Water Supply and Hydrology Study

For the

MCCULLOCH RESERVOIR WATER SUPPLY AREA

(Year 2 - 2004 Report)

Prepared for the
SOUTH EAST KELOWNA IRRIGATION DISTRICT
Kelowna, BC

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SOUTH EAST KELOWNA IRRIGATION DISTRICT
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1.0 INTRODUCTION

In 1979 the Ministry of Environment completed a report titled *Report on South East Kelowna Irrigation District Water Supply Hydrology* and in 1984 a letter update to the 1979 report was completed. A key recommendation from this report was that hydrometric data collection should continue for the SEKID system and that the annual supply capabilities of the system should be re-evaluated in 7 – 10 years.

With increasing demands for water and the potential that climate change and land use change (changes in vegetative cover due to forestry activities) may be affecting runoff, it is important that the District has a clear understanding of the current water supply situation.

2.0 PROJECT DESCRIPTION

Water Survey of Canada (WSC) operated hydrometric stations at several locations in the water supply area over the period 1973 to 1984 including station 08NM210 - *Pooley Creek Above Pooley Ditch (active 1973, 1974, & 1976-1979)*, and station 08NM212 - *Stirling Creek Diversion to McCulloch Reservoir (active 1977-1979 and 1984)*. Based on the 1979 Ministry of Environment report, Pooley Creek contributes the largest proportion of run-off to the McCulloch reservoir, and nearly 40% of the mean annual runoff for the Hydraulic Creek drainage area was derived from the areas draining to both the Pooley Creek and Stirling Creek diversions. Based on this information, the first priority was to re-establish these two hydrometric stations (completed in October 2003). Additional new hydrometric stations were established in April 2004 to quantify the water yield from both Canyon Creek and the upper Hydraulic Creek supply areas (refer to Appendix A - Map).

The purpose of re-establishing the hydrometric gauging stations is to provide the District with current data on the spring, summer and fall runoff from the watersheds upstream from the storage reservoirs. This data will be used to compute unit area runoff values that will be compared to those values computed in the previous reports. It is important for the District to know if these unit runoff values have changed. If they have changed then they may impact the ability of the District to meet its supply obligations in the future. Accurate estimates of unit runoff values will require several years of data. Because of the importance of this data, one of the objectives of the project is identify which stations are of greatest value and what are the best locations for the stations to meet the District's needs.

2.1 Project Activities - 2004

The completion dates for the various project activities completed in 2004 are outlined in Table 1 below.

Table 1 – 2004 Project Activities

Dates	Activity
March 24, 2004	Start-up Pooley and Stirling Creek sites, attempt to de-ice wells
April 6, 2004	De-ice Stirling Creek site
April 11, 2004	Calculate Stirling flow, check flow balance at end of ditch
April 17, 2004	De-ice Pooley station, calculate flow and install temporary structure at Canyon Creek
April 22, 2004	De-ice Pooley station, calculate flow at Canyon Creek
April 29, 2004	Install temporary structure at Hydraulic Creek
May 3, 2004	Calculate flow at all four sites
May 18, 2004	Calculate flow at all four sites
June 18, 2004	Calculate flow and download datalogger at all four sites
July 13, 2004	Install permanent structure at Canyon Creek and Hydraulic Creek Calculate flow and download datalogger at all four sites
July 28, 2004	Calculate flow and download datalogger at all four sites. Check flow balance in Pooley ditch
Sept. 22, 2004	Calculate flow and download datalogger at all four sites. Check flow balance in Pooley ditch
Oct. 29, 2004	Survey benchmarks and download datalogger at all four sites. Closed stations for the year.

The old WSC stations at both Pooley Creek and Stirling Creek were re-established in October 2003. New hydrometric stations were installed in April 2004 at Canyon Creek and Hydraulic Creek. Permanent survey benchmarks were established to enable elevation references for water levels.

Discharge measurements were completed on at least six occasions for each station (refer to Table 2). This data was used to develop stage-discharge curves for each site. (Refer to Appendix B for detailed stage and discharge data). Final field data was collected on October 29, 2004.

2.2 Data Collection

The stations are designed to record water levels, which is converted to discharge data using the stage discharge curve. The stage-discharge curve for each site must be established by measuring the discharge over a range of water levels. Discharge [Q] (m^3/s) is calculated by measuring water velocity [V] (m/s) multiplied by channel cross sectional area [A] (m^2). The discharge and corresponding water levels are graphed to determine the relationship between stage and discharge. From this graph, water levels can be converted to discharge values. A minimum of three points is required to establish this relationship, however better accuracy is obtained with more points to plot the curve.

An Ott Thalimedes float operated shaft encoder and datalogger were installed and programmed to record the water level (stage) every hour at all four stations. The corresponding discharge from “each hour” was used to calculate average daily discharges and monthly yields. From May 1 to July 13, 2004 a Stevens Pressure Transducer and a Campbell Scientific CR510 Data Logger were temporarily installed at the Hydraulic Creek station. After July 13, 2004 the Ott Thalimedes was installed at this station. The technical specifications for this equipment are found in Appendix C.

The velocity measurements (used to calculate discharge) were made using a Marsh McBirney Flow Mate Model 2000 flowmeter (refer to Appendix C for equipment specifications).

2.3 Quality Assurance and Quality Control

Data collection is undertaken in accordance with the standards outlined by the Resource Inventory Standards Committee (RISC) in the *Manual of Standard Operating Procedures for Hydrometric Surveys in British Columbia*. The accuracy of the flow meter was confirmed by taking velocity measurements in a uniform open concrete channel and comparing the results with the values obtained using the floating object method of estimating stream velocity, as well as applying Manning’s Equation for that channel.

3.0 2004 DATA

Continuous water level data (hourly data) was collected from March 24 to October 29, 2004 at Pooley Creek; from April 6 to October 29, 2004 at Stirling Creek; from April 17 to October 29, 2004 at Canyon Creek and from April 29 to October 29, 2004 at Hydraulic Creek (refer to Appendix B).

Environment Canada data indicates that in 2004, the Southern BC Mountains Region experienced the 3rd warmest and 36th wettest spring since 1948 (57 years of record). The warm weather resulted in an early onset of the spring freshet. The summer of 2004 was the 4th warmest and 14th wettest summer on record. The fall was the 28th warmest and 5th wettest on record. The relatively wet fall period resulted in increased runoff.

Table 2 summarizes the discharge measurements for 2004. Table 3 compares mean monthly discharges for 2003 and 2004 with previous WSC data. Monthly water yields are compared in Table 4.

Table 2 – Stage and Discharge Measurements

Date	Pooley Creek		Stirling Creek		Canyon Creek		Hydraulic Creek	
	Stage (m)	Q (m^3/s)	Stage (m)	Q (m^3/s)	Stage (m)	Q (m^3/s)	Stage (m)	Q (m^3/s)
April 6, 2004	-	-	0.345	0.1479	-	-	-	-
April 11, 2004	-	-	0.403	0.3249	-	-	-	-
April 17, 2004	0.148	0.2018	-	-	-	-	-	-
April 22, 2004	-	-	-	-	0.460	0.2417	-	-
May 3, 2004	0.356	0.9538	0.480	0.5198	0.774	0.9658	0.604	2.142
May 18, 2004	0.337	0.8808	0.411	0.3375	0.696	0.7595	0.576	2.054
June 18, 2004	0.163	0.2623	0.328	0.0783	0.401	0.1670	0.439	0.535
July 13, 2004	0.064	0.0402	0.268	0.0146	0.300	0.0321	0.354	0.127
July 28, 2004	-0.018	0.0055	0.230	0.0016	0.234	0.0097	0.266	0.012
Sept. 22, 2004	0.166	0.2739	0.301	0.0598	0.334	0.0660	0.431	0.431

The data in Table 2 was used to develop the stage discharge curves for each site (refer to Appendix B).

Table 3 – Mean Monthly Discharge (WSC Data vs 2003/04 Data)

Data	Mean Monthly Discharge (m^3/s)						
	Apr.	May	June	July	Aug.	Sept.	Oct.
Pooley 2003	-	-	-	-	-	-	0.025
Pooley 2004	0.294	1.020	0.454	0.036	0.013	0.136	0.067
WSC Pooley	-	0.957	0.868	0.123	0.016	0.063	0.018
Stirling 2003	-	-	-	-	-	-	*0.021
Stirling 2004	0.349	0.334	0.121	0.018	0.007	0.037	0.036
WSC Stirling	0.041	0.356	0.148	0.012	0.003	0	0
Canyon 2004	0.329	0.722	0.206	0.028	0.005	0.036	0.034
Hydraulic 2004	-	2.349	0.868	**0.072	0.039	0.286	0.162

*This value is estimated based on hourly data collected from Oct 14, 2003 08:45 PST to Oct 31, 2003 23:45 PST.
**Power lost/data missing from July 4, 2004 08:00 PST to July 13, 2004 09:00 PST (8 days of data missing, 0.072 is the 23 day mean).
WSC Pooley values based on data collected from 1973 - 1979, WSC Stirling values based on data collected from 1977 – 1984.

The mean monthly discharges were calculated using the hourly field data (stage/water level) and the corresponding discharge values derived from the stage discharge curves. The total discharge from each hour was calculated and then summed for each month. This value was then divided by the total number of seconds in that month to arrive at the above discharges.

Table 4 –Monthly Yields (WSC Data vs 2003/04 Data)

Data	Monthly Yields (AF)							
	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
Pooley 2003	-	-	-	-	-	-	54.3	-
Pooley 2004	617	2216	953	77.5	27.8	286	136	4313
WSC Pooley	-	2078	1824	267	35	132	39	4375
Stirling 2003	-	-	-	-	-	-	45.6	-
Stirling 2004	*733	725	254	38	16	78.7	73.3	1918
WSC Stirling	86	773	311	26	6.5	0	0	1203
Canyon 2004	*694	1568	433	60	11.2	74.9	73.7	2915
Hydraulic 2004	-	5103	1885	**156	86.1	622	351	8203

*Incomplete monthly data, yields estimated using mean monthly discharge (m^3/s) multiplied by the number of seconds in that month and converted to Acre Feet.
**This value is estimated, because 8 days of hourly data are missing, the 23 day average from Table 4 was used to calculate a 31 day yield.
WSC Pooley values based on mean data collected from 1973 - 1979, WSC Stirling values based on mean data collected from 1977 – 1984.

The total monthly yield was calculated in cubic meters and converted to acre-feet by multiplying the cubic meter value by 0.0008107 (1 m^3 = 0.0008107 acre feet). The metric data was converted to acre-feet so that it is consistent with other water supply data used by SEKID staff.

In 2004, the maximum yields from all sites occurred in May during the snowmelt period. The minimum yields occurred during August 2004, even though significant rainfall occurred during the latter part of the month (45.5 mm of rain was recorded at the Kelowna Airport from August 21-31, 2004). The combined yield recorded at the Hydraulic Creek station and the Stirling Creek station for the period May 1, 2004 to October 29, 2004 is 9,388 AF.

3.1 Pooley Creek

As discussed in the 2003 annual report, flows less than approximately 0.0044 m^3/s (4.4 l/s, or 0.31 ac. ft/day) that are diverted into the Pooley Ditch do not reach the ditch outlet during the hot summer months. These low flow conditions occurred on several dates from July 24, 2004 through August 21, 2004. Flows exceeding 0.0044 m^3/s likely reach the reservoir, however it is not known what proportion of these flows are lost to evaporation. Since the air temperature is typically much lower from late September through October than the air temperature during the summer months, the evaporation losses are assumed to be negligible and all flows diverted during the cooler fall period are assumed to reach the McCulloch Reservoir.

During the hot summer months flows in the ditch are subject to losses from both evaporation and leakage. During other times of the year, the ditch intercepts additional water/run-off along its length. On two occasions, the flows at the inlet of the ditch were compared with flows near the outlet of the ditch (immediately upstream from the

Canyon Creek confluence) to determine what the water losses and gains were (refer to map for locations).

On July 28, 2004 between 10:00 AM and 11:30 AM the flows at the inlet and outlet of the ditch were 0.0055 m^3/s and 0.0032 m^3/s respectively, indicating a loss of 0.0023 m^3/s or 42% along the length of the ditch. There was nearly zero cloud cover and the air temperature at 11:00 AM was approximately 28 °C, which suggests evaporation was primarily responsible for the losses. This procedure was repeated on September 22, 2004 between 2:00 PM and 3:30 PM, during which time the air temperature was 12 °C and the sky was 100% overcast. The flows at the inlet and outlet of the ditch were 0.274 m^3/s and 0.293 m^3/s, indicating an increase of 0.019 m^3/s or 7%. Significant rainfall in the weeks preceding this date likely charged the water table. The ditch flow increased along its length due to run-off and groundwater interception.

The maximum daily discharge occurred on May 22, 2004 and was 1.54 m^3/s. The minimum daily discharge (0.00 m^3/s) occurred on August 20, 2004. The 2004 data for Pooley Creek (May 1 through October 29) indicates there was 679 AF (16%) less volume diverted than the average amount diverted from 1973-1979 (May 1 through October 31). Additional years of data are required to determine current run-off trends. From May 1, 2004 through October 31, 2004 Pooley Creek supplied approximately 3,696 AF or 45% of the volume measured at the Hydraulic Creek station (8,203 AF). Refer to Appendix B for additional details.

3.2 Stirling Creek

Very low flows were observed in Stirling Creek from July 24, 2004 through August 21, 2004, which coincides with the low flow period in Pooley Creek. It is likely that flows less than 0.0026 m^3/s (2.6 l/s, or 0.18 ac ft/day) were lost to evaporation and did not reach the McCulloch Reservoir during this period. During late September and October, it is assumed that evaporation losses are negligible and the autumn flows reached the McCulloch Reservoir. On several occasions outside of the high water period, leaves and small debris accumulated at the intake to the stilling well causing errors in the water level readings. Modifications to the well intake should alleviate the interference.

On April 11, 2004 from 10:30 AM to 11:30 AM the flows at the inlet and outlet of the ditch were 0.325 m^3/s and 0.316 m^3/s respectively (refer to Appendix A – Map for locations). This suggests a loss of 0.009m^3/s or 2.8% along the length of the ditch, which is considered negligible and within the measurement error. No further assessments of water losses or gains along the Stirling ditch were conducted in 2004.

The maximum daily discharge occurred on April 14, 2004 and was 0.67 m^3/s. The minimum daily discharge (0.002 m^3/s) occurred on August 21, 2004. The 2004 data for Stirling Creek (May 1 through October 29) indicates there was 68 AF (6%) more volume diverted than the average amount diverted from 1977-1984 (May 1 through October 31). Additional years of data are required to determine current run-off trends. The station was operating properly on April 11, 2004, but ice buildup was observed in the stilling well on April 17, 2004. Ice in the stilling well causes errors in water level records and the corresponding discharge estimates. It is uncertain how much data between April 11 and 17 was affected by ice conditions. For this reason the records for April are suspect. From May 1 through October 29 Stirling Creek supplied approximately 1,185 AF to the McCulloch Reservoir.

3.3 Canyon Creek

For the majority of the 2004 open water period, Canyon Creek supplied water to the McCulloch Reservoir, however during August 1-3 and August 13-21, flows at the Canyon Creek station approached zero.

This is a new hydrometric station so no comparative WSC data exists for this site. The maximum daily discharge occurred on May 3, 2004 and was 1.06 m^3/s. The minimum daily discharge (0.000 m^3/s) occurred on August 19, 2004. From May 1 through October 29, Canyon Creek supplied approximately 2,221 AF or 27% of the volume measured at the Hydraulic Creek station (8,203 AF).

3.4 Hydraulic Creek

This station records the run-off from the Pooley Creek and Canyon Creek diversions as well as the run-off from the residual catchment area upstream from this station location (refer to map). The Stirling Creek diversion enters Hydraulic Creek downstream from the Hydraulic Creek hydrometric station. The maximum daily discharge occurred on May 2, 2004 and was 3.65 m^3/s. The minimum daily discharge (0.01 m^3/s) occurred on August 19, 2004. From May 1 through October 29 approximately 8,203 AF of water was recorded at the Hydraulic Creek station.

The following table identifies the sources and proportions of the total flows recorded at the Hydraulic Creek station.

Table 5 – Inflow Sources for the Hydraulic Creek Station

Station/Drainage Area	2004 Yield (May 1 – October 29)	Percent Yield
Pooley Creek	3,696 AF	45%
Canyon Creek	2,221 AF	27%
*Residual Areas	2,286 AF	28%
Hydraulic Creek Total	8,203 AF	100%

*Residual Areas include the combined remaining catchment areas upstream from the Hydraulic Creek station (refer to map).

4.0 SUMMARY OF 2004 RESULTS

- The previous water supply analysis for the McCulloch Reservoir water catchment area was completed in 1979. Runoff conditions may have changed since 1979 due to climate change and changes in forest cover in the upper watersheds.

- Based on data collected from May 1 through October 29 of 2004, the yield at the Hydraulic Creek station was 8,203 AF. The yield at the Stirling Creek station was 1,185 AF for a total supply of 9,388 AF of run-off to the McCulloch Reservoir from the upper catchment areas.

- Pooley Creek provided 3,696 AF or 45% of the run-off measured at the Hydraulic Creek station (8,203 AF). Canyon Creek provided 2,221 AF or 27% of the run-off measured at the Hydraulic Creek site. The remaining 28% (2,286 AF) was from the residual areas upstream from the Hydraulic Creek station.

- The 2004 data for Pooley Creek (May 1 through October 29) indicates there was 679 AF (16%) less volume diverted than the average amount diverted from 1973-1979 (May 1 through October 31). The 2004 Stirling Creek data (May 1 through October 29) indicates there was 68 AF (6%) more volume diverted than the average amount diverted from 1977-1984 (May 1 through October 31). Additional years of data are required to determine run-off trends.

- On several occasions outside of the high water period, leaves and small debris accumulations obstructed the intake to the Stirling Creek stilling well. The debris caused errors in the water level readings. Modifications to the well intake should alleviate the interference.

- Environment Canada reports that for the Southern BC Mountains region the 2004 spring was the 3rd warmest and 36 wettest. The warm spring weather attributed to the early onset of freshet. The 2004 summer was the 4th warmest and the 14th wettest on record. Although average temperatures were high through July and August, there was above normal precipitation that may have helped offset any water lost to evaporation. The 2004 autumn was the 28th warmest and 5th wettest, which resulted in increased streamflows during the autumn period.

- From July 24 through August 21 there were occasions when Pooley, Stirling and Canyon Creek flows approached zero, which is typical of many small interior streams during the hot summer months. For the Pooley diversion, summer flows less than 0.0044 m^3/s (0.31 AF/day) did not likely reach the McCulloch Reservoir. For the Stirling diversion, summer flows less than 0.0026 m^3/s (0.18 ac ft/day) did not likely reach the reservoir (most likely due to evaporation losses along the diversion ditches).

- For both the Pooley and Stirling ditches water is lost to evaporation and leakage and gained from groundwater and run-off interception. The flow at the inlet and outlet of the Pooley ditch was measured on two occasions to estimate potential losses and gains.

On July 28 the flow near the Pooley ditch outlet was 0.0023 m^3/s or 42% less than at the flow at the inlet (losses due to evaporation). On September 22, 2004 there was a gain of 0.019 m3/s or 7% (gains due to intercepted run-off and groundwater). On April 13, 2004 the flow was measured at the inlet and outlet of the Stirling ditch. The flow was approximately 2.8% less at the outlet, which indicates minimal losses/gains in the ditch at this time.

5.0 RECOMMENDATIONS

- Continue to collect and analyze hydrometric data at the four stations to develop a database that can be used to define the run-off trends for these catchments.

- Continue to measure stage and discharge during the 2005 open water season to better define the stage discharge relationship at all four stations.

- Replace the broken concrete fixture on the Stirling stilling well intake pipe with plastic (Dobson Engineering Ltd. staff could complete this when installing the equipment at the site in the spring of 2005). This should reduce errors associated with leaves and debris building up at the stilling well intake.

- Compare daily reservoir level data and reservoir outflow data (collected by SEKID) with the inflow data from the upstream stations to better understand the effects of upstream run-off on reservoir water supply.

- Continue with routine site inspections at the hydrometric stations to confirm proper operation. The inspections can, for the most part, be completed during times when flow measurements are made, and at a minimum should be conducted biweekly during freshet and monthly thereafter.

G.J. VanEmmerik, Project Manager

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — D. A. DOBSON

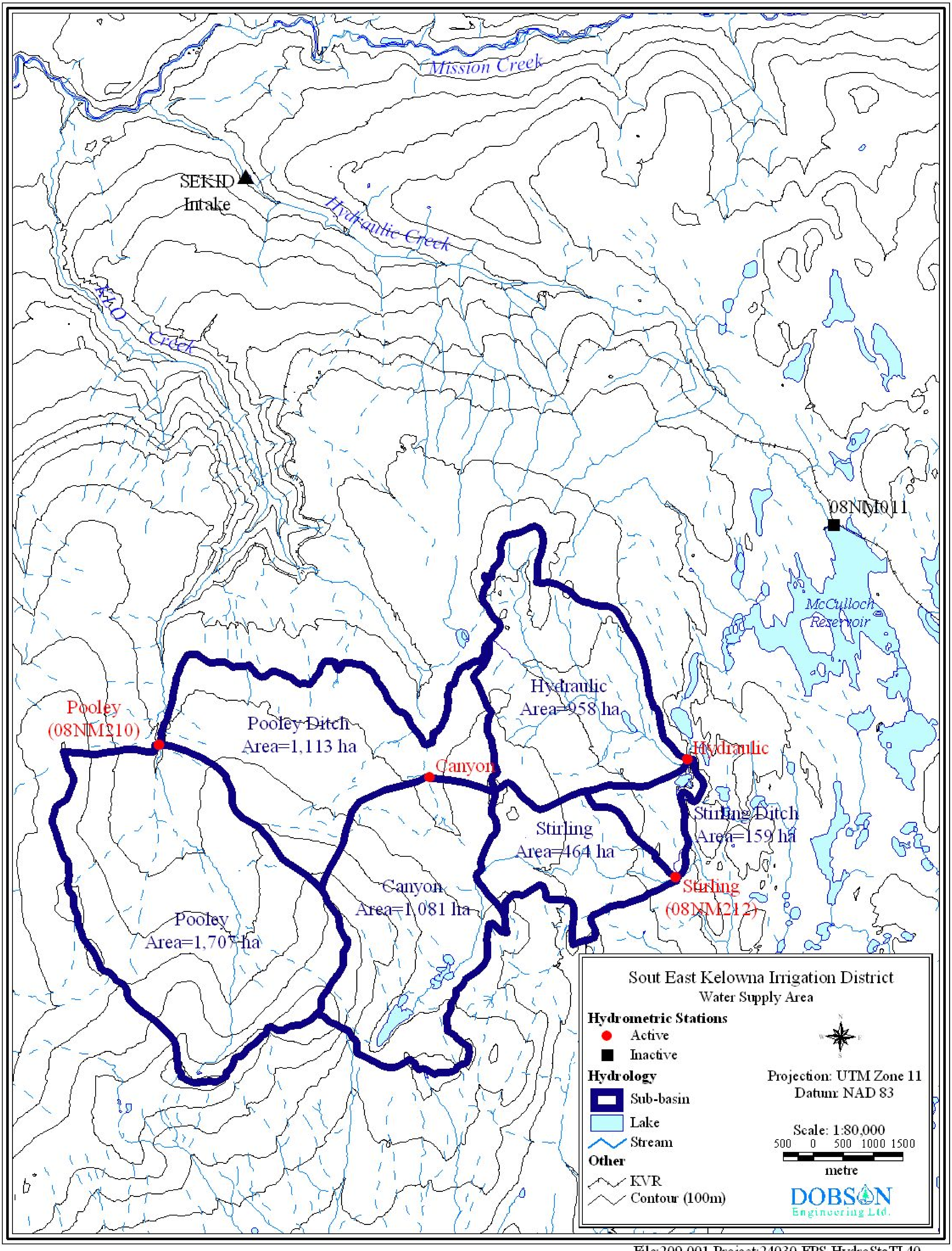
D.A. Dobson, P. Eng., Senior Reviewer

Jan 28/05

GV/dd

APPENDIX A

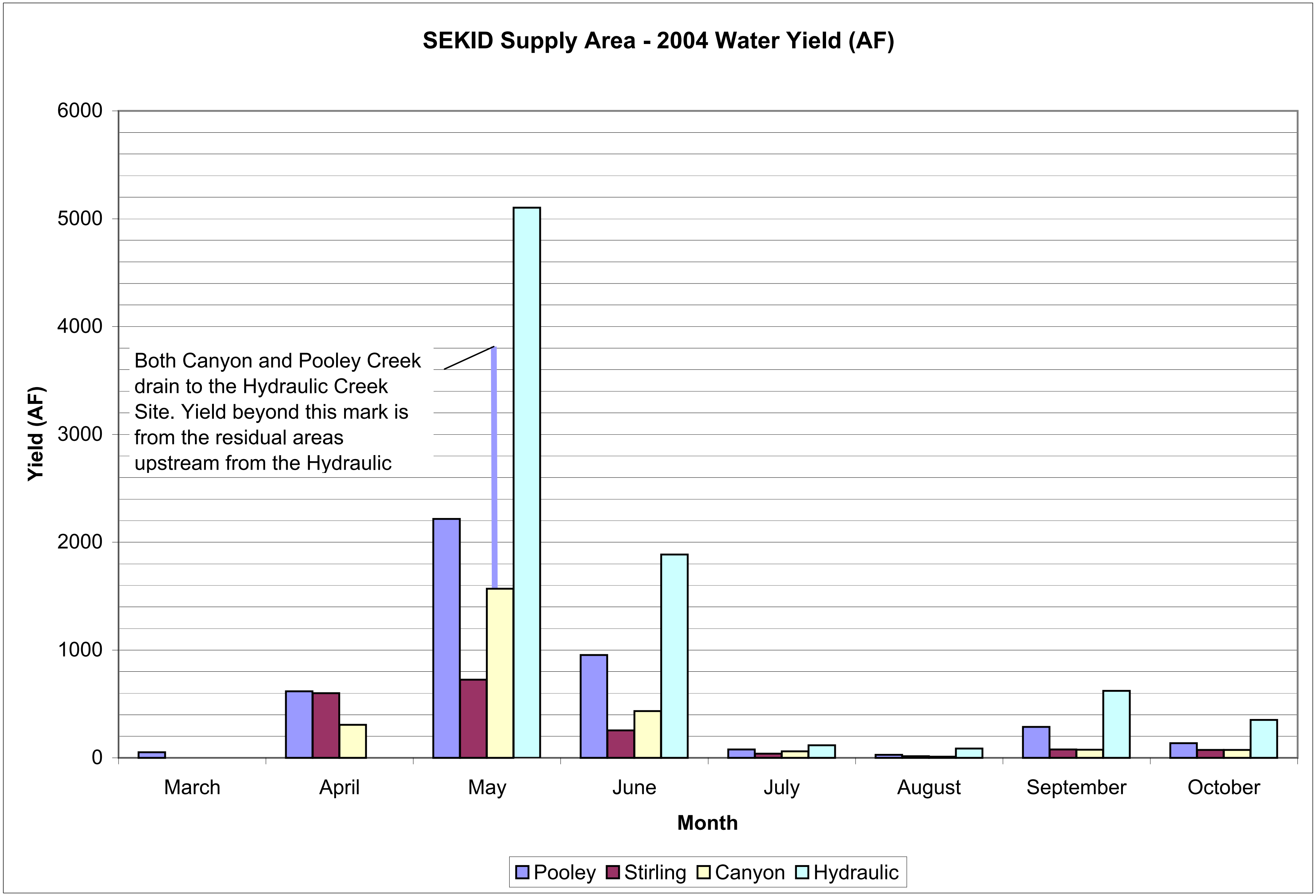
Map

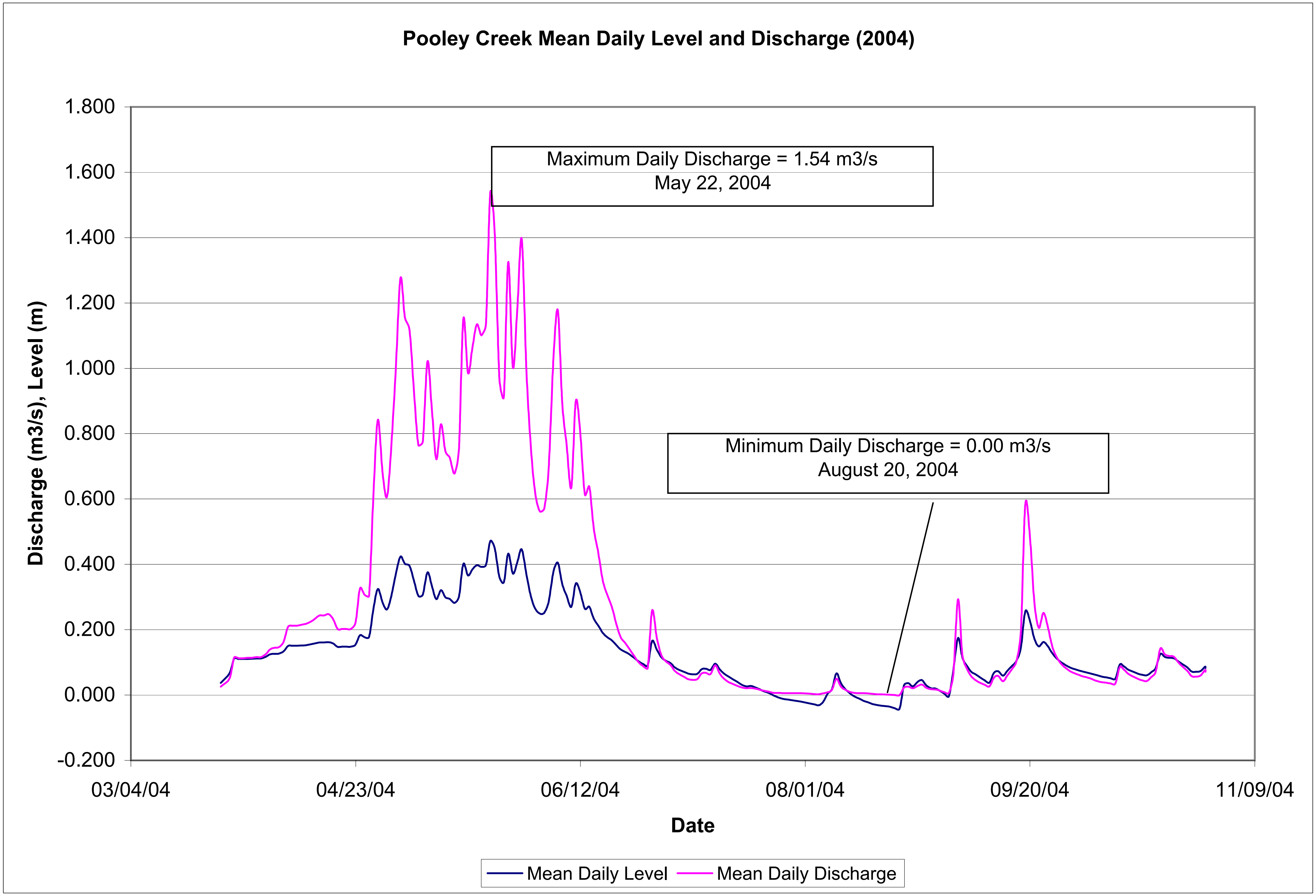


File:209-001 Project:24030-FPS-HydroStaTL40

APPENDIX B

2004 Data


SEKID Supply Area - 2004 Water Yield (AF)
6000
5000
4000
3000
2000
1000
0
Yield (AF)
Both Canyon and Pooley Creek drain to the Hydraulic Creek Site. Yield beyond this mark is from the residual areas upstream from the Hydraulic
March
April
May
June
July
August
September
October
Month
Pooley
Stirling
Canyon
Hydraulic



Pooley Creek Mean Daily Level and Discharge (2004)
Maximum Daily Discharge = 1.54 m3/s
May 22, 2004
Minimum Daily Discharge = 0.00 m3/s
August 20, 2004
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
-0.200
Discharge (m3/s), Level (m)
03/04/04
04/23/04
06/12/04
08/01/04
09/20/04
11/09/04
Date
Mean Daily Level
Mean Daily Discharge

Expanded Stage Discharge Table For Pooley Creek (2004)

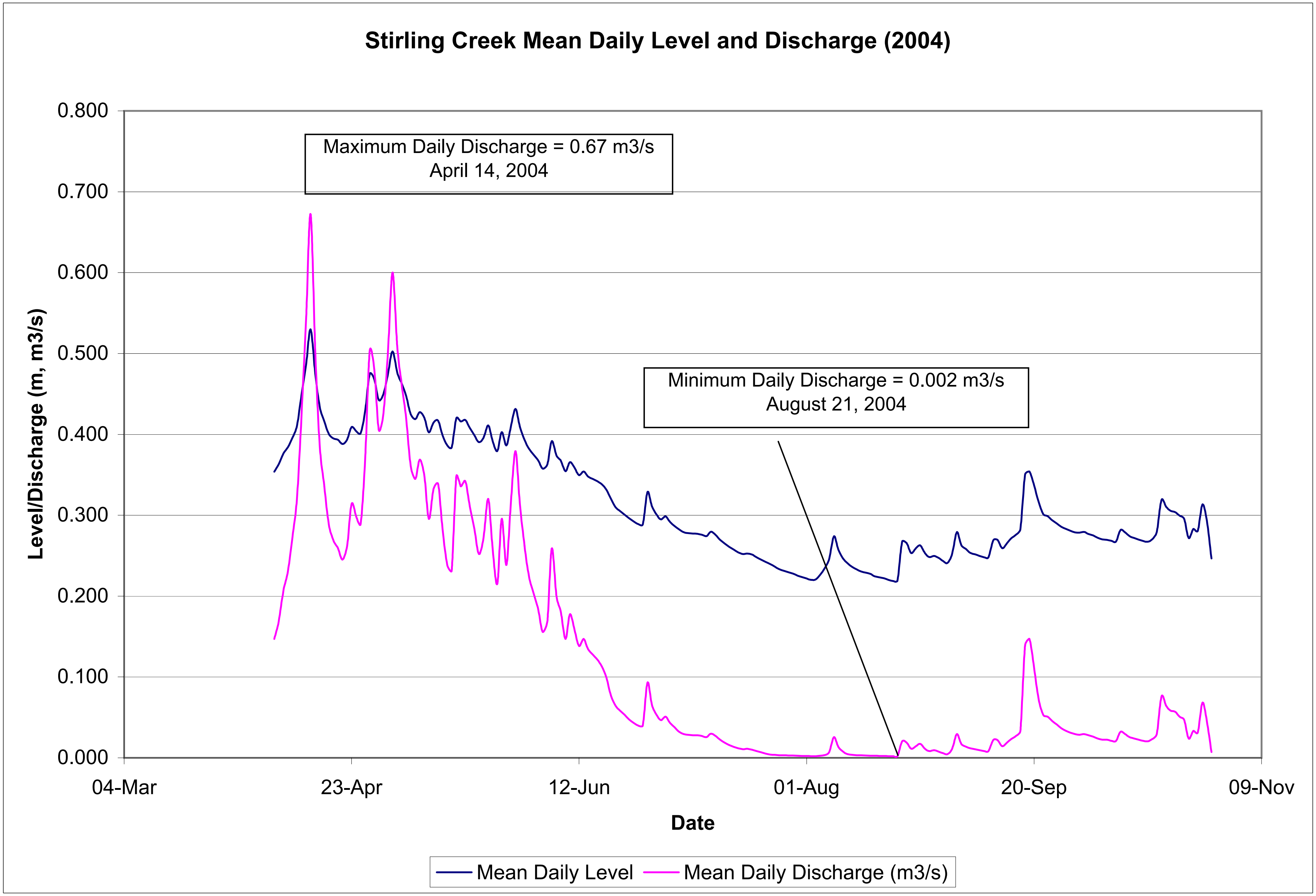
		0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001	
Meters	**0.000**	**0.001**	**0.002**	**0.003**	**0.004**	**0.005**	**0.006**	**0.007**	**0.008**	**0.009**	**Meters**
-0.04	0.0000	0.0003	0.0006	0.0008	0.0011	0.0014	0.0017	0.0019	0.0022	0.0025	**-0.04**
-0.03	0.0028	0.0030	0.0033	0.0036	0.0039	0.0041	0.0044	0.0047	0.0050	0.0052	**-0.03**
-0.02	0.0055	0.0056	0.0056	0.0057	0.0057	0.0058	0.0058	0.0059	0.0059	0.0060	**-0.02**
-0.01	0.0060	0.0061	0.0061	0.0062	0.0062	0.0063	0.0063	0.0064	0.0064	0.0064	**-0.01**
0.00	0.0065	0.0070	0.0076	0.0081	0.0087	0.0092	0.0098	0.0104	0.0109	0.0115	**0.00**
0.01	0.0120	0.0126	0.0131	0.0137	0.0142	0.0148	0.0153	0.0159	0.0164	0.0170	**0.01**
0.02	0.0175	0.0180	0.0185	0.0190	0.0195	0.0200	0.0205	0.0210	0.0215	0.0220	**0.02**
0.03	0.0225	0.0230	0.0235	0.0240	0.0245	0.0250	0.0255	0.0260	0.0265	0.0270	**0.03**
0.04	0.0275	0.0283	0.0290	0.0298	0.0305	0.0313	0.0320	0.0328	0.0335	0.0343	**0.04**
0.05	0.0350	0.0358	0.0365	0.0373	0.0380	0.0388	0.0395	0.0403	0.0410	0.0418	**0.05**
0.06	0.0425	0.0438	0.0450	0.0463	0.0475	0.0488	0.0500	0.0513	0.0525	0.0538	**0.06**
0.07	0.0550	0.0563	0.0575	0.0588	0.0600	0.0613	0.0625	0.0638	0.0650	0.0663	**0.07**
0.08	0.0675	0.0689	0.0703	0.0716	0.0730	0.0744	0.0758	0.0771	0.0785	0.0799	**0.08**
0.09	0.0813	0.0826	0.0840	0.0854	0.0868	0.0881	0.0895	0.0909	0.0923	0.0936	**0.09**
0.10	0.0950	0.0968	0.0985	0.1003	0.1020	0.1038	0.1055	0.1073	0.1090	0.1108	**0.10**
0.11	0.1125	0.1143	0.1160	0.1178	0.1195	0.1213	0.1230	0.1248	0.1265	0.1283	**0.11**
0.12	0.1300	0.1324	0.1348	0.1371	0.1395	0.1419	0.1443	0.1466	0.1490	0.1514	**0.12**
0.13	0.1538	0.1561	0.1585	0.1609	0.1633	0.1656	0.1680	0.1704	0.1728	0.1751	**0.13**
0.14	0.1775	0.1806	0.1838	0.1869	0.1900	0.1931	0.1963	0.1994	0.2025	0.2056	**0.14**
0.15	0.2088	0.2119	0.2150	0.2181	0.2213	0.2244	0.2275	0.2306	0.2338	0.2369	**0.15**
0.16	0.2400	0.2438	0.2475	0.2513	0.2550	0.2588	0.2625	0.2663	0.2700	0.2737	**0.16**
0.17	0.2775	0.2812	0.2850	0.2887	0.2925	0.2962	0.3000	0.3037	0.3075	0.3112	**0.17**
0.18	0.3150	0.3186	0.3222	0.3259	0.3295	0.3331	0.3367	0.3404	0.3440	0.3476	**0.18**
0.19	0.3512	0.3549	0.3585	0.3621	0.3657	0.3694	0.3730	0.3766	0.3802	0.3839	**0.19**
0.20	0.3875	0.3911	0.3947	0.3984	0.4020	0.4056	0.4092	0.4129	0.4165	0.4201	**0.20**
0.21	0.4237	0.4274	0.4310	0.4346	0.4382	0.4419	0.4455	0.4491	0.4527	0.4564	**0.21**
0.22	0.4600	0.4635	0.4670	0.4705	0.4740	0.4775	0.4810	0.4845	0.4880	0.4915	**0.22**
0.23	0.4950	0.4985	0.5020	0.5055	0.5090	0.5125	0.5160	0.5195	0.5230	0.5265	**0.23**
0.24	0.5300	0.5335	0.5370	0.5405	0.5440	0.5475	0.5510	0.5545	0.5580	0.5615	**0.24**
0.25	0.5650	0.5685	0.5720	0.5755	0.5790	0.5825	0.5860	0.5895	0.5930	0.5965	**0.25**
0.26	0.6000	0.6035	0.6070	0.6105	0.6140	0.6175	0.6210	0.6245	0.6280	0.6315	**0.26**
0.27	0.6350	0.6385	0.6420	0.6455	0.6490	0.6525	0.6560	0.6595	0.6630	0.6665	**0.27**
0.28	0.6700	0.6740	0.6780	0.6820	0.6860	0.6900	0.6940	0.6980	0.7020	0.7060	**0.28**
0.29	0.7100	0.7140	0.7180	0.7220	0.7260	0.7300	0.7340	0.7380	0.7420	0.7460	**0.29**
0.30	0.7500	0.7537	0.7575	0.7612	0.7650	0.7687	0.7725	0.7762	0.7800	0.7837	**0.30**
0.31	0.7875	0.7912	0.7950	0.7987	0.8025	0.8062	0.8100	0.8137	0.8175	0.8212	**0.31**

Expanded Stage Discharge Table For Pooley Creek (2004)

		0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001	
Meters	**0.000**	**0.001**	**0.002**	**0.003**	**0.004**	**0.005**	**0.006**	**0.007**	**0.008**	**0.009**	**Meters**
0.32	0.8250	0.8285	0.8320	0.8355	0.8390	0.8425	0.8460	0.8495	0.8530	0.8565	**0.32**
0.33	0.8600	0.8635	0.8670	0.8705	0.8740	0.8775	0.8810	0.8845	0.8880	0.8915	**0.33**
0.34	0.8950	0.8985	0.9020	0.9055	0.9090	0.9125	0.9160	0.9195	0.9230	0.9265	**0.34**
0.35	0.9300	0.9335	0.9370	0.9405	0.9440	0.9475	0.9510	0.9545	0.9580	0.9615	**0.35**
0.36	0.9650	0.9685	0.9720	0.9755	0.9790	0.9825	0.9860	0.9895	0.9930	0.9965	**0.36**
0.37	1.0000	1.0035	1.0070	1.0105	1.0140	1.0175	1.0210	1.0245	1.0280	1.0315	**0.37**
0.38	1.0350	1.0405	1.0460	1.0515	1.0570	1.0625	1.0680	1.0735	1.0790	1.0845	**0.38**
0.39	1.0900	1.0955	1.1010	1.1065	1.1120	1.1175	1.1230	1.1285	1.1340	1.1395	**0.39**
0.40	1.1450	1.1505	1.1559	1.1614	1.1668	1.1723	1.1777	1.1832	1.1886	1.1941	**0.40**
0.41	1.1995	1.2050	1.2104	1.2159	1.2213	1.2268	1.2322	1.2377	1.2431	1.2486	**0.41**
0.42	1.2540	1.2595	1.2649	1.2704	1.2758	1.2813	1.2867	1.2922	1.2976	1.3031	**0.42**
0.43	1.3085	1.3140	1.3194	1.3249	1.3303	1.3358	1.3412	1.3467	1.3521	1.3576	**0.43**
0.44	1.3630	1.3685	1.3739	1.3794	1.3848	1.3903	1.3957	1.4012	1.4066	1.4121	**0.44**
0.45	1.4175	1.4230	1.4284	1.4339	1.4393	1.4448	1.4502	1.4557	1.4611	1.4666	**0.45**
0.46	1.4720	1.4775	1.4829	1.4884	1.4938	1.4993	1.5047	1.5102	1.5156	1.5211	**0.46**
0.47	1.5265	1.5320	1.5374	1.5429	1.5483	1.5538	1.5592	1.5647	1.5701	1.5756	**0.47**
0.48	1.5810	1.5865	1.5919	1.5974	1.6028	1.6083	1.6137	1.6192	1.6246	1.6301	**0.48**
0.49	1.6355	1.6410	1.6464	1.6519	1.6573	1.6628	1.6682	1.6737	1.6791	1.6846	**0.49**
0.50	1.6900	1.6956	1.7013	1.7069	1.7126	1.7182	1.7238	1.7295	1.7351	1.7408	**0.50**
0.51	1.7464	1.7520	1.7577	1.7633	1.7690	1.7746	1.7802	1.7859	1.7915	1.7972	**0.51**
0.52	1.8028	1.8084	1.8141	1.8197	1.8254	1.8310	1.8366	1.8423	1.8479	1.8536	**0.52**
0.53	1.8592	1.8648	1.8705	1.8761	1.8818	1.8874	1.8930	1.8987	1.9043	1.9100	**0.53**
0.54	1.9156	1.9212	1.9269	1.9325	1.9382	1.9438	1.9494	1.9551	1.9607	1.9664	**0.54**
0.55	1.9720	1.9776	1.9833	1.9889	1.9946	2.0002	2.0058	2.0115	2.0171	2.0228	**0.55**
0.56	2.0284	2.0340	2.0397	2.0453	2.0510	2.0566	2.0622	2.0679	2.0735	2.0792	**0.56**
0.57	2.0848	2.0904	2.0961	2.1017	2.1074	2.1130	2.1186	2.1243	2.1299	2.1356	**0.57**
0.58	2.1412	2.1468	2.1525	2.1581	2.1638	2.1694	2.1750	2.1807	2.1863	2.1920	**0.58**
0.59	2.1976	2.2032	2.2089	2.2145	2.2202	2.2258	2.2314	2.2371	2.2427	2.2484	**0.59**
0.60	2.2540	2.2615	2.2689	2.2764	2.2838	2.2913	2.2988	2.3062	2.3137	2.3211	**0.60**
0.61	2.3286	2.3361	2.3435	2.3510	2.3584	2.3659	2.3734	2.3808	2.3883	2.3957	**0.61**
0.62	2.4032	2.4107	2.4181	2.4256	2.4330	2.4405	2.4480	2.4554	2.4629	2.4703	**0.62**
0.63	2.4778	2.4853	2.4927	2.5002	2.5076	2.5151	2.5226	2.5300	2.5375	2.5449	**0.63**
0.64	2.5524	2.5599	2.5673	2.5748	2.5822	2.5897	2.5972	2.6046	2.6121	2.6195	**0.64**
0.65	2.6270	2.6345	2.6419	2.6494	2.6568	2.6643	2.6718	2.6792	2.6867	2.6941	**0.65**
0.66	2.7016	2.7091	2.7165	2.7240	2.7314	2.7389	2.7464	2.7538	2.7613	2.7687	**0.66**
0.67	2.7762	2.7837	2.7911	2.7986	2.8060	2.8135	2.8210	2.8284	2.8359	2.8433	**0.67**

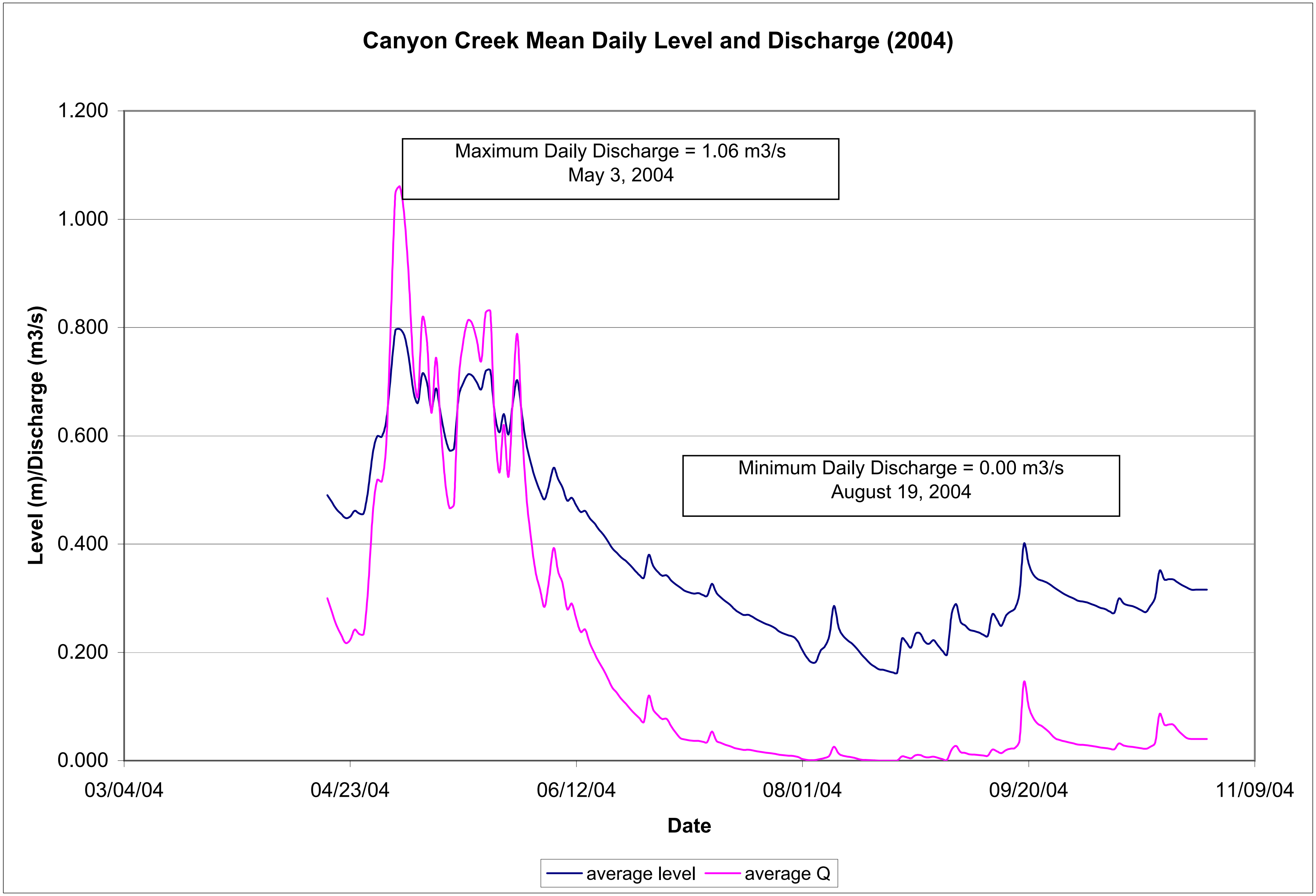
Expanded Stage Discharge Table For Pooley Creek (2004)

		0.009	0.008	0.007	0.006	0.005	0.004	0.003	0.002	0.001	
Meters	**0.000**	**0.001**	**0.002**	**0.003**	**0.004**	**0.005**	**0.006**	**0.007**	**0.008**	**0.009**	**Meters**
0.68	2.8508	2.8583	2.8657	2.8732	2.8806	2.8881	2.8956	2.9030	2.9105	2.9179	**0.68**
0.69	2.9254	2.9329	2.9403	2.9478	2.9552	2.9627	2.9702	2.9776	2.9851	2.9925	**0.69**
0.70	3.0000	3.0075	3.0150	3.0225	3.0300	3.0375	3.0450	3.0525	3.0600	3.0675	**0.70**
0.71	3.0750	3.0825	3.0900	3.0975	3.1050	3.1125	3.1200	3.1275	3.1350	3.1425	**0.71**
0.72	3.1500	3.1575	3.1650	3.1725	3.1800	3.1875	3.1950	3.2025	3.2100	3.2175	**0.72**
0.73	3.2250	3.2325	3.2400	3.2475	3.2550	3.2625	3.2700	3.2775	3.2850	3.2925	**0.73**
0.74	3.3000	3.3075	3.3150	3.3225	3.3300	3.3375	3.3450	3.3525	3.3600	3.3675	**0.74**
0.75	3.3750	3.3825	3.3900	3.3975	3.4050	3.4125	3.4200	3.4275	3.4350	3.4425	**0.75**
0.76	3.4500	3.4575	3.4650	3.4725	3.4800	3.4875	3.4950	3.5025	3.5100	3.5175	**0.76**
0.77	3.5250	3.5325	3.5400	3.5475	3.5550	3.5625	3.5700	3.5775	3.5850	3.5925	**0.77**
0.78	3.6000	3.6075	3.6150	3.6225	3.6300	3.6375	3.6450	3.6525	3.6600	3.6675	**0.78**
0.79	3.6750	3.6825	3.6900	3.6975	3.7050	3.7125	3.7200	3.7275	3.7350	3.7425	**0.79**
0.80	3.7500	3.7576	3.7652	3.7728	3.7804	3.7880	3.7956	3.8032	3.8108	3.8184	**0.80**
0.81	3.8260	3.8336	3.8412	3.8488	3.8564	3.8640	3.8716	3.8792	3.8868	3.8944	**0.81**
0.82	3.9020	3.9096	3.9172	3.9248	3.9324	3.9400	3.9476	3.9552	3.9628	3.9704	**0.82**
0.83	3.9780	3.9856	3.9932	4.0008	4.0084	4.0160	4.0236	4.0312	4.0388	4.0464	**0.83**
0.84	4.0540	4.0616	4.0692	4.0768	4.0844	4.0920	4.0996	4.1072	4.1148	4.1224	**0.84**
0.85	4.1300	4.1376	4.1452	4.1528	4.1604	4.1680	4.1756	4.1832	4.1908	4.1984	**0.85**
0.86	4.2060	4.2136	4.2212	4.2288	4.2364	4.2440	4.2516	4.2592	4.2668	4.2744	**0.86**
0.87	4.2820	4.2896	4.2972	4.3048	4.3124	4.3200	4.3276	4.3352	4.3428	4.3504	**0.87**
0.88	4.3580	4.3656	4.3732	4.3808	4.3884	4.3960	4.4036	4.4112	4.4188	4.4264	**0.88**
0.89	4.4340	4.4416	4.4492	4.4568	4.4644	4.4720	4.4796	4.4872	4.4948	4.5024	**0.89**
0.90	4.5100	4.5191	4.5282	4.5373	4.5464	4.5555	4.5646	4.5737	4.5828	4.5919	**0.90**
0.91	4.6010	4.6101	4.6192	4.6283	4.6374	4.6465	4.6556	4.6647	4.6738	4.6829	**0.91**
0.92	4.6920	4.7011	4.7102	4.7193	4.7284	4.7375	4.7466	4.7557	4.7648	4.7739	**0.92**
0.93	4.7830	4.7921	4.8012	4.8103	4.8194	4.8285	4.8376	4.8467	4.8558	4.8649	**0.93**
0.94	4.8740	4.8831	4.8922	4.9013	4.9104	4.9195	4.9286	4.9377	4.9468	4.9559	**0.94**
0.95	4.9650	4.9741	4.9832	4.9923	5.0014	5.0105	5.0196	5.0287	5.0378	5.0469	**0.95**
0.96	5.0560	5.0651	5.0742	5.0833	5.0924	5.1015	5.1106	5.1197	5.1288	5.1379	**0.96**
0.97	5.1470	5.1561	5.1652	5.1743	5.1834	5.1925	5.2016	5.2107	5.2198	5.2289	**0.97**
0.98	5.2380	5.2471	5.2562	5.2653	5.2744	5.2835	5.2926	5.3017	5.3108	5.3199	**0.98**
0.99	5.3290	5.3381	5.3472	5.3563	5.3654	5.3745	5.3836	5.3927	5.4018	5.4109	**0.99**
1.00	5.4200										**1.00**


Stirling Creek Mean Daily Level and Discharge (2004)
Maximum Daily Discharge = 0.67 m3/s
April 14, 2004
Minimum Daily Discharge = 0.002 m3/s
August 21, 2004
Level/Discharge (m, m3/s)
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
04-Mar
23-Apr
12-Jun
01-Aug
20-Sep
09-Nov
Date
Mean Daily Level
Mean Daily Discharge (m3/s)

Expanded Stage Discharge Table For Stirling Creek (2004)

Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.20	0.0000	0.0001	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	**0.20**
0.21	0.0010	0.0011	0.0012	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019	**0.21**
0.22	0.0020	0.0021	0.0022	0.0023	0.0024	0.0025	0.0026	0.0027	0.0028	0.0029	**0.22**
0.23	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035	0.0036	0.0037	0.0038	0.0039	**0.23**
0.24	0.0040	0.0046	0.0051	0.0057	0.0062	0.0068	0.0073	0.0079	0.0084	0.0090	**0.24**
0.25	0.0095	0.0101	0.0106	0.0112	0.0117	0.0123	0.0128	0.0134	0.0139	0.0145	**0.25**
0.26	0.0150	0.0158	0.0165	0.0173	0.0180	0.0188	0.0195	0.0203	0.0210	0.0218	**0.26**
0.27	0.0225	0.0233	0.0240	0.0248	0.0255	0.0263	0.0270	0.0278	0.0285	0.0293	**0.27**
0.28	0.0300	0.0311	0.0322	0.0333	0.0344	0.0355	0.0366	0.0377	0.0388	0.0399	**0.28**
0.29	0.0410	0.0421	0.0432	0.0443	0.0454	0.0465	0.0476	0.0487	0.0498	0.0509	**0.29**
0.30	0.0520	0.0533	0.0545	0.0558	0.0570	0.0583	0.0595	0.0608	0.0620	0.0633	**0.30**
0.31	0.0645	0.0658	0.0670	0.0683	0.0695	0.0708	0.0720	0.0733	0.0745	0.0758	**0.31**
0.32	0.0770	0.0790	0.0810	0.0830	0.0850	0.0870	0.0890	0.0910	0.0930	0.0950	**0.32**
0.33	0.0970	0.0990	0.1010	0.1030	0.1050	0.1070	0.1090	0.1110	0.1130	0.1150	**0.33**
0.34	0.1170	0.1192	0.1213	0.1235	0.1256	0.1278	0.1299	0.1321	0.1342	0.1364	**0.34**
0.35	0.1385	0.1407	0.1428	0.1450	0.1471	0.1493	0.1514	0.1536	0.1557	0.1579	**0.35**
0.36	0.1600	0.1629	0.1658	0.1687	0.1716	0.1745	0.1774	0.1803	0.1832	0.1861	**0.36**
0.37	0.1890	0.1919	0.1948	0.1977	0.2006	0.2035	0.2064	0.2093	0.2122	0.2151	**0.37**
0.38	0.2180	0.2214	0.2248	0.2282	0.2316	0.2350	0.2384	0.2418	0.2452	0.2486	**0.38**
0.39	0.2520	0.2554	0.2588	0.2622	0.2656	0.2690	0.2724	0.2758	0.2792	0.2826	**0.39**
0.40	0.2860	0.2891	0.2922	0.2953	0.2984	0.3015	0.3046	0.3077	0.3108	0.3139	**0.40**
0.41	0.3170	0.3201	0.3232	0.3263	0.3294	0.3325	0.3356	0.3387	0.3418	0.3449	**0.41**
0.42	0.3480	0.3506	0.3532	0.3558	0.3584	0.3610	0.3636	0.3662	0.3688	0.3714	**0.42**
0.43	0.3740	0.3766	0.3792	0.3818	0.3844	0.3870	0.3896	0.3922	0.3948	0.3974	**0.43**
0.44	0.4000	0.4026	0.4052	0.4078	0.4104	0.4130	0.4156	0.4182	0.4208	0.4234	**0.44**
0.45	0.4260	0.4286	0.4312	0.4338	0.4364	0.4390	0.4416	0.4442	0.4468	0.4494	**0.45**
0.46	0.4520	0.4554	0.4588	0.4622	0.4656	0.4690	0.4724	0.4758	0.4792	0.4826	**0.46**
0.47	0.4860	0.4894	0.4928	0.4962	0.4996	0.5030	0.5064	0.5098	0.5132	0.5166	**0.47**
0.48	0.5200	0.5236	0.5272	0.5308	0.5344	0.5380	0.5416	0.5452	0.5488	0.5524	**0.48**
0.49	0.5560	0.5596	0.5632	0.5668	0.5704	0.5740	0.5776	0.5812	0.5848	0.5884	**0.49**
0.50	0.5920	0.5947	0.5974	0.6000	0.6027	0.6054	0.6081	0.6108	0.6134	0.6161	**0.50**
0.51	0.6188	0.6215	0.6242	0.6268	0.6295	0.6322	0.6349	0.6376	0.6402	0.6429	**0.51**
0.52	0.6456	0.6483	0.6510	0.6536	0.6563	0.6590	0.6617	0.6644	0.6670	0.6697	**0.52**
0.53	0.6724	0.6751	0.6778	0.6804	0.6831	0.6858	0.6885	0.6912	0.6938	0.6965	**0.53**
0.54	0.6992	0.7019	0.7046	0.7072	0.7099	0.7126	0.7153	0.7180	0.7206	0.7233	**0.54**
0.55	0.7260	0.7287	0.7314	0.7340	0.7367	0.7394	0.7421	0.7448	0.7474	0.7501	**0.55**
0.56	0.7528	0.7555	0.7582	0.7608	0.7635	0.7662	0.7689	0.7716	0.7742	0.7769	**0.56**
0.57	0.7796	0.7823	0.7850	0.7876	0.7903	0.7930	0.7957	0.7984	0.8010	0.8037	**0.57**
0.58	0.8064	0.8091	0.8118	0.8144	0.8171	0.8198	0.8225	0.8252	0.8278	0.8305	**0.58**
0.59	0.8332	0.8359	0.8386	0.8412	0.8439	0.8466	0.8493	0.8520	0.8546	0.8573	**0.59**
0.60	0.8600	0.8627									**0.60**


Canyon Creek Mean Daily Level and Discharge (2004)
Maximum Daily Discharge = 1.06 m3/s
May 3, 2004
Minimum Daily Discharge = 0.00 m3/s
August 19, 2004
Level (m)/Discharge (m3/s)
1.200
1.000
0.800
0.600
0.400
0.200
0.000
03/04/04
04/23/04
06/12/04
08/01/04
09/20/04
11/09/04
Date
average level
average Q

Canyon Cre **Expanded Stage Discharge Table For Canyon Creek (2004)**

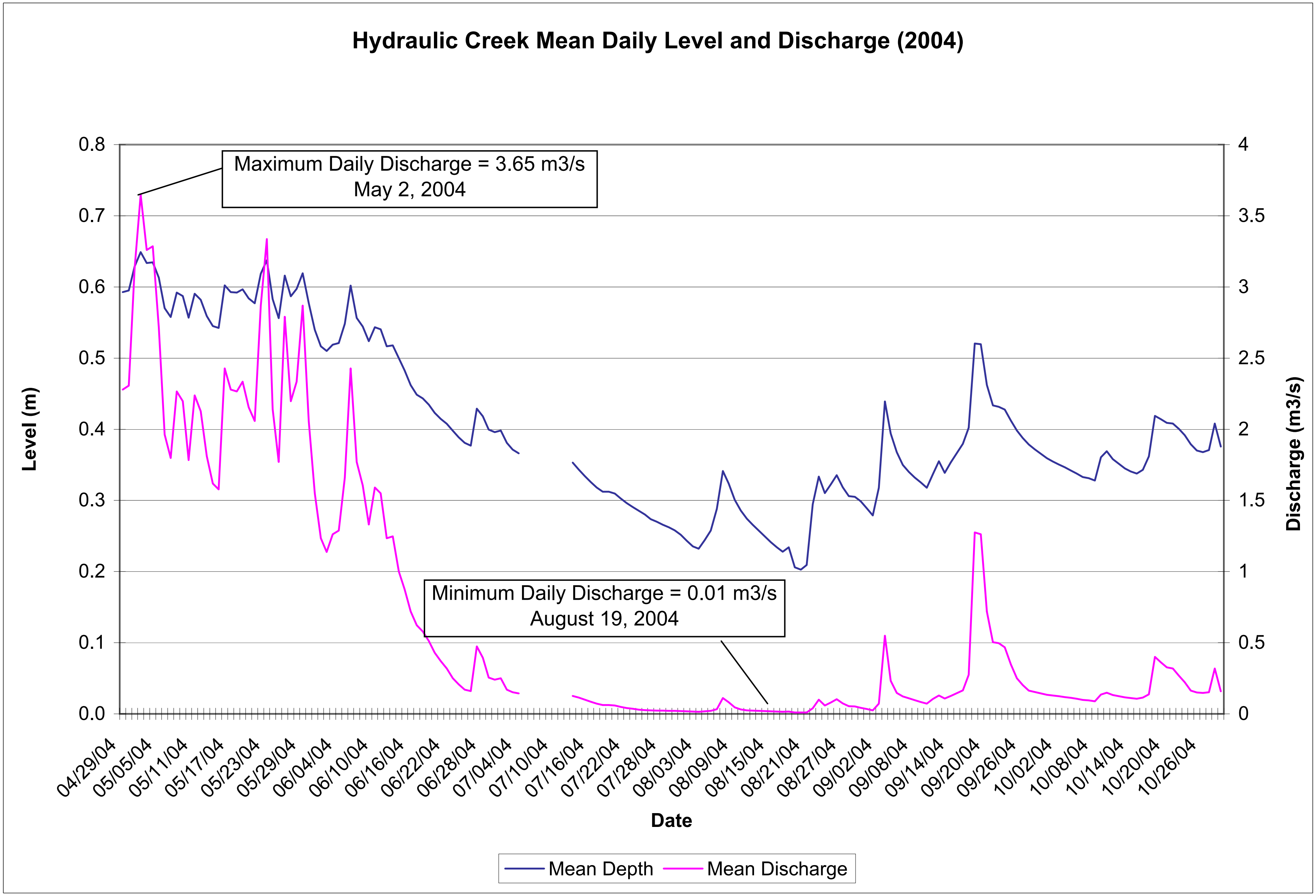
Stage (m)	Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.166	**0.16**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0002	**0.16**
	0.17	0.0003	0.0003	0.0004	0.0004	0.0005	0.0006	0.0006	0.0007	0.0008	0.0008	**0.17**
0.18	**0.18**	0.0009	0.0009	0.0010	0.0011	0.0011	0.0012	0.0013	0.0013	0.0014	0.0014	**0.18**
	0.19	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019	0.0019	0.0020	0.0021	**0.19**
0.2	**0.20**	0.0021	0.0024	0.0026	0.0028	0.0031	0.0033	0.0036	0.0038	0.0040	0.0043	**0.20**
	0.21	0.0045	0.0047	0.0050	0.0052	0.0055	0.0057	0.0059	0.0062	0.0064	0.0066	**0.21**
0.22	**0.22**	0.0069	0.0071	0.0073	0.0075	0.0077	0.0079	0.0082	0.0084	0.0086	0.0088	**0.22**
	0.23	0.0090	0.0092	0.0094	0.0096	0.0098	0.0101	0.0103	0.0105	0.0107	0.0109	**0.23**
0.24	**0.24**	0.0111	0.0114	0.0117	0.0120	0.0123	0.0126	0.0129	0.0132	0.0135	0.0138	**0.24**
	0.25	0.0141	0.0144	0.0147	0.0149	0.0152	0.0155	0.0158	0.0161	0.0164	0.0167	**0.25**
0.26	**0.26**	0.0170	0.0173	0.0176	0.0179	0.0183	0.0186	0.0189	0.0192	0.0195	0.0198	**0.26**
	0.27	0.0201	0.0204	0.0208	0.0211	0.0214	0.0217	0.0220	0.0223	0.0226	0.0229	**0.27**
0.28	**0.28**	0.0233	0.0237	0.0241	0.0246	0.0250	0.0254	0.0259	0.0263	0.0268	0.0272	**0.28**
	0.29	0.0276	0.0281	0.0285	0.0289	0.0294	0.0298	0.0303	0.0307	0.0311	0.0316	**0.29**
0.3	**0.30**	0.0320	0.0325	0.0330	0.0335	0.0340	0.0345	0.0350	0.0355	0.0360	0.0365	**0.30**
	0.31	0.0370	0.0375	0.0380	0.0385	0.0390	0.0395	0.0400	0.0405	0.0410	0.0415	**0.31**
0.32	**0.32**	0.0420	0.0437	0.0453	0.0470	0.0486	0.0503	0.0519	0.0536	0.0552	0.0569	**0.32**
	0.33	0.0585	0.0602	0.0618	0.0635	0.0651	0.0668	0.0684	0.0701	0.0717	0.0734	**0.33**
0.34	**0.34**	0.0750	0.0760	0.0770	0.0780	0.0790	0.0800	0.0810	0.0820	0.0830	0.0840	**0.34**
	0.35	0.0850	0.0860	0.0870	0.0880	0.0890	0.0900	0.0910	0.0920	0.0930	0.0940	**0.35**
0.36	**0.36**	0.0950	0.0963	0.0975	0.0988	0.1000	0.1013	0.1025	0.1038	0.1050	0.1063	**0.36**
	0.37	0.1075	0.1088	0.1100	0.1113	0.1125	0.1138	0.1150	0.1163	0.1175	0.1188	**0.37**
0.38	**0.38**	0.1200	0.1213	0.1225	0.1238	0.1250	0.1263	0.1275	0.1288	0.1300	0.1313	**0.38**
	0.39	0.1325	0.1338	0.1350	0.1363	0.1375	0.1388	0.1400	0.1413	0.1425	0.1438	**0.39**
0.4	**0.40**	0.1450	0.1464	0.1477	0.1491	0.1504	0.1518	0.1531	0.1545	0.1558	0.1572	**0.40**
	0.41	0.1585	0.1599	0.1612	0.1626	0.1639	0.1653	0.1666	0.1680	0.1693	0.1707	**0.41**
0.42	**0.42**	0.1720	0.1735	0.1750	0.1765	0.1780	0.1795	0.1810	0.1825	0.1840	0.1855	**0.42**
	0.43	0.1870	0.1885	0.1900	0.1915	0.1930	0.1945	0.1960	0.1975	0.1990	0.2005	**0.43**
0.44	**0.44**	0.2020	0.2039	0.2058	0.2077	0.2096	0.2115	0.2134	0.2153	0.2172	0.2191	**0.44**
	0.45	0.2210	0.2229	0.2248	0.2267	0.2286	0.2305	0.2324	0.2343	0.2362	0.2381	**0.45**
0.46	**0.46**	0.2400	0.2420	0.2440	0.2460	0.2480	0.2500	0.2520	0.2540	0.2560	0.2580	**0.46**
	0.47	0.2600	0.2620	0.2640	0.2660	0.2680	0.2700	0.2720	0.2740	0.2760	0.2780	**0.47**
0.48	**0.48**	0.2800	0.2820	0.2840	0.2860	0.2880	0.2900	0.2920	0.2940	0.2960	0.2980	**0.48**
	0.49	0.3000	0.3020	0.3040	0.3060	0.3080	0.3100	0.3120	0.3140	0.3160	0.3180	**0.49**
0.5	**0.50**	0.3200	0.3215	0.3230	0.3245	0.3260	0.3275	0.3290	0.3305	0.3320	0.3335	**0.50**
	0.51	0.3350	0.3365	0.3380	0.3395	0.3410	0.3425	0.3440	0.3455	0.3470	0.3485	**0.51**
0.52	**0.52**	0.3500	0.3520	0.3540	0.3560	0.3580	0.3600	0.3620	0.3640	0.3660	0.3680	**0.52**

Canyon Cre **Expanded Stage Discharge Table For Canyon Creek (2004)**

Stage (m)	Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
	0.53	0.3700	0.3720	0.3740	0.3760	0.3780	0.3800	0.3820	0.3840	0.3860	0.3880	**0.53**
0.54	**0.54**	0.3900	0.3925	0.3950	0.3975	0.4000	0.4025	0.4050	0.4075	0.4100	0.4125	**0.54**
	0.55	0.4150	0.4175	0.4200	0.4225	0.4250	0.4275	0.4300	0.4325	0.4350	0.4375	**0.55**
0.56	**0.56**	0.4400	0.4420	0.4440	0.4460	0.4480	0.4500	0.4520	0.4540	0.4560	0.4580	**0.56**
	0.57	0.4600	0.4620	0.4640	0.4660	0.4680	0.4700	0.4720	0.4740	0.4760	0.4780	**0.57**
0.58	**0.58**	0.4800	0.4820	0.4840	0.4860	0.4880	0.4900	0.4920	0.4940	0.4960	0.4980	**0.58**
	0.59	0.5000	0.5020	0.5040	0.5060	0.5080	0.5100	0.5120	0.5140	0.5160	0.5180	**0.59**
0.6	**0.60**	0.5200	0.5220	0.5240	0.5260	0.5280	0.5300	0.5320	0.5340	0.5360	0.5380	**0.60**
	0.61	0.5400	0.5420	0.5440	0.5460	0.5480	0.5500	0.5520	0.5540	0.5560	0.5580	**0.61**
0.62	**0.62**	0.5600	0.5630	0.5660	0.5690	0.5720	0.5750	0.5780	0.5810	0.5840	0.5870	**0.62**
	0.63	0.5900	0.5930	0.5960	0.5990	0.6020	0.6050	0.6080	0.6110	0.6140	0.6170	**0.63**
0.64	**0.64**	0.6200	0.6225	0.6250	0.6275	0.6300	0.6325	0.6350	0.6375	0.6400	0.6425	**0.64**
	0.65	0.6450	0.6475	0.6500	0.6525	0.6550	0.6575	0.6600	0.6625	0.6650	0.6675	**0.65**
0.66	**0.66**	0.6700	0.6725	0.6750	0.6775	0.6800	0.6825	0.6850	0.6875	0.6900	0.6925	**0.66**
	0.67	0.6950	0.6975	0.7000	0.7025	0.7050	0.7075	0.7100	0.7125	0.7150	0.7175	**0.67**
0.68	**0.68**	0.7200	0.7230	0.7260	0.7290	0.7320	0.7350	0.7380	0.7410	0.7440	0.7470	**0.68**
	0.69	0.7500	0.7530	0.7560	0.7590	0.7620	0.7650	0.7680	0.7710	0.7740	0.7770	**0.69**
0.7	**0.70**	0.7800	0.7825	0.7850	0.7875	0.7900	0.7925	0.7950	0.7975	0.8000	0.8025	**0.70**
	0.71	0.8050	0.8075	0.8100	0.8125	0.8150	0.8175	0.8200	0.8225	0.8250	0.8275	**0.71**
0.72	**0.72**	0.8300	0.8325	0.8350	0.8375	0.8400	0.8425	0.8450	0.8475	0.8500	0.8525	**0.72**
	0.73	0.8550	0.8575	0.8600	0.8625	0.8650	0.8675	0.8700	0.8725	0.8750	0.8775	**0.73**
0.74	**0.74**	0.8800	0.8825	0.8850	0.8875	0.8900	0.8925	0.8950	0.8975	0.9000	0.9025	**0.74**
	0.75	0.9050	0.9075	0.9100	0.9125	0.9150	0.9175	0.9200	0.9225	0.9250	0.9275	**0.75**
0.76	**0.76**	0.9300	0.9325	0.9350	0.9375	0.9400	0.9425	0.9450	0.9475	0.9500	0.9525	**0.76**
	0.77	0.9550	0.9575	0.9600	0.9625	0.9650	0.9675	0.9700	0.9725	0.9750	0.9775	**0.77**
0.78	**0.78**	0.9800	0.9847	0.9895	0.9942	0.9990	1.0037	1.0085	1.0132	1.0180	1.0227	**0.78**
	0.79	1.0275	1.0322	1.0370	1.0417	1.0465	1.0512	1.0560	1.0607	1.0655	1.0702	**0.79**
0.8	**0.80**	1.0750	1.0790	1.0830	1.0870	1.0910	1.0950	1.0990	1.1030	1.1070	1.1110	**0.80**
	0.81	1.1150	1.1190	1.1230	1.1270	1.1310	1.1350	1.1390	1.1430	1.1470	1.1510	**0.81**
0.82	**0.82**	1.1550	1.1590	1.1630	1.1670	1.1710	1.1750	1.1790	1.1830	1.1870	1.1910	**0.82**
	0.83	1.1950	1.1990	1.2030	1.2070	1.2110	1.2150	1.2190	1.2230	1.2270	1.2310	**0.83**
0.84	**0.84**	1.2350	1.2390	1.2430	1.2470	1.2510	1.2550	1.2590	1.2630	1.2670	1.2710	**0.84**
	0.85	1.2750	1.2790	1.2830	1.2870	1.2910	1.2950	1.2990	1.3030	1.3070	1.3110	**0.85**
0.86	**0.86**	1.3150	1.3190	1.3230	1.3270	1.3310	1.3350	1.3390	1.3430	1.3470	1.3510	**0.86**
	0.87	1.3550	1.3590	1.3630	1.3670	1.3710	1.3750	1.3790	1.3830	1.3870	1.3910	**0.87**
0.88	**0.88**	1.3950	1.3990	1.4030	1.4070	1.4110	1.4150	1.4190	1.4230	1.4270	1.4310	**0.88**
	0.89	1.4350	1.4390	1.4430	1.4470	1.4510	1.4550	1.4590	1.4630	1.4670	1.4710	**0.89**
0.9	**0.90**	1.4750	1.4803	1.4855	1.4908	1.4960	1.5013	1.5065	1.5118	1.5170	1.5222	**0.90**
	0.91	1.5275	1.5327	1.5380	1.5432	1.5485	1.5537	1.5590	1.5642	1.5695	1.5747	**0.91**

Canyon Cre **Expanded Stage Discharge Table For Canyon Creek (2004)**

Stage (m)	Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.92	**0.92**	1.5800	1.5852	1.5905	1.5957	1.6010	1.6062	1.6115	1.6167	1.6220	1.6272	**0.92**
	0.93	1.6325	1.6377	1.6430	1.6482	1.6535	1.6587	1.6640	1.6692	1.6745	1.6797	**0.93**
0.94	**0.94**	1.6850	1.6902	1.6955	1.7007	1.7060	1.7112	1.7165	1.7217	1.7270	1.7322	**0.94**
	0.95	1.7375	1.7427	1.7480	1.7532	1.7585	1.7637	1.7690	1.7742	1.7795	1.7847	**0.95**
0.96	**0.96**	1.7900	1.7952	1.8005	1.8057	1.8110	1.8162	1.8215	1.8267	1.8320	1.8372	**0.96**
	0.97	1.8425	1.8477	1.8530	1.8582	1.8635	1.8687	1.8740	1.8792	1.8845	1.8897	**0.97**
0.98	**0.98**	1.8950	1.9002	1.9055	1.9107	1.9160	1.9212	1.9265	1.9317	1.9370	1.9422	**0.98**
	0.99	1.9475	1.9527	1.9580	1.9632	1.9685	1.9737	1.9790	1.9842	1.9895	1.9947	**0.99**
1	**1.00**	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	2.0000	**1.00**



Hydraulic Creek Mean Daily Level and Discharge (2004)
Maximum Daily Discharge = 3.65 m3/s
May 2, 2004
Minimum Daily Discharge = 0.01 m3/s
August 19, 2004
Level (m)
Discharge (m3/s)
Date
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
4
3.5
3
2.5
2
1.5
1
0.5
0
04/29/04
05/05/04
05/11/04
05/17/04
05/23/04
05/29/04
06/04/04
06/10/04
06/16/04
06/22/04
06/28/04
07/04/04
07/10/04
07/16/04
07/22/04
07/28/04
08/03/04
08/09/04
08/15/04
08/21/04
08/27/04
09/02/04
09/08/04
09/14/04
09/20/04
09/26/04
10/02/04
10/08/04
10/14/04
10/20/04
10/26/04
Mean Depth
Mean Discharge

Expanded Stage Discharge Table For Hydraulic Creek (2004)

Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.16	0.0000	0.0002	0.0004	0.0006	0.0009	0.0011	0.0013	0.0015	0.0017	0.0019	**0.16**
0.17	0.0021	0.0023	0.0026	0.0028	0.0030	0.0032	0.0034	0.0036	0.0038	0.0040	**0.17**
0.18	0.0043	0.0045	0.0047	0.0049	0.0051	0.0053	0.0055	0.0057	0.0060	0.0062	**0.18**
0.19	0.0064	0.0066	0.0068	0.0070	0.0072	0.0074	0.0077	0.0079	0.0081	0.0083	**0.19**
0.20	0.0085	0.0087	0.0089	0.0091	0.0094	0.0096	0.0098	0.0100	0.0102	0.0104	**0.20**
0.21	0.0106	0.0108	0.0111	0.0113	0.0115	0.0117	0.0119	0.0121	0.0123	0.0125	**0.21**
0.22	0.0128	0.0130	0.0132	0.0134	0.0136	0.0138	0.0140	0.0142	0.0145	0.0147	**0.22**
0.23	0.0149	0.0151	0.0153	0.0155	0.0157	0.0159	0.0162	0.0164	0.0166	0.0168	**0.23**
0.24	0.0170	0.0172	0.0174	0.0176	0.0179	0.0181	0.0183	0.0185	0.0187	0.0189	**0.24**
0.25	0.0191	0.0193	0.0196	0.0198	0.0200	0.0202	0.0204	0.0206	0.0208	0.0210	**0.25**
0.26	0.0213	0.0215	0.0217	0.0219	0.0221	0.0223	0.0225	0.0227	0.0230	0.0232	**0.26**
0.27	0.0234	0.0236	0.0238	0.0240	0.0242	0.0244	0.0247	0.0249	0.0251	0.0253	**0.27**
0.28	0.0255	0.0264	0.0274	0.0283	0.0292	0.0301	0.0311	0.0320	0.0329	0.0338	**0.28**
0.29	0.0348	0.0357	0.0366	0.0375	0.0385	0.0394	0.0403	0.0412	0.0422	0.0431	**0.29**
0.30	0.0440	0.0456	0.0471	0.0487	0.0502	0.0518	0.0533	0.0549	0.0564	0.0580	**0.30**
0.31	0.0595	0.0611	0.0626	0.0642	0.0657	0.0673	0.0688	0.0704	0.0719	0.0735	**0.31**
0.32	0.0750	0.0768	0.0785	0.0803	0.0820	0.0838	0.0855	0.0873	0.0890	0.0908	**0.32**
0.33	0.0925	0.0943	0.0960	0.0978	0.0995	0.1013	0.1030	0.1048	0.1065	0.1083	**0.33**
0.34	0.1100	0.1113	0.1125	0.1138	0.1150	0.1163	0.1175	0.1188	0.1200	0.1213	**0.34**
0.35	0.1225	0.1238	0.1250	0.1263	0.1275	0.1288	0.1300	0.1313	0.1325	0.1338	**0.35**
0.36	0.1350	0.1365	0.1380	0.1395	0.1410	0.1425	0.1440	0.1455	0.1470	0.1485	**0.36**
0.37	0.1500	0.1515	0.1530	0.1545	0.1560	0.1575	0.1590	0.1605	0.1620	0.1635	**0.37**
0.38	0.1650	0.1698	0.1745	0.1793	0.1840	0.1888	0.1935	0.1983	0.2030	0.2078	**0.38**
0.39	0.2125	0.2173	0.2220	0.2268	0.2315	0.2363	0.2410	0.2458	0.2505	0.2553	**0.39**
0.40	0.2600	0.2674	0.2748	0.2822	0.2896	0.2970	0.3044	0.3118	0.3192	0.3266	**0.40**
0.41	0.3340	0.3414	0.3488	0.3562	0.3636	0.3710	0.3784	0.3858	0.3932	0.4006	**0.41**
0.42	0.4080	0.4154	0.4228	0.4302	0.4376	0.4450	0.4524	0.4598	0.4672	0.4746	**0.42**
0.43	0.4820	0.4894	0.4968	0.5042	0.5116	0.5190	0.5264	0.5338	0.5412	0.5486	**0.43**
0.44	0.5560	0.5634	0.5708	0.5782	0.5856	0.5930	0.6004	0.6078	0.6152	0.6226	**0.44**
0.45	0.6300	0.6374	0.6448	0.6522	0.6596	0.6670	0.6744	0.6818	0.6892	0.6966	**0.45**
0.46	0.7040	0.7114	0.7188	0.7262	0.7336	0.7410	0.7484	0.7558	0.7632	0.7706	**0.46**
0.47	0.7780	0.7854	0.7928	0.8002	0.8076	0.8150	0.8224	0.8298	0.8372	0.8446	**0.47**

Expanded Stage Discharge Table For Hydraulic Creek (2004)

Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.48	0.8520	0.8594	0.8668	0.8742	0.8816	0.8890	0.8964	0.9038	0.9112	0.9186	**0.48**
0.49	0.9260	0.9334	0.9408	0.9482	0.9556	0.9630	0.9704	0.9778	0.9852	0.9926	**0.49**
0.50	1.0000	1.0138	1.0275	1.0413	1.0550	1.0688	1.0825	1.0963	1.1100	1.1238	**0.50**
0.51	1.1375	1.1513	1.1650	1.1788	1.1925	1.2063	1.2200	1.2338	1.2475	1.2613	**0.51**
0.52	1.2750	1.2888	1.3025	1.3163	1.3300	1.3438	1.3575	1.3713	1.3850	1.3988	**0.52**
0.53	1.4125	1.4263	1.4400	1.4538	1.4675	1.4813	1.4950	1.5088	1.5225	1.5363	**0.53**
0.54	1.5500	1.5638	1.5775	1.5913	1.6050	1.6188	1.6325	1.6462	1.6600	1.6737	**0.54**
0.55	1.6875	1.7012	1.7150	1.7287	1.7425	1.7562	1.7700	1.7837	1.7975	1.8112	**0.55**
0.56	1.8250	1.8387	1.8525	1.8662	1.8800	1.8937	1.9075	1.9212	1.9350	1.9487	**0.56**
0.57	1.9625	1.9762	1.9900	2.0037	2.0175	2.0312	2.0450	2.0587	2.0725	2.0862	**0.57**
0.58	2.1000	2.1137	2.1275	2.1412	2.1550	2.1687	2.1825	2.1962	2.2100	2.2237	**0.58**
0.59	2.2375	2.2512	2.2650	2.2787	2.2925	2.3062	2.3200	2.3337	2.3475	2.3612	**0.59**
0.60	2.3750	2.4010	2.4270	2.4530	2.4790	2.5050	2.5310	2.5570	2.5830	2.6090	**0.60**
0.61	2.6350	2.6610	2.6870	2.7130	2.7390	2.7650	2.7910	2.8170	2.8430	2.8690	**0.61**
0.62	2.8950	2.9210	2.9470	2.9730	2.9990	3.0250	3.0510	3.0770	3.1030	3.1290	**0.62**
0.63	3.1550	3.1810	3.2070	3.2330	3.2590	3.2850	3.3110	3.3370	3.3630	3.3890	**0.63**
0.64	3.4150	3.4410	3.4670	3.4930	3.5190	3.5450	3.5710	3.5970	3.6230	3.6490	**0.64**
0.65	3.6750	3.7010	3.7270	3.7530	3.7790	3.8050	3.8310	3.8570	3.8830	3.9090	**0.65**
0.66	3.9350	3.9610	3.9870	4.0130	4.0390	4.0650	4.0910	4.1170	4.1430	4.1690	**0.66**
0.67	4.1950	4.2210	4.2470	4.2730	4.2990	4.3250	4.3510	4.3770	4.4030	4.4290	**0.67**
0.68	4.4550	4.4810	4.5070	4.5330	4.5590	4.5850	4.6110	4.6370	4.6630	4.6890	**0.68**
0.69	4.7150	4.7410	4.7670	4.7930	4.8190	4.8450	4.8710	4.8970	4.9230	4.9490	**0.69**
0.70	4.9750	5.0240	5.0730	5.1220	5.1710	5.2200	5.2690	5.3180	5.3670	5.4160	**0.70**
0.71	5.4650	5.5140	5.5630	5.6120	5.6610	5.7100	5.7590	5.8080	5.8570	5.9060	**0.71**
0.72	5.9550	6.0040	6.0530	6.1020	6.1510	6.2000	6.2490	6.2980	6.3470	6.3960	**0.72**
0.73	6.4450	6.4940	6.5430	6.5920	6.6410	6.6900	6.7390	6.7880	6.8370	6.8860	**0.73**
0.74	6.9350	6.9840	7.0330	7.0820	7.1310	7.1800	7.2290	7.2780	7.3270	7.3760	**0.74**
0.75	7.4250	7.4740	7.5230	7.5720	7.6210	7.6700	7.7190	7.7680	7.8170	7.8660	**0.75**
0.76	7.9150	7.9640	8.0130	8.0620	8.1110	8.1600	8.2090	8.2580	8.3070	8.3560	**0.76**
0.77	8.4050	8.4540	8.5030	8.5520	8.6010	8.6500	8.6990	8.7480	8.7970	8.8460	**0.77**
0.78	8.8950	8.9440	8.9930	9.0420	9.0910	9.1400	9.1890	9.2380	9.2870	9.3360	**0.78**
0.79	9.3850	9.4340	9.4830	9.5320	9.5810	9.6300	9.6790	9.7280	9.7770	9.8260	**0.79**
0.80	9.8750	9.9577	10.0405	10.1233	10.2060	10.2888	10.3715	10.4543	10.5370	10.6198	**0.80**
0.81	10.7025	10.7853	10.8680	10.9508	11.0335	11.1163	11.1990	11.2818	11.3645	11.4473	**0.81**

Expanded Stage Discharge Table For Hydraulic Creek (2004)

Meters	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	Meters
0.82	11.5300	11.6128	11.6955	11.7783	11.8610	11.9438	12.0265	12.1093	12.1920	12.2748	**0.82**
0.83	12.3575	12.4403	12.5230	12.6058	12.6885	12.7713	12.8540	12.9368	13.0195	13.1023	**0.83**
0.84	13.1850	13.2678	13.3505	13.4333	13.5160	13.5988	13.6815	13.7643	13.8470	13.9298	**0.84**
0.85	14.0125	14.0953	14.1780	14.2608	14.3435	14.4263	14.5090	14.5918	14.6745	14.7573	**0.85**
0.86	14.8400	14.9228	15.0055	15.0883	15.1710	15.2538	15.3365	15.4193	15.5020	15.5848	**0.86**
0.87	15.6675	15.7503	15.8330	15.9158	15.9985	16.0813	16.1640	16.2468	16.3295	16.4123	**0.87**
0.88	16.4950	16.5778	16.6605	16.7433	16.8260	16.9088	16.9915	17.0743	17.1570	17.2398	**0.88**
0.89	17.3225	17.4053	17.4880	17.5708	17.6535	17.7363	17.8190	17.9018	17.9845	18.0673	**0.89**
0.90	18.1500	18.2685	18.3870	18.5055	18.6240	18.7425	18.8610	18.9795	19.0980	19.2165	**0.90**
0.91	19.3350	19.4535	19.5720	19.6905	19.8090	19.9275	20.0460	20.1645	20.2830	20.4015	**0.91**
0.92	20.5200	20.6385	20.7570	20.8755	20.9940	21.1125	21.2310	21.3495	21.4680	21.5865	**0.92**
0.93	21.7050	21.8235	21.9420	22.0605	22.1790	22.2975	22.4160	22.5345	22.6530	22.7715	**0.93**
0.94	22.8900	23.0085	23.1270	23.2455	23.3640	23.4825	23.6010	23.7195	23.8380	23.9565	**0.94**
0.95	24.0750	24.1935	24.3120	24.4305	24.5490	24.6675	24.7860	24.9045	25.0230	25.1415	**0.95**
0.96	25.2600	25.3785	25.4970	25.6155	25.7340	25.8525	25.9710	26.0895	26.2080	26.3265	**0.96**
0.97	26.4450	26.5635	26.6820	26.8005	26.9190	27.0375	27.1560	27.2745	27.3930	27.5115	**0.97**
0.98	27.6300	27.7485	27.8670	27.9855	28.1040	28.2225	28.3410	28.4595	28.5780	28.6965	**0.98**
0.99	28.8150	28.9335	29.0520	29.1705	29.2890	29.4075	29.5260	29.6445	29.7630	29.8815	**0.99**
1.00	30.0000	30.0000	30.0000	30.0000	30.0000	30.0000	30.0000	30.0000	30.0000	30.0000	**1.00**

APPENDIX C

Equipment Specifications

Equipment Specifications – Marsh McBirney Flow Mate Model 2000 Flow Meter

Velocity Measurement
Method (Electromagnetic)
Zero Stability (+/- 0.05 ft/sec)
Accuracy (+/- 2% of reading + zero stability)
Range (-0.5 to +19.99 ft/sec, -0.15 to +6 m/s)

Power Requirements
Batteries (2 D-Cells)

Battery Life Continuous ON hours
Alkaline (25-30 hours)
NiCad (10-15 hours/charge)
External Power Supply (Optional)
120V, 1W or 220V, 1W

Water Resistant Electronic Case
Submersible one Foot for 30 Seconds

Outputs
3.5 Digit
Signal Output Connector (Optional)
Analog 0.1V = 1 ft/sec or 1 m/s
2V = Full Scale

Materials
Sensor (Polyurethane)
Cable (Polyurethane Jacket)
Electronic Case (High Impact Molded Plastic)

Weight
3 lb 9 oz with case and 20 ft of cable
2 lb 10 oz without sensor and cable

Temperature
Open-Channel-Velocity-Sensor (0°C - 72°C)
Full Pipe Sensor (0°C - 72°C at 250 psi)
Electronics (0°C - 50°C)

OTT Thalimedes Float Operated Shaft Encoder - Technical Data

Measurement range switch-selectable	±19.999 m	±199.99 m	±199.99ft
Resolution	0.001 m	0.01 m	0.01 ft
Maximum measuring error	±0.002 m ± 1 digit	±0.002 m ±1 digit	±0.0066 ft ±1 digit

Data Logger Unit	
Display	LCD 1 single-line, 4.5 places, characters 12 mm high
Measured value memory	approximately 30 000 measured values (EEPROM)
Sample interval/Storage interval	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 min 1, 2, 3, 4, 6, 8, 12, 24 h 0 = Off
Interfaces	RS 232 C + infrared (IrDa)
Power Supply	1 x 1.5 V C-cells (LR 14 C AM 2) alkaline type (exclusively battery powered)
Dimensions L x diameter	244 mm x 47 mm
Weight including battery	0.320 kg
Casing	Plastic
Degree of protection	IP 68
Temperature range	-20°C to +70°C
Encoder Unit	
Circumference of pulley	200.0 mm
Standard float cable	1 mm ∅ other diameters can be graduated; e.g. 0.6 mm float cable ∅ - set float pulley circumference to 198.7 mm
Dimensions L x W x H	82 mm x 82 mm x 34 mm
Weight	0.140 kg
Casing	Plastic
Degree of protection	IP 54
Temperature range	-20°C to +70°C
Transducer cable	
Length	1 m
EMC limit values	
-Resistance to electrostatic discharge (ESD)	complies with EN 61000-4-2 degree of severity 2 (4 kV contact discharge)
-Resistance to electromagnetic fields	complies with EN 61000-4-3 degree of severity 3 (10 V/m)
-Resistance to transient fields (burst)	complies with EN 61000-4-4 special degree of severity (4 kV)
-Resistance to surge	complies with EN 61000-4-5 degree of severity 2 (1 kV)
-Line-borne and radiated interference	complies with EN 55022 Class B

Campbell Scientific Model CR 510 Data Logger - Technical Specifications

Electrical specifications are valid over a -25° to +50°C range unless otherwise specified; non-condensing environment required. To maintain electrical specifications, Campbell Scientific recommends recalibrating dataloggers every two years**.**

PROGRAM EXECUTION RATE

System tasks initiated in sync with real-time up
to 64 Hz. One measurement with data transfer is
possible at this rate without interruption.

ANALOG INPUTS

NUMBER OF CHANNELS: 2 differential or 4
single-ended, individually configured.
RANGE AND RESOLUTION:
Full Scale Resolution (μV)

Input Range (mV)	Differential	Single-Ended
±2500	333	666
±250	33.3	66.6
±25	3.33	6.66
±7.5	1.00	2.00
±2.5	0.33	0.66

INPUT SAMPLE RATES: Includes the measurement time and conversion to engineering units. The fast and slow measurements integrate the signal for 0.25 and 2.72 ms, respectively. Differential measurements incorporate two integrations with reversed input polarities to reduce thermal offset and common mode errors.
Fast differential voltage: 4.2 ms
Slow differential voltage: 9.2 ms
Differential with 60 Hz rejection: 25.9 ms
ACCURACY: ±0.1% of FSR (-25° to 50°C); ±0.05% of FSR (0° to 40°C);
e.g., ±0.1% FSR = ±5.0 mV for ±2500 mV range
INPUT NOISE VOLTAGE (for ±2.5 mV range):
Fast differential: 0.82 μV rms
Slow differential: 0.25 μV rms
Differential with
60 Hz rejection: 0.18 μV rms
COMMON MODE RANGE: ±2.5 V
DC COMMON MODE REJECTION: > 140 dB
NORMAL MODE REJECTION: 70 dB (60 Hz with slow differential measurement)
INPUT CURRENT: ±9 nA maximum
INPUT RESISTANCE: 20 Gohms typical

ANALOG OUTPUTS

DESCRIPTION: 2 switched excitations, active only during measurement, one at a time.
RANGE: ±2.5 V
RESOLUTION: 0.67 mV
ACCURACY: ±2.5 mV (0° to 40°C); ±5 mV (-25° to 50°C)
CURRENT SOURCING: 25 mA
CURRENT SINKING: 25 mA
FREQUENCY SWEEP FUNCTION: The switched outputs provide a programmable swept frequency, 0 to 2.5 V square wave for exciting vibrating wire transducers.

RESISTANCE MEASUREMENTS

MEASUREMENT TYPES: The CR510 provides
ratiometric bridge measurements of 4- and 6-wire full bridge, and 2-, 3-, and 4-wire half bridges. Precise dual polarity excitation using any of the switched outputs eliminates dc errors. Conductivity measurements use a dual polarity 0.75 ms excitation to minimize polarization errors.
ACCURACY: ±0.02% of FSR plus bridge errors.

PERIOD AVERAGING MEASUREMENTS

DEFINITION: The average period for a single cycle is determined by measuring the duration of a specified number of cycles. Any of the 4 single-ended analog input channels can be used. Signal attentuation and ac coupling is typically required.
INPUT FREQUENCY RANGE:
Signal peak-to-peak[1] Min. Max

Min.	Max.	Pulse w.	Freq.[2]
500 mV	5.0 V	2.5 μs	200 kHz
10 mV	2.0 V	10 μs	50 kHz
5 mV	2.0 V	62 μs	8 kHz
2 mV	2.0 V	100 μs	5 kHz

RESOLUTION: 35 ns divided by the number of cycles measured
ACCURACY: ±0.03% of reading
TIME REQUIRED FOR MEASUREMENT: Signal period multiplied by the number of cycles measured plus 1.5 cycles + 2 ms.

PULSE COUNTERS

NUMBER OF CHANNELS: 2 eight-bit or 1 sixteenbit; software selectable as switch closure, high frequency pulse, or low-level ac modes. An additional channel (C2/P3) can be software configured to read switch closures at rates up to 40 Hz.
MAXIMUM COUNT RATE: 16 kHz, eight-bit counter; 400 kHz, sixteen-bit counter. Channels are scanned at 8 or 64 Hz (software selectable).
SWITCH CLOSURE MODE:
Minimum Switch Closed Time: 5 ms
Minimum Switch Open Time: 6 ms
Maximum Bounce Time: 1 ms open without being counted
HIGH FREQUENCY PULSE MODE:
Minimum Pulse Width: 1.2 μs
Maximum Input Frequency: 400 kHz
Maximum Input Voltage: ±20 V
Voltage Thresholds: Count upon transition from below 1.5 V to above 3.5 V at low frequencies. Larger input transitions are required at high frequencies because of input filter with 1.2 μs time constant. Signals up to 400 kHz will be counted if centered around +2.5 V with deviations = ± 2.5 V for = 1.2 μs.
LOW LEVEL AC MODE:
(Typical of magnetic pulse flow transducers or other low voltage, sine wave outputs.)
Input Hysteresis: 14 mV
Maximum ac Input Voltage: ±20 V
Minimum ac Input Voltage:

(Sine wave mV rms)*	Range (Hz)
20	1 to 1000
200	0.5 to 10,000
1000	0.3 to 16,000

*16-bit config. or 64 Hz scan req'd for freq. > 2048 Hz

DIGITAL I/O PORTS

DESCRIPTION: Port C1 is software selectable as a binary input, control output, or as an SDI-12 port.
Port C2/P3 is input only and can be software configured as an SDI-12 port, a binary input, or as a switch closure counter (40 Hz max).
OUTPUT VOLTAGES (no load): high 5.0 V ±0.1 V; low < 0.1 V

OUTPUT RESISTANCE: 500 ohms

INPUT STATE: high 3.0 to 5.5 V; low -0.5 to 0.8 V

INPUT RESISTANCE: 100 kohms

SDI-12 INTERFACE STANDARD

DESCRIPTION: Digital I/O Ports C1-C2 support SDI-12 asynchronous communication; up to ten SDI-12 sensors can be connected to each port. Meets SDI-12 standard Version 1.2 for datalogger and sensor modes.

EMI and ESD PROTECTION

The CR510 is encased in metal and incorporates EMI filtering on all inputs and outputs. Gas discharge tubes provide robust ESD protection on all terminal block inputs and outputs. The following European standards apply.
EMC tested and conforms to BS EN61326:1998.
Details of performance criteria applied are available upon request.

CPU AND INTERFACE

PROCESSOR: Hitachi 6303.
PROGRAM STORAGE: Up to 16 kbytes for active program; additional 16 kbytes for alternate programs. Operating system stored in 128 kbytes Flash memory.
DATA STORAGE: 128 kbytes SRAM standard (approximately 62,000 values). Additional 2 Mbytes Flash available as an option.
OPTIONAL KEYBOARD DISPLAY: 8 digit LCD (0.5" digits).
PERIPHERAL INTERFACE: 9 pin D-type connector for keyboard display, storage module, modem, printer, card storage module, and RS-232 adapter.
BAUD RATES: Selectable at 300, 1200, and 9600, 76,800 for certain synchronous devices. ASCII communication protocol is one start bit, one stop bit, eight data bits (no parity).
CLOCK ACCURACY: ±1 minute per month

SYSTEM POWER REQUIREMENTS

VOLTAGE: 9.6 to 16 Vdc
TYPICAL CURRENT DRAIN: 1.3 mA quiescent, 13 mA during processing, and 46 mA during analog measurement.
BATTERIES: Any 12 V battery can be connected as a primary power source. Several power supply options are available from Campbell Scientific.
The model CR2430 lithium battery for clock and SRAM backup has a capacity of 270 mAhr.

PHYSICAL SPECIFICATIONS

SIZE: 8.4" x 1.5" x 3.9" (21.3 cm x 3.8 cm x 9.9 cm). Additional clearance required for serial cable and sensor leads.
WEIGHT: 15 oz. (425 g)

WARRANTY

Three years against defects in materials and workmanship.