APPENDIX B

4Q3 LOW-FLOW

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It is often necessary to calculate a critical flow for a portion of a watershed where there is no stage gage. This can be accomplished by applying one of two formulas developed by the USGS. One formula (Thomas, 1993) is recommended when the ratio between the two watershed areas is between 0.5 and 1.5. The other formula, to be used when the watershed ratio is outside this range, is a regression formula also developed by the USGS (Borland, 1970).

1. 4Q3 flow at USGS Streamflow Gage 08387000 (Rio Ruidoso at Hollywood, NM) in cubic feet per second

a) *Annual* 4Q3 Flow Using Log-Pearson Type III Statistics (SWSTAT 4.1)

(based on USGS Program A193)

April 1 - start of season
March 31 - end of season
1955 - 2005 - time period
4-day low - parameter

0.725	1.175	1.150	1.100	1.750	0.775	1.000	1.400	2.775
1.225	0.550	3.800	3.275	1.155	4.950	3.325	1.750	1.400
3.950	3.800	2.450	5.775	6.375	6.075	8.300	7.625	6.150
5.975	2.850	6.825	8.350	5.775	9.600	8.575	11.000	7.100
7.725	10.500	7.450	8.850	1.950	6.850	5.400	10.000	7.725
4.825	5.275	4.525	2.675	3.425	3.550			

The following 7 statistics are based on non-zero values:

Mean (logs)	0.558
Variance (logs)	0.125
Standard Deviation (logs)	0.354
Skewness (logs)	-0.623
Standard Error of Skewness (logs)	0.333
Serial Correlation Coefficient (logs)	0.687
Coefficient of Variation (logs)	0.634

Non-exceedance Probability	Recurrence Interval	Parameter Value
0.0100	100.00	0.378
0.0200	50.00	0.524
0.0500	20.00	0.833
0.1000	10.00	1.224
0.2000	5.00	1.888
0.3333	3.00	**2.731**
0.5000	2.00	3.931
0.8000	1.25	7.262
0.9000	1.11	9.573
0.9600	1.04	12.450
0.9800	1.02	14.510
0.9900	1.01	16.476

4Q3 Low-Flow

2. 4Q3 flow at UNGAGED locations

a) The nearest gage to the points of interest is the Rio Ruidoso at Hollywood, NM (USGS Gage 08387000). The drainage area above this gage (A_g) is 120 mi^2. Using the guidelines recommended by the USGS, when the ratio between the ungaged and gaged watersheds is outside the 0.5-1.5 range we apply **Equation 1**. (*Latitude and longitude of the point of interest were input into GIS Weasel to determine the basin and climatic characteristics necessary for these computations*.)

Equation 1

$$7Q2_{(u)} = 1.36x10^{-4} * (A_u)^{0.566} * (P_a)^{3.32} \qquad \textbf{(Reference: USGS, 1970)}$$

Where:

$7Q2_{(u)}$ = weighted 7Q2 flow estimate at ungaged site, in cubic feet per second (cfs)
A_u = drainage area above the ungaged site, in square miles
P_a = mean precipitation (October through April), in inches

b) Using the ratio between 4Q3 and 7Q2 at the gaged site and applying **Equation 2**, the annual 4Q3 flow at the ungaged site can be calculated.

Equation 2

$$4Q3_{(u)} = 7Q2_{(u)} * (4Q3_{(g)}/7Q2_{(g)}) \qquad \textbf{(Reference: USGS, 1970)}$$

Where:

$4Q3_{(u)}$ = weighted annual 4Q3 flow estimate at ungaged site, in cfs
$7Q2_{(u)}$ = calculated annual 7Q2 flow at ungaged site (from **Equation 1**), in cfs
$4Q3_{(g)}$ = Log-Pearson Type III annual 4Q3 flow at gaged site, in cfs
$7Q2_{(g)}$ = Log-Pearson Type III annual 7Q2 flow at gaged site, in cfs

parameter	Ruidoso @ Hollywood (gage location)	Upper Bonito (ungaged portion)	Carrizo (ungaged portion)	Rio Hondo (ungaged portion)
Ag	120.00	-	-	-
Au	-	45.96	24.62	878.41
Au/Ag	-	**0.38**	**0.21**	**7.32**
P*annual*	22.22	25.00	22.70	18.10
P*winter*	7.61	8.60	8.00	5.70
7Q2 (cfs)	**4.147**	1.503	0.830	2.038
4Q3(g)/7Q2(g)	**0.659**	-	-	-
4Q3 (cfs)	**2.731**	**0.990**	**0.547**	**1.342**
4Q3 (mgd)	**1.765**	**0.640**	**0.353**	**0.867**