Figure E.17. Statistical Evaluation of the Differences Between a Segment Not Affected by Hanford Site Operations and Downstream Segments Affected by Hanford Site Operations for the Resident Scenario. (Under the analytes, chromium has two entries: "chromium-car" indicates chromium treated as a carcinogenic chemical and "chromium-tox" indicates chromium treated as a non-carcinogenic toxic chemical.)

		Reference								Based on stochastic output of Industrial Worker Scenario																		
		Above reference, insignificantly								Results identified using "RISKS" program, implementing Kruskal-Wallis Test (2-sided) and Mann-Whitney U Test (1-sided) (Gibbons 1971)																		
		Human risk greater than 1 in 1,000,000 or Hazard Index of 0.01								The statistical tests use a tail probability of 5%, yielding a 1-in-20 chance of false positives																		
		Human risk greater than 1 in 10,000 or Hazard Index of 1.0																										
		Segments																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	Priest	B/C		KE/KW	K-	N		D		H		White	F	F		Hanf.	Hanf.	Supp.		300	1100		Yakima	Snake	Boise	Walla	McNary
Analyte	Rapids	Area		Area	Trench	Area		Area	Horn	Area		Bluffs	Area	Slough		Slough	Town.	Sys.		Area	Area	Richland	Riv.	Riv.	Casc.	Walla R.	Res.
Ammonia																											
Benzene																											
Carbon-14																											
Cesium-137																											
Chromium-Car																											
Chromium-Tox																											
Cobalt-60																											
Copper																											
Cyanide																											
Diesel																											
Europium-152																											
Europium-154																											
Iodine-129																											
Kerosene																											
Lead																											
Mercury																											
Neptunium-237																											
Nickel																											
Nitrate																											
Nitrite																											
Phosphate																											
Strontium-90																											
Sulfate																											
Technetium-99																											
Tritium																											
Uranium-234																											
Uranium-238																											
Xylene																											
Zinc																											

Figure E.18. Statistical Evaluation of the Differences Between a Segment Not Affected by Hanford Site Operations and Downstream Segments Affected by Hanford Site Operations for the Agricultural Resident Scenario. (Under the analytes, chromium has two entries: “chromium-car” indicates chromium treated as a carcinogenic chemical and “chromium-tox” indicates chromium treated as a non-carcinogenic toxic chemical.)

Reference

Above reference, insignificantly

Human risk greater than 1 in 1,000,000 or Hazard Index of 0.01

Human risk greater than 1 in 10,000 or Hazard Index of 1.0

Based on stochastic output of Industrial Worker Scenario

Results identified using "RISKS" program, implementing Kruskal-Wallis Test (2-sided) and Mann-Whitney U Test (1-sided) (Gibbons 1971)

The statistical tests use a tail probability of 5%, yielding a 1-in-20 chance of false positives

Segments

Analyte	1 Priest Rapids	2 B/C Area	3	4 KE/KW Area	5 K-Trench Area	6 N Area	7	8 D Area	9 Horn	10 H Area	11	12 White Bluffs	13 F Area	14 F Slough	15	16 Hanf. Slough	17 Hanf. Town.	18 Supp. Sys.	19	20 300 Area	21 1100 Area	22 Richland	23 Yakima Riv.	24 Snake Riv.	25 Boise Casc.	26 Walla Walla R.	27 McNary Res.
Ammonia																											
Benzene																											
Carbon-14																											
Cesium-137																											
Chromium-Car																											
Chromium-Tox																											
Cobalt-60																											
Copper																											
Cyanide																											
Diesel																											
Europium-152																											
Europium-154																											
Iodine-129																											
Kerosene																											
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Phosphate																											
Strontium-90																											
Sulfate																											
Technetium-99																											
Tritium																											
Uranium-234																											
Uranium-238																											
Xylene																											
Zinc																											

The process of creating a compound scenario involves selecting the base scenario (that which forms the basic life style of the individual) and adding to it a fraction or multiple of the additional scenario. The river segments applicable for each scenario also need to be defined. For example, consider the hypothetical case of the risk from radionuclides to a near-river resident of the City of Richland (Resident Scenario, Segment 21) who occasionally visits the Wahluke Slope Wildlife Refuge Area (Segment 13) for recreation. The median estimate for the lifetime risk from radionuclides to the Richland resident can be found in the radionuclides portion of Figure E.8 to be about 4.4×10^{-4}. The median lifetime risk to a casual visitor to the Wahluke Slope recreation area in the vicinity of F-Reactor (Segment 13) is found in the radionuclides portion of Figure E.4 to be about 1×10^{-5}. The joint risk is the sum of these two values, about 4.5×10^{-4}. The additional activities that the individual enjoys on the Hanford Site add about 2 percent to her/his lifetime risk. The simple addition works because the time spent on site is so small in the Casual Recreational Visitor Scenario that adjustments to the residential portion of the scenario are not significant.

For a more complex example, consider the hypothetical case of the heavy metal risk (as measured using the hazard index) to a traditional Native American subsistence resident who might permanently live north of the 300 Area (Segment 19) but regularly fishes near the influx of the Yakima River at Columbia Point (Segment 22). In this case, the underlying assumption of the Native American Subsistence Resident Scenario is 365 days/year at Segment 19 and 150 days/year at Segment 22. These fractions need to be adjusted to make a reasonable total number of days per year. If the individual is assumed to fish 75 days/year, then the total risk from the Native American Subsistence Resident Scenario can be reduced by a factor of (365-75)/365 and the total risk from the Native American Hunter/Fisher Scenario can be reduced by a factor of (150-75)/150. The hazard index in Segment 19, assuming full-time occupancy, for the Native American Subsistence Resident Scenario is found in the toxic chemical portion of Figure 5.6 to be about 4.3. The hazard index in Segment 22 for 100 percent of the Hunter/Fisher scenario is found in the toxic chemical portion of Figure E.6 to be about 2.7. Thus, the overall hazard index for this combined life style would be

$$(365\text{-}75)/365 * 4.3 + (150\text{-}75)/150 * 2.7 = 4.77$$

Very little overall change is achieved in the average hazard index for the subsistence resident by combining these two activities in this way. The net increase results because, while ingestion of foods from Segment 19 is assumed to be reduced, they are increased by foods caught by the individual fishing at Segment 22. Note, too, that the bulk of the overall hazard index results from Segments 19 and 22 are caused by the intake of copper and lead, which are not significantly above background. This level of detail can be found by decompressing the file, “nasubs_d.dtl,” from the diskette of results (compressed in the “det_dtl.exe” file) and viewing it with a text editor.

Other combinations of scenarios can be evaluated in a similar fashion. Those wishing more detail should adapt one of the input files provided and run the HUMAN code.

Sample Calculation of Human Risk

Any one of the human risk calculations requires the use of data and parameters located throughout this report. A brief set of example calculations is presented here to illustrate the data flow through the

calculations. For this illustration, the deterministic hazard index for an individual under the Native American Subsistence scenario in Segment 2 is given for chromium.

The deterministic concentrations of chromium in sediment, surface water, and seep water are taken from the data described in Section 3 and provided on disk in three separate files: MED-SD.CSV, MED-SW.CSV, and MED-SP.CSV and are summarized in the EXCEL spreadsheet FIN-DATA.XLS. All four files may be viewed using the EXCEL program, and each gives the same numerical values.

In the following example calculation, the source of information is provided in italics. The major equations are repeated and referenced. The locations within the report or the supporting computer disks where confirmatory results may be found are also given in italics.

A test case example - Native American Subsistence Lifestyle Scenario
Segment 2 Chromium

1. Scenario Parameters *Table 5.7*

Medium	Route	Intake Rate	(Units)	Exposure Frequency (d/yr)	Exposure Duration (yr)	Other Parameters	
Soil	Ingestion	0.0002	kg/d	365	70		
	External	24	hr/d	365	70		
	Dermal	1	mg/cm^2-d	365	70	SA_soil	5000 cm^2
	Inhalation	30	m^3/d	365	70	ML	0.0001 g/m^3
Air	Inhalation	30	m^3/d	365	70		
Seep/spring	Ingestion	3	L/d	365	70		
	Inhalation	15	m^3/d	365	70	VF	0.1 L/m^3
	Implied ET	*12*	*hr/d*				
	Dermal	1	hr/d	365	70	SA_seep	20000 cm^2
Surface water	Ingestion	3	L/d	365	70		
	Inhalation	15	m^3/d	365	70		
	Implied ET	*12*	*hr/d*				
	Dermal	2.6	hr/d	70	70	SA_river	20000 cm^2
Biota	Fish	0.54	kg/d	365	70		
	Fruit/Veg.	0.66	kg/d	365	70		
	Meat	0.204	kg/d	365	70		
	Birds	0.018	kg/d	365	70		
	Waterfowl	0.07	kg/d	365	70		
Sediment	Ingestion	0.0002	kg/d	365	70		
	Dermal	1	mg/cm^2-d	270	70	SA_sed	5000 cm^2
	External	12	hr/d	270	70		
Cultural	Dermal	1	hr/d	365	70	SA_other	1000 cm^2
	Inhalation	1	hr/d	365	70	CF_other	0.3 L/m^3

2. Measured and Derived Parameters for Chromium in Segment 2

C_river	0.0541 mg/L	*From Section 3, Data File FIN-DATA.XLS, or MED-SW.CSV*
C_seep	0.0406 mg/L	*From Section 3, Data File FIN-DATA.XLS, or MED-SP.CSV*
C_sediment	69.5 mg/kg	*From Section 3, Data File FIN-DATA.XLS, or MED-SD.CSV*

C_fish	10.8200 mg/kg	*Equation 5.7*	*Compare File:*
C_veg	0.3336 mg/kg	*Equation 5.8*	*NASUBS_D.FOD*
C_meat	0.0193 mg/kg	*Equation 5.8*	
C_bird	0.0080 mg/kg	*Equation 5.8*	
C_other	0.0406 (Sweat lodge water = seep water)	*Equation 5.9*	

3. Transfer Parameters For Chromium From *Table 5.14* (Common with Eco Assessment)

BIO_fish	200 mg/kg per mg/L
CR_veg	0.0048 mg/kg plant per mg/kg soil
TF_meat	0.058 mg/kg per mg/kg
TF_bird	0.024 mg/kg per mg/kg

4. Chemical Exposure Risk Factors for Chromium from *Table 5.16*

RfD Inhalation	0.005 mg/kg-d
RfD Ingestion	0.005 mg/kg-d
ABS	0.001 unitless
Kp	0.001 cm/hr

5. Miscellaneous Parameters from *Table 5.17*

VF		0 L/m^3
BW		70 kg
AT	70yr x 365	25550 days

6. Dermal Exposure to Chromium *(Equation 5.2)*

DAD = [C_sed x AF_sed x ABS x SA_sed X EF_sed x CF1 +
(C_other x AF_other x Kp x SA_other x ET_other x EF_other +
C_seep x Kp x SA_seep x ET_seep x EF_seep) X CF3 +
C_river x Kp x SA_river x ET_river x EF_river x CF3) x ED /(BW x AT)

DAD =	2.35596E-05	mg/kg-day
	sediment =	3.67E-06 mg/kg-day
	other =	5.80E-07 mg/kg-day
	seeps =	1.16E-05 mg/kg-day
	river =	7.71E-06 mg/kg-day
	Subtotal	2.36E-05 mg/kg-day

7. Inhalation of Chromium *(Equation 5.3)*

INH = (C_seep x VF x ET_seep x EF_seep +
C_river x VF x ET_river x EF_river +
C_other x CF_other x ET_other x EF_other)
x ED * BR / (BW x AT x CF4)

INH =	0.0002175	mg/kg-d
seep=	0	mg/kg-d
river=	0	mg/kg-d
other=	0.0002175	mg/kg-d
Subtotal	0.0002175	mg/kg-d

8. Ingestion of Chromium *(Equation 5.5)*

ING = [(C_sed x IR_sed x EF_sed) + (C_river * IR_river + C_seep x IR_seep +
C_fish x IR-fish + C_veg x IR_veg + C_meat x IR_meat +
C_bird x IR_bird) x EF] x ED / (AT x BW)

ING =	0.090937539
sediment =	0.000198571
river=	0.002318571
seep=	0.00174
fish=	0.083468571
veg. =	0.003145371
meat=	5.63879E-05
birds=	1.00652E-05
Subtotal	0.090937539

9. Risks by Media

Risk(SD) = (Dermal + Ingestion) /RfD	*Equation 5.18*	
Dermal	3.672E-06	
Ingestion(sediment+veg.+meat+birds)	0.0034104	
RfD (Ingestion)	0.005	*Compare to:*
Risk(SD) - Hazard Index	0.68	*0.69*
		File: NASUBS-D.DTL

Risk(SW) = (Dermal+Inhalation+Ingestion)/RfD	*Equation 5.19*	
Dermal	7.707E-06	
Ingestion (SW+fish)	0.0857871	
Inhalation	0	*Compare to:*
RfD (Inhalation)	0.005	*17.15*
Risk(SW) - Hazard Index	17.16	*File: NASUBS-D.DTL*

Risk(SP) = (Dermal + Ingestion)/RfD_ing + Inhalation/RfD_inh		*Equation 5.20*	
	Dermal(Seep + Sweat Lodge)	1.22E-05	
	Ingestion	1.74E-03	
	Inhalation (seep + Sweat Lodge)	2.18E-04	
	RfD_ingestion	5.00E-03	
	RfD_inhalation	5.00E-03	*Compare to:*
	Risk(SP) - Hazard Index	0.39	*0.39*
			File: NASUBS-D.DTL
			Compare to:
Total Risk (SD+SW+SP) =	18.24		*18.23*
			File: NASUBS-D.DTL
	Total Hazard Index in Segment 1	*2.42*	*File: NASUBS-D.DTL*
			Compare to:
	Ratio, Segment 2:Segment 1	*7.53*	*Figure 5.12*

Note: the comparison is not exact because this simplified example does not account for the difference between children and adults.