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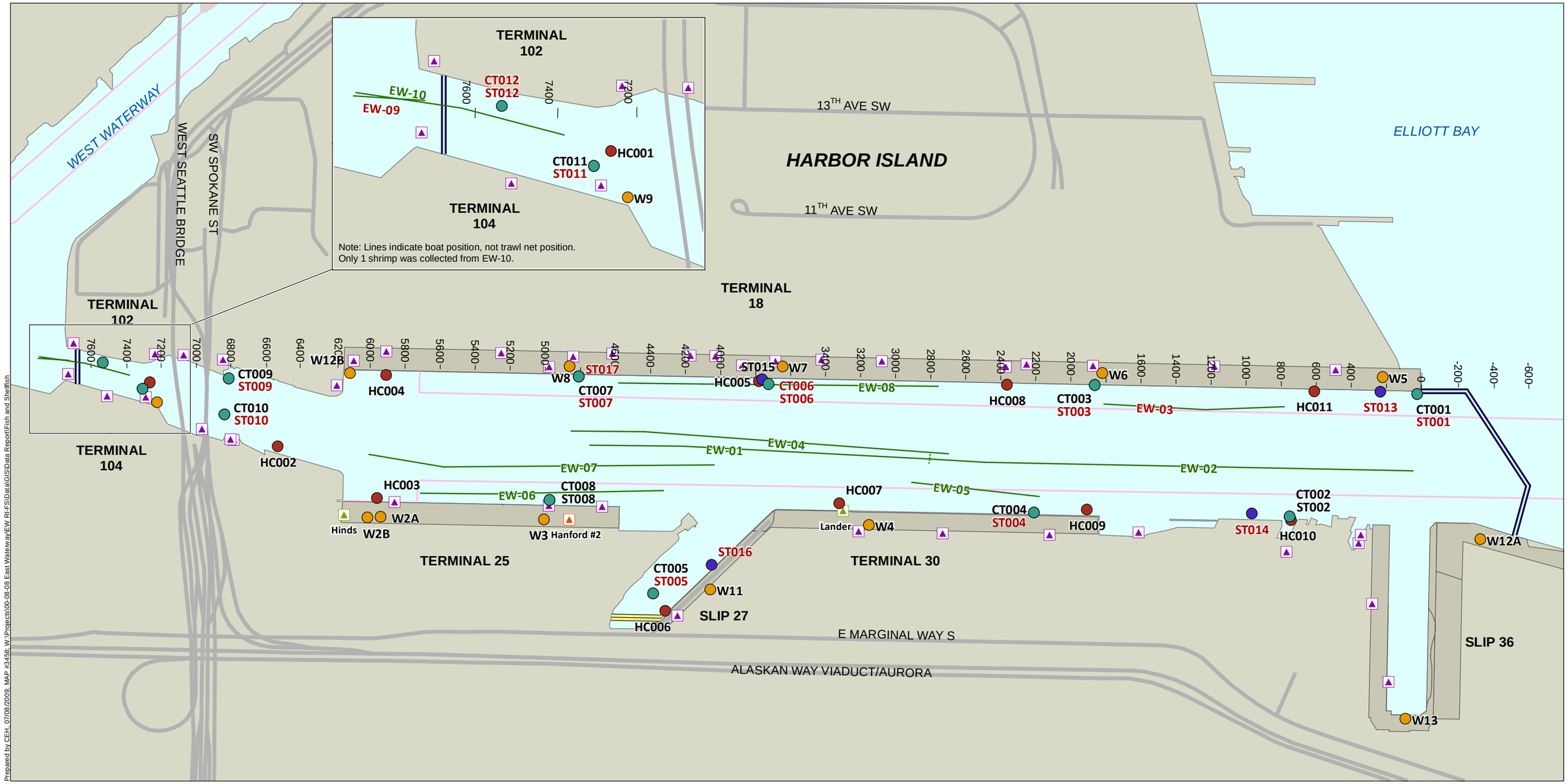
Acronyms

Acronym	Definition
ARI	Analytical Resources, Inc.
BEHP	bis(2-ethylhexyl) phthalate
CAS	Columbia Analytical Services, Inc.
CCV	continuing calibration verification
CFR	Code of Federal Regulations
COC	chain of custody
CVAA	cold vapor atomic absorption
DCM	dichloromethane
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
dw	dry weight
EPA	US Environmental Protection Agency
EW	East Waterway
GC/ECD	gas chromatography/electron capture detector
GC/MS	gas chromatography/mass spectrometry
GFAAS	graphite furnace atomic absorption spectrophotometry
HG/AFS	hydride generation/atomic fluorescence spectrometry
ICP/AES	inductively couple/plasma atomic emission spectrometry
ICP/MS	inductively coupled/plasma mass spectrometry
ID	identification
J-qualifier	estimated concentration
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MS	matrix spike
MSD	matrix spike duplicate
MDL	method detection limit
PAH	polycyclic aromatic hydrocarbon
N-qualifier	tentative identification

Acronym	Definition
NAD-83	North American Datum of 1983
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RL	reporting limit
RPD	relative percent difference
SDG	sample delivery group
SVOC	semivolatile organic compound
TBT	tributyltin
U-qualifier	not detected at given concentration
Windward	Windward Environmental LLC
ww	wet weight



Prepared by CEH, 07/08/2009; MAP #3458; W:\Projects\00-08-08 East Waterway\GIS\Data Report\Fish and Shellfish\EW RI-FS\Data\GIS\Data

Location type

- Crab trap and shrimp trap[a]
- Shrimp trap
- Mussel
- Rockfish
- Trawl line
- CSO
- Storm Drain
- CSO/Storm Drain
- Dock/Pier
- Road
- Slip 27 Bridge
- Navigation Channel
- East Waterway Study Area Boundary

0 600

Scale in feet

[a] Crabs were collected from crab traps, and shrimp from shrimp traps, with the exception of shrimp trap ST002 which captured three red rock crab. Coordinates for locations CT003/ST003 and CT004/ST004 are approximate.

Note: Location labels in red indicate no larger organisms were captured or retained.

Map 2-1
Fish and Shellfish Sample Locations
Fish and Shellfish Data Report
East Waterway Study Area

Collection Method	Sampling Location	Target Species Captured and retained?	Location Coordinates[a]	
			Latitude	Longitude
Crab trap	CT001	yes	47.59043	-122.346
	CT002	yes	47.58847	-122.343
	CT003	yes	47.58541	-122.344
	CT004	yes	47.58448	-122.342
	CT005	yes	47.57854	-122.341
	CT006	no[d]	47.58028	-122.346
	CT007	yes	47.57731	-122.346
	CT008	yes	47.57689	-122.343
	CT009	yes	47.57183	-122.346
	CT010	yes	47.57178	-122.345
	CT011	yes	47.57049	-122.345
	CT012	no[d]	47.56986	-122.346
Shrimp trap	ST001	no[d]	47.59043	-122.346
	ST002	yes[e]	47.58847	-122.343
	ST003	no[d]	47.58541	-122.344
	ST004	no[d]	47.58448	-122.342
	ST005	no[d]	47.57854	-122.341
	ST006	no[d]	47.58028	-122.346
	ST007	no[d]	47.57731	-122.346
	ST008	yes	47.57689	-122.343
	ST009	no[d]	47.57183	-122.346
	ST010	no[d]	47.57178	-122.345
	ST011	no[d]	47.57049	-122.345
	ST012	no[d]	47.56986	-122.346
	ST013	no[d]	47.58985	-122.346
	ST014	no[d]	47.58788	-122.343
	ST015	no[d]	47.58018	-122.346
	ST016	no[d]	47.57945	-122.342
	ST017	no[d]	47.57731	-122.346

Collection Method	Sampling Location	Target Species Captured and retained?	Location Coordinates[a]	
			Latitude	Longitude
Hand collection (mussel)	HC001	yes	47.5706	-122.346
	HC002	yes	47.57262	-122.344
	HC003	yes	47.57419	-122.343
	HC004	yes	47.5743	-122.346
	HC005	yes	47.58013	-122.346
	HC006	yes	47.57873	-122.341
	HC007	yes	47.58142	-122.343
	HC008	yes	47.58401	-122.346
	HC009	yes	47.5853	-122.343
	HC010	yes	47.58849	-122.343
	HC011	yes	47.58882	-122.346
Scuba diver (rockfish)	W2A	yes	47.57425	-122.343
	W2B	yes	47.57404	-122.343
	W3	yes	47.5768	-122.343
	W4	yes	47.58189	-122.343
	W5	yes	47.58989	-122.346
	W6	yes	47.5855	-122.346
	W7	yes	47.5805	-122.346
	W8	yes	47.57717	-122.346
	W9	yes	47.57029	-122.346
	W11	yes	47.57923	-122.341
	W12A	yes	47.59145	-122.343
	W12B	yes	47.57373	-122.346
	W13	yes	47.59034	-122.339

[a] NAD-83 horizontal datum.

[b] No fish were captured from the EW-03 trawl.

[c] None of the fish species were retained from the EW-09 trawl because they did not meet the size specifications or sufficient numbers had already been captured.

[d] No shrimp or crabs were captured in these traps.

[e] No shrimp were captured from this shrimp trap, although three red rock crabs were captured and retained.

NAD83 – North American Datum 1983

2.1.2.1 High-rise otter trawl

Trawling was conducted in the EW on September 2, 2008; specifications for the high-rise otter trawl are presented in the QAPP (Windward 2008). All trawling was conducted using the research vessel *Kittiwake*, captained by Charles Eaton (Bio-Marine Enterprises). Target species collected by trawling included English sole, shiner surfperch, Dungeness and red rock crabs, and coonstripe shrimp. Ten trawls were conducted to obtain all target species throughout the EW (see Map 2-1 for trawl locations).

2.1.2.2 Crab and shrimp traps

Crab and shrimp traps were deployed in the EW on August 26 and 27, 2008. Crab traps were Ladner 30-in. rubber-wrapped stainless steel crab traps; shrimp traps were Ladner 30-in. nestable shrimp traps with 0.5-in. mesh. Bait was placed in a mesh bait bag and tied to the inside of each trap so the bags could not be opened and the contents consumed. Bait for crabs consisted of salmon scraps and frozen squid and bait for shrimp consisted of shrimp pellet bait. Target species collected by the traps included Dungeness crab, red rock crab, and coonstripe shrimp.

Twelve crab traps and sixteen shrimp traps were dispersed throughout the EW (Map 2-1). Trap deployment times typically ranged from approximately 4 to 6 hours, with the exception of nine traps that were deployed overnight.

2.1.2.3 Scuba divers

Scuba divers collected brown rockfish divers from August 11 to 13 and on October 24, 2008, at 13 locations (Map 2-1). Divers collected rockfish by using barrier nets and a spear gun. Specifications for diver sampling methods are presented in the QAPP (Windward 2008).

2.1.2.4 Mussel collection

A mussel reconnaissance survey was conducted on July 31, 2008, to determine potential sampling locations in the EW. The locations and abundance of mussels were noted. Mussels were found to be present where ever there was suitable substrate (e.g., pilings and sheetpile walls). Mussels were collected by hand from a boat on August 27, 2008, from 11 locations throughout the EW on pilings or sheetpile (Map 2-1).

2.1.2.5 Field sample processing

After an individual trawl or trap was collected, the catch was sorted by species and size into holding trays that contained site water. Prior to release within their area of capture, non-target species were identified to the lowest practical taxonomic level, numbers of each species were counted (or estimated if a species was present in large numbers), and these data were recorded on the non-target species tally form (Appendix F).

Individual specimens of target fish, crabs, or shrimp were rinsed in site water to remove any foreign matter from the external surface. The target species were then grouped by

species and general size class and placed in clean holding trays to prevent cross contamination. All fish and crabs were inspected carefully to ensure that their skin or shells had not been damaged by the sampling equipment; specimens with broken skin or shells were not included in composite tissue samples. Each fish or crab in the selected target species was measured to determine that the actual total length was greater than or equal to the minimum target length for that species. Large fish were killed by placing them in a ziplock bag and giving them a sharp blow to the head on the side of the processing table. Small fish and shrimp were killed by placing them on ice as recommended by the US Environmental Protection Agency (EPA) (2000). Crabs were killed in the field by placing them on dry ice (Windward 2007). After the target numbers of each species had been obtained, additional specimens of target size captured (but not retained) during sampling were measured, enumerated, and returned to the EW.

Individual specimens of the same species from a particular sampling area and equipment deployment (i.e., a single trawl or trap) were kept together in one large re-sealable plastic bag with the date, time, effort number, species, and collection method recorded on the outside of the bag in indelible ink. Fish and crab that did not meet the targeted size were not retained (≥ 200 mm for English sole and brown rockfish, ≥ 80 mm for shiner surfperch, and ≥ 90 mm for crab). Shrimp and mussels did not have size specifications. The bagged and iced fish, crabs, and shrimp were transported in coolers to Analytical Resources, Inc. (ARI) either that same day or were stored overnight at less than 4˚ C in the Windward Environmental LLC (Windward) processing laboratory and delivered to ARI the following day.

After mussels had been removed from pilings and sheetpile walls, they were rinsed in site water and stored on ice in separate ziplock bags (i.e., one bag per sampling location) and labeled with the date, time, and location identification (ID). The bagged and iced mussels were transported to directly to ARI for processing.

Brown rockfish collected by scuba divers were brought to the surface in collection bags, where they were given to the field crew for processing. Rockfish were weighed and measured in the field. Rockfish that were collected by speargun were killed upon collection. Rockfish collected opportunistically in nets by scuba divers were killed by placing them in a ziplock bag and giving them a sharp blow to the head on the side of the processing table. Individual specimens were placed in separate ziplock bags and labeled with the date, time, and location ID. The specimens were stored on ice and transported to ARI for final processing.

The date, time, and location of each effort were recorded in the field notebook, the target species collection form, and the non-target species tally form. Completed field forms are presented in Appendix F.

2.1.3 Catch results

A total of 292 fish, crab, and shrimp specimens of target species and size were collected and processed from 8 successful trawls, 10 successful crab traps, and 2 successful shrimp traps. A total of 1,075 mussels were collected from throughout EW by hand. Target numbers of fish and shellfish specified in the QAPP (Windward 2008) were met or exceeded for all target species. Catch results for all target fish and shellfish species collected and processed from the EW are presented in Table 2-2. Compositing information, including the specimen ID, length, and weight for each target specimen included in a composite sample, are presented in Appendix B.

Table 2-2. Target species catch results

Target Species	Number of Specimens Retained
English sole	110
Shiner surfperch	80
Brown rockfish	13
Dungeness crab	7
Red rock crab	56
Coonstripe shrimp	26
Mussels	1,075
Total	**1,367**

Non-target fish, crab, shrimp, and other invertebrate species captured in the EW were identified, recorded, and returned to the EW. A total of 23 fish species and 12 types of invertebrates classified to the lowest taxonomic level practicable were collected from the EW, including both target and non-target species. The names and numbers of each species captured by traps or trawls are presented in Table 2-3.

Table 2-3. Numbers of individual species captured in the EW using trawls, crab traps, and shrimp traps

Species	Scientific Name	Number of Specimens Captured			
		Otter Trawl	Crab Trap	Shrimp Trap	Total
American shad	*Alosa sapidissima*	3	0	0	3
Bay goby	*Lepidogobius lepidus*	31	0	0	31
Brown rockfish	*Sebastes auriculatus*	2	3	3	8[a]
Decorator crab	*Loxorhynchus crispatus*	3	0	0	3
Dungeness crab	*Cancer magister*	10	4	0	14
Coonstripe shrimp	*Pandalus danae*	17	0	9	26
English sole	*Parophrys vetulus*	610	0	0	610

Species	Scientific Name	Number of Specimens Captured			
		Otter Trawl	Crab Trap	Shrimp Trap	Total
Flathead sole	*Hippoglossoides elassodon*	8	0	0	8
Great sculpin	*Myoxocephalus polyacanthocephalus*	2	0	0	2
Kelp crab	*Pugettia producta*	1	0	0	1
Longfin smelt	*Spirinchus thaleichthys*	5	0	0	5
Pacific herring	*Clupea pallasii marisalbi*	29	0	0	29
Pacific sanddab	*Citharichthys sordidus*	12	0	0	12
Pacific staghorn sculpin	*Leptocottus armatus*	38	0	2	40
Pacific Tomcod	*Microgadus proximus*	234	0	0	234
Plainfin midshipman	*Porichthys notatus*	82	0	0	82
Plumose anemone	*Metridium senile*	38	0	0	38
Pygmy rock crab	*Cancer oregensis*	3	0	0	3
Rat fish	*Hydrolagus colliei*	14	0	0	14
Red rock crab	*Cancer productus*	6	63	25	94
Rock sole	*Lepidopsetta bilineata*	33	0	0	33
Sand sole	*Psettichthys melanostictus*	46	0	0	46
Sea star	*Evasterias sp*	12	0	0	12
Sea star	*Luidia sp.*	3	0	0	3
Sea star, sunflower	*Pycnopodia helianthoides*	1	1	0	2
Shiner surfperch	*Cymatogaster aggregata*	199	0	0	199
Slender crab	*Cancer gracilis*	7	1	3	11
Slender sole	*Lyopsetta exilis*	1	0	0	1
Snake prickleback	*Lumpenus sagitta*	2	0	0	2
Solaster star	*Solaster stimpsoni*	0	3	2	5
Speckled sanddab	*Citharichthys stigmaeus*	11	0	0	11
Spotted greenling	*Hexagrammos stelleri*	1	0	0	1
Starry flounder	*Platichthys stellatus*	18	0	0	18
Urchin	*Echinodermata sp.*	1	0	0	1
Warbonnet	*Chirolophis decoratus*	1	0	0	1
Total		**1,484**	**75**	**44**	**1,616**

[a] An additional 13 brown rockfish were collected by scuba divers.

2.1.4 Sample processing, identification, and compositing

This section presents methods used to process fish and shellfish following collection in the field. Specimen and sample ID numbers are described for individual fish and shellfish and also for the composite tissue samples. In addition, the compositing scheme is described.

2.1.4.1 Laboratory sample processing

At the end of each day, all sample labels were checked against field forms, and sample ID numbers were recorded on COC forms. COC forms were placed together with samples collected that day. Prior to transport to ARI, samples were securely packed inside a cooler with ice packs and were kept on ice. Samples were delivered to ARI either that same day or were stored overnight at less than 4°C in the Windward processing laboratory and delivered to the laboratory the following day. Following compositing and homogenization at ARI, frozen tissue subsamples were shipped via UPS to Brooks Rand and CAS.

Initial processing of samples (i.e., weighing, measuring, and packaging) was conducted by Windward personnel at ARI. Fish and crab were weighed using an analytical scale accurate to 0.1 g wet weight, measured, and individually packaged. Each target specimen was individually wrapped in heavy-duty aluminum foil, enclosed in a resealable plastic bag with an ID label (also enclosed in a resealable bag). Shrimp and mussels were weighed and then packaged by sampling location. Crabs and rockfish were double-wrapped in heavy-duty aluminum foil to minimize punctures prior to placing them in the plastic bag. Rockfish gender was determined at ARI according to procedures in the QAPP (Windward 2008) prior to packaging.

All relevant information for each individually wrapped and labeled specimen was recorded on the target fish and crab species collection forms (Appendix F). Relevant information included the specimen ID, length, weight, gender (when differences between the sexes were visually discernable, such as with gravid females), sampling date, time, and location number. Samples were kept frozen at ARI at -20°C until the fish compositing scheme was determined.

Fish composite samples were created and fish were homogenized at ARI. All fish and shellfish tissue preparation, including filleting of fish, dissection of crabs, removal of whole-body mussel tissue from the shells, and homogenization of tissues, was conducted following ARI's standard operating procedures as specified in the QAPP (Windward 2008). Specimens were grouped for composite samples prior to homogenization (see Section 2.1.4.3 and Appendix B). Large fish were chopped into small pieces and included in their entirety in the composite sample. For fillet samples, partially thawed whole fish were filleted (skin on), and the fillets were then homogenized. Crabs were dissected, and the hepatopancreas and edible-meat tissues were combined into the relevant composite samples prior to homogenization (Appendix B). Mussels were removed from their shells prior to homogenization.

2.1.4.2 Sample identification

Unique alphanumeric sample IDs were assigned to each individual target fish or crab specimen and recorded on the target fish and crab species form (Appendix F). Shrimp and mussels were grouped as multiple specimens according to trawl or trap location;

these combined specimens were assigned unique alphanumeric sample IDs based on sampling location.Table 2-4 presents the ID scheme for fish and shellfish specimens.

Table 2-4. Identification scheme for fish and shellfish specimens

Identifier	Description
EW	Identifies the project area.
08	Identifies the year in which the sample was collected.
TR, CT, ST, SCUBA, or HC followed by sequential three-digit number	Identifies the collection method (trawl, crab trap, shrimp trap, scuba diver, or hand collection, respectively) and the effort as a unique number over all areas (e.g., the 15th trawl after the start of sampling would be TR015).
ES, SS, DC, RR, SR, BR,[a] or MS	Identifies the species type (English sole, shiner surfperch, Dungeness crab, red rock crab, shrimp, brown rockfish, or mussel, respectively).
Sequential number	Identifies the order in which a specimen (or group of specimens for shrimp and mussels) was captured during the sampling event.

[a] Eight specimens were identified with "RF" instead of "BR." Sample IDs were corrected after delivery to ARI.

EW – East Waterway

Thus, for example, the 28th English sole captured in the 5th trawl was identified as EW-08-TR05-ES-028. After individual fish and shellfish specimens (or groups of specimens for shrimp and mussels) were combined to form composite samples, as discussed in Section 2.1.4.3, composite sample IDs were assigned as shown in Table 2-5.

Table 2-5. Identification scheme for fish and shellfish composite tissue samples

Identifier	Description
EW	Identifies the project area.
08	Identifies the year in which the samples were collected.
ES, SS, DC, RR, SR, or MS	Identifies the species type (English sole, shiner surfperch, Dungeness crab, red rock crab, shrimp, or mussel, respectively).
WB, FL, EM, or HP	Identifies whole-body, fillet, edible-meat, or hepatopancreas samples, respectively.
comp	Indicates the sample as a composite of individual specimens.
sequential number	Identifies the composite number for a specific species.

Thus, for example, the second composite whole-body English sole sample was identified as EW-08-ES-WB-comp2.

2.1.4.3 Compositing scheme

Fish (except brown rockfish) and shellfish tissue samples were chemically analyzed as composite samples, which were created by homogenizing individual specimens together. The compositing plan was developed in coordination with EPA, and the final plan was approved by EPA (Windward 2009a). Most of the specimens retained for

analysis were included in composite samples. Rockfish were not composited but were instead analyzed as 13 individual whole body samples. The numbers and types of composite samples created and chemically analyzed are presented in Table 2-6.

Table 2-6. Numbers of fish and shellfish composite tissue samples collected

Species[a]	Total Length (mm)	Sample Type	No. of Composite Tissue Samples	No. of Specimens per Sample
English sole	≥ 200	whole body	11	5
		fillet (skin on)	11	5
Shiner surfperch	≥ 80	whole body	8	10
Dungeness crab	≥ 90	edible meat	1	7
		hepatopancreas	1	7
Red rock crab	≥ 90	edible meat	8	7
		hepatopancreas	8	7
Shrimp	any size	whole body	1	26
Mussel	any size	whole body (soft tissue only)	11	89 –101

[a] Brown rockfish are not included in this table because they were analyzed as 13 individual samples.

English sole, shiner surfperch, and crab specimens were evenly distributed among composites based on specimen weights, genders, and collection locations of a given species. The first step in this distribution process was to divide all specimens into three size categories based on the weight distribution of the specimens, with equal weight intervals in each size category. Each composite sample then received approximately the same number of specimens from each size class. In addition, specimens of different genders and from different locations were distributed as evenly as possible among the composite samples. All shrimp collected were included in one composite sample because there was insufficient numbers and mass to create more than one composite sample. Brown rockfish collected were analyzed as individuals rather than as composite samples as specified in the QAPP. Mussels were composited by location collected. A summary of each of the composite samples is presented in Table 2-7. Comprehensive compositing information, including length and weight data for each individual specimen included in the composite samples and gender data, is presented in Appendix B. Individual rockfish ranged in length from 193 to 310 mm.

Super composites were created for English sole fillet, English sole whole body, shiner surfperch, mussels, crab edible meat, and crab hepatopancreas. These composites were created by combining the existing composites for each species and tissue type. A detailed discussion of the creation of the super composites is provided in Appendix I.

Table 2-7. Summary of composite tissue samples

Species	Sample IDs	Number of Individuals	Average Length (mm)	Minimum Length (mm)	Maximum Length (mm)
English sole whole body	EW-08-ES-WB-comp1	5	230	202	285
	EW-08-ES-WB-comp2	5	235	201	308
	EW-08-ES-WB-comp3	5	237	202	298
	EW-08-ES-WB-comp4	5	233	200	285
	EW-08-ES-WB-comp5	5	237	195	313
	EW-08-ES-WB-comp6	5	230	200	280
	EW-08-ES-WB-comp7	5	227	200	275
	EW-08-ES-WB-comp8	5	233	205	271
	EW-08-ES-WB-comp9	5	230	209	259
	EW-08-ES-WB-comp10	5	225	197	250
	EW-08-ES-WB-comp11	5	227	204	243
English sole fillet	EW-08-ES-FL-comp1	5	253	205	355
	EW-08-ES-FL-comp2	5	249	207	348
	EW-08-ES-FL-comp3	5	245	208	351
	EW-08-ES-FL-comp4	5	244	201	342
	EW-08-ES-FL-comp5	5	236	208	280
	EW-08-ES-FL-comp6	5	235	208	285
	EW-08-ES-FL-comp7	5	235	200	273
	EW-08-ES-FL-comp8	5	228	205	266
	EW-08-ES-FL-comp9	5	229	201	259
	EW-08-ES-FL-comp10	5	227	209	252
	EW-08-ES-FL-comp11	5	231	200	259
English sole total		**110**	**234**	**195**	**355**
Shiner surfperch	EW-08-SS-WB-comp1	10	112	97	131
	EW-08-SS-WB-comp2	10	114	105	131
	EW-08-SS-WB-comp3	10	112	102	129
	EW-08-SS-WB-comp4	10	112	104	125
	EW-08-SS-WB-comp5	10	112	100	125
	EW-08-SS-WB-comp6	10	112	104	123
	EW-08-SS-WB-comp7	10	113	105	123
	EW-08-SS-WB-comp8	10	115	100	132
Shiner surfperch total		**80**	**113**	**97**	**132**

Species	Sample IDs	Number of Individuals	Average Length (mm)	Minimum Length (mm)	Maximum Length (mm)
Dungeness crab	EW-08-DC-EM-comp1 EW-08-DC-HP-comp1	7	147	127	161
Dungeness crab total		**7**	**147**	**127**	**161**
Red rock crab	EW-08-RR-EM-comp1 EW-08-RR-HP-comp1	7	133	106	164
	EW-08-RR-EM-comp2 EW-08-RR-HP-comp2	7	137	110	157
	EW-08-RR-EM-comp3 EW-08-RR-HP-comp3	7	136	120	156
	EW-08-RR-EM-comp4 EW-08-RR-HP-comp4	7	139	120	154
	EW-08-RR-EM-comp5 EW-08-RR-HP-comp5	7	141	123	157
	EW-08-RR-EM-comp6 EW-08-RR-HP-comp6	7	138	120	156
	EW-08-RR-EM-comp7 EW-08-RR-HP-comp7	7	137	110	153
	EW-08-RR-EM-comp8 EW-08-RR-HP-comp8	7	132	113	149
Red rock crab total		**56**	**137**	**106**	**164**
Coonstripe shrimp	EW-08-SR-WB-comp1	26	na	na	na
Coonstripe shrimp total		**26**	na	na	na
Mussel	EW-08-MS-WB-comp1	89	na	na	na
	EW-08-MS-WB-comp2	93	na	na	na
	EW-08-MS-WB-comp3	91	na	na	na
	EW-08-MS-WB-comp4	100	na	na	na
	EW-08-MS-WB-comp5	101	na	na	na
	EW-08-MS-WB-comp6	101	na	na	na
	EW-08-MS-WB-comp7	100	na	na	na
	EW-08-MS-WB-comp8	100	na	na	na
	EW-08-MS-WB-comp9	100	na	na	na
	EW-08-MS-WB-comp10	100	na	na	na
	EW-08-MS-WB-comp11	100	na	na	na
Mussel total		**1,075**	na	na	na

Note: Brown rockfish are not included in the table because they were analyzed as individuals rather than as composite samples. Lengths of individual rockfish ranged from 193 to 310 mm, as presented in Appendix B.

na – not applicable (lengths were not measured for coonstripe shrimp or mussels)

A small number of the specimens collected were not used in creating composite tissue samples because they were not needed to meet the target number of specimens for a particular sample. These specimens included six English sole and four red rock crab.

2.2 FIELD DEVIATIONS FROM THE QAPP

Field deviations from the QAPP (Windward 2008) included minor modifications to collection and processing methods. These field deviations did not affect the data quality and are discussed in detail below.

- All specimen IDs for brown rockfish used "SCUBA" instead of "SB" and eight specimen IDs contained "RF" instead of "BR." Sample IDs were corrected after delivery to ARI.
- The target length for brown rockfish was 200 mm. One rockfish retained for chemical analysis had a length of 193 mm because it was killed during capture and could not be released.
- The target length for English sole was 200 mm. Two English sole retained for chemical analysis had lengths of 195 and 197 mm. These fish were included in the whole-body composite samples EW-08-ES-WB-comp5 and EW-08-ES-WB-comp10, respectively. Including these two English soles in composite samples was approved by EPA in the fish and shellfish compositing memorandum.
- The QAPP specified that rockfish would be collected in August. Slip 36 was not initially a target location because of the US Coast Guard's strict access regulations. However, Coast Guard granted access to collect rockfish from Slip 36 in October.
- The Washington State Department of Fish and Wildlife permit changed after the QAPP went final to account for higher numbers of shiner surfperch and mussels noted in the field. The number of mussels was increased from 140 to 1,100, and the number of shiner surfperch was increased from 60 to 85 because the abundance of both species in the EW was much greater than originally expected.

3 Analytical Methods

The methods and procedures used to prepare and chemically analyze the composite tissue samples are described briefly in this section and in detail in the QAPP (Windward 2008). This section also summarizes any laboratory deviations from the QAPP. Analytical testing adhered to the most recent EPA quality assurance/quality control (QA/QC) guidelines and analysis protocols (PSEP 1997; EPA 2002a).

3.1 FISH AND SHELLFISH TISSUE ANALYTICAL METHODS

Individual fish and shellfish specimens were homogenized into composite tissue samples at ARI according to the compositing scheme presented in the fish compositing

memorandum (Windward 2009a, b). Windward personnel oversaw the initial homogenization procedures to ensure that the correct specimens were included in the composite tissue samples. Individual specimens used in each composite tissue sample are presented in Appendix B.

All composite tissue samples and whole-body rockfish tissue samples were analyzed for PCBs as Aroclors, SVOCs, phthalates, polycyclic aromatic hydrocarbons (PAHs), low-level PAHs, total metals, inorganic arsenic, TBT, pesticides, lipids, and total solids, with the following exceptions. Because of limited sample mass, the coonstripe shrimp composite tissue sample was only analyzed for total metals, SVOCs, PCBs as Aroclors, lipids, and total solids. In addition, rockfish sample EW-08-SB002-BR-01, English sole whole-body sample EW-08-ES-WB-comp2, and two crab hepatopancreas samples (EW-08-DC-HP-comp1 and EW-08-RR-HP-comp6) were not analyzed for low-level PAHs because of limited sample mass. The whole-body rockfish tissue samples were reanalyzed to achieve lower reporting limits for bis(2-ethylhexyl) phthalate (BEHP) and pentachlorophenol (PCP) at ARI. The results are presented in Section 4.1.5. In addition, for English sole, shiner surfperch, crab edible meat, crab hepatopancreas, and mussel tissue super composite samples were created by combining all the original composite samples for each species to create new composite samples that were submitted for low-level BEHP and PCP analysis. Results for the super composite samples are presented in Appendix H.

The analytical methods are identified in Table 3-1. The analytical methods followed by ARI, CAS, and Brooks Rand Labs adhered to the most recent EPA quality assurance/quality control (QA/QC) guidelines and standard analysis protocols (EPA 2002b; PSEP 1997). All methods selected represent standard methods used for the analysis of these analytes in tissue.

Table 3-1. Analytical methods for fish and shellfish tissue analyses

Parameter	Method	Reference	Maximum Sample Holding Time	Method of Preservation	Laboratory
PCBs as Aroclors	GC/ECD	EPA 8082	1 year to extract, 40 days to analyze	freeze/-20 °C	CAS
Organochlorine pesticides[a]	GC/ECD	EPA 8081A	1 year to extract, 40 days to analyze	freeze/-20 °C	ARI
SVOCs including PAHs[b]	GC/MS	EPA 8270D	1 year to extract, 40 days to analyze	freeze/-20 °C	ARI
Low-level PAHs	GC/MS-SIM	EPA 8270C-SIM	1 year to extract, 40 days to analyze	freeze/-20°C	CAS
Low-level BEHP	GC/MS-SIM	EPA 8270D-SIM	1 year to extract, 40 days to analyze	freeze/-20°C	ARI
Low-level PCP	GC/ECD	EPA 8041	1 year to extract, 40 days to analyze	freeze/-20°C	ARI

Parameter	Method	Reference	Maximum Sample Holding Time	Method of Preservation	Laboratory
Inorganic arsenic	HG-AFS	EPA 1632	6 months[c]	freeze/-20 °C	Brooks Rand Labs
Total arsenic	ICP-MS with DRC	EPA 1638	6 months[c]	freeze/-20°C	Brooks Rand Labs
Total metals[c]	ICP-MS and ICP-AES	EPA 6020 and EPA 6010B	6 months[c]	freeze/-20 °C	ARI
Mercury	CVAA	EPA 7471	6 months	freeze/-20 °C	ARI
Tributyltin, dibutyltin, monobutyltin (as ions)	GC/MS-SIM	Krone et al. (1989)	1 year to extract, 40 days to analyze	freeze/-20 °C	ARI
Lipids	DCM: acetone extraction gravimetric	NOAA (1993)	1 year	freeze/-20 °C	ARI
Total solids	freeze-dried	PSEP (1986) or EPA 160.2	6 months	freeze/-20 °C	ARI

[a] Target pesticides include: 4,4′-DDT, 4,4′-DDE, 4,4′-DDD, 2,4′-DDT, 2,4′-DDE, 2,4′-DDD, aldrin, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC, oxychlordane, alpha- and gamma-chlordane, cis- and trans-nonachlor, dieldrin, endosulfan, endosulfan sulfate, endrin, heptachlor, heptachlor epoxide, hexachlorobenzene, methoxychlor, mirex, and toxaphene.

[b] Target PAHs include: anthracene, pyrene, dibenzofuran, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, fluoranthene, benzo(k)fluoranthene, acenaphthylene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(a)anthracene, acenaphthene, phenanthrene, fluorene, 1-methylnaphthalene, naphthalene, 2-methylnaphthalene.

[c] Tissue samples were frozen to extend the maximum holding time to 1 year.

[d] Arsenic, antimony, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc**.**

ARI – Analytical Resources, Inc.BEHP – bis(2-ethylhexyl) phthalate

CAS – Columbia Analytical Services, Inc.

CVAA – cold vapor atomic absorption

DCM – dichloromethane

DDD – dichlorodiphenyldichloroethane

DDE – dichlorodiphenyldichloroethylene

DDT – dichlorodiphenyltrichloroethane

EPA – US Environmental Protection Agency

GC/ECD – gas chromatography/electron capture detector

GC/MS – gas chromatography/mass spectrometry

HG-AFS – hydride generation/atomic fluorescence spectrometry

ICP-AES – inductively couple/plasma atomic emission spectrometry

ICP-MS – inductively coupled/plasma mass spectrometry

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyls

PCP – pentachlorophenol

PSEP – Puget Sound Estuary Program

SIM – select ion monitoring

SVOC – semivolatile organic carbon

3.2 LABORATORY DEVIATIONS FROM THE QAPP

The laboratories followed the methods and procedures described in the QAPP with the following exceptions:

- The QAPP (Windward 2008) specified that total metals would be analyzed by ARI using inductively coupled plasma-atomic emission spectrometry (ICP-AES), inductively coupled plasma-mass spectrometry (ICP-MS), or graphite furnace atomic absorption (GFAA) per EPA Methods 6010B, 6020, or 7000 series, respectively, within 6 months of sample collection. Total metals were analyzed by ARI using EPA 6010B and EPA 200.8, which is equivalent to EPA 6020.
- In consultation with the EPA QA office, total arsenic was also analyzed in the fish and shellfish tissue samples by Brooks Rand Labs using Dynamic Reaction Cell (DRC) with ICP-MS per EPA Method 1638, in addition to total arsenic analysis by ARI as specified in the QAPP (Windward 2008). This laboratory and test method was selected to minimize potential matrix interferences in the tissue samples and to ensure comparability by having a single laboratory generate both the total and inorganic arsenic results. The total arsenic results from both laboratories were similar; the results from Brooks Rand Labs are presented in this data report and the project database. All samples were analyzed for total metals and inorganic arsenic within the laboratories' standard holding times of one year for frozen tissues, which is consistent with PSEP guidance (PSEP 1997), rather than the 6 month holding time that was listed in the QAPP (Windward 2008).
- PCBs as Aroclors were analyzed in all tissue samples at CAS, per EPA agreement (Sanga 2009) instead of ARI as specified in the QAPP (Windward 2008).
- Butyltins were analyzed using gas chromatography/mass spectrometry with selective ion monitoring by (Krone et al. 1989). The QAPP (Windward 2008) listed butyltin analysis using gas chromatography/flame photometric detection in error. The quality of the data is not affected by this deviation.

4 Results of Chemical Analyses

This section presents results of the chemical analyses and data validation of the fish and shellfish tissue samples. Laboratory report forms are presented in Appendix E. The approach used to average laboratory replicates and the methods for calculating concentrations of total PCBs are presented in Appendix C.

The QA review of the chemistry data was conducted in accordance with the QA/QC requirements and technical specifications of the methods and the national functional guidelines for organic and inorganic data review (EPA 1999, 2002b, 2004). EcoChem, Inc., conducted the data review and summary validation. The results of the data validation are summarized in Section 4.3 and presented in full in Appendix D.

associated with each analysis, whereas the MDL is statistically derived following EPA methods (40 CFR 136). Detected concentrations between the MDL and RL were reported by the laboratories and are flagged with a J-qualifier to indicate that the reported concentration is an estimate. Non-detect results were reported at the RL.

The RLs and MDLs for fish and shellfish tissue samples are compared with risk-based ACGs for all analytes in Table 4-10. Analytes with RLs greater than ACGs include inorganic arsenic, mercury, thallium, vanadium, 8 individual PAHs, BEHP, di-n-butyl phthalate, 25 other SVOCs, 6 individual Aroclors, and 16 pesticides. All of these chemicals also had one or more samples with MDLs exceeding ACGs with the exception of mercury, thallium, vanadium, and di-n-butyl phthalate.

The chemicals with RLs above ACGs were identified in Appendix D of the QAPP as having target MDLs and/or RLs above human health ACGs, with the exception of chrysene, dibenzofuran, BEHP, di-n-butyl phthalate, and nine other SVOCs. RLs for these additional chemicals were elevated because of analytical dilutions used by the laboratory. The samples were analyzed with a dilution because of the analytical interferences (i.e., lipid content) in the sample extracts.

Table 4-10. Number of RLs and MDLs above the ACGs for tissue samples

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target RL	Target MDL	ACG[a]
Metals											
Arsenic (inorganic)	mg/kg ww	61	0.004 – 0.133	11	0.007 – 0.009	11	0.002 – 0.003	11	0.03	0.003	0.00054
Mercury	mg/kg ww	63	0.01 – 0.418	10	0.009 – 0.01	10	0.00094 – 0.00098	0	0.01	0.005	0.0084
Thallium	mg/kg ww	0	nd	73	0.004 – 0.008	17	0.0001 – 0.0002	0	0.02	0.011	0.0059
Vanadium	mg/kg ww	39	0.06 – 0.62	34	0.06 – 0.1	17	0.0077 – 0.016	0	0.2	0.034	0.084
PAHs											
Benzo(a)anthracene	µg/kg ww	0	nd	5	200 – 330	5	150 - 240	5	67	16	1.1
Benzo(a)pyrene	µg/kg ww	0	nd	5	200 – 330	5	110 - 190	5	67	17	0.11
Benzo(b)fluoranthene	µg/kg ww	0	nd	5	200 – 330	5	160 - 260	5	67	27	1.1
Benzo(k)fluoranthene	µg/kg ww	0	nd	5	200 – 330	5	140 - 230	5	67	15	11
Chrysene	µg/kg ww	0	nd	5	200 – 330	5	200 - 330	5	67	15	110
Dibenzo(a,h)anthracene	µg/kg ww	0	nd	5	200 – 330	5	130 - 220	5	67	14	0.11
Dibenzofuran	µg/kg ww	0	nd	5	200 – 330	5	82 - 140	5	67	15	84
Indeno(1,2,3–cd)pyrene	µg/kg ww	0	nd	5	200 – 330	5	120 - 200	5	67	12	1.1
Low-Level PAHs											
Benzo(a)anthracene	µg/kg ww	25	0.35 – 95	43	0.47—7.4	13	0.16 – 7.4	8	0.5	0.16	1.1
Benzo(a)pyrene	µg/kg ww	27	0.12 – 70	41	0.47–3.7	41	0.061 – 1.9	8	0.5	0.061	0.11
Benzo(b)fluoranthene	µg/kg ww	37	0.15 – 140	31	0.47–3.7	1	0.14 – 1.1	0	0.5	0.14	1.1
Dibenzo(a,h)anthracene	µg/kg ww	29	0.071 – 8.1	39	0.47–3.7	39	0.045 – 0.33	1	0.5	0.045	0.11
Indeno(1,2,3-cd)pyrene	µg/kg ww	36	0.1 – 37	32	0.48 – 3.7	1	0.1 – 0.73	0	0.5	0.10	1.1
Phthalates											

Analyte	Unit	No. of Detected Results	Range of Detected Results	No. of Non-Detected Results	Range of RLs for Non-Detected Results	No. of RLs > ACG	Range of MDLs for Non-Detected Results	No. of MDLs > ACG	Target RL	Target MDL	ACG[a]
BEHP	µg/kg ww	0	nd	60	200–1300	60	200 - 1,300	60	67	27	58
Low-level BEHP	µg/kg ww	0	nd	31	16 - 240	20	16 – 83	9	20	20	58
Di-n-butyl phthalate	µg/kg ww	0	nd	73	200 – 1,600	5	140 – 910	0	67	7.1	1,170 – 8,400
Other SVOCs											
1,2,4-Trichlorobenzene	µg/kg ww	0	nd	73	200 – 1,300	8	150 – 1,000	8	67	16	840
1,3-Dichlorobenzene	µg/kg ww	0	nd	73	200 – 1,300	43	110 – 760	8	67	16	250
1,4-Dichlorobenzene	µg/kg ww	1	4,800	72	200 – 1,300	73	120 – 820	72	67	14	34
2,4,6-Trichlorophenol	µg/kg ww	0	nd	73	990 – 6,700	73	530 – 3,600	73	330	65	73
2,4-Dichlorophenol	µg/kg ww	0	nd	73	990 – 6,700	73	590 – 4,000	73	330	120	250
2,4-Dinitrophenol	µg/kg ww	0	nd	73	2,000 – 13,000	73	1,100 – 7,200	73	670	110	170
2,4-Dinitrotoluene	µg/kg ww	0	nd	73	990 – 6,700	73	700 – 4,700	73	330	100	170
2,6-Dinitrotoluene	µg/kg ww	0	nd	73	990 – 6,700	73	900 – 6,000	73	330	110	84
2-Chlorophenol	µg/kg ww	0	nd	73	200 – 1,300	8	110 – 740	8	67	12	420
3,3'-Dichlorobenzidine	µg/kg ww	0	nd	70	990 – 6,700	70	160 – 1,100	70	330	210	1.8
4-Chloroaniline	µg/kg ww	0	nd	71	990 – 6,700	71	120 – 790	8	330	200	340
4-Methylphenol	µg/kg ww	0	nd	73	200 – 1,300	8	140 – 950	8	67	33	420
Aniline	µg/kg ww	0	nd	69	200 – 1,300	69	200 – 1,300	69	67	67	140
Bis(2-chloroethyl)ether	µg/kg ww	0	nd	73	200 – 1,300	73	150 – 980	73	67	15	0.73
Bis(2-chloroisopropyl)ether	µg/kg ww	0	nd	73	200 – 1,300	73	100 – 680	73	67	15	0.73
Carbazole	µg/kg ww	0	nd	73	200 – 1,300	73	140 – 970	73	67	7.7	40
Hexachlorobenzene	µg/kg ww	0	nd	73	4.6 – 330	73	1.9 – 250	73	10	4.2	0.5
Hexachlorobutadiene	µg/kg ww	0	nd	73	4.6 – 330	3	1.7 – 260	1	67	15	10
Hexachloroethane	µg/kg ww	0	nd	73	4.9 – 1,300	72	4.9 – 790	72	67	16	58

4.3 DATA VALIDATION RESULTS

Independent data validation was performed by EcoChem on all results in accordance with the QA/QC requirements and technical specifications of the methods and the national functional guidance for organic and inorganic data review (EPA 1999, 2004, 2002b). EcoChem conducted full-level data validation on at least 20% of the results. All sample results that were not selected for full validation underwent a summary validation. The percent of samples submitted for full validation for each analysis is consistent with QAPP requirements. Table 4-11 provides a summary of the number of samples in each sample delivery group (SDG) and the level of data validation.

Table 4-11. Data validation performed for each SDG

Laboratory	SDG	Validation Level	Number of Tissue Samples	Analyses
Brooks Rand Labs	0902011	full/summary [a]	71	total and inorganic arsenic
ARI	OF34	summary	8	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OF35	full	8	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OF36	summary	11	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OF41	summary	13	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OF42	summary	11	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OF43	summary	11	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OG18	full	8	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	OG20	summary	2	total metals including mercury, butyltins, SVOCs, pesticides, lipids, total solids
ARI	PJ35	full	13	low-level BEHP and PCP
ARI	PJ64	summary	15	low-level BEHP and PCP
ARI	PJ68	summary	3	low-level BEHP and PCP
CAS	K0900129	full	8	PCB Aroclors
CAS	K0900132	summary	11	PCB Aroclors
CAS	K0900134	summary	11	PCB Aroclors
CAS	K0900136	summary	13	PCB Aroclors
CAS	K0900137	summary	8	PCB Aroclors
CAS	K0900138	full	11	PCB Aroclors
CAS	K0900139	summary	2	PCB Aroclors