QUANTITATIVE RISK CHARACTERIZATION

Mountain Creek Lake

Tarrant County, Texas

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Prepared by

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BACKGROUND AND STATEMENT OF ISSUES

The Commissioner of Health for the State of Texas issued an order on April 25, 1996 that bans possession of fish taken from Mountain Creek Lake in Dallas County, Texas [1]. That order does not prohibit catch-and-release fishing from the lake. This order is enforceable under Texas law and remains in effect. The commissioner ordered this action because edible fish collected from Mountain Creek Lake in July 1995 contained polychlorinated biphenyls (PCBs), chlordane, heptachlor epoxide, dieldrin, DDD, DDE, and DDT at concentrations that exceeded guidelines utilized by the Texas Department of Health (TDH) to protect the public from deleterious effects of eating seafood contaminated with environmental pollutants. Funded by a grant from the Texas Natural Resource Conservation Commission (TNRCC), the Texas Department of Health (TDH) reevaluated two small sample sets of fish from Mountain Creek Lake collected in 2000 and 2001 (five samples each year) to determine the need for a full-scale reevaluation of fish from this reservoir. A comprehensive reevaluation would be necessary to decide whether consumption of fish from Mountain Creek Lake still poses a public health hazard and whether it is feasible to lift the ban on possession of fish from Mountain Creek Lake.

Mountain Creek Lake, a 3,050-acre reservoir impounded in 1937 by damming Mountain Creek, a tributary of the West Fork Trinity River, borders the cities of Grand Prairie and Dallas, Texas near Interstate Highway 20. A power-generating company owns and operates the reservoir, which drains a 46,000-acre watershed downstream of Joe Pool Lake, another reservoir created by damming Mountain Creek. The water in Mountain Creek Lake is shallow and turbid, with an average depth of eight feet and a sparsely vegetated shoreline. The reservoir serves primarily as a source of cooling water for power-generating plants, but is also a popular destination for fishers and boaters. The public accesses Mountain Creek Lake by way of parks and a boat-launch facility. Extensive development west of the lake has occurred since 1985; runoff to the lake from these areas is primarily of a suburban nature. A Texas Utilities (TXU) power plant, a decommissioned naval air station (NAS), and a naval weapons industrial reserve plant (NWIRP) border the reservoir. In 1994, a survey by the United States Geological Survey (USGS), under contract to the US Navy (USN), showed that people regularly fish Mountain Creek Lake and that fishers were likely to consume channel catfish, common carp and largemouth bass from the lake [2]. The USGS also examined several composite samples of fish from Mountain Creek Lake in 1994. That preliminary examination revealed contaminant concentrations that were of concern to TDH, TNRCC, and the U.S. Environmental Protection Agency (EPA). In July 1995, after consulting with TDH, TNRCC, EPA, the USN, and other interested parties, the USGS conducted a comprehensive survey of largemouth bass, common carp, and channel catfish from Mountain Creek Lake. This investigation showed widespread contamination of fish [3] and led to the 1996 ban on possession of fish from the reservoir.

DISCUSSION

Sample Collection and Data Analysis

To evaluate potential health risks to recreational and subsistence fishers who consume environmentally contaminated seafood, the Texas Department of Health (TDH) collects and

analyzes samples of edible seafood tissues from the state's public waters that represent the species, trophic levels and legal-sized specimens available for consumption. When practical, TDH collects samples from several sites within a water body to characterize the geographical distribution of contaminants. The TDH laboratory utilizes established methodology to analyze edible fillets (skin off) of fish and edible portions of shellfish for seven metals – arsenic, cadmium, copper, lead, mercury, selenium, and zinc – and for many volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), twenty-seven pesticides, and seven polychlorinated biphenyl (PCB) mixtures (Aroclors 1016, 1221, 1224, 1232, 1248, 1254, and 1260).

Description of the Mountain Creek Lake Sample Set

TDH collected five samples from Mountain Creek Lake on June 12, 2000: one freshwater drum, two largemouth bass, one common carp, and one channel catfish. TDH sampled again on June 14, 2001, collecting three common carp and two largemouth bass. The TDH laboratory analyzed the samples in the years in which they were collected.

Results of Chemical Analysis of the Mountain Creek Lake Sample Set

Table 1 summarizes the principal analytical results. TDH analyzed ten samples from Mountain Creek Lake for metals and a comprehensive range of organic contaminants. Several samples contained small quantities of cadmium, copper, lead, selenium, or zinc. Three samples contained detectable levels of mercury. Five samples contained traces of carbon disulfide, a common laboratory contaminant or product of tissue necrosis that could have formed between sample collection and analysis (data not shown). Two fish contained low levels of chlordane, while the single common carp collected in 2000 contained Aroclor 1260. One sample contained a trace of toluene (data not shown). Not all contaminants were present in all samples. No other pesticides, VOCs or SVOCs were detected.

Results of Statistical Analyses of the Mountain Creek Lake Sample Sets

The two sample sets were collected at different times. Each sample set was analyzed at the time of collection. Thus, statistical analyses were used to determine whether the two data sets were from the same population, a necessary step before combining data sets. Mercury, present in 2001, but not in 2000, was statistically significantly higher in 2001; selenium was higher in 2001 than in 2000; and carbon disulfide, present in 2000, was not detected in 2001. Although statistical differences were evident, none were toxicologically significant. Therefore, TDH combined the sample sets from 2000 and 2001 to increase sample size, using the combined data set for hazard analyses.

Deriving Health-based Assessment Comparison Values (HACs)

Generally, people who regularly eat contaminated seafood are exposed to low concentrations of contaminants over an extended time. This exposure pattern seldom results in acute toxicity but may increase the risk of subtle, delayed or chronic adverse health effects. Presuming that people eat a variety of fish, TDH routinely evaluates average contaminant concentrations across species

and locations within a specific water body since this approach best reflects the likely exposure pattern of consumers over time. TDH may also examine the risks associated with ingestion of individual species from specific collection sites within the water body.

TDH evaluates chemical contaminants in fish by comparing average contaminant concentration with health-based assessment comparison (HAC) values (in mg contaminant per kg edible tissue or mg/kg) for non-cancer and cancer endpoints. Following approaches suggested by the United States Environmental Protection Agency (USEPA) in its *Guidance for assessing chemical contaminant data for use in fish advisories* [4], TDH has developed noncancer (HAC_{nonca}) and cancer (HAC_{ca}) comparison values. To derive HAC_{nonca} values, TDH uses oral reference doses (RfDs) from the USEPA or chronic oral minimal risk levels (MRLs) from the Agency for Toxic Substances and Disease Registry (ATSDR). RfDs and MRLs are estimates of long-term daily exposure doses considered unlikely to cause adverse noncancerous (systemic) health effects even if exposure occurs over a lifetime [5]. MRLs are similar to RfDs but may not be identical because the two agencies may use different assumptions or constants to derive the values. TDH derives HAC_{ca} values from the USEPA's chemical-specific cancer slope factors (SFs) using an acceptable lifetime risk level (ARL) of one excess cancer in 10,000 (1×10^{-4}) people exposed and an exposure period of 30 years. TDH utilizes a standard adult body weight of 70 kilograms and assumes that adults consume 30 grams of fish per day (about one eight-ounce meal per week) in these derivations. TDH also utilizes hazard quotients (HQ) to evaluate contaminants in fish and shellfish. A hazard quotient is the ratio of the estimated exposure dose of a contaminant to its RfD or MRL. If the HQ is less than 1.0, consumption of seafood containing an isolated contaminant probably will not present a significant hazard to human health.

Most referents (i.e., RfDs or MRLs) employed in calculating HAC_{nonca} values and hazard quotients contain built-in margins of safety (uncertainty factors). Uncertainty factors are based on scientific judgment and are chosen to minimize the potential for adverse health effects in those people – including sensitive subgroups (e.g., pregnant women, infants, children, the elderly, people with chronic illnesses, or those regularly consuming large quantities of fish or shellfish) – who eat environmentally contaminated seafood. The cancer slope factors (SFs) from which TDH derives HAC_{ca} values also ensure a wide margin of safety. Furthermore, health-based assessment comparison values (HAC values) do not represent a sharp dividing line between safe and unsafe exposures. The strict demarcation between acceptable and unacceptable exposures or risks is a tool used by risk managers to assure protection of public health. The Texas Department of Health finds it unacceptable when consumption of four or fewer meals per month would result in exposures that exceed a HAC value or other measure of risk. TDH also advises that people who wish to further minimize exposure to environmental contaminants in seafood eat a variety of fish and shellfish and limit consumption of those species that are likely to contain environmental toxicants.

Addressing the Potential for Cumulative Effects

When multiple chemicals similarly affecting a target organ or having the same mechanism of action occur simultaneously in one or more seafood samples in a survey, TDH follows standard practice, assuming for the assessment process that potential adverse systemic or carcinogenic effects from toxicants are cumulative (i.e., additive) [6].

Cumulative Systemic (Noncancerous) Effects

The Texas Department of Health Seafood Safety Division (SSD) evaluates potential cumulative noncancerous (systemic) health effects from simultaneous consumption of multiple chemicals in environmentally contaminated seafood by calculating a hazard index (HI) for those contaminants with similar effects. To derive an HI, TDH sums the hazard quotients (HQ) for each contaminant. A HI of less than 1.0 usually indicates that no significant health effects will occur for the observed combination of contaminants at observed concentrations. On the other hand, while a HI greater than 1.0 may indicate some level of hazard, it does not mean that exposure to the contaminants at these doses will result in adverse systemic health effects. Nonetheless, finding an HI that exceeds 1.0 may prompt the agency to consider some public health intervention strategy.

Cumulative Carcinogenic Effects

To estimate the potential additive effects of simultaneous exposure to multiple carcinogens on excess lifetime cancer risk, TDH sums the risks calculated for each carcinogenic contaminant observed in a sample set to get a composite risk value. As with individual contaminants, TDH recommends limiting consumption of seafood containing multiple carcinogenic chemicals to quantities that would result in an estimated combined theoretical lifetime cancer risk of not more than one excess cancer in 10,000 exposed persons.

Addressing Children's Unique Vulnerabilities

TDH recognizes that fetuses, infants, and children may be uniquely susceptible to the effects of toxic chemicals and that any such vulnerabilities demand special attention. Windows of vulnerability (i.e., critical periods) exist during development. These critical periods are particularly evident during early gestation, but may also appear throughout pregnancy, infancy, childhood, and adolescence [7]. Unique childhood vulnerabilities may result because, at birth, many organs and systems have not achieved structural or functional maturity, but continue to develop up until the age of sexual maturity. Such structural and functional differences mean that children can differ from adults in absorption, metabolism, storage, and excretion of toxicants, any of which factors could result in higher biologically effective doses at target the target cell(s), tissue(s) or organ(s). Children's exposures to toxicants may be more extensive than those of adults because children consume more food and liquids in proportion to their body weight than do adults [7]. Infants who are breast-fed can also ingest toxicants through breast milk – often unrecognized as an exposure pathway. Differences in target organ sensitivity in children may also contribute to toxic effects at lower doses than those that affect adults. Stated differently, children could respond more severely than might adults to an equivalent exposure dose [7]. Children may also be more prone to developing certain cancers from chemical exposures than are adults. If a

chemical – or a class of chemicals – is determined to be more toxic to children than to adults, the RfD or MRL will be commensurately lower to reflect children's potentially greater susceptibility. Therefore, in accordance with ATSDR's *Child Health Initiative* [8] and USEPA's *National Agenda to Protect Children's Health from Environmental Threats* [7], TDH seeks to protect children from the potentially greater effects of toxicants in fish or shellfish. One mechanism by which TDH accomplishes this task is to suggest that children consume smaller quantities of environmentally contaminated fish or shellfish than adults consume. TDH routinely recommends that children who weigh 35 kg or less – and/or who are eleven years of age or younger – eat no more than four ounces of contaminated seafood per meal. TDH also suggests that the parents spread out the recommended number of meals over time. For instance, if the consumption advice recommends eating more than two meals per month, children consuming seafood from the affected water body should eat no more than one meal every two weeks.

Characterizing the Risk

Assessing Systemic Effects from Consumption of Individual Contaminants in Fish from Mountain Creek Lake

Average concentrations of chlordane and Aroclor 1260 in fish collected from Mountain Creek Lake during 2000 and 2001 did not exceed HAC_{nonca} values for these contaminants (Table 1). Nevertheless, TDH computed hazard ratios (HRs) for each contaminant in common carp and in largemouth bass, as well as for the combined species. The hazard ratios for chlordane were each less than 1.0. The HR for Aroclor 1260 in common carp was also less than 1.0. Largemouth bass did not contain PCBs. Averaged across the two collection years and across all species collected, the concentration of Aroclor 1260 did not exceed the noncancer HAC value (Table 1). No other contaminants occurred in concentrations sufficient to exceed the HAC values used to screen for either cancerous or noncancerous adverse health effects.

Assessing Systemic Effects from Consumption of Multiple Contaminants in Fish from Mountain Creek Lake

TDH assessed the potential for cumulative systemic (noncancerous) adverse health outcomes from chronic exposure to chlordane and Aroclor 1260 in common carp from Mountain Creek Lake by calculating a hazard index (HI) for Aroclor 1260 and chlordane in the carp. The hazard index for Aroclor 1260 and chlordane in common carp was 0.539, due, for the most part, to the Aroclor 1260. The hazard index for all ten fish (largemouth bass did not contain PCBs) was 0.22. TDH may consider regulatory action when – in combination with other information (i.e., toxicity profile for the contaminants of interest; probability that sensitive subgroups exist and will consume the seafood; site-specific information) – the hazard index exceeds one.

TDH also compared concentrations of mercury, selenium, zinc, and cadmium in fish from Mountain Creek Lake to HAC values for these contaminants. Selenium, zinc, and cadmium in fish from this reservoir did not exceed HAC_{nonca} values. Mercury was not detected in samples from 2000, but was detected in three of five samples from 2001. Although mercury was statistically different between the two years, concentrations of this contaminant did not exceed

the HAC_{nonca}. Thus, it was not necessary to further consider mercury in this characterization of the theoretical risks associated with consumption of fish from Mountain Creek Lake.

Assessing Risk of Cancer from Individual Contaminants in Fish from Mountain Creek Lake

The average concentrations of chlordane and of Aroclor 1260 in fish from Mountain Creek Lake were lower than the respective HAC_{ca} values for these contaminants (Table 1). It is unlikely that exposure to either of these contaminants in fish from this lake will result in an increase in the theoretical excess risk of cancer.

Assessing the Cumulative Risk of Cancer from Multiple Contaminants in Fish from Mountain Creek Lake

The USEPA classifies both Aroclor 1260 and chlordane as probable human carcinogens (Group B2) based on an increase in the incidence of tumors in experimental animals [9]. Consumption of fish – especially common carp – from this reservoir may expose people concurrently to both contaminants. As a result, TDH estimated cumulative cancer risk for persons exposed to chlordane and Aroclor 1260 in carp, largemouth bass, or both species (Table 2). The overall calculated theoretical excess cancer risk from exposure to both Aroclor 1260 and chlordane in fish from Mountain Creek Lake was approximately 1 per 259,000 people who eat fish of both species from the reservoir. For common carp, the calculated theoretical excess cancer risk was approximately 1 in 272,200 people consuming carp. The risk of excess cancers from eating either or both species containing the observed contaminants does not exceed TDH's acceptable risk level.

CONCLUSIONS AND PUBLIC HEALTH IMPLICATIONS

Limitations on the present survey data make it difficult to clearly define the systemic or carcinogenic risks associated with consumption of common carp from Mountain Creek Lake. For instance, different laboratories performed the 1995 and the 2000-2001 analyses, but TDH was unable to examine potential differences in laboratory procedures, controls, or other variables that could affect the integrity of the analytical data. Furthermore, finding that only one of ten samples collected during the most recent sampling expedition contained Aroclor 1260 while sixty-seven of the sixty-eight samples collected in 1995 contained this contaminant suggests that Aroclor 1260 contamination is not as widely spread as in 1995. This conclusion is significantly limited, however, by the small size of the current sample data set and, perhaps, by selection of sampling sites. Thus, it was difficult to draw reliable conclusions from these data. TDH thus finds an **indeterminate health hazard** from consumption of fish from Mountain Creek Lake because due to insufficient data.

RECOMMENDATIONS

TDH risk managers have established certain criteria for issuing fish consumption advisories. When the risk characterization confirms that consumption of four or fewer meals per month would result in exposures that exceed TDH health-based risk guidelines, risk managers may wish to recommend that the Commissioner of Health issue consumption advice or ban possession of fish from the affected water body. Based on a quantitative assessment of chemical contaminants in fish from Mountain Creek Lake, the Environmental Epidemiology and Toxicology Division (EE&TD), Texas Department of Health (TDH), recommend that:

1. TDH continues the existing ban on possession of fish from Mountain Creek Lake until the agency can examine a more representative sample set from this reservoir.

2. TDH conducts a comprehensive survey of contaminants in fish from Mountain Creek Lake. Appropriate sample sites and numbers of samples will address the major limitations of the present data, resulting in a more complete characterization of the types and extent of contamination. TDH should collect a minimum of thirty samples from sites within the reservoir that are consistent with those sampled in 1995.

PUBLIC HEALTH ACTION PLAN

TDH fish consumption advisories and bans are published in booklet form and are available through the TDH Seafood Safety Division: (512-719-0215). TDH also posts this information on the Internet at URL: http://www.tdh.state.tx.us/bfds/ssd, which is regularly updated. Some risk characterizations (formerly called health assessments) for water bodies surveyed by the Texas Department of Health may also be available from the Agency for Toxic Substances and Disease Registry (http://www.atsdr.cdc.gov/HAC/PHA/region6.html). The Texas Department of Health provides all consumption advisory and ban information to the U.S. Environmental Protection Agency (URL: http://fish.rti.org), the Texas Natural Resource Conservation Commission (TNRCC; URL: http://www.tnrcc.state.tx.us) and the Texas Parks and Wildlife Department (TPWD; URL: http://www.tpwd.state.tx.us). Each year, the TPWD informs the fishing and hunting public of fishing bans in an official hunting and fishing regulations booklet [10] that is available at some state parks and at establishments that sell fishing licenses.

Readers may direct questions about the scientific information or recommendations in this risk assessment to the Seafood Safety Division (512-719-0215) or the Environmental Epidemiology and Toxicology Division (512-458-7269) at the Texas Department of Health. Readers may also obtain toxicological information on a variety of environmental contaminants from the Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology by telephoning that agency at the toll free number (800-447-1544) or by visiting ATSDR's web site (http://www.atsdr.cdc.gov).

Table 1. Contaminant concentrations (mg/kg) in fish collected from Mountain Creek Lake in 2000 and 2001.

Chemical	Number Affected/ Sampled	Average Concentration (Min-Max)*	Health Assessment Comparison Value†	Basis for Comparison Value
Principal Inorganic Contaminants				
Cadmium	4/10	0.003 (nd‡-0.010)	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg -day
Copper	6/10	0.146 (nd-0.345)	----	Not available
Lead	1/10	0.001 (nd-0.012)	----	Not available
Mercury	3/10	0.057 (nd-0.181)	0.7	ATSDR Chronic oral MRL: 0.0003 mg/kg -day
Selenium	10/10	0.352 (0.07-0.545)	12	ATSDR Chronic oral MRL/EPA RfD: 0.005 mg/kg -day
Zinc	10/10	5.46 (3.96-11.9)	700	ATSDR Chronic oral MRL/EPA RfD: 0.3 mg/kg -day
Principal Organic Contaminants				
Chlordane	2/10	0.003 (nd-0.015)	1.2	EPA chronic oral RfD: 0.0005 mg/kg -day
			1.6	EPA slope factor: 0.35 per mg/kg -day
Aroclor 1260	1/10	.010 (nd-0.100)	0.047	EPA chronic oral RfD for Aroclor 1254: .00002 mg/kg -day
			0.27	EPA slope factor: 2 per mg/kg -day

* *Data Spread: Minimum to Maximum: Smallest reported value to largest reported value; (range = maximum conc - minimum conc)*
† *Derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of* $1x10^{-4}$
‡ *nd-not detected at concentrations above the laboratory reporting limit*

Table 2. Theoretical risks from consuming fish from Mountain Creek Lake based on a limited sample (n=10) collected in 2000 (n=5) and 2001 (n=5).

	HAZARD RATIO			CANCER RISK		
CONTAMINANT	**Common Carp**	**Largemouth Bass**	**All Species**	**Common Carp**	**Largemouth Bass**	**All Species**
Chlordane	0.003	0.0032	0.003	2.2×10^{-7}	2.4×10^{-7}	1.8×10^{-7}
Aroclor 1260	**0.536**	Not Applicable	0.214	9.2×10^{-6}	Not Applicable	3.7×10^{-6}
	HAZARD INDEX			**CUMULATIVE CANCER RISK**		
	0.539	**0.0032**	**0.217**	**9.4×10^{-6}**	**2.4×10^{-7}**	**3.9×10^{-6}**

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