Adaptive Environmental Management for the Columbia River Channel Improvement Project:

Annual Report for 2006

prepared by

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1 Introduction

Phase I construction Projects for the Columbia River Channel Improvement Project (CRCIP) were initiated in FY06. Phase I focused on channel modifications in two separate river segments: Columbia River Mile (CRM) 3 to 21 and CRM 95 to 104. Phase I, constitutes approximately 25 percent of the entire CRCIP, was anticipated to be finished in mid-February 2006.

This 2006 annual report documents the results of the CRCIP adaptive environmental management (AEM) Project for the Phase I construction was completed by January 31, 2006. This annual report also briefly describes the major issues and their resolution for calendar year 2005, in part because Project construction began in 2005. Subsequent annual reports will similarly refer back to earlier years to maintain continuity throughout the reporting of the AEM Project.

Following a brief description of the CRCIP AEM process, each monitoring action of the adaptive management effort is addressed. Summaries of the monitoring results for 2006 are provided along with comparisons of the results with AEM decision criteria. Decisions concerning adaptive management for each of the monitoring actions recorded by the Adaptive Management Team (AMT) during the assessment year are also reported.

Each annual report is developed as a stand-alone document. However, more detailed descriptions of the actions of the AMT during calendar 2006 and additional supporting information are documented in the CRCIP AEM workbook and minutes of the quarterly AMT meetings. The workbook is updated as additional monitoring data become available and serves as ongoing documentation of the AEM process. The workbook is reviewed by the AMT at each of the quarterly meetings.

1-1 CRCIP AEM Process

The AEM process includes the following steps for adaptively managing the environmental resources of concern in relation to channel deepening (Bartell 2004):

1. Results of the ongoing monitoring programs are summarized and reported quarterly to the AMT.

2. The AMT evaluates monitoring results in relation to the consensus management decision criteria (see Appendix D in Bartell 2004).

3. If none of the decision criteria are exceeded, the AEM process can continue with the current monitoring programs until the next evaluation (i.e., Step 1).

4. If decision criteria are exceeded, the AMT can request the U.S. Army Corps of Engineers (Corps) to explain the variances or offer a mitigation plan.

5. Based on an evaluation of the Corps submission, the AMT may (a) determine that there is no justification for changing the current management practices, or (b) recommend changes to the current management practices and/or modifications to the decision criteria.

6. Following resolution of the proposed adaptive management actions and possible revisions to monitoring and criteria recommended by the AMT, the AEM process cycles back to analysis and review of new data and information at the next quarterly meeting.

The steps in the above described AEM process are schematically illustrated in the following AEM plan flowchart (Figure 1.1).

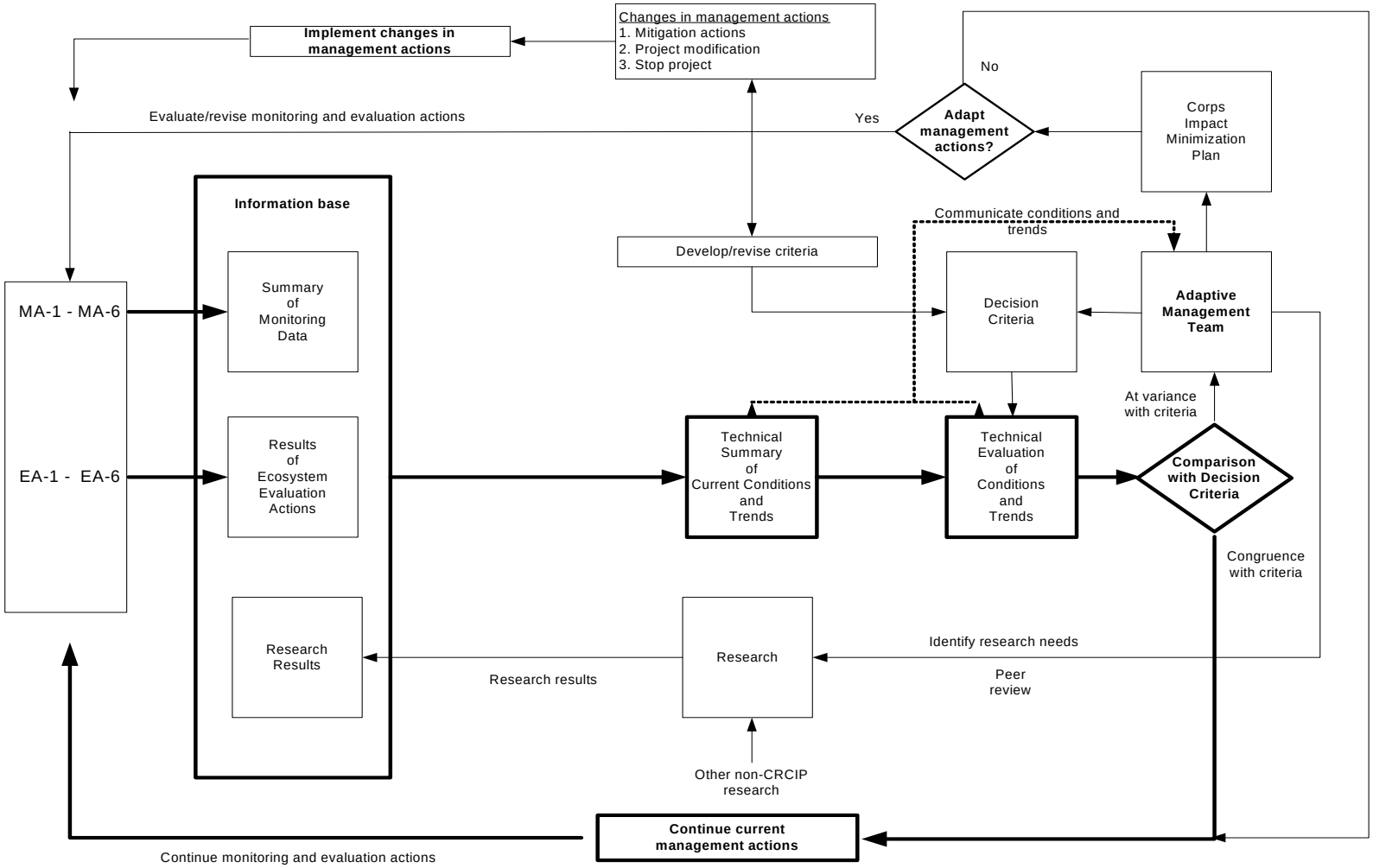


Figure 1.1. Flowchart describing the AEM process for the CRCIP.

2 Monitoring Action 1—Physical, Chemical Data

The following figures and tables summarize the MA-1 results of monitoring depth, temperature, and salinity values in relation to channel improvements for calendar 2006. The results are based on analyses of verified data downloaded from the CORIE public web site. The monitoring data are obtained from three sampling stations located in the lower river and estuary: red26, grays, and cbnc3 (Figure 2.1).

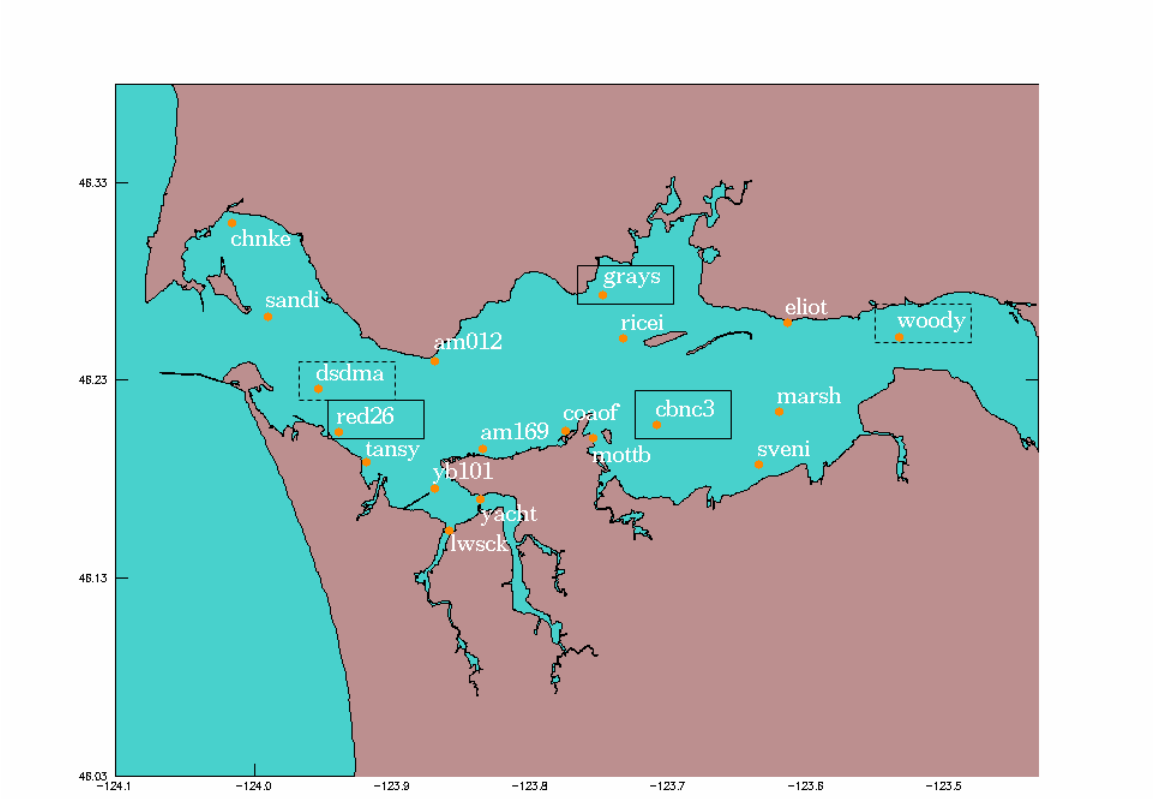


Figure 2.1. Location of CORIE monitoring stations in the Lower Columbia River (LCR) and estuary. The three stations (red26, grays, cbnc3) indicated by the solid rectangles provide data for MA-1. The two stations indicated by the dashed rectangle provide salinity (desdemona) and temperature (woody) data used in normalization of the data collected at the three MA-1 stations.

CORIE monitoring data collected from 1996–2004 provided the pre-Project (baseline) physical-chemical data. Decision criteria were defined for depth, temperature, and salinity through analyses of these data. Two sets of criteria were defined during the development of the AEM plan in calendar 2004–2005: (1) the upper and lower 90th percentile criteria were defined by the 5th and 95th percentile values computed for each month, and (2) the upper and lower 60th percentile criteria were defined by the 20th and 80th percentile computed monthly values. These values were approved as AEM decision criteria by the AMT.

2-1 Depth

Depth data were only available for the grays sampling station in 2006 (Figure 2.1.1).

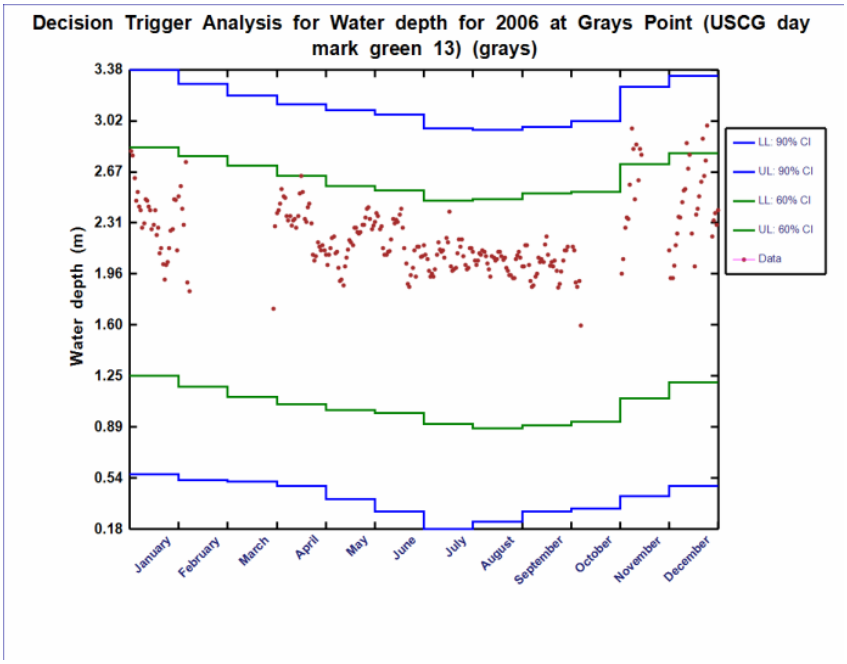


Figure 2.1.1. Daily median values of depth for the grays sampling location for 2006 plotted in relation to the CRCIP AEM decision criteria.

Except for five days in early November, the median daily depths lie within the 60th percentile decision criteria derived from the baseline data. Additional days in early January and mid-April nearly exceed these percentile values as well. None of the monitoring results exceed the 90-th percentile decision criteria. The depth values that exceed or nearly exceed the 60th percentile criteria coincide with periods of increased flows measured at the Bonneville Dam (see Figure 2.4.1 below). The observed elevated depth values for 2006 appear correlated to the observed increases in flows in the lower river and estuary.

Table 2.1.1 lists the monthly median depth values calculated using the 2006 data from the grays station. All 12 monthly values are within the 20–80th percentile range of the decision criteria derived from the 1996–2004 pre-Project data.

By definition, channel deepening could have an effect on water depth within the navigation channel. For a given discharge, measurable changes in depth are not anticipated outside the Project construction area, unless associated changes in circulation caused significant erosion in shallower areas. MA-3 was designed to measure the potential impacts of channel modification on side slope adjustments in the navigation channel.

Table 2.1.1. Summary of monthly median depth values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median depth (m)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.4	0.5
20	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.1	1.2
	2.3	**2.3**	**2.3**	**2.3**	**2.2**	**2.2**	**2.1**	**2.0**	**2.0**	**2.0**	**2.6**	**2.5**
80	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.7	2.8
95	3.4	3.3	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.3	3.3

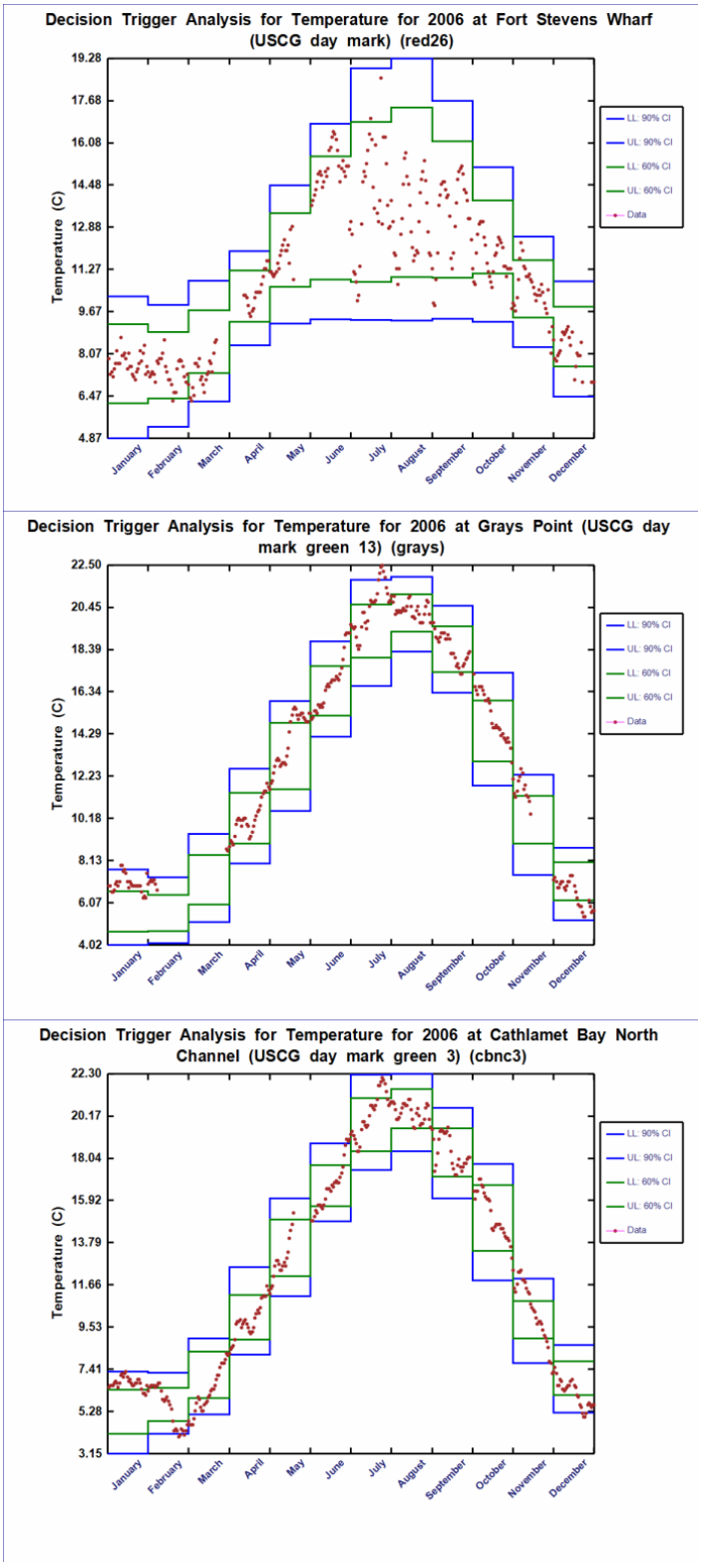
2-2 Temperature

Figure 2.2.1(a,b,c) shows the calculated daily median temperature values for 2006 at all three CORIE stations in relation to the 60th and 90th percentile decision criteria established by the AMT. The values measured at red26 exhibit the greatest variation, particularly during January through March and June through October. This sampling station is located nearest the river mouth and its temperatures are variously affected by tidal mixing and river flows. The grays and cbnc3 stations are located upriver and are less influenced by tides. Temperature values for all three stations exceed the 60th and in some instances the 90th percentile decision criteria. The elevated temperatures early and later in the year might well be explained by the influence of increased flows of warmer river water (Figure 2.4.1).

Tables 2.2.1–2.2.3 list the calculated monthly median values and the corresponding temperature decision criteria derived from analysis of the pre-Project data (1996–2004). The monthly values for red26 all are within the 20–80th percentile values (Table 2.2.1), even though daily exceedances of these criteria are evident (Figure 2.2.1a). Monthly values measured at the grays station are between the 80 and 95th percentile decision criteria for January–March, July, and November 2006 (Table 2.2.2 a,b,c). No monthly values for grays exceeded either the 5th or 95th percentile criteria in 2006. Except for the January value, all monthly values for cbnc3 were within the 20–80th percentile decision criteria (Table 2.2.3).

To further evaluate the potential impacts of channel modification on water temperatures, the daily median values for 2006 (red dots) were plotted against corresponding baseline (blue dots) values (1996–2004) for the upriver "woody" (Woody Island) sampling location (Figure 2.2.2). Water temperatures at woody are primarily determined by river flows.

Explicit decision criteria were not formulated by the AMT to evaluate the nature of the MA-1 temperature values relative to the woody baseline data. However, the Team agreed that if the MA-1 results were essentially included in the baseline cluster of points then it could be concluded that the channel modifications likely did not alter the complex relationships between river flow and tidal mixing in the lower river and estuary. The 2006 monitoring results, with perhaps the exception of 4−5 points for cbnc3, appear within the baseline variations observed at all three MA-1 stations.



(a)

(b)

(c)

Figure 2.2.1. Daily median values of water temperature for (a) red26, (b) grays, and (c) cbnc3 sampling stations for 2006 plotted in relation to the CRCIP AEM decision criteria.

Table 2.2.1. Summary of monthly median temperature values (bold numbers) for red26 station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.9	5.3	6.3	8.4	9.2	9.4	9.4	9.3	9.4	9.3	8.3	6.5
20	6.2	6.4	7.4	9.3	10.6	10.9	10.8	11.0	11.0	11.1	9.4	7.6
	7.8	**7.4**	**7.5**	**10.4**	**11.4**	**14.9**	**13.7**	**12.7**	**13.4**	**11.4**	**10.5**	8.3
80	9.2	8.9	9.7	11.2	13.4	15.6	16.9	17.4	16.1	13.9	11.6	9.9
95	10.3	9.9	10.8	12.0	14.5	16.8	18.9	19.3	17.7	15.1	12.5	10.8

Table 2.2.2. Summary of monthly median temperature values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.0	4.1	5.2	8.0	10.5	14.1	16.6	18.3	16.3	11.8	7.4	5.2
20	4.7	4.7	6.0	9.0	11.6	15.2	18.0	19.3	17.3	12.9	9.0	6.2
				10.1	**14.7**	**16.8**		**20.2**	**18.3**	**14.9**		**6.7**
80	6.6	6.5	8.4	11.4	14.8	17.6	20.6	21.1	19.5	15.9	11.3	8.0
	6.9	**7.1**	**8.7**				**20.6**				11.6	
95	7.7	7.3	9.4	12.6	15.9	18.8	21.8	21.9	20.5	17.3	12.3	8.8

Table 2.2.3. Summary of monthly median temperature values (bold numbers) for cnbc3 station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	3.2	4.2	5.1	8.1	11.1	14.9	17.4	18.4	16.0	11.9	7.7	5.2
20	4.1	4.8	6.0	8.9	12.1	15.6	18.4	19.5	17.1	13.4	9.0	6.1
		5.7	**6.2**	**9.9**	**12.8**	**16.6**	**20.5**	**20.3**	**18.3**	**14.8**	**10.3**	**6.2**
80	6.4	6.5	8.3	11.2	15.0	17.7	21.1	21.5	19.5	16.7	10.9	7.6
95	7.3	7.2	9.0	12.6	16.0	18.8	22.3	22.3	20.6	17.8	12.0	8.6

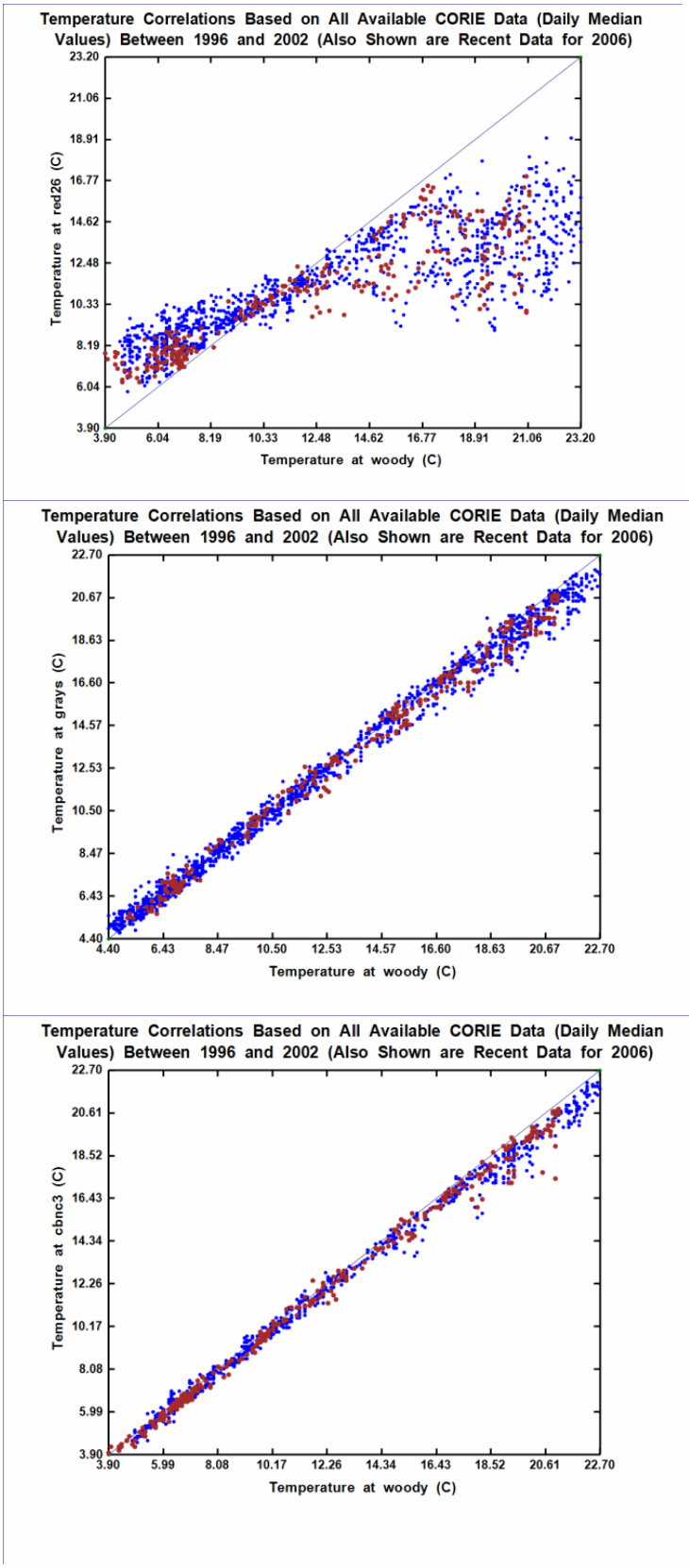


Figure 2.2.2. Median daily water temperatures for (a) red26, (b) grays, and (c) cbnc3 stations plotted for 2006 against median daily water temperatures for the 'woody' station.

2-3 Salinity

MA-1 provides an analysis of potential Project impacts on salinity analogous to the previously presented analysis of water temperatures. The concern is that channel modifications might alter flows in such manner to increase salt-water intrusions that might degrade habitat for juvenile salmon. Figure 2.3.1(a,b,c) shows the daily median values of salinity measured at the three MA-1 sampling locations and the corresponding decision criteria based on analysis of pre-Project data (i.e., 1996–2004) by the AMT.

In absolute terms, the greatest variations in salinity are observed for red26, which is the station most strongly influenced by tidal forcing among the three MA-1 stations. Despite the substantial variation in salinity at red26, few values exceeded the 80th percentile decision criteria for elevated salinity. Salinity values fluctuated throughout the year at both grays and cbnc3; however, the magnitudes of salinity values at these upriver locations are much less than red26. For periods of 2006 characterized by higher river flows, salinity values were near zero for grays and cbnc3. However, elevated salinity values during July–October in 2006 produced exceedances of the 80th percentile decision criteria for grays and cbnc3. This was a period of very low river flow compared to the 1996–2004 baseline flows (Figure 2.4.1). These low flows and correspondingly increased tidal influences can account for the observed increases in salinity at the grays and cbnc3 locations.

Tables 2.3.1–2.3.3 list the monthly median salinity values and the decision criteria developed by the AMT for MA-1. The monthly values at red26 are within the 20–80th percentile values for all 12 months (Table 2.3.1). Several monthly values demonstrate slight decreases in salinity for grays (Table 2.3.2) and cbnc3 (Table 2.3.3). However, the issue of concern is an increase in salinity as the result of channel-induced salt water intrusion. In addition, the calculated monthly decreases on the order of 0.1 psu below the decision criteria might well be within the precision of the salinity measurements. The baseline data indicate that zero values for salinity are common at these CORIE locations.

Further evaluation of 2006 channel modifications on salinity was based on plots of MA-1 salinity values against corresponding values for the CORIE Desdemona station (dsdma). This station is located downriver from red26 and is influenced by tidal mixing. Figure 2.3.2a illustrates the relationship between salinity values at dsdma and red26 based on pre-Project data (1996–2004, blue dots). With perhaps several exceptions, the 2006 MA-1 salinity values for red26 are within the range of variation determined by the pre-Project data. The relationships between salinity measured at dsdma and grays or cbnc3 are less clear (Figures 2.3.2b,c). As stated, the location of these stations in comparatively shallow and upriver areas emphasizes the influence freshwater river flows. Salinity values are often zero for these MA-1 stations. The ranges of salinity values at these stations are much less than values for the more estuarine stations of dsdma and red26. Nevertheless, the 2006 MA-1 data (red dots) were superimposed on the baseline values (blue dots) for comparison. The 2006 values are well within the range defined by the pre-Project salinity data for grays and cbnc3.

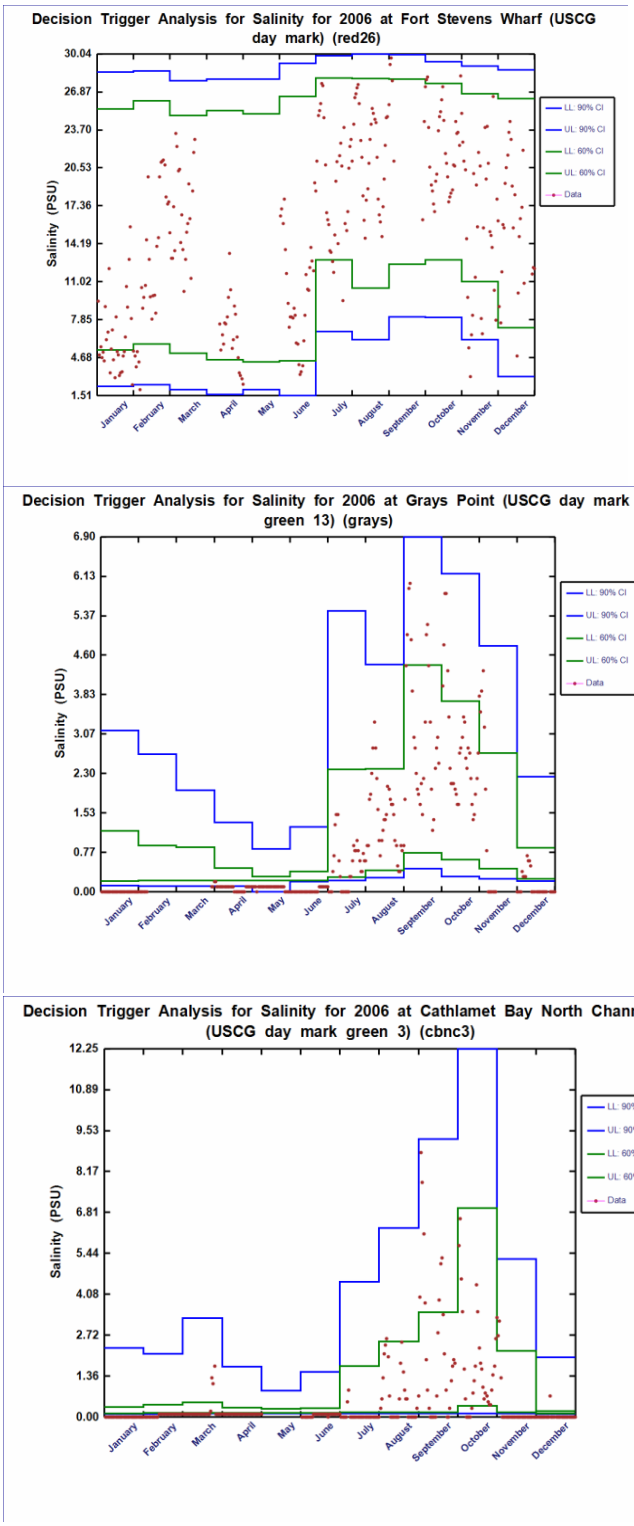


Figure 2.3.1. Daily median values of salinity for (a) red26, (b) grays, and (c) cbnc3 sampling stations for 2006 plotted in relation to the CRCIP AEM decision criteria.

Table 2.3.1. Summary of monthly median salinity values (bold numbers) for red26 station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	2.3	2.4	2.0	1.6	2.0	1.5	6.9	6.2	8.1	8.1	6.2	3.1
20	5.3	5.8	5.1	4.5	4.3	4.4	12.8	10.5	12.5	12.8	11.1	7.2
	6.2	**12.6**	**17.6**	**6.4**	No data	**10.1**	**20.6**	**23.1**	**27.7**	**23.5**	**16.5**	**17.8**
80	25.5	26.1	24.9	25.3	25.0	26.5	28.1	28.0	27.9	27.6	26.7	26.3
95	28.5	28.6	27.8	27.9	27.9	29.3	29.9	30.0	30.0	29.4	29.0	28.7

Table 2.3.2. Summary of monthly median salinity values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
			0.1	**0.1**								
5	0.2	0.2	0.2	0.2	0.0	0.2	0.3	0.3	0.5	0.4	0.3	0.3
					0.1							
20	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.8	0.7	0.5	0.3
	No data						**0.4**	**1.5**	**3.2**	**2.6**		
80	1.2	0.8	0.8	0.7	0.7	0.7	2.4	2.4	4.4	3.7	2.7	0.8
95	3.1	2.7	2.0	1.4	0.8	1.3	5.5	4.4	6.9	6.2	4.8	2.2

Table 2.3.3. Summary of monthly median salinity values (bold numbers) for cbnc3 station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
		0.1	**0.1**	**0.1**		**0.1**						
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.2	0.2
					No data			**0.5**	**1.7**	**1.4**		
80	0.7	0.7	0.7	0.7	0.7	0.7	1.7	2.5	3.5	7.0	2.2	0.7
95	2.3	2.1	3.3	1.7	0.9	1.5	4.5	6.3	9.3	12.3	5.3	2.0

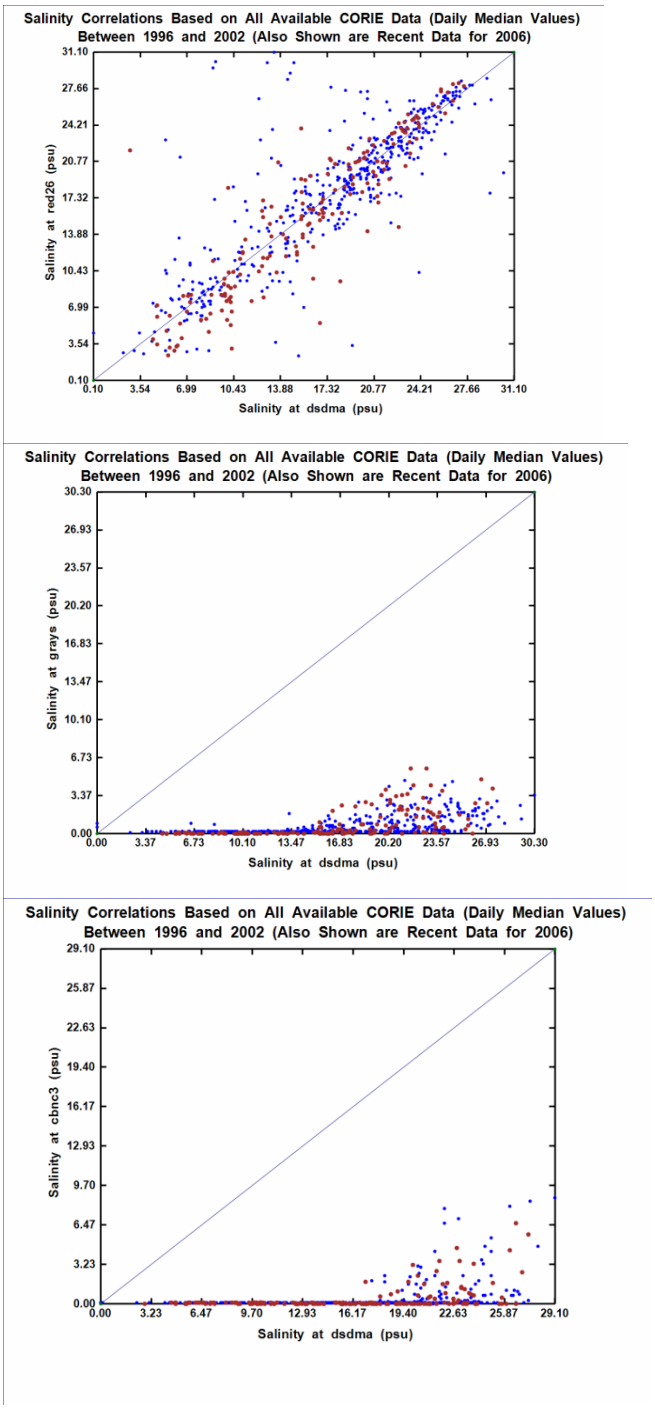


Figure 2.3.2. Median daily salinity for (a) red26, (b) grays, and (c) cbnc3 stations plotted for 2006 in relation to median daily salinity for the "dsdma" (Desdemona) station.

2-4 Columbia River Discharge

Early 2006 observations by the AMT of MA-1 water temperature values that appeared elevated in comparisons with pre-Project temperatures initiated an attempt to explain this pattern. AMT members suggested that unusually high river flows could account for elevated temperatures. Representative Columbia River daily flow data were obtained from a sampling location near the Bonneville Dam (Figure 2.4.1). Analysis of the flows in January and February confirmed the speculation that flows were high. MA-1 values of temperature and depth for this period were correspondingly higher.

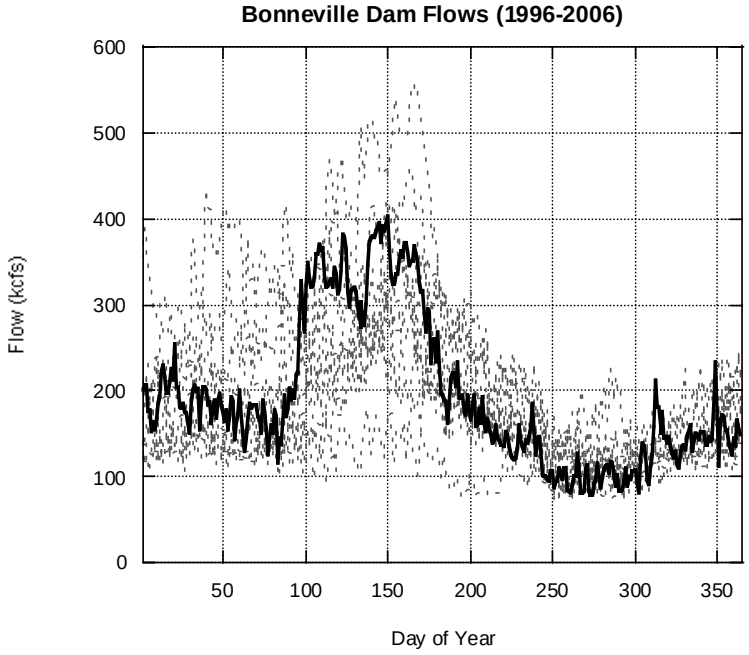


Figure 2.4.1. Daily flow values recorded at Bonneville Dam for calendar year 2006 (solid line). Dashed lines show pre-Project (baseline) values for 1996–2004.

The collation and analysis of the Bonneville Dam flow data continued through 2006 as flow data became available (Figure 2.4.1). The elevated flows later in the year (~DOY 315, 350) also correspond to increased values of depth and temperature recorded at the MA-1 stations; salinity values were also lower during these flow events.

The Bonneville Dam flow data are consistent with the temporal changes in observations at the MA-1 stations. It is recognized that the Bonneville Dam flows are not exact predictors of water circulation at the MA-1 stations. However, the overall qualitative agreement between the patterns in recorded Bonneville flows and the MA-1 monitoring results provide a simple and compelling explanation for deviations from pre-Project conditions and exceedances of decision criteria.

2-5 AMT Decisions for MA-1

Table 2.5.1. CRCIP AEM Plan Record of AMT Decisions

Date	Issue	MA-1 Decisions	Comments
16-Dec-2006	**MA-1**	Compare with different monthly confidence intervals (CI) (e.g., 70, 80, 90 percentiles)	
16-Dec-2006	**MA-1**	Develop plots of daily mean values against the CI	
16-Dec-2006	**MA-1**	Add state water quality standards (e.g., temperature for Washington, Oregon)	
16-Dec-2006	**MA-1**	Produce plots in "real time" as data QA/QC process permits	
16-Dec-2006	**MA-1**	Make plots (analyses) available to AMT via FTP site - daily values posted every 1−5 days	
16-Dec-2006	**MA-1**	At end of each month, calculate monthly average and compare to monthly CI values	
16-Dec-2006	**MA-1**	Meet monthly during construction phase to evaluate consensus on criteria	
14-Jun-2005	**MA-1**	The team tentatively agreed to the water elevation decision criteria. The Science Center should have the opportunity to review the proposed criteria.	
21-Jun-2005	**MA-1**	Concerns were expressed that cbnc3 had incomplete data and that the Marsh station would provide better data. The cbnc3 station was selected because it was located at the channel into Cathlamet Bay and would be a good indicator of changes that could affect the bay. The Marsh station is too far upstream and would likely not show any changes in salinity or temperature from the deepening. The cnbc3 location is also important for connectivity and conductivity. NMFS agreed with the stated rationale for the selection of cbnc3.	
28-Jun-2005	**MA-1**	The team discussed the desire by WDOE and ODEQ to substitute CBNCE for one of the other close proximity CORIE stations, such as Marsh, because of the limited historical data availability and it's susceptibility to bio-fouling. However, the change was not agreed to by the AMT and as a result the CBNCE data that are interpolated will be flagged	
28-Jun-2005	**MA-1**	From last meeting, Cathy was going to talk to the Science Center about the water elevation decision criteria. She stated that she was waiting for an e-mail back from Ed Castillas. She stated that Ed talked with Antonio Baptista who stated that the evaluation criteria were too broad and we would not be able detect change. The Corps agreed to have a conference call between S. Bartell, A. Bastista and S. Nair to discuss the concerns.	
28-Jun-2005	**MA-1**	Sample sizes will be added to the WA-1 tables. The numbers in the tables will be revised and presented to the 10th decimal point. Corrections to the salinity calculations (i.e., binning erros) will be included in revised tables. Any reference to real time data needs to be taken out of the decision criteria document. WDOE and ODEQ also requested that the depth at which each CORIE station is monitoring is included in each data table provided to the AMT.	

Table 2.5.1. CRCIP AEM Plan Record of AMT Decisions. (Continued).

Date	Issue	MA-1 Decisions	Comments
22-Aug-2005	**MA-1**	There was discussion of the normalization of daily median water temperature data for selected CORIE stations to daily median water temperature data for the "woody" sampling location. Temperature values at the woody station are largely determined by river flows. These normalizations have been summarized by simply plotting the data from selected stations against the woody data. Deviations from a linear relationship suggest increasing influence of ocean water on temperature. The suggestion is that alterations in circulation within the estuary due to channel modifications might be indicated by changes in the relations summarized in the plots.	
31-Aug-2005	**MA-1 Decision Criteria**	All agencies concurred on the triggers for MA-1: Two trigger tables will be developed showing triggers values set between the 5th and 90th percentile and the 20th and 80th percentile. Median daily water temperature values for the three MA-1 CORIE stations will be also plotted against corresponding values for the woody station. The data will be evaluated quarterly for the first year and/or after each contract for channel modifications starting October 12, 2005. These data will be reviewed and summarized annually.	
31-Aug-2005	**MA-1 Decision Criteria**	The group also agreed that if one of the stations being used breaks down, one of the other stations close to the unavailable station will be used as a surrogate, if possible.	
1-Sep-2005	**MA-1 Data Analysis**	E2 Consulting Engineers, Inc., (S. Bartell) will be responsible for analyzing and summarizing the MA-1 data.	
12-Oct-2005	**MA-1 Data Analysis**	Based on the results for depth, temperature, and salinity presented at the AMT Meeting, the AMT concluded that adaptive management would not be initiated.	
12-Oct-2006	**MA-1 Data Analysis**	The AMT requested that normalized salinity plots be developed by E2 for the three MA-1 monitoring stations.	
11-Jan-2006	**MA-1 Salinity Plots**	E2 developed salinity plots for the three MA-1 stations and several candidate reference stations. After examining the results of these plots, the AMT agreed that the Desdemona station appeared to provide the best relationship between values of median daily salinity. The AMT concluded that these kinds of normalized salinity plots should become part of the adaptive management process (AMP) and used in the same way as the normalized temperature plots.	
12-Apr-2006	**MA-1 Data Analysis**	Based on the results for depth, temperature, and salinity presented at the AMT Meeting, the AMT concluded that adaptive management would not be initiated.	
12-Apr-2006	**Columbia River flow data**	The AMT requested that summaries of flow data be provided to assist in the interpretation of depth, temperature, and salininty data.	
12-Apr-2006	**MA-1 Current Velocity Data**	The AMT asked that the availability of current velocity data be re-examined in relation to MA-1 assessments of changes in physical habitat that might be associated with the CRCIP construction.	
11-Oct-2006	**MA-1 Data Analysis**	The AMT requested that the MA-1 analyses be performed in a more timely manner. (This is largely determined by the availability of the data as provided by CORIE.)	

3 Monitoring Action 2—Dredging Volumes

3-1 Volumes of Dredged Materials

MA-2 provides annual dredging volumes associated with construction and operation of the 48-foot navigation channel. Volumes are reported for each dredging bar (~3-mile reaches). Adaptive management can be triggered if actual construction volumes exceed projected volumes (e.g., Table 3.1.1). In addition, the adaptive component of the proposed AEM Plan might be initiated if the volumes of dredged materials exceed the capacity for disposal. Volumes and disposal of operations and maintenance dredging are also tracked in relation to the Project. These three aspects of Project construction contribute to decision-making concerning adaptive management based on the MA-2 results.

Project construction to date has occurred at Desdemona, Flavel Bar, Upper Sands, Willow Bar, Morgan Bar, and Lower Vancouver. Thus far, actual new construction has not exceeded the projected dredging volumes at any of these locations (Table 3.1.1).

3-2 Disposal of Project Dredged Materials

To date, the CRCIP construction has resulted in the disposal of 1,317,978 cubic yards (cy) to the Deep Water Site. In-water disposal accounted for 557,284 cy. Approximately 724,843 cy were rehandled materials that went to the Gateway disposal site. (This is an approximate estimate that refers to the volume contracted by the Corps. The actual amount placed at Gateway might differ.) Table 3.2.1 lists in detail the potential disposal sites, their associated capacities and amounts of dredged materials disposed of to date.

Table 3.1.1. Comparisons of projected and actual CRCIP construction volumes for 2006.

Sheet ID	Chart	Bar Name	Bar Stations by River Mile	D/S River Mile	Projected Volume Above 48 ft	Projected Volume Above 45 ft	Projected New Work (48−45) Volume	Sum (48−45) Volume	Sum (48−45) Volume	Sum (48−45) Volume	Actual New Work		Location of Placed Material			
											(48−45) Volume	(O&M) Volume		State	OR	WA
CL-4		**Lower Desdemona**	04+20+00	04+00+00	317,100	222,412	94,688	317,100	222,412	94,688	38,894		DWS/IW	OR	317,100	
				05+00+00	550,640	353,916	196,724	867,740	576,328	291,412				OR	550,640	
CL-5		**Upper Desdemona**	06+22+00	06+00+00	66,193	0	66,193	933,933	576,328	357,605	22,704	35,000	DWS/IW	OR	66,193	
	Predicted Bar New Construction Volume =	473,894		07+00+00	1,039	0	1,039	934,972	576,328	358,644				OR	1,039	
	Actual Bar New Construction Volume =	61,598		8+00+00	61,140	8,742	52,398	996,112	585,070	411,042				OR	61,140	
	Percentage of Prediction =	13%		9+00+00	71,593	8,742	62,851	1,067,705	593,811	473,894				OR	71,593	
CL-9		**Flavel Bar**	10+00+00	10+00+00	379,028	49,732	329,296	1,446,733	643,543	803,190	337,154		DWS/IW	OR	379,028	
	Predicted Bar New Construction Volume =	1,169,720		11+00+00	833,973	298,900	535,074	2,280,706	942,443	1,338,264	275,367		DWS/IW	OR	833,973	
	Actual Bar New Construction Volume =	716,828		12+00+00	360,900	121,292	239,608	2,641,606	1,063,735	1,577,871	300	110,000	DWS/IW	OR	360,900	
	Percentage of Prediction =	61%		13+00+00	138,168	72,425	65,743	2,779,773	1,136,160	1,643,614	104,007		DWS/IW	OR	138,168	
CL-14		**Upper Sands**	13+30+00	14+00+00	226,017	54,585	171,432	3,005,790	1,190,745	1,815,045	172,699	40,000	DWS/IW	OR	226,017	
	Predicted Bar New Construction Volume =	858,622		15+00+00	323,787	51,945	271,842	3,329,577	1,242,690	2,086,888	213,913	70,000	DWS/IW	OR	323,787	
	Actual Bar New Construction Volume =	539,552		16+00+00	354,274	47,557	306,717	3,683,851	1,290,246	2,393,605	152,940	90,000	DWS/IW	OR	354,274	

Table 3.1.1. Comparisons of projected and actual CRCIP construction volumes for 2006. (Continued).

Sheet ID	Chart	Bar Name	Bar Station by River Mile	D/S River Mile	Projected Volume Above 48 ft	Projected Volume Above 45 ft	Projected New Work (48−45) Volume	Sum (48−45) Volume	Sum (48−45) Volume	Sum (48−45) Volume	Actual New Work (48−45) Volume	Actual New Work O&M Volume	Location of Placed Material	State	OR	WA
CL-14		**Upper Sands**														
	Percentage of Prediction =	63%		17+00+00	108,631	0	108,631	3,792,482	1,290,246	2,502,236				OR	108,631	
CL-94		**Willow Bar**	93+50+00	93+00+00	261,237	67,579	193,659							WA		261,237
	Predicted Bar New Construction Volume =	537,183		94+00+00	156,838	45,286	111,552							OR/WA	78,419	78,419
	Actual Bar New Construction Volume =	355,623		95+00+00	78,237	6,356	71,881				355,623		Rehandled Material	OR/WA	39,118	39,118
	Percentage of Prediction =	66%		96+00+00	191,681	31,588	160,093							OR/WA	95,840	95,840
CL-97		**Morgan Bar**	97+40+00	97+00+00	167,351	31,430	135,922							OR/WA	83,676	83,676
	Predicted Bar New Construction Volume =	191,689		98+00+00	50,416	3,821	46,595				33,637		Rehandled Material	OR/WA	25,208	25,208
	Actual Bar New Construction Volume =	33,637		99+00+00	9,172	0	9,172							OR	9,172	
	Percentage of Prediction =	18%		100+00+00	0	0	0							OR	0	
CL-102		**Lower Vancouver**	101+18+00	101+00+00	87,054	10,311	76,744							OR	87,054	
	Predicted Bar New Construction Volume =	556,043		102+00+00	84	0	84				352,718		Rehandled Material	OR	84	
	Actual Bar New Construction Volume =	352,718		103+00+00	87,909	1,810	86,099							WA		87,909
	Percentage of Prediction =	63%		104+00+00	393,116	0	393,116							WA		393,116

Table 3.1.2. Disposal of CRCIP dredged materials.

Disposal	Site	CRCIP Construction		Projected O&M	Actual O&M	Percent	Total Estimated
Site	Location/Name	Projected Volume	Volume Placed	Volume	Volume Placed	Full	Capacity
W-21.0	Rice island	0		5,500,000			5,500,000
O-23.5	Miller Sands	0		7,000,000			NA
O-27.2	Pillar Rock Island	0		1,000,000			2,555,000
W-33.4	Skamokawa	0		varies			250,000
O-34.0	Welch island	0		400,000			446,000
O-38.3	Tenasillahe Island	0		2,300,000			2,300,000
O-42.9	James River	240,000		830,000			1,280,000
W-44.0	Puget Island (Vik Prop.)	500,000		2,700,000			3,500,000
W-46.3/W-46.0	Brown Island	1,200,000		3,400,000			4,700,000
O-54.0	Port Westward	150,000		1,500,000			1,875,000
O-57.0	Crims Island	30,000		1,100,000			1,600,000
W-59.7	Hump Island	400,000		900,000			1,500,000
W-62.0	Mt. Solo	300,000		2,100,000			2,500,000
W-63.5	Reynolds Aluminum	180,000		0			500,000
O-63.5	Lord Island Upstream	0		600,000			1,255,000
O-64.8	Rainier Industrial	270,000		2,400,000			2,235,000
W-67.5	International Paper	140,000		2,700,000			1,000,000
O-67.0	Rainier Beach	450,000		2,400,000			1,095,000
W-68.7	Howard Island	0		600,000			6,400,000
W-70.1	Cottonwood Island	240,000		1,300,000			3,200,000
W-71.9	Northport	189,000		1,800,000			900,000
O-75.8	Sandy Island	120,000		860,000			1,100,000
O-77.0	Lower Deer Island	440,000		700,000			1,498,000
W-80.0	Martin Island Mitigation	370,000		0			550,000
W-82.0	Martin Bar	46,000		700,000			1,500,000
O-82.6	Reichold	320,000		2,300,000			1,285,000
O-86.2	Sand Island	150,000		860,000			1,250,000
W-86.5	Austin Point	136,000		1,500,000			1,645,000
O-87.8	Railroad Corridor	300,000		0			540,000
O-91.5	Lonestar	900,000		3,200,000			5,350,000
W-96.9	Adjacent to Fazio	0		varies			475,000
W-97.1	Fazio Sand & Gravel	112,000		1,000,000			650,000
W-101.0	Gateway	587,000	724,843	1,600,000		32%	2,300,000
O-105.0	West Hayden Island	600,000		3,900,000			5,750,000
Total upland			724,843			1%	57,433,000
DWS		6,500,000	1,317,978			1%	225,000,000
IW			557,284				
Rehandled Material			724,843				

3-3 AMT Decisions for MA-2

Table 3.3.1. CRCIP AEM Plan Record of AMT Decisions.

Date	Issue	MA-2 Decisions	Comments
16-Dec-2006	**MA-2 Decision Criterion**	Compare actual dredging volumes with predicted volumes	
16-Dec-2006	**MA-2 Decision Criterion**	Annual O&M dredging volumes plus construction volumes	
16-Dec-2006	**MA-2 Decision Criterion**	Develop plots of predicted vs actual dredged volumes for the contracted river mile segments; show percentages (e.g., 5, 10, 15, etc.) of possible exceedance	
16-Dec-2006	**MA-2 Decision Criterion**	Develop similar summaries for dredge disposal	
16-Dec-2006	**MA-2 Decision Criterion**	Communicate summaries, plots, etc. to the AMT within 2 months after each contract is completed	
16-Dec-2006	**MA-2 Decision Criterion**	Trigger for other disposal options (e.g., in-water vs upland), if larger than predicted volumes are dredged	
5-Jul-2005	**MA-2 Decision Criterion**	Initial consensus was for reporting the results of dredging on a contract basis, although Washington expressed continued interest in a bar-by-bar summary as well as a summary by contract.	
5-Jul-2005	**MA-2 Decision Criterion**	The AMT achieved consensus that the decision criteria for MA-2 would derive from comparisons between estimated and actual dredging volumes, as summarized and presented in the March annual AMT meeting.	
1-Sept-2005	**MA-2 Decision Criterion**	All agencies concurred that if the dredging volumes exceed the projected amounts in the CRCIP FSEIS by 15% or more that the AMT team members would be notified. Agreement was also reached, that at the quarterly meetings, the Corps would provide: dredging volumes updates for CRCIP construction and O&M, estimated amounts would be compared with actual amounts placed at individual upland sites and that volumes would be provide by bar and river mile.	
12-Oct-2005	**MA-2 Decision Criterion**	The AMT decision criteria refer to bar-by-bar summary of projected and actual dredging volumes. The spreadsheet currently provides a summary based on river miles. The spreadsheet will be modified to include additional rows that provide the bar-by-bar summaries. The location of disposal sites for Project dredging should also be included in the reporting for MA-2.	
11-Jan-2005	**MA-2 Decision Criterion**	It has proved difficult to determine the original source or relevance of the 15% proposed exceedance value. Therefore, following discussion, the AMT reached consensus to abandon the 15 percent decision criterion and simply compare projected dredging volumes to actual volumes.	
12-Apr-2006	**MA-2 Reporting**	The AMT made recommendations concerning the format of reporting dredging and disposal of dredged materials. A revised reporting template will be presented to the AMT at the next quarterly meeting.	

4 Monitoring Action 3—Crossline Surveys

MA-3 examines accretion/erosion and changes in bathymetry of the main channel in relation to the channel deepening. Crossline surveys will be performed annually for two years prior to construction, during construction, and three years after construction. Surveys will be performed at CRM 42, 46, 72, 75, 86, and 99. These river mile locations were identified through previous Corps analysis of locations that appeared potentially sensitive to accretion and erosion. Additional surveys will be performed at 0.5 miles up-river and 0.5 miles down-river from each of the selected CRM locations. Comparisons of survey results obtained during and after construction (year 2005+) with the MA-3 decision criteria will determine any need for adaptive management.

4-1 MA-3 Decision Criteria

In 2006, the results of pre-construction surveys (1996–2004) were used to developed consensus decision criteria to evaluate surveys performed in relation to Project construction (Table 4.1.1). The resulting depth "envelopes" define upper and lower depths that should not be exceeded as the result of construction dredging at these locations. The envelopes were calculated by subtracting the value of one standard deviation (SD) (sigma) from the minimum reported depth and adding one SD (sigma) to the maximum reported depth.

Table 4.1.1. Adaptive management depth envelopes for MA-3 crossline surveys.

	Pre-construction depth values (ft)			AEM Envelope depth (ft)	
CRM	**Minimum**	**Maximum**	**Sigma[1]**	**Upper**	**Lower**
41.5south	47.94	50.48	0.69	47.25	51.17
north	46.17	52.02	1.48	44.69	53.50
42.0	51.38	55.60	1.48	49.90	57.08
	43.58	48.74	1.64	41.94	50.38
42.5	47.17	54.54	2.71	44.46	57.25
	41.90	44.95	1.07	40.83	46.02
45.5	44.98	47.13	0.71	44.27	47.84
	40.71	44.31	1.20	39.51	45.51
46.0	46.53	52.64	1.67	44.86	54.31
	40.46	46.72	1.93	38.53	48.65
46.5	42.41	47.83	1.55	40.86	49.38
	41.43	46.83	1.45	39.98	48.28
71.5	40.75	46.79	1.61	39.14	48.40
	45.10	50.98	1.73	43.37	52.71
72.0	47.30	53.48	1.93	45.37	55.41
	44.37	50.44	2.13	42.24	52.57
72.5	61.39	77.15	4.40	56.99	81.55
	60.71	69.81	2.46	58.25	72.27
74.5	43.32	46.25	0.95	42.37	47.20
	52.33	59.04	1.85	50.48	60.89
75.0	42.17	47.14	1.60	40.57	48.74
	42.44	47.90	1.49	40.95	49.39
75.5	41.92	46.86	1.51	40.41	48.37
	45.84	49.54	1.29	44.55	50.83
85.5	42.18	46.55	1.46	40.72	48.01
	43.92	49.88	1.69	42.23	51.57
86.0	41.11	46.70	1.63	39.48	48.33
	46.78	55.77	2.68	44.10	58.45
86.5	39.64	44.42	1.50	38.14	45.92
	45.35	49.66	1.65	43.70	51.31
98.5	49.43	52.69	1.21	48.22	53.90
	43.15	46.94	1.26	41.89	48.20
99.0	50.35	54.55	1.25	49.10	55.80
	43.76	48.81	1.65	42.11	50.46
99.5	48.65	49.92	0.46	48.19	50.38
	45.13	47.36	0.77	44.36	48.13

[1]One SD of mean depth based on analysis of pre-Project surveys.

4-2 AMT Decisions for MA-3

Table 4.2.1. CRCIP AEM Plan Record of AMT Decisions.

Date	Issue	MA-3 Decisions	Comments
16-Dec-2005	**MA-3 Decision Criterion**	Develop plots that compare pre-construction variations in side slopes with post-construction slopes using results of crossline surveys; show percentages (e.g., 5, 10, 15, etc.) of measured changes in side slopes.	
16-Dec-2005	**MA-3 Decision Criterion**	Focus on six locations identified in the EIS.	
16-Dec-2006	**MA-3 Decision Criterion**	Use recorded dredging volumes to identify other possible locations for impacts on slopes. O&M dredging volumes that substantially exceed predicted values might indicate locations of increased side slope adjustments.	
16-Dec-2005	**MA-3 Decision Criterion**	Communicate summaries, plots, etc. to the AMT 2 years prior, 2 years during, and 3 years after construction is completed.	
16-Dec-2005	**MA-3 Decision Criterion**	Trigger for adaptive management if larger than predicted changes in side slope adjustment are observed.	
9-Aug-2005	**MA-3 Decision Criterion**	Crossline data are available at approximately 500-foot intervals throughout the navigable river. The results also summarized the minimum, maximum, and SD for surveyed depths at the southern and northern edges of the navigation channel. An envelope defined by the minimum + 1 SD and the maximum +1 SD was also plotted for each of the cross sections.	
9-Aug-2005	**MA-3 Decision Criterion**	Concerns were expressed that the selected few locations did not provide a sufficient description of potential impacts of channel dredging on slide slope adjustments and corresponding potential impacts on shallow water habitats. Requests were made to include two additional cross sections, upriver and downriver, to the locations currently included in the MA-3 design. Inclusion of more cross sections at other selected river miles into the MA-3 effort was also desired by several AMT members.	
9-Aug-2005	**MA-3 Decision Criterion**	Concerns were raised about the number of years included in the analysis. The years represent different flow conditions, for example, with 1996-97 being years with comparatively higher flows, and 2001 being an example of a low flow year. The surveys are part of an ongoing activity in support of navigation the CRCIP was funding several surveys in relation to the time periods outlined in the terms and conditions of the Biological Opinion - i.e., 2 years before, 2 years during, and 2 years after project construction.	
1-Sept-2005	**MA-3 Decision Criterion**	The consensus AMT decision criteria for MA-3 are defined as an "envelope" calculated as the minimum surveyed depth + 1 SD and the maximum depth + 1 SD. The envelope is defined across the channel for each survey with particular emphasis on the northern and southern boundaries of the navigation channel.	
1-Sept-2005	**MA-3 Decision Criterion**	All agencies concurred that the crossline survey results will be reviewed for exceedances and will reported yearly after the cross line surveys are completed. The MA-3 will examine accretion/erosion and changes in bathymetry of the main channel in relation to the channel deepening. Surveys will be conducted annually for two years prior to construction (by individual contract), two years during construction, and three years after construction. Crossline surveys will be conducted within a December-February time period to coincide with the end of the dredging season. Surveys will be conducted along the navigation channel from RM 3 to RM 106. Statistical analyses will produce estimates of mean and median depth at each sampled location across the channel; minimum and maximum values as well as SD and coefficients of variation will also be determined.	
11-Jan-2006	**MA-3 Decision Criterion**	The AMT agreed that the 'envelope' calculations for side slope adjustments would serve as initial decision criteria for MA-3. The AMT requested that the O'Brien-Michalsen' plots be incorporated as part of the AEM Plan implementation.	

5 Monitoring Action 4—Habitat Opportunity

MA-4 will augment the estuary habitat surveys being conducted by NMFS as part of the Anadromous Fish Evaluation Program (AFEP). The objective is to determine if changes in habitat opportunity and habitat capacity result from modifications to the channel. Habitat opportunity is defined as the number of hours within a 30-day (720-hour) month wherein values of physical habitat criteria are consistent with criteria developed for juvenile salmonids (Bottom et al. 2005). Pre-construction characterizations of habitat opportunity have been provided for juvenile chinook and chum in terms of suitable water depths and current velocity. Bottom et al. (2005) used a 2-dimensional circulation model to estimate historical (1880) and modern (1980, 1997–1999) habitat opportunity for selected months based on available data and information describing LCR bathymetry and flows. Habitat opportunities were calculated from model results for six regions of the LCR. These estimates can serve as a basis for comparing post-Project estimates of habitat opportunity to determine any impacts of channel modifications on physical habitat for juvenile salmonids.

5-1 MA-4 Decision Criteria

Estimates of habitat opportunity will be calculated using the post-Project bathymetry of the LCR. Pre- and post-Project comparisons may require re-calculation of pre-Project opportunity values given the availability of more recent pre-Project bathymetry than that used in the original Bottom et al. (2005) analyses. The post-construction MA-3 survey data can contribute to the calculations of habitat opportunity.

The CRCIP will fund one habitat survey conducted under the AFEP. The survey will be conducted three years following Project construction. As a result of the AFEP, there will be approximately 10-years of pre-Project habitat survey data. The results of the pre- and post-Project habitat comparisons will be evaluated in the AEM process.

Threshold values of change (i.e., decision criteria) will be defined for each habitat type as a result of the pre-project survey data. Measures that exceed any of the decision criteria may result in adaptation to current management actions. Table 5.1.1 illustrates a template for use in evaluating results of MA-4 habitat surveys.

Table 5.1.1. Template for evaluating changes in habitat opportunity (velocity, depth) using results from MA-4 habitat surveys.

	Habitat Opportunity (h/month)[2]											
LCR	Pre-construction[3]			Post-construction[5]			Percent change			Decision criteria (%-change)[6]		
Region[1]	Velocity	Depth	Combined	Velocity	Depth	Combined	Velocity	Depth	Combined	Velocity	Depth	Combined
1	580 - 620[4]	125 - 160										
2	275 - 310	~50										
3	590 - 610	210 - 240										
4	350 - 550	190 - 210	140 - 180									
5	390 - 500	155 - 180										
6	50 - 490	10 - 90										

[1] Regions defined by Bottom et al. (2005)

Region 1	Baker Bay
Region 2	Lower mainstem
Region 3	Youngs Bay
Region 4	Cathlamet Bay
Region 5	Grays Bay
Region 6	Upper estuary

[2] Calculated for 30-d (720 h) month

[3] Results reported in Bottom et al. (2005)

[4] Ranges reflect seasonal variations in river discharge

[5] Post-Project values of habitat opportunity will be estimated using the same methodology as Bottom et al. (2005) and bathymetry data revised in relation to channel deepening

[6] MA-4 decision criteria have yet to be defined by the Adaptive Management Team

5.2 AMT Decisions for MA-4

Table 5.2.1. CRCIP AEM Plan Record of AMT Decisions.

Date	Issue	MA-4 Decisions	Comments
16-Dec-2004	**MA-4 Decision Criterion**	Re-evaluation of Bottom et al.(in prep.) calculations of habitat opportunity.	
16-Dec-2004	**MA-4 Decision Criterion**	Detailed survey to be conducted 3 years after project construction.	
16-Dec-2004	**MA-4 Decision Criterion**	Presentation of ongoing studies (Science Center) that are further elaborating salmonid utilization of the lower river and estuary.	
5-Jul-2005	**MA-4 Decision Criterion**	The Channel Improvement Project will fund one of the 10 years and include support for in-depth analysis of the data obtained during this study. Discussion continues concerning which one of the 10 years will be funded by the CRCIP. It was proposed to select the year corresponding to 3 years after Project completion.	
5-Jul-2005	**MA-4 Decision Criterion**	NOAA Fisheries (C. Tortorici) expressed an interest in selecting the year of Project funding for the more intensive studies to be supported by MA-4. The NOAA emphasis resides in ensuring that the intensive study is performed. NOAA was silent concerning the Corps proposed target year designated as three years post-construction.	
5-Jul-2005	**MA-4 Decision Criterion**	The Corps noted that additional discussion is needed to come to an agreement on identifying the post-construction year selected for MA-4. This should be a topic of future AMT meetings until resolved.	
1-Sep-2005	**MA-4 Decision Criterion**	The agencies concurred that setting triggers at this time would be premature and that this MA would be reviewed quarterly. It was also agreed that either NOAA or the Corps would report the study findings at the yearly AFEP meeting.	

6 Monitoring Action 5—Sediment Contaminants

Another concern associated with channel improvement is the potential for any existing sediment contaminants to be suspended by dredging activities. Once suspended, these contaminants might pose risks to aquatic organisms, including juvenile salmonids. Monitoring Action 5 addresses this concern through the collation and evaluation of existing data that describe sediment contaminants in the LCR and estuary. Given limitations in available data, MA-5 has initially focused on samples that were collected well before the onset of the CRCIP. More recent data will be included as they are identified and become available to the AMT.

6-1 Sediment Contaminants

Sediment samples were collected and analyzed for three reaches on the Columbia River and estuary (Table 6.1.1). The analyses focused on metals and organic contaminants. The majority of samples did not exceed DMEF or NOAA screening-level threshold values. A total of four samples exceeded these values for total DDT and total PAH in reach 2. However, these samples were collected outside of the navigation channel.

Table 6.1.1. Summary of sediment contaminant analyses.

Reach/Years	River Miles	Sampling Trips	Stations Sampled	Number of Analyses	Exceedance of DMEF/NOAA Thresholds	Locations
2/ 1986–1997	85–95	7	25	341	Total DDT, Total PAH	Outside navigation channel
5/ 1990–2005	41–56	22	106	2,818	None	-
6/ 1990–1997	35–41	8	15	406	None	-

In April and May 1989, sediment samples for physical and bulk chemical analyses were collected by the Corps from the cross barge channel at St. Helens, Oregon. The channel is located downstream of Sauvie Island and connects the Columbia River at approximately RM 86.5 and the St. Helens Channel at mile 2.0. The sediment collected in April was clean sand with less than 2 percent fines and less than 1 percent total volatile solids. Three analyses were conducted for PAHs. The results were 863 ug/Kg and 1055.9 ug/Kg for SH-VC-5 and 70 ug/Kg for SH-VC-6. [Note: SH-VC-5 is approximately one-tenth of a mile south of the Advanced Maintenance Area and the channel.] These values were below the TPAH screening levels in effect at that time (1,500–2,000 ug/Kg) as well the subsequent 1998 DMEF screening level (5,200 ug/Kg). The TPAH value of 1,055.9 ug/Kg does exceed the 2000 NOAA threshold value of 1,000 ug/Kg suggested to protect estuarine fish.

The LCR Bi-State Water Quality Program was initiated in 1990 by the Oregon and Washington state legislatures to address concerns regarding overall water quality of the LCR. As part of this effort sediment samples were collected and analyzed in 1991 and 1993. These are known as the Reconnaissance Survey (RS) and the Reconnaissance Backwater Survey, respectively. In Reach 2 (RM 85–95 only) there were 5 RS sample stations (E9D, D24, D25, D26, and D27) assessed with regard to the CRCIP. Sample E9D and D24 exceeded DMEF SL for DDT at 100 ug/Kg

and 9.4 ug/Kg, respectively. D24 exceeded NOAA threshold values for TPAH at 2,140 ug/Kg but not the DMEF SL at 5,400 ug/Kg. Sample D24 is located in the St. Helens channel behind Sand Island. It is in 8 feet of water and contained 25 percent silt and clay. Sample E9D was collected in 26 feet of water and contained 21percent silt and clay. Neither of these samples are representative of the material in the overwidth areas to be dredged as part of the CRCIP.

6-2 AMT Decisions for MA-5

Table 6.2.1. CRCIP AEM Plan Record of AMT Decisions.

Date	Issue	MA-5 Decisions	Comments
16-Dec-2004	**MA-5 Decision Criterion**	AMT will solicit summaries of sediment contamination data from technical group already performing this work.	
16-Dec-2004	**MA-5 Decision Criterion**	The AMT will interact with the LCREP to acquire additional data and information concerning chemical contaminants in the lower river and estuary.	
1-Sep-2005	**MA-5 Decision Criterion**	WDOE agreed to verify whether they would be housing the system. (Update: WDOE e-mailed the Corps on September 6, stating that WDOE "…will always maintain the SEDQUAL system as for their purposes so it will always be available to use of the AMT.)	
1-Sep-2005	**MA-5 Decision Criterion**	As for the triggers, the team discussed using the new SEF as triggers for sediment quality upon approval and adoption of the SEF.	
12-Oct-2005	**MA-5 Decision Criterion**	While there are some gaps, the SEF largely addresses the sediment contaminants of interest to WA, OR, and ID. The AMT agrees that decision criteria for MA-5 should be made on the basis of the final SEF.	
12-Apr-2006	**MA-5 Reporting**	The AMT agreed that the SEDQUAL input template was adequate to describe newly obtained sediment contaminants data.	

7 Monitoring Action 6—Fish Stranding

7-1 Frequency of Stranding

The proposed decision criterion is based on a comparison of pre- and post-Project numbers of stranded fish. An increase in the number of stranded fish following channel improvements will presumably initiate the adaptive components of the CRCIP AEM Plan. An important consideration in developing this decision criterion lies in establishing a statistical difference between pre- and post-Project fish stranding. Table 7.1.1 summarizes the results of intensive field studies aimed at understanding the potential for fish stranding by commercial navigation in the Columbia River and estuary (Pearson et al. 2005a). The studies suggest site-specific differences in the frequency of vessel passages that result in fish stranding. On average across all three locations, approximately 26 percent of the vessel passages were associated with stranding events. This frequency ranged from ~18 to 30 percent for these three locations. If corresponding post-Project stranding frequencies are statistically greater than the values summarized in Table 7.1.1, it would prove reasonable and prudent to follow the adaptive components of the AEM Plan and attempt to determine the likely cause for the measured increase. The feasibility in performing these statistical comparisons will be determined by (1) the quantitative nature of the previous and continuing measures of fish stranding, and (2) the statistical design of MA-6 for the collection of appropriate post-construction data.

Table 7.1.1. Frequency of fish stranding events at study sites (Pearson et al. 2005a).

Sites	Stranding events	Total passages	Frequency (%)
County Line Park (RM 51)	3	17	17.6
Barlow Point (RM 62)	7	23	30.4
Sauvie Island (RM 97)	4	14	28.6
Overall frequency: 25.9%	Chi square: p=0.64		

7-2 Susceptibility to Stranding

In addition to potentially changing the frequency of fish stranding events, channel modifications in the Columbia River and estuary might alter the susceptibility of different fish species to stranding. Pearson et al. (2005a) estimated the relative percentage of 11 species commonly collected in the locations of the stranding studies (Table 7.2.1). The results of seining indicated that the relative abundance of fish subject to stranding was dominated by three-spine stickleback, peamouth, American shad, and age 0+ chinook salmon. The relative abundances of these species among the stranded fish were also calculated. Dividing the relative frequency of stranding by the relative abundance produced a ratio that defines the susceptibility for each of the 11 species (Table 7.2.1). Ratios greater than 1.0 indicate greater susceptibility to stranding. That is, the species is proportionally over-represented among the stranded fish compared to its relative availability. In contrast, susceptibility ratios less than 1.0 indicate some ability of the species to reduce its likelihood of stranding.

Bass (fry) were the most susceptible of the 11 species to stranding by commercial vessel passage. Sunfish (bluegill), crappie, and age 0+ chinook were also susceptible. The remaining six species demonstrated some capability to avoid stranding. The susceptibility ratios can also serve as decision criteria for fish stranding in the AEM Plan. Potential modifications in fish habitat and changes in fish behavior associated with channel modifications could increase the local availability or susceptibility of these (or other) species. If post-Project susceptibility ratios increase significantly compared to those reported in Table 7.2.1, the adaptive components of the AEM Plan should be followed to determine the likely reason for the increases.

Table 7.2.1. Relative susceptibility of different fish species to stranding (Pearson et al. 2005a).

Species	Percent stranded	Percent seined	Susceptibility ratio
Chinook salmon (0+)	30.1	12.5	2.4
Three-spin stickleback	25.9	28.7	0.9
Peamouth	5.7	22.3	0.3
Banded killifish	10.6	12.3	0.9
Bass (fry)	16.0	0.2	80.0
American shad	8.2	20.1	0.4
Yellow perch	0.8	1.7	0.5
Mountain whitefish	0.6	0	0
Starry flounder	0.8	2.0	0.4
Crappie	0.4	0.1	4.0
Sunfish/bluegill	0.8	0.1	8.0

7-3 AMT Decisions for MA-6

Table 7.3.1. CRCIP AEM Plan Record of AMT Decisions.

Date	Issue	MA-6 Decisions	Comments
16-Dec-2004	**MA-6 Decision Criterion**	Studies of fish stranding will continue in 2005.	
16-Dec-2004	**MA-6 Decision Criterion**	Need to examine the statistical model to identify the factors and interaction terms that can be effectively incorporated into the AEM process.	
16-Dec-2004	**MA-6 Decision Criterion**	Revisit decision criteria after studies are completed (approx. November-December 2005).	
1-Sep-2005	**MA-6 Decision Criterion**	Post-construction studies of stranding will be performed and the results will be compared to pre-construction stranding study results.	
12-Oct-2005	**MA-6 Decision Criterion**	While there are some gaps, the SEF largely addresses the sediment contaminants of interest to WA, OR, and ID. The AMT agrees that decision criteria for MA-5 should be made on the basis of the final SEF.	
12-Apr-2006	**MA-6 Reporting**	The AMT suggested that tables describing fish stranding be modified to focus on species of concern (i.e., salmonids).	

8 Sturgeon

Criteria to protect sturgeon as part of the AEM process will address the possible CRCIP impacts on the mortality, survival, growth, movements, feeding behavior, and habitat utilization of these fish in relation to the dredging process and the disposal of dredged materials. These actions emphasize the selection of alternative sites for disposing of dredged materials if significant impacts are observed. Alternatively, the dredging schedule can be modified to minimize impacts on sturgeon.

8-1 Decision Criteria for Sturgeon

The results of the Parsley and Popoff (2004) study indicated that sturgeon were not detrimentally affected by dredging operations or disposal of dredged materials. In some instances the fish did not leave areas that were being dredged. Other instances, the monitored individuals returned to dredged areas soon after dredging operations were completed. These results are based on the monitoring of a comparatively small number of individuals. However, the degree of consistency in the general behavioral patterns recorded for these fishes questions the value-added of further monitoring.

There are additional concerns that modification of channel slopes and bedform might impact the quality and distribution of preferred sturgeon habitat. Preliminary analysis of the monitoring data suggests that these fish prefer steeply-sloped channels and rough channel bedform. Further analysis continues to examine this initial result. If confirmed, changes in channel bathymetry (see MA-3 and MA-4) caused by channel modifications might require examination in relation to the availability of preferred sturgeon habitat.

The AMT will determine the utility of the sturgeon habitat study results for deriving AEM criteria when it examines the final Project report.

8-2 AMT Decisions regarding Sturgeon

Table 8.2.1. CRCIP AEM Plan Record of Adaptive Management Team Decisions.

Date	Issue	Sturgeon Decisions	Comments
16-Dec-2004	**Sturgeon**	Slope characteristics will be further analyzed to identify categories of slope and bed form using existing data. Results will be used to guide dredging and dredge disposal.	
16-Dec-2004	**Sturgeon**	Awaiting completion of report (due mid-January 2005)	
16-Dec-2004	**Sturgeon**	Mitigation strategy to be developed during January	
16-Dec-2004	**Sturgeon**	Ongoing studies will look at disposal impacts.	
5-Jul-2005	**Sturgeon**	Previous monitoring studies of tagged sturgeon suggest minimal or no impacts of dredging or disposal of dredged materials on these fish. Additional analyses of the data are awaited to determine the nature of bottom type (flat or presence of structure) that seem important to sturgeon in the lower river and estuary. With the exception of a desire for additional studies by Washington (L. Randall), there is general consensus among the AMT that sturgeon can be removed from further consideration in relation to implementing the Project AEM Plan.	
1-Sep-2005	**Sturgeon**	At the July 5, 2005 weekly AMT meeting, the AMT agreed that previous monitoring studies of tagged sturgeon suggested minimal or no impacts due to dredging or disposal of dredged materials and that adaptive management will be required only if dredging activities alter habitat. The Corps had previously indicated that additional work would be done on correlating sturgeon abundance with habitat using the existing data.	
1-Sep-2005	**Sturgeon**	The Corps at the current meeting had concerns with funding stating that the work plan for this study was stopped and the study plan was not finalized. The agencies also requested that any study plans for this work be reviewed by all agencies.	

9 Smelt

9-1 Decision Criteria for Smelt

Decision criteria concerning disposal of dredged materials were developed for smelt within the context of the channel deepening AEM Plan (Table 9.1.1). The criteria are essentially compliance or non-compliance with state requirements for disposal of dredged materials during smelt migration. The AMT concurred that no variances of the decision criteria for smelt were reported for 2006.

Table 9.1.1. Compliance measures offered as decision criteria for smelt in implementation of the CRCIP AEM Plan.

Washington
In-water disposal of dredged material will not occur in areas shallower than 43-feet between CRM 35 and CRM 75 along the Washington shoreline. These areas are defined by depths determined in the pre-construction bank-to-bank bathymetry supplemented by additional channel bathymetry.
Washington, Oregon
In-water disposal will not occur during the period of peak Eulachon out migration (between the 8th and 20th weeks of the year) from the identified spawning areas (CRM 35–CRM 75). If in-water disposal is essential during the period of peak out migration, then the Corps shall further study the potential for Eulachon losses as a result of dredged material disposal impacts. Appropriate mitigation measures shall be developed based on the study outcomes, as determined through an AMP.

9-2 AMT Decisions regarding Smelt

Table 9.2.1. CRCIP AEM Plan Record of AMT Decisions for Smelt.

Date	Issue	Smelt Decisions	Comments
16-Dec-2004	**Smelt**	Regularly report compliance with state issues concerning flow-lane disposal.	
16-Dec-2004	**Smelt**	If flow-lane disposal becomes necessary, the abundance of smelt and time of peak out-migration will be documented by the Corps and provided to the AMT to determine timing and guidance for dredge disposal.	
28-Jun-2005	**Sturgeon**	The team agreed that dredging will occur between RM 35-75 between August 1 and September 30.	

10 Dungeness Crab

The objectives of the AEM Plan concerning Dungeness crab are to avoid or minimize (1) entrainment mortality during dredging and (2) crab burial by disposal of dredged materials. The underlying intent is "no net loss" of these organisms as a result of channel improvement.

Field studies were undertaken from 2002 through 2004 to (1) determine the distribution of age 0+, 1+, and 2+ crabs, (2) estimate the numbers of crab entrained and killed by the dredging process, and (3) develop a model that predicts the distribution of crab as a function of salinity in the estuary (Pearson et al. 2005b).

10-1 Decision Criteria for Dungeness Crab

Entrainment studies were performed at several locations within the estuary, including the mouth of the Columbia River, Desdemona Shoals, Upper Sands, Miller Sands, and Flavel Bar. Estimated crab entrainment rates varied by location, age class, and year. Entrainment rates decreased progressively upriver from the mouth of the estuary, presumably in relation to the reduced abundance of crabs (Table 10.1.1).

Table 10.1.1. Crab entrainment rates (crabs/cubic yard) estimated for 2004 (Pearson et al. 2005b).

Location	Age 0+	Age 1+	Age 2+	Age 3+	All
MCR All	0.0572	0.0028	0.0210	0.0128	0.0937
MCR-1	0.0535	0.0023	0.0147	0.0179	0.0883
MCR-2	0.0445	0.0022	0.0341	0.0126	0.0934
MCR-3	0.0760	0.0042	0.0137	0.0067	0.1007
Desdemona	0.0139	0	0.0035	0.0065	0.0239
Flavel Bar	0	0.0031	0.0035	0.0046	0.0112

Pearson et al. (2005b) recommended actions to mitigate the potential impacts of Project dredging on Dungeness crabs. One, understanding of seasonal patterns of salinity values throughout the lower river and estuary could be used to schedule dredging operations when salinity values are low (<16 psu) and crabs are correspondingly less abundant. Additionally, disposal of dredged materials should be avoided at the North Jetty Site reduce potential impacts on 1+ crabs that migrate through this area during the October–November time frame.

The AMT agreed that the results of the crab entrainment studies provide useful information for evaluating the effects of Project-related dredging on crab mortality and distribution.

10-2 AMT Decisions regarding Dungeness Crab

Table 10.2.1. CRCIP AEM Plan Record of AMT Decisions for Crab.

Date	Issue	Crab Decisions	Comments
1-Sep-2004	**Crab**	The draft crab mitigation strategy document was sent out for review by the AMT on June 21, 2005. The agencies had no feedback on the document but considered it to be a living document that could potentially change as new information on crabs was obtained. They also indicated that additional information should be obtained on the distribution and abundance of 1+ crab at Desdemona shoal.	
12-Apr-2006	**Crab**	The AMT agreed that reporting on crab enrtainment would mainly take the form of including new data that became available during the course of the Project.	
12-Apr-2006	**Crab**	The Washington Department of Ecology accepted the Corps crab mitigation plan subject to the collection of additional data in 2006 at the Desdemona sampling location.	
11-Oct-2006	**Crab**	The final version of the Pearson et al. (2005b) report on crab entrainment will be posted at the E2 Project web site.	

11 Sediments

11-1 Decision Criteria for Sediments

The AMT progressed towards development of a consensus statement concerning the relevance of the CRCIP to more comprehensive management of sediments in the LCR and estuary. Lack of consensus results in part from two competing points of view. One argument is that the CRCIP should develop a comprehensive sediment management plan that addresses sediment issues, federal and state, beyond the scope of the channel improvement Project. An alternative perspective is that management of Project dredged materials should contribute towards a more comprehensive sediment management program, but not be the originator of the program. In addition, the CRCIP should take advantage of opportunities for beneficial uses of Project dredged materials. Revisions to earlier draft statements are circulating among the AMT members for review and comment.

11-2 Summary and Recommendations

The sediment issues will be discussed again at the April 2007 quarterly meeting of the AMT.

Table 11.2.1. CRCIP AEM Plan Record of AMT Decisions for Sediments.

Date	Issue	Sediments Decisions	Comments
11-Jan-2006	**Sediment Management**	The Corps and E2 agreed to collaborate with WDOE in the development of language concerning sediments (i.e., management of disposal of dredged materials) for incorporation into the Project AEM Plan.	
12-Apr-2006	**Sediment Management**	The Corps agreed to further consultation with WDOE concerning the incorporation of sediment management language into the AEM Plan.	

12 Integration with 2005 AEM Results

A consensus opinion among the AMT is that each annual report should refer to the prior years' AEM activities and conclusions to instill continuity throughout the CRCIP AMP. The remainder of this section briefly outlines 2005 AMT activities and summarizes some of the 2005 MA-1 monitoring results. Additional detail can be found in the notes from the quarterly AMT meetings and the AEM workbook that are posted on the Project FTP site hosted by E2.

The AMT spent much of calendar 2005 in (1) revising preliminary drafts and finalizing the Project AEM Plan; (2) reviewing preliminary results of ongoing studies relevant to developing the AEM decision criteria (e.g., analysis of CORIE data, crab entrainment study, fish stranding Project, sturgeon study); (3) developing an initial set of decision criteria, and (4) implementing the AEM process for a portion of 2005 that included actual Project construction.

12-1 Results for Analyses of 2005 Data for MA-1

The primary MA-1 decision criteria are the monthly percentile values for depth, temperature, and salinity. Monthly median values calculated from the CORIE data for red26, grays, and cbnc3 are compared against these criteria. Tables 12.1.1–12.1.7 list these decision criteria and corresponding MA-1 monthly results for 2005. Detailed plots of daily median values and normalized values of temperature and salinity can be examined by downloading the corresponding files at the E2 Consulting Engineers, Inc., FTP site.

Depth

Table 12.1.1 lists the monthly median depths for the grays station. All 12 monthly values are within the 20–80th percentile decision criteria.

Temperature

With only three exceptions, the monthly median values of water temperature are all with the 20 – 80th percentile ranges for red26 (Table 12.1.2), grays (Table 12.1.3), and cbnc3 (Table 12.1.4). The other three monthly values show slight elevations in temperature that are between the 80 – 95th percentile decision criteria. None of the monthly median values for 2005 are outside of the 5–95th percentile ranges.

Salinity

Tables 12.1.5–12.1.7 present the monthly median salinity values for red26, grays, and cbnc3. The 2005 results are quite similar to those observed in 2006. The available data for red26 are all within the 20–80th percentile decision criteria. The 2005 monthly median values for grays are more variable in relation to the decision criteria. However, the overall magnitudes of salinity changes are small. Similar results were obtained for cbnc3, although if there were any tendency, it was towards decreased values of salinity – again, not indicative of salinity intrusions.

Other Management Endpoints

Much of 2005 was spent in arriving at the decision criteria for MA-2 through MA-6, Dungeness crab, smelt, and sturgeon, which have been described in the previous sections of this 2006 annual

report. Ongoing studies in 2005 (e.g., crab entrainment, sturgeon movements, fish stranding) were reviewed and discussed by the AMT in relation to implementation of the AEM Plan. Considerable progress was made as evidenced by the content of this 2006 report.

Table 12.1.1. Summary of 2005 monthly median depth values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median depth (m)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.6	0.5	0.5	0.5	0.4	0.3	0.2	0.2	0.3	0.3	0.4	0.5
20	1.3	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.1	1.2
	2.2	**2.0**	**2.1**	**2.0**	**2.2**	**2.1**	**2.0**	**2.0**	**1.9**	**2.1**	**2.1**	**2.3**
80	2.8	2.8	2.7	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.7	2.8
95	3.4	3.3	3.2	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.3	3.3

Table 12.1.2. Summary of 2005 monthly median temperature values (bold numbers) for red26 station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.9	5.3	6.3	8.4	9.2	9.4	9.4	9.3	9.4	9.3	8.3	6.5
20	6.2	6.4	7.4	9.3	10.6	10.9	10.8	11.0	11.0	11.1	9.4	7.6
	8.1	**8.1**	**9.6**	**10.1**	No data			**12.7**	**12.5**	**13.5**	**11.2**	**8.5**
80	9.2	8.9	9.7	11.2	13.4	15.6	16.9	17.4	16.1	13.9	11.6	9.9
						16.1						
95	10.3	9.9	10.8	12.0	14.5	16.8	18.9	19.3	17.7	15.1	12.5	10.8

Table 12.1.3. Summary of 2005 monthly median temperature values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	4.0	4.1	5.2	8.0	10.5	14.1	16.6	18.3	16.3	11.8	7.4	5.2
20	4.7	4.7	6.0	9.0	11.6	15.2	18.0	19.3	17.3	12.9	9.0	6.2
	5.9	**5.6**		**10.1**	**14.6**	**17.1**	**20.4**		**18.2**	**15.7**	**10.3**	**6.7**
80	6.6	6.5	8.4	11.4	14.8	17.6	20.6	21.1	19.5	15.9	11.3	8.0
			8.6					**21.2**				
95	7.7	7.3	9.4	12.6	15.9	18.8	21.8	21.9	20.5	17.3	12.3	8.8

Table 12.1.4. Summary of 2005 monthly median temperature values (bold numbers) for cnbc3 station in relation to AEM percentile decision criteria.

	Monthly median temperature (C)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	3.2	4.2	5.1	8.1	11.1	14.9	17.4	18.4	16.0	11.9	7.7	5.2
20	4.1	4.8	6.0	8.9	12.1	15.6	18.4	19.5	17.1	13.4	9.0	6.1
	5.1	**5.2**	**8.1**	**9.7**	**14.2**	**16.7**	**20.1**	**21.1**	**18.4**	**15.6**	**10.4**	**5.9**
80	6.4	6.5	8.3	11.2	15.0	17.7	21.1	21.5	19.5	16.7	10.9	7.6
95	7.3	7.2	9.0	12.6	16.0	18.8	22.3	22.3	20.6	17.8	12.0	8.6

Table 12.1.5. Summary of 2005 monthly median salinity values (bold numbers) for red26 station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	2.3	2.4	2.0	1.6	2.0	1.5	6.9	6.2	8.1	8.1	6.2	3.1
20	5.3	5.8	5.1	4.5	4.3	4.4	12.8	10.5	12.5	12.8	11.1	7.2
	No data	No data	No data	No data	No data	**14.0**	**22.4**	**24.6**	**24.5**	**22.6**	**21.1**	**20.4**
80	25.5	26.1	24.9	25.3	25.0	26.5	28.1	28.0	27.9	27.6	26.7	26.3
95	28.5	28.6	27.8	27.9	27.9	29.3	29.9	30.0	30.0	29.4	29.0	28.7

Table 12.1.6. Summary of 2005 monthly median salinity values (bold numbers) for grays station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
5	0.2	0.2	0.2	0.2	0.0	0.2	0.3	0.3	0.5	0.4	0.3	0.3
				0.2	**0.1**		**0.3**				**0.4**	
20	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.8	0.7	0.5	0.3
	0.8	0.8				No data		**1.7**	**3.0**	**1.8**		**0.4**
80	1.2	0.8	0.8	0.7	0.7	0.7	2.4	2.4	4.4	3.7	2.7	0.8
			1.0									
95	3.1	2.7	2.0	1.4	0.8	1.3	5.5	4.4	6.9	6.2	4.8	2.2

Table 12.1.7. Summary of 2005 monthly median salinity values (bold numbers) for cbnc3 station in relation to AEM percentile decision criteria.

	Monthly median salinity (psu)											
Percentile	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
	0.0	**0.1**	**0.1**	**0.1**	**0.1**		**0.1**				**0.1**	**0.1**
5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
20	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.2	0.2	0.2
						No data		**0.6**	**1.8**	**2.0**		
80	0.7	0.7	0.7	0.7	0.7	0.7	1.7	2.5	3.5	7.0	2.2	0.7
95	2.3	2.1	3.3	1.7	0.9	1.5	4.5	6.3	9.3	12.3	5.3	2.0

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