

APPENDIX C: PROTOCOLS FOR DIOXIN AND  
FURAN SEDIMENT SAMPLING IN THE  
GREATER SEATTLE AREA, AND TABLE  
OUTLINING THE SELECTION OF SAMPLES  
FOR PCB CONGENER ANALYSES

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# Lower Duwamish Waterway Group

*Port of Seattle / City of Seattle / King County / The Boeing Company*

## MEMORANDUM

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To: EPA and Ecology  
From: LDWG  
Subject: Sampling protocols at dioxin background locations (FINAL)  
Date: January 28, 2005

As a supplement to the final Quality Assurance Project Plan (QAPP) for surface sediment sampling (Windward 2005), this memorandum describes more specific protocols for sampling sediments at urban background locations described in Appendix E for dioxin/furan analyses. These protocols have been approved by EPA.

At least one composite sediment sample will be collected at each of nine different locations (see Figure E-1 in the QAPP). Each composite sample will consist of six separate grab samples. One composite sample will be collected at Locations 3, 4, 6, 7, and 8. Two composite samples will be collected at Locations 1a/1b, 2a/2b, 5a/5b, and 9a/9b, as described below.

The sampling design at each of the nine locations is dependent on whether the location was selected in association with a specific outfall or whether the location was selected to characterize a general area. Locations 1a/1b, 2a/2b, 5a/5b, 8, and 9a/9b are located near specific outfalls (see Table E-5 in the QAPP). Locations 3, 4, 6, and 7 are not necessarily associated with specific outfalls.

At locations with outfalls, sampling will be conducted at a distance of approximately 30 to 50 feet from the outfall. Three grabs will be collected at approximately 30 feet from the outfall along an arc at this distance, and three grabs will be collected at approximately 50 feet from the outfall (see Figure 1 for the sampling design at Location 1a/1b, as an example). These six grabs will be combined into a single composite sample. This arc pattern represents general guidance to ensure that samples are collected within this general area, but samples may be collected in a more random pattern at a specific location if site-specific constraints are encountered. At locations with an "a/b" designation, the "a" composite sample will be collected as described above. The "b" composite sample will consist of three grabs collected at approximately 100 feet and three grabs collected at approximately 120 feet from the outfall (Figure 1). These six grabs will be combined to make the "b" composite sample. A 8-oz glass jar and two 1-L glass jars will be filled with homogenized sediment from each composite location.

The specified distances from the outfall (e.g., 30 feet) are approximate and will be based on the % gravel measured in the field at each location (see Section E.3.1 in the QAPP). The intent is to capture general runoff that is mixed with other local sedimentary material within an area affected by the discharge. The following guidelines will be followed by field personnel to determine, for each location, the most appropriate sampling area.

- ◆ Grab samples to be included in the “a” composite sample should contain less than 50% gravel (i.e., material retained on a 2 mm sieve). If a grab contains greater than 50% gravel, the grab will be discarded and additional samples will be collected 5 to 10 feet further from the outfall until grab samples with finer materials (including some sand)<sup>1</sup> are obtained.<sup>2</sup>
- ◆ Grab samples to be included in the “b” composite sample should contain material representative of the general receiving environment. For example, samples collected in Lake Union will be finer muds.

At locations without an associated outfall, the six grab samples will be collected according to a general grid pattern (see Figure 2 for the design at Location 4, as an example). These six grabs will be composited into a single sediment sample. Percent gravel will not be determined in these grabs.

At each sampling location, the field crew will record the following information:

- ◆ GPS coordinates of each grab sample included in a composite sample
- ◆ Receiving environment conditions, such as general water flow, based on visual observation
- ◆ If near an outfall, whether the outfall was observed to be flowing at the time of sampling and whether a turbidity plume is observed<sup>3</sup>
- ◆ A detailed description of each grab sample included in composite samples near outfalls, including qualitative grain size information as determined through the use of the 2 mm sieve

Digital photographs will also be taken at each sampling location. All other protocols described in the surface sediment QAPP will be followed (see Appendix E of Windward 2005).

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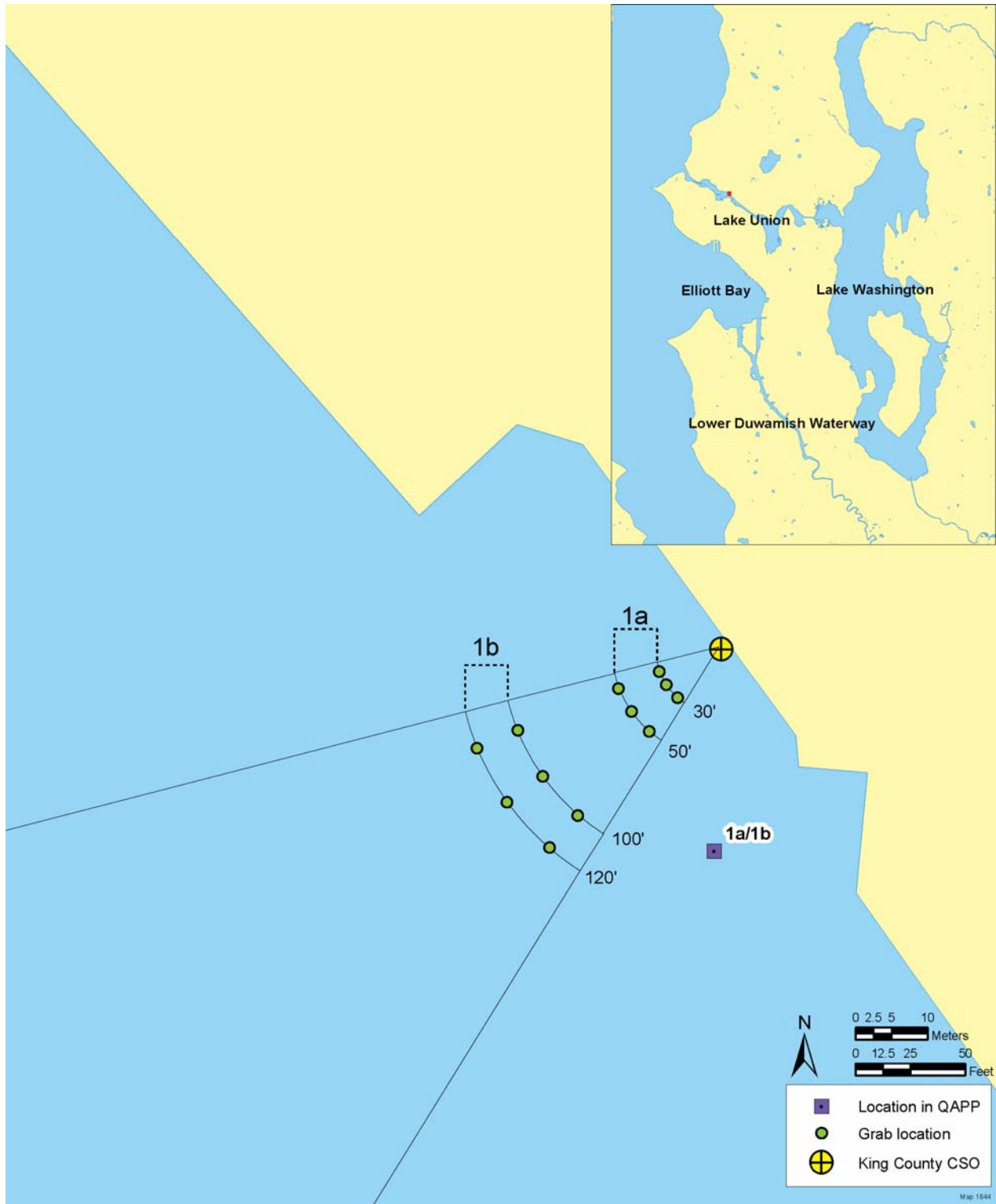
<sup>1</sup> Note that at combined sewer overflow (CSO) locations 1ab and 8, the material close to the drain may be more of a floc than gravel

<sup>2</sup> Percent gravel will be assessed on a split from each grab

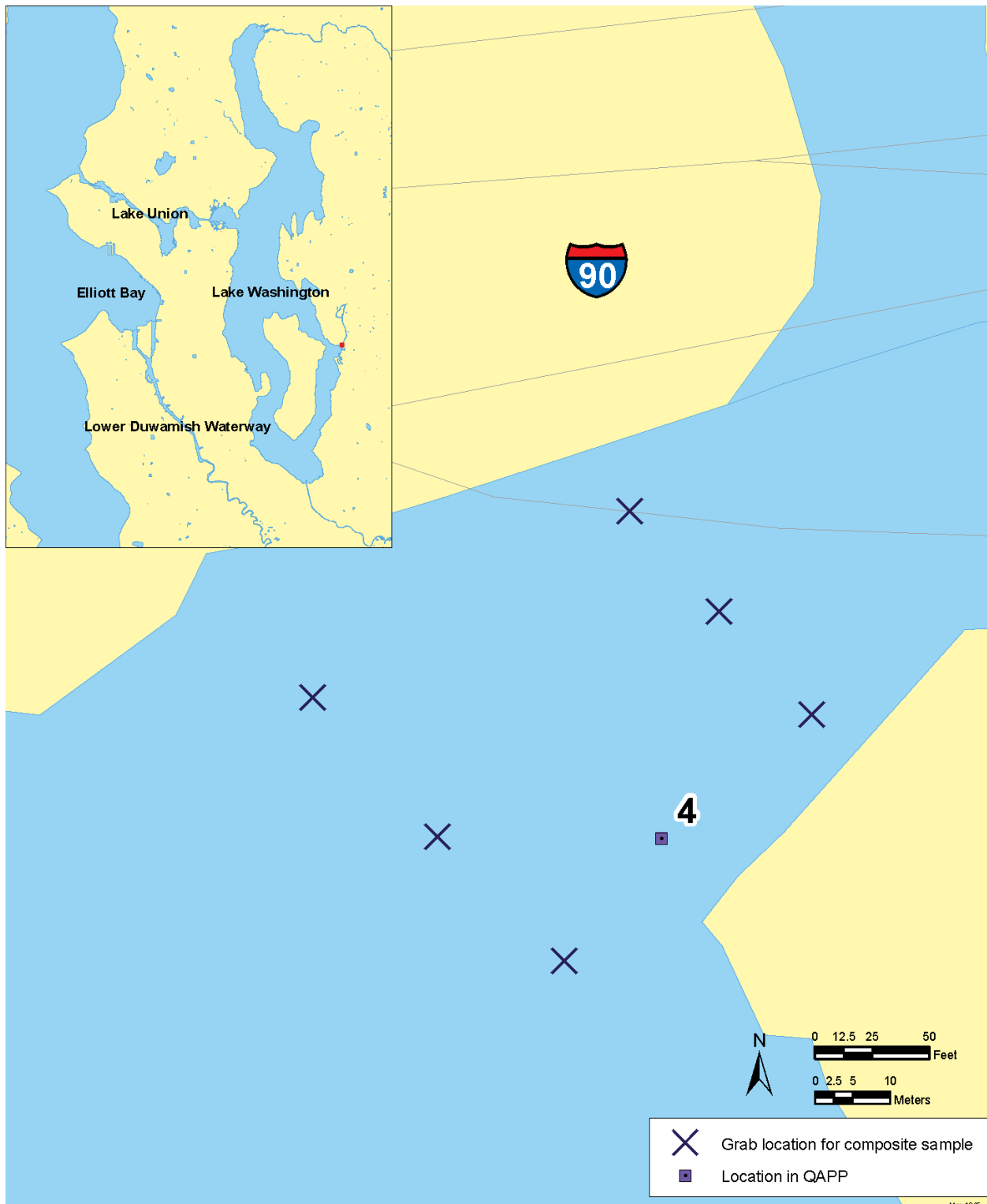
<sup>3</sup> If a plume is observed, the centerline of the “arc” sampling will be aligned with the path of the turbidity plume

## REFERENCES

Windward. 2005. Lower Duwamish Waterway remedial investigation. Quality assurance project plan: Surface sediment sampling for chemical analyses and toxicity testing of the Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.



**Figure 1. Grab sampling design for composite sediment samples at Location 1a/1b**



**Figure 2. Grab sampling design for composite sediment samples at Location 4**

Criteria considered in selecting locations for PCB congener analysis

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
1	1	0.00	161 J							
2	2	0.00	240							
3	2	0.00	76							
4	1	0.05	153 J							
5	1	0.02	20 U							
6	2	0.06	1920				>33% 1242 or 1248		X	
7	2	0.10	240							
8	2	0.12	250							near B1b with congener data
9	2	0.13	119		X	h;h				near C1 with congener data; intertidal
10	1	0.20	31					SS (1A)		SS covered by C1 and 14
11	2	0.25	73 J							
12	1	0.22	171 J					SS (1A)		SS covered by C1 and 14
13	1	0.29	191 J							
14	1	0.28	50 J	yes		h;p	> 50% 1242 or 1248	SS (1A)	X	intertidal
15	1	0.30	128 J					SS (1A)		SS covered by C1 and 14
16	2	0.29	320					SS (1A)		SS covered by C1 and 14
17	1	0.33	120						X	spatial coverage
19	2	0.42	220					SS (1A)	X	SS covered by location 14
21	2	0.43	420					SS (1A)		SS covered by C1 and 14
22	1	0.52	250 J	yes			>33% 1242 or 1248	PS (1D)		PS covered by 25
23	1	0.54	60							
24	2	0.53	290		X	h;h			X	intertidal
25	2	0.63	19 U		X	h;h		PS (1D)	X	intertidal
26	1	0.72	650				>33% 1242 or 1248	PS and SS (1F)		PS/SS covered by B2b
27	1	0.80	97 J			h;p		PS and SS (1F)		PS/SS covered by 31; intertidal
28	1	0.74	112	yes	X	h;h			X	intertidal
29	2	0.82	123			h;h				sandpiper covered by 28; intertidal
30	2	0.94	240					PS and SS (1F)		PS/SS covered by B3b
31	1	0.99	96					PS and SS (1F)		near B3b with congener data
32	1	0.99	122 J					PS and SS (1F)		near B3b with congener data
33	1	0.93	26			h;h				near B2a with congener data; intertidal
34	2	0.94	19 U							
35	2	0.99	650							

Criteria considered in selecting locations for PCB congener analysis

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
36	1	0.99	24	yes		marginal btwn h;h & n;n				intertidal?
37	1	1.04	5100	yes					X	
38	1	1.08	115							
39	2	1.10	230			h;n to S, n;n to N				intertidal
40	1	1.18	510 J							
41	2	1.18	198							
42	1	1.23	108							
43	1	1.23	18 J	yes						
44	1	1.28	103 J							
45	2	1.29	290							
46	2	1.30	240						X	
47	2	1.32	70							
48	1	1.34	131 J							
49	1	1.37	70							
50	1	1.40	590 J				>33% 1242 or 1248			near B4b with congener data
51	1	1.39	155 J							near B4b with congener data
52	1	1.41	209							near B4b with congener data
53	2	1.39	220							near B4b with congener data
54	1	1.42	91							near B4b with congener data
55	1	1.42	24 J							
56	1	1.43	750 J	yes		h;p			X	near C4 with congener data; intertidal
57	1	1.47	750	yes		h;p				near C4 with congener data; intertidal
58	1	1.48	260	yes		h;p				intertidal
59	2	1.52	53	yes						
60	1	1.58	250 J			p;n				intertidal
61	2	1.60	62					SS (2B)		SS covered by 64 and 67
62	2	1.59	340							
63	1	1.66	95					SS (2B)		SS covered by 64 and 67
64	1	1.66	127	yes				SS (2B)	X	
65	2	1.69	141 J					SS (2B)		SS covered by 64 and 67
66	2	1.68	270							
67	1	1.73	36			p;n		SS (2B)	X	intertidal



Criteria considered in selecting locations for PCB congener analysis

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
68	2	1.79	193							
69	2	1.81	340					SS (2B)		SS covered by 64 and 67
70	1	1.86	96							
71	2	1.91	460	yes		n;n	>33% 1242 or 1248		X	intertidal
72	1	1.93	82 J					PS (2C)	X	
73	2	2.02	230							
74	2	2.00	166						X	
75	1	1.97	520					PS (2C)		PS covered by 72
76	1	2.03	117							
77	2	2.08	70							
78	2	2.08	110				>33% 1242 or 1248			
79	1	2.05	68				>33% 1242 or 1248			
81	2	2.19	210					PS (2F)		PS covered by 83
82	2	2.19	200					SS (2E)		SS covered by 84 and 86
83	1	2.34	97 J	yes				PS (2F)	X	
84	1	2.21	23000	yes		h;p	>50% 1242 or 1248	SS (2E)	X	near B5a with congener data; intertidal
85	2	2.32	630			n;n		SS (2E)		SS covered by 84 and 86; intertidal
86	2	2.34	24			n;n		SS (2E)	X	intertidal
87	1	2.50	72							
88	1	2.59	660 J			h;p				intertidal
89	1	2.64	1800							
90	2	2.60	54			p;n				intertidal
91	2	2.62	170			p;n				intertidal
92	1	2.74	970 J		X	h;p	1242, 1248, 1254, and 1260		X	intertidal
93	2	2.70	130			p;n				intertidal
94	1	2.78	72		X					
95	2	2.73	198				>33% 1242 or 1248			
96	1	2.84	24							
97	1	2.83	81		X					near C9 with congener data
98	2	2.91	72 J			p;n				intertidal
99	1	2.98	20 U							
100	2	3.02	72		X	p;n				intertidal
101	1	3.03	20 U		X	p;n			X	intertidal

**Criteria considered in selecting locations for PCB congener analysis**

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
102	1	3.08	74		X	p;n				intertidal
103	2	3.09	80		X	p;n				intertidal
104	1	3.16	75		X	p;n		SS (3A/3C)		SS covered by 106; intertidal
105	2	3.23	46		X	p;n		SS (3C)		SS covered by 106; intertidal
106	2	3.28	210		X	p;n		SS (3C)	X	intertidal
107	2	3.37	121		X	n;n		SS (3C)		SS covered by 106; intertidal
108	2	3.46	128					PS and SS (3E)	X	
109	1	3.59	110000	yes		p;n		SS (3F)	X	near B8a with congener data; intertidal
110	1	3.67	13000 J	no		p;n		SS (3F)	X	intertidal
111	1	3.68	3200 J			p;n		SS (3F)		SS covered by 109 and 110; intertidal
112	1	3.72	470			p;n				intertidal
113	2	3.73	18 J							
114	1	3.76	820			p;n				intertidal
115	1	3.79	220			h;n				intertidal
116	1	3.82	157 J			h;n				intertidal
117	1	3.81	79 J			p;n				intertidal
118	1	3.82	24							
119	1	3.85	880 J			h;n				intertidal
120	1	3.89	630 J			h;n			X	spatial coverage and SP habitat; intertidal
121	1	3.91	1060 J	no		h;n				intertidal
122	2	3.90	370			p;n				intertidal
123	1	3.93	149	yes		h;n				near B9b with congener data; intertidal
124	2	4.00	19 U			n;n				intertidal
125	1	4.05	19 U			h;n				intertidal
126	1	4.10	20 U			h;n				intertidal
127	1	4.16	58	yes				SS (4B)		SS covered by 130
128	1	4.17	20 U					SS (4B)		SS covered by 130
129	1	4.18	19 U					SS (4B)		SS covered by 130
130	1	4.20	26					SS (4B)	X	
131	2	4.17	22 J	yes		n;n				intertidal
132	2	4.30	127					SS (4B)		SS covered by 130
133	2	4.23	36 J			n;n				intertidal
134	1	4.27	19 U							

Criteria considered in selecting locations for PCB congener analysis

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
135	2	4.29	240			h;h				intertidal
136	2	4.33	19 U		X	h;h			X	intertidal
137	2	4.37	78 J			n;n		SS (4B)		SS covered by 130; intertidal
138	2	4.43	17 J			h;n		SS (4B)		SS covered by 130; intertidal
139	2	4.42	20 U			n;p				intertidal
140	2	4.48	20 U							
141	2	4.56	20 U		X	h;p		PS (4C)	X	intertidal
142	1	4.80	162 J			n;n		PS and SS (4D)	X	intertidal
143	1	4.85	2700	yes		n;n	100% 1242		X	intertidal
144	2	4.90	480	no		n;n	>33% 1242 or 1248			intertidal
145	2	4.85	20 U			h;h				intertidal?
146	2	4.78	20 U			h;h		PS (4C)		PS covered by 141 and 149; intertidal
147	2	4.64	20 U			h;h		PS (4C)		PS covered by 141 and 149; intertidal
148	2	4.74	520			h;h		PS (4C)		PS covered by 141 and 149; near B10a with congener data; intertidal
149	2	4.68	98		X	h;h	>50% 1242 or 1248	PS (4C)	X	PS covered by 141 and 149; intertidal
150	2	4.72	54			h;h		PS (4C)		PS covered by 141 and 149; intertidal
151	2	5.05	19 U							
152	2	5.14	19 U							
153	2	5.26	20 U							
154	2	5.56	19 U							
155	2	5.66	19 U		X					
156	2	5.79	19 U		X					
157	2	3.79	260							
158	2	3.79	390 J							
159	2	3.82	173							
B2b	2	0.83	790				>50% 1242 or 1248		X	
B4a	2	1.46	810							near C4 with congener data
B5b	2	1.45	107							
B6a	2	2.09	153							near C6 with congener data
B7a	2	3.05	104							
B9a	2	4.52	100				100% 1242		X	
C1	2	0.19	19 U							congener data
									8 in RM 0-1	

**Criteria considered in selecting locations for PCB congener analysis**

Location	Round	RM	Total PCBs (as Aroclors) concentration (µg/kg dw)	Dioxin/furan data?	Human use area	Sandpiper habitat (foraging; nesting)	Aroclor pattern	Fish subarea	Selected?	Other notes
									7 in RM 1-2	
									5 in RM 2-3	
									6 in RM 3-4	
									7 in RM 4-6	
									33 total	

Congeners analyzed in sediments from B1b (1A), B2a (1E), B3b (1F), B4b (na), B8a (3F), B5a (2E), B9b (na), B10a (4c), C1 (1A), C2-2 (1E), C4 (na), C6 (2C), C7-1 (na), C-8 (na), C9 (na), C10-1 (3E).

Sandpiper habitat designations: n - no habitat; p - poor quality habitat; h - high quality habitat

SS - shiner surfperch

PS - Pacific staghorn sculpin