

Table B6 - 3 Background-related DQO Statistics for Former Ponds and Pads Soils (0 - 5 feet)

Metal	Background Data Set			Site Characterization Statistics				Pooled Statistics /1		Estimation Uncertainty Based on Two-sample t-test Ho: Study Area Within Background				Estimation Uncertainty (likelihood of beta-type error > 0.1)	Toxicity-Related Decision Uncertainty /3					Actual Decision Uncertainty /5	Background-Related DQO Met?	Comment
	N used for test	Background Mean	Background Stdev	N	Study Area Mean	Study Area Stdev	Point Difference (study area mean - background mean)	N _{pooled}	S ² _{pooled}	beta	alpha	MDD /2	Study Area Within Background?		20% Background Mean	SL /4 Lowest Toxicological Screening Level	Stated MDDgoal	MDD/ MDDgoal	Stated Decision Uncertainty (low if MDD/ MDDgoal < 1)			
Barium	42	71.32	36.08	156	199.60	204.4	128.28	66.2	178.27	0.1	0.2	4.97	reject at alpha < 0.2	adequate (low)	14.26	330	330.00	0.015	adequate (low)	adequate (low)	Yes	DQO well met.
Beryllium	22	0.52	0.13	156	0.43	0.435	-0.09	38.6	0.17	0.1	0.2	0.20	accept	high	0.10	10	10.00	0.020	adequate (low)	adequate (low)	Yes	DQO adequately met. Conclusion of within background is uncertain, however study area mean is well below SL.
Cadmium	43	0.89	0.58	156	1.45	1.468	0.56	67.4	1.72	0.1	0.2	0.48	reject at alpha < 0.2	adequate (low)	0.18	0.36	0.36	1.342	high	high	Yes	DQO well met.
Chromium	18	28.93	6.01	156	27.84	28.46	-1.09	32.3	702.02	0.1	0.2	14.27	accept	high	5.79	0.4	5.79	2.465	high *	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Cobalt	43	5.93	4.71	156	5.97	6.201	0.04	67.4	32.73	0.1	0.2	2.11	accept	high	1.19	13	13.00	0.162	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Copper	36	9.48	3.35	156	14.93	15.29	5.45	58.5	183.85	0.1	0.2	5.38	reject at alpha < 0.2	adequate (low)	1.90	28	28.00	0.192	adequate (low)	adequate (low)	Yes	DQO well met.
Lead	46	3.18	2.28	156	19.05	17.97	15.87	71.0	282.54	0.1	0.2	6.04	reject at alpha < 0.2	adequate (low)	0.64	11	11.00	0.549	adequate (low)	adequate (low)	Yes	DQO well met.
Mercury	6	0.0225	0.0024	153	0.03	0.0348	0.01	11.5	0.00	0.1	0.2	0.03	accept	high	0.0045	0.1	0.10	0.294	adequate (low)	adequate (low)	Yes	DQO adequately met. Conclusion of within background is uncertain, however study area mean is well below SL.
Molybdenum	43	3.85	2.96	156	4.04	4.11	0.19	67.4	14.74	0.1	0.2	1.42	accept	high	0.77	2	2.00	0.708	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Nickel	43	28.13	8.16	156	35.18	36.07	7.05	67.4	988.19	0.1	0.2	11.60	accept	high	5.63	30	30.00	0.387	adequate (low) *	high	No	DQO not met. Conclusion of "within background" has estimation uncertainty higher than beta=0.1 and conclusion potentially drives COPC selection.
Selenium	43	1.11	0.67	156	1.54	1.53	0.43	67.4	1.97	0.1	0.2	0.52	accept	high	0.22	1	1.00	0.518	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Thallium	17	0.34	0.09	156	0.38	0.355	0.04	30.7	0.13	0.1	0.2	0.20	accept	high	0.07	1	1.00	0.203	adequate (low)	moderate	OK	Stated DQO is not met however it is unlikely to be met by adding any feasible number of samples. Decision uncertainty exists due to proximity of study area mean and background mean.
Tin	18	23.38	18.17	156	44.04	44.51	20.66	32.3	1780.26	0.1	0.2	22.72	accept	high	4.68	50	50.00	0.454	adequate (low) *	moderate-high	No	DQO not met. Conclusion of "within background" has estimation uncertainty higher than beta=0.1 and conclusion potentially drives COPC selection.
Vanadium	43	37.2	16.04	156	25.54	25.66	-11.66	67.4	568.01	0.1	0.2	8.79	accept	adequate (low)	7.44	2	7.44	1.182	high *	adequate (low)	Yes	DQO well met.
Zinc	43	50.48	19.87	156	54.72	55.94	4.24	67.4	2440.45	0.1	0.2	18.22	accept	high	10.10	50	50.00	0.364	adequate (low) *	moderate-high	No	DQO not met. Conclusion of "within background" has estimation uncertainty higher than beta=0.1 and conclusion potentially drives COPC selection.

/1 Pooled Statistics
 Sample Size: $N_{pooled} = (2 \cdot N1 \cdot N2) / (N1 + N2)$
 Degrees of Freedom: $D1 = N1 - 1$; $D2 = N2 - 1$; $D_{pooled} = N_{pooled} - 1$
 Pooled standard deviation: $S^2_{pooled} = (S1^2 \cdot D1 + S2^2 \cdot D2) / (D_{pooled})$

/2 t-test statistics
 H0: study area is within background
 HA: study area exceeds background
 point difference = study area mean - background mean
 Reject H0 if $MDD < \text{point difference}$

Sources of uncertainty are bolded
 /3 Stated DQO goal is **not** met if $MDD/MDDgoal > 1$
 * Stated MDLgoal from work plan included estimation uncertainty and an approximate measure of decision uncertainty. However, occasionally actual decision uncertainty was not accurately represented in the Stated MDDgoal.
 /4 SL = the lowest toxicological screening level is used without consideration of the background UTL to avoid circularity in assessing the background-related DQO.
 /5 Actual Decision Uncertainty is high when study area mean is close to the SL.
/6 Background-related DQO is not met if both estimation uncertainty and actual decision uncertainty are high

Minimum detectable difference (MDD) at stated alpha and beta: $MDD = \text{SQRT}(2S^2_{pooled}/N_{pooled}) \cdot (t_{alpha, D_{pooled}} + t_{beta, D_{pooled}})$
 (Zar(1984), minimum detectable difference for t-test with unequal sample sizes)
 If $MDD < \text{absolute value of (point difference)}$, then power was inadequate to detect a difference from background.

