

**HUMAN HAZARD  
ASSESSMENT FOR  
PERCHLORATE IN  
UPLAND GAME FROM  
THE POTRERO CANYON  
UNIT IN THE SAN JACINTO  
WILDLIFE AREA,  
RIVERSIDE COUNTY**

**August 2005**

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**Human Hazard Assessment for Perchlorate in Upland Game from  
the Potrero Canyon Unit in the San Jacinto Wildlife Area,  
Riverside County**

**August 2005**

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## EXECUTIVE SUMMARY

The Office of Environmental Health Hazard Assessment (OEHHA) performed a hazard assessment for upland game collected from the Potrero Canyon Unit of the San Jacinto Wildlife Area in Riverside County, California. The Department of Fish and Game (DFG) is considering allowing public access to this area for hunting of certain upland game (i.e., Mourning Dove, California Quail, jack rabbit, and cottontail rabbit) present in this locale. To address the concern that these local game species may be contaminated with perchlorate from a former rocket motor testing burn site (Beaumont Site 1) within this area, DFG collected samples of these species and analyzed their muscle tissue for perchlorate residues. Using the residue data and information from published reports, data on weights of edible muscle in the collected samples, and DFG estimates of meal sizes, OEHHA estimated seasonal and annual consumption and the associated perchlorate exposures for hunters and their families consuming game from Beaumont Site 1. Exposures were higher when all game was consumed within hunting seasons (seasonal exposure) than when the same meals were consumed over a longer period of time. Seasonal exposures for females and males respectively were: Mourning Dove September season,  $3.98E-7$  and  $1.35E-6$  mg/kg-day; Mourning Dove November/December season,  $1.30E-7$  and  $4.51E-7$  mg/kg-day; California Quail,  $6.81E-8$  and  $1.13E-7$  mg/kg-day; jack rabbit,  $2.75E-7$  and  $1.28E-6$ ; and cottontail rabbit,  $3.96E-8$  and  $1.84E-7$ . And male exposures were greater than female exposures due to a higher game consumption rate. These exposures were compared to a toxicity benchmark equivalent to a reference dose ( $7.4E-5$  mg/kg-day assuming that perchlorate in wild game contributes 20% of exposure) based on OEHHA's Public Health Goal for Perchlorate (OEHHA, 2004). The assessment showed that the health hazards from consuming these game species from this site are well below a level of human health concern.

## BACKGROUND

The California Department of Fish and Game (DFG) requested that the Office of Environmental Health Hazard Assessment (OEHHA) perform a preliminary hazard assessment for upland game collected from the Potrero Canyon Unit of the San Jacinto Wildlife Area in Riverside County, California. DFG is considering allowing public access to this area for hunting of certain upland game (i.e., Mourning Dove, California Quail, jack rabbit, and cottontail rabbit) present in this locale. DFG is concerned that these local game species may be contaminated with perchlorate from a former rocket motor testing burn site (Beaumont Site 1) within this area. Perchlorate served as an oxidant in rocket fuel and is found in ground water and soil samples at this site up to levels of ~141,000 µg/L and 1,260 µg/g, respectively (Tetra Tech, 2005). The wildlife area and contaminated site are located in the mountains near the cities of Beaumont, Banning and San Jacinto, California. DFG is concerned that these game species could accumulate perchlorate from drinking contaminated water (the water table is shallow and at some times of the year it breaks through to the surface where game might drink it), or from eating local flora, which may take up perchlorate from contaminated ground water. Perchlorate accumulation has been found elsewhere in animals and plants (Smith et al., 2001, Smith et al., 2004, Yu et al., 2004, Jackson et al., 2005, Sanchez et al., 2005). DFG consulted OEHHA in developing a sampling plan for collection and analysis of upland game (DFG, 2005a) from the contaminated site so that OEHHA could determine whether consuming game from this site presented a human health hazard due to perchlorate. The health concern for human exposure to perchlorate is inhibition or reduction in iodide uptake by the thyroid gland causing health effects similar to those caused by iodine deficiency (OEHHA, 2004; Van Sande et al., 2003). This is of special concern to sensitive subpopulations including pregnant women and their fetuses, lactating women, infants, and persons with thyroid problems.

## SAMPLE COLLECTION METHODS

Upland game animals were collected from the Potrero Canyon Unit of the San Jacinto Wildlife Area in Riverside County, California for analysis to determine the presence of perchlorate in muscle tissue. The DFG sampling plan (DFG, 2005a) called for collecting representative numbers of the upland game species found near the Beaumont 1 test site that the public could hunt and eat if this area were opened to hunting. The local species collected were California Quail (*Callipepla californica*), Mourning Dove (*Zenaida macroura*), black-tailed jack rabbit (*Lepus californicus*), and desert cottontail rabbit (*Sylvilagus audubonii*). Animals were collected in May 2005 using shotguns in the same manner employed by hunters during the regular hunting season. The hunting seasons and bag limits for these species are shown in Table 1. The sampling plan originally called for the collection of 10 California Quail, 10 Mourning Dove, and 10 cottontail rabbits to obtain representative samples. Sixteen California Quail, 17 Mourning Dove, three jack rabbits, and seven cottontail rabbits were collected and immediately frozen intact. The animals were shipped on dry ice to the Department of Fish and Game Pesticide Investigations Unit for preparation of tissue samples.

Table 1: Hunting Season, Bag and Possession Limits\* for Upland Game Species in Riverside County, California

Species	Season	Days in Season	Bag & Possession Limits
Mourning Dove	Sept. 1- Sept. 15	15	10 daily, 20 possession
	Nov. 13 – Dec 27	45	10 daily, 20 possession
	Total both seasons	60	
California Quail	Oct. 16 – Jan. 30	107	10 daily, 20 possession
Jack rabbit	All year	365	No limit, no limit
Cottontail rabbit	July 1 – Jan. 30	214	5 daily, 10 possession

\* Source: DFG, 2005b.

### ANALYTICAL METHODOLOGY FOR PERCHLORATE

Animals were individually thawed and edible muscle tissue (without skin) was prepared for analysis to determine the presence of perchlorate. Breast muscle tissue was dissected and weighed from each of the birds. Leg muscle tissue was dissected and weighed from the large muscle masses on the front and hind legs of the rabbits. The tissue samples were individually homogenized using a Brinkman polytron. After homogenization the samples were refrozen until analyzed at the Department of Fish and Game Water Pollution Control Laboratory (WPCL). The samples were analyzed by High Performance Liquid Chromatography, Mass Spectrometry (HPLC-MS). The reporting limit for the analytical method was 2 parts per billion (ppb), fresh weight. The detection limit for the method was 1.0 ppb, fresh weight (WPCL, 2005a). The method was initially validated in the laboratory using chicken muscle as the surrogate for game species. Chicken tissue was spiked with perchlorate at 16.7, 33.3, 166, 330, and 3,300 ppb. The mean recovery, standard deviation, and relative standard deviation (RSD) were 88.2%, 11.09 and 12.6%, respectively. Continuing laboratory performance during analysis of game was checked using matrix spikes and matrix spike duplicates of California Quail samples. Spiking of this matrix (five replicates) at 330 ppb resulted in a mean, standard deviation and RSD of 235 ppb, 9.94, and 4.22%, respectively. Replicate samples of jack rabbit, cottontail rabbit, and California Quail were analyzed to verify duplicate sample precision of the complete method for field samples. For jack rabbit the mean, standard deviation and RSD for three samples were 17.63 ppb, 2.15 and 12.32%, respectively. For cottontail rabbit the data for three replicates yielded a mean, standard deviation and RSD of 15.17 ppb, 1.23 and 8.14%, respectively. Finally, for three replicates of California Quail, the mean, standard deviation and RSD were 3.06 ppb, 0.221 and 7.21%, respectively. These results indicate good recoveries and precision for the analytical method used and that the results were reliable.

## ANALYTICAL RESULTS FOR PERCHLORATE IN GAME TISSUES

Table 2 contains the analytical results (WPCL, 2005b) from analysis of perchlorate in the tissues of quail, doves, and two species of rabbits (jack and cottontail). For the two species of birds, perchlorate was detected in at least half of the samples. Perchlorate was detected in more than half of the jack rabbit samples, but less than half of the cottontail rabbit samples. The mean concentrations of perchlorate residues in quail and dove were 3.34 and 2.35 ng/g, respectively. The sample residues in the quail and dove range from non-detected to 18.8 ng/g and non-detected to 9.77 ng/g, respectively. The mean concentrations of perchlorate in jack rabbits and cotton tail were 11.97 and 1.01 ng/g, respectively. Perchlorate concentrations in jack rabbits ranged from non-detected to 20 ng/g, and in cottontail rabbits from non-detected to 3.0 ng/g. One-half the detection limit (0.5 ng/g) was used for non-detectable values to calculate mean concentrations.

**Table 2.** Concentration of Perchlorate in Upland Game Species of Birds and Rabbits from Beaumont Site 1, San Jacinto Wildlife Area, Riverside County, California

Species	Tissue	Sample Detects (total N)	Mean Concentration (ng/g)	Standard Deviation	Range (ng/g)
Dove	Breast muscle	9 (17)	2.35	2.64	ND - 9.77
Quail	Breast muscle	8 (16)	3.34	5.39	ND - 18.8
Rabbit					
Jack	Leg muscle*	2 (3)	11.97	10.19	ND - 20
Cottontail	Leg muscle*	2 (7)	1.01	0.96	ND - 3
ND	= non-detected, assigned a value of 0.5 ng/g which is ½ the method detection limit of 1.0 ng/g.				
*	Muscle from hind and front legs				

## CALCULATION OF EXPOSURE

Human exposure to perchlorate from consuming upland game was calculated for game harvested and consumed completely within hunting seasons and for game harvested during hunting seasons and consumed throughout a calendar year. Estimates of the mean number of animals bagged per yearly season in Riverside County were obtained from Game Take Hunter Surveys (DFG 2000, 2001, 2002, 2003) for all four upland game species. DFG staff who hunt and consume upland game species provided estimates of meals sizes for rabbits and the approximate number of birds needed to yield a typical meal. These meal sizes were assumed to be representative of male consumption. The mean weight of the total breast muscle collected from bird species was reported with the analytical results (DFG, 2005b) and multiplied by the number of birds needed per meal to calculate the typical size of a meal. A summary of this information, including estimates of total game consumed during a year, is shown in Table 3. Estimates of daily consumption for game consumed completely within hunting seasons (daily consumption per season) and throughout a calendar year (daily consumption per 365 days) are also given in

Table 3. Seasonal consumption values are estimated to account for potentially higher short term exposures to sensitive populations (e.g., pregnant women).

These estimates were compared to the number and size of meals of dove, quail, and rabbit consumed by males and females from a study of consumption of wild game and fish in South Carolina (Burger, 2002). Burger (2002) interviewed 278 men and 137 women attending an event at a sportsman’s club about their consumption of wild fish and game. Estimates from this survey were useful because the number of interviewees was relatively large, the treatment of the data was statistically detailed, and consumption estimates of meal frequency and size were made for men and women. No comparable consumption surveys of wild game in California were available. Total consumption and seasonal and annual daily consumption estimates based on the Burger survey (2002) are given in Table 4.

Table 3: Harvest and Consumption Estimates for California Hunters

Game type	Animals needed to make one meal <sup>1</sup>	Animals bagged/season <sup>2</sup> rounded N (calculated mean)	Meals per season <sup>3</sup>	Estimate of meal size <sup>4</sup> (g)	Total consumed per season <sup>5</sup> (g/season)	Daily consumption per season <sup>6</sup> (g/day)	Daily consumption per 365 days <sup>7</sup> (g/day)
Mourning Dove	5	16 (16.2) <sup>2a</sup>	3	131.85 <sup>4a</sup>	395.55	26.37	–
	5	14 (14.14) <sup>2b</sup>	3	131.85 <sup>4a</sup>	395.55	8.79	–
	5	30 <sup>2c</sup>	6	131.85 <sup>4a</sup>	791.1	–	2.17
CA Quail	3	9 (8.53)	3	84.39 <sup>4a</sup>	253.17	2.37	0.69
Rabbit							
jack	1/3	4 (4.33)	12	227 <sup>4b</sup>	2724	7.46	7.46
cottontail	1/2	6 (6.21)	12	227 <sup>4b</sup>	2724	12.73	7.46

1 = based on DFG estimates of how many animals it takes to get enough meat (muscle) to make a typical-sized meal (personal communication, Bob Hosea).

2 = mean calculated from DFG game take surveys (DFG 2000, 2001, 2002, and 2003) for Riverside County, CA.

2a = September dove season (the dove season is split).

2b = November/December dove season (the dove season is split).

2c = Sum of catch from both seasons.

3 = meals that can be made per season from the mean number of animals of a species bagged in Riverside County: CA Quail, animals bagged (9) ÷ animals needed to make a meal (3) = 3 meals.

4 = based on DFG estimates (personal communication, Bob Hosea).

4a = based on the mean weight of breast muscle from birds of each species x number of birds needed to make one meal: dove, 26.37 g x 5 = 131.85 g; quail, 28.13 x 3 = 84.39 g.

4b = 0.5 pound estimate of rabbit meal size (personal communication, Bob Hosea).

5 = total grams of tissue consumed in a season: quail, meals per season (3) x meal size (84.39 g) = 253.17 grams.

6 = daily consumption on a seasonal basis: quail, total grams of tissue consumed in a season (253.17 g) ÷ days in a season from Table 1 (107) = 2.37 g/day.

7 = daily consumption on a yearly basis: quail, total grams of tissue consumed in all seasons in a year (253.17 g) ÷ days in a year (365) = 0.69 g/day.

– = Not applicable

Table 4: Estimates of Consumption of Wild Game based on Burger (2002)

Game type	Gender	Meals/month <sup>1</sup>	Meals/year <sup>2</sup> rounded off	Meal size (g) <sup>1</sup>	Total consumed per year (g/year) <sup>3</sup>	Daily consumption per season (g/day) <sup>4</sup>	Daily consumption per 365 days (g/day) <sup>5</sup>
Dove	Female	0.14	2	80.6	161.2	–	0.44
	Male	0.38	5	121	605	–	1.66
Season 1	Female	–	2	80.6	161.2	10.75	–
	Male	–	5	121	605	40.33	–
Season 2	Female	–	2	80.6	161.2	3.58	–
	Male	–	5	121	605	13.44	–
Quail (wild)	Female	0.10	1	50.4	50.4	0.47	0.14
	Male	0.15	2	90.7	181.4	1.70	0.5
Rabbit	Female	0.03	1 (0.4)#	20.2	20.2	–	0.06
	Male	0.16	2	90.7	181.4	–	0.5
Jack *	Female	–	1	20.2	20.2	0.06	0.06
	Male	–	2	90.7	181.4	0.5	0.5
Cottontail*	Female	–	1	20.2	20.2	0.09	0.06
	Male	–	2	90.7	181.4	0.85	0.5

1 = Mean value from Burger (2002).

2 = Meals/year: dove (female), meals/month (0.14) x 12 months/year = 2 meals (rounded off)

3 = Total consumed per year (g/year): dove (female), meals/year (2) x meal size (80.6 g) = 161.2 g/year consumed.

4 = Daily consumption per season: dove September Season 1 (female), total consumed per year (161.2 g/year) ÷ days per season (15) = 10.75 g/day in Season 1.

5 = Daily consumed per 365 days: dove (female), total consumed per year (161.2 g/year) ÷ 365 days per year = 0.44 g/day.

# = Value in parentheses is meals/year for women eating wild rabbit calculated by Burger. So the number of meals consumed is less than one, but has been rounded to one.

\* = Burger does not break rabbits into different species. The same yearly total consumption values are used for cottontail and jack rabbits to estimate seasonal values.

– = Not applicable

Comparison of the California consumption estimates with the results of the Burger survey show that the California estimates are very similar to those from Burger (2002). The California estimates are very close for the bird species and higher than estimates for South Carolina for the rabbits. The California estimates are not based on gender but are presumed to be more applicable to men. Burger provides consumption values for men and women, and concluded that women eat less game than men (Burger, 2002). These differences are relevant when considering exposures to sensitive populations. The number of total meals of dove (i.e., combining consumption from both California seasons) was similar for the Burger survey and the California estimate: 5 and 6 meals/year, respectively for males. The estimated meal sizes were larger for dove from California (131.85 g) than South Carolina (121 g). This might be due to differences

in the size of dove species consumed in the two states, but the difference is small. The estimated number of meals of quail consumed per year are also similar: two and three for the Burger survey and California, respectively, for males. The South Carolina meal sizes are slightly larger than the California estimates, 90.7 g and 84.39 g, respectively. On-the-other-hand, the estimates of the number of meals of rabbit (either species) and meal size are much higher for California than from Burger (2002). Estimates based on California data are that hunters may eat 12 meals per year, and each would be 227 g. Burger's calculations for South Carolina were that males consume two 90.7 g meals per year. Since the methods on which the California and Burger estimates are based are different it is difficult to evaluate whether one is more representative of California hunting and game consumption. We will use whichever estimate of total annual consumption for males is highest to calculate daily exposure. The values for seasonal and annual daily consumption from Burger will be used for dove for both women and men, and the California seasonal and annual daily consumption values for quail, jack rabbit and cotton tail rabbit will be used for men. We will use the ratio of the meal sizes between women and men in the Burger survey (0.56 for quail and 0.2 for rabbit) to estimate women's meal sizes for the estimates based on California data.

Table 5 shows the tissue residues for the four species of game collected and analyzed by DFG, the consumption values assumed for each species for men and women, and the calculated daily exposure. Daily exposure was calculated using the following equation:

$$\text{Daily exposure (mg/kg - day)} = \frac{\text{Residue (mg/kg)} \times \text{SDC or ADC (kg/day)}}{\text{BW (kg)}}$$

where:

SDC = seasonal daily consumption (consumption of all game during the hunting season)

ADC = annual daily consumption (consumption of game throughout the calendar year)

BW males = 70 kg

BW females = 65 kg

Seasonal exposures are either equal to or greater than annual exposures for men and women consuming all upland game species. The seasonal exposure for women and men consuming mourning dove from this site would be 3.89E-7 and 1.35 E-6 mg/kg-day, respectively, for the September dove season and 1.30E-7 and 4.51E-7 mg/kg-day, respectively for the November/December dove season. The seasonal exposure for women and men consuming California Quail from this site would be 6.81E-8 and 1.13E-7 mg/kg-day, respectively. The daily exposure for women and men consuming rabbit from this site would be 2.75E-7 and 1.28E-6 mg/kg-day for jack rabbit and 3.96E-08 and 1.84E-7 mg/kg-day for cotton tail rabbit, respectively. Male exposures were greater than female exposures due to a higher game consumption rate.

## HAZARD ASSESSMENT

Perchlorate inhibits uptake of iodide by the thyroid gland by competing with iodide for the sodium-iodide-symporter, a transport molecule necessary to transport iodide into the thyroid gland (Van Sande et al., 2003) in humans and laboratory animals. Excessive perchlorate exposures are expected to be associated with health effects similar to those of iodine deficiency. OEHHA (2004) calculated a Bench Mark Dose (BMD) and the 95 percent lower limit on the confidence interval (the BMDL) for perchlorate for reduced thyroid uptake of iodine using data from a study by Greer et al. (2002), who administered oral doses of perchlorate to humans and measured several physiological parameters related to thyroid function. The perchlorate BMDL derived by OEHHA was 0.0037 mg/kg-day. Applying a 10-fold uncertainty factor to the perchlorate BMDL for inter-individual variation in response (the same uncertainty factor used in the PHG) yields a value of 0.00037 mg/kg-day, which is equivalent to a reference dose (RfD) for perchlorate. An RfD is the level of daily exposure that is not anticipated to result in adverse effects in the exposed population over a lifetime of exposure. The RfD equivalent for perchlorate is protective of sensitive subpopulations, including infants, pregnant women and their fetuses, lactating women, and individuals with thyroid problems (OEHHA, 2004).

This RfD equivalent value will be used to calculate a hazard quotient (HQ) to determine whether exposure from consuming these game species containing perchlorate is a health concern. The HQ is calculated as follows:

$$\text{Hazard Quotient} = \frac{\text{Exposure (mg / kg - day)}}{\text{RfD equivalent (mg / kg - day)} \times \text{RSC}}$$

where:

RSC = Relative source contribution, 20% for consumption of upland game

If the quotient of this relationship is  $\leq 1$ , then it is considered that the exposure will not result in an adverse effect because the exposure is less than the RfD equivalent. People may be exposed to perchlorate from other sources through contaminated water. A relative source contribution (RSC) of 60% was used in the PHG (OEHHA, 2004) for perchlorate in drinking water. Since Smith et al. (2001, 2004) and the DFG results used in this assessment demonstrate that wild animals can accumulate perchlorate from contaminated sites an RSC of 20% is used here for perchlorate exposure (0.000074 mg/kg-day) from consuming upland game. This leaves an additional RSC of 20% for exposures from other foods, e.g., lettuce. These values are estimates since the concentration of perchlorate in water and foods has not been extensively monitored.

Table 5 shows the HQ values for upland game species from Beaumont Site 1 in the Potrero Canyon Unit of the San Jacinto Wildlife area. The HQs for each species for men and women for seasonal and annual exposures are less than one, and far below a level of concern for exposure to perchlorate through consumption of these game species. Although the HQs are calculated for exposure to single species, someone could consume a mixture of species at these consumption rates and still be below a level of concern.

Table 5: Yearly and Seasonal Exposure and Hazard Quotients from Consumption of Upland Game Containing Perchlorate from Beaumont Site 1

Meal type	Gender	Total Consumed (kg/year)	Perchlorate Residue (mg/kg)	Seasonal exposure (mg/kg/day) <sup>1</sup>	Annual exposure (mg/kg/day) <sup>2</sup>	Seasonal Hazard Quotient <sup>3</sup>	Annual Hazard Quotient <sup>4</sup>
Dove*	Female	1.61E-1	2.35E-3	–	1.60E-8	–	2.16E-4
	Male	6.05E-1	2.35E-3	–	5.56E-8	–	7.52E-4
Season 1	Female	1.61E-1	2.35E-3	3.89E-7	–	5.25E-3	–
	Male	6.05E-1	2.35E-3	1.35E-6	–	1.83E-2	–
Season 2	Female	1.61E-1	2.35E-3	1.30E-7	–	1.75E-3	–
	Male	6.05E-1	2.35E-3	4.51E-7	–	6.10E-3	–
Quail**	Female	1.42E-1	3.34E-3	6.81E-8	2.00E-8	9.20E-4	2.70E-4
	Male	2.53E-1	3.34E-3	1.13E-7	3.31E-8	1.53E-3	4.47E-4
Jack rabbit**	Female	5.45E-1	11.97E-3	2.75E-7	2.75E-7	3.71E-3	3.71E-3
	Male	2.72	11.97E-3	1.28E-6	1.28E-6	1.72E-2	1.72E-2
Cottontail rabbit**	Female	5.45E-1	1.01E-3	3.96E-8	2.32E-8	5.35E-4	3.13E-4
	Male	2.72	1.01E-3	1.84E-7	1.08E-7	2.48E-3	1.46E-3

\* = Total consumption (kg/year) of this species was based on estimates from Burger (2002) in Table 4.

\*\* = Consumption (kg/year) of these species was based on California estimates directly from Table 3 for males. Female consumption was calculated using the ratio of female to male meal sizes from Burger (2002).

1 = Seasonal exposure assumes all consumption is during the hunting season: dove (female) season 1, seasonal daily consumption (1.075E-2 mg/d) x residue (2.35E-3 mg/kg) ÷ BW (65 kg) = 3.89E-7 mg/kg-day. For males 70 kg BW was used. Exposures less than 7.4E-5 are below the RfD assuming that upland game consumption contributes 20% of perchlorate exposure.

2 = Annual exposure assumes consumption is spread throughout the whole year: dove (female), daily consumption 365 days (4.42E-4 mg/d) x residue (2.35E-3 mg/kg) ÷ BW (65 kg) = 1.60E-8 mg/kg-day. For males 70 kg BW was used. Exposures less than 7.4E-5 are below the RfD assuming that upland game consumption contributes 20% of perchlorate exposure.

3 = Seasonal hazard quotient: dove (female) season 1, seasonal exposure (3.89E-7 mg/kg-day) ÷ RfD (0.00037 mg/kg-day) x RSC (0.2) = 5.25E-3. A hazard quotient less than 1 (one) indicates that exposure is below the RfD assuming that upland game consumption contributes 20% of perchlorate exposure.

4 = Annual hazard quotient: dove (female), annual exposure (1.60E-8 mg/kg-day) ÷ RfD (0.00037 mg/kg-day) x RSC (0.2) = 2.16E-4. A hazard quotient less than 1 (one) indicates that exposure is below the RfD assuming that upland game consumption contributes 20% of perchlorate exposure.

– = Not applicable

OEHHA also considered whether exposure from a single meal might exceed the RfD in a pregnant woman. The highest single meal exposure for women consuming upland game from the study site was from jack rabbit. Single meal exposure was calculated from the concentration of perchlorate in jack rabbit (11.97 ng/g) and the grams in a meal for women (227 g [for males] x 0.2 [female to male meal size ratio from Burger, 2002]). A woman's meal of jack rabbit was calculated to contain 543.4 ng of perchlorate. This was compared to a woman's whole body dose by multiplying body weight (65 kg) by the RfD (7.4E-5 mg/kg-day), assuming that 20% of exposure is from consumption of game. This yields an allowable whole body dose of 4.81 µg or 4810 ng. A meal containing 543.4 ng of perchlorate is less than the allowable dose of 4810 ng (HQ = 0.1), so even for a single days exposure the RfD would not be exceeded.

## **SUMMARY AND EXPOSURE/RISK APPRAISAL**

### Quail and Dove

DFG collected and analyzed a representative sample of these species from the study site. Perchlorate was found in edible muscle of both species. The mean concentration of perchlorate in each bird species was used to evaluate the human health hazard from consuming that species. The hazard evaluation indicates that hunters would be able to harvest and consume these species from the area near Beaumont Site 1 in Southern California without exceeding the RfD for perchlorate, assuming that upland game consumption contributed 20% of perchlorate exposure. The largest HQ for birds (1.83E-2, for males eating Mourning Dove) is more than 50 times below the RfD. This shows that the levels of perchlorate in these game species from the area near Beaumont Site 1 in Southern California are well below levels of concern for hunters harvesting and consuming them.

### Rabbits

DFG was unable to collect and analyze a representative sample of both jack rabbits and cottontail rabbits from the study site. Although the combined sample size of the two species did reach the study goal of 10 samples, the two rabbit species vary almost 8-fold in their perchlorate concentrations in edible muscle. This suggests that accumulation of perchlorate by these species was different and would be better characterized by collecting and analyzing more samples to confirm the present results. A hazard evaluation was performed using the mean concentration of perchlorated in each rabbit species to determine whether hunters consuming them would exceed the RfD for perchlorate, assuming that upland game consumption contributed 20% of perchlorate exposure. The largest HQ for rabbits (1.72E-2, for males eating jack rabbit) is more than 50 times below the RfD. Based on the available results, both rabbit species contain levels of perchlorate that are substantially below levels of concern for hunters harvesting and consuming them from the study site.

This assessment utilizes data from game take survey (DFG, 2000, 2001, 2002, and 2003) but also relies on anecdotal information to estimate meals sizes for California hunters. The wild game consumption survey conducted by Burger (2002) supports the estimates used in the present assessment. Even if the consumption of game in California were 10-fold higher than the estimates used the HQs calculated in this evaluation would still not be of health concern. However, quantitative information on consumption of wild game by California hunters and their families expressed as g/meal, g/month and/or g/hunting season similar to that presented by Burger (2002) would make this exposure and hazard appraisal better reflect exposures and hazards to hunters and their families consuming wild game in California.

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