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San Francisco Bay Triennial Bird Egg Monitoring Program for Contaminants – 2009 Data Summary

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San Francisco Estuary Institute and the Regional Monitoring Program

Summary

As part of the San Francisco Estuary Institute's *Regional Monitoring Program* and the USGS's long-term *Contaminant Impacts to Wildlife Program*, the USGS samples double-crested cormorant and Forster's tern eggs throughout the San Francisco Bay Estuary every three years to assess temporal trends and contaminant concentrations. This document summarizes egg collections for 2009, as well as mercury concentrations in Forster's tern eggs on an individual basis.

Egg Collection

Double-crested cormorant eggs were sampled between 19 March and 27 May 2009 from three locations: (1) Wheeler Island, (2) Richmond-San Rafael Bridge, and (3) South Bay PG&E towers (Moffett ponds; Towers 37, 38, and 4/30). Twenty-one eggs were sampled from each location. Egg mass, egg length, and egg breadth were measured for each egg (**Appendix 1**) and the eggs were shipped unopened to AXYS Analytical laboratories in June 2009 for contaminant analyses.

Forster's tern eggs were sampled between 12 May and 19 June 2009 from six different colonies: (1) Pond A16, (2) Pond A2W, and (3) Pond AB2 on Don Edwards National Wildlife Refuge; (4) Eden Landing Ecological Reserve; (5) Hayward Shoreline Regional Park; and (6) Napa-Sonoma Marsh Wildlife Area (**Figure 1**). Twenty-one eggs were sampled from each location. Forster's tern eggs were individually weighed, measured, dissected, dried, homogenized, and analyzed for total mercury (THg) concentrations at the USGS Davis Field Station Environmental Mercury Laboratory at UC Davis (**Appendix 2-3**). After homogenizing the eggs, equal masses (dried) from each of seven randomly chosen eggs per colony were combined to make three separate composite samples of seven eggs each per colony. Composite aliquots were then sent to the California Department of Fish and Game Moss Landing Marine Lab for selenium determination, and the California Department of Fish and Game Water Pollution Control Laboratory for PBDE analyses.

Forster's Tern Egg Total Mercury Concentrations

Across all sites, the geometric mean (± standard error) THg concentration (μg/g fresh wet weight [fww]) in Forster's tern eggs was 0.97 ± 0.05 μg/g, and concentrations in individual eggs ranged from 0.38 μg/g to 9.03 μg/g. Geometric mean THg concentrations did not vary among colonies (ANOVA: $F_{5,120} = 1.15$, $p = 0.34$; **Figure 2**). We also evaluated risk to hatching by assessing individual egg THg concentrations in relation to a threshold value of 1.4 μg/g fww, which is associated with 90% hatching success in relation to THg concentrations in Forster's tern eggs (Ackerman and Eagles-Smith 2008). Overall, 15% of eggs sampled (19 of 126) exceeded this threshold. Importantly, on a site-specific basis 29%, 19%, and 14% of individual eggs from the A16, AB2, and A2W colonies, respectively, exceeded 1.4 μg/g fww, whereas 10% of eggs from each of the remaining three colonies exceeded this value. Our results indicate that Forster's terns at several colonies continued to be at high risk to potentially impaired reproduction due to egg mercury concentrations, and suggest that simply evaluating the mean mercury concentrations among colonies may not adequately characterize risk of mercury to Forster's terns in San Francisco Bay.

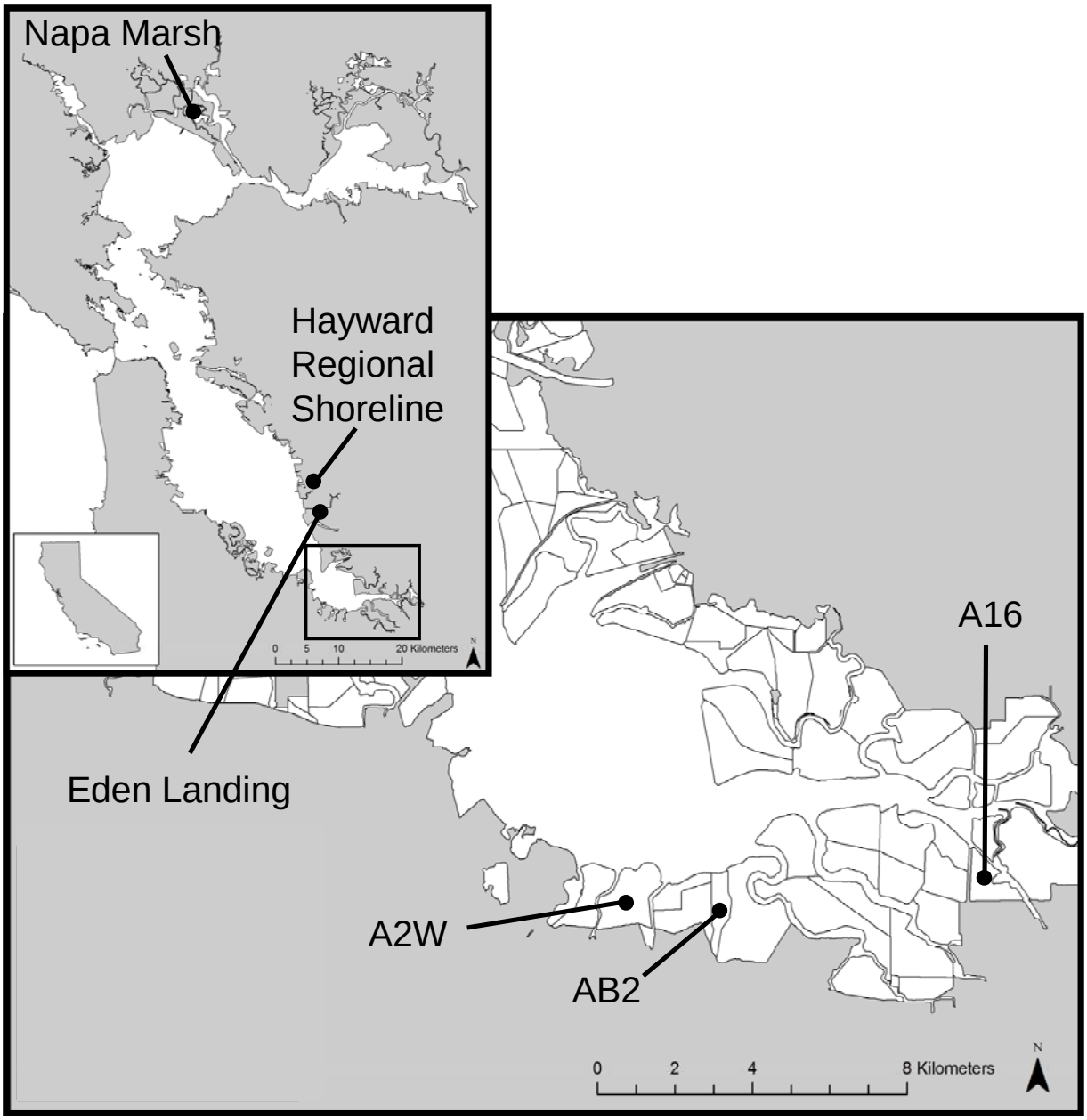

Figure 1. Forster's tern colony locations sampled for Regional Monitoring Program in 2009.

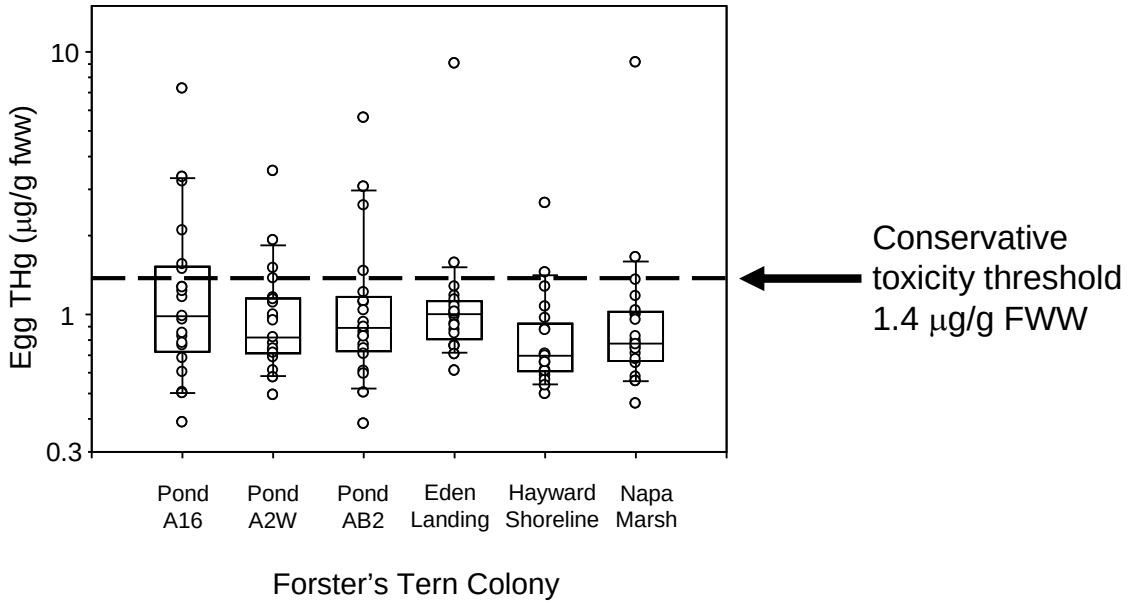

Figure 2. Total mercury (THg) concentrations (µg/g fresh wet weight) in Forster's tern eggs sampled from six colonies in San Francisco Bay during the 2009 breeding season.

Literature Cited

Ackerman, JT, and CA Eagles-Smith. 2008. A dual life-stage approach to monitoring the effects of mercury concentrations on the reproductive success of Forster's Terns in San Francisco Bay. Administrative Report, U. S. Geological Survey, Western Ecological Research Center, Davis, CA 47 pp.

Appendix 1. Double-crested cormorant egg collection data and egg measurements for eggs collected from San Francisco Bay, California in 2009.

Sample ID	Species	Collection Date	Year	Colony	UTM-Northing (NAD83)	UTM-Easting (NAD83)	Egg measuring date	Whole Egg Mass (g)	Egg Length (mm)	Egg Width (mm)
W-1	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	49.45	58.69	40.25
W-2	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	50.94	63.39	39.63
W-3	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	45.61	56.51	40.12
W-4	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	47.25	57.54	40.66
W-5	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	51.80	61.51	39.98
W-6	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	44.81	56.73	39.33
W-7	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	51.57	59.59	40.79
W-8	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	30.96	58.10	38.58
W-9	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	25.30	59.79	37.87
W-10	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	56.02	64.82	41.90
W-11	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	53.06	59.71	41.64
W-12	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	47.65	59.66	39.94
W-13	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	46.52	59.34	39.12
W-14	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	51.94	64.17	39.75
W-15	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	60.37	60.33	44.10
W-16	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	49.17	60.00	39.94
W-17	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	56.58	67.23	40.31
W-18	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	57.40	66.09	41.66
W-19	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	52.15	61.40	40.93
W-20	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	42.91	57.11	37.79
W-21	Double-crested Cormorant	3/19/2009	2009	Wheeler Island	590750	4215217	6/1/2009	41.90	58.30	39.76
RB-1	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	49.24	61.55	38.76
RB-2	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	47.61	63.02	38.50
RB-3	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	48.45	63.73	37.88
RB-4	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	51.19	65.22	39.54
RB-5	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	48.49	60.19	38.84
RB-6	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	50.61	63.79	38.54
RB-7	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	51.91	65.38	39.05
RB-8	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	52.62	64.25	40.08
RB-9	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	46.18	55.76	39.06
RB-10	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	44.51	56.92	39.74
RB-11	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	46.73	61.36	37.54
RB-12	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	46.17	60.10	37.46
RB-13	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	48.80	61.16	38.78
RB-14	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	48.71	63.10	39.22
RB-15	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	46.68	57.05	39.75
RB-16	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	37.70	56.04	38.14
RB-17	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	47.70	59.49	38.89
RB-18	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	52.32	60.15	41.24
RB-19	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	47.10	59.94	39.26
RB-20	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	48.88	63.75	39.35
RB-21	Double-crested Cormorant	5/1/2009	2009	Richmond Bridge	550313	4198962	6/1/2009	55.00	66.67	39.66
SB-1	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	51.98	63.10	39.08
SB-2	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	41.86	62.30	37.32
SB-3	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	45.38	65.73	37.53
SB-4	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	50.08	62.08	39.79
SB-5	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	52.21	63.85	41.34
SB-6	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	46.26	57.28	38.57
SB-7	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 37)	584543	4144235	6/9/2009	50.58	63.52	38.45
SB-8	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 38)	584531	4143896	6/9/2009	53.12	64.80	41.72
SB-9	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 38)	584531	4143896	6/9/2009	49.43	59.30	39.30
SB-10	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 38)	584531	4143896	6/9/2009	47.37	61.40	39.73
SB-11	Double-crested Cormorant	5/27/2009	2009	South Bay (Tower 38)	584531	4143896	6/9/2009	49.05	62.84	40.41
SB-12	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	48.30	65.38	39.03
SB-13	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	51.38	62.84	38.57
SB-14	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	51.91	61.34	39.21
SB-15	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	42.32	57.62	36.68
SB-16	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	55.01	64.28	39.68
SB-17	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	46.37	64.38	37.67
SB-18	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	42.10	60.62	36.28
SB-19	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	50.27	65.64	37.68
SB-20	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	43.31	64.04	34.70
SB-21	Double-crested Cormorant	5/24/2009	2009	South Bay (Tower 4/30)	580807	4145242	6/9/2009	53.37	61.18	40.39

Appendix 2. Forster's tern egg collection data and THg concentrations for eggs collected from San Francisco Bay, California in 2009.

Sample ID	COMPOSITE-ID	Egg [THg] (µg/g dw)	Egg [THg] (µg/g fww)	Sample Year	Colony	Collection Date (mm/dd/yyyy)	Whole Egg Mass (g)	Egg Length (mm)	Egg Width (mm)	UTM-Northing	UTM-Easting	Egg Content mass (g ww)	Egg Content mass (g dw)	% Moisture
9FE0039	A16-1	3.60	0.76	2009	A16	6/4/2009	18.09	45.24	29.49	591146	4144328	16.5538	4.1794	74.75
9FE0112	A16-1	6.17	1.27	2009	A16	6/4/2009	18.52	43.05	30.04	591146	4144328	16.8959	4.0101	76.27
9FE0113	A16-1	2.24	0.50	2009	A16	6/4/2009	18.53	42.15	30.36	591146	4144328	16.9710	4.3664	74.27
9FE0120	A16-1	3.77	0.83	2009	A16	6/4/2009	18.06	41.40	30.64	591146	4144328	16.5652	4.2828	74.15
9FE0175	A16-1	3.84	0.85	2009	A16	5/29/2009	19.95	44.10	31.05	591146	4144328	18.1543	4.6978	74.12
9FE0177	A16-1	5.05	1.16	2009	A16	5/29/2009	20.08	42.63	30.29	591146	4144328	18.4697	4.5448	75.39
9FE0180	A16-1	2.37	0.51	2009	A16	5/28/2009	20.08	43.61	31.38	591146	4144328	18.0969	4.5277	74.98
9FE0051	A16-2	4.35	0.96	2009	A16	5/29/2009	18.47	42.71	30.48	591146	4144328	16.7803	4.3463	74.10
9FE0110	A16-2	5.63	1.23	2009	A16	6/4/2009	19.30	41.89	31.19	591146	4144328	17.6025	4.4476	74.73
9FE0111	A16-2	3.11	0.68	2009	A16	6/4/2009	21.38	44.48	31.75	591146	4144328	19.5076	4.9111	74.82
9FE0174	A16-2	6.10	1.27	2009	A16	5/29/2009	18.28	42.39	30.66	591146	4144328	16.6437	4.1377	75.14
9FE0178	A16-2	14.92	3.34	2009	A16	5/29/2009	17.56	42.89	29.58	591146	4144328	15.9122	4.1702	73.79
9FE0179	A16-2	6.47	1.49	2009	A16	5/29/2009	17.81	40.84	30.46	591146	4144328	16.0595	4.3228	73.08
9FE0209	A16-2	2.86	0.60	2009	A16	6/11/2009	17.00	42.40	29.82	591146	4144328	15.3889	3.9476	74.35
9FE0033	A16-3	1.82	0.39	2009	A16	5/29/2009	19.90	41.98	31.45	591146	4144328	18.2650	4.4722	75.51
9FE0035	A16-3	33.04	7.25	2009	A16	6/4/2009	17.09	41.85	29.29	591146	4144328	15.4993	3.9148	74.74
9FE0036	A16-3	9.67	2.09	2009	A16	6/4/2009	18.71	43.12	30.28	591146	4144328	17.0347	4.2689	74.94
9FE0038	A16-3	14.42	3.21	2009	A16	6/4/2009	20.22	42.27	31.06	591146	4144328	18.3319	4.5083	75.41
9FE0094	A16-3	4.99	0.99	2009	A16	6/4/2009	20.60	44.37	31.25	591146	4144328	18.8785	4.2992	77.23
9FE0104	A16-3	3.48	0.78	2009	A16	6/4/2009	19.36	44.02	30.60	591146	4144328	17.7134	4.6347	73.84
9FE0109	A16-3	7.14	1.55	2009	A16	5/29/2009	20.33	43.04	32.09	591146	4144328	18.5549	4.8272	73.98
9FE0078	A2W-1	2.85	0.71	2009	A2W	5/12/2009	20.20	40.84	31.04	582356	4144411	17.6134	4.6870	73.39
9FE0085	A2W-1	6.67	1.50	2009	A2W	6/3/2009	17.41	41.75	29.70	582356	4144411	15.7082	4.1031	73.88
9FE0088	A2W-1	2.81	0.61	2009	A2W	5/19/2009	18.89	44.14	29.87	582356	4144411	17.2083	4.2887	75.08
9FE0095	A2W-1	3.52	0.78	2009	A2W	6/3/2009	18.36	41.99	30.17	582356	4144411	16.7175	4.2093	74.82
9FE0156	A2W-1	5.09	1.16	2009	A2W	5/27/2009	20.91	44.09	31.64	582356	4144411	19.2028	5.0710	73.59
9FE0157	A2W-1	4.79	1.11	2009	A2W	5/27/2009	18.07	41.04	30.52	582356	4144411	16.6948	4.4797	73.17
9FE0302	A2W-1	14.74	3.52	2009	A2W	6/17/2009	18.62	41.97	30.79	582356	4144411	17.2078	4.8056	72.07
9FE0006	A2W-2	2.33	0.49	2009	A2W	5/19/2009	20.07	43.45	30.89	582356	4144411	18.4229	4.4187	76.02
9FE0049	A2W-2	3.45	0.74	2009	A2W	5/27/2009	18.52	43.61	29.88	582356	4144411	17.0374	4.1919	75.40
9FE0061	A2W-2	4.07	0.97	2009	A2W	5/12/2009	19.53	45.62	28.91	582356	4144411	16.6290	4.2462	74.47
9FE0067	A2W-2	3.30	0.82	2009	A2W	5/12/2009	19.36	40.26	30.48	582356	4144411	16.7988	4.4193	73.69
9FE0070	A2W-2	5.15	1.14	2009	A2W	5/12/2009	18.24	42.32	29.94	582356	4144411	16.4185	4.1527	74.71
9FE0073	A2W-2	3.24	0.69	2009	A2W	5/19/2009	17.45	43.24	31.16	582356	4144411	15.7196	4.3976	72.02
9FE0079	A2W-2	3.27	0.73	2009	A2W	5/12/2009	19.47	43.22	29.63	582356	4144411	16.8578	4.0462	76.00
9FE0041	A2W-3	3.57	0.74	2009	A2W	6/10/2009	18.99	44.04	29.94	582356	4144411	17.2469	4.0807	76.34
9FE0076	A2W-3	5.69	1.37	2009	A2W	6/3/2009	19.30	41.81	30.59	582356	4144411	17.6593	4.7359	73.18
9FE0089	A2W-3	2.64	0.58	2009	A2W	6/3/2009	17.68	42.86	29.51	582356	4144411	15.9027	4.0186	74.73
9FE0091	A2W-3	4.67	1.00	2009	A2W	6/3/2009	17.65	43.47	29.77	582356	4144411	16.1161	4.1271	74.39
9FE0153	A2W-3	8.62	1.92	2009	A2W	5/27/2009	18.37	45.57	29.45	582356	4144411	16.5955	4.3584	73.74
9FE0155	A2W-3	3.87	0.95	2009	A2W	5/27/2009	17.99	40.70	30.62	582356	4144411	16.2319	4.6309	71.47
9FE0159	A2W-3	3.00	0.71	2009	A2W	5/27/2009	17.71	41.86	29.76	582356	4144411	16.0893	4.4016	72.64
9FE0050	AB2-1	5.25	1.11	2009	AB2	5/28/2009	20.15	41.88	31.63	584055	4143555	18.5366	4.4792	75.84
9FE0055	AB2-1	3.45	0.77	2009	AB2	5/28/2009	18.51	43.32	30.29	584055	4143555	16.7220	4.3822	73.79
9FE0058	AB2-1	5.62	1.21	2009	AB2	6/2/2009	17.26	42.54	29.16	584055	4143555	15.6039	3.8763	75.16
9FE0074	AB2-1	7.31	1.47	2009	AB2	5/20/2009	18.30	44.02	30.28	584055	4143555	16.7523	4.0572	75.78
9FE0108	AB2-1	12.25	2.60	2009	AB2	5/28/2009	18.03	43.68	29.63	584055	4143555	16.6613	4.1292	75.22
9FE0161	AB2-1	5.15	1.12	2009	AB2	5/28/2009	18.54	43.79	29.65	584055	4143555	16.8491	4.1835	75.17
9FE0164	AB2-1	4.21	0.94	2009	AB2	5/28/2009	20.13	44.92	30.43	584055	4143555	18.4964	4.6542	74.84
9FE0107	AB2-2	2.30	0.51	2009	AB2	5/28/2009	20.40	42.84	31.27	584055	4143555	18.7267	4.6279	75.29
9FE0160	AB2-2	3.59	0.74	2009	AB2	5/28/2009	20.40	44.23	31.05	584055	4143555	18.7671	4.4432	76.32
9FE0162	AB2-2	2.85	0.61	2009	AB2	5/28/2009	18.67	42.54	30.47	584055	4143555	16.9481	4.2081	75.17
9FE0167	AB2-2	13.87	3.06	2009	AB2	5/28/2009	18.03	43.63	29.65	584055	4143555	16.4463	4.2351	74.25
9FE0168	AB2-2	1.77	0.38	2009	AB2	5/28/2009	20.08	44.14	30.77	584055	4143555	18.1919	4.5089	75.21
9FE0169	AB2-2	2.62	0.60	2009	AB2	5/28/2009	17.16	42.04	29.36	584055	4143555	15.6451	4.1058	73.76
9FE0173	AB2-2	4.87	1.04	2009	AB2	5/28/2009	18.20	40.32	30.58	584055	4143555	16.6287	4.0251	75.79
9FE0059	AB2-3	3.99	0.86	2009	AB2	6/2/2009	19.86	42.70	31.33	584055	4143555	18.0967	4.4917	75.18
9FE0106	AB2-3	4.24	0.89	2009	AB2	5/28/2009	17.80	44.74	29.69	584055	4143555	16.0548	4.0917	74.51
9FE0163	AB2-3	24.52	5.61	2009	AB2	5/28/2009	17.84	42.19	29.97	584055	4143555	16.1286	4.2957	73.37
9FE0165	AB2-3	3.92	0.83	2009	AB2	5/28/2009	20.61	43.80	31.62	584055	4143555	18.7652	4.6089	75.44
9FE0166	AB2-3	3.98	0.83	2009	AB2	5/28/2009	19.32	43.71	30.87	584055	4143555	17.4018	4.2668	75.48
9FE0171	AB2-3	3.52	0.71	2009	AB2	5/28/2009	16.78	41.36	29.35	584055	4143555	15.4312	3.6112	76.60
9FE0172	AB2-3	4.06	0.90	2009	AB2	5/28/2009	18.13	42.57	29.48	584055	4143555	16.5291	4.0838	75.29

Appendix 2 – continued.

Sample ID	COMPOSITE-ID	Egg [THg] (µg/g dw)	Egg [THg] (µg/g fww)	Sample Year	Colony	Collection Date (mm/dd/yyyy)	Whole Egg Mass (g)	Egg Length (mm)	Egg Width (mm)	UTM-Northing	UTM-Easting	Egg Content mass (g ww)	Egg Content mass (g dw)	% Moisture
9FE0003	EL-1	4.55	1.01	2009	Eden Landing	5/22/2009	20.57	43.88	31.02	578539	4159713	18.3976	4.6015	74.99
9FE0004	EL-1	4.29	0.93	2009	Eden Landing	5/22/2009	19.92	44.25	30.77	578539	4159713	18.2905	4.5490	75.13
9FE0010	EL-1	5.33	1.18	2009	Eden Landing	5/22/2009	19.57	43.12	30.18	578539	4159713	17.6785	4.3045	75.65
9FE0014	EL-1	4.21	0.87	2009	Eden Landing	5/22/2009	21.31	46.29	30.59	578539	4159713	19.1399	4.4245	76.88
9FE0017	EL-1	3.75	0.76	2009	Eden Landing	5/22/2009	19.60	41.99	30.95	578539	4159713	17.8512	4.0893	77.09
9FE0018	EL-1	3.48	0.76	2009	Eden Landing	5/22/2009	18.82	43.03	30.17	578539	4159713	17.2002	4.2747	75.15
9FE0027	EL-1	4.12	0.85	2009	Eden Landing	5/22/2009	17.94	40.67	29.80	578539	4159713	15.4854	3.5115	77.32
9FE0007	EL-2	5.07	1.11	2009	Eden Landing	5/22/2009	19.90	42.73	31.16	578539	4159713	18.2592	4.5693	74.98
9FE0009	EL-2	4.44	0.98	2009	Eden Landing	5/22/2009	17.73	41.09	29.40	578539	4159713	15.8169	3.8433	75.70
9FE0020	EL-2	4.67	1.00	2009	Eden Landing	5/22/2009	18.62	41.24	30.56	578539	4159713	16.8858	4.1152	75.63
9FE0023	EL-2	3.37	0.71	2009	Eden Landing	5/22/2009	18.06	43.40	29.22	578539	4159713	16.4786	3.8819	76.44
9FE0026	EL-2	3.43	0.76	2009	Eden Landing	5/22/2009	19.04	43.09	29.66	578539	4159713	17.1864	4.1438	75.89
9FE0028	EL-2	5.15	1.14	2009	Eden Landing	5/22/2009	18.82	44.95	29.28	578539	4159713	16.7177	4.1519	75.16
9FE0029	EL-2	2.77	0.61	2009	Eden Landing	5/22/2009	18.01	41.04	29.59	578539	4159713	16.4463	3.9726	75.85
9FE0013	EL-3	42.35	9.03	2009	Eden Landing	5/22/2009	18.51	43.13	29.02	578539	4159713	16.6577	3.8202	77.07
9FE0025	EL-3	5.83	1.28	2009	Eden Landing	5/22/2009	20.42	43.10	31.05	578539	4159713	18.3794	4.4987	75.52
9FE0031	EL-3	7.26	1.57	2009	Eden Landing	5/22/2009	19.27	42.86	30.40	578539	4159713	17.4921	4.2699	75.59
9FE0324	EL-3	5.01	1.04	2009	Eden Landing	6/19/2009	21.67	43.39	31.23	578539	4159713	19.7059	4.3884	77.73
9FE0326	EL-3	4.55	1.08	2009	Eden Landing	6/19/2009	16.37	41.30	28.85	578539	4159713	14.7313	4.0096	72.78
9FE0330	EL-3	4.25	0.91	2009	Eden Landing	6/19/2009	20.23	44.61	31.06	578539	4159713	18.5084	4.6234	75.02
9FE0349	EL-3	5.05	1.02	2009	Eden Landing	6/19/2009	18.56	42.48	30.30	578539	4159713	17.0448	3.9829	76.63
9FE8021	HS-1	4.93	1.07	2009	Hayward Shoreline	5/27/2009	19.92	44.39	30.25	575155	4164927	18.1044	4.3981	75.71
9FE8022	HS-1	3.14	0.66	2009	Hayward Shoreline	5/27/2009	18.59	43.32	29.86	575155	4164927	16.9705	4.0490	76.14
9FE8024	HS-1	2.11	0.50	2009	Hayward Shoreline	5/27/2009	19.76	40.68	30.81	575155	4164927	17.8493	4.5148	74.71
9FE8026	HS-1	2.71	0.59	2009	Hayward Shoreline	5/27/2009	17.75	43.87	29.07	575155	4164927	16.3816	4.0467	75.30
9FE8028	HS-1	3.89	0.88	2009	Hayward Shoreline	5/27/2009	23.12	43.93	31.77	575155	4164927	21.1242	5.0096	76.29
9FE8029	HS-1	2.99	0.70	2009	Hayward Shoreline	5/27/2009	19.02	44.17	30.35	575155	4164927	17.3473	4.7609	72.56
9FE8030	HS-1	3.13	0.65	2009	Hayward Shoreline	5/27/2009	18.60	43.45	29.46	575155	4164927	16.9276	3.9316	76.77
9FE8025	HS-2	2.45	0.54	2009	Hayward Shoreline	5/27/2009	19.58	42.08	31.30	575155	4164927	17.1136	4.3313	74.69
9FE8032	HS-2	3.20	0.70	2009	Hayward Shoreline	5/27/2009	19.11	43.00	30.00	575155	4164927	17.3621	4.2462	75.54
9FE8033	HS-2	3.91	0.87	2009	Hayward Shoreline	5/27/2009	19.67	44.83	29.82	575155	4164927	17.8887	4.4401	75.18
9FE8036	HS-2	4.28	0.97	2009	Hayward Shoreline	5/27/2009	19.64	41.49	30.56	575155	4164927	17.8377	4.3729	75.49
9FE8037	HS-2	2.90	0.71	2009	Hayward Shoreline	5/27/2009	18.58	43.21	29.56	575155	4164927	16.9703	4.6134	72.81
9FE8040	HS-2	2.66	0.61	2009	Hayward Shoreline	5/27/2009	17.04	41.25	28.64	575155	4164927	15.4339	3.8416	75.11
9FE8041	HS-2	2.54	0.56	2009	Hayward Shoreline	5/27/2009	19.61	43.17	30.36	575155	4164927	17.8910	4.4081	75.36
9FE8023	HS-3	2.90	0.61	2009	Hayward Shoreline	5/27/2009	19.57	42.12	31.21	575155	4164927	17.8481	4.3336	75.72
9FE8027	HS-3	2.64	0.61	2009	Hayward Shoreline	5/27/2009	21.39	41.65	31.33	575155	4164927	19.4170	4.6915	75.84
9FE8031	HS-3	3.11	0.70	2009	Hayward Shoreline	5/27/2009	21.93	43.12	32.02	575155	4164927	20.0584	4.9642	75.25
9FE8034	HS-3	5.57	1.28	2009	Hayward Shoreline	5/27/2009	19.06	41.97	29.85	575155	4164927	17.4073	4.2934	75.34
9FE8035	HS-3	5.92	1.44	2009	Hayward Shoreline	5/27/2009	22.43	43.83	31.68	575155	4164927	20.5407	5.3866	73.78
9FE8038	HS-3	2.98	0.66	2009	Hayward Shoreline	5/27/2009	18.04	42.28	29.04	575155	4164927	16.4609	3.9359	76.09
9FE8039	HS-3	12.19	2.66	2009	Hayward Shoreline	5/27/2009	18.54	41.51	29.17	575155	4164927	16.7593	3.8120	77.25
9FE8001	NM-1	3.78	0.80	2009	Napa Marsh	5/29/2009	20.52	46.10	30.16	558849	4223942	18.9569	4.4824	76.35
9FE8011	NM-1	3.24	0.78	2009	Napa Marsh	5/26/2009	18.18	40.89	29.61	558849	4223942	16.2768	4.2028	74.18
9FE8013	NM-1	3.97	0.83	2009	Napa Marsh	5/26/2009	22.22	44.13	32.02	558849	4223942	20.3259	4.7215	76.77
9FE8015	NM-1	4.46	1.00	2009	Napa Marsh	5/26/2009	18.83	43.62	29.39	558849	4223942	16.9792	4.1598	75.50
9FE8017	NM-1	3.37	0.75	2009	Napa Marsh	5/26/2009	20.09	41.64	30.58	558849	4223942	18.0002	4.2583	76.34
9FE8018	NM-1	3.35	0.71	2009	Napa Marsh	5/26/2009	20.92	44.21	31.11	558849	4223942	19.1184	4.5380	76.26
9FE8019	NM-1	40.11	9.12	2009	Napa Marsh	5/26/2009	18.13	42.61	29.26	558849	4223942	16.2556	4.0755	74.93
9FE8000	NM-2	7.72	1.65	2009	Napa Marsh	5/26/2009	17.96	43.22	29.87	558849	4223942	15.1822	3.8189	74.85
9FE8002	NM-2	4.81	1.02	2009	Napa Marsh	5/26/2009	20.16	41.89	31.52	558849	4223942	18.4148	4.4017	76.10
9FE8003	NM-2	5.28	1.18	2009	Napa Marsh	5/29/2009	19.90	42.44	30.18	558849	4223942	17.9369	4.2569	76.27
9FE8005	NM-2	6.51	1.36	2009	Napa Marsh	5/26/2009	20.68	43.84	30.74	558849	4223942	18.6712	4.2709	77.13
9FE8006	NM-2	2.84	0.65	2009	Napa Marsh	5/26/2009	20.29	43.84	30.80	558849	4223942	18.4347	4.7653	74.15
9FE8007	NM-2	3.48	0.74	2009	Napa Marsh	5/26/2009	21.12	42.92	31.26	558849	4223942	19.0980	4.4226	76.84
9FE8016	NM-2	2.63	0.58	2009	Napa Marsh	5/26/2009	19.09	43.63	29.92	558849	4223942	17.3350	4.2799	75.31
9FE8004	NM-3	4.72	1.04	2009	Napa Marsh	5/26/2009	20.36	43.72	30.87	558849	4223942	18.5664	4.5812	75.33
9FE8008	NM-3	3.50	0.77	2009	Napa Marsh	5/26/2009	15.91	42.24	29.28	558849	4223942	14.2798	3.9206	72.54
9FE8009	NM-3	3.05	0.68	2009	Napa Marsh	5/26/2009	21.50	44.60	30.79	558849	4223942	19.3965	4.6456	76.05
9FE8010	NM-3	2.64	0.56	2009	Napa Marsh	5/26/2009	22.18	43.72	32.23	558849	4223942	20.1805	4.7934	76.25
9FE8012	NM-3	4.49	0.95	2009	Napa Marsh	5/25/2009	20.01	42.39	30.75	558849	4223942	17.9842	4.1951	76.67
9FE8014	NM-3	2.29	0.46	2009	Napa Marsh	5/26/2009	16.85	45.53	29.51	558849	4223942	15.2086	3.9273	74.18
9FE8020	NM-3	2.44	0.56	2009	Napa Marsh	5/26/2009	19.87	42.72	30.73	558849	4223942	17.7632	4.5172	74.57

Appendix 3. QA/QC results for THg analyses in Forster's tern eggs collected from San Francisco Bay, California in 2009.

QA/QC Results:

BLANKS

Sample ID	[Hg] (ug/g)	Analysis date
System blank	0.0034	90109
Method blank	0.0018	90109
System blank	0.0091	91109
Method blank	0.0037	91109
System blank	0.0040	90109
Method blank	0.0036	90109
System blank	0.0020	90209
Method blank	0.0020	90209
System blank	0.0066	90809
Method blank	0.0058	90809
System blank	0.0026	90409
Method blank	0.0030	90409
System blank	0.0060	90909
Method blank	0.0060	90909
System blank	0.0067	91009
Method blank	0.0061	91009
System blank	0.0050	92109
Method blank	0.0051	92109

STANDARD REFERENCE MATERIAL

Analysis date	Sample ID	[Hg] (ug/g) dw	Certified Value	CRM %Recovery
90109	DOLT-3	**3.2885**	3.37	**97.58**
91109	DOLT-3	**3.5536**	3.37	**105.45**
90109	DOLT-3	**3.3371**	3.37	**99.02**
90209	DOLT-3	**3.3502**	3.37	**99.41**
90809	DOLT-3	**3.5027**	3.37	**103.94**
91009	DOLT-3	**3.4843**	3.37	**103.39**
92109	DOLT-3	**3.5635**	3.37	**105.74**
90109	DORM-2	**4.5001**	4.64	**96.99**
91109	DORM-2	**4.9407**	4.64	**106.48**
90109	DORM-2	**4.4440**	4.64	**95.78**
90209	DORM-2	**4.5707**	4.64	**98.51**
90809	DORM-2	**4.1192**	4.64	**88.78**
90409	DORM-2	**4.6697**	4.64	**100.64**
90909	DORM-2	**4.5972**	4.64	**99.08**
91009	DORM-2	**4.4103**	4.64	**95.05**
92109	DORM-2	**4.5433**	4.64	**97.92**

Appendix 3 – Continued.

MARTIX SPIKE RESULTS

			Amount spiked (ng Hg)	100.00
9/1/2009	9/1/2009		9FE8009	62.7339
			9FE8009 + spike	163.2293
			Amount recovered	100.4954
			Percent recovered	100.4954
			Amount spiked (ng Hg)	100.00
9/1/2009	9/1/2009		9FE8009	62.7339
			9FE8009 + spike	161.4833
			Amount recovered	98.7494
			Percent recovered	98.7494
			RPD	1.7526
			Amount spiked (ng Hg)	100.00
9/2/2009	9/2/2009		9FE0091	93.4511
			9FE0091 + spike	195.9118
			Amount recovered	102.4607
			Percent recovered	102.4607
			Amount spiked (ng Hg)	100.00
9/2/2009	9/2/2009		9FE0091	93.4511
			9FE0091 + spike	192.4759
			Amount recovered	99.0248
			Percent recovered	99.0248
			RPD	3.4106
			Amount spiked (ng Hg)	100.00
9/4/2009	9/4/2009		9FE0094	158.3225
			9FE0094 + spike	247.2565
			Amount recovered	88.9339
			Percent recovered	88.9339
			Amount spiked (ng Hg)	100.00
9/4/2009	9/4/2009		9FE0094	158.3225
			9FE0094 + spike	243.1635
			Amount recovered	84.8410
			Percent recovered	84.8410
			RPD	4.7106
			Amount spiked (ng Hg)	100.00
9/9/2009	9/9/2009		9FE0107	73.5867
			9FE0107 + spike	179.4502
			Amount recovered	105.8635
			Percent recovered	105.8635
			Amount spiked (ng Hg)	100.00
9/9/2009	9/9/2009		9FE0107	73.5867
			9FE0107 + spike	177.9103
			Amount recovered	104.3236
			Percent recovered	104.3236
			RPD	1.4653
			Amount spiked (ng Hg)	100.00
9/21/2009	9/21/2009		9FE0020	170.8854
			9FE0020 + spike	254.7823
			Amount recovered	83.8970
			Percent recovered	83.8970
			Amount spiked (ng Hg)	100.00
9/21/2009	9/21/2009		9FE0020	170.8854
			9FE0020 + spike	251.8142
			Amount recovered	80.9288
			Percent recovered	80.9288
			RPD	3.6016

Appendix 3 – Continued.

REPLICATE ANALYSES

Analysis Date		Sample ID	[Hg] (ug/g) dw
9/1/2009		9FE8003-r1	5.2790
9/1/2009		9FE8003-r2	5.2387
		RPD	0.7655
9/1/2009		9FE8009-r1	3.0453
9/1/2009		9FE8009-r2	3.3566
		RPD	9.7238
9/1/2009		9FE8010-r1	2.6382
9/1/2009		9FE8010-r2	2.7798
		RPD	5.2285
9/1/2009		9FE8015-r1	4.4568
9/1/2009		9FE8015-r2	4.5220
		RPD	1.4520
9/1/2009		9FE8019-r1	40.1096
9/1/2009		9FE8019-r2	39.4204
		RPD	1.7331
9/1/2009		9FE8022-r1	3.1415
9/1/2009		9FE8022-r2	2.9841
		RPD	5.1421
9/1/2009		9FE8026-r1	2.7128
9/1/2009		9FE8026-r2	2.8683
		RPD	5.5691
9/11/2009		9FE8032-r1	3.1971
9/11/2009		9FE8032-r2	2.8510
		RPD	11.4425
9/11/2009		9FE8041-r1	2.5412
9/11/2009		9FE8041-r2	2.5487
		RPD	0.2950
9/1/2009		9FE0041-r1	3.5701
9/1/2009		9FE0041-r2	3.5102
		RPD	1.6927
9/1/2009		9FE0061-r1	4.0730
9/1/2009		9FE0061-r2	4.2751
		RPD	4.8414
9/2/2009		9FE0067-r1	3.2959
9/2/2009		9FE0067-r2	3.5146
		RPD	6.4240
9/2/2009		9FE0078-r1	2.8496
9/2/2009		9FE0078-r2	2.7526
		RPD	3.4630
9/2/2009		9FE0089-r1	2.6396
9/2/2009		9FE0089-r2	2.5787
		RPD	2.3354
9/2/2009		9FE0091-r1	4.6726
9/2/2009		9FE0091-r2	4.2754
		RPD	8.8777
9/2/2009		9FE0302-r1	14.7435
9/2/2009		9FE0302-r2	15.6440
		RPD	5.9263
9/4/2009		9FE0036-r1	9.6710
9/4/2009		9FE0036-r2	10.0806
		RPD	4.1469
9/4/2009		9FE0094-r1	4.9944
9/4/2009		9FE0094-r2	4.7087
		RPD	5.8890
9/4/2009		9FE0179-r1	6.4685
9/4/2009		9FE0179-r2	6.5604
		RPD	1.4106
9/9/2009		9FE0107-r1	2.2996
9/9/2009		9FE0107-r2	2.6094
		RPD	12.6231
9/9/2009		9FE0162-r1	2.8459
9/9/2009		9FE0162-r2	3.2048
		RPD	11.8620
9/9/2009		9FE0171-r1	3.5216
9/9/2009		9FE0171-r2	3.6747
		RPD	4.2556
9/10/2009		9FE0029-r1	2.7650
9/10/2009		9FE0029-r2	2.9837
		RPD	7.6073
9/21/2009		9FE0003-r1	4.5494
9/21/2009		9FE0003-r2	4.4066
		RPD	3.1873
9/21/2009		9FE0014-r1	4.2134
9/21/2009		9FE0014-r2	3.6899
		RPD	13.2461
9/21/2009		9FE0020-r1	4.6690
9/21/2009		9FE0020-r2	4.4983
		RPD	3.7250