30	147.0	540.4						
03/05/2012 14:07								
04/05/2012 11:30				1574.2				
05/05/2012 10:17			677.0					
06/05/2012 13:28								
07/05/2012 09:00	104.7	600.0						
08/05/2012 10:35						15.66		
09/05/2012 08:45								
31/05/2012								
01/06/2012		368.9875	388.94					
03/06/2012	88.65							
04/06/2012					221.895			15.636
05/06/2012						12.12		
06/06/2012 14:00								
07/06/2012 09:05				429.68				
01/07/2012 10:00								
02/07/2012 14:47								
03/07/2012 12:05								
04/07/2012 13:40	85.35							
05/07/2012 09:50								
07/07/2012 12:00				243.5	118.2			
08/07/2012 14:55								
09/07/2012 08:50								
10/07/2012 10:30						13.3		
16/07/2012 15:30	104.69	205.67						
01/08/2012 10:25	91							
02/08/2012 12:30		258	192					
03/08/2012 10:00				239	115			
05/08/2012 13:05								3
07/08/2012 08:10						5		
02/09/2012 08:50								1.6
03/09/2012 13:15								
20/09/2012 15:10								
21/09/2012 14:00		270.1	97.1					
22/09/2012 10:33				245.2				

**Discharge (Flow) (L/s)**

Sample Date	KV-6	KV-7	KV-8	KV-9	KV-9A	KV-12	KV-17	KV-18
23/09/2012 08:15	89.1				109.2			
25/09/2012 09:29						8.7		
10/10/2012 16:40								
11/10/2012 14:00			84.31					
12/10/2012 10:30				136.8563				
14/10/2012 13:30					73.291			
15/10/2012 10:45								
16/10/2012 12:50	76.18							
17/10/2012 10:34								
19/11/2012 13:40								
10/12/2012 15:10								
12/01/2013 13:30		74.75						
15/01/2013 09:30								
16/01/2013 14:00								1.18
08/02/2013 15:30		65.91						
09/02/2013 10:30								
10/02/2013 12:10								
12/02/2013 11:10								
07/03/2013 15:30								
08/03/2013 14:00		109.69						
12/03/2013 14:00								
14/03/2013 12:00								
04/04/2013 11:45								
06/04/2013 09:15								
09/04/2013 12:40							0	
10/04/2013 11:15								
02/05/2013 15:25								
03/05/2013 09:45								
04/05/2013 09:35								
07/05/2013 11:50								
01/06/2013 12:00								
02/06/2013 16:00								16.2425
03/06/2013 08:45								
04/06/2013 11:50					199.39			
05/06/2013 11:00				765.66				
07/06/2013 14:50		852						
08/06/2013 09:40	122.62							
09/06/2013 08:45								
01/07/2013 13:45				290.41				
02/07/2013 13:50			207.927					
03/07/2013 12:00								
04/07/2013 15:00		223.8						
05/07/2013 10:40								
06/07/2013 09:30								
07/07/2013 09:45					31.968			

























**Discharge (Flow) (L/s)**

Sample Date	KV-19	KV-20	KV-21	KV-33	KV-35	KV-37	KV-38	KV-41
02/10/2008					4.5	474.275	842.38	1190.65
03/10/2008								
04/10/2008								
05/10/2008								
26/05/2009 17:15	0.25	2.5						
27/05/2009 14:15								
28/05/2009 12:00				4	7			
05/06/2009 17:00								3589.96
06/06/2009								
04/07/2009 13:45	0.25	3						
05/07/2009 14:35				3	6	421.55	625.68	718.62
06/07/2009 14:10								
07/07/2009 09:30			3					
08/09/2009								1035.19
09/09/2009								
11/09/2009								
06/10/2009			6					645.7
07/10/2009	0.5			3	7	443.8		
08/10/2009		4						
09/10/2009								
03/05/2010								440.68
04/05/2010								
05/05/2010			10					
26/05/2010	0.75	8						
27/05/2010				3	10	900.9395		
28/05/2010								
08/06/2010			8					1675.405
05/07/2010	3							
06/07/2010		4		4				967.45467
07/07/2010								
08/07/2010			7		12	594.67633		
09/07/2010								
04/08/2010								818.157667
14/09/2010								483.2
15/09/2010								
05/10/2010								415.336
06/10/2010	0.5				15	241.745		
07/10/2010		8	8					
09/02/2011 12:00								
12/05/2011 15:30								
13/05/2011 08:50								
25/05/2011 15:20	3							
26/05/2011 11:55				10				
27/05/2011 14:00		15	20					
21/06/2011 12:00	0.2			7				1054.925

**Discharge (Flow) (L/s)**

Sample Date	KV-19	KV-20	KV-21	KV-33	KV-35	KV-37	KV-38	KV-41
22/06/2011 15:20		4						
12/07/2011 13:20	0.5	4	5	10				
13/07/2011 13:15					8			1075.31
14/07/2011 15:15						1020.97		
19/07/2011 12:20								
16/08/2011 14:50								
17/08/2011 10:45		1						1713.42
18/08/2011 16:00	2		11					
17/09/2011 08:25						347.615		973.035
22/09/2011 15:05				8				
23/09/2011 09:30								766.75
24/09/2011 14:40								
25/09/2011 12:55								
23/10/2011								
24/10/2011								
25/10/2011								
26/10/2011 16:20								
27/10/2011					1.69			
29/10/2011 16:00			0.181818					
30/10/2011 14:30						206	330.5	404
31/10/2011 12:30								
20/11/2011 14:25								
21/11/2011 11:00								
22/11/2011 10:00						162		
24/11/2011 15:00					10			
26/11/2011 09:00								
13/12/2011 14:15								
14/12/2011 16:25								
15/12/2011 12:20								
16/12/2011 15:10								
17/12/2011 09:30								
18/12/2011 12:25						92.1	205.3	267.6
20/12/2011 13:30								
21/12/2011 15:20								
12/01/2012 15:30								
13/01/2012 12:00								
14/01/2012 14:40								
17/01/2012 13:00								251.2
18/01/2012 09:40						119.7	100.3	
24/01/2012 15:45								
09/02/2012 15:25						135.3	168.7	
11/02/2012 15:30								
12/02/2012 10:35								
13/02/2012 13:30								
14/02/2012 13:40			2.2					









**Discharge (Flow) (L/s)**

Sample Date	KV-19	KV-20	KV-21	KV-33	KV-35	KV-37	KV-38	KV-41
21/09/2014 11:15								
22/09/2014 12:45		11.864	25.646		29.424			
27/09/2014 09:40								
16/10/2014 10:00						348.5	457.2	650.4
17/10/2014 11:00					26.1			
18/10/2014 14:25								
19/10/2014 09:00								
20/10/2014 13:20								
21/10/2014 14:30								
22/10/2014 11:10								
23/10/2014 09:40					16.1			
24/10/2014 14:55								
25/10/2014 11:00		10.5	12.5					
26/10/2014 09:00				3.508				
13/11/2014 13:30							259.2	
14/11/2014 12:30				2.79				
15/11/2014 14:20								
16/11/2014 14:45								
17/11/2014 14:15								
18/11/2014 10:00			6.7					
19/11/2014 14:05								
20/11/2014 09:59		6.4			13.3			
21/11/2014 14:00								
22/11/2014 14:31								
12/12/2014 13:20					10			
13/12/2014 13:20							180.3	186.8
14/12/2014 11:30				2.3		138.2		
15/12/2014 13:00								
16/12/2014 09:50								
18/12/2014 14:23		4.3						
19/12/2014 15:40								
11/01/2015 13:16						104.5	164.4	203.4
12/01/2015 11:57				2.5	6.8			
13/01/2015 13:12								
14/01/2015 10:13		7	3.3					
17/01/2015 13:00								
19/01/2015 15:05								
22/01/2015 13:24								
28/01/2015 10:00					2.7			
05/02/2015 13:07						91.7	112.8	
06/02/2015 11:50								
07/02/2015 14:00					5.6			
12/02/2015 13:07								
14/02/2015 14:47								
15/02/2015 11:30		0.6						

**Discharge (Flow) (L/s)**

Sample Date	KV-19	KV-20	KV-21	KV-33	KV-35	KV-37	KV-38	KV-41
16/02/2015 15:20								
17/02/2015 12:50								
18/02/2015 08:00								
06/03/2015 13:30						89.7	122.6	199.6
07/03/2015 13:00					4.2			
09/03/2015 10:30								
10/03/2015 12:05		3.5						
11/03/2015 14:30								
13/03/2015 13:00								
03/04/2015 11:10			2.4					
06/04/2015 09:40					5.3	76	118.7	122.1
07/04/2015 13:20								
08/04/2015 11:30								
09/04/2015 13:25		3.2						
10/04/2015 12:00								
12/04/2015 10:40								
12/05/2015 10:15								
13/05/2015 13:01								1225.3
14/05/2015 11:30			243.5					
23/05/2015 14:20								
24/05/2015 16:14								
26/05/2015 07:30		5.5						
27/05/2015 12:34								
28/05/2015 12:42					44.2			
02/06/2015 13:16								1349.8
03/06/2015 14:30								
04/06/2015 10:30								
09/06/2015 13:23								
11/06/2015 10:24			10.8					
12/06/2015 11:48								
16/06/2015 08:48		5.6						
17/06/2015 08:50				4.3	7.2			
18/06/2015 10:41								
19/06/2015 09:30								
23/06/2015 15:05								
09/07/2015 14:56								
13/07/2015 12:30								
15/07/2015 13:10				6.67				
16/07/2015 12:15							718.4	
18/07/2015 14:10								
19/07/2015 12:20								
26/07/2015 09:22		4.8						
28/07/2015 12:00								
29/07/2015 10:30								
30/07/2015 13:40			0.152		21.8			





**Discharge (Flow) (L/s)**

Sample Date	KV-19	KV-20	KV-21	KV-33	KV-35	KV-37	KV-38	KV-41
05/01/2016 11:56	4							200.3
06/01/2016 13:00								
07/01/2016 15:00				3.2	3.3			
08/01/2016 10:41								
09/01/2016 11:50		10.3	5.4					
10/01/2016 10:30								
30/01/2016 10:40					3.9			
01/02/2016 11:30			3.6					
02/02/2016 14:00								213
03/02/2016 11:20	2.8	4.9		0.42				
04/02/2016 11:45								
08/02/2016 13:19						112.2	93.9	
02/03/2016 15:54						102.5		228.8
03/03/2016 10:45								
04/03/2016 12:15								
05/03/2016 14:55	2.7	4.1		2.3	2.8			
06/03/2016 12:45			5.8					
05/04/2016 16:00			2.7					
06/04/2016 09:30								175.7
07/04/2016 09:10	2.1	3						
08/04/2016 12:50				2.3	2.8	78		
01/05/2016 14:35						92.8	156.4	236
02/05/2016 13:00								
03/05/2016 12:25								
04/05/2016 15:28			48.9					
05/05/2016 10:20	2.8	4.4						
06/05/2016 10:10								
18/05/2016 17:15					29.2			
19/05/2016 09:42				8.9				
13/06/2016 11:05								
14/06/2016 11:18		10			15.8			
15/06/2016 08:37	1.3							
16/06/2016 14:30			16.2	5.8		1180.2		1801.7
21/06/2016 14:50								
12/07/2016 13:30						440.5	688.6	884.1
13/07/2016 13:20								
14/07/2016 11:15								
15/07/2016 10:45	2.3		21.6					
16/07/2016 15:51								
17/07/2016 15:00		10.7		6	22.7			
19/07/2016 12:15								
05/08/2016 11:56		13.5						
06/08/2016 13:43			45.2					
07/08/2016 08:59								1365.8
08/08/2016 10:02	2.8			7.2				





















**Discharge (Flow) (L/s)**

Sample Date	KV-47	KV-49	KV-50	KV-51	KV-52	KV-53	KV-55	KV-56	KV-60
01/03/2014 11:15									
02/03/2014 13:10					26.8				
04/03/2014 14:40									
04/04/2014 16:00					30.80				
05/04/2014 13:15									
06/04/2014 12:30									
07/04/2014 12:00									
03/05/2014 15:35									
04/05/2014 09:35									
05/05/2014 13:00									
06/05/2014 14:50			21.9	49.4					
07/05/2014 11:50									
08/05/2014 13:15									
10/05/2014 11:25							44.4	62.8	770
11/05/2014 11:20	367.42				40				
13/05/2014 10:45									
14/05/2014 12:00									
03/06/2014 15:00									
04/06/2014 11:40									
05/06/2014 11:45									
06/06/2014 10:43									
07/06/2014 12:50					27.5				
08/06/2014 12:25									
09/06/2014 10:45	23.3								
10/06/2014 11:00									23
01/07/2014 11:35									
02/07/2014 12:30							7.0		
03/07/2014 15:35			27.6	30.62	34.94				
04/07/2014 10:15									
05/07/2014 13:25									
06/07/2014 09:00									18.0
07/07/2014 10:00	26.81								
01/08/2014 09:50									
02/08/2014 12:00									
03/08/2014 09:00					31.99				
04/08/2014 09:30									19.73
05/08/2014 16:00	19.419								
22/08/2014 15:30									
24/08/2014 11:00									
25/08/2014 09:45									
02/09/2014 14:15									
16/09/2014 13:10									
18/09/2014 12:20									
19/09/2014 12:00					53				
20/09/2014 10:00						0.67114			





**Discharge (Flow) (L/s)**

Sample Date	KV-47	KV-49	KV-50	KV-51	KV-52	KV-53	KV-55	KV-56	KV-60
06/08/2015 11:05									
12/08/2015 13:25									
17/08/2015 10:35					38.8				
19/08/2015 14:30									
20/08/2015 14:20									
21/08/2015 11:50									
22/08/2015 13:00									93.5
23/08/2015 14:25									
26/08/2015 12:10									
01/09/2015 11:30									
03/09/2015 10:56									
04/09/2015 09:15									
10/09/2015 11:59									
11/09/2015 15:05									
12/09/2015 13:31					42.3				
13/09/2015 15:25									
15/09/2015 14:46									
16/09/2015									172.1
17/09/2015 12:07									
18/09/2015				45.7					
19/09/2015									
10/10/2015 15:07					38.2				
11/10/2015 12:07									
14/10/2015 15:04									
16/10/2015 13:45									
17/10/2015 15:30			36.3	37.5					
18/10/2015 10:05						0			
19/10/2015 12:19									
20/10/2015 13:16							12.1	6.2	75.6
14/11/2015 14:48									
15/11/2015 13:42									
16/11/2015 10:57									
17/11/2015 14:10									
18/11/2015 10:08									
19/11/2015 10:55					70.8				
20/11/2015 15:38									
22/11/2015 15:30									
23/11/2015 12:09									23.3
24/11/2015 12:50									
15/12/2015 11:50									17.4
16/12/2015 11:20									
17/12/2015 12:00									
18/12/2015 12:15					86.7				
19/12/2015 11:44									
20/12/2015 09:37				34.5					





**Discharge (Flow) (L/s)**

Sample Date	KV-47	KV-49	KV-50	KV-51	KV-52	KV-53	KV-55	KV-56	KV-60
09/08/2016 08:24									
16/08/2016 13:25									
18/08/2016 15:54									
21/09/2016 17:45									
22/09/2016 14:18									
23/09/2016 14:20				53.2	41.9				
24/09/2016 10:13									82.9
25/09/2016 09:35									
19/10/2016 17:33									
20/10/2016 13:46									
21/10/2016 13:17									
22/10/2016 12:10					39.4				
23/10/2016 14:21			43.3	41.5					21.2
31/10/2016 10:10									
08/11/2016 12:45									
09/11/2016 10:31									
10/11/2016 15:50					41.2				17.2
11/11/2016 15:06				29.7					
12/11/2016 08:56									
01/12/2016 12:05									
02/12/2016 09:00									12.6
03/12/2016 10:20					53.3				
04/12/2016 14:15									
05/12/2016 08:40				37.1					







**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
02/10/2008								
03/10/2008								
04/10/2008								
05/10/2008								
26/05/2009 17:15								
27/05/2009 14:15								
28/05/2009 12:00								
05/06/2009 17:00				1300.56				
06/06/2009								
04/07/2009 13:45								
05/07/2009 14:35				177.475				
06/07/2009 14:10								
07/07/2009 09:30			3.5					
08/09/2009				266.785				
09/09/2009								
11/09/2009								
06/10/2009				188.85				
07/10/2009								
08/10/2009								
09/10/2009								
03/05/2010								
04/05/2010								
05/05/2010	25		142.48					
26/05/2010				527.0095				
27/05/2010								
28/05/2010								
08/06/2010								
05/07/2010	12		150					
06/07/2010				221.428067				
07/07/2010								
08/07/2010								
09/07/2010								
04/08/2010								
14/09/2010								
15/09/2010								
05/10/2010				597.44				
06/10/2010								
07/10/2010								
09/02/2011 12:00								
12/05/2011 15:30								
13/05/2011 08:50								
25/05/2011 15:20								
26/05/2011 11:55					0			
27/05/2011 14:00								
21/06/2011 12:00				246.37				





**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
23/09/2012 08:15								
25/09/2012 09:29								
10/10/2012 16:40								
11/10/2012 14:00						1991.792		
12/10/2012 10:30								
14/10/2012 13:30								
15/10/2012 10:45			22.823					
16/10/2012 12:50				163.7675				
17/10/2012 10:34								
19/11/2012 13:40								
10/12/2012 15:10								
12/01/2013 13:30								
15/01/2013 09:30				44.94				
16/01/2013 14:00								
08/02/2013 15:30								
09/02/2013 10:30				39.1				
10/02/2013 12:10								
12/02/2013 11:10					0			
07/03/2013 15:30								
08/03/2013 14:00								
12/03/2013 14:00								
14/03/2013 12:00				71.54				
04/04/2013 11:45				30.3				
06/04/2013 09:15								
09/04/2013 12:40								
10/04/2013 11:15				41.23				
02/05/2013 15:25				26.38				
03/05/2013 09:45								
04/05/2013 09:35					0			
07/05/2013 11:50								
01/06/2013 12:00								
02/06/2013 16:00								
03/06/2013 08:45								
04/06/2013 11:50							313.61	329.448
05/06/2013 11:00								
07/06/2013 14:50								
08/06/2013 09:40			67.45	575.46				
09/06/2013 08:45								
01/07/2013 13:45								
02/07/2013 13:50						5511.28		
03/07/2013 12:00					0			
04/07/2013 15:00								
05/07/2013 10:40								
06/07/2013 09:30								
07/07/2013 09:45							44.77	58.916





**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
01/03/2014 11:15								
02/03/2014 13:10								
04/03/2014 14:40								
04/04/2014 16:00								
05/04/2014 13:15								
06/04/2014 12:30								
07/04/2014 12:00								
03/05/2014 15:35					0			
04/05/2014 09:35							209.2	492
05/05/2014 13:00								
06/05/2014 14:50								
07/05/2014 11:50				800.13				
08/05/2014 13:15								
10/05/2014 11:25	150		540					
11/05/2014 11:20								
13/05/2014 10:45								
14/05/2014 12:00								
03/06/2014 15:00			336.5					
04/06/2014 11:40								
05/06/2014 11:45								
06/06/2014 10:43							44.9	64.2
07/06/2014 12:50				356.1				
08/06/2014 12:25		2.4						
09/06/2014 10:45								
10/06/2014 11:00								
01/07/2014 11:35								
02/07/2014 12:30				239.4	0			
03/07/2014 15:35								
04/07/2014 10:15	14.3							
05/07/2014 13:25								
06/07/2014 09:00		1.64					73.4	137
07/07/2014 10:00			33.0					
01/08/2014 09:50								
02/08/2014 12:00								
03/08/2014 09:00							51.51	48
04/08/2014 09:30								
05/08/2014 16:00								
22/08/2014 15:30								
24/08/2014 11:00		5.465	102.8					
25/08/2014 09:45				662.4				
02/09/2014 14:15								
16/09/2014 13:10								
18/09/2014 12:20							142.7	115
19/09/2014 12:00						3999		
20/09/2014 10:00	17.7	0.9935		119.9				

**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
21/09/2014 11:15			42.7					
22/09/2014 12:45								
27/09/2014 09:40								
16/10/2014 10:00								
17/10/2014 11:00					0			
18/10/2014 14:25						3812.2		
19/10/2014 09:00								
20/10/2014 13:20								
21/10/2014 14:30			51.4					
22/10/2014 11:10								
23/10/2014 09:40								
24/10/2014 14:55							129.9	124.7
25/10/2014 11:00	18	3						
26/10/2014 09:00				197.3				
13/11/2014 13:30								
14/11/2014 12:30								
15/11/2014 14:20								
16/11/2014 14:45								
17/11/2014 14:15								
18/11/2014 10:00	10.2		16.1	107.9				
19/11/2014 14:05								
20/11/2014 09:59								
21/11/2014 14:00							48	42.8
22/11/2014 14:31								
12/12/2014 13:20								
13/12/2014 13:20								
14/12/2014 11:30				30.7				
15/12/2014 13:00								
16/12/2014 09:50								
18/12/2014 14:23								
19/12/2014 15:40								35.9
11/01/2015 13:16				50.3				
12/01/2015 11:57								
13/01/2015 13:12								
14/01/2015 10:13								
17/01/2015 13:00								
19/01/2015 15:05								
22/01/2015 13:24		2.7						
28/01/2015 10:00								
05/02/2015 13:07								
06/02/2015 11:50								
07/02/2015 14:00					0			
12/02/2015 13:07								
14/02/2015 14:47								
15/02/2015 11:30				46.1				





**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
05/01/2016 11:56								
06/01/2016 13:00				62.5				
07/01/2016 15:00								
08/01/2016 10:41								
09/01/2016 11:50			8.8					
10/01/2016 10:30								34.3
30/01/2016 10:40								
01/02/2016 11:30			4.2					
02/02/2016 14:00								
03/02/2016 11:20	5.4							
04/02/2016 11:45								
08/02/2016 13:19				47.6				
02/03/2016 15:54								
03/03/2016 10:45			3.4					
04/03/2016 12:15								
05/03/2016 14:55								
06/03/2016 12:45				45.7				
05/04/2016 16:00								
06/04/2016 09:30								
07/04/2016 09:10				35.9				
08/04/2016 12:50			2.7					
01/05/2016 14:35				44.8				
02/05/2016 13:00								
03/05/2016 12:25						527.1		
04/05/2016 15:28	26.8							
05/05/2016 10:20					2			
06/05/2016 10:10		65.7	142.9					931
18/05/2016 17:15								
19/05/2016 09:42								
13/06/2016 11:05								
14/06/2016 11:18								
15/06/2016 08:37								
16/06/2016 14:30		1.9	44.5	223.3				126.5
21/06/2016 14:50								
12/07/2016 13:30				75.4				
13/07/2016 13:20								
14/07/2016 11:15						724.4		
15/07/2016 10:45	10.4	1.7	38.6					
16/07/2016 15:51					1.2			467.9
17/07/2016 15:00								
19/07/2016 12:15								
05/08/2016 11:56								
06/08/2016 13:43								
07/08/2016 08:59								
08/08/2016 10:02			130.8					1077.2

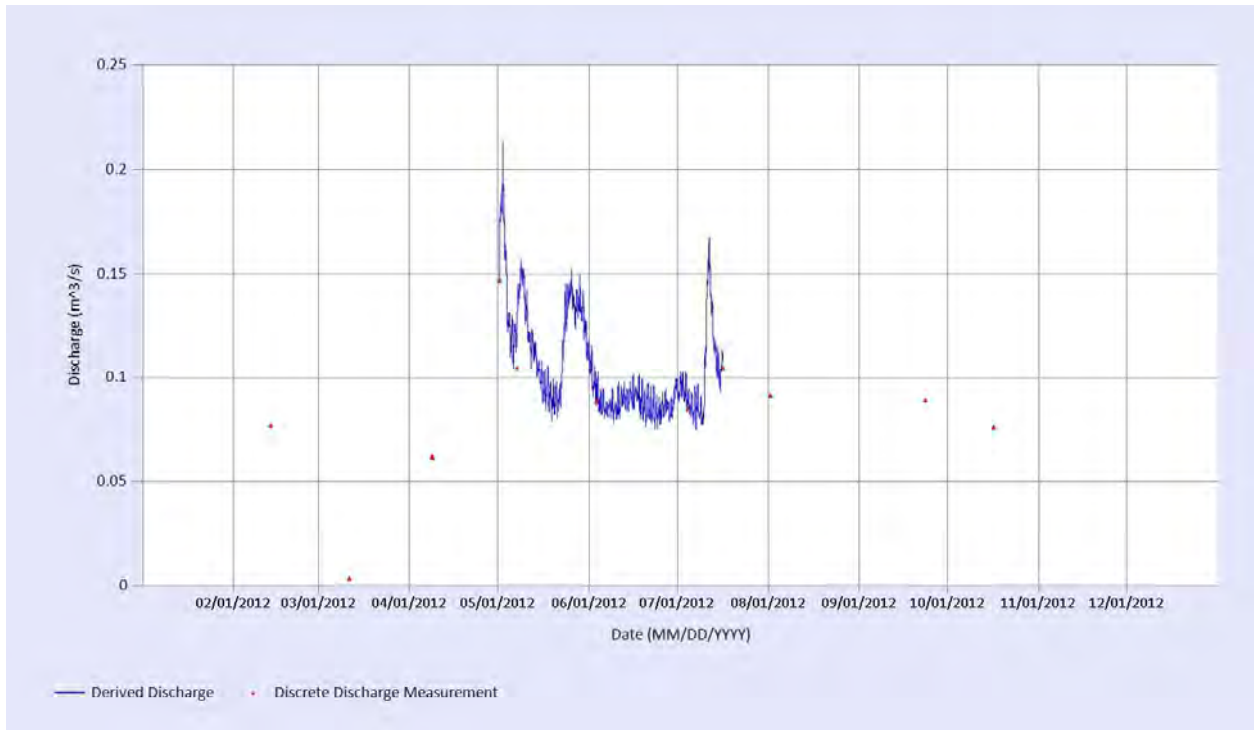
**Discharge (Flow) (L/s)**

Sample Date	KV-61	KV-62	KV-64	KV-65	KV-66	KV-72	WILC	FIEC
09/08/2016 08:24				136.6				
16/08/2016 13:25								
18/08/2016 15:54								
21/09/2016 17:45								
22/09/2016 14:18				97.8				
23/09/2016 14:20			64.3					
24/09/2016 10:13								
25/09/2016 09:35								222.2
19/10/2016 17:33								
20/10/2016 13:46	14			134				
21/10/2016 13:17					1.6			
22/10/2016 12:10						357.4		
23/10/2016 14:21			21.9					84.6
31/10/2016 10:10								
08/11/2016 12:45								
09/11/2016 10:31								
10/11/2016 15:50			15					
11/11/2016 15:06				90.9				
12/11/2016 08:56								53
01/12/2016 12:05								
02/12/2016 09:00			11.4					
03/12/2016 10:20								
04/12/2016 14:15								43.1
05/12/2016 08:40				75.6				

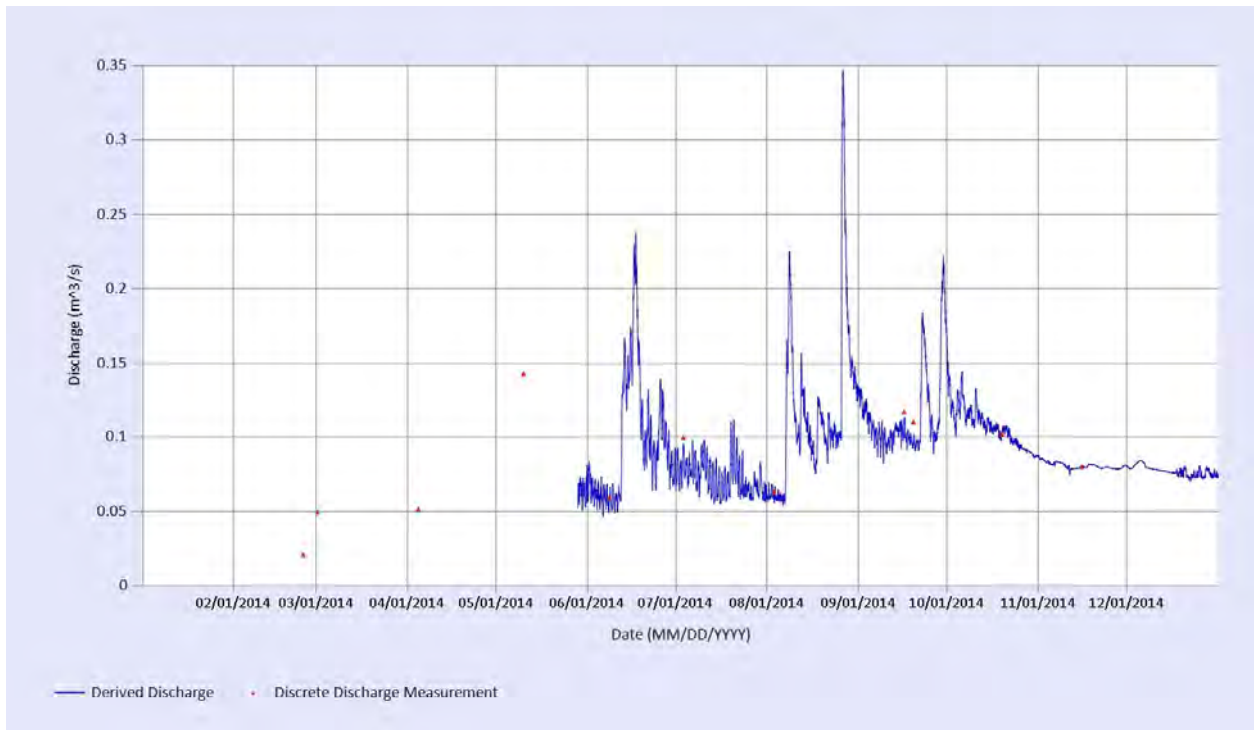
# **APPENDIX C**

## **HYDROGRAPHS**

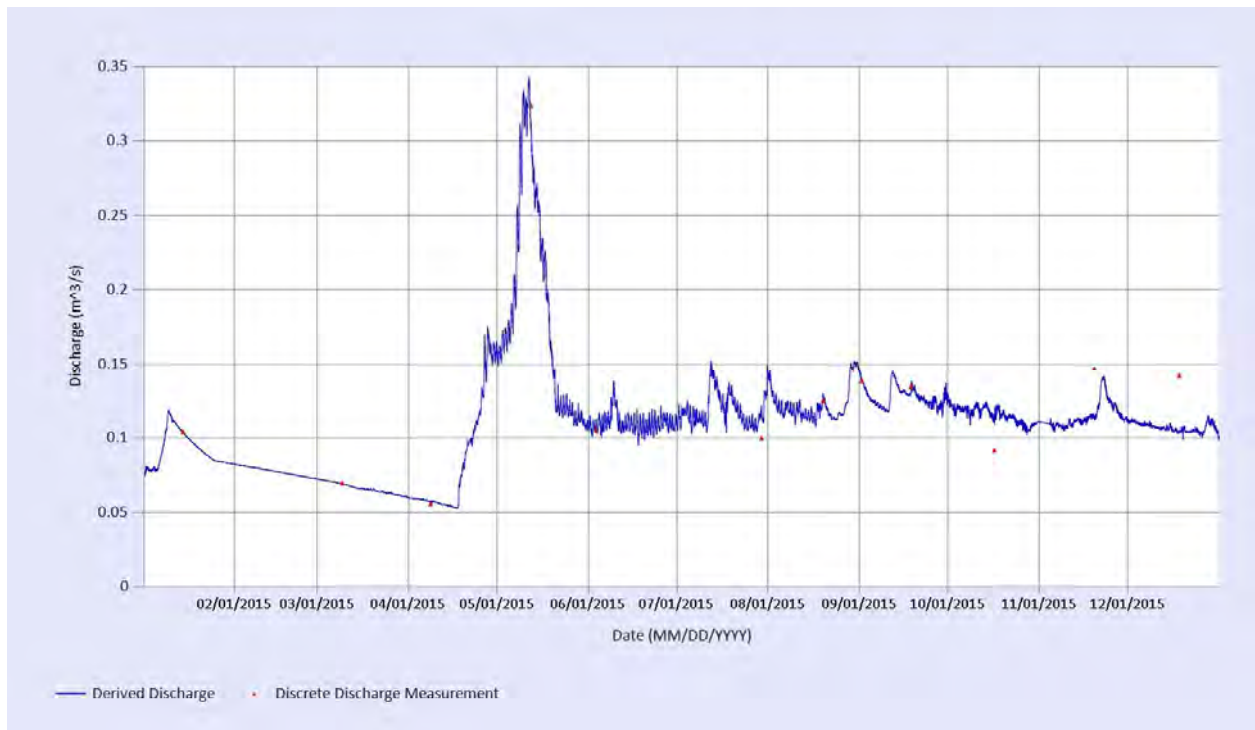




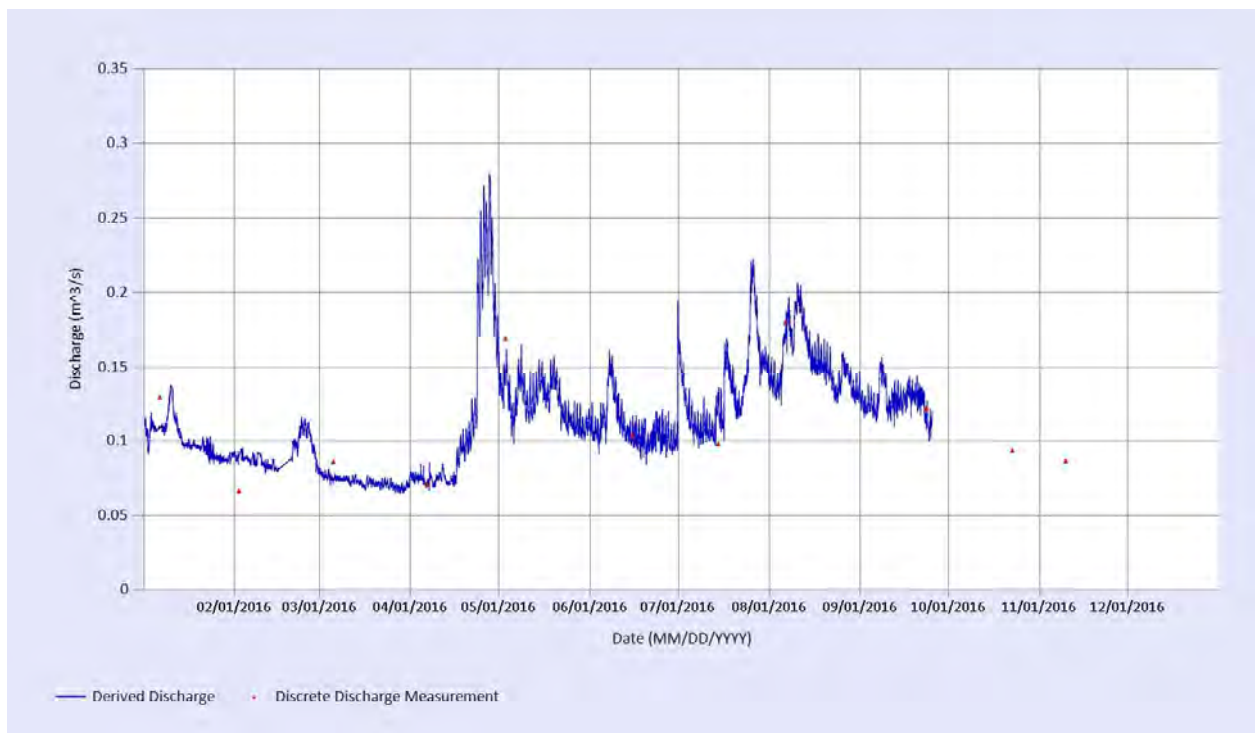
**Figure C1 – Discharge at KV-6, Christal Creek below Christal Lake, 2012 open water season**



**Figure C2 – Discharge at KV-6, Christal Creek below Christal Lake, 2014**



**Figure C3 – Discharge at KV-6, Christal Creek below Christal Lake, 2015**



**Figure C4 – Discharge at KV-6, Christal Creek below Christal Lake, 2016**

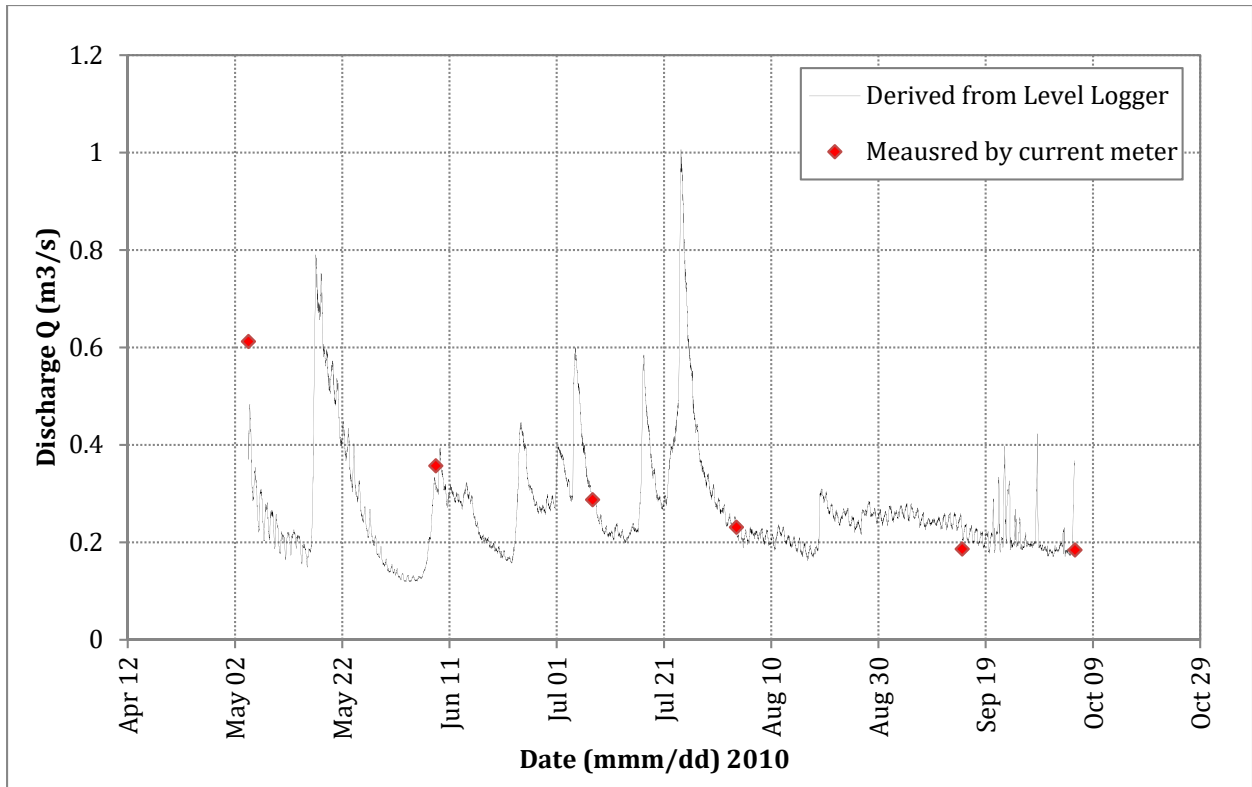


Figure C5 - Discharge at KV-7, Christal Creek at Hansen Road 2010

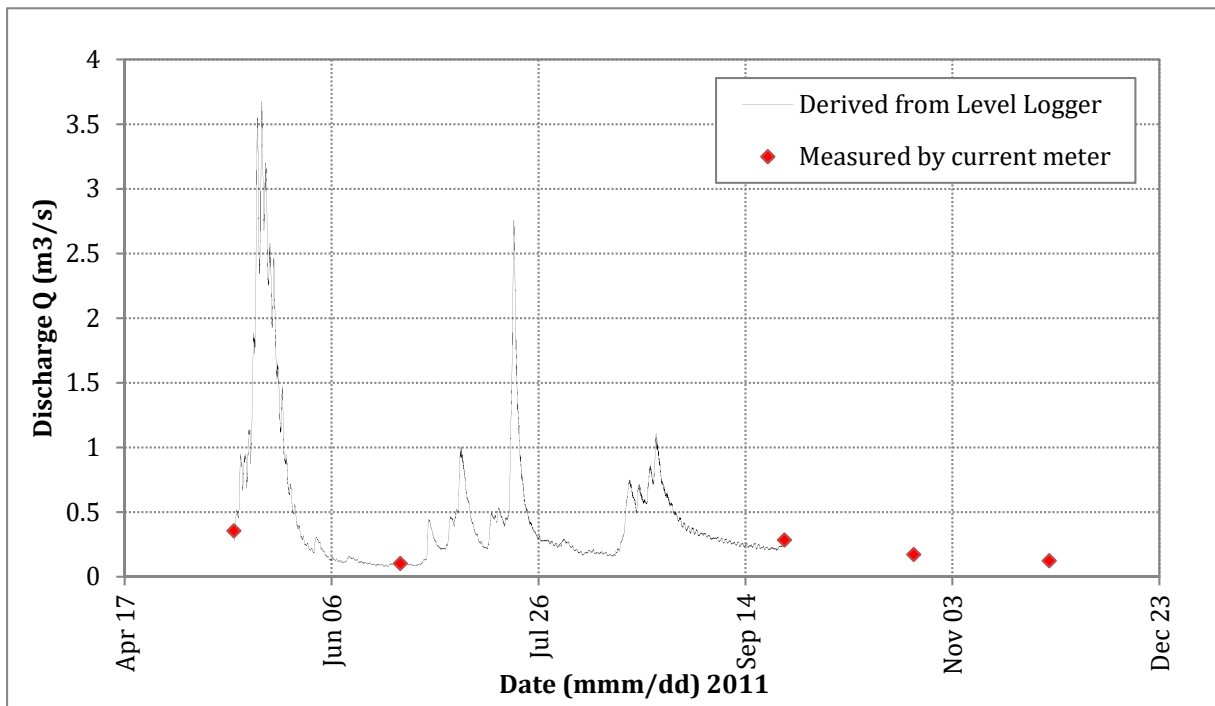


Figure C6 - Discharge at KV-7, Christal Creek at Hansen Road 2011

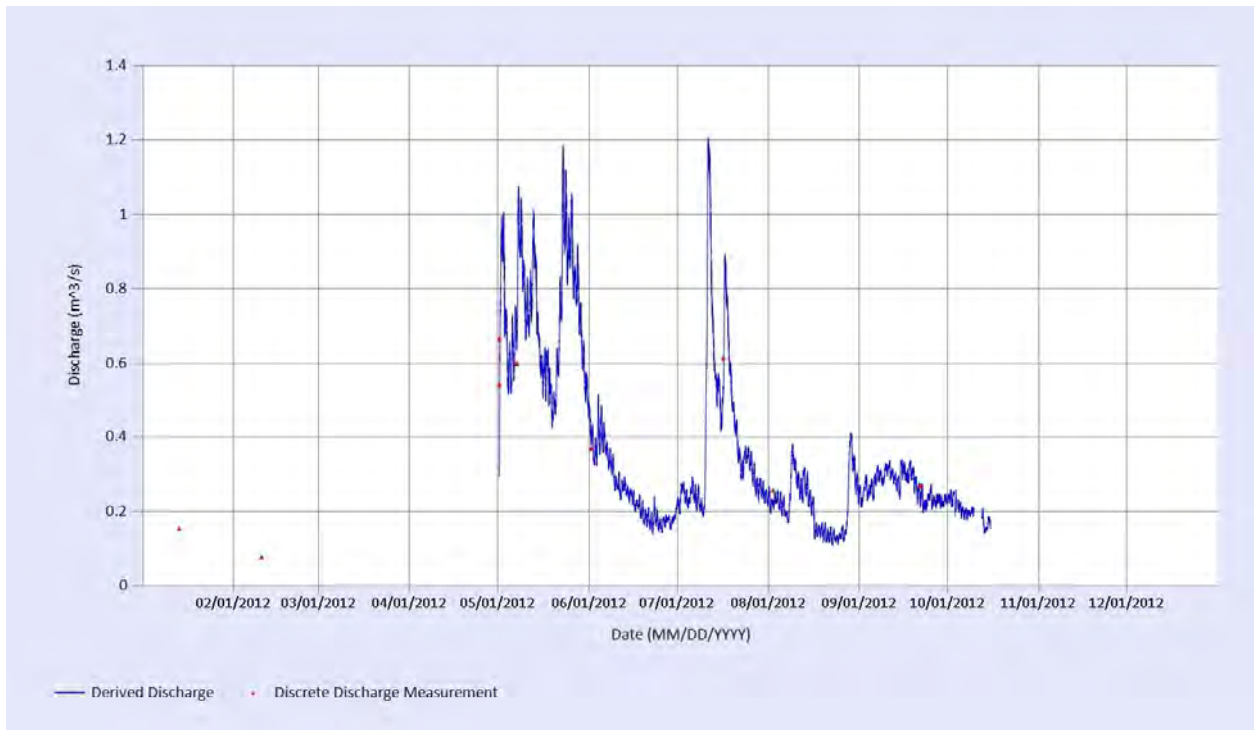


Figure C7 – Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2012

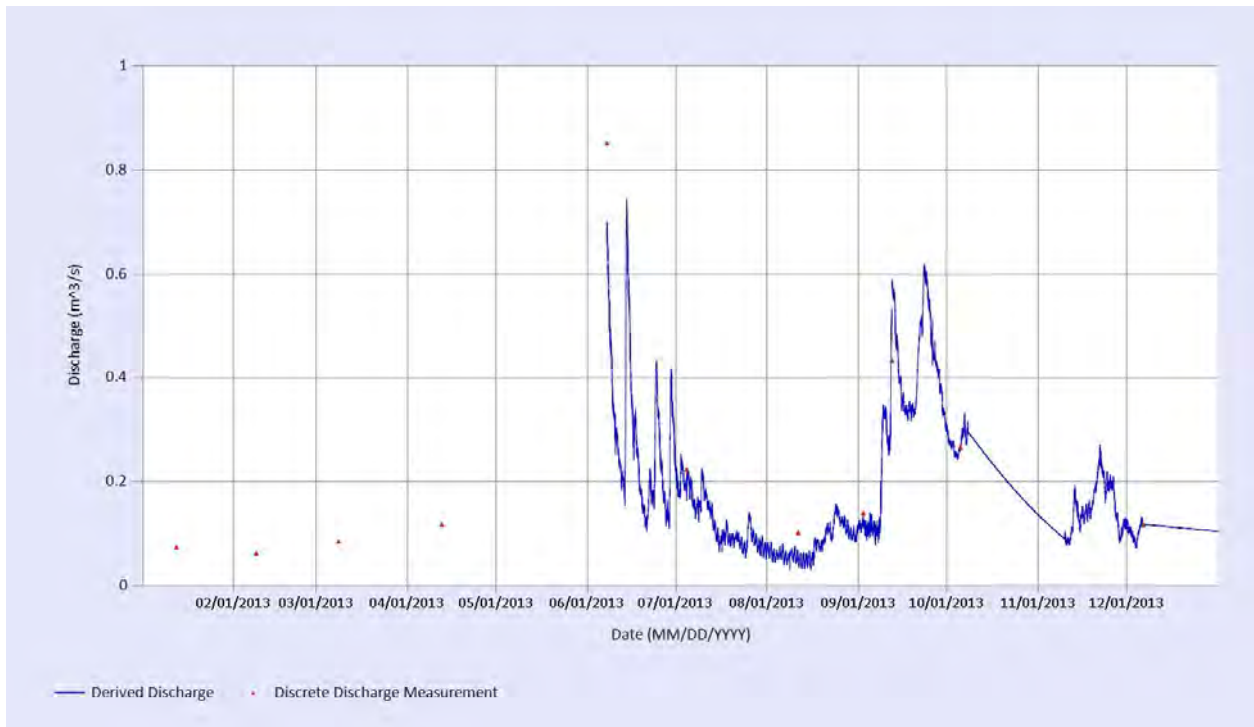
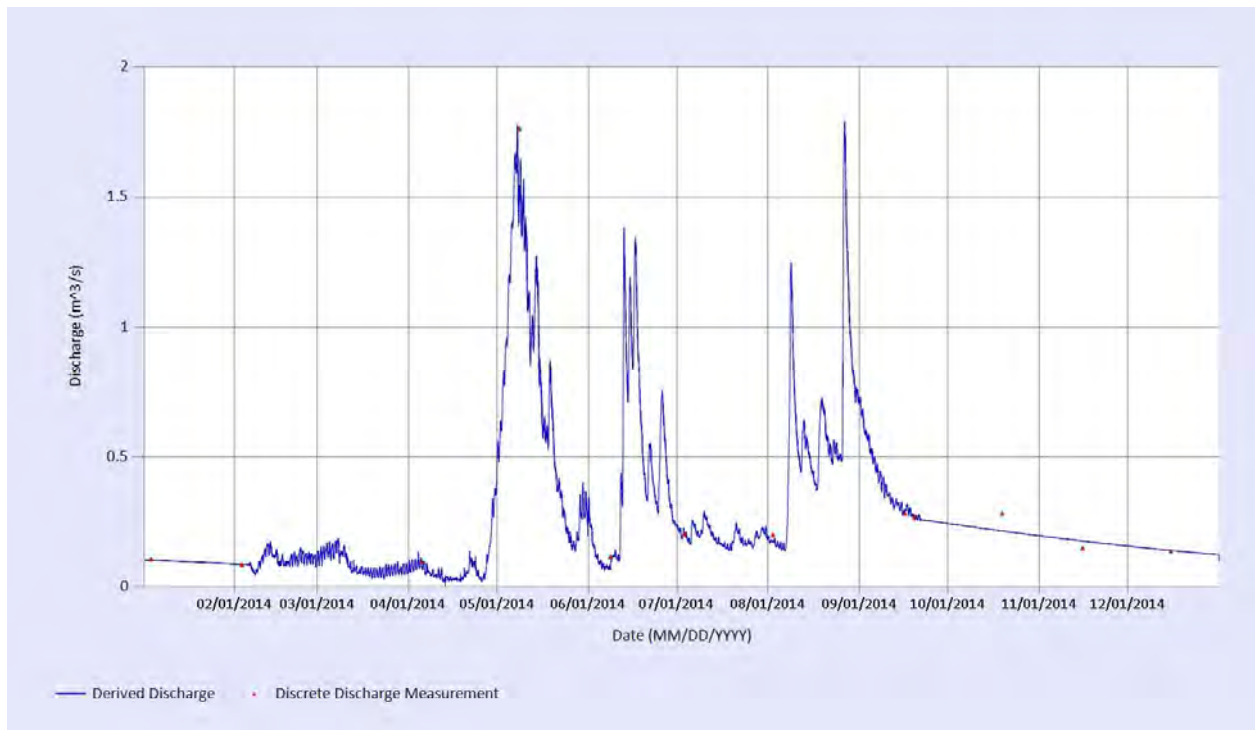
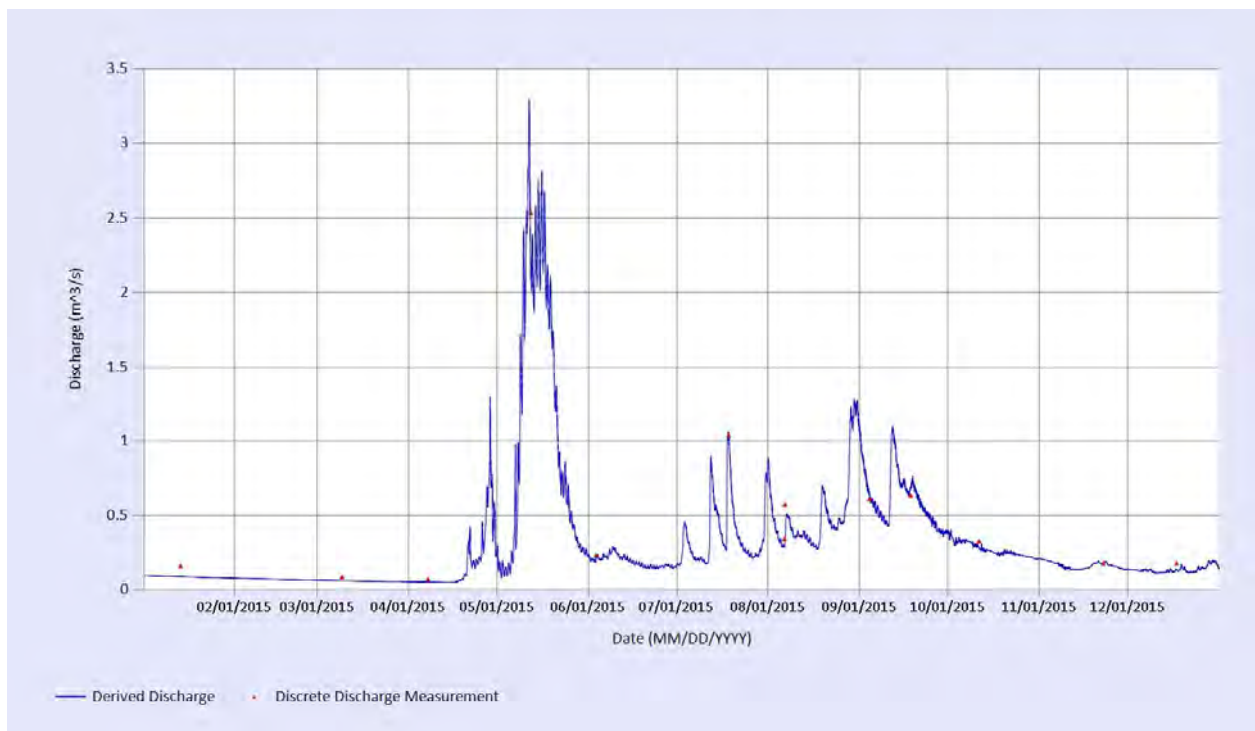


Figure C8 - Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2013



**Figure C9 - Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2014**



**Figure C10 - Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2015**

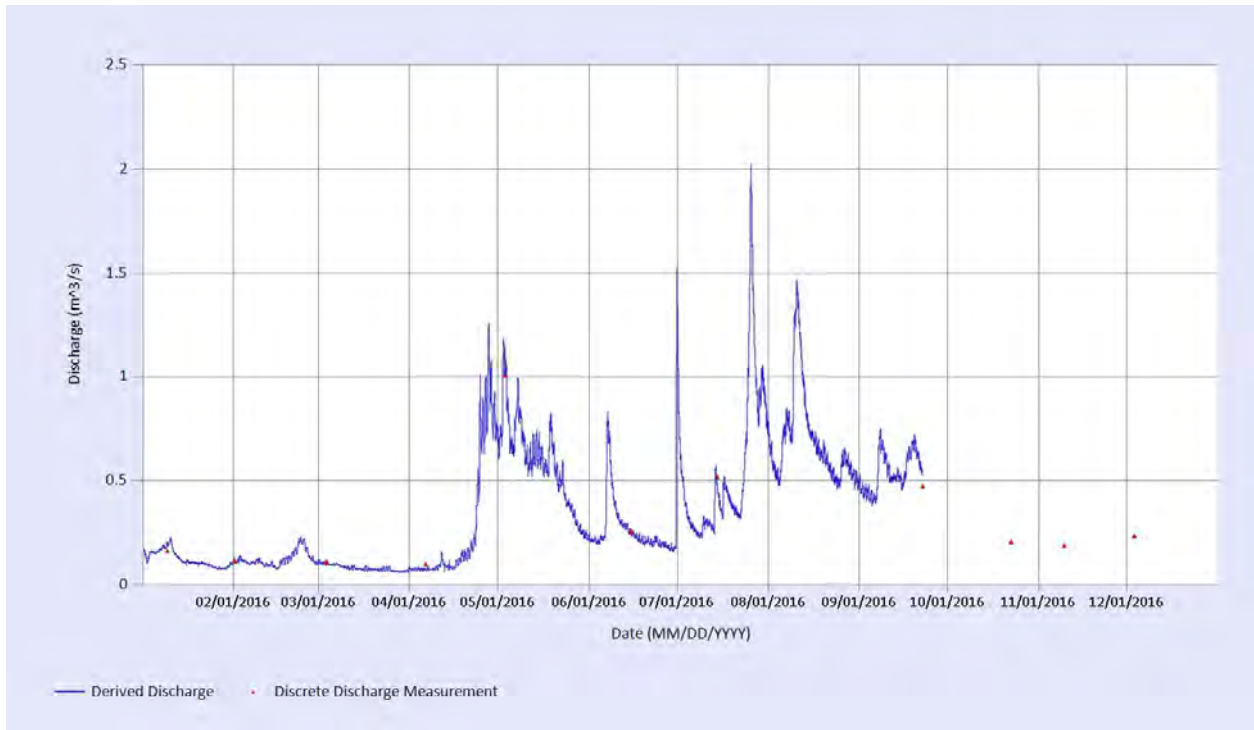


Figure C11 - Discharge at KV-7, Christal Creek at Hanson-McQuesten Lakes Road Bridge, 2016

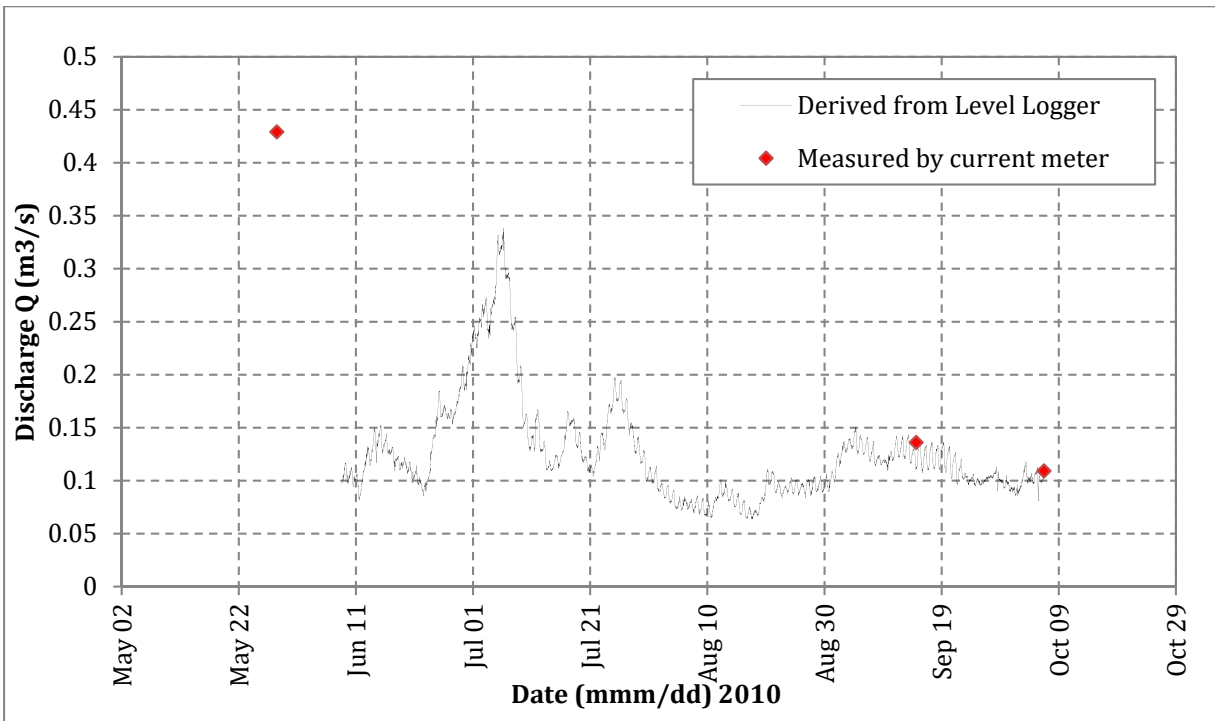


Figure C12 - Discharge at KV-9, Flat Creek 2010

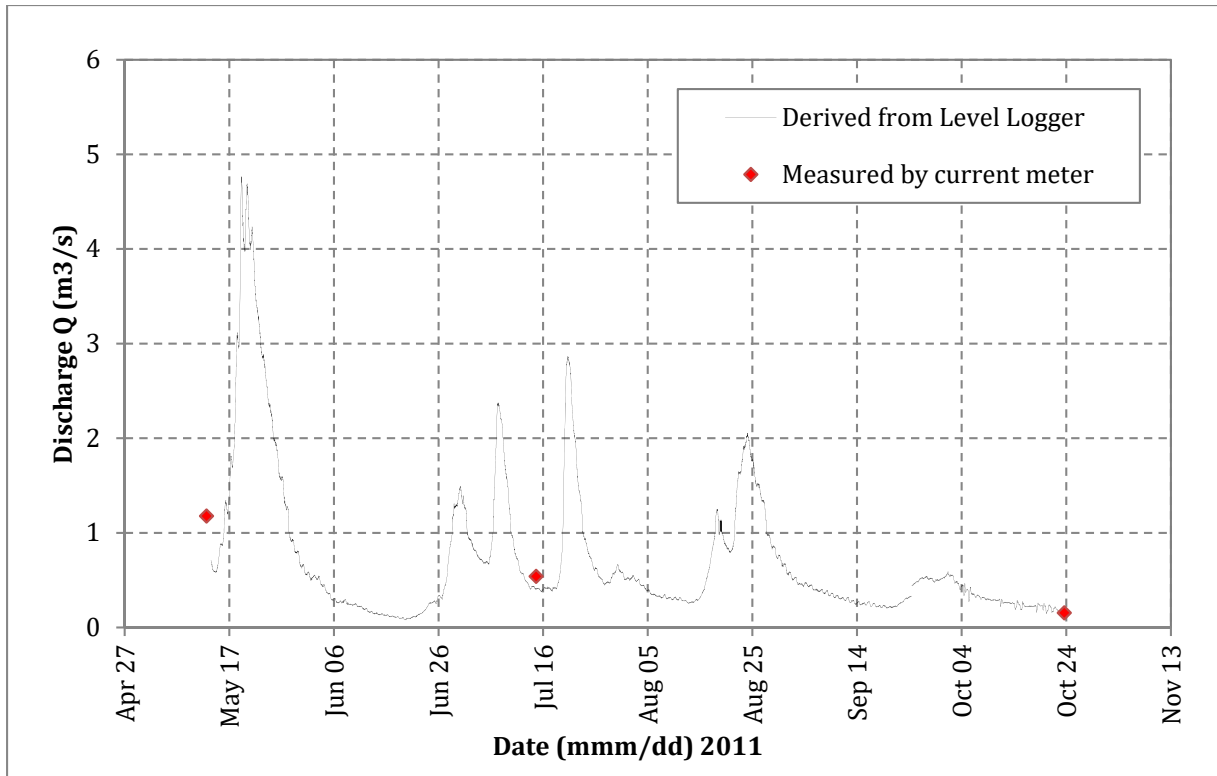


Figure C13 - Discharge at KV-9, Flat Creek 2011

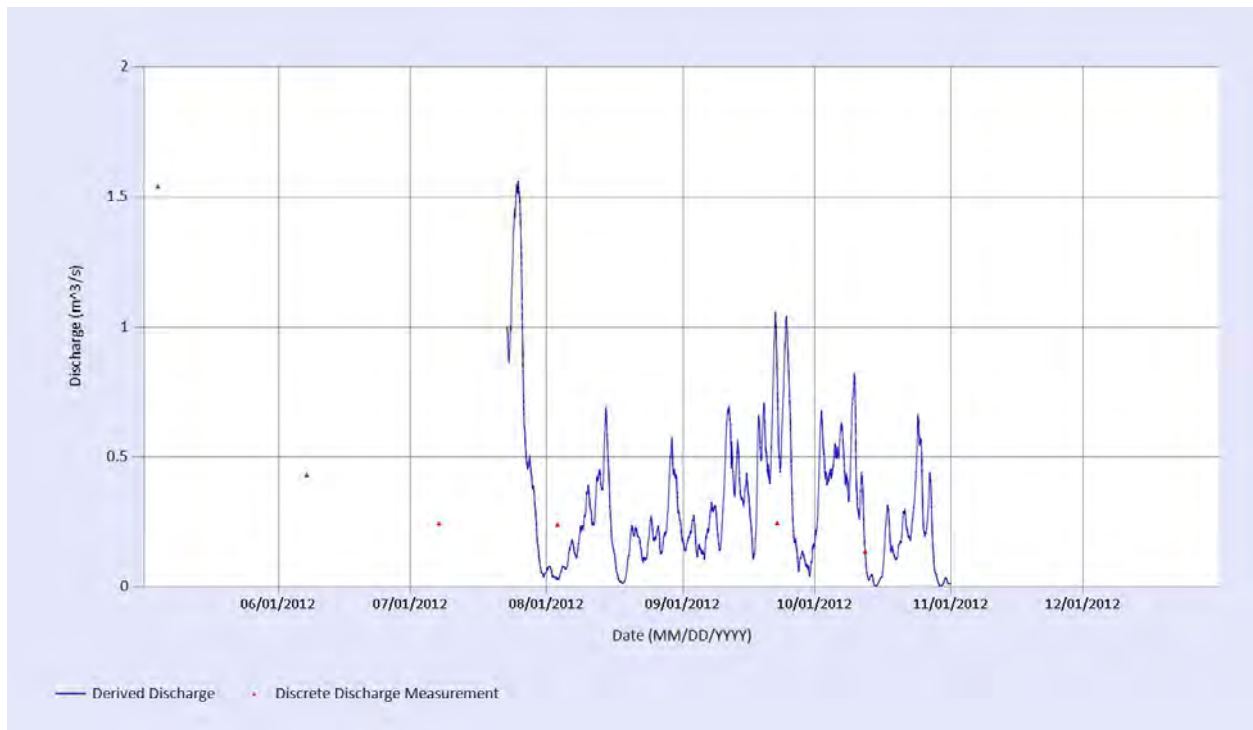
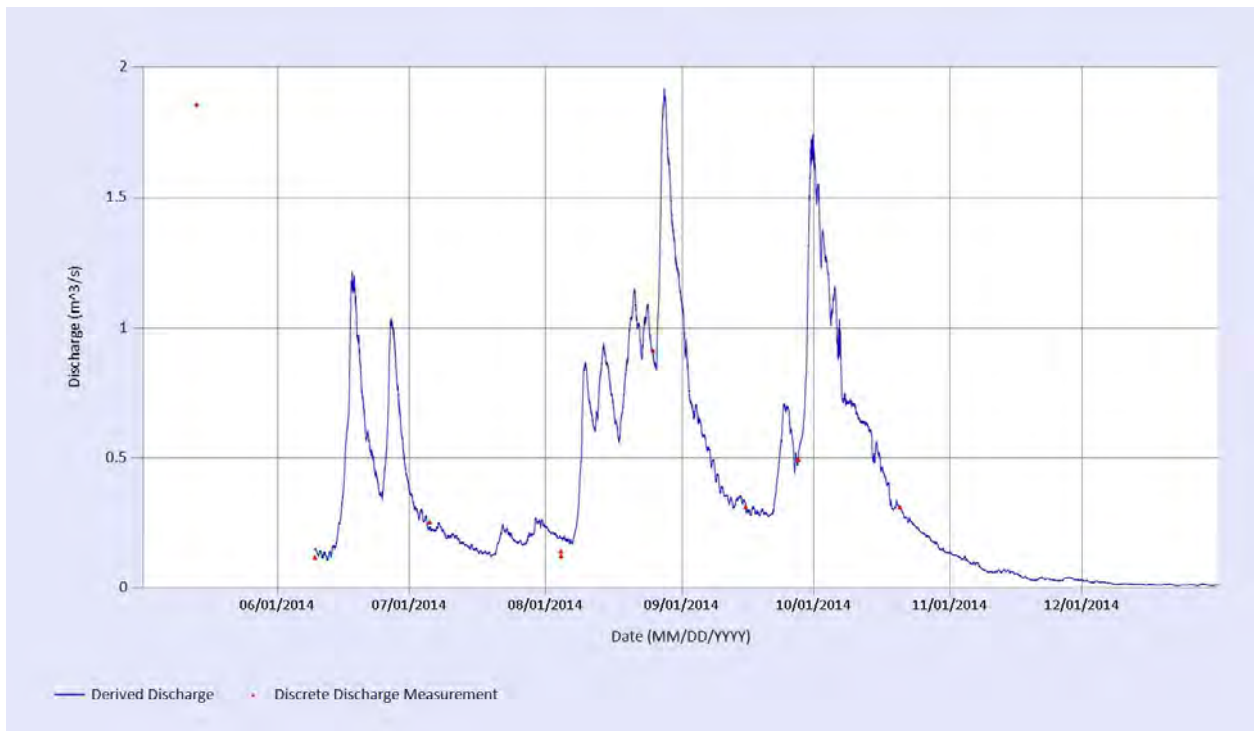


Figure C14 - Discharge at KV-9, Flat creek near the mouth, 2012

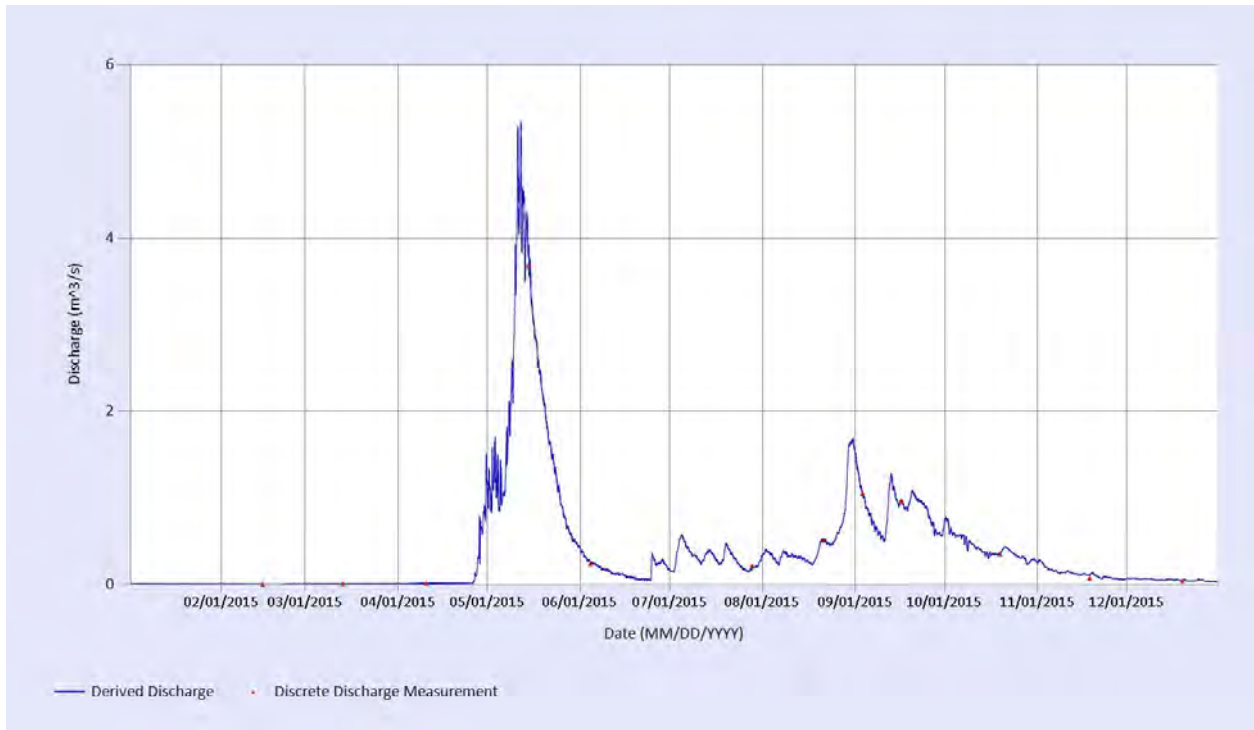


**Figure C15 - Discharge at KV-9, Flat creek near the mouth, 2013**

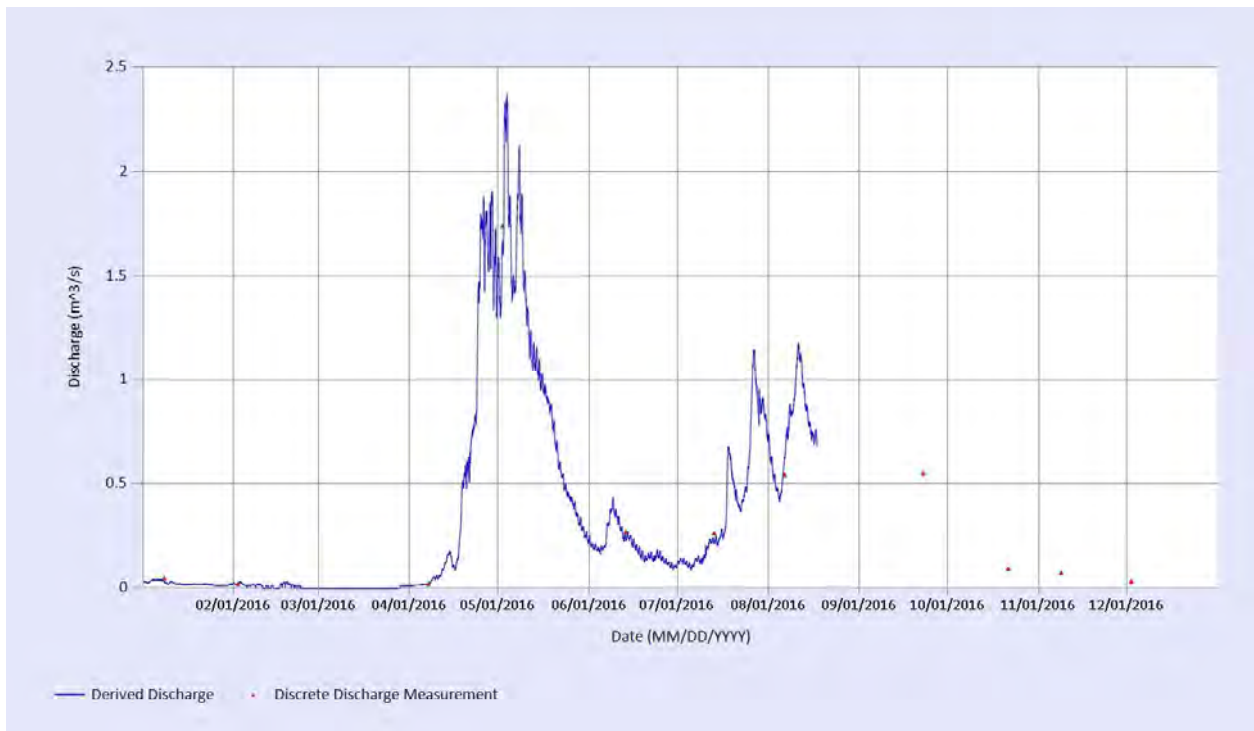


**Figure C16 - Discharge at KV-9, Flat creek near the mouth, 2014**

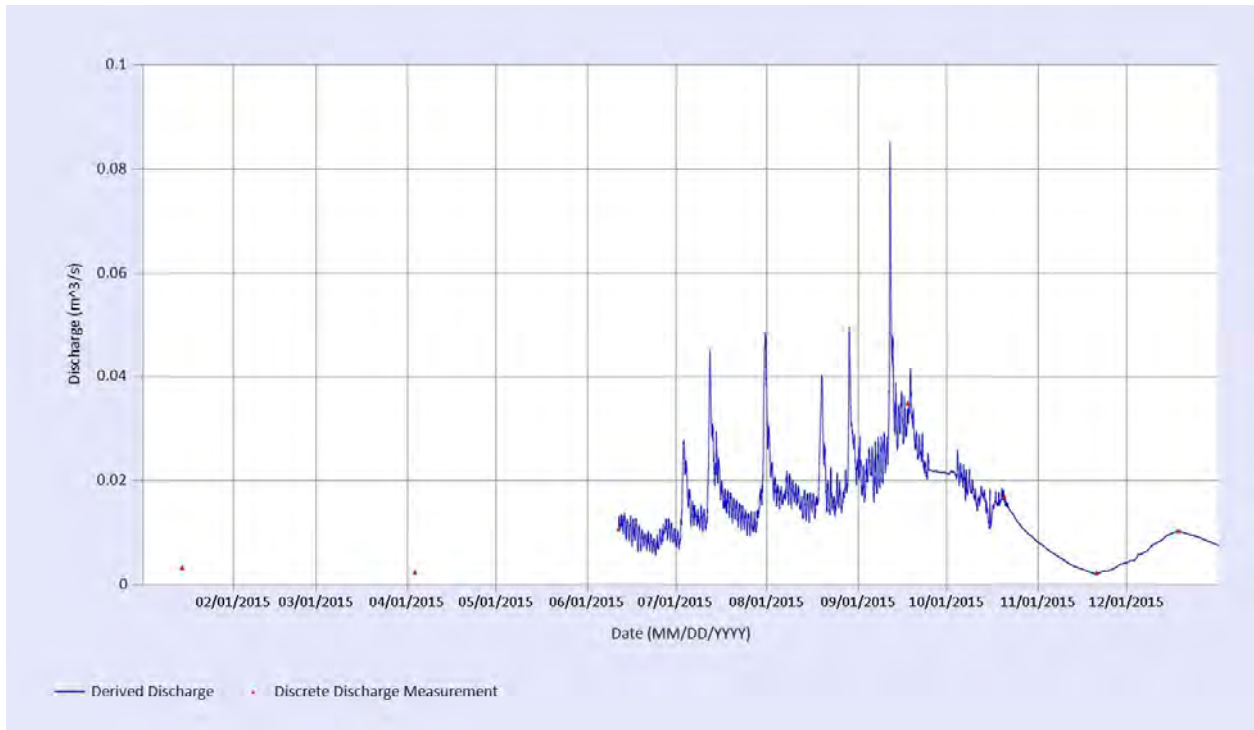




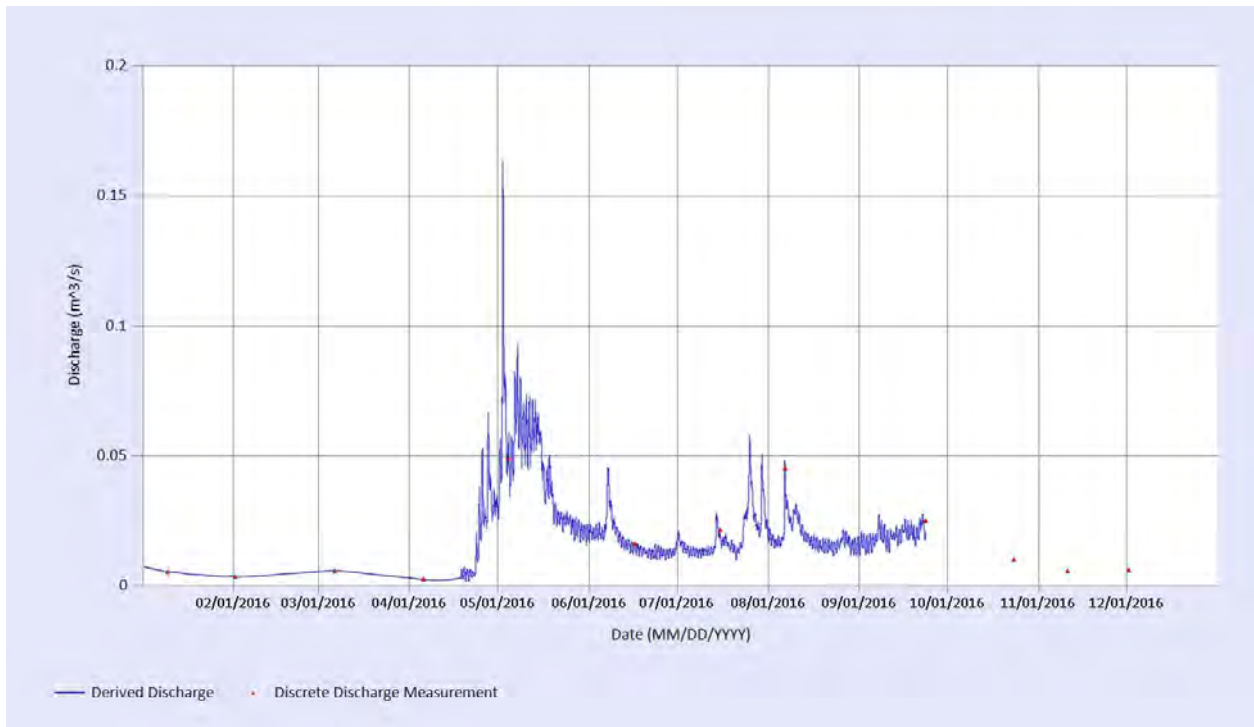
**Figure C17 - Discharge at KV-9, Flat creek near the mouth, 2015**



**Figure C18 - Discharge at KV-9, Flat creek near the mouth, 2016**



**Figure C19 – Discharge at KV-21, No Cash Creek below Silver Trail Highway, 2015**



**Figure C20 – Discharge at KV-21, No Cash Creek below Silver Trail Highway, 2016**

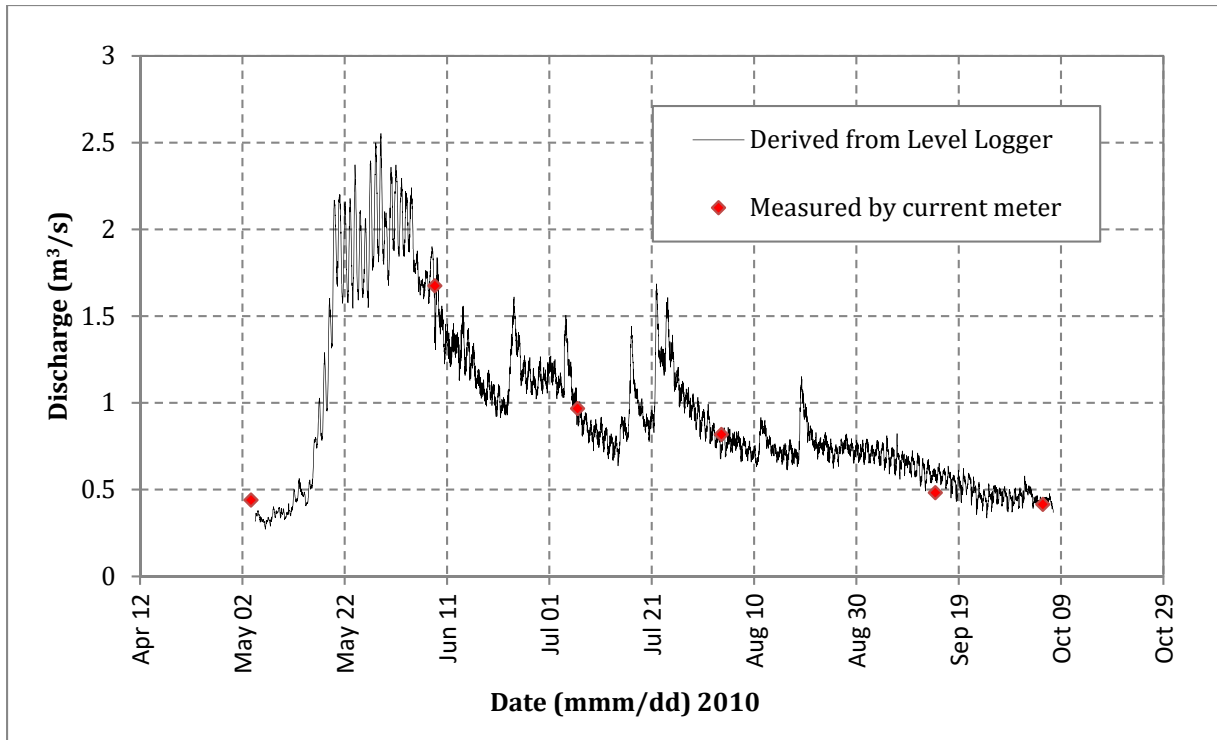


Figure C21 - Discharge at KV-41, Lightning Creek 2010

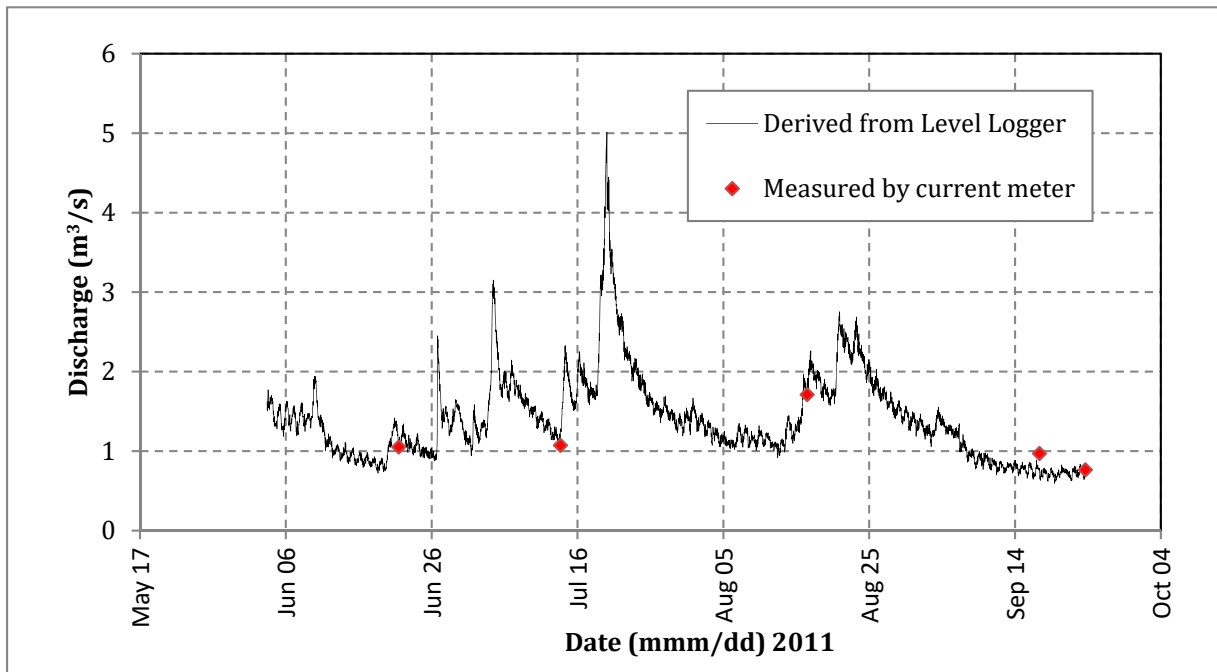
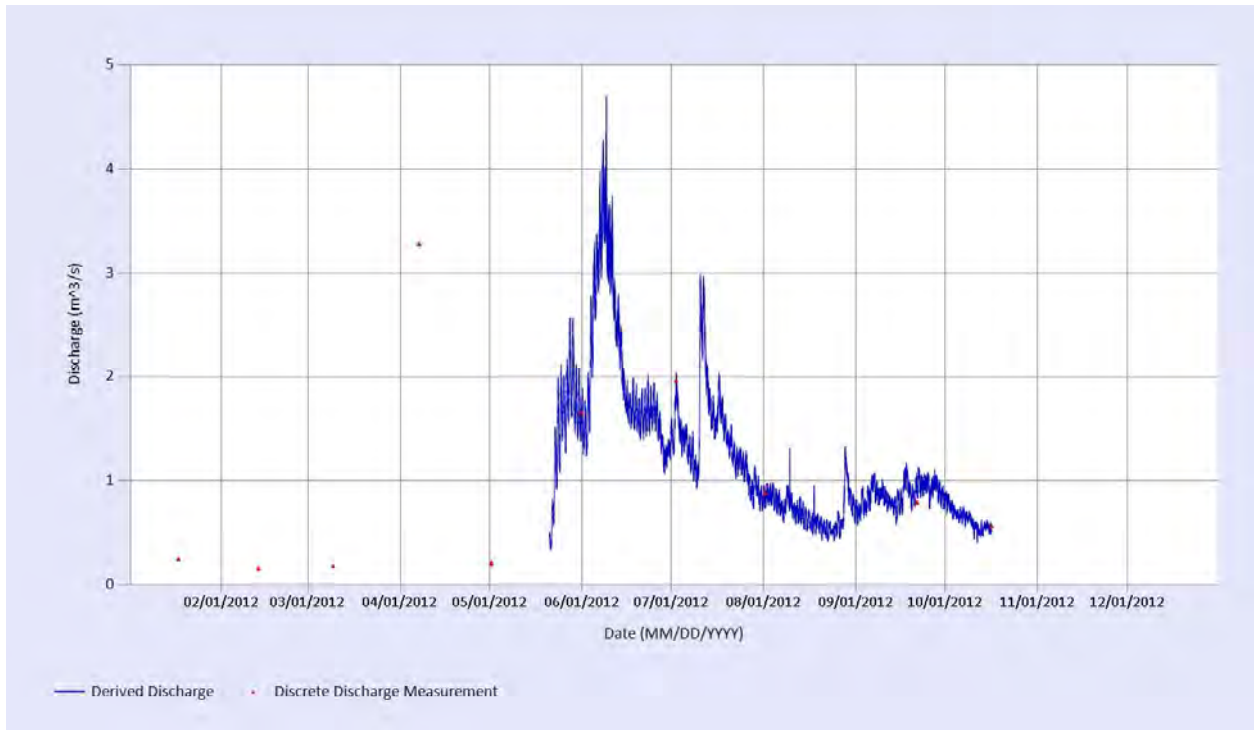
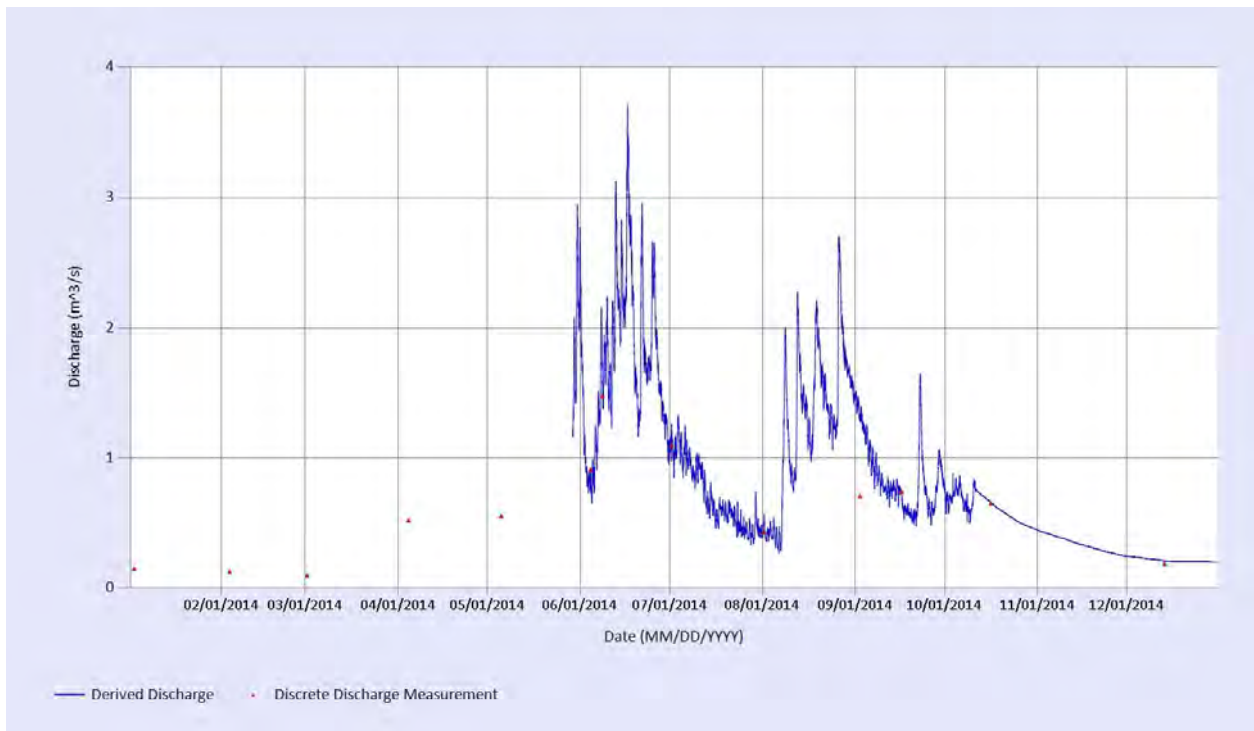


Figure C22 - Discharge at KV-41, Lightning Creek 2011



**Figure C23 – Discharge at KV-41, Lightning Creek above Keno City Bridge, 2012**



**Figure C24 – Discharge at KV-41, Lightning Creek above Keno City Bridge, 2014 open water season**

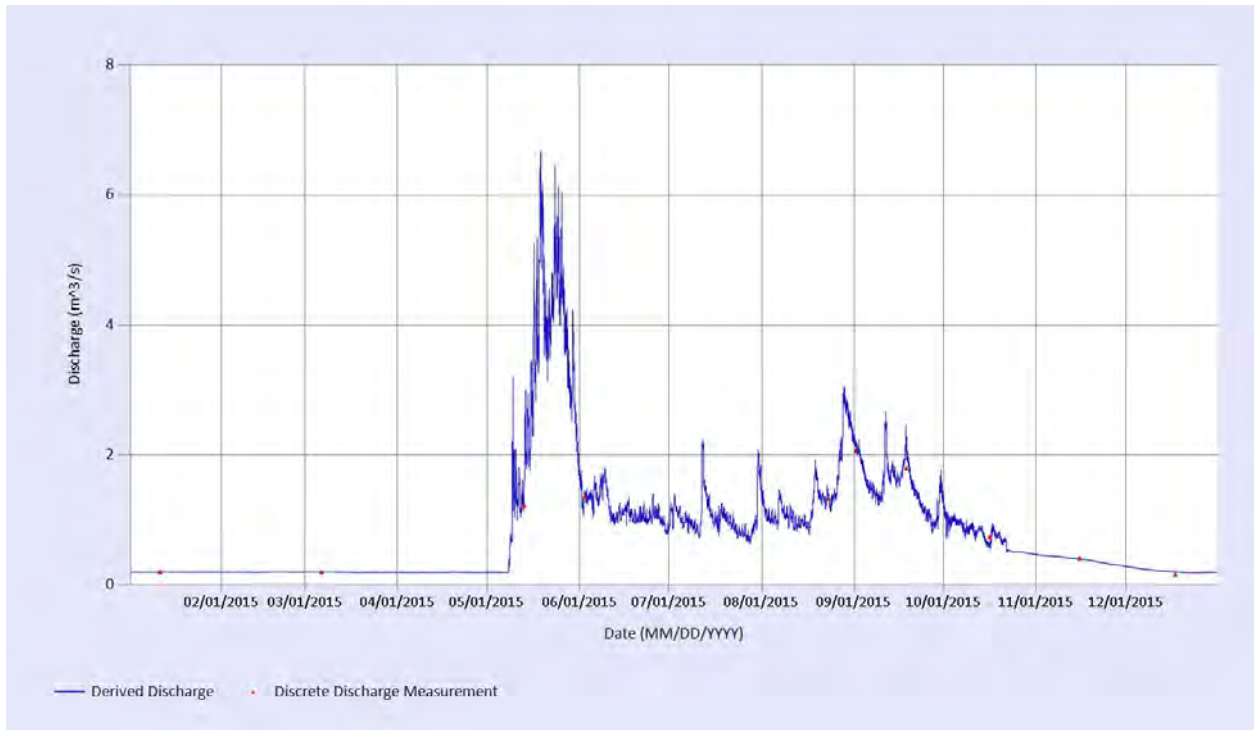


Figure C25 – Discharge at KV-41, Lightning Creek above Keno City Bridge, 2015

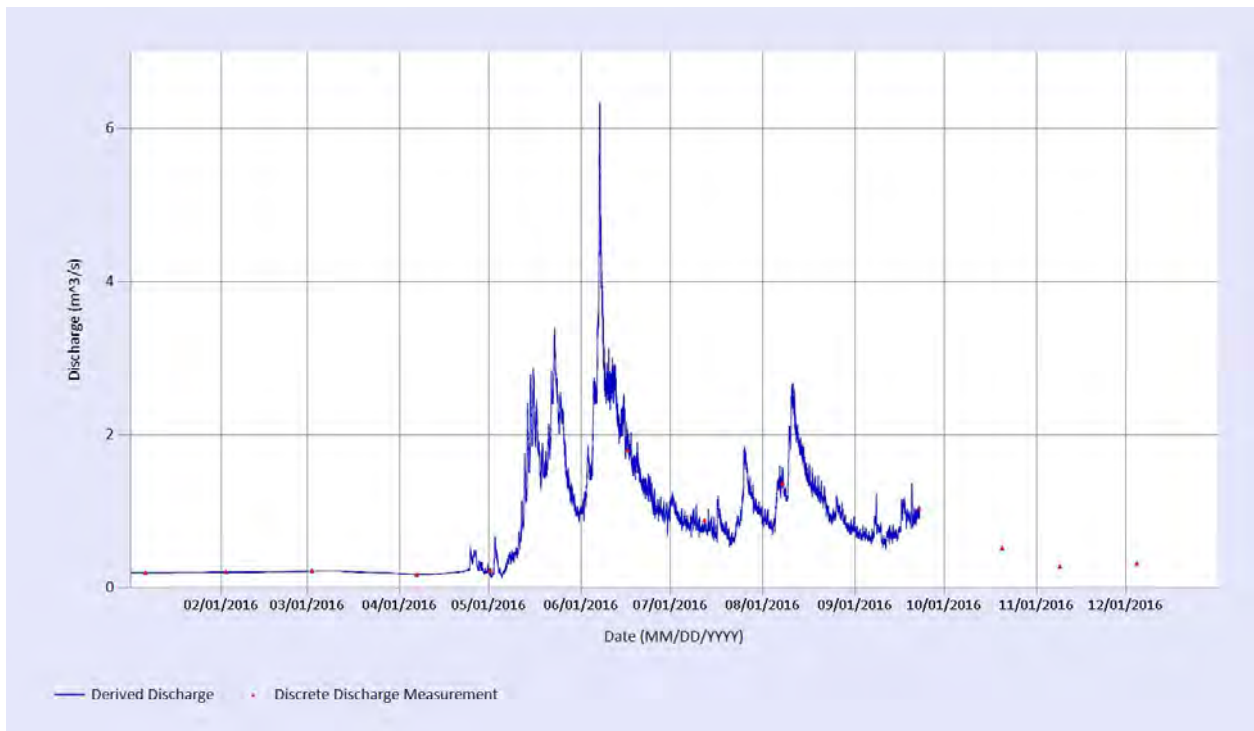
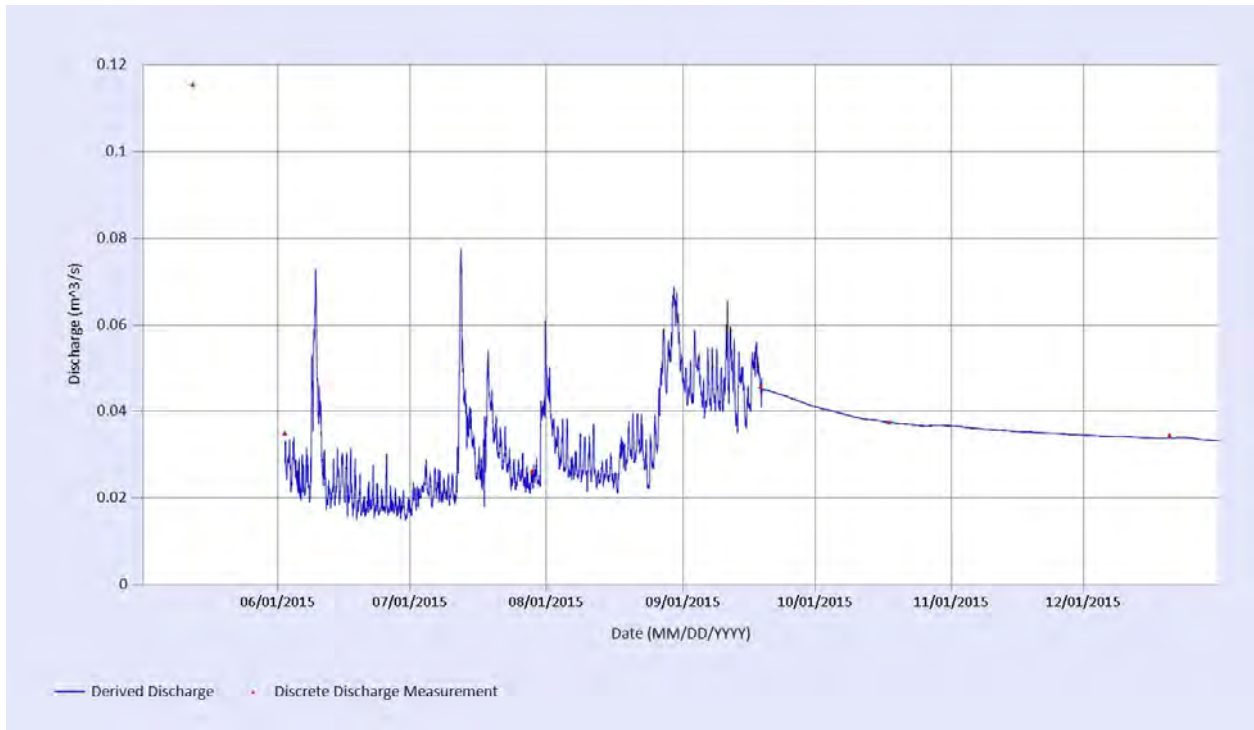
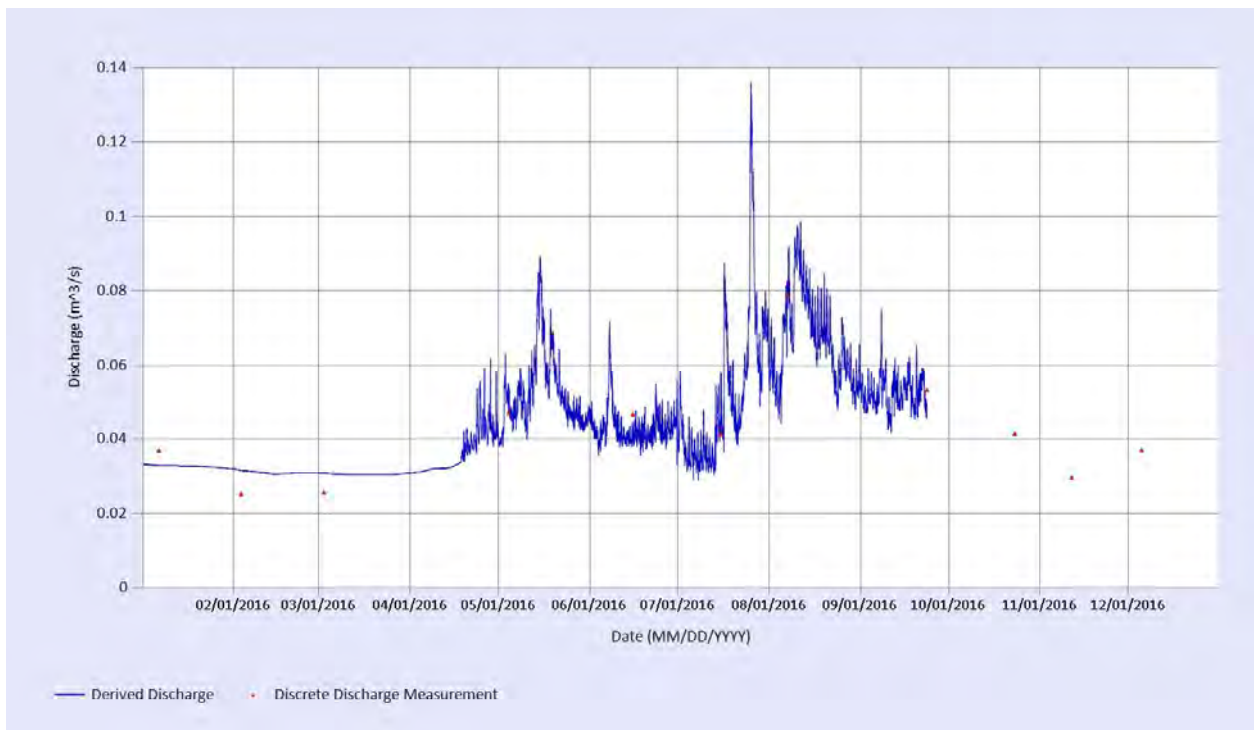


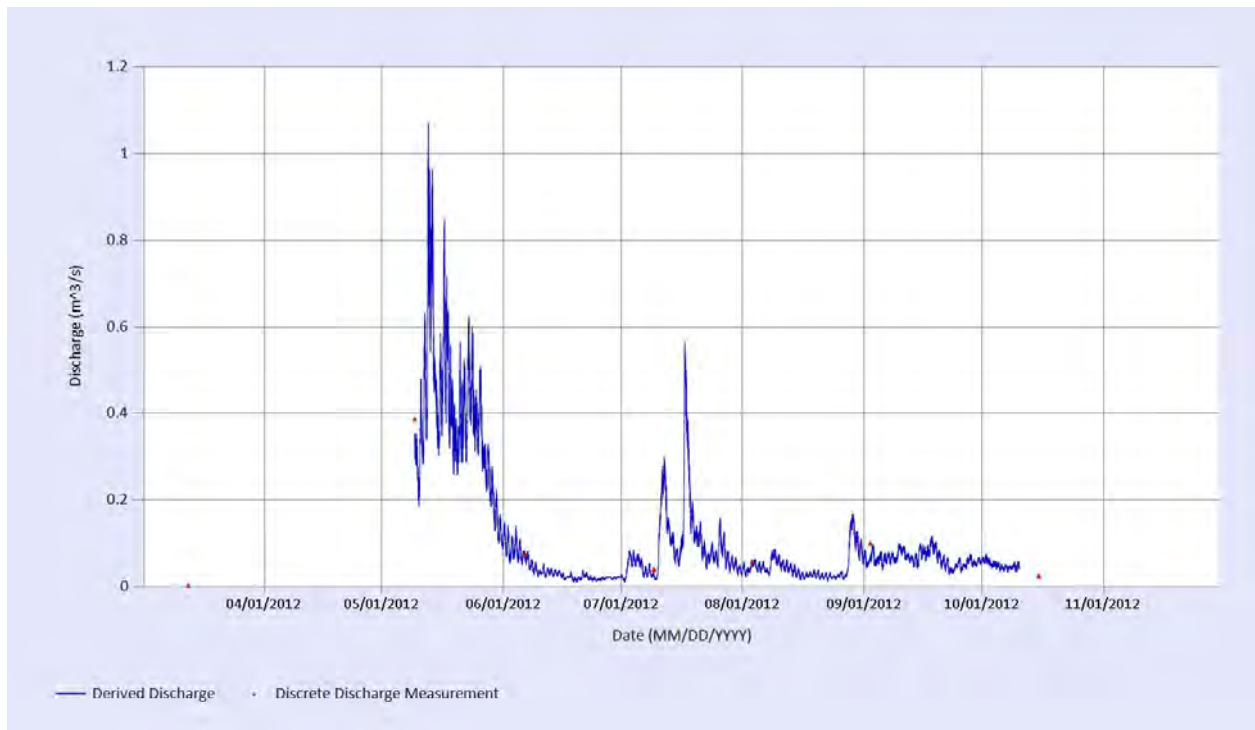
Figure C26 – Discharge at KV-41, Lightning Creek above Keno City Bridge, 2016



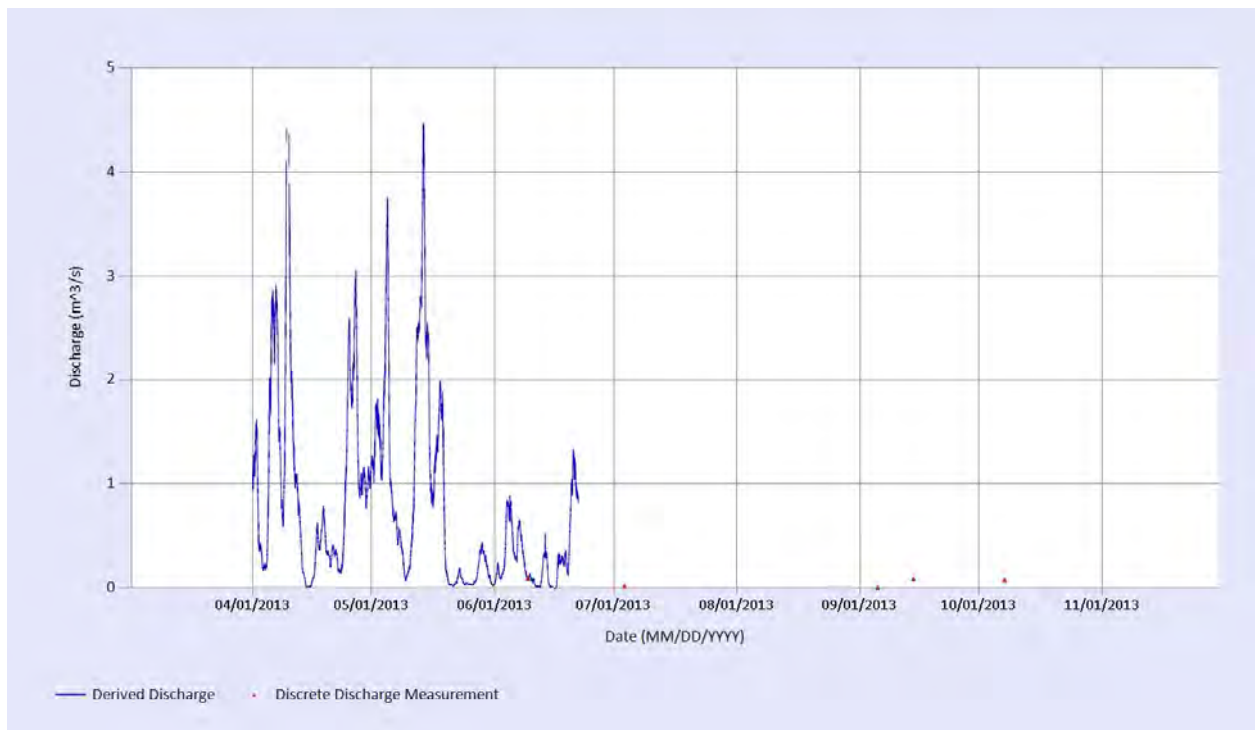
**Figure C27 – Discharge at KV-51, Christal Creek downstream of Hinton Creek, 2015**



**Figure C28 – Discharge at KV-51, Christal Creek downstream of Hinton Creek, 2016**



**Figure C29 – Discharge at KV-60, Galena Creek above Silver King Adit, 2012 open water season**



**Figure C30 – Discharge at KV-60, Galena Creek above Silver King Adit, 2013 open water season**

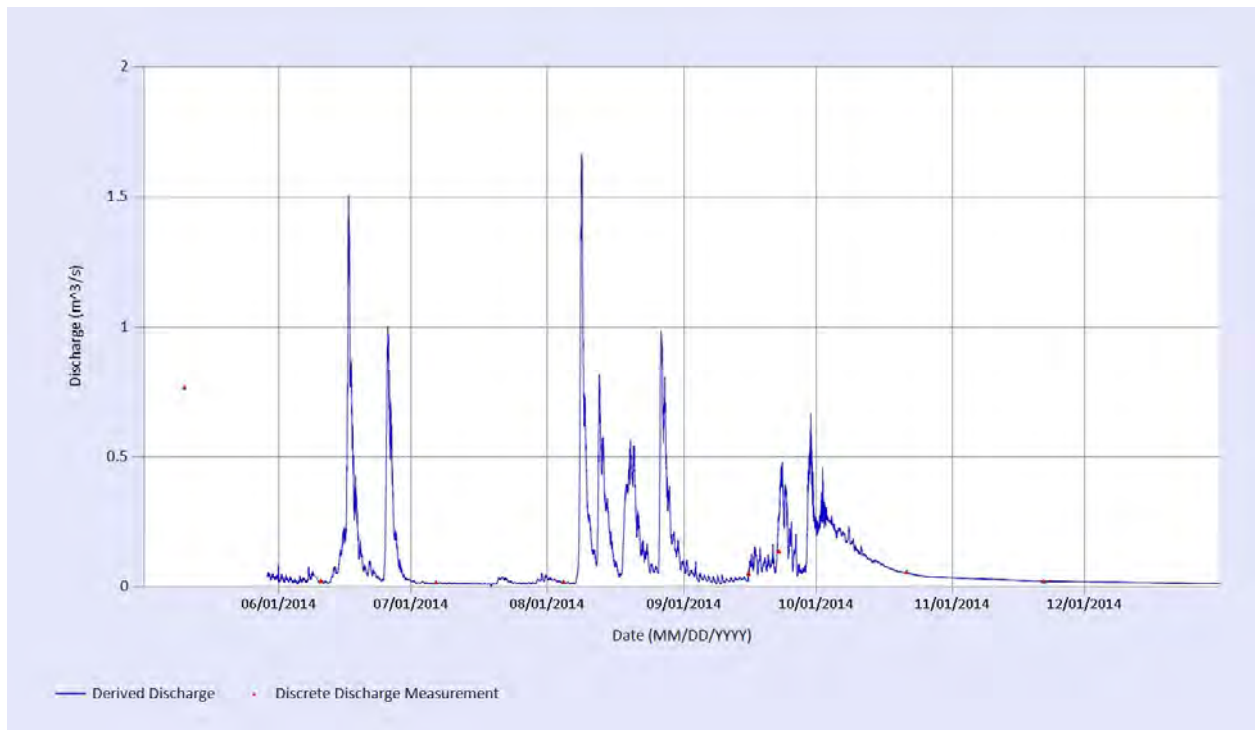


Figure C31 – Discharge at KV-60, Galena Creek above Silver King Adit, 2014 open water season

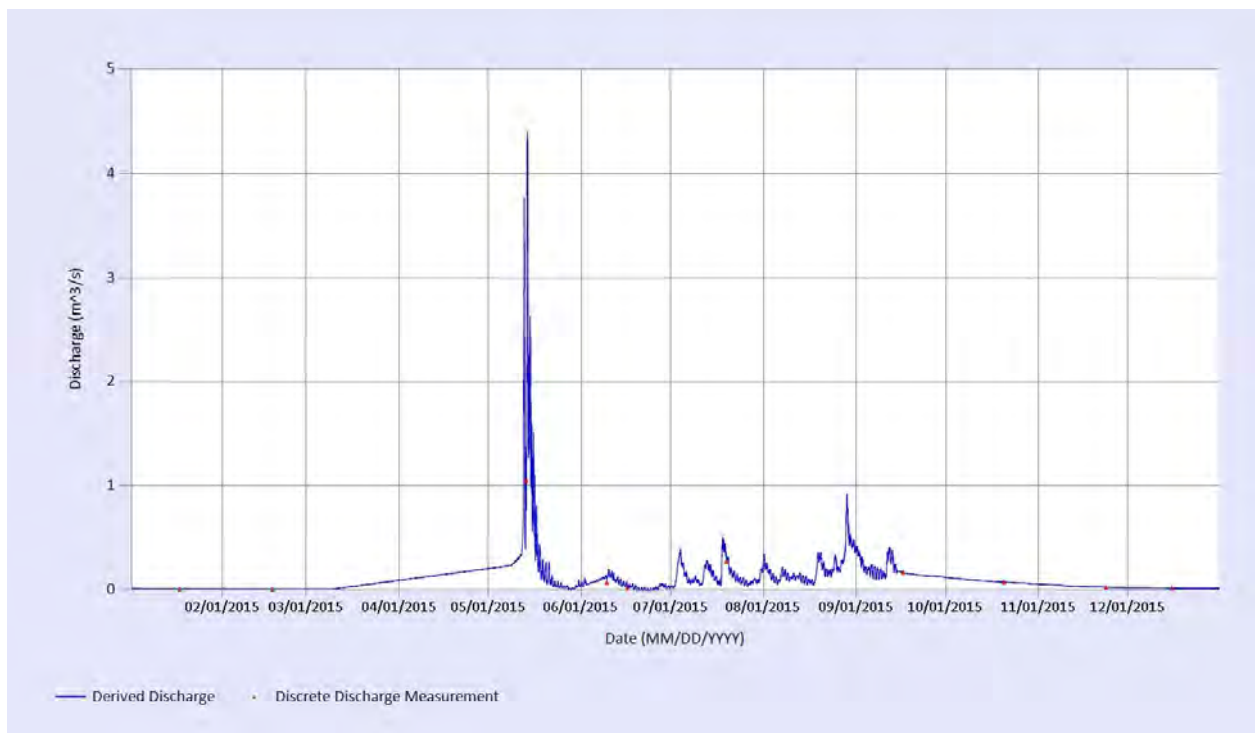
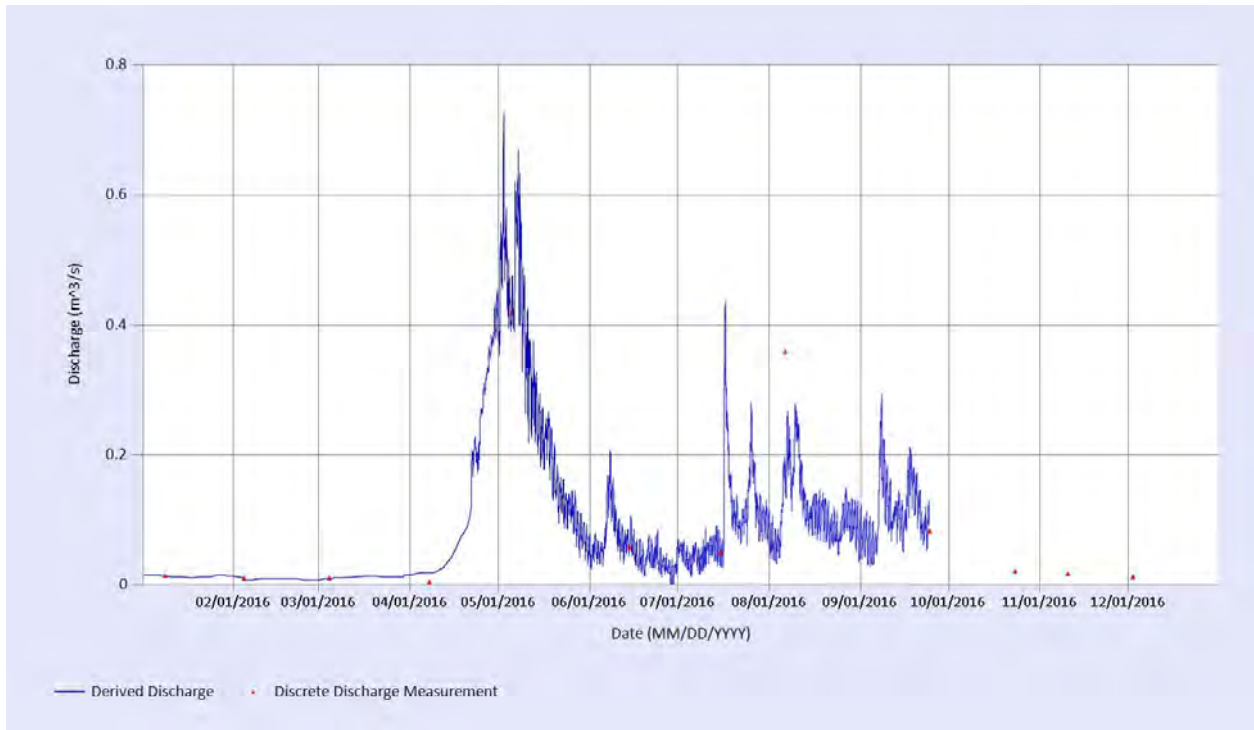
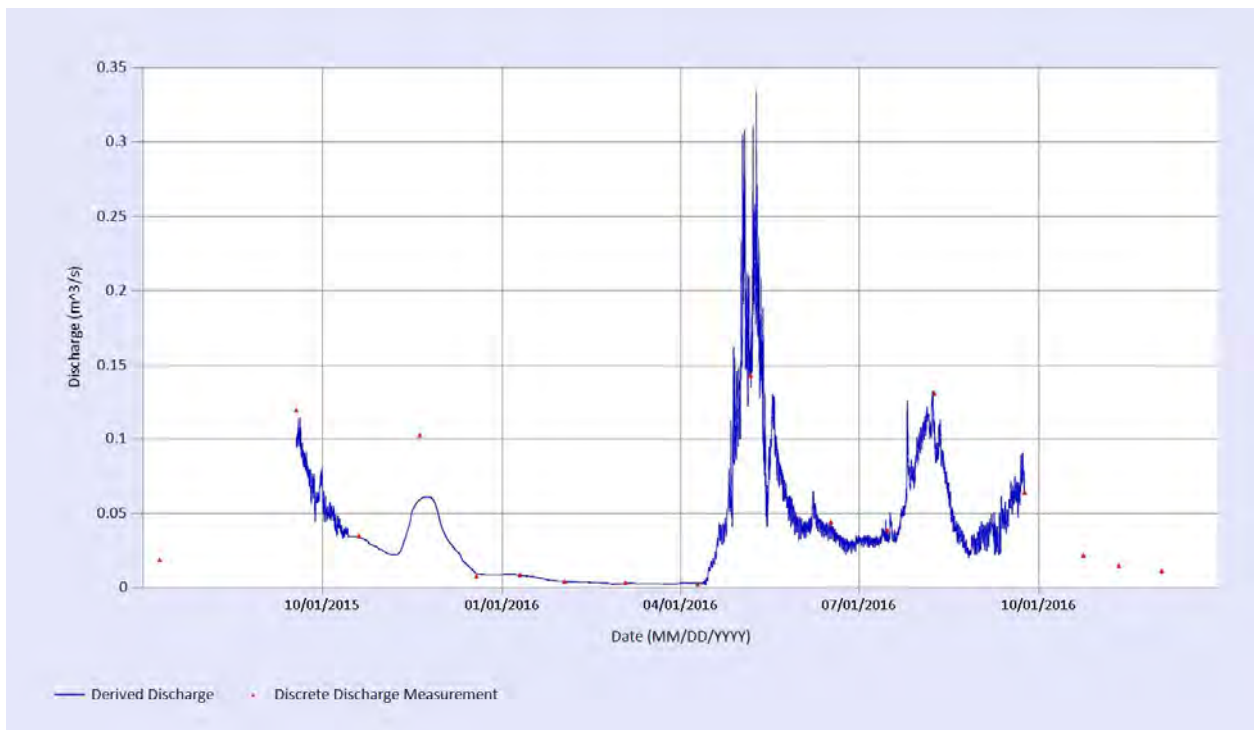


Figure C32 – Discharge at KV-60, Galena Creek above Silver King Adit, 2015





**Figure C33 – Discharge at KV-60, Galena Creek above Silver King Adit, 2016**



**Figure C34 – Discharge at KV-64, Flat Creek below Silver Trail Highway, 2015-2016**

# **APPENDIX D**

## **PHOTOGRAPHS**



Photo 1: KV-6, required periodic vegetation control, June 15<sup>th</sup>, 2016.



Photo 2: KV-7, old wooden cribbing, June 15<sup>th</sup>, 2016.



Photo 3: KV-9, looking downstream, moderate-high stage, May 2<sup>nd</sup>, 2016.



Photo 4: KV-21, weir pond showing significant sediment accumulation, June 16<sup>th</sup>, 2016.



Photo 5: KV-41, staff gauge and aging wooden cribbing structure, June 16<sup>th</sup>, 2016.



Photo 6: KV-51, looking upsteam, May 4<sup>th</sup>, 2016.



Photo 7: KV-60, looking upsteam, July 15<sup>th</sup>, 2016.



Photo 8: KV-64, looking downstream May 5<sup>th</sup>, 2016.