2012 Port Gardner Bay Marine Sediment Monitoring

Sediment Chemistry Data Summary

Table of Contents

Results and Statistical Summaries 3

Summary statistics for concentrations of TOC, metals, and organic compounds from sediments collected for the 2012 Port Gardner Bay survey..... 4

Chemical Contamination 10

No chemicals exceeded (did not meet) the Washington State Sediment Management Standards criteria in the 2012 Port Gardner Bay survey..... 10

Spatial patterns for mean SQS quotients (SQSQ) in the 2012 Port Gardner Bay survey. *The numbers on the map are the station identifications.*..... 11

Spatial patterns in Sediment Chemistry Index in the 2012 Port Gardner Bay survey. *The numbers on the map are the station identifications.*..... 12

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay survey, as measured with the Sediment Chemistry Index..... 13

Comparisons with the Region and all of Puget Sound13

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay study area, Whidbey Basin monitoring region, and all of Puget Sound, as measured by chemical concentrations exceeding applicable Washington State Sediment Cleanup Objective (SCO) benthic chemical criteria..... 13

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay study area, Whidbey Basin monitoring region, and all of Puget Sound, as measured with the Sediment Chemistry Index. 14

Chemistry Case Narratives 15

Results and Statistical Summaries

Laboratory chemistry results (data) for the 2012 Port Gardner Bay survey.

Concentrations of contaminants in the sediment samples are displayed graphically below. Qualified (estimated) and undetected results are indicated. Stations are ordered approximately north to south.

Summary statistics for concentrations of TOC, metals, and organic compounds from sediments collected for the 2012 Port Gardner Bay survey.

Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
Organic Carbon Content (%)											
Total Organic Carbon	30	29	1	0	1.575	1.977	1.575	0.045	10.2	0.1	
Total Organic Carbon (M)	30	29	1	0	1.587	1.996	1.585	0.045	10.3	0.1	
Metals (mg/kg dry weight)											
Arsenic	30	30	0		8.416	3.329	8.35	3.47	18.8	18.8	1
Cadmium	30	24	6	0	0.2581	0.4653	0.169	0.0144	2.57	0.05	
Chromium	30	30	0		46.78	15.71	46.7	23.3	78.9	78.9	1
Copper	30	30	0		26.73	14.76	31.8	4.75	66.4	66.4	1
Lead	30	30	0		10.72	6.7	10.57	3.37	30.7	30.7	1
Mercury	30	30	0		0.0831	0.0585	0.0912	0.0078	0.222	0.222	1
Nickel	30	30	0		35.3	8.29	34.8	21.2	47.9	47.9	1
Selenium	30	18	12	0	0.4587	0.2312	0.4365	0.1554	1.05	0.251	
Silver	30	19	11	0	0.1595	0.0625	0.1525	0.0668	0.299	0.05	
Tin	30	30	0		0.879	0.668	0.815	0.19	3.16	3.16	1
Zinc	30	30	0		63.53	27.28	66.7	27.2	168	168	1
Organic Compounds (µg/kg dry weight)											
Polycyclic Aromatic Hydrocarbons (PAH)											
LPAH											
1,6,7-Trimethylnaphthalene	30	27	3	0	7.14	6.36	6.46	0.69	26.6	1.02	
1-Methylnaphthalene	30	21	9	0	33.91	50.64	22	3.6	240	2.86	
1-Methylphenanthrene	30	25	5	0	17.07	22.63	11.95	0.53	94	5.08	
2,6-Dimethylnaphthalene	30	23	7	0	38.37	50.06	27.2	2.3	209	5.73	
2-Methylnaphthalene	30	20	10	0	58.1	85	34.2	7	349	6.62	

Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
2-Methylphenanthrene	30	30	0		31.17	48.54	17.45	0.53	192	192	1
Acenaphthene	30	21	9	0	28.6	58.9	8.3	0.7	273	2.06	
Acenaphthylene	30	24	6	0	28.45	38.31	20.85	0.94	170	1.02	
Anthracene	30	24	6	0	72.1	153.7	29.3	0.6	737	1.02	
Biphenyl	30	20	10	0	20.67	28.9	14.5	3.76	135	5.16	
Dibenzothiophene	30	25	5	0	14.66	29.12	5.85	0.47	136	1.02	
Fluorene	30	27	3	0	38	74.7	15.2	0.8	354	1.46	
Naphthalene	30	25	5	0	227	419.3	107.5	3.7	1880	4.15	
Phenanthrene	30	26	4	0	168.8	302.7	99.7	2.2	1460	4.78	
Retene	30	28	2	0	290	1005	82	2	5500	4.96	
HPAH											
Benzo(a)anthracene	30	27	3	0	73.4	181.9	24.4	0.6	960	1.02	
Benzo(a)pyrene	29	23	6	0	59.3	101.7	29.7	1.6	441	2.03	
Benzo(b)fluoranthene	30	26	4	0	127.4	321.7	50	1.4	1740	2.03	
Benzo[e]pyrene	30	29	1	0	71	166.4	31	0.6	897	1.02	
Benzo(g,h,i)perylene	29	28	1	0	52.2	72.2	36.2	0.8	320	1.02	
Benzo(k)fluoranthene	29	21	8	0	30.04	48.58	14.7	1.4	212	2.06	
Chrysene	30	30	0		126.1	290.1	46.9	1	1520	1520	1
Dibenzo(a,h)anthracene	30	21	9	0	13.51	23.08	6.55	0.57	104	1.02	
Fluoranthene	30	30	0		194.4	373.2	101.3	1.3	1820	1820	1
Indeno(1,2,3-c,d)pyrene	29	27	2	0	59	91.6	34.9	0.5	397	1.02	
Perylene	29	29	0		110.3	99.1	111	2.3	384	384	1
Pyrene	30	28	2	0	203.5	405.3	109.2	1.9	2050	2.03	
Total Benzofluoranthenes	30	26	4	0	155.9	335.4	66.7	1.6	1740	2.03	
Base/Neutral/Acid (BNA)											

Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
Semivolatile Compounds											
Chlorinated Alkenes											
Hexachlorobutadiene	30	0								21	2
Chlorinated and Nitro-substituted Phenols											
Pentachlorophenol	30	0								210	2
Chlorinated Aromatic Compounds											
1,2,4-Trichlorobenzene	30	0								21	2
1,2-Dichlorobenzene	27	0								21	2
1,3-Dichlorobenzene	30	0								21	2
1,4-Dichlorobenzene	30	0								21	2
2-Chloronaphthalene	30	0								2.12	2
Hexachlorobenzene	30	0								21	2
Miscellaneous Compounds											
Beta-coprostanol	30	5	25	0	304.4	225.3	216.7	107.4	1000	830	
Carbazole	30	22	8	0	11.54	16.87	6.51	2.88	80.2	5.16	
Cholesterol	30	26	4	0	1401	960	1300	294	4000	330	
Dibenzofuran	30	20	10	0	43.5	76.2	24.5	4.8	362	4.41	
Isophorone	30	0								410	2
Organonitrogen Compounds											
Caffeine	30	0								41	2
N-Nitrosodiphenylamine	30	0								41	2
Phenols											
P-nonylphenol	30	0								83	2
Phthalate Esters											
Bis(2-Ethylhexyl)phthalate	30	2	28	0						70	5

Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
Butylbenzylphthalate	30	0								83	2
Diethylphthalate	30	0								210	2
Dimethylphthalate	30	0								41	2
Di-N-Butylphthalate	30	1	29	1						41	3,5
Di-N-Octyl Phthalate	30	0								410	2
Chlorinated Pesticides and herbicides - all others not detected											
2,4'-DDD	30	0								0.53	2
2,4'-DDE	30	0								1.1	2
2,4'-DDT	30	0								1.1	2
4,4'-DDD	30	3	27	0	0.1685	0.3314	0.0584	0.005	1.6	0.52	
4,4'-DDE	30	0								1.1	2
4,4'-DDT	30	2	28	0						1	5
Hexachlorobenzene (Method 8081/8082)	30	3	27	0	0.357	1.68	0	0	9.2	0.52	
Gamma-BHC (Lindane)	30	2	28	0						0.52	5
Toxaphene	30	1	29	0						14	5
Polychlorinated Biphenyls (PCB)											
PCB Congeners											
PCB Congener 8	30	0								1.1	2
PCB Congener 18	30	0								1.1	2
PCB Congener 28	30	2	28	0						1	5
PCB Congener 44	30	0								1.1	2
PCB Congener 52	30	1	29	0						1.1	5
PCB Congener 66	30	2	28	0						1	5
PCB Congener 77	30	0								1.1	2
PCB Congener 101	30	1	29	0						1.1	5

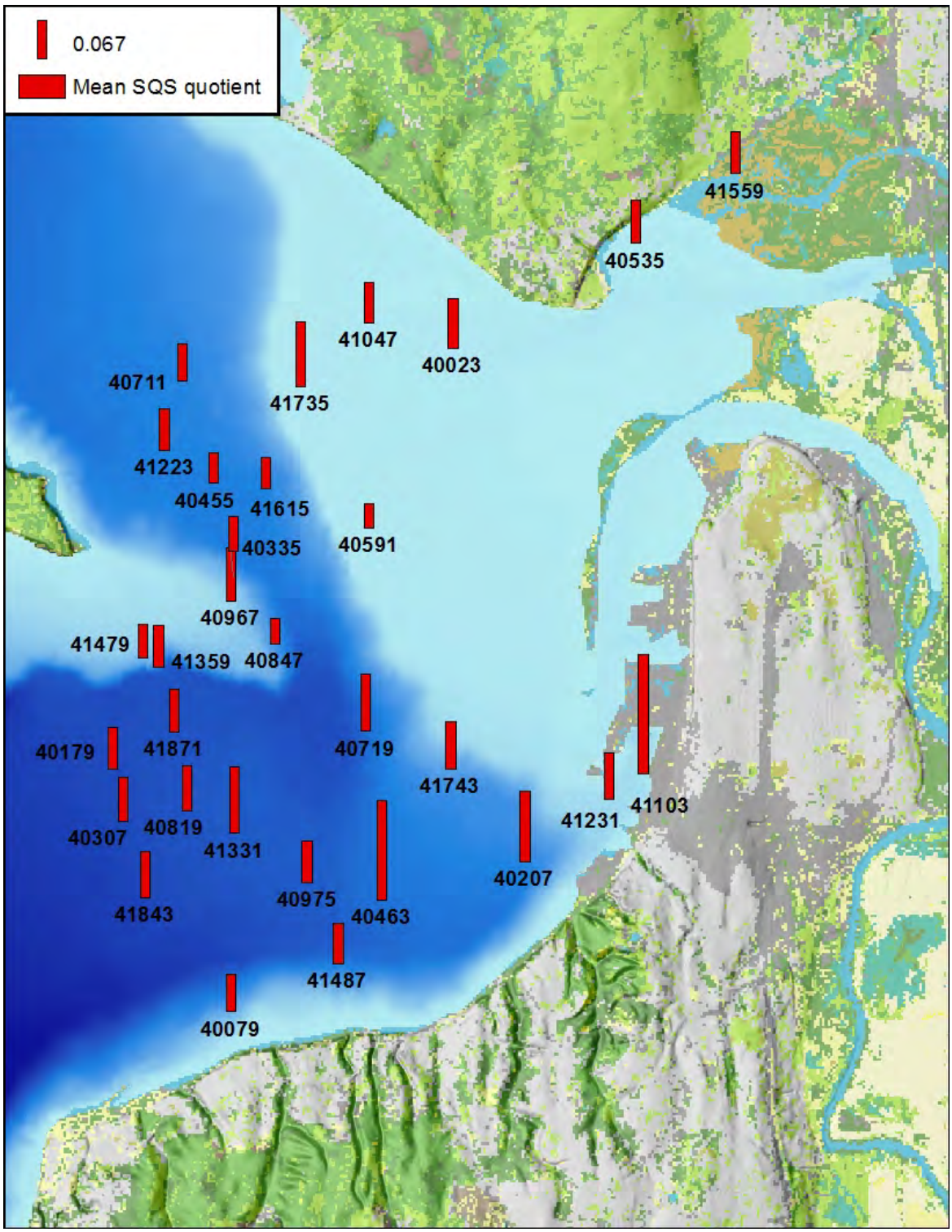
Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
PCB Congener 105	30	1	29	0						1.1	5
PCB Congener 118	30	4	26	0	0.336	0.609	0.115	0.007	3	1	
PCB Congener 126	30	0								1.1	2
PCB Congener 128	30	0								2.1	2
PCB Congener 138	30	2	28	0						1	5
PCB Congener 153	30	3	27	0	0.306	0.885	0.028	0	4.6	1	
PCB Congener 169	30	0								2.1	2
PCB Congener 170	30	0								1.1	2
PCB Congener 180	30	1	29	0						1.1	5
PCB Congener 187	30	0								1.1	2
PCB Congener 195	30	0								2.1	2
PCB Congener 206	30	0								1.1	2
PCB Congener 209	30	0								2.1	2
PCB Aroclors											
PCB Aroclor 1016	30	0								11	2
PCB Aroclor 1221	30	0								21	2
PCB Aroclor 1232	30	0								21	2
PCB Aroclor 1242	30	1	29	2						21	3,5
PCB Aroclor 1248	30	3	27	2	3.896	1.614	3.618	1.973	9.1	15	3
PCB Aroclor 1254	30	14	16	0	6.57	6.77	3.97	1.36	36	5.2	
PCB Aroclor 1260	30	1	29	0						5.3	5
PCB Aroclor 1262	30	0								9.6	2
PCB Aroclor 1268	30	0								5.3	2
Polybrominated Diphenylethers (PBDE)											
PBDE- 47	30	19	11	0	0.2727	0.0788	0.269	0.16	0.46	0.41	

Parameter	N	# Detects	# ND	# ND > highest detect	Mean*	Std. Dev.*	Median*	Minimum*	Maximum (detected)	Max RL (ND)	Notes (see bottom)
PBDE- 49	30	13	17	17						0.42	3,4
PBDE- 66	30	0								0.42	2
PBDE- 71	30	0								0.42	2
PBDE- 99	30	11	19	19						0.42	3,4
PBDE-100	30	2	28	28						0.42	3,4
PBDE-138	30	0								0.85	2
PBDE-153	30	0								0.85	2
PBDE-154	30	1	29	29						0.85	3,4
PBDE-183	30	0								0.85	2
PBDE-184	30	0								0.85	2
PBDE-191	30	0								0.85	2
PBDE-209	30	19	11	0	2.689	1.705	2.2	0.772	7.9	2.1	

Notes
RL = reporting limit; ND = nondetect; CDF = cumulative distribution function
*: Estimated by regression on order statistics (ROS) when nondetects present.
1: All values detected (no nondetects).
2: All nondetect.
3: Nondetects higher than the maximum detect are set to missing values.
4: All nondetects are higher than the maximum detect.

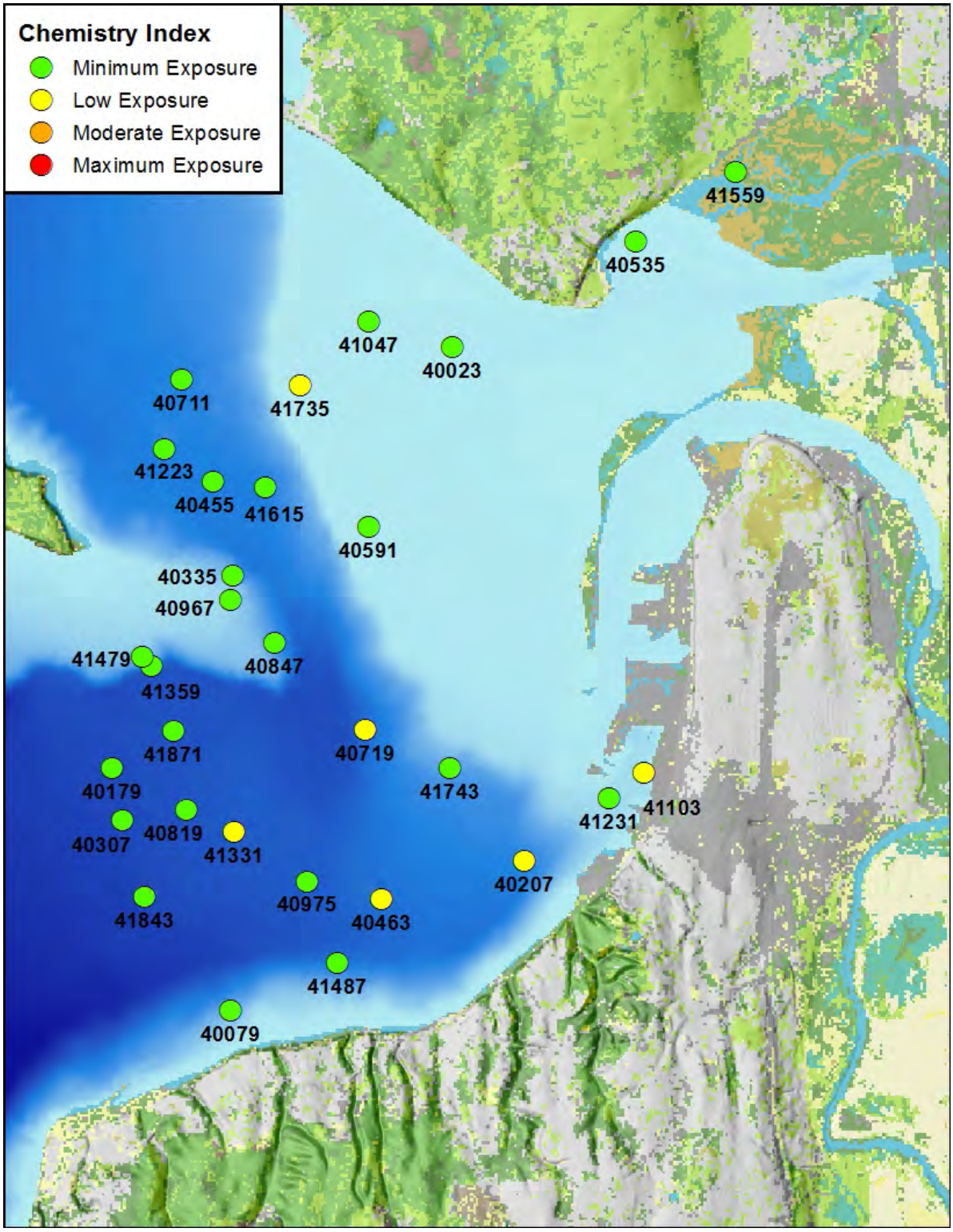
Chemical Contamination

No chemicals exceeded (did not meet) the Washington State Sediment Management Standards criteria in the 2012 Port Gardner Bay survey.



Spatial patterns for mean SQS[1] quotients (SQSQ) in the 2012 Port Gardner Bay survey. *The numbers on the map are the station identifications.*

[1] now called Sediment Cleanup Objective (SCO) instead of Sediment Quality Standard (SQS)



Spatial patterns in Sediment Chemistry Index in the 2012 Port Gardner Bay survey. *The numbers on the map are the station identifications.*

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay survey, as measured with the Sediment Chemistry Index.

Sediment Chemistry Category	Stations		Area	
	No.	(%)	km^2	(%)
Everett	30	(100.0)	38.1	(100.0)
Minimum exposure	24	(80.0)	30.5	(80.0)
Low exposure	6	(20.0)	7.6	(20.0)
Moderate exposure	0	(0.0)	0	(0.0)
Maximum exposure	0	(0.0)	0	(0.0)

Comparisons with the Region and all of Puget Sound

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay study area, Whidbey Basin monitoring region, and all of Puget Sound, as measured by chemical concentrations exceeding applicable Washington State Sediment Cleanup Objective (SCO[2]) benthic chemical criteria.

Monitoring Region	Year(s) sampled	Numbers of Samples	Percent of samples > SCO	Percent of area (km^2) > SCO
Port Gardner Bay	2012	30	0.0	0.0
Whidbey Basin	1997	39	12.8	9.1
	2007	40	5.0	2.4
All of Puget Sound	1997-2003	381	15.7	4.8

[2] formerly called Sediment Quality Standard (SQS)

Incidence and spatial extent of chemical contamination in the 2012 Port Gardner Bay study area, Whidbey Basin monitoring region, and all of Puget Sound, as measured with the Sediment Chemistry Index.

Sediment Chemistry Index Category	Baseline				Second Baseline			
	Stations		Area		Stations		Area	
	No.	(%)	km^2	(%)	No.	(%)	km^2	(%)
Port Gardner Bay	30	(100.0)	38.1	(100.0)	Available after 2018			
Minimal exposure	24	(80.0)	30.5	(80.0)				
Low exposure	6	(20.0)	7.6	(20.0)				
Moderate exposure	0	(0.0)	0	(0.0)				
High exposure	0	(0.0)	0	(0.0)				
Whidbey Basin	39	(100.0)	338.1	(100.0)	40	(100.0)	353.3	(100.0)
Minimal exposure	29	(74.4)	307.0	(90.8)	36	(90.0)	344.4	(97.5)
Low exposure	6	(15.4)	20.7	(6.1)	4	(10.0)	8.9	(2.5)
Moderate exposure	3	(7.7)	10.4	(3.1)	0	(0.0)	0.0	(0.0)
High exposure	1	(2.6)	0.1	(0.0)	0	(0.0)	0.0	(0.0)
Total Study Area	381	(100.0)	2294.1	(100.0)	Available after 2014			
Minimal exposure	269	(70.6)	2087.0	(91.0)				
Low exposure	80	(21.0)	187.36	(8.2)				
Moderate exposure	22	(5.8)	18.15	(0.8)				
High exposure	10	(2.6)	1.57	(0.1)				

Chemistry Case Narratives

General Chemistry

2012 TOC Case Narrative.pdf

Metals

PSAMP_Metals-1206024.pdf

BNAs

PSAMP&UW 2012_BNASQS- Batch 1-1206024.pdf

PSAMP&UW 2012_BNASQS- Batch 2-1206024.pdf

PSAMP&UW 2012_BNASQS- Batch 3-1206024.pdf

PSAMP&UW 2012_BNASQS- Batch 4-1206024.pdf

PAHs

PSAMP&UW_PAHNOAA_BATCH 1-1206024.pdf

PSAMP&UW_PAHNOAA_BATCH 2-1206024.pdf

PSAMP&UW_PAHNOAA_BATCH 3-1206024.pdf

PSAMP&UW_PAHNOAA_BATCH 4-1206024.pdf

PSAMP&UW_PAHNOAA_BATCH 5-1206024.pdf

PBDEs

PSAMP & Urban Waters_PBDE1-1206024-01-21.pdf

PSAMP & Urban Waters_PBDE2-1206024-01-21.pdf

PSAMP & Urban Waters_PBDE3-1206024-01-21.pdf

PSAMP & Urban Waters_PBDE4-1206024-01-21.pdf

PCBs and Pesticides

PSAMP-UW_PestPCB-1206024-01-41.pdf

PSAMP-UW_PestPCB-1206024-42-67.pdf

PSAMP-UW_PestPCB-1206024-68-83.pdf