APPENDIX 8

APPENDIX 8-1

Project 1: City of Lompoc, Lompoc Valley Leak Detection and Repair Project

- Water Treatment and Distribution Energy Requirements
- Energy and Greenhouse Gas Emissions
- *Assembly Bill 32, Global Warming Solutions Act of 2006*

Handout #10: BMP 5 Example Avoided Energy Costs

Electricity rate	$0.12	per kWh

Energy Requirement Per MG

Water Treatment/Distribution	Energy	Cost
Raw Water Pumping & Water Treatment	350	$42.00
Pump to Distribution System	1,150	$138.00
Total Per MG	1,500	$180.00
Total Per AF	489	$58.63
Raw Water & Pumping	114	$13.68
Pump to Distribution System	375	$44.95

Wastewater Processing/Disposal	Energy	Cost
Pump to Wastewater	150	$18.00
Wastewater Treatment	1,050	$126.00
Total Per MG	1,200	$144.00
Total Per AF	391	$46.91

Source: EPRI Municipal Water & Wastewater Program

Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation 1998-2000

Energy Information Administration
Office of Integrated Analysis and Forecasting
Energy Information Administration
U.S. Department of Energy

April 2002

1. INTRODUCTION

Authorized by Title XVI, Section 1605(b) of the Energy Policy Act of 1992 (Public Law 102-486), the Voluntary Reporting of Greenhouse Gases Program provides the opportunity for corporations, government agencies, households, and voluntary organizations to report to the Energy Information Administration (EIA) their emissions of greenhouse gases and their actions taken to reduce or avoid emissions or to sequester carbon.

To assist reporters in estimating emissions and emission reductions, EIA has made available in the instructions to Forms EIA-1605 and EIA-1605EZ emission coefficients for most commonly used fossil fuels and electricity. The emission coefficients for electricity originally presented in these instructions were state-level coefficients developed by the Department of Energy's Office of Policy for inclusion in the supporting documents to the Program's guidelines.[1] These coefficients were based on 1992 emissions and generation data. In 1999, updated coefficients were prepared based on the most recent data (1998) then available; however, the updated coefficients were not included in the instructions for the 1999 data year. Last year, these state-level factors were updated again, but based on a weighted average of three-years worth of data (1997, 1998, and 1999) rather than a single year. The adoption of this new three-year "rolling average" approach was intended to ameliorate the impact of transient anomalies (e.g., unusual weather) on the coefficients, while still enabling EIA to capture the impacts of long-term developments such as the deregulation of the utility industry.

The updated 1997-1999 coefficients from last year reflected only electric utilities; data for non-utility generators were purposely excluded from the computations performed to derive the coefficients. However, in a few states, the percentage of power produced by nonutility generators has become quite high, particularly where independent power producers have purchased plants previously owned by electric utilities. In 1999, nonutility generation exceeded 20 percent of the total amount of power generated in the following 10 states: Rhode Island (100 percent), Maine (90 percent), Massachusetts (89 percent), California (52 percent), Hawaii (37 percent), New York (33 percent), New Jersey (32 percent), Connecticut (27 percent), Louisiana (27 percent), and Alaska (22 percent).[2] Therefore, EIA has included all generators, including utilities, nonutilities, and industrial cogenerators, in this year's update of the state-level electricity emission factors.

This report documents the preparation of these updated state-level electricity coefficients for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which represent a three-year weighted average for 1998-2000.

[1] U.S. Department of Energy, *Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992*, Volume I, October 1994 (DOE/PO-00280), pp. C.2-C.3.

[2] Energy Information Administration, *Electric Power Annual*, Volume I, DOE/EIA-0348(00)/1, June 2000, table A.7, p. 34.

2. UPDATED EMISSIONS COEFFICIENTS

This section presents a table with the final State average electricity emissions coefficients for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Table 1). These coefficients are included in the instructions to Forms EIA-1605 and EIA-1605EZ for the 2001 (data year) reporting cycle. Table 2 offers a comparison between these updated coefficients and the 1997-1999, utility-only coefficients included with the instructions to Forms EIA-1605 and EIA-1605EZ last year.

Carbon Dioxide

The national average coefficient for carbon dioxide declined by 2.7 percent from 0.686 tons per MWH to 0.668 tons per MWH. Several States exhibited increases, including California (99.7 percent),Vermont (80.5 percent), Oregon 59.7 percent), Washington (33.3 percent), New Jersey (24.7 percent), and Rhode Island (14.1 percent). These are States where either nonutility generators generate a significant proportion of the power or hydroelectric power is a significant source of electricity. The inclusion of nonutility generators in the average emission factors changes the basis of the calculations and typically results in the addition of a relatively higher proportion of fossil fuel-fired generating plants than was in the universe of utility-only plants included in the calculations for last year's emission coefficients. The generation of hydroelectric power in the United States in 2000 was 23 percent lower than in 1997.[3] Years in which hydroelectric power is low results in higher carbon dioxide emissions as generation from fossil fuel increases. The effect on the U.S. average emission factors was offset by the an increasing share of national electricity generation provided by low- or zero-emission sources, including natural gas and nuclear power plants.

Nitrous Oxide and Methane

The emission coefficient for nitrous oxide declined by 2.8 percent, from 0.0197 to 0.092 lbs/MWH, which is similar to the decline for carbon dioxide. In contrast, the emission coefficient for methane increased by 21.9 percent, from 0.0096 to 0.0118 lbs per MWH. This increase can be attributed to greater proportion of power generated from wood and waste by the electric power industry as a whole compared to electric utilities. Wood accounted for 3.1 percent of the heat input to conventional (combustion) utility and non-utility power plants in the U.S. 1998-2000. For utility plants only over the 1997-1999 time period on which last year's coefficients were based, wood accounted for 0.1 percent of the heat input to conventional power plants. The methane emissions produced by wood- and waste-fired power plants is about an order of magnitude or more greater than emissions from plants using fossil fuels (0.0111 lbs methane/MMBtu versus 0.000287 to 0.00163 lbs methane/MMBtu).[4]

[3] Energy Information Administration, *Annual Energy Review 2000*, DOE/EIA-0384(2000), August 2001, Table 8.2, p. 221.

[4] See Table 3 and the discussion of the methodology used to calculate these updated coefficients in the following section.

Table 1. 1998-2000 Average State-level Carbon Dioxide Emissions Coefficients for Electric Power

	Carbon Dioxide			Methane	Nitrous Oxide
Region/State	lbs/kWh	short tons/ MWH	metric tons/ MWH	lbs/MWH	lbs/MWH
New England	**0.98**	**0.491**	**0.446**	**0.0207**	**0.0146**
Connecticut	0.94	0.471	0.427	0.0174	0.0120
Maine	0.85	0.426	0.386	0.0565	0.0270
Massachusetts	1.28	0.639	0.579	0.0174	0.0159
New Hampshire	0.68	0.341	0.310	0.0172	0.0141
Rhode Island	1.05	0.526	0.477	0.0068	0.0047
Vermont	0.03	0.014	0.013	0.0096	0.0039
Mid Atlantic	**1.04**	**0.520**	**0.471**	**0.0093**	**0.0145**
New Jersey	0.71	0.353	0.320	0.0077	0.0079
New York	0.86	0.429	0.389	0.0081	0.0089
Pennsylvania	1.26	0.632	0.574	0.0107	0.0203
East-North Central	**1.63**	**0.815**	**0.740**	**0.0123**	**0.0257**
Illinois	1.16	0.582	0.528	0.0082	0.0180
Indiana	2.08	1.038	0.942	0.0143	0.0323
Michigan	1.58	0.790	0.717	0.0146	0.0250
Ohio	1.80	0.900	0.817	0.0130	0.0288
Wisconsin	1.64	0.821	0.745	0.0138	0.0260
West-North Central	**1.73**	**0.864**	**0.784**	**0.0127**	**0.0269**
Iowa	1.88	0.941	0.854	0.0138	0.0298
Kansas	1.68	0.842	0.764	0.0112	0.0254
Minnesota	1.52	0.762	0.691	0.0157	0.0247
Missouri	1.84	0.920	0.835	0.0126	0.0288
Nebraska	1.40	0.700	0.635	0.0095	0.0219
North Dakota	2.24	1.121	1.017	0.0147	0.0339
South Dakota	0.80	0.399	0.362	0.0053	0.0121
South Atlantic	**1.35**	**0.674**	**0.612**	**0.0127**	**0.0207**
Delaware	1.83	0.915	0.830	0.0123	0.0227
Florida	1.39	0.697	0.632	0.0150	0.0180
Georgia	1.37	0.683	0.619	0.0129	0.0226
Maryland*	1.37	0.683	0.620	0.0118	0.0206
North Carolina	1.24	0.621	0.563	0.0105	0.0203
South Carolina	0.83	0.417	0.378	0.0091	0.0145
Virginia	1.16	0.582	0.528	0.0137	0.0192
West Virginia	1.98	0.988	0.897	0.0137	0.0316
East-South Central	**1.49**	**0.746**	**0.677**	**0.0128**	**0.0240**
Alabama	1.31	0.656	0.595	0.0137	0.0223
Kentucky	2.01	1.004	0.911	0.0140	0.0321
Mississippi	1.29	0.647	0.587	0.0132	0.0165
Tennessee	1.30	0.648	0.588	0.0105	0.0212
West-South Central	**1.43**	**0.714**	**0.648**	**0.0087**	**0.0153**
Arkansas	1.29	0.643	0.584	0.0125	0.0203
Louisiana	1.18	0.589	0.534	0.0094	0.0112
Oklahoma	1.72	0.861	0.781	0.0110	0.0223
Texas	1.46	0.732	0.664	0.0077	0.0146

Table 1. 1998-2000 Average State-Level Carbon Dioxide Emissions Coefficients for Electric Power (Cont'd)

Region/State	Carbon Dioxide			Methane	Nitrous Oxide
	lbs/kWh	short tons/ MWH	metric tons/ MWH	lbs/MWH	lbs/MWH
Mountain	**1.56**	**0.781**	**0.709**	**0.0108**	**0.0236**
Arizona	1.05	0.525	0.476	0.0068	0.0154
Colorado	1.93	0.963	0.873	0.0127	0.0289
Idaho	0.03	0.014	0.013	0.0080	0.0033
Montana	1.43	0.717	0.650	0.0108	0.0227
Nevada	1.52	0.759	0.688	0.0090	0.0195
New Mexico	2.02	1.009	0.915	0.0131	0.0296
Utah	1.93	0.967	0.878	0.0134	0.0308
Wyoming	2.15	1.073	0.973	0.0147	0.0338
Pacific Contiguous	**0.45**	**0.224**	**0.203**	**0.0053**	**0.0037**
California	0.61	0.303	0.275	0.0067	0.0037
Oregon	0.28	0.141	0.127	0.0033	0.0034
Washington	0.25	0.123	0.111	0.0037	0.0040
Pacific Non-contiguous	**1.56**	**0.780**	**0.707**	**0.0161**	**0.0149**
Alaska	1.38	0.690	0.626	0.0068	0.0089
Hawaii	1.66	0.831	0.754	0.0214	0.0183
United States	**1.34**	**0.668**	**0.606**	**0.0111**	**0.0192**

Note: These state- and regional-level electricity emission factors represent average emissions per kWh or MWH generated by utility and nonutility electric generators for the 1998-2000 time period. The Voluntary Reporting of Greenhouse Gases Program believes these factors provide reasonably accurate default values for power generated in a given state or region (U.S. Census Division). However, reporters should use these state- and regional-level factors only if utility-specific or power pool-specific emission factors are not available.

*Includes the District of Columbia

Source: Energy Information Administration, *Updated State- and Regional-level Greenhouse Gas Emission Factors for Electricity* (March 2002), http:/www.eia.doe.gov/oiaf/1605/e-factor.html.

Table 2. Comparison of Updated 1998-2000 Average State-level Utility Emission Coefficients with Last Year's 1997-1999 Emissions Coefficients

State	2000 Data Year (1997-1999)			2001 Data Year (1998-2000)			Difference		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	tons/MWH	lbs/MWH	lbs/MWH	tons/MWH	lbs/MWH	lbs/MWH	Percent	Percent	Percent
Alabama	0.673	0.0092	0.0212	0.656	0.0137	0.0223	-2.5	48.9	5.0
Alaska	0.620	0.0060	0.0067	0.690	0.0068	0.0089	11.3	13.7	33.2
Arizona	0.508	0.0067	0.0152	0.525	0.0068	0.0154	3.3	1.9	1.4
Arkansas	0.655	0.0084	0.0189	0.643	0.0125	0.0203	-1.8	49.2	7.6
California	0.152	0.0009	0.0007	0.303	0.0067	0.0037	99.7	644.1	423.8
Colorado	1.024	0.0138	0.0316	0.963	0.0127	0.0289	-6.0	-7.8	-8.6
Connecticut	0.568	0.0131	0.0115	0.471	0.0174	0.0120	-17.2	32.5	4.0
Delaware	0.928	0.0124	0.0232	0.915	0.0123	0.0227	-1.4	-0.4	-2.3
Florida	0.716	0.0098	0.0170	0.697	0.0150	0.0180	-2.7	52.7	5.9
Georgia	0.710	0.0098	0.0223	0.683	0.0129	0.0226	-3.9	31.3	1.3
Hawaii	0.909	0.0175	0.0150	0.831	0.0214	0.0183	-8.6	22.4	21.8
Idaho	0.000	0.0000	0.0000	0.014	0.0080	0.0033	—	—	—
Illinois	0.589	0.0079	0.0179	0.582	0.0082	0.0180	-1.2	4.0	0.3
Indiana	1.067	0.0146	0.0338	1.038	0.0143	0.0323	-2.7	-2.1	-4.4
Iowa	0.991	0.0134	0.0306	0.941	0.0138	0.0298	-5.0	2.9	-2.6
Kansas	0.870	0.0113	0.0257	0.842	0.0112	0.0254	-3.2	-0.7	-1.2
Kentucky	0.993	0.0138	0.0317	1.004	0.0140	0.0321	1.1	1.2	1.2
Louisiana	0.665	0.0065	0.0127	0.589	0.0094	0.0112	-11.4	44.3	-12.0
Maine	0.450	0.0085	0.0073	0.426	0.0565	0.0270	-5.3	564.4	270.4
Maryland*	0.676	0.0096	0.0202	0.683	0.0118	0.0206	1.1	23.3	1.8
Massachusetts	0.618	0.0076	0.0167	0.639	0.0174	0.0159	3.3	128.7	-4.6
Michigan	0.871	0.0117	0.0264	0.790	0.0146	0.0250	-9.3	24.9	-5.4
Minnesota	0.794	0.0118	0.0248	0.762	0.0157	0.0247	-4.1	32.9	-0.5
Mississippi	0.660	0.0082	0.0149	0.647	0.0132	0.0165	-1.9	61.4	10.9
Missouri	0.950	0.0128	0.0292	0.920	0.0126	0.0288	-3.1	-1.8	-1.4
Montana	0.645	0.0086	0.0199	0.717	0.0108	0.0227	11.1	26.1	13.9
Nebraska	0.703	0.0094	0.0215	0.700	0.0095	0.0219	-0.5	1.1	1.6
Nevada	0.832	0.0103	0.0227	0.759	0.0090	0.0195	-8.8	-12.8	-14.3
New Hampshire	0.373	0.0056	0.0105	0.341	0.0172	0.0141	-8.5	206.5	34.0
New Jersey	0.283	0.0035	0.0072	0.353	0.0077	0.0079	24.7	119.8	10.2
New Mexico	1.050	0.0135	0.0306	1.009	0.0131	0.0296	-3.9	-3.2	-3.4
New York	0.398	0.0050	0.0080	0.429	0.0081	0.0089	7.9	62.0	11.5
North Carolina	0.622	0.0086	0.0198	0.621	0.0105	0.0203	-0.2	21.8	2.6

Table 2. Comparison of Updated 1998-2000 Average State-level Utility Emission Factors with Last Year's 1997-1999 Emissions Factors (Cont'd)

State	2000 Data Year (1997-1999)			2001 Data Year (1998-2000)			Difference		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
	tons/MWH	lbs/MWH	lbs/MWH	tons/MWH	lbs/MWH	lbs/MWH	Percent	Percent	Percent
North Dakota	1.095	0.0145	0.0335	1.121	0.0147	0.0339	2.4	1.2	1.1
Ohio	0.907	0.0126	0.0290	0.900	0.0130	0.0288	-0.7	3.2	-0.5
Oklahoma	0.884	0.0102	0.0223	0.861	0.0110	0.0223	-2.6	8.2	-0.1
Oregon	0.088	0.0010	0.0020	0.141	0.0033	0.0034	59.7	226.7	68.4
Pennsylvania	0.611	0.0085	0.0192	0.632	0.0107	0.0203	3.5	26.1	5.8
Rhode Island	0.461	0.0024	0.0019	0.526	0.0068	0.0047	14.1	184.0	147.0
South Carolina	0.408	0.0057	0.0129	0.417	0.0091	0.0145	2.1	60.4	12.3
South Dakota	0.359	0.0047	0.0107	0.399	0.0053	0.0121	11.1	13.4	12.7
Tennessee	0.623	0.0086	0.0198	0.648	0.0105	0.0212	4.0	22.4	7.0
Texas	0.774	0.0083	0.0173	0.732	0.0077	0.0146	-5.4	-7.7	-15.7
Utah	0.970	0.0134	0.0308	0.967	0.0134	0.0308	-0.3	0.2	0.1
Vermont	0.008	0.0045	0.0019	0.014	0.0096	0.0039	80.5	112.5	106.4
Virginia	0.544	0.0076	0.0165	0.582	0.0137	0.0192	7.0	80.4	16.2
Washington	0.092	0.0016	0.0029	0.123	0.0037	0.0040	33.3	128.3	36.6
West Virginia	0.986	0.0137	0.0316	0.988	0.0137	0.0316	0.2	-0.1	-0.1
Wisconsin	0.896	0.0129	0.0278	0.821	0.0138	0.0260	-8.3	6.6	-6.4
Wyoming	1.097	0.0148	0.0341	1.073	0.0147	0.0338	-2.2	-1.0	-0.8
U.S. Average	**0.686**	**0.0091**	**0.0197**	**0.668**	**0.0111**	**0.0192**	**-2.7**	**21.9**	**-2.8**

*Includes the District of Columbia

3. METHODOLOGY

The basic steps for determining each State's emissions coefficient are as follows:

1. Generation data for electric utilities and non-utilities for 1998-2000 by state were obtained from EIA's Office of Coal, Nuclear Energy, and Alternative Fuels (CNEAF).[5]

2. Estimates of carbon dioxide emissions for 1998-2000 by state were also obtained from CNEAF.[6]

3. Carbon dioxide emission coefficients were calculated by dividing emissions (in tons) by generation (in MWH). These calculations were also performed on data aggregated by U.S. Census Division to provide regional coefficients.

4. Data on the consumption of coal, fuel oil, natural gas, wood and wood waste (in billion Btu) by non-utilities, and municipal solid waste by state for 1998-2000 were obtained from CNEAF. As utility wood consumption data for 1998-2000 was unavailable, the 1997-1999 values used in calculating last year's coefficients were used as proxies.[7]

5. Emission factors for methane and nitrous oxide were calculated using the above fuel consumption data and the emissions coefficients presented in Table 3 using the following equation:

   Fuel consumption (BBtu) * Emission coefficient (lbs gas/MMBtu) * 1000 MMBtu/1 BBtu

   Again, these calculations were also performed on data aggregated by U.S. Census Division to provide regional methane and nitrous oxide coefficients.

[5]Energy Information Administration, Form EIA-759, *Monthly Power Plant Report*; Form EIA-767, *Steam-Electric Plant Operation and Design Report*; Form EIA-860B, *Annual Nonutility Power Producer Report*; Form EIA-900, *Monthly Nonutility Power Report*; Federal Energy Regulatory Commission, FERC Form 423, *Monthly Cost and Quality of Fuels for Electric Power Plants*.

[6]Energy Information Administration, Office of Coal, Nuclear Energy, and Alternative Fuels, *Electric Power Industry Estimated CO2 Emissions 1998-1999*, December 27, 2000. (Unpublished data). Personal communication between Paul McArdle, Office of Integrated Analysis and Forecasting and Channelle Carner, June 2001.

[7]Energy Information Administration, Form EIA-759, *Monthly Power Plant Report*; Form EIA-767, *Steam-Electric Plant Operation and Design Report*; Form EIA-860B, *Annual Nonutility Power Producer Report*; Form EIA-900, *Monthly Nonutility Power Report*; Federal Energy Regulatory Commission, FERC Form 423, *Monthly Cost and Quality of Fuels for Electric Power Plants*.

Table 3. Fuel Emissions Coefficients for Methane and Nitrous Oxide

Fuel	Emission Coefficient (lbs gas/MMBtu)	Source*
Methane		
Anthracite	0.00141	A
Bituminous	0.00141	A
Subbituminous	0.00141	A
Lignite	0.00141	A
Coke	0.00141	B
Residual Fuel (No. 6 Fuel Oil)	0.00163	A
Distillate Fuel (No. 2 Fuel Oil)	0.00163	A
Natural Gas	0.000287	A
Wood	0.0111	E
Waste (Refuse)	0.0111	E
Nitrous Oxide		
Anthracite	0.00326	C
Bituminous	0.00326	C
Subbituminous	0.00326	C
Lignite	0.00326	C
Coke	0.00326	B
Residual Fuel (No. 6 Fuel Oil)	0.0014	C
Distillate Fuel (No. 2 Fuel Oil)	0.0014	C
Natural Gas	0.000233	C
Wood	0.00444	E
Waste (Refuse)	0.00444	E

* Key to Sources:

A: EIA's *Emissions of Greenhouse Gases in the United States* source data, derived from emissions coefficients for stationary fuel in the EPA's Office of Air Quality Planning and Standards, *Compilation of Air Pollutant Emission Factors*, AP-42, and Intergovernmental Panel on Climate Change, *Greenhouse Gas Inventory Reference Manual: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 3 (Paris, France, 1997),www.ipcc.ch/pub/guide.htm .

B: Assumed to be the same as for anthracite, following the example of the *Electric Power Annual 1997*, which states that "Emissions factors for petroleum coke are assumed to be the same as those for anthracite." Footnote 6 to Table A3 "Sulfur Dioxide, Nitrogen Oxide and Carbon Dioxide Emissions Factors," p.121

C: Intergovernmental Panel on Climate Change, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3)*, 1996, Table 1-8 (http://www.ipcc-nggip.iges.or.jp/public/gl/invs6a.htm).

F. Wood and waste are assumed to have no CO_2 emissions because the carbon in these fuels are considered to be part of the natural carbon cycle. See Intergovernmental Panel on Climate Change, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual (Volume 3)*, 1996, p. 6.28 (http://www.ipcc-nggip.iges.or.jp/public/gl/invs6a.htm).

E: The coefficient for wood is taken from EPA's AP-42 (using
their assumed 4500 Btu/lb and their coefficients of 0.1 lb CH_4/ton and 0.04 lb N_2O/ton). Coefficients for refuse assumed to be the same as for wood.

Assembly Bill No. 32

CHAPTER 488

An act to add Division 25.5 (commencing with Section 38500) to the Health and Safety Code, relating to air pollution.

[Approved by Governor September 27, 2006. Filed with Secretary of State September 27, 2006.]

LEGISLATIVE COUNSEL'S DIGEST

AB 32, Nunez. Air pollution: greenhouse gases: California Global Warming Solutions Act of 2006.

Under existing law, the State Air Resources Board (state board), the State Energy Resources Conservation and Development Commission (Energy Commission), and the California Climate Action Registry all have responsibilities with respect to the control of emissions of greenhouse gases, as de ned, and the Secretary for Environmental Protection is required to coordinate emission reductions of greenhouse gases and climate change activity in state government.

This bill would require the state board to adopt regulations to require the reporting and veri cation of statewide greenhouse gas emissions and to monitor and enforce compliance with this program, as speci ed. The bill would require the state board to adopt a statewide greenhouse gas emissions limit equivalent to the statewide greenhouse gas emissions levels in 1990 to be achieved by 2020, as speci ed. The bill would require the state board to adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions, as speci ed. The bill would authorize the state board to adopt market-based compliance mechanisms, as de ned, meeting speci ed requirements. The bill would require the state board to monitor compliance with and enforce any rule, regulation, order, emission limitation, emissions reduction measure, or market-based compliance mechanism adopted by the state board, pursuant to speci ed provisions of existing law. The bill would authorize the state board to adopt a schedule of fees to be paid by regulated sources of greenhouse gas emissions, as speci ed.

Because the bill would require the state board to establish emissions limits and other requirements, the violation of which would be a crime, this bill would create a state-mandated local program.

The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a speci ed reason.

The people of the State of California do enact as follows:

SECTION 1. Division 25.5 (commencing with Section 38500) is added to the Health and Safety Code, to read:

DIVISION 25.5. CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006

PART 1. GENERAL PROVISIONS

Chapter 1. Title of Division

38500. This division shall be known, and may be cited, as the California Global Warming Solutions Act of 2006.

Chapter 2. Findings and Declarations

38501. The Legislature nds and declares all of the following:

(a) Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California. The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems.

(b) Global warming will have detrimental effects on some of California's largest industries, including agriculture, wine, tourism, skiing, recreational and commercial shing, and forestry. It will also increase the strain on electricity supplies necessary to meet the demand for summer air-conditioning in the hottest parts of the state.

(c) California has long been a national and international leader on energy conservation and environmental stewardship efforts, including the areas of air quality protections, energy ef ciency requirements, renewable energy standards, natural resource conservation, and greenhouse gas emission standards for passenger vehicles. The program established by this division will continue this tradition of environmental leadership by placing California at the forefront of national and international efforts to reduce emissions of greenhouse gases.

(d) National and international actions are necessary to fully address the issue of global warming. However, action taken by California to reduce emissions of greenhouse gases will have far-reaching effects by encouraging other states, the federal government, and other countries to act.

(e) By exercising a global leadership role, California will also position its economy, technology centers, nancial institutions, and businesses to bene t from national and international efforts to reduce emissions of greenhouse gases. More importantly, investing in the development of innovative and pioneering technologies will assist California in achieving the 2020 statewide limit on emissions of greenhouse gases established by this division and will provide an opportunity for the state to take a global economic and technological leadership role in reducing emissions of greenhouse gases.

(f) It is the intent of the Legislature that the State Air Resources Board coordinate with state agencies, as well as consult with the environmental justice community, industry sectors, business groups, academic institutions, environmental organizations, and other stakeholders in implementing this division.

(g) It is the intent of the Legislature that the State Air Resources Board consult with the Public Utilities Commission in the development of emissions reduction measures, including limits on emissions of greenhouse gases applied to electricity and natural gas providers regulated by the Public Utilities Commission in order to ensure that electricity and natural gas providers are not required to meet duplicative or inconsistent regulatory requirements.

(h) It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established pursuant to this division in a manner that minimizes costs and maximizes bene ts for California's economy, improves and modernizes California's energy infrastructure and maintains electric system reliability, maximizes additional environmental and economic co-bene ts for California, and complements the state's efforts to improve air quality.

(i) It is the intent of the Legislature that the Climate Action Team established by the Governor to coordinate the efforts set forth under Executive Order S-3-05 continue its role in coordinating overall climate policy.

Chapter 3. Definitions

38505. For the purposes of this division, the following terms have the following meanings:

(a) "Allowance" means an authorization to emit, during a speci ed year, up to one ton of carbon dioxide equivalent.

(b) "Alternative compliance mechanism" means an action undertaken by a greenhouse gas emission source that achieves the equivalent reduction of greenhouse gas emissions over the same time period as a direct emission reduction, and that is approved by the state board. "Alternative compliance mechanism" includes, but is not limited to, a

exible compliance schedule, alternative control technology, a process change, or a product substitution.

(c) "Carbon dioxide equivalent" means the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas, based on the best available science, including from the Intergovernmental Panel on Climate Change.

(d) "Cost-effective" or "cost-effectiveness" means the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential.

(e) "Direct emission reduction" means a greenhouse gas emission reduction action made by a greenhouse gas emission source at that source.

(f) "Emissions reduction measure" means programs, measures, standards, and alternative compliance mechanisms authorized pursuant to this division, applicable to sources or categories of sources, that are designed to reduce emissions of greenhouse gases.

(g) "Greenhouse gas" or "greenhouse gases" includes all of the following gases: carbon dioxide, methane, nitrous oxide, hydro uorocarbons, per uorocarbons, and sulfur hexa ouride.

(h) "Greenhouse gas emissions limit" means an authorization, during a speci ed year, to emit up to a level of greenhouse gases speci ed by the state board, expressed in tons of carbon dioxide equivalents.

(i) "Greenhouse gas emission source" or "source" means any source, or category of sources, of greenhouse gas emissions whose emissions are at a level of signi cance, as determined by the state board, that its participation in the program established under this division will enable the state board to effectively reduce greenhouse gas emissions and monitor compliance with the statewide greenhouse gas emissions limit.

(j) "Leakage" means a reduction in emissions of greenhouse gases within the state that is offset by an increase in emissions of greenhouse gases outside the state.

(k) "Market-based compliance mechanism" means either of the following:

(1) A system of market-based declining annual aggregate emissions limitations for sources or categories of sources that emit greenhouse gases.

(2) Greenhouse gas emissions exchanges, banking, credits, and other transactions, governed by rules and protocols established by the state board, that result in the same greenhouse gas emission reduction, over the same time period, as direct compliance with a greenhouse gas emission limit or emission reduction measure adopted by the state board pursuant to this division.

(*l*) "State board" means the State Air Resources Board.

(m) "Statewide greenhouse gas emissions" means the total annual emissions of greenhouse gases in the state, including all emissions of greenhouse gases from the generation of electricity delivered to and consumed in California, accounting for transmission and distribution line losses, whether the electricity is generated in state or imported. Statewide emissions shall be expressed in tons of carbon dioxide equivalents.

(n) "Statewide greenhouse gas emissions limit" or "statewide emissions limit" means the maximum allowable level of statewide greenhouse gas emissions in 2020, as determined by the state board pursuant to Part 3 (commencing with Section 38850).

Chapter 4. Role of State Board

38510. The State Air Resources Board is the state agency charged with monitoring and regulating sources of emissions of greenhouse gases that cause global warming in order to reduce emissions of greenhouse gases.

PART 2. MANDATORY GREENHOUSE GAS EMISSIONS REPORTING

38530. (a) On or before January 1, 2008, the state board shall adopt regulations to require the reporting and veri cation of statewide greenhouse gas emissions and to monitor and enforce compliance with this program.

(b) The regulations shall do all of the following:

(1) Require the monitoring and annual reporting of greenhouse gas emissions from greenhouse gas emission sources beginning with the sources or categories of sources that contribute the most to statewide emissions.

(2) Account for greenhouse gas emissions from all electricity consumed in the state, including transmission and distribution line losses from electricity generated within the state or imported from outside the state. This requirement applies to all retail sellers of electricity, including load-serving entities as de ned in subdivision (j) of Section 380 of the Public Utilities Code and local publicly owned electric utilities as de ned in Section 9604 of the Public Utilities Code.

(3) Where appropriate and to the maximum extent feasible, incorporate the standards and protocols developed by the California Climate Action Registry, established pursuant to Chapter 6 (commencing with Section 42800) of Part 4 of Division 26. Entities that voluntarily participated in the California Climate Action Registry prior to December 31, 2006, and have developed a greenhouse gas emission reporting program, shall not be required to signi cantly alter their reporting or veri cation program except as necessary to ensure that reporting is complete and veri able for the purposes of compliance with this division as determined by the state board.

(4) Ensure rigorous and consistent accounting of emissions, and provide reporting tools and formats to ensure collection of necessary data.

(5) Ensure that greenhouse gas emission sources maintain comprehensive records of all reported greenhouse gas emissions.

(c) The state board shall do both of the following:

(1) Periodically review and update its emission reporting requirements, as necessary.

(2) Review existing and proposed international, federal, and state greenhouse gas emission reporting programs and make reasonable efforts to promote consistency among the programs established pursuant to this part and other programs, and to streamline reporting requirements on greenhouse gas emission sources.

PART 3. STATEWIDE GREENHOUSE GAS EMISSIONS LIMIT

38550. By January 1, 2008, the state board shall, after one or more public workshops, with public notice, and an opportunity for all interested parties to comment, determine what the statewide greenhouse gas emissions level was in 1990, and approve in a public hearing, a statewide greenhouse gas emissions limit that is equivalent to that level, to be achieved by 2020. In order to ensure the most accurate determination feasible, the state board shall evaluate the best available scienti c, technological, and economic information on greenhouse gas emissions to determine the 1990 level of greenhouse gas emissions.

38551. (a) The statewide greenhouse gas emissions limit shall remain in effect unless otherwise amended or repealed.

(b) It is the intent of the Legislature that the statewide greenhouse gas emissions limit continue in existence and be used to maintain and continue reductions in emissions of greenhouse gases beyond 2020.

(c) The state board shall make recommendations to the Governor and the Legislature on how to continue reductions of greenhouse gas emissions beyond 2020.

PART 4. GREENHOUSE GAS EMISSIONS REDUCTIONS

38560. The state board shall adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources or categories of sources, subject to the criteria and schedules set forth in this part.

38560.5. (a) On or before June 30, 2007, the state board shall publish and make available to the public a list of discrete early action greenhouse gas emission reduction measures that can be implemented prior to the measures and limits adopted pursuant to Section 38562.

(b) On or before January 1, 2010, the state board shall adopt regulations to implement the measures identi ed on the list published pursuant to subdivision (a).

(c) The regulations adopted by the state board pursuant to this section shall achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from those sources or categories of

sources, in furtherance of achieving the statewide greenhouse gas emissions limit.

(d) The regulations adopted pursuant to this section shall be enforceable no later than January 1, 2010.

38561. (a) On or before January 1, 2009, the state board shall prepare and approve a scoping plan, as that term is understood by the state board, for achieving the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from sources or categories of sources of greenhouse gases by 2020 under this division. The state board shall consult with all state agencies with jurisdiction over sources of greenhouse gases, including the Public Utilities Commission and the State Energy Resources Conservation and Development Commission, on all elements of its plan that pertain to energy related matters including, but not limited to, electrical generation, load based-standards or requirements, the provision of reliable and affordable electrical service, petroleum re ning, and statewide fuel supplies to ensure the greenhouse gas emissions reduction activities to be adopted and implemented by the state board are complementary, nonduplicative, and can be implemented in an ef cient and cost-effective manner.

(b) The plan shall identify and make recommendations on direct emission reduction measures, alternative compliance mechanisms, market-based compliance mechanisms, and potential monetary and nonmonetary incentives for sources and categories of sources that the state board nds are necessary or desirable to facilitate the achievement of the maximum feasible and cost-effective reductions of greenhouse gas emissions by 2020.

(c) In making the determinations required by subdivision (b), the state board shall consider all relevant information pertaining to greenhouse gas emissions reduction programs in other states, localities, and nations, including the northeastern states of the United States, Canada, and the European Union.

(d) The state board shall evaluate the total potential costs and total potential economic and noneconomic bene ts of the plan for reducing greenhouse gases to California's economy, environment, and public health, using the best available economic models, emission estimation techniques, and other scienti c methods.

(e) In developing its plan, the state board shall take into account the relative contribution of each source or source category to statewide greenhouse gas emissions, and the potential for adverse effects on small businesses, and shall recommend a de minimis threshold of greenhouse gas emissions below which emission reduction requirements will not apply.

(f) In developing its plan, the state board shall identify opportunities for emission reductions measures from all veri able and enforceable voluntary actions, including, but not limited to, carbon sequestration projects and best management practices.

(g) The state board shall conduct a series of public workshops to give interested parties an opportunity to comment on the plan. The state board shall conduct a portion of these workshops in regions of the state that have the most signi cant exposure to air pollutants, including, but not limited to, communities with minority populations, communities with low-income populations, or both.

(h) The state board shall update its plan for achieving the maximum technologically feasible and cost-effective reductions of greenhouse gas emissions at least once every ve years.

38562. (a) On or before January 1, 2011, the state board shall adopt greenhouse gas emission limits and emission reduction measures by regulation to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions in furtherance of achieving the statewide greenhouse gas emissions limit, to become operative beginning on January 1, 2012.

(b) In adopting regulations pursuant to this section and Part 5 (commencing with Section 38570), to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall do all of the following:

(1) Design the regulations, including distribution of emissions allowances where appropriate, in a manner that is equitable, seeks to minimize costs and maximize the total bene ts to California, and encourages early action to reduce greenhouse gas emissions.

(2) Ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.

(3) Ensure that entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this section receive appropriate credit for early voluntary reductions.

(4) Ensure that activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.

(5) Consider cost-effectiveness of these regulations.

(6) Consider overall societal bene ts, including reductions in other air pollutants, diversi cation of energy sources, and other bene ts to the economy, environment, and public health.

(7) Minimize the administrative burden of implementing and complying with these regulations.

(8) Minimize leakage.

(9) Consider the signi cance of the contribution of each source or category of sources to statewide emissions of greenhouse gases.

(c) In furtherance of achieving the statewide greenhouse gas emissions limit, by January 1, 2011, the state board may adopt a regulation that establishes a system of market-based declining annual aggregate emission limits for sources or categories of sources that emit greenhouse gas emissions, applicable from January 1, 2012, to December 31, 2020, inclusive, that the state board determines will achieve the maximum

technologically feasible and cost-effective reductions in greenhouse gas emissions, in the aggregate, from those sources or categories of sources.

(d) Any regulation adopted by the state board pursuant to this part or Part 5 (commencing with Section 38570) shall ensure all of the following:

(1) The greenhouse gas emission reductions achieved are real, permanent, quanti able, veri able, and enforceable by the state board.

(2) For regulations pursuant to Part 5 (commencing with Section 38570), the reduction is in addition to any greenhouse gas emission reduction otherwise required by law or regulation, and any other greenhouse gas emission reduction that otherwise would occur.

(3) If applicable, the greenhouse gas emission reduction occurs over the same time period and is equivalent in amount to any direct emission reduction required pursuant to this division.

(e) The state board shall rely upon the best available economic and scienti c information and its assessment of existing and projected technological capabilities when adopting the regulations required by this section.

(f) The state board shall consult with the Public Utilities Commission in the development of the regulations as they affect electricity and natural gas providers in order to minimize duplicative or inconsistent regulatory requirements.

(g) After January 1, 2011, the state board may revise regulations adopted pursuant to this section and adopt additional regulations to further the provisions of this division.

38563. Nothing in this division restricts the state board from adopting greenhouse gas emission limits or emission reduction measures prior to January 1, 2011, imposing those limits or measures prior to January 1, 2012, or providing early reduction credit where appropriate.

38564. The state board shall consult with other states, and the federal government, and other nations to identify the most effective strategies and methods to reduce greenhouse gases, manage greenhouse gas control programs, and to facilitate the development of integrated and cost-effective regional, national, and international greenhouse gas reduction programs.

38565. The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and bene t from statewide efforts to reduce greenhouse gas emissions.

PART 5. MARKET-BASED COMPLIANCE MECHANISMS

38570. (a) The state board may include in the regulations adopted pursuant to Section 38562 the use of market-based compliance mechanisms to comply with the regulations.

(b) Prior to the inclusion of any market-based compliance mechanism in the regulations, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall do all of the following:

(1) Consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution.

(2) Design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants.

(3) Maximize additional environmental and economic bene ts for California, as appropriate.

(c) The state board shall adopt regulations governing how market-based compliance mechanisms may be used by regulated entities subject to greenhouse gas emission limits and mandatory emission reporting requirements to achieve compliance with their greenhouse gas emissions limits.

38571. The state board shall adopt methodologies for the quanti cation of voluntary greenhouse gas emission reductions. The state board shall adopt regulations to verify and enforce any voluntary greenhouse gas emission reductions that are authorized by the state board for use to comply with greenhouse gas emission limits established by the state board. The adoption of methodologies is exempt from the rulemaking provisions of the Administrative Procedure Act (Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code).

38574. Nothing in this part or Part 4 (commencing with Section 38560) confers any authority on the state board to alter any programs administered by other state agencies for the reduction of greenhouse gas emissions.

PART 6. ENFORCEMENT

38580. (a) The state board shall monitor compliance with and enforce any rule, regulation, order, emission limitation, emissions reduction measure, or market-based compliance mechanism adopted by the state board pursuant to this division.

(b) (1) Any violation of any rule, regulation, order, emission limitation, emissions reduction measure, or other measure adopted by the state board pursuant to this division may be enjoined pursuant to Section 41513, and the violation is subject to those penalties set forth in Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(2) Any violation of any rule, regulation, order, emission limitation, emissions reduction measure, or other measure adopted by the state board pursuant to this division shall be deemed to result in an emission of an air contaminant for the purposes of the penalty provisions of Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(3) The state board may develop a method to convert a violation of any rule, regulation, order, emission limitation, or other emissions reduction measure adopted by the state board pursuant to this division into the number of days in violation, where appropriate, for the purposes of the penalty provisions of Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(c) Section 42407 and subdivision (i) of Section 42410 shall not apply to this part.

PART 7. MISCELLANEOUS PROVISIONS

38590. If the regulations adopted pursuant to Section 43018.5 do not remain in effect, the state board shall implement alternative regulations to control mobile sources of greenhouse gas emissions to achieve equivalent or greater reductions.

38591. (a) The state board, by July 1, 2007, shall convene an environmental justice advisory committee, of at least three members, to advise it in developing the scoping plan pursuant to Section 38561 and any other pertinent matter in implementing this division. The advisory committee shall be comprised of representatives from communities in the state with the most signi cant exposure to air pollution, including, but not limited to, communities with minority populations or low-income populations, or both.

(b) The state board shall appoint the advisory committee members from nominations received from environmental justice organizations and community groups.

(c) The state board shall provide reasonable per diem for attendance at advisory committee meetings by advisory committee members from nonpro t organizations.

(d) The state board shall appoint an Economic and Technology Advancement Advisory Committee to advise the state board on activities that will facilitate investment in and implementation of technological research and development opportunities, including, but not limited to, identifying new technologies, research, demonstration projects, funding opportunities, developing state, national, and international partnerships and technology transfer opportunities, and identifying and assessing research and advanced technology investment and incentive opportunities that will assist in the reduction of greenhouse gas emissions. The committee may also advise the state board on state, regional, national, and

international economic and technological developments related to greenhouse gas emission reductions.

38592. (a) All state agencies shall consider and implement strategies to reduce their greenhouse gas emissions.

(b) Nothing in this division shall relieve any person, entity, or public agency of compliance with other applicable federal, state, or local laws or regulations, including state air and water quality requirements, and other requirements for protecting public health or the environment.

38593. (a) Nothing in this division affects the authority of the Public Utilities Commission.

(b) Nothing in this division affects the obligation of an electrical corporation to provide customers with safe and reliable electric service.

38594. Nothing in this division shall limit or expand the existing authority of any district, as de ned in Section 39025.

38595. Nothing in this division shall preclude, prohibit, or restrict the construction of any new facility or the expansion of an existing facility subject to regulation under this division, if all applicable requirements are met and the facility is in compliance with regulations adopted pursuant to this division.

38596. The provisions of this division are severable. If any provision of this division or its application is held invalid, that invalidity shall not affect other provisions or applications that can be given effect without the invalid provision or application.

38597. The state board may adopt by regulation, after a public workshop, a schedule of fees to be paid by the sources of greenhouse gas emissions regulated pursuant to this division, consistent with Section 57001. The revenues collected pursuant to this section, shall be deposited into the Air Pollution Control Fund and are available upon appropriation, by the Legislature, for purposes of carrying out this division.

38598. (a) Nothing in this division shall limit the existing authority of a state entity to adopt and implement greenhouse gas emissions reduction measures.

(b) Nothing in this division shall relieve any state entity of its legal obligations to comply with existing law or regulation.

38599. (a) In the event of extraordinary circumstances, catastrophic events, or threat of signi cant economic harm, the Governor may adjust the applicable deadlines for individual regulations, or for the state in the aggregate, to the earliest feasible date after that deadline.

(b) The adjustment period may not exceed one year unless the Governor makes an additional adjustment pursuant to subdivision (a).

(c) Nothing in this section affects the powers and duties established in the California Emergency Services Act (Chapter 7 (commencing with Section 8550) of Division 1 of Title 2 of the Government Code).

(d) The Governor shall, within 10 days of invoking subdivision (a), provide written noti cation to the Legislature of the action undertaken.

SEC. 2 No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that

may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the de nition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

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APPENDIX 8-2

Project 2: City of Santa Maria, Untreated Water Landscape Irrigation Project

- City of Santa Maria Urban Water Management Plan
- M&I Water Quality
- Metropolitan Water Quality Report
- Nitrogen Landscape Use

Final Report

2005 Urban Water Management Plan – City of Santa Maria

Prepared for

City of Santa Maria

2065 East Main Street
Santa Maria, CA 93454

April 2007

CH2MHILL
325 E. Hillcrest Drive
Suite 125
Thousand Oaks, CA 91360

Final Report

2005 Urban Water Management Plan – City of Santa Maria

Submitted to

City of Santa Maria

April 2007

CH2MHILL

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F SANTA MARIA VALLEY GROUNDWATER BASIN STIPULATION

G CITY OF SANTA MARIA 2004 WATER QUALITY REPORT

treated wastewater at the City's WWTP is an indirect use of recycled water which, in effect, improves the overall reliability of the City's groundwater supplies.

It should be noted that the water supply available to the City is much greater than the supply needed to meet the projected demand. A detailed description of the available supply to the City is presented in the Reliability section below.

Table 3-1
Current and Planned Water Supplies for City of Santa Maria

Source	2005	2010	2015	2020	2025	2030
Purchased Water from SWP	13,706	13,706	13,706	13,706	13,706	13,706
Groundwater(2)	12,795	12,795	12,795	12,795	12,795	12,795
Twitchell Yield/Commingled Groundwater(3)	14,300	14,300	14,300	14,300	14,300	14,300
Return Flows from SWP Water(4)	8,909	8,909	8,909	8,909	8,909	8,909
Recycled Water	0	0	0	0	0	0
Total(5)	49,710	49,710	49,710	49,710	49,710	49,710

Notes
1. Unit of measure: ac-ft/yr
2. Groundwater supplies are based on appropriative rights in Santa Maria Groundwater Basin as defined in the Stipulation. Pursuant to the Court's Phase 5 Tentative Decision, the City has been assigned 5,100 ac-ft/yr of prescriptive rights.
3. Further details can be found in Exhibit F of the Stipulation.
4. Pursuant to the Stipulation, the City is entitled to recapture 65% of its SWP use in the Basin.
5. See Reliability section for details on these supplies.
6. Table format based on DWR Guidance Document Table 4.

The City's water supply is projected to remain relatively constant from 2005 to 2030 to meet the associated projected water demands, with the majority of this demand being met by imported surface water. The City is expected to have an available supply in excess of the projected demands through 2030. Water demand projections are documented in Chapter 4. Details of the imported water, return flows, Twitchell Yield, and native groundwater supplies are presented in the following section followed by a discussion of the reliability of all sources of water supply.

Imported Water

Santa Maria has a Water Supply Agreement with CCWA for 17,280 ac-ft/yr of Table A imported SWP water. Pursuant to this Stipulation, Santa Maria agreed to import and use within the Basin no less than 10,000 ac-ft/yr of available SWP water, or the full amount of available SWP water if the amount available is less than 10,000 ac-ft in a given year. Both GSWC and Guadalupe will import and use all their available SWP water within the Basin.

SWP water originates within the Feather River watershed, is captured in Lake Oroville, and flows via the Sacramento-San Joaquin Delta, the California Aqueduct and the Coastal Branch Extension into CCWA's treatment and conveyance facilities.

Table 4-4
Additional Water Uses and Loses

Water Use Type	2000	2005	2010	2015	2020	2025	2030
Other Water Uses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unaccounted-for System Losses	1,480	1,171	1,276	1,396	1,461	1,566	1,670
Total	1,480	1,171	1,276	1,396	1,461	1,566	1,670

Notes
1. This table is based on the DWR Guidebook Table 14.
2. Based on calendar year.
3. Unaccounted-for water includes system losses due to leaks, reservoir overflows, and inaccurate meters, as well as water used in operations.
4. Unit of measure: ac-ft/yr

Total Water Demand

As mentioned above, other water uses, as well as any water lost during conveyance, must be added to the customer demand in order to project the City's water demand. In addition to the City's sales to other agencies, unaccounted-for water must be incorporated to the total water demand (refer to the section above for a definition of unaccounted-for water). Table 4-5 summarizes the projections of water sales to other agencies, demand within the City, unaccounted-for water, and total water demand through the year 2030. The projected water sales in the remainder of the analysis, including Table 4-5 represent the total demand of the population-based projections and sales to other agencies.

The water demand projections below do not include any reduction due to future implementation of DMM. More information regarding the status of demand reduction measures is available in Chapter 5.

Table 4-5
Projected Water Sales, Unaccounted-for System Losses, and Total Water Demand

Year	Projected Water Sales[4]	Unaccounted-for System Losses	Total Water Demand
2000[2]	14,232	1,480	15,712
2005	16,658	1,171	17,829
2010	17,853	1,276	19,129
2015	19,211	1,396	20,607
2020	20,273	1,461	21,734
2025	21,697	1,566	23,263
2030	23,110	1,670	24,780

Notes
1. This table is based on the DWR Guidebook Table 15.
2. Based on calendar year.
3. Unit of measure: ac-ft/yr
4. Projected Water Sales includes total demands within the City of Santa Maria and sales to other agencies

M&I Water Quality

Input Data, Average Conditior	
	Level of Development
Households	28,471
Without project conditior	
Supply AF	19,129
Total Hardness mg/L	547.5
TDS mg/L	859.0
With project condition	
Supply AF	19,129
Total Hardness mg/L	546.5
TDS mg/L	858.0

Source: City of Santa Maria UWMP 2005 and City of Santa Maria Water Quality Report 2009

Equations for Household Costs and Life of Household Features as a Function of TDS or Total Hardness[1]

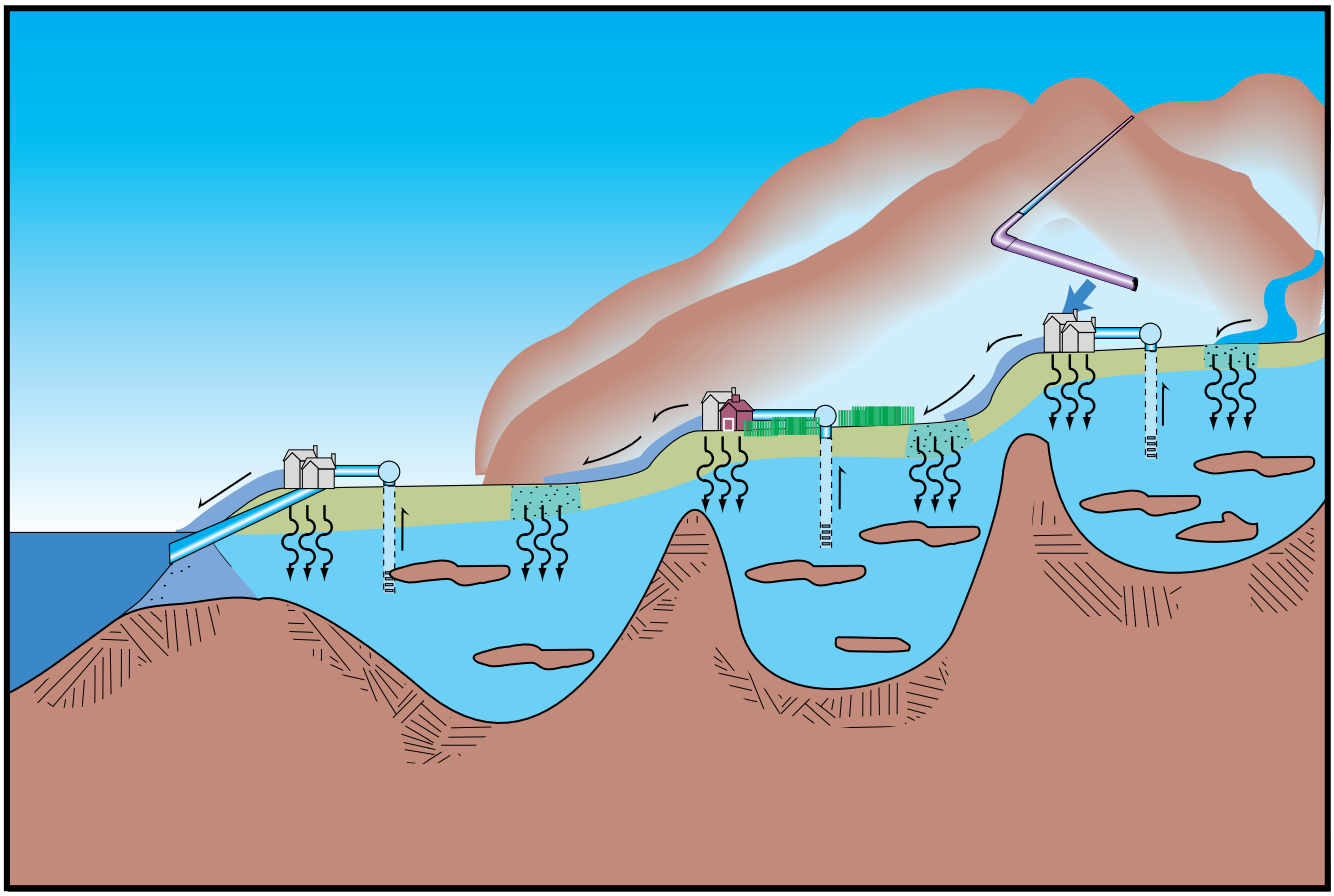
Customer Cost Category	How Measured	Equation Constant	Parameter on TDS	Parameter on TH	w/o	with
Bottled water usage	Percent hshlds using	5.70000	0.0400000		40.06%	40.02%
Soap and detergent use	$/hshld	85.00000		0.1200000	$150.70	$150.58
Water softeners	$/hshld	-4.66635		0.1119650	$56.63	$56.52
	% hshlds using softeners	-7.13000		0.0940000	44.34%	44.24%
Galvanized waste water pipe	log life yrs	1.54900	-0.0007970		7.32	7.33
Water Heaters	Life yrs	13.10000	-0.0041500		9.54	9.54
Faucets and Fixtures	Life yrs	11.50000	-0.0030000		8.92	8.93
Galvanized water pipe	Life yrs	16.56000	-0.0067000		10.80	10.81
Dishwashers	Log Life yrs	1.03150	-0.0003441		5.44	5.45
Clothes washers	Life yrs	14.42000	-0.0110000		8.37	8.37
Garbage disposals	Life yrs	9.20000	-0.0040000		6.50	6.50
Brass faucets	Log Life yrs	1.30400	-0.0007000		5.04	5.05

[1]Results of Equations, 1983 values

Additional Data Needed for Calculations	No Per hshld (2001)	No Per hshld (2020)	Year of Equation	Adjustments to 2006 Price Increase	Dollars of Water Quality Cost by Type of Damages
Bottled water usage			83	2.02	3,688
Soap and detergent use				2.02	6,915
Water softeners				1.51	4,429
Galvanized waste water pipe	0.25	0.25	83	2.24	3,995
Water Heaters	1	1	83	2.21	660
Faucets and Fixtures	1	1	96	1.21	569
Galvanized water pipe	0.25	0.25	83	2.24	1,006
Dishwashers	0.9	0.95	86	1.44	2,415
Clothes washers	0.98	0.99	86	1.15	607
Garbage disposals	0.9	0.95	96	1.22	202
Brass faucets	5	6	83	2.24	8,656
			Total in 2006$ (000)		33.141
			Total in 2009$ (000)		**35.130**

Update Cost of Appliances to Current Dollars			
		$/unit	
	Initial Cost, $/unit	**2006**	
Bottled water usage	$160.00	$324	
Soap and detergent use		$0	
Water softeners		$0	
Galvanized waste water pipe	$1,000.00	$2,240	
Water Heaters	$230.00	$508	
Faucets and Fixtures	$440.00	$530	
Galvanized water pipe	$1,100.00	$2,464	
Dishwashers	$450.00	$648	This source says just under $500.
Clothes washers	$425.00	$491	http://www.bewatersmart.org/pdfs/rebates/Dishwasher
Garbage disposals	$120.00	$146	
Brass faucets	$85.00	$190	

SALINITY MANAGEMENT STUDY
Final Report



MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

June 1999

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
UNITED STATES BUREAU OF RECLAMATION

SALINITY MANAGEMENT STUDY
FINAL REPORT

LONG-TERM STRATEGY AND RECOMMENDED ACTION PLAN

JUNE 1999

BOOKMAN-EDMONSTON
ENGINEERING, INC.

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List of Abbreviations

♦ *CDHS*	*California Department of Health Services*
♦ *CRA*	*Colorado River Aqueduct*
♦ *CRW*	*Colorado River Water*
♦ *DWR*	*Department of Water Resources*
♦ *EDR*	*Electrodialysis Reversal*
♦ *IX*	*Ion Exchange*
♦ *mg/L*	*Milligrams per Liter*
♦ *RO*	*Reverse Osmosis*
♦ *RWQCB*	*Regional Water Quality Control Board*
♦ *SPW*	*State Project Water*
♦ *SPW EB*	*State Project Water East Branch*
♦ *SPW WB*	*State Project Water West Branch*
♦ *SWP*	*State Water Project*
♦ *SWP EB*	*State Water Project East Branch*
♦ *SWP WB*	*State Water Project West Branch*
♦ *TDS*	*Total Dissolved Solids*
♦ *USBR*	*United States Bureau of Reclamation*

EXECUTIVE SUMMARY

This report presents the findings and recommendations of a two-and-one-half year technical investigation of the impacts of total dissolved solids or salinity to the coastal plain of Southern California. Metropolitan conducted the Salinity Management Study (Study) in close collaboration with member agencies and numerous other concerned agencies. The United States Bureau of Reclamation (USBR) was a primary study partner, contributing financial assistance under its congressional authority (P.L. 102-575) to develop a regional water recycling plan for Southern California, because high salinity is a significant constraint to water recycling.

For analytical purposes in developing this report, the Colorado River Aqueduct (CRA) was considered full for the study period, consistent with the objectives of the California 4.4 Plan.

BENEFITS OF REDUCED SALINITY

When salinity levels of imported water are reduced, the region benefits from:

- Improved use of local groundwater and recycled water
- Reduced costs to water consumers and utilities.

Metropolitan estimates that $95 million per year of economic benefits would result if the CRA and State Water Project (SWP) waters were to simultaneously experience a 100 milligram per liter (mg/L) reduction in salt content over their historic average. Conversely, about the same dollar amount of impacts would result if imported water salinity increased by 100 mg/L. Primary salinity impact categories include residential, commercial, industrial and agricultural water users; groundwater and recycled water resources; and utility distribution systems.

SALT SOURCES

About half of the region's salt is contributed by imported water, and the other half comes from local sources. The CRA constitutes Metropolitan's highest source of salinity, averaging about 700 mg/L. Hardness comprises about one-half of the CRA salt load and causes troublesome scaling problems to indoor plumbing appliances and equipment at homes, business and industries.

The SWP provides Metropolitan with lower salinity water (an average of 250 mg/L on the East Branch and 325 mg/L on the West Branch), which can be used to blend down CRA concentrations. SWP salinity levels can change rapidly in response to hydrologic conditions, and such changes are noticeable and disruptive as compared to the very gradual, almost imperceptible changes that occur in local streams, groundwater and wastewater collection systems. A CALFED Bay-Delta solution could lower SWP salinity by 100 mg/L and reduce its short-term variability.

Local salinity sources include naturally occurring salts, salts added by urban water users, infiltration of brackish groundwater into sewers, irrigated agriculture, and confined animal waste management practices. Urban use salt contributions to wastewater range from 250 to 400 mg/L or more in some locations.

SALINITY MANAGEMENT POLICY STATEMENT AND ACTION PLAN

The proposed salinity management policy (Section 4) and corresponding Action Plan (Section 5) were adopted by Metropolitan in April 1999. The Action Plan consists of four basic components:

- Imported water source control actions
- Distribution system salinity management actions
- Collaborative actions with other agencies
- Local actions to protect groundwater and recycled water supplies

The adopted action plan should be revisited and updated periodically as clarity emerges from a number of critical areas, including the CALFED Bay-Delta Plan, California's Colorado River Water Supply Plan, wheeling practices, Stage II disinfection by-products rules under the Safe Drinking Water Act Amendments, and operational experience gained through implementation. The first major update is recommended to occur in 2004 when the Inland Feeder becomes operational, or sooner if a significant unanticipated change occurs in controlling conditions.

RESOURCE LIMITATIONS ON BLENDING COLORADO RIVER WATER SALINITY

The foundation of Metropolitan's Action Plan is an imported water salinity target of 500 mg/L. Managing imported water through blending would be supplemented by source control in the two imported water river systems, storage and exchange operations along the CRA, and a CALFED solution. Blending in Metropolitan's system is achieved by curtailing delivery of higher-salinity CRA water and substituting it with comparable amounts of lower-salinity SWP water.

Annual changes in imported water supply availability and salinity concentrations greatly affect Metropolitan's ability to achieve the target through blending. For example, above-normal runoff in 1998 provided unusually favorable conditions resulting in lower-than-target salinity levels in some months. In contrast, under such conditions as the 1977 drought, Metropolitan would not have been able to meet the target because SWP water was in short supply and its salinity levels rose to over 400 mg/L. To meet its blending target, Metropolitan would have had to take less of its CRA water. Whenever a shortage of SWP supply and high salinity occur concurrently, Metropolitan would have to fully use its CRA water and experience the higher salinity. The key trade-off in achieving a salinity target is the risk to supply reliability. To achieve the 500 mg/L

target under certain adverse conditions, up to several hundred thousand acre-feet of CRA water would have to be replaced by SWP water.

On average, the target will be met in about seven of every ten years. In the remaining years, hydrologic conditions constrain primarily the SWP with insufficient and often higher salinity supplies. The proposed policy includes clear recognition of this resource limitation and calls upon local agencies to develop and manage their local projects and groundwater to accommodate these inevitable swings in salinity of imported water due to natural hydrologic variation.

Recognizing the significant constraint of resource availability, the action plan calls for achievement of the 500 mg/L salinity objective in two stages. When conditions are favorable, 500 mg/L would be pursued year-round. When conditions are less favorable, emphasis is placed on reducing salinity during April through September primarily to support irrigation with recycled water. The summer period corresponds to the peak irrigation season and requires proportionally less curtailment of CRA water. Under current conditions, the objective would be achieved in seven out of ten years on average; higher salinity would occur during dry years. A long-term solution will require success in the CALFED process in reducing the salinity of SWP water on a sustained basis. Exchanges for Sierra water south of the Delta offer an additional method of significantly lowering SWP salinity. Furthermore, expanding storage and exchange of CRA water for SWP water will also be necessary to achieve the year-round salinity objective within the constraints of water resource availability.

If the anticipated salinity benefits of a CALFED solution or CRA exchanges and storage fall short of need, then the ultimate method of achieving salinity targets may be desalination associated with the CRA. However, given the current state of technology, the costs would be high and there would be significant resource and environmental concerns associated with large quantities of brine disposal. Hence, the action plan calls for an aggressive program of research and development (R&D) of a more efficient desalination technology. This R&D effort is already being initiated by Metropolitan in partnership with interested agencies

INTEGRATION OF QUALITY AND QUANTITY

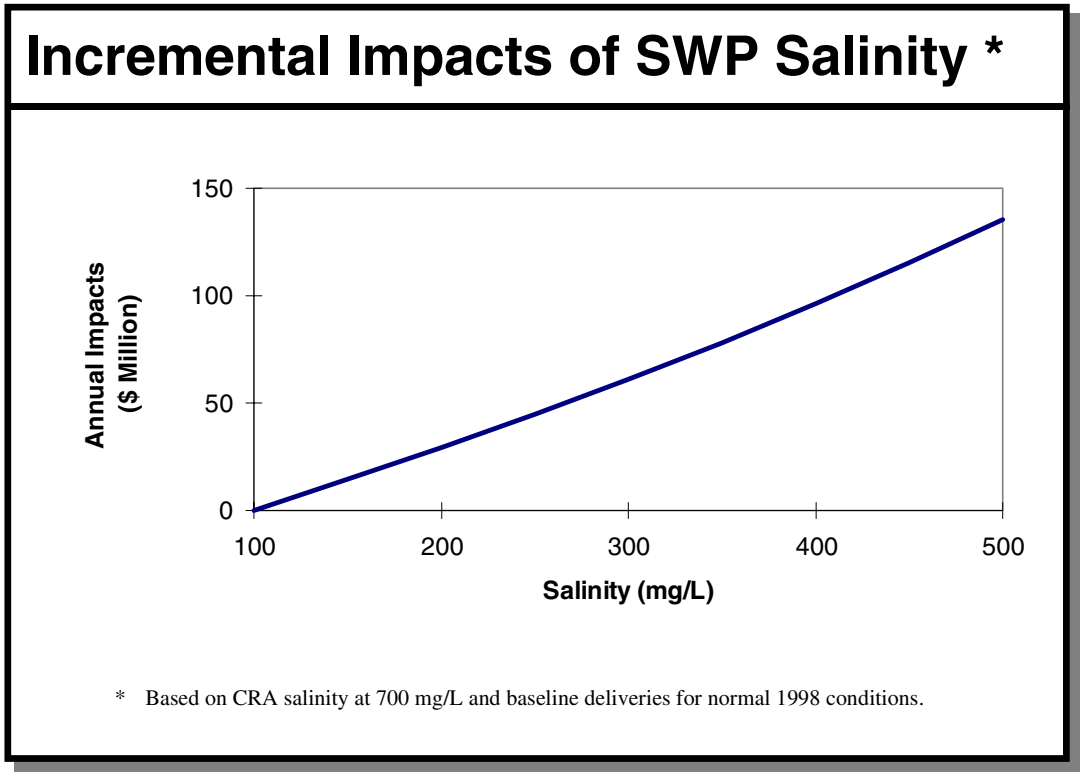
The Study shows that managing the salinity of imported water is important to the region's overall supply mix, especially in regards to local groundwater and recycled water. Metropolitan routinely assesses the pros and cons of quality-to-quantity relationships when planning and negotiating new facilities and resources, a practice that is an important part of the Salinity Management Policy and Action Plan.

REGIONAL APPROACH

The region must manage both local and imported sources to achieve a long-term salt balance. About half of the regional salt load is derived from local sources and half from imported water.

Other agencies that can influence the salt balance of the coastal plain must participate in this effort if the region is to achieve a cohesive strategy. The Action Plan calls for concurrent management of both local and imported sources of salt for the region to achieve a long-term salt balance.

Figure 2-22



Likewise, Figure 2-23 shows the range of economic consequences of CRA salinity changes when the SWP salinity is fixed at 250 mg/L at the O'Neill Forebay. While, there may be economic benefits when CRA salinity is below 500 mg/L, this graph shows the "incremental" impacts of CRA salinity compared to 500 mg/L. Historically, the average annual salinity of CRA has never been below 500 mg/L.

Technical Appendix 5 provides additional information on the derivation of salinity economic functions. Technical Appendix 6 specifically addresses the high-profile issue of the impacts of water softeners.

DEMOGRAPHIC DATA

Updated population 2000 MWD-UWMP

MWD Sevice Area

POPULATION	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
1.) North West	545,364	575,974	622,366	653,286	694,837	739,031
2.) San Fernando Valley - West	1,365,961	1,453,749	1,553,614	1,652,082	1,778,844	1,915,332
3.) San Fernando Valley - East	298,056	309,479	320,179	332,166	353,551	376,311
4.) San Gabriel Valley	1,405,924	1,469,231	1,522,440	1,579,990	1,655,867	1,735,388
5.) Central Los Angeles -	2,321,482	2,457,029	2,599,958	2,740,991	2,927,514	3,126,730
6.) Central and West Basins	3,172,278	3,288,380	3,369,568	3,458,066	3,600,086	3,747,938
7.) Coastal Plain	153,385	158,311	162,884	165,694	171,354	177,207
8.) North West Orange County	2,151,859	2,259,087	2,378,173	2,472,008	2,602,582	2,740,053
9.) South East Orange County	585,392	625,140	671,761	699,998	739,403	781,027
10.) Western MWD	671,797	746,555	829,396	891,613	974,258	1,064,563
11.) Eastern MWD	493,442	596,000	722,793	867,326	1,034,314	1,233,453
12.) Upper Chino	803,098	875,407	942,095	1,000,525	1,064,805	1,133,216
13.) Lower Chino	130,684	145,808	159,823	172,549	190,934	211,278
14.) North San Diego	1,101,836	1,261,318	1,412,419	1,550,349	1,585,019	1,620,464
15.) South San Diego	1,675,078	1,786,549	1,872,926	1,942,353	1,965,184	1,988,284
TOTAL	16,877,637	18,010,021	19,142,405	20,181,010	21,340,571	22,592,299

Updated population 2000 MWD-UWMP

NO. OF HOUSEHOLDS	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
1.) North West	175,142	188,439	203,857	215,892	229,877	244768.42
2.) San Fernando Valley - West	454,197	480,759	514,564	541,671	584,298	630278.68
3.) San Fernando Valley - East	111,465	116,827	123,017	129,012	137,587	146731.50
4.) San Gabriel Valley	412,521	429,928	448,253	465,509	492,277	520584.88
5.) Central Los Angeles -	745,056	787,596	841,537	883,987	953,443	1028355.84
6.) Central and West Basins	966,858	998,200	1,021,874	1,043,338	1,086,969	1132424.62
7.) Coastal Plain	68,244	70,985	72,997	74,887	78,166	81587.98
8.) North West Orange County	673,937	710,742	745,329	774,984	811,674	850101.05
9.) South East Orange County	224,269	242,751	264,582	278,377	297,137	317160.10
10.) Western MWD	210,719	237,928	263,408	290,084	318,851	350470.43
11.) Eastern MWD	173,903	213,018	256,275	304,912	366,290	440023.71
12.) Upper Chino	235,481	257,851	278,696	299,931	318,635	338505.20
13.) Lower Chino	35,673	40,581	44,466	49,091	52,920	57047.03
14.) North San Diego	359,306	421,032	478,914	534,467	588,847	648760.36
15.) South San Diego	592,958	644,701	685,176	722,790	759,383	797829.02

Administrative Draft - TECHNICAL MEMORANDUM

Plan for Agronomic Application of Nitrogen

PREPARED FOR: Delta Diablo Sanitation District
Ms. Amanda Roa

PREPARED BY: Mary Grace Pawson/Winzler & Kelly

REVIEWED BY: Neal Carnum/Winzler & Kelly

DATE: December 10 2009

PROJECT NUMBER: 11811-09-001

Background and Purpose

The Delta Diablo Sanitation District (District) currently operates a recycled water system in the City of Pittsburg, California under *the San Francisco Bay Regional Water Quality Control Board's General Water Reuse Order 96-011(RWQCB Order 96-011).* In October 2009, the District filed a Notice of Intent to seek coverage under the *State Water Resources Control Board's Order 2009-006 Waste Discharge Requirements for Landscape Irrigation Uses of Municipal Recycled Water (SWRCB Order 2009-006)* for its Antioch Recycled Water Project which will deliver approximately 150 acre-feet of water annually for landscape irrigation purposes.

SWRCB Order 2009-006 includes provisions that the District work with its customers to assure that nutrients, particularly nitrogen, are applied at agronomic rates. Because recycled water can contain nutrient loading that is higher than the nutrient loading in potable water, this often means that fertilization schedules need to be adjusted.

As part of its Notice of Intent, the District provided information on nitrate loading from the recycled water. However, because the District is currently not required to monitor for nitrogen under either RWQCB Order 96-011 or its NPDES permit, the loading calculation was made based on one available data point for nitrate nitrogen.

As part of its review, the SWRCB requested that the District provide information on Total Kjeldahl Nitrogen (TKN). The District collected three samples on November 18, 19 and 20 of 2009 and submitted the results to the SWRCB on December 1st, shortly after the analytical results were available. Upon review of the limited TKN results, the SWRCB expressed concern that the total calculated nitrogen load, an average of approximately 380 pounds per acre per year, could exceed the agronomic rate of application for turf grass. The purpose of this memorandum is to present the District's plan for managing nutrient loading at agronomic rates.

Fate of Nitrogen in Treated Effluent

Nitrogen exists in treated effluent, or recycled water, in several different forms including organic nitrogen, nitrite, nitrate and ammonia nitrogen (which includes ammonium and ammonia). Total Kjeldahl Nitrogen is the sum of organic and ammonia nitrogen. Each of these forms of nitrogen has a different effect on the agronomic rate calculation.[1]

The District's current data allows calculation of total nitrogen loadings but is not enough to perform definitive agronomic calculations. The District's plan should include additional sampling to develop a more complete data set.

Agronomic Rate for Turf Grass

The SWRCB has indicated that it believes the agronomic nitrogen application rate for turf grass is 174 pounds per acre per year. This is consistent with published rates from various cooperative extentions.

Plant Available Nitrogen[2]

Not all nitrogen applied through recycled water is available to meet agronomic demands. Ammonium N can be readily transformed and lost as a gas. For the purposes of preliminary calculations, it estimated that 55% of ammonium N is available and 45% is lost as gas.[3]

Organic N must go through mineralization before it is available for agronomic uptake. For the purposes of preliminary calculations it is estimated that 35% of the applied organic N is available. [4]

Application Rate Calculations

In order to estimate if the nutrients provided by recycled water rate meet agronomic standards, we will use the following equation:

Total applied nitrogen = 55% of ammonium N + 35% of organic N + nitrate/nitrite N

This accounts for the volization of ammonium N, the mineralization of organic N and the fact that nitrate/nitrite N is not included in the reported TKN. For this initial estimate, it is assumed that 80% of the TKN, is in the form organic N and 20% is in the form of ammonium N. This is based on guidance provide for biosolids and needs to be verified, by additional sampling, for the District's recycled water. Based on these assumptions and District's data the breakdown of total nitrogen is as follows:

---

[1] Chemistry for Sanitary Engineers, Sawyer & McCarty

[2] This discussion is drawn from PNW0511e Worksheet for Calculating Application Rates in Agricuture, Pacific Northwest Extension, Cogger and Sullivan.

[3] IBID, Table 2.

[4] IBID, Table 3.

Nitrogen State	Equivalent lbs per acre per year	Data Source
TKN	379 lbs/acre/year	Average November samples
Ammonium N	76 lbs/acre/year	20% of Average November samples
Organic N	303 lbs/acre/year	80% of Average November samples
Nitrate/Nitrite N	7 lbs/acre/year	Previous District Sampling

Using this data to estimate the nitrogen loading results in the following equation:

Total applied nitrogen = 0.55* (76lbs/a/yr) + 0.35* (303lbs/a/yr) + 7lbs/a/y
or
Total applied nitrogen = 155 lbs/a/y

This theoretically calculated value is less than the estimated agronomic rate which provides an allowance for ongoing mineralization of the applied organic N.

District Actions

The District currently utilizes recycled water for irrigation purposes in its Pittsburg service area without adverse impacts. While the District does not currently monitor for nutrients or conduct loading calcuations, the empirical evidence suggests that the recycled water program is not exceeding agronomic application rates. The estimated agronomic demand calcuations provided above support this empirical evidence.

Because of the very limited data available, the various fates of nitrogen in treated effluent, and the fact that different states of nitrogen impact the agronomic rate calculation, the District will need additional data to demonstrate ongoing compliance with SWRCB Order 2009-006 Provision C.5 (b). The intent of this provision is to assure that nutrients are being applied at a rate that can be utilized by the vegetation, so that over-applied nutrients do not impact groundwater quality.

Because the potential impacts are long-term, an active monitoring program is the best way to assure compliance. The following program is more aggressive then that included in the SWRCB Order 2009-006 and will allow collection of data to support the theoretical estimated calculations provided above.

- Quarterly monitoring of TKN, ammonium-N and nitrate;
- Quartely calculation of the applied nutrients;
- Quarterly submittal of data and calculations to the SWRCB

If the District begins the program now, before it brings the Antioch project on-line, we have the opportunity to support our estimated calculations before the project goes online or make adjustments based on the data.

If after two years, the actual data supports the estimated calcuations provided above, the District could then request reporting in accordance with the Reporting Schedule outlined in SWRCB Order 2009-06.

APPENDIX 8-3

Project 3: City of Santa Maria, LeakWatch Project

- City of Santa Maria Urban Water Management Plan
- M&I Water Quality
- Metropolitan Water Quality Report

Final Report

2005 Urban Water Management Plan – City of Santa Maria

Prepared for

City of Santa Maria

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April 2007

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Final Report

2005 Urban Water Management Plan – City of Santa Maria

Submitted to

City of Santa Maria

April 2007

CH2MHILL

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G CITY OF SANTA MARIA 2004 WATER QUALITY REPORT

treated wastewater at the City's WWTP is an indirect use of recycled water which, in effect, improves the overall reliability of the City's groundwater supplies.

It should be noted that the water supply available to the City is much greater than the supply needed to meet the projected demand. A detailed description of the available supply to the City is presented in the Reliability section below.

Table 3-1
Current and Planned Water Supplies for City of Santa Maria

Source	2005	2010	2015	2020	2025	2030
Purchased Water from SWP	13,706	13,706	13,706	13,706	13,706	13,706
Groundwater(2)	12,795	12,795	12,795	12,795	12,795	12,795
Twitchell Yield/Commingled Groundwater(3)	14,300	14,300	14,300	14,300	14,300	14,300
Return Flows from SWP Water(4)	8,909	8,909	8,909	8,909	8,909	8,909
Recycled Water	0	0	0	0	0	0
Total(5)	49,710	49,710	49,710	49,710	49,710	49,710

Notes
1. Unit of measure: ac-ft/yr
2. Groundwater supplies are based on appropriative rights in Santa Maria Groundwater Basin as defined in the Stipulation. Pursuant to the Court's Phase 5 Tentative Decision, the City has been assigned 5,100 ac-ft/yr of prescriptive rights.
3. Further details can be found in Exhibit F of the Stipulation.
4. Pursuant to the Stipulation, the City is entitled to recapture 65% of its SWP use in the Basin.
5. See Reliability section for details on these supplies.
6. Table format based on DWR Guidance Document Table 4.

The City's water supply is projected to remain relatively constant from 2005 to 2030 to meet the associated projected water demands, with the majority of this demand being met by imported surface water. The City is expected to have an available supply in excess of the projected demands through 2030. Water demand projections are documented in Chapter 4. Details of the imported water, return flows, Twitchell Yield, and native groundwater supplies are presented in the following section followed by a discussion of the reliability of all sources of water supply.

Imported Water

Santa Maria has a Water Supply Agreement with CCWA for 17,280 ac-ft/yr of Table A imported SWP water. Pursuant to this Stipulation, Santa Maria agreed to import and use within the Basin no less than 10,000 ac-ft/yr of available SWP water, or the full amount of available SWP water if the amount available is less than 10,000 ac-ft in a given year. Both GSWC and Guadalupe will import and use all their available SWP water within the Basin.

SWP water originates within the Feather River watershed, is captured in Lake Oroville, and flows via the Sacramento-San Joaquin Delta, the California Aqueduct and the Coastal Branch Extension into CCWA's treatment and conveyance facilities.

Table 4-4
Additional Water Uses and Loses

Water Use Type	2000	2005	2010	2015	2020	2025	2030
Other Water Uses	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Unaccounted-for System Losses	1,480	1,171	1,276	1,396	1,461	1,566	1,670
Total	1,480	1,171	1,276	1,396	1,461	1,566	1,670

Notes
1. This table is based on the DWR Guidebook Table 14.
2. Based on calendar year.
3. Unaccounted-for water includes system losses due to leaks, reservoir overflows, and inaccurate meters, as well as water used in operations.
4. Unit of measure: ac-ft/yr

Total Water Demand

As mentioned above, other water uses, as well as any water lost during conveyance, must be added to the customer demand in order to project the City's water demand. In addition to the City's sales to other agencies, unaccounted-for water must be incorporated to the total water demand (refer to the section above for a definition of unaccounted-for water). Table 4-5 summarizes the projections of water sales to other agencies, demand within the City, unaccounted-for water, and total water demand through the year 2030. The projected water sales in the remainder of the analysis, including Table 4-5 represent the total demand of the population-based projections and sales to other agencies.

The water demand projections below do not include any reduction due to future implementation of DMM. More information regarding the status of demand reduction measures is available in Chapter 5.

Table 4-5
Projected Water Sales, Unaccounted-for System Losses, and Total Water Demand

Year	Projected Water Sales[4]	Unaccounted-for System Losses	Total Water Demand
2000[2]	14,232	1,480	15,712
2005	16,658	1,171	17,829
2010	17,853	1,276	19,129
2015	19,211	1,396	20,607
2020	20,273	1,461	21,734
2025	21,697	1,566	23,263
2030	23,110	1,670	24,780

Notes
1. This table is based on the DWR Guidebook Table 15.
2. Based on calendar year.
3. Unit of measure: ac-ft/yr
4. Projected Water Sales includes total demands within the City of Santa Maria and sales to other agencies

M&I Water Quality

Input Data, Average Conditior	
	Level of Development
Households	28,471
Without project conditior	
Supply AF	19,129
Total Hardness mg/L	547.5
TDS mg/L	859.0
With project condition	
Supply AF	19,129
Total Hardness mg/L	546.5
TDS mg/L	858.0

Source: City of Santa Maria UWMP 2005 and City of Santa Maria Water Quality Report 2009

Equations for Household Costs and Life of Household Features as a Function of TDS or Total Hardness[1]

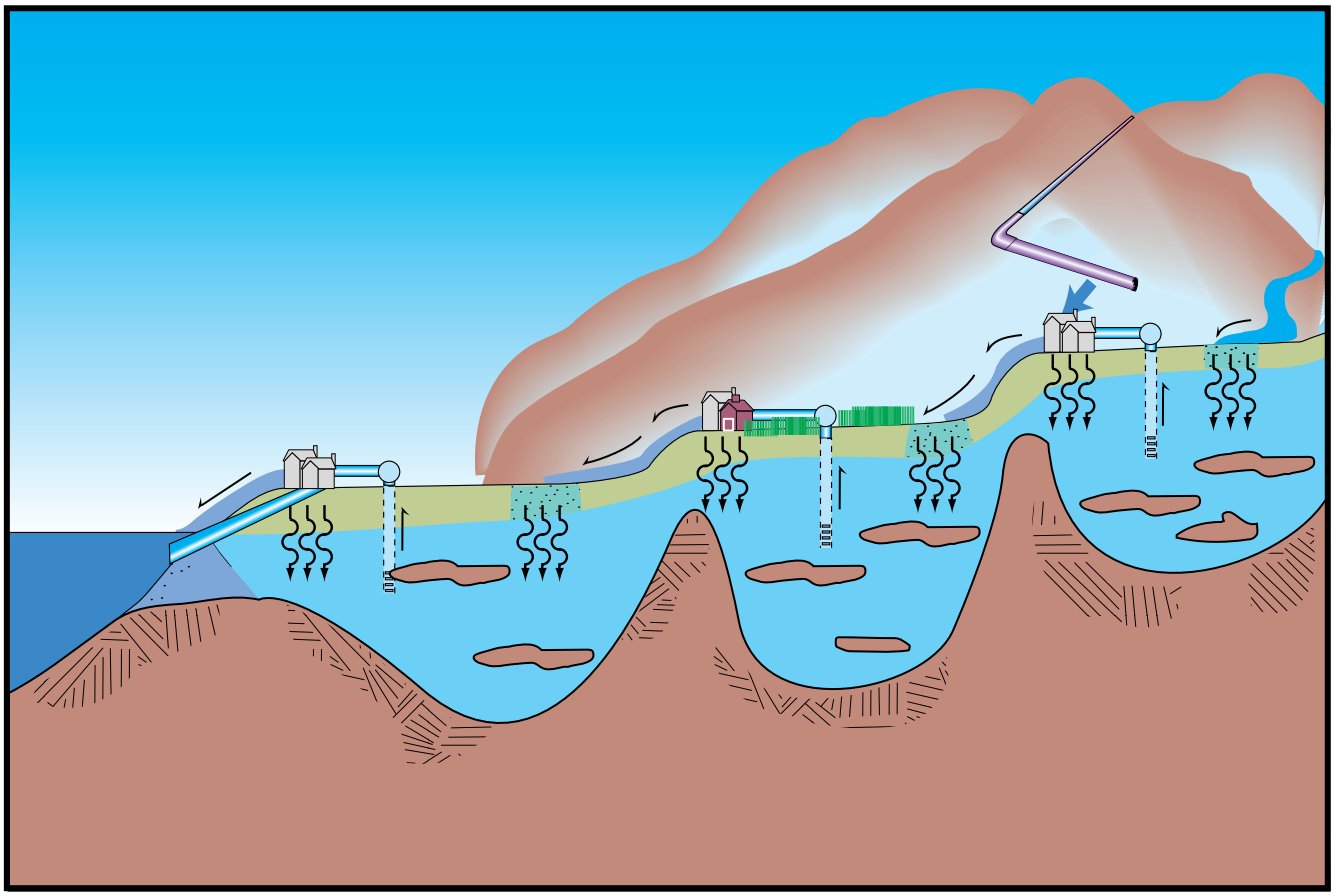
Customer Cost Category	How Measured	Equation Constant	Parameter on TDS	Parameter on TH	w/o	with
Bottled water usage	Percent hshlds using	5.70000	0.0400000		40.06%	40.02%
Soap and detergent use	$/hshld	85.00000		0.1200000	$150.70	$150.58
Water softeners	$/hshld	-4.66635		0.1119650	$56.63	$56.52
	% hshlds using softeners	-7.13000		0.0940000	44.34%	44.24%
Galvanized waste water pipe	log life yrs	1.54900	-0.0007970		7.32	7.33
Water Heaters	Life yrs	13.10000	-0.0041500		9.54	9.54
Faucets and Fixtures	Life yrs	11.50000	-0.0030000		8.92	8.93
Galvanized water pipe	Life yrs	16.56000	-0.0067000		10.80	10.81
Dishwashers	Log Life yrs	1.03150	-0.0003441		5.44	5.45
Clothes washers	Life yrs	14.42000	-0.0110000		8.37	8.37
Garbage disposals	Life yrs	9.20000	-0.0040000		6.50	6.50
Brass faucets	Log Life yrs	1.30400	-0.0007000		5.04	5.05

[1]Results of Equations, 1983 values

Additional Data Needed for Calculations	No Per hshld (2001)	No Per hshld (2020)	Year of Equation	Adjustments to 2006 Price Increase	Dollars of Water Quality Cost by Type of Damages
Bottled water usage			83	2.02	3,688
Soap and detergent use				2.02	6,915
Water softeners				1.51	4,429
Galvanized waste water pipe	0.25	0.25	83	2.24	3,995
Water Heaters	1	1	83	2.21	660
Faucets and Fixtures	1	1	96	1.21	569
Galvanized water pipe	0.25	0.25	83	2.24	1,006
Dishwashers	0.9	0.95	86	1.44	2,415
Clothes washers	0.98	0.99	86	1.15	607
Garbage disposals	0.9	0.95	96	1.22	202
Brass faucets	5	6	83	2.24	8,656
			Total in 2006$ (000)		33.141
			Total in 2009$ (000)		**35.130**

Update Cost of Appliances to Current Dollars			
		$/unit	
	Initial Cost, $/unit	**2006**	
Bottled water usage	$160.00	$324	
Soap and detergent use		$0	
Water softeners		$0	
Galvanized waste water pipe	$1,000.00	$2,240	
Water Heaters	$230.00	$508	
Faucets and Fixtures	$440.00	$530	
Galvanized water pipe	$1,100.00	$2,464	
Dishwashers	$450.00	$648	This source says just under $500.
Clothes washers	$425.00	$491	http://www.bewatersmart.org/pdfs/rebates/Dishwasher
Garbage disposals	$120.00	$146	
Brass faucets	$85.00	$190	

SALINITY MANAGEMENT STUDY
Final Report



MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

June 1999

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
UNITED STATES BUREAU OF RECLAMATION

SALINITY MANAGEMENT STUDY
FINAL REPORT

LONG-TERM STRATEGY AND RECOMMENDED ACTION PLAN

JUNE 1999

BOOKMAN-EDMONSTON
ENGINEERING, INC.

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12. Colorado River Water Total Dissolved Solids Removal Feasibility Study - Black & Veatch.
13. Impacts of Salinity on Human Health

List of Abbreviations

♦ *CDHS*	*California Department of Health Services*
♦ *CRA*	*Colorado River Aqueduct*
♦ *CRW*	*Colorado River Water*
♦ *DWR*	*Department of Water Resources*
♦ *EDR*	*Electrodialysis Reversal*
♦ *IX*	*Ion Exchange*
♦ *mg/L*	*Milligrams per Liter*
♦ *RO*	*Reverse Osmosis*
♦ *RWQCB*	*Regional Water Quality Control Board*
♦ *SPW*	*State Project Water*
♦ *SPW EB*	*State Project Water East Branch*
♦ *SPW WB*	*State Project Water West Branch*
♦ *SWP*	*State Water Project*
♦ *SWP EB*	*State Water Project East Branch*
♦ *SWP WB*	*State Water Project West Branch*
♦ *TDS*	*Total Dissolved Solids*
♦ *USBR*	*United States Bureau of Reclamation*

EXECUTIVE SUMMARY

This report presents the findings and recommendations of a two-and-one-half year technical investigation of the impacts of total dissolved solids or salinity to the coastal plain of Southern California. Metropolitan conducted the Salinity Management Study (Study) in close collaboration with member agencies and numerous other concerned agencies. The United States Bureau of Reclamation (USBR) was a primary study partner, contributing financial assistance under its congressional authority (P.L. 102-575) to develop a regional water recycling plan for Southern California, because high salinity is a significant constraint to water recycling.

For analytical purposes in developing this report, the Colorado River Aqueduct (CRA) was considered full for the study period, consistent with the objectives of the California 4.4 Plan.

BENEFITS OF REDUCED SALINITY

When salinity levels of imported water are reduced, the region benefits from:

- Improved use of local groundwater and recycled water
- Reduced costs to water consumers and utilities.

Metropolitan estimates that $95 million per year of economic benefits would result if the CRA and State Water Project (SWP) waters were to simultaneously experience a 100 milligram per liter (mg/L) reduction in salt content over their historic average. Conversely, about the same dollar amount of impacts would result if imported water salinity increased by 100 mg/L. Primary salinity impact categories include residential, commercial, industrial and agricultural water users; groundwater and recycled water resources; and utility distribution systems.

SALT SOURCES

About half of the region's salt is contributed by imported water, and the other half comes from local sources. The CRA constitutes Metropolitan's highest source of salinity, averaging about 700 mg/L. Hardness comprises about one-half of the CRA salt load and causes troublesome scaling problems to indoor plumbing appliances and equipment at homes, business and industries.

The SWP provides Metropolitan with lower salinity water (an average of 250 mg/L on the East Branch and 325 mg/L on the West Branch), which can be used to blend down CRA concentrations. SWP salinity levels can change rapidly in response to hydrologic conditions, and such changes are noticeable and disruptive as compared to the very gradual, almost imperceptible changes that occur in local streams, groundwater and wastewater collection systems. A CALFED Bay-Delta solution could lower SWP salinity by 100 mg/L and reduce its short-term variability.

Local salinity sources include naturally occurring salts, salts added by urban water users, infiltration of brackish groundwater into sewers, irrigated agriculture, and confined animal waste management practices. Urban use salt contributions to wastewater range from 250 to 400 mg/L or more in some locations.

SALINITY MANAGEMENT POLICY STATEMENT AND ACTION PLAN

The proposed salinity management policy (Section 4) and corresponding Action Plan (Section 5) were adopted by Metropolitan in April 1999. The Action Plan consists of four basic components:

- Imported water source control actions
- Distribution system salinity management actions
- Collaborative actions with other agencies
- Local actions to protect groundwater and recycled water supplies

The adopted action plan should be revisited and updated periodically as clarity emerges from a number of critical areas, including the CALFED Bay-Delta Plan, California's Colorado River Water Supply Plan, wheeling practices, Stage II disinfection by-products rules under the Safe Drinking Water Act Amendments, and operational experience gained through implementation. The first major update is recommended to occur in 2004 when the Inland Feeder becomes operational, or sooner if a significant unanticipated change occurs in controlling conditions.

RESOURCE LIMITATIONS ON BLENDING COLORADO RIVER WATER SALINITY

The foundation of Metropolitan's Action Plan is an imported water salinity target of 500 mg/L. Managing imported water through blending would be supplemented by source control in the two imported water river systems, storage and exchange operations along the CRA, and a CALFED solution. Blending in Metropolitan's system is achieved by curtailing delivery of higher-salinity CRA water and substituting it with comparable amounts of lower-salinity SWP water.

Annual changes in imported water supply availability and salinity concentrations greatly affect Metropolitan's ability to achieve the target through blending. For example, above-normal runoff in 1998 provided unusually favorable conditions resulting in lower-than-target salinity levels in some months. In contrast, under such conditions as the 1977 drought, Metropolitan would not have been able to meet the target because SWP water was in short supply and its salinity levels rose to over 400 mg/L. To meet its blending target, Metropolitan would have had to take less of its CRA water. Whenever a shortage of SWP supply and high salinity occur concurrently, Metropolitan would have to fully use its CRA water and experience the higher salinity. The key trade-off in achieving a salinity target is the risk to supply reliability. To achieve the 500 mg/L

target under certain adverse conditions, up to several hundred thousand acre-feet of CRA water would have to be replaced by SWP water.

On average, the target will be met in about seven of every ten years. In the remaining years, hydrologic conditions constrain primarily the SWP with insufficient and often higher salinity supplies. The proposed policy includes clear recognition of this resource limitation and calls upon local agencies to develop and manage their local projects and groundwater to accommodate these inevitable swings in salinity of imported water due to natural hydrologic variation.

Recognizing the significant constraint of resource availability, the action plan calls for achievement of the 500 mg/L salinity objective in two stages. When conditions are favorable, 500 mg/L would be pursued year-round. When conditions are less favorable, emphasis is placed on reducing salinity during April through September primarily to support irrigation with recycled water. The summer period corresponds to the peak irrigation season and requires proportionally less curtailment of CRA water. Under current conditions, the objective would be achieved in seven out of ten years on average; higher salinity would occur during dry years. A long-term solution will require success in the CALFED process in reducing the salinity of SWP water on a sustained basis. Exchanges for Sierra water south of the Delta offer an additional method of significantly lowering SWP salinity. Furthermore, expanding storage and exchange of CRA water for SWP water will also be necessary to achieve the year-round salinity objective within the constraints of water resource availability.

If the anticipated salinity benefits of a CALFED solution or CRA exchanges and storage fall short of need, then the ultimate method of achieving salinity targets may be desalination associated with the CRA. However, given the current state of technology, the costs would be high and there would be significant resource and environmental concerns associated with large quantities of brine disposal. Hence, the action plan calls for an aggressive program of research and development (R&D) of a more efficient desalination technology. This R&D effort is already being initiated by Metropolitan in partnership with interested agencies

INTEGRATION OF QUALITY AND QUANTITY

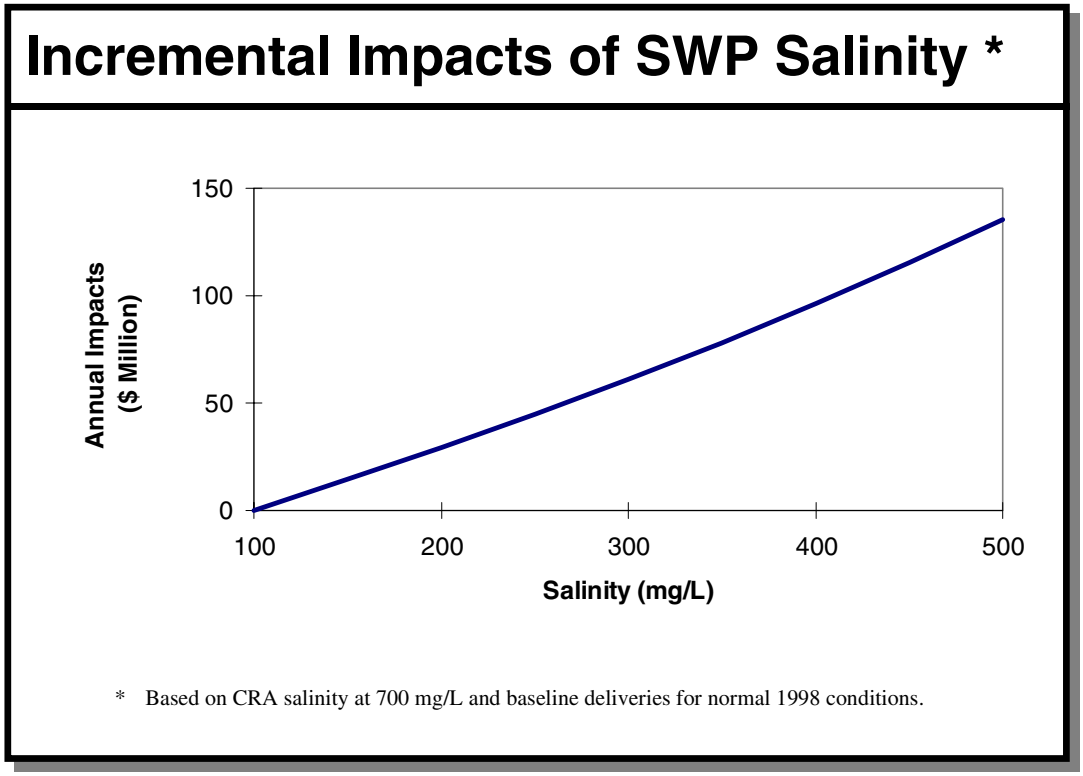
The Study shows that managing the salinity of imported water is important to the region's overall supply mix, especially in regards to local groundwater and recycled water. Metropolitan routinely assesses the pros and cons of quality-to-quantity relationships when planning and negotiating new facilities and resources, a practice that is an important part of the Salinity Management Policy and Action Plan.

REGIONAL APPROACH

The region must manage both local and imported sources to achieve a long-term salt balance. About half of the regional salt load is derived from local sources and half from imported water.

Other agencies that can influence the salt balance of the coastal plain must participate in this effort if the region is to achieve a cohesive strategy. The Action Plan calls for concurrent management of both local and imported sources of salt for the region to achieve a long-term salt balance.

Figure 2-22



Likewise, Figure 2-23 shows the range of economic consequences of CRA salinity changes when the SWP salinity is fixed at 250 mg/L at the O'Neill Forebay. While, there may be economic benefits when CRA salinity is below 500 mg/L, this graph shows the "incremental" impacts of CRA salinity compared to 500 mg/L. Historically, the average annual salinity of CRA has never been below 500 mg/L.

Technical Appendix 5 provides additional information on the derivation of salinity economic functions. Technical Appendix 6 specifically addresses the high-profile issue of the impacts of water softeners.

DEMOGRAPHIC DATA

Updated population 2000 MWD-UWMP

MWD Sevice Area

POPULATION	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
1.) North West	545,364	575,974	622,366	653,286	694,837	739,031
2.) San Fernando Valley - West	1,365,961	1,453,749	1,553,614	1,652,082	1,778,844	1,915,332
3.) San Fernando Valley - East	298,056	309,479	320,179	332,166	353,551	376,311
4.) San Gabriel Valley	1,405,924	1,469,231	1,522,440	1,579,990	1,655,867	1,735,388
5.) Central Los Angeles -	2,321,482	2,457,029	2,599,958	2,740,991	2,927,514	3,126,730
6.) Central and West Basins	3,172,278	3,288,380	3,369,568	3,458,066	3,600,086	3,747,938
7.) Coastal Plain	153,385	158,311	162,884	165,694	171,354	177,207
8.) North West Orange County	2,151,859	2,259,087	2,378,173	2,472,008	2,602,582	2,740,053
9.) South East Orange County	585,392	625,140	671,761	699,998	739,403	781,027
10.) Western MWD	671,797	746,555	829,396	891,613	974,258	1,064,563
11.) Eastern MWD	493,442	596,000	722,793	867,326	1,034,314	1,233,453
12.) Upper Chino	803,098	875,407	942,095	1,000,525	1,064,805	1,133,216
13.) Lower Chino	130,684	145,808	159,823	172,549	190,934	211,278
14.) North San Diego	1,101,836	1,261,318	1,412,419	1,550,349	1,585,019	1,620,464
15.) South San Diego	1,675,078	1,786,549	1,872,926	1,942,353	1,965,184	1,988,284
TOTAL	16,877,637	18,010,021	19,142,405	20,181,010	21,340,571	22,592,299

Updated population 2000 MWD-UWMP

NO. OF HOUSEHOLDS	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
1.) North West	175,142	188,439	203,857	215,892	229,877	244768.42
2.) San Fernando Valley - West	454,197	480,759	514,564	541,671	584,298	630278.68
3.) San Fernando Valley - East	111,465	116,827	123,017	129,012	137,587	146731.50
4.) San Gabriel Valley	412,521	429,928	448,253	465,509	492,277	520584.88
5.) Central Los Angeles -	745,056	787,596	841,537	883,987	953,443	1028355.84
6.) Central and West Basins	966,858	998,200	1,021,874	1,043,338	1,086,969	1132424.62
7.) Coastal Plain	68,244	70,985	72,997	74,887	78,166	81587.98
8.) North West Orange County	673,937	710,742	745,329	774,984	811,674	850101.05
9.) South East Orange County	224,269	242,751	264,582	278,377	297,137	317160.10
10.) Western MWD	210,719	237,928	263,408	290,084	318,851	350470.43
11.) Eastern MWD	173,903	213,018	256,275	304,912	366,290	440023.71
12.) Upper Chino	235,481	257,851	278,696	299,931	318,635	338505.20
13.) Lower Chino	35,673	40,581	44,466	49,091	52,920	57047.03
14.) North San Diego	359,306	421,032	478,914	534,467	588,847	648760.36
15.) South San Diego	592,958	644,701	685,176	722,790	759,383	797829.02

APPENDIX 8-4

Project 4: City of Goleta,
San Jose Creek Capacity Improvement and Fish Passage Project

- SWRCB Impaired Stream List
- *Steelhead Assessment and Recovery Opportunities in Southern Santa Barbara County*
- Passive Use Value of Wild Salmon
- San Jose Creek Watershed Plan

2006 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS REQUIRING TMDLS

CENTRAL COAST REGIONAL WATER QUALITY CONTROL BOARD

USEPA APPROVAL DATE: JUNE 28, 2007

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
3	R	Franklin Creek	31534020				
				Nitrate as Nitrate (NO3)		2.8 Miles	2019
					Source Unknown		
3	R	Gabilan Creek	30919000				
				Fecal Coliform		6.4 Miles	2007
					Urban Runoff/Storm Sewers		
					Natural Sources		
					Nonpoint Source		
				Nitrate as Nitrate (NO3)		6.4 Miles	2019
					Source Unknown		
3	R	Glen Annie Canyon	31531020				
				Nitrate as Nitrate (NO3)		5.7 Miles	2019
					Source Unknown		
3	E	Goleta Slough/Estuary	31531020				
				Pathogens		196 Acres	2015
					Urban Runoff/Storm Sewers		
				Priority Organics		196 Acres	2019
					Nonpoint Source		
3	R	Kings Creek	30412011				
				Sedimentation/Siltation		4.4 Miles	2019
					Silviculture		
					Road Construction		
					Disturbed Sites (Land Develop.)		
					Erosion/Siltation		
					Nonpoint Source		
3	R	Las Tablas Creek	30981293				
				Metals		5.7 Miles	2019
					Surface Mining		

Steelhead Assessment and Recovery Opportunities in Southern Santa Barbara County, California

BY

Matt W. Stoecker

and

Conception Coast Project

June 2002

Cover Illustration Courtesy of Joe Tomelleri©

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Executive Summary

Steelhead are migratory rainbow trout (*Oncorhynchus mykiss*) that exhibit an anadromous life history; being born in freshwater streams and spending a portion of their lives in the ocean before returning to freshwater to spawn. During the early 1900's steelhead were abundant in the smaller coastal streams of southern Santa Barbara County. Over the past century, human modification of riverine habitat has devastated steelhead populations in southern California. The National Marine Fisheries Service (NMFS) listed the unique southern steelhead as a federally endangered species in 1997. The NMFS estimates the southern steelhead population to be less than 1% of its historic population size. The southern steelhead population has experienced the most dramatic decline throughout California and likely North America. The loss of freshwater habitat due to the construction of migration barriers such as road crossings, dams, and flood control structures presents the single greatest limiting factor for steelhead in southern Santa Barbara County streams.

The objectives of this study are to identify site-specific restoration actions for wild, southern steelhead in those watersheds from Jalama Creek to Rincon Creek and to prepare a report prioritizing site-specific restoration actions. The primary focus of the study is to identify, prioritize, and formulate recommended actions for migration barriers within the study area.

Due to the large number of unique watersheds within the study area, focal watersheds were identified following a preliminary watershed investigation. Field surveying of focal watersheds was conducted to collect information about salmonid habitat conditions, current salmonid population status, and the location and severity of migration barriers. An extensive data collection and interviewing effort was conducted to develop a comprehensive table of historical and contemporary salmonid sightings for study area watersheds. A Geographic Information System (GIS) database was developed specifically for this project to compile collected data, assess salmonid habitat conditions, analyze migration barrier impacts to steelhead, and prioritize watershed recovery opportunities. Multiple barrier ranking methods were developed specifically for this project to prioritize over 500 identified migration barriers for steelhead passage improvement benefits. These biologically based barrier ranking methods allow prioritization at a watershed and regional level and immediate and long-term scope.

Of 168 stream miles analyzed in this report, 125 stream miles are currently upstream of migration barriers that are impassable or severely impede upstream steelhead migration. The 43 stream miles that are currently available to steelhead generally occur in the lowest reaches of the watersheds where salmonid habitat conditions and stream flows are often inadequate for successful steelhead production. Impassable barriers have completely blocked access to several watersheds and eliminated the steelhead population. Removing or modifying barriers to allow steelhead access to spawning and rearing habitat that is currently blocked was determined to be the highest regional priority and essential first step for steelhead recovery in the study area.

Restoring steelhead access to upstream habitat requires a bottom to top approach. Keystone barriers that are the most downstream barrier blocking or significantly impeding upstream adult steelhead passage were identified in focal watersheds. Steelhead restoration priorities should focus on these keystone barriers prior to steelhead passage projects upstream in their respective watershed. Providing effective upstream steelhead passage at keystone barriers is an essential step to steelhead recovery within each watershed and the region.

The following keystone barriers were identified as the top seven immediate barrier priorities for implementing a project that provides upstream steelhead passage. These barriers are all known to directly impede upstream access to a currently (2000-2002) documented adult steelhead population. Upstream passage at these locations would directly benefit southern steelhead populations. These barriers are listed in descending order of their upstream habitat score (habitat quality multiplied by habitat quantity) that would be immediately available to steelhead with passage provided at that barrier.

1) Gaviota Creek- Northern-most Highway 101 Culvert (CALTRANS)
2) Arroyo Hondo- Highway 101 Culvert (CALTRANS)
3) San Jose Creek- Concrete Channel (S.B. County Flood Control District)
4) Carpinteria Creek- Private Road Crossing (Bliss)
5) Maria Ygnacio Creek- Old San Marcos Road Crossing (S.B. Co. Public Works)
6) Mission Creek- Flood Control Channels (2) (CALTRANS)
7) Las Canovas Creek (Gaviota Creek)- Highway 101 Culvert (CALTRANS)

The following six keystone barriers are also high regional priorities for implementing upstream steelhead passage projects. These barriers occur in watersheds that have existing or historic salmonid documentation and may currently impede upstream steelhead migration. These barriers are also listed in descending order of their available upstream habitat score.

1) El Capitan Creek- Highway 101 Culvert (CALTRANS)
2) Corral Creek- Highway 101 Culvert (CALTRANS)
3) Montecito Creek- Flood Control Channel (Casa Dorina)
4) San Ysidro Creek- Pipeline (Montecito Water) and Debris Basin Dam (S.B. Co.)
5) Dos Pueblos Creek- Flood Control Channel (Shulte)
6) Rincon Creek- Highway 101 Culvert (CALTRANS)

Site-specific recommended actions for steelhead passage at individual barriers is detailed in this report along with specific barrier analysis and photographs. The steelhead passage projects pursued for barriers should be the most effective, long-term, self-sustainable, alternative that consistently allows upstream passage without dependence on human maintenance, while helping to restore other important aquatic functions. While many other factors will help improve riverine habitat conditions and long-term steelhead sustainability, steelhead recovery cannot occur without providing access to habitat currently blocked by migration barriers. Implementing recommended actions outlined in this report would help to lay the foundation for southern steelhead recovery in southern Santa Barbara County.

Steelhead recovery is dependant on cooperating with all interested parties, promoting the positives, understanding the perspective of others, and being respectful of the role each of us play in the challenging job of welcoming the elusive steelhead home.

Focal Watershed Identification Table
Initial methodology used to identify watersheds for detailed study

WATERSHED NAME	STREAM CODE	Historical Documentation of Salmonid(s) < 16"	Historical Documentation of Salmonid(s) ≥ 16"	Contemporary Documentation of Salmonid(s) < 16"	Contemporary Documentation of Salmonid(s) ≥ 16"	Salmonid Documentation Subtotal (A)	Relative Watershed Size (Maximum = 1.0)	Public Ownership (% 0-1.0)	Stakeholder Interest / Steelhead Project (1)	Estimated Steelhead Recovery Potential (0 - 2)	Watershed / Salmonid Recovery Potential Subtotal (B)	Focal Watershed Score (A+B)	Focal Watershed Category (1=Primary, 2=Secondary, 0=Non-Focal)
Rincon	RN	1	0	1	0	**2**	0.60	0.59	1	1.5	**3.69**	**5.7**	**1**
Carpinteria	CA	1	0	1	2	**4**	0.62	0.58	1	2.0	**4.20**	**8.2**	**1**
Franklin	FN	0	0	0	0	**0**	0.18	0.03	0	0.0	**0.21**	**0.2**	**0**
Santa Monica	SM	0	0	0	0	**0**	0.15	0.05	0	1.0	**1.20**	**1.2**	**0**
Arroyo Paredon	AP	0	0	1	0	**1**	0.19	0.17	1	1.0	**2.36**	**3.4**	**2**
Toro	TR	0	0	0	0	**0**	0.15	0.18	0	0.0	**0.33**	**0.3**	**0**
Romero	RO	0	0	0	0	**0**	0.24	0.37	0	1.0	**1.61**	**1.6**	**0**
San Ysidro	SY	0	0	1	0	**1**	0.16	0.49	0	1.0	**1.65**	**2.7**	**2**
Montecito	MO	1	0	1	0	**2**	0.28	0.48	1	1.5	**3.26**	**5.3**	**1**
Sycamore	SC	0	0	0	0	**0**	0.16	0.13	0	0.5	**0.79**	**0.8**	**0**
Mission	MN	1	1	1	2	**5**	0.47	0.35	1	1.5	**3.32**	**8.3**	**1**
Arroyo Burro	AB	0	0	0	0	**0**	0.40	0.16	1	1.0	**2.56**	**2.6**	**2**
Atascadero*	AO	1	1	1	2	**5**	0.81	0.27	1	1.5	**3.58**	**8.6**	**1**
San Jose*	SJ	1	1	1	2	**5**	0.64	0.24	1	1.5	**3.38**	**8.4**	**1**
Tecolotito*	TO	1	0	0	0	**1**	0.49	0.29	0	1.0	**1.78**	**2.8**	**2**
Devereaux	DX	0	0	0	0	**0**	0.15	0.07	0	0.0	**0.22**	**0.2**	**0**
Bell	BL	0	0	0	0	**0**	0.25	0.33	0	0.5	**1.08**	**1.1**	**0**
Tecolote	TE	1	1	0	0	**2**	0.23	0.57	0	1.0	**1.80**	**3.8**	**2**
Eagle	EE	0	0	0	0	**0**	0.19	0.31	0	0.0	**0.50**	**0.5**	**0**
Dos Pueblos	DP	1	0	1	0	**2**	0.34	0.54	0	1.0	**1.88**	**3.9**	**2**
Las Varas	LV	0	0	0	0	**0**	0.12	0.05	0	0.0	**0.17**	**0.2**	**0**
Gato	GO	1	0	0	0	**1**	0.14	0.62	0	1.0	**1.76**	**2.3**	**2**
Las Llagas	LL	0	0	0	0	**0**	0.11	0.10	0	0.0	**0.12**	**0.1**	**0**
El Capitan	EC	0	0	0	0	**0**	0.25	0.63	1	1.0	**2.88**	**2.9**	**2**
Corral	CL	1	0	0	0	**1**	0.26	0.52	0	1.0	**1.78**	**2.8**	**2**
Refugio	RE	1	1	1	0	**3**	0.34	0.27	1	1.5	**3.11**	**6.1**	**1**
Tajiguas	TS	1	0	0	0	**1**	0.25	0.01	0	1.0	**1.26**	**2.3**	**2**
Arroyo Quemado	AQ	1	0	0	0	**1**	0.12	0.82	0	1.0	**1.94**	**2.9**	**2**
Arroyo Hondo	AH	1	1	1	0	**3**	0.18	0.69	1	2.0	**3.87**	**6.9**	**1**
Molino	ML	0	0	0	0	**0**	0.06	0.48	0	0.5	**1.04**	**1.0**	**0**
San Onofre	SO	1	0	1	0	**2**	0.08	0.43	0	1.0	**1.51**	**3.5**	**2**
Gaviota	GA	1	1	1	0	**3**	0.82	0.27	1	2.0	**4.09**	**7.1**	**1**
Agua Caliente	AC	0	0	0	0	**0**	0.10	0.18	0	0.5	**0.78**	**0.8**	**0**
Alegria	AA	0	0	0	0	**0**	0.14	0.00	1	1.0	**2.14**	**2.1**	**2**
Cuarta	CU	0	0	0	0	**0**	0.06	0.00	0	0.5	**0.56**	**0.6**	**0**
Sacate	SE	1	0	0	0	**1**	0.06	0.00	1	0.5	**1.56**	**2.6**	**2**
Santa Anita	SA	1	0	1	0	**2**	0.13	0.00	1	1.5	**2.63**	**4.6**	**2**
Arroyo El Bulito	AE	0	0	0	0	**0**	0.10	0.00	1	1.0	**2.10**	**2.1**	**2**
Arroyo San Augustin	AS	0	0	0	0	**0**	0.07	0.00	1	1.0	**2.07**	**2.1**	**2**
Barranca Honda	BH	0	0	0	0	**0**	0.10	0.00	0	0.5	**0.60**	**0.6**	**0**
Cojo	CO	1	0	0	0	**1**	0.13	0.00	1	1.5	**2.63**	**3.6**	**2**
Wood	WD	0	0	0	0	**0**	0.16	0.00	0	0.0	**0.16**	**0.2**	**0**
Black	BK	0	0	0	0	**0**	0.06	0.00	0	0.0	**0.06**	**0.1**	**0**
Jalama	JA	1	1	1	2	**5**	1.00	0.03	0	2.0	**3.03**	**8.0**	**1**

*Sub-watersheds of the Goleta Slough Watershed

WATERSHED CATEGORY	TOTAL
Focal-Primary (5.0-10.0)	10
Focal-Secondary (2.0-4.99)	18
Non-Focal (0-1.99)	16

Table 2.3

4. Stated Preference Benefit Transfer Approaches for Estimating Passive Use Value of Wild Salmon

John Loomis

1 SIMILARITY OF CHOICE MODELING AND CONTINGENT VALUATION METHODS FOR BENEFIT TRANSFER

As is well known both the contingent valuation method (CVM) and choice modelling (CM) are stated preference methods in that they ask individuals what they would do in a particular circumstance. Each method started from a different disciplinary tradition: CVM from natural resource economics and CM from marketing. More recently, the two methods are looking more and more indistinguishable. This is especially true of applications of choice methods for economic valuation as compared to marketing purposes. Specifically, while choice methods used to focus more on conjoint analysis using ratings or rankings, they are often now done using a discrete choice (select one alternative). Contingent valuation questioning format has also evolved from open-ended questions (what is the most you would pay), to a discrete choice format (would you pay $X, yes or no). Underlying the discrete choice CVM and CM is random utility theory (McFadden, 1974; Hanemann, 1984). The random utility theory relied upon by both CVM and CM partitions the utility an individual receives from some choice into deterministic (i.e. observable) and random (non-observable) components. Not only does discrete choice CVM and CM share the same utility theoretic foundation, but they share very similar empirical methods as well. Specifically, both approaches usually rely on some form of a logistic regression model to estimate the parameters from which benefit estimates are calculated.

In some respects, a series of dichotomous choice CVM questions asked to elicit WTP for various levels of a particular natural resource look very similar to the question format in CM. In Hoehn and Loomis

(1993) a series of dichotomous choice CVM questions were asked that allowed valuation of two different levels of wetlands protection, two different levels of waterfowl contamination control and an increase in the level of salmon protection. In the CM world, these would be three attributes, two with two levels and one with one level. In the CVM example, pooling these responses and including dummy variables for the levels of the attributes allows the researcher to calculate part-worths or marginal values for these attributes, similar to CM.

Loomis and duVair (1993) asked each respondent a series of dichotomous choice CVM questions about greater and greater reductions in risk. This allowed estimates of a willingness to pay (WTP) function with risk level as a variable. In this case, there was one attribute for which marginal values could be calculated. Cameron's (1988) reparameterisation of the logistic regression coefficients into marginal values or part-worths makes transparent that a series of dichotomous choice questions yields a WTP function quite comparable to that of CM. Just as in CM, in Cameron's reparamertisation the marginal values are calculated by dividing the attribute coefficient by the coefficient on cost. Specifically if the logistic regression is:

$$\log (Y/1\text{-}Y) = Bo - B1(\$Bid) + B2(A1) + B3(A2) + \ldots Bn(An) \qquad (4.1)$$

then the WTP equation is:

$$WTP = (Bo/B1) + [B2/B1](A1) + [B3/B1](A2) + \ldots [Bn/B1](An) \qquad (4.2)$$

Thus the part-worths or marginal WTP for one more unit of A1 is B2/B1 just like one would arrive at using CM. Thus if CVM is done using a series of questions with different quality levels, it can produce marginal values of attributes that can be used in benefit transfer like those from CM. It is only when CVM is used to value one program, that CVM becomes much more limited in its benefit transfer capability than CM.

With this demonstration of the similarity of the two methods in mind, we now turn to an example of using benefit transfer from CVM and CM for valuing passive use benefits of salmon in the Pacific Northwest. In this case study we are attempting to estimate a marginal value per salmon from the existing literature and apply it in a real world policy analysis on the Snake River in Washington. Some of the pitfalls of conducting such a benefit transfer are illustrated.

2 SETTING OF THE CASE STUDY AND NEED FOR THE PASSIVE USE VALUE ANALYSIS

Wild salmon populations are declining throughout the states of Idaho, Oregon and Washington, an area collectively known as the Pacific Northwest. This problem is particularly acute on the Columbia River and its largest tributary, the Snake River. This large river stretches from Idaho to Washington and had historically provided habitat for many different types of salmon. However, a series of four large hydroelectric dams built along the last 140 miles of the Snake River just up from its confluence with the Columbia River, essentially blocked off much of the Snake River in Idaho from migrating salmon. The four dams created 140 miles of nearly continuous slack reservoir water which makes downstream migration of young salmon very slow, delaying their migration to the ocean. While the dams have fish ladders, they are only partially effective at moving adult salmon upstream.

The cumulative influence of these dams resulted in the Snake River sockeye salmon being listed as endangered in 1991. Within a few years the chinook salmon and steelhead were listed as threatened under the Endangered Species Act (ESA). The National Marine Fisheries Service and US Army Corps of Engineers (the COE is the agency which operates the dams) are required by ESA to develop a plan to recover the species using any reasonable and prudent alternatives. Under the existing baseline situation (A1), the average annual return of wild salmon is 67 116 fish. One alternative (A4) is to remove the four large hydroelectric dams and restore a free-flowing river that would allow natural salmon migration. Another alternative (A2) is to maximise artificial transport of juvenile salmon around the dams through barging and trucking. Finally, another alternative (A3) is to make a series of minor system operating improvements at the dam to minimise young salmon intake in the turbines.

While all of these alternatives have costs in the millions of dollars, dam removal (A4) had an annualised direct costs and opportunity costs of foregone hydropower of over 300 million dollars. Unlike the few past dam removal efforts that focused on small or very old dams that had often outlived their usefulness, the four Lower Snake River dams are very large hydropower producers, and facilitated barge transportation from Washington into Idaho. In addition the dams are relatively new, being just 20-30 years old at the time when the analysis of dam removal was being studied. Yet dam removal was estimated by biologists to result in more than a 50 per cent increase in wild salmon and steelhead populations. However, being biologically the best, does not necessarily

translate into having positive net economic benefits, given the several hundred million dollar costs. The US Water Resources Council (1983) project evaluation guidelines require the Corps of Engineers to evaluate the net economic benefits of each alternative before selecting the preferred alternative.

3 IMPORTANCE OF PASSIVE USE VALUES IN ECONOMIC ANALYSIS OF ENDANGERED SPECIES

Dam removal will eliminate 140 miles of reservoir recreation and replace it with 140 miles of river recreation. Eventual recovery of the species and removal from the Endangered Species List will allow for improved salmon and steelhead fishing. But the economic justification for recovery of a threatened and endangered species probably does not hinge on future recreation use values which get heavily discounted at most interest rates. Rather, the economic justification probably hinges on the option, existence and bequest values that the general public has for wild salmon in the Snake River.

Avoiding extinction of endangered species is recognised as a source of existence or passive use values (Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. Free-flowing rivers were one of the first examples of such resources with existence values (Krutilla and Fisher, 1975). Essentially people who never plan to visit, raft, or fish these rivers may still pay something to have a free-flowing river. Wild stocks of Snake River sockeye and chinook salmon clearly fit into this picture. As noted by Olsen et al. (1991) in his existence value of salmon study 'Existence value as the value an individual (or society) places on the knowledge that a resource exists in a certain state is theoretically sound and can be measured for assessment within the resource decision making arena'. Passive use values are also public goods, in that these benefits can be simultaneously enjoyed by millions of people all across the region and the country (Loomis, 1996a).

Government agencies are increasingly including passive use values when evaluating actions that affect fisheries. Passive use values are often important, because many times the vast majority of the species affected by a project are non-game/non-sport species, or the population levels of the game species are so low that fishing is no longer allowed. However, due to limited time and budget, agencies often quantify passive use value through benefit transfer. For example, the US Environmental

Protection Agency, (2002) suggests that benefit transfer can be used to value threatened and endangered species when evaluating cooling water intake structures. The USDA Economic Research Service's economic analysis of salmon recovery efforts on the Snake River included estimates of passive use values drawn from the existing literature (Aillery et al., 1996). Nonetheless, passive use values have not been formally part of the COE's economic analysis. This may be due, in part, to the benefit-cost procedures which must be followed by the COE being originally written more than 20 years ago (US Water Resources Council, 1979), before measurement of passive use values had become common. These benefit-cost procedures are silent on measurement of passive use values, although they do allow for measurement of other categories of benefits as long as the procedures are documented and WTP is used. Passive use values are estimated using a method recommended by the US Water Resources Council for valuing recreation, but its use to measure passive use values has been controversial (Diamond and Hausman, 1996; McFadden, 1994). Nonetheless, using CVM to measure passive use values has been given a limited endorsement by a Blue-Ribbon panel chaired by two Nobel Laureate economists (Arrow et al., 1993).

In the Snake River case, the interagency Drawdown Economic Workgroup (DREW) guiding the COE economic analysis asked that passive use values be included in the benefit and cost summary in the economic analysis section of the Final Environmental Impact Statement. Therefore, passive use values were calculated to be included in that part of the overall economic analysis. DREW had originally requested an original passive use value survey, and such a survey was pre-tested. However, due to political pressure the COE decided passive use values for the Lower Snake River would be approximated based on existing passive use value estimates using a benefit transfer approach rather than a new survey as was originally proposed.

Before reviewing the specific studies on the economic value of salmon and free-flowing rivers, it is important to define benefit transfer. There are several closely related definitions of benefit transfer. A commonly referred to definition is provided by Boyle and Bergstrom (1992, p. 657) '..benefit transfer is defined as the transfer of existing estimates of nonmarket values to a new study [site] which is different from the study for which the values were originally estimated.'

4 EXISTING EMPIRICAL MEASUREMENTS OF PASSIVE USE VALUES FOR SALMON

A review of two large computerised economic databases (American Economic Association's EconLit and Environment Canada's recently developed Environmental Values Reference Inventory or EVRI) yielded four published studies, but only three of which presented original passive use values for salmon. These three are:

1. Olsen, Richards and Scott's 1991 article published in 'Rivers' on existence values for doubling the size of Columbia River Basin salmon and steelhead runs;
2. Loomis's 1996 article in 'Water Resources Research' on the economic benefits of increased salmon from removing the dams on the Elwha River in Washington state; and
3. Hanemann, Loomis and Kanninen's 1991 article published in 'American Journal of Agricultural Economics' on the benefits of increasing chinook salmon populations in the San Joaquin River in California.

An unpublished, stated CM discrete choice survey of Washington residents undertaken by Layton, Brown and Plummer (1999) was made available by the authors for this benefit transfer as well. To provide the reader with the salient details for the benefit transfer application, we summarise the studies below.

The Olsen et al. (1991) study involved a telephone interview of Pacific Northwest households, using an open-ended WTP question format. Their means of payment (i.e. payment vehicle) was an increase in the household electric bill. The change in salmon was a doubling from 2.5 million to 5 million salmon, for a net change of 2.5 million salmon. The response rate on the phone interviews was quite good at 72 per cent. The original study existence value is $26.52 per household amounting to $32.52 in 1996 dollars.

The Loomis (1996a) Elwha study used a mail questionnaire and a dichotomous choice WTP question format. An increase in federal taxes was the payment vehicle. The mail survey had a response rate of 68 per cent for Washington residents and 55 per cent for rest of US residents. Respondents were shown a bar chart in the survey indicating the increase in salmon population due to dam removal was approximately 300 000 fish. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars.

The Hanemann et al. (1991) study involved a combination phone contact, mail survey booklet and then phone interview of respondents

using the survey booklet. A dichotomous choice WTP question was used, with taxes as the means of payment. The resource was an increase from 100 chinook salmon to 15 000 chinook salmon for a net increase of 14 900 in the San Joaquin River in California. The combination phone-mail-phone survey had a 51 per cent response rate. The value per household was $181 in 1989 dollars or $222 in 1996 dollars.

The Layton, Brown and Plummer (1999) study was a CM survey that asked Washington residents to rate four different scenarios which involved five different stocks of fish species. These species included the species of relevance for the Snake River (Eastern Washington and Columbia River migratory fish) as well as freshwater species and Western Washington/Puget Sound freshwater, migratory and saltwater fish. This study was specifically designed to allow valuation of a wide variety of fish improvement scenarios in the state of Washington, similar to its application here to the Lower Snake River. Half the respondents received a survey that set a non-declining future fish population as the baseline future, and half received a baseline future that involved further declines if nothing is done. As expected, the stable or non-declining baseline results lower values per fish than the declining baseline, confirming the existence of diminishing marginal value of incremental gains in fish. Layton et al. (1999) found their estimated values per household were consistent with past passive use value studies of Loomis (1996a) and Olsen et al. (1991) using the non-declining future baseline. The use of the non-declining baseline is consistent with the interagency assumption of non-declining future salmon numbers, although other biologists using past trend data suggest continued future declines (Weber, 1999).

The survey by Layton et al. (1999) was conducted by mail and had a response rate of 68 per cent, which is quite good. The survey design included a budget reminder exercise which involved households having to determine how their household spending would change with a reduction in monthly income that was equal to the dollar amounts the households were asked to pay for the four different fish programs. Layton et al. (1999) analysed their data using a censored rank order logit model.

From the results of their statistical analysis, a value per household for a one million increase in Eastern Washington/Columbia River migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the percentage changes being evaluated in the COE Environmental Impact Statement (EIS) for the Lower Snake River. The resulting value is $119 per household annually for each additional one million salmon and steelhead.

5 BENEFIT TRANSFER APPROACHES AND ESTIMATES

Three approaches are used to transfer benefits from this existing literature to estimate the change in passive use value for salmon populations in the Lower Snake River: (a) point estimate transfer of a value per salmon per household from the most similar study is applied to the gain in salmon in the Lower Snake River; (b) value function transfer using the marginal value per fish from the stated CM study is applied to the gain in salmon in the Lower Snake River; (c) a mini-meta analysis regression function is estimated using the values per salmon, and this new value function is applied to the gain in salmon in the Lower Snake River.

While none of these approaches is perfect (which is why a Lower Snake River specific passive use value study was originally planned), each provides an indication of the likely range of the passive use values for increasing salmon populations. All of these approaches do a reasonable job of meeting the criteria for benefit transfer presented by Boyle and Bergstrom (1992). In particular, all of the original empirical studies used in the three approaches valued the same resource of interest in the Lower Snake River, namely, salmon. Three out of the four original empirical studies measure this value of salmon in the same state as the Lower Snake River (e.g. Washington). All the original studies, and all three of our benefit transfer approaches use the same valuation measure, e.g. WTP.

It should be noted that to the extent these existing studies do not perfectly match the policy setting on the Lower Snake River, the direction of error is in the conservative direction. That is, most of the source studies did not provide specific reference in their surveys to whether the salmon were listed as threatened or endangered species. The salmon in the Lower Snake River are listed as threatened and endangered. Had the surveys in the source studies been of threatened and endangered stocks, and this was pointed out to survey respondents, the resulting values per fish would have likely been higher. Thus, the existing value per salmon estimates are likely conservative measures of WTP to increase threatened and endangered stocks in the Lower Snake River. Second, most of the existing studies valued a larger increase than is being evaluated at the Lower Snake River. Given diminishing marginal existence values found in these studies and confirmed in other literature (Rollins and Lyke, 1998), the larger the increase in fish proposed in a survey, the smaller the marginal value per fish. Thus taking a marginal value per fish from a study that valued a large increment and applying it to a smaller increment on the Lower Snake River will underestimate the value of that smaller increment.

5.1 Value per Fish Estimate Transfer from the Elwha River CVM Study

Point estimate transfer is the simplest approach to calculate the passive use values for wild salmon in the Lower Snake River. The transfer can be performed by matching the change in wild salmon populations in the Lower Snake River alternatives A1 to A4 to an existing study which valued a similar size change in salmon, the Loomis (1996a) Elwha River study. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars for an increase in 300 000 salmon. However, to apply this to the rest of the Pacific Northwest so as to calculate total passive use value, two further adjustments need to be made to this point estimate transfer.

To adapt this Washington household value to what households in the rest of the Pacific Northwest and California would pay, it is possible to make a downward adjustment based on a past survey (Loomis, 1996a), which compared Washington residents' WTP for salmon on the Elwha River to what households in the rest of the US would pay for the same increase in salmon on the Elwha River. Specifically, Washington household WTP was $73 annually while the rest of US households would pay $68 annually (Loomis, 1996a, p. 445). Dividing the $68 by $73 yields a downward adjustment ratio of 0.93, meaning households outside of Washington would pay 93 per cent of what a Washington household would pay. This 0.93 is an average adjustment and actually overstates the downward adjustment since the rest of US households included those in the eastern US where the ratio was 0.75. See Loomis (1999b) for a graph of the distance-WTP function for salmon.

The second adjustment is to multiply the value per household by the number of non-angler (e.g. non-user) households in California, Idaho, Oregon, Washington, and western Montana (our expanded definition of the Pacific Northwest for this study). Given the public good nature of restoring salmon in the Snake River, the total passive use value in the study area is the sum of passive use values held by non-user households in these states. This Pacific Northwest market area is quite conservative as it assumes that users and households in the rest of the United States receive no passive use values from restoring Snake River salmon, an unlikely situation.

Applying the 0.93 adjustment factor to the Washington value of $76.48 yields a value to the rest of Pacific Northwest residents of $71.12 in 1996 dollars. To calculate the total passive use value in the Pacific Northwest, we multiplied per household values by the respective non-user populations. We utilised non-user households, defined as non-fishing households from the US Fish and Wildlife Service's National

Survey of Hunting, Fishing and Wildlife Associated Recreation. In Washington, the number of non-fishing households was 1.4 million while it was 11.1 million for the rest of the Pacific Northwest. Therefore, passive use value for an additional 300 000 salmon was $110.3 million for Washington non-anglers, while for the rest of the Pacific Northwest it was $789.5 million, for a total of $899.7 million. Dividing the $899.7 million by the 300 000 additional salmon posited in the Elwha River survey, yields a value of $2,999 per salmon.

Applying this value per salmon to the increase in number of salmon with dam removal (alternative A4 minus A1) yields an annualised gain in passive use value of about $48.8 million per year over the 50 year project analysis time period. This is a reasonable and conservative benefit transfer. It is conservative because the Lower Snake River salmon are threatened and endangered while the salmon returning to the Elwha were not listed species at the time the survey was written. Thus, while the definition of the public good is not exactly equivalent between Elwha River and the Lower Snake River, the direction of the error is to underestimate the passive use values for the Lower Snake River's threatened and endangered salmon. This is a reasonable benefit transfer because the proposed action to increase salmon is dam removal in both the original Elwha River case study and the Snake River policy case. Finally, the change in number of salmon with the Elwha (around 300 000) is the closest match of the change in salmon likely to result from dam removal on the Lower Snake River (around 37 000). While the change in salmon on the Elwha River is about eight times that expected on the Lower Snake River, this further reinforces the conservative nature of the passive use value per fish calculated from the Elwha due to diminishing marginal existence values.

5.2 Transfer of Layton, Brown and Plummer Columbia River Choice Modelling Estimates

Because Layton et al. (1999) used a CM approach that yields a marginal value per salmon, it is possible to apply their point estimate directly. From the results of their statistical analysis a value per household for a one million increase in Eastern Washington/Columbia river migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the relative change from A1 to A4. The resulting value is $119 per household annually for each additional one million salmon and steelhead. This is a larger absolute increment in fish than A1 to A4, and will result in a very conservative estimate of the passive use values per fish. The same adjustment described above in the Elwha River study

was used to adjust the Washington household values to estimate the rest of the Pacific Northwest values. For the Layton et al. (1999) study, marginal value per salmon was $1,400 per salmon for the entire Pacific Northwest and California non-user households. If one uses the declining future baseline salmon population, and the additional associated gain of 250 000 salmon, the value per salmon is $10,172 for the entire Pacific Northwest and California non-user households.

The Layton et al. (1999) study illustrates the strength of CM for benefit transfer as compared to the Elwha CVM study. In the Layton et al. (1999) study households were explicitly valuing the number of salmon as a separate and distinct attribute. In the Elwha study, the number of salmon was an attribute but it was part of the overall dam removal and river restoration program. In some sense, calculating the marginal value per salmon from the Elwha CVM could overstate the WTP per salmon, as it attributes the entire program value to salmon. To the extent that the other attributes such as a free-flowing river have value separate from the salmon, the Elwha CVM derived fish values may overstate their true part-worths. As noted in the introduction this is not an inherent limitation of CVM, but rather it is a feature of having just one CVM scenario or program being valued in the CVM survey. If several CVM scenarios with different numbers of salmon were being valued then, a separate part-worth for salmon from the CVM could be accurately estimated.

In the Snake River case study, the value per fish calculated from the Layton et al. (1999) study is then applied to number of wild salmon and steelhead that would return with each EIS alternative to estimate the passive use values associated with each alternative. Using Layton, et al.'s (1999) first scenario of an assumed stable future salmon population baseline, the annualised gain from A1 to A4 is $22.8 million over the 50 year time period of analysis.

5.3 Meta Analysis Regression Approach

Rather than relying on point estimate transfers which imply a constant marginal value per fish, one could utilise meta analysis to improve the benefit transfer in two dimensions by: (a) use of more than one study, and (b) allow the marginal value per salmon to vary with the absolute increase in the number of salmon that each EIS alternative produces. The meta approach involves the statistical estimation of a WTP function for salmon using incremental passive use values per salmon calculated from the four studies of West Coast residents' WTP for increasing salmon populations discussed above. We obtained one estimate of value from the Olsen et al. (1991), Hanemann et al. (1991), and Loomis (1996a)

studies, and two from Layton et al. (1999) due to use of declining versus non-declining baseline salmon populations.

In order to arrive at commensurate passive use values per salmon from the different studies, several steps were necessary. The first was to calculate a marginal value per salmon from each study. This is straightforward with CM as this value is simply the attribute value. For the available CVM studies only one program was valued. For each program, the WTP was divided by the change in the number of salmon from baseline (the no payment status quo) to the number of salmon if the program is implemented. Then study values were updated for inflation. This value per salmon per household was aggregated upwards to account for the pure public good nature of passive use values in the Pacific Northwest. That is, multiplying the value per household, per fish by the number of households valuing that increment. The geographic area being used for all the economic analyses was residents of California, Idaho, Oregon, Washington and western Montana. Performing these steps for the Olsen et al. (1991) study yields a marginal value per salmon of $153 for the 2.5 million salmon increase (in 1996 dollars). For the Hanemann et al. (1991) study, the marginal value per salmon in the Pacific Northwest and California of $175,256 for the 14 900 salmon increase. As previously stated, the Loomis Elwha River study had a value of $2,999 for a 300 000 salmon increase.

A double log model fit the data best. The regression equation is:

Natural Log of Marginal Passive Use Values /Salmon in 4 state region =

$$24.953 - 1.315426 \text{ (Natural Log \# of Salmon)} \qquad (4.3)$$

T-statistics: (12.21) (-8.214)

The regression has an explanatory power of 95.7 per cent and the number of salmon is significant at the one per cent level, even given the limited degrees of freedom (dof=4). The negative sign on natural log of salmon indicates that marginal value per salmon decreases as the salmon population increases. This is as would be expected with a declining marginal benefit curve. This equation is then applied to the number of salmon in each EIS alternative in each time period to calculate the benefit estimates shown in Table 4.1.

Table 4. 1 Change in annual passive use value of Pacific Northwest non-user households for salmon by EIS alternative (in millions)

Alternative	Avg annual wild return during 50 yrs	Adapting Layton et al CM	Meta regression	Adapting Elwha River CVM
Baseline (A1)	67 116	-	-	-
Improved Transport (A2)	67 286	$25.0	$4.02	$5.39
System Improvements (A3)	66 288	-$657.0	-$31.08	-$1.41
Dam Removal (A4)	104 000	$22.8	$301.50	$48.80

6 APPLICATION OF BENEFIT TRANSFER APPROACHES TO LOWER SNAKE RIVER ALTERNATIVES

Using the point estimates from the Elwha River study, the Washington CM and the meta analysis function, the change in annual total passive use values with different levels of wild salmon and wild steelhead recovery is calculated. Data on population size of wild chinook salmon and wild steelhead associated with each alternative over the time period of analysis was obtained from PATH analyses provided by Shannon Davis (Radtke, Davis and Johnson, 1999). Application of this function to wild salmon and steelhead populations in alternative A1 is treated as the baseline or future without. The change in annual passive use values is then calculated for each of the three alternatives for an increase in wild salmon and steelhead populations.

Dam removal and restoration of natural river conditions (Alternative A4), is estimated by biologists to yield a 55 per cent higher run of wild salmon and wild steelhead and produces a $301 million average annual increase in passive use values using the meta regression equation. Given the reduction in wild salmon and steelhead run sizes of A3 from the baseline (A1), there is a reduction in passive use values for A3 of $31 million annually. These changes in aggregate passive use values are conservative estimates as it assumes no passive use value for households in the rest of the US outside of the study area, despite evidence from past surveys that such households do receive passive use values from salmon recovery and dam removal in the Pacific Northwest (Loomis, 1996a,b). The results of these calculations are displayed in Table 4.1 for all three benefit transfer approaches.

7 COMPARISON OF PASSIVE USE VALUES TO PROJECT COSTS

Excluding passive use values, the Corps of Engineers (COE, 2002) indicated there were negative net benefits to dam removal of $266.7 million annually. The costs of dam removal were dominated by foregone hydropower production, which was not completely offset by the gain in river recreation, including fishing. That fact that commercial and recreational fishing values for a threatened species are likely to be a small part of the initial benefits of salmon restoration is not surprising. It will take many years to rebuild the depleted salmon stocks to the levels where they can be removed from the Endangered Species List. It will be several decades before initial catch levels will produce significant economic benefits. Given the effect of discounting, these meager use values cannot overcome the upfront cost of dam removal and foregone hydropower.

However, it seems somewhat paradoxical to economically evaluate recovery of threatened and endangered species solely on their use value. The importance of passive use values in this case are simply too great to overlook. Yet, passive use values are not always the trump card. Only the meta analysis benefit transfer estimate of $301 million annually is large enough to change the outcome of the benefit-cost analysis. Using the Elwha River point estimate or Layton et al. (1999) CM benefit transfer estimates, the dam removal still has negative net benefits.

However, given the large variance in estimated benefits from using benefit transfer and the very high stakes in the policy decision, an original passive use value study would probably be justified. With literally millions of dollars at stake every year, and billions in present value, even a $250,000 passive use value study that could determine whether it is economically efficient or not to remove the dams would pay its investment back in less than a month. Unfortunately, benefit transfer was used in this real policy case not because of lack of money or time, but lack of political will. The ability of just one senator from one of the four states to block the passive use value study due to the mere possibility it might show dam removal was economically feasible (an outcome this senator was publicly against), indicates the symbolic as well as empirical importance of passive use values.

8 CONCLUSION

It is clear that passive use or existence value is a relevant value for decision making involving threatened and endangered salmon at risk in the Lower Snake River. The challenge in this study was to approximate these values based on the existing literature. Four studies, three of which valued salmon in the Pacific Northwest, were applied in three different ways to estimate the passive use values of increases in salmon populations in the Lower Snake River. The incremental passive use values for the increase in anadromous fish due to the dam breaching is ranges from a high of $301 million for households in the Pacific Northwest and California to a low of $23 million with a middle estimate of $49 million.

From a methodological perspective, this chapter has illustrated how CVM and CM approaches can be used for benefits transfer. In the meta regression benefit transfer approach the marginal values per salmon estimates from CVM and CM studies were utilised to estimate a WTP function.

This chapter also discussed the situations where CVM and CM can yield conceptually similar marginal values, and when this is not the case. Specifically, if a series of CVM willingness to pay questions are asked for programs that have differing levels of attributes, then marginal values for these attributes can be calculated. The calculation is similar to CM where the attribute coefficient is divided by the cost coefficient to yield a marginal value. However, when CVM is used to value just one program, calculation of a marginal value per unit for one of the attributes may overstate its marginal value as the entire value of the program change may be reflected in that attribute value.

Improvements in CM and CVM for increasing the accuracy of benefit transfer include allowing for declining marginal values per unit of attributes as the level of the attributes increases. Currently most CM and CVM studies provide constant marginal values per unit, which is equivalent to assuming a horizontal marginal benefit curve. This may be locally correct, but for large changes such as those in the Lower Snake River dam removal, the application of a constant marginal value may overstate the total benefits of an increase in the resource. Layton (2001) has demonstrated two refinements in empirical estimation of discrete choice models to allow for diminishing marginal value per unit of attribute. This can also be accomplished in CVM using quadratic terms in the WTP equation. These are important refinements to enhance the use of CM and CVM in future benefit transfers.

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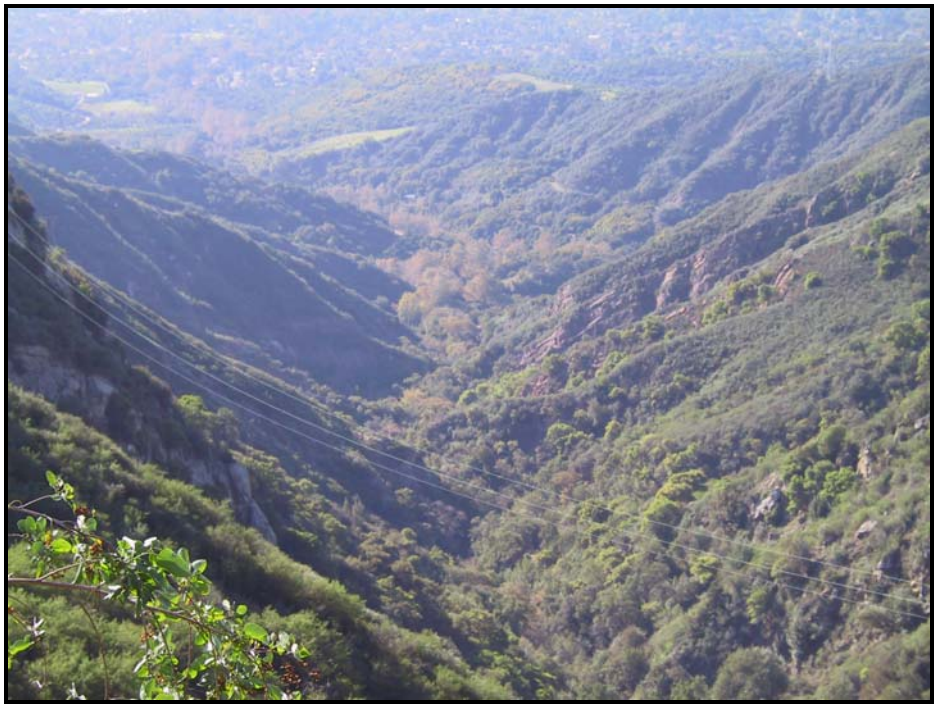
FINAL
SAN JOSE CREEK
WATERSHED PLAN



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APPENDIX 8-5

Project 5: Central Coast Water Authority,
Water Supply Reliability and Infrastructure Improvement Project

- Passive Use Value of Wild Salmon

4. Stated Preference Benefit Transfer Approaches for Estimating Passive Use Value of Wild Salmon

John Loomis

1 SIMILARITY OF CHOICE MODELING AND CONTINGENT VALUATION METHODS FOR BENEFIT TRANSFER

As is well known both the contingent valuation method (CVM) and choice modelling (CM) are stated preference methods in that they ask individuals what they would do in a particular circumstance. Each method started from a different disciplinary tradition: CVM from natural resource economics and CM from marketing. More recently, the two methods are looking more and more indistinguishable. This is especially true of applications of choice methods for economic valuation as compared to marketing purposes. Specifically, while choice methods used to focus more on conjoint analysis using ratings or rankings, they are often now done using a discrete choice (select one alternative). Contingent valuation questioning format has also evolved from open-ended questions (what is the most you would pay), to a discrete choice format (would you pay $X, yes or no). Underlying the discrete choice CVM and CM is random utility theory (McFadden, 1974; Hanemann, 1984). The random utility theory relied upon by both CVM and CM partitions the utility an individual receives from some choice into deterministic (i.e. observable) and random (non-observable) components. Not only does discrete choice CVM and CM share the same utility theoretic foundation, but they share very similar empirical methods as well. Specifically, both approaches usually rely on some form of a logistic regression model to estimate the parameters from which benefit estimates are calculated.

In some respects, a series of dichotomous choice CVM questions asked to elicit WTP for various levels of a particular natural resource look very similar to the question format in CM. In Hoehn and Loomis

(1993) a series of dichotomous choice CVM questions were asked that allowed valuation of two different levels of wetlands protection, two different levels of waterfowl contamination control and an increase in the level of salmon protection. In the CM world, these would be three attributes, two with two levels and one with one level. In the CVM example, pooling these responses and including dummy variables for the levels of the attributes allows the researcher to calculate part-worths or marginal values for these attributes, similar to CM.

Loomis and duVair (1993) asked each respondent a series of dichotomous choice CVM questions about greater and greater reductions in risk. This allowed estimates of a willingness to pay (WTP) function with risk level as a variable. In this case, there was one attribute for which marginal values could be calculated. Cameron's (1988) reparameterisation of the logistic regression coefficients into marginal values or part-worths makes transparent that a series of dichotomous choice questions yields a WTP function quite comparable to that of CM. Just as in CM, in Cameron's reparamertisation the marginal values are calculated by dividing the attribute coefficient by the coefficient on cost. Specifically if the logistic regression is:

$$\log (Y/1\text{-}Y) = Bo - B1(\$Bid) + B2(A1) + B3(A2) + \ldots Bn(An) \qquad (4.1)$$

then the WTP equation is:

$$WTP = (Bo/B1) + [B2/B1](A1) + [B3/B1](A2) + \ldots [Bn/B1](An) \qquad (4.2)$$

Thus the part-worths or marginal WTP for one more unit of A1 is B2/B1 just like one would arrive at using CM. Thus if CVM is done using a series of questions with different quality levels, it can produce marginal values of attributes that can be used in benefit transfer like those from CM. It is only when CVM is used to value one program, that CVM becomes much more limited in its benefit transfer capability than CM.

With this demonstration of the similarity of the two methods in mind, we now turn to an example of using benefit transfer from CVM and CM for valuing passive use benefits of salmon in the Pacific Northwest. In this case study we are attempting to estimate a marginal value per salmon from the existing literature and apply it in a real world policy analysis on the Snake River in Washington. Some of the pitfalls of conducting such a benefit transfer are illustrated.

2 SETTING OF THE CASE STUDY AND NEED FOR THE PASSIVE USE VALUE ANALYSIS

Wild salmon populations are declining throughout the states of Idaho, Oregon and Washington, an area collectively known as the Pacific Northwest. This problem is particularly acute on the Columbia River and its largest tributary, the Snake River. This large river stretches from Idaho to Washington and had historically provided habitat for many different types of salmon. However, a series of four large hydroelectric dams built along the last 140 miles of the Snake River just up from its confluence with the Columbia River, essentially blocked off much of the Snake River in Idaho from migrating salmon. The four dams created 140 miles of nearly continuous slack reservoir water which makes downstream migration of young salmon very slow, delaying their migration to the ocean. While the dams have fish ladders, they are only partially effective at moving adult salmon upstream.

The cumulative influence of these dams resulted in the Snake River sockeye salmon being listed as endangered in 1991. Within a few years the chinook salmon and steelhead were listed as threatened under the Endangered Species Act (ESA). The National Marine Fisheries Service and US Army Corps of Engineers (the COE is the agency which operates the dams) are required by ESA to develop a plan to recover the species using any reasonable and prudent alternatives. Under the existing baseline situation (A1), the average annual return of wild salmon is 67 116 fish. One alternative (A4) is to remove the four large hydroelectric dams and restore a free-flowing river that would allow natural salmon migration. Another alternative (A2) is to maximise artificial transport of juvenile salmon around the dams through barging and trucking. Finally, another alternative (A3) is to make a series of minor system operating improvements at the dam to minimise young salmon intake in the turbines.

While all of these alternatives have costs in the millions of dollars, dam removal (A4) had an annualised direct costs and opportunity costs of foregone hydropower of over 300 million dollars. Unlike the few past dam removal efforts that focused on small or very old dams that had often outlived their usefulness, the four Lower Snake River dams are very large hydropower producers, and facilitated barge transportation from Washington into Idaho. In addition the dams are relatively new, being just 20-30 years old at the time when the analysis of dam removal was being studied. Yet dam removal was estimated by biologists to result in more than a 50 per cent increase in wild salmon and steelhead populations. However, being biologically the best, does not necessarily

translate into having positive net economic benefits, given the several hundred million dollar costs. The US Water Resources Council (1983) project evaluation guidelines require the Corps of Engineers to evaluate the net economic benefits of each alternative before selecting the preferred alternative.

3 IMPORTANCE OF PASSIVE USE VALUES IN ECONOMIC ANALYSIS OF ENDANGERED SPECIES

Dam removal will eliminate 140 miles of reservoir recreation and replace it with 140 miles of river recreation. Eventual recovery of the species and removal from the Endangered Species List will allow for improved salmon and steelhead fishing. But the economic justification for recovery of a threatened and endangered species probably does not hinge on future recreation use values which get heavily discounted at most interest rates. Rather, the economic justification probably hinges on the option, existence and bequest values that the general public has for wild salmon in the Snake River.

Avoiding extinction of endangered species is recognised as a source of existence or passive use values (Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. Free-flowing rivers were one of the first examples of such resources with existence values (Krutilla and Fisher, 1975). Essentially people who never plan to visit, raft, or fish these rivers may still pay something to have a free-flowing river. Wild stocks of Snake River sockeye and chinook salmon clearly fit into this picture. As noted by Olsen et al. (1991) in his existence value of salmon study 'Existence value as the value an individual (or society) places on the knowledge that a resource exists in a certain state is theoretically sound and can be measured for assessment within the resource decision making arena'. Passive use values are also public goods, in that these benefits can be simultaneously enjoyed by millions of people all across the region and the country (Loomis, 1996a).

Government agencies are increasingly including passive use values when evaluating actions that affect fisheries. Passive use values are often important, because many times the vast majority of the species affected by a project are non-game/non-sport species, or the population levels of the game species are so low that fishing is no longer allowed. However, due to limited time and budget, agencies often quantify passive use value through benefit transfer. For example, the US Environmental

Protection Agency, (2002) suggests that benefit transfer can be used to value threatened and endangered species when evaluating cooling water intake structures. The USDA Economic Research Service's economic analysis of salmon recovery efforts on the Snake River included estimates of passive use values drawn from the existing literature (Aillery et al., 1996). Nonetheless, passive use values have not been formally part of the COE's economic analysis. This may be due, in part, to the benefit-cost procedures which must be followed by the COE being originally written more than 20 years ago (US Water Resources Council, 1979), before measurement of passive use values had become common. These benefit-cost procedures are silent on measurement of passive use values, although they do allow for measurement of other categories of benefits as long as the procedures are documented and WTP is used. Passive use values are estimated using a method recommended by the US Water Resources Council for valuing recreation, but its use to measure passive use values has been controversial (Diamond and Hausman, 1996; McFadden, 1994). Nonetheless, using CVM to measure passive use values has been given a limited endorsement by a Blue-Ribbon panel chaired by two Nobel Laureate economists (Arrow et al., 1993).

In the Snake River case, the interagency Drawdown Economic Workgroup (DREW) guiding the COE economic analysis asked that passive use values be included in the benefit and cost summary in the economic analysis section of the Final Environmental Impact Statement. Therefore, passive use values were calculated to be included in that part of the overall economic analysis. DREW had originally requested an original passive use value survey, and such a survey was pre-tested. However, due to political pressure the COE decided passive use values for the Lower Snake River would be approximated based on existing passive use value estimates using a benefit transfer approach rather than a new survey as was originally proposed.

Before reviewing the specific studies on the economic value of salmon and free-flowing rivers, it is important to define benefit transfer. There are several closely related definitions of benefit transfer. A commonly referred to definition is provided by Boyle and Bergstrom (1992, p. 657) '..benefit transfer is defined as the transfer of existing estimates of nonmarket values to a new study [site] which is different from the study for which the values were originally estimated.'

4 EXISTING EMPIRICAL MEASUREMENTS OF PASSIVE USE VALUES FOR SALMON

A review of two large computerised economic databases (American Economic Association's EconLit and Environment Canada's recently developed Environmental Values Reference Inventory or EVRI) yielded four published studies, but only three of which presented original passive use values for salmon. These three are:

1. Olsen, Richards and Scott's 1991 article published in 'Rivers' on existence values for doubling the size of Columbia River Basin salmon and steelhead runs;
2. Loomis's 1996 article in 'Water Resources Research' on the economic benefits of increased salmon from removing the dams on the Elwha River in Washington state; and
3. Hanemann, Loomis and Kanninen's 1991 article published in 'American Journal of Agricultural Economics' on the benefits of increasing chinook salmon populations in the San Joaquin River in California.

An unpublished, stated CM discrete choice survey of Washington residents undertaken by Layton, Brown and Plummer (1999) was made available by the authors for this benefit transfer as well. To provide the reader with the salient details for the benefit transfer application, we summarise the studies below.

The Olsen et al. (1991) study involved a telephone interview of Pacific Northwest households, using an open-ended WTP question format. Their means of payment (i.e. payment vehicle) was an increase in the household electric bill. The change in salmon was a doubling from 2.5 million to 5 million salmon, for a net change of 2.5 million salmon. The response rate on the phone interviews was quite good at 72 per cent. The original study existence value is $26.52 per household amounting to $32.52 in 1996 dollars.

The Loomis (1996a) Elwha study used a mail questionnaire and a dichotomous choice WTP question format. An increase in federal taxes was the payment vehicle. The mail survey had a response rate of 68 per cent for Washington residents and 55 per cent for rest of US residents. Respondents were shown a bar chart in the survey indicating the increase in salmon population due to dam removal was approximately 300 000 fish. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars.

The Hanemann et al. (1991) study involved a combination phone contact, mail survey booklet and then phone interview of respondents

using the survey booklet. A dichotomous choice WTP question was used, with taxes as the means of payment. The resource was an increase from 100 chinook salmon to 15 000 chinook salmon for a net increase of 14 900 in the San Joaquin River in California. The combination phone-mail-phone survey had a 51 per cent response rate. The value per household was $181 in 1989 dollars or $222 in 1996 dollars.

The Layton, Brown and Plummer (1999) study was a CM survey that asked Washington residents to rate four different scenarios which involved five different stocks of fish species. These species included the species of relevance for the Snake River (Eastern Washington and Columbia River migratory fish) as well as freshwater species and Western Washington/Puget Sound freshwater, migratory and saltwater fish. This study was specifically designed to allow valuation of a wide variety of fish improvement scenarios in the state of Washington, similar to its application here to the Lower Snake River. Half the respondents received a survey that set a non-declining future fish population as the baseline future, and half received a baseline future that involved further declines if nothing is done. As expected, the stable or non-declining baseline results lower values per fish than the declining baseline, confirming the existence of diminishing marginal value of incremental gains in fish. Layton et al. (1999) found their estimated values per household were consistent with past passive use value studies of Loomis (1996a) and Olsen et al. (1991) using the non-declining future baseline. The use of the non-declining baseline is consistent with the interagency assumption of non-declining future salmon numbers, although other biologists using past trend data suggest continued future declines (Weber, 1999).

The survey by Layton et al. (1999) was conducted by mail and had a response rate of 68 per cent, which is quite good. The survey design included a budget reminder exercise which involved households having to determine how their household spending would change with a reduction in monthly income that was equal to the dollar amounts the households were asked to pay for the four different fish programs. Layton et al. (1999) analysed their data using a censored rank order logit model.

From the results of their statistical analysis, a value per household for a one million increase in Eastern Washington/Columbia River migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the percentage changes being evaluated in the COE Environmental Impact Statement (EIS) for the Lower Snake River. The resulting value is $119 per household annually for each additional one million salmon and steelhead.

5 BENEFIT TRANSFER APPROACHES AND ESTIMATES

Three approaches are used to transfer benefits from this existing literature to estimate the change in passive use value for salmon populations in the Lower Snake River: (a) point estimate transfer of a value per salmon per household from the most similar study is applied to the gain in salmon in the Lower Snake River; (b) value function transfer using the marginal value per fish from the stated CM study is applied to the gain in salmon in the Lower Snake River; (c) a mini-meta analysis regression function is estimated using the values per salmon, and this new value function is applied to the gain in salmon in the Lower Snake River.

While none of these approaches is perfect (which is why a Lower Snake River specific passive use value study was originally planned), each provides an indication of the likely range of the passive use values for increasing salmon populations. All of these approaches do a reasonable job of meeting the criteria for benefit transfer presented by Boyle and Bergstrom (1992). In particular, all of the original empirical studies used in the three approaches valued the same resource of interest in the Lower Snake River, namely, salmon. Three out of the four original empirical studies measure this value of salmon in the same state as the Lower Snake River (e.g. Washington). All the original studies, and all three of our benefit transfer approaches use the same valuation measure, e.g. WTP.

It should be noted that to the extent these existing studies do not perfectly match the policy setting on the Lower Snake River, the direction of error is in the conservative direction. That is, most of the source studies did not provide specific reference in their surveys to whether the salmon were listed as threatened or endangered species. The salmon in the Lower Snake River are listed as threatened and endangered. Had the surveys in the source studies been of threatened and endangered stocks, and this was pointed out to survey respondents, the resulting values per fish would have likely been higher. Thus, the existing value per salmon estimates are likely conservative measures of WTP to increase threatened and endangered stocks in the Lower Snake River. Second, most of the existing studies valued a larger increase than is being evaluated at the Lower Snake River. Given diminishing marginal existence values found in these studies and confirmed in other literature (Rollins and Lyke, 1998), the larger the increase in fish proposed in a survey, the smaller the marginal value per fish. Thus taking a marginal value per fish from a study that valued a large increment and applying it to a smaller increment on the Lower Snake River will underestimate the value of that smaller increment.

5.1 Value per Fish Estimate Transfer from the Elwha River CVM Study

Point estimate transfer is the simplest approach to calculate the passive use values for wild salmon in the Lower Snake River. The transfer can be performed by matching the change in wild salmon populations in the Lower Snake River alternatives A1 to A4 to an existing study which valued a similar size change in salmon, the Loomis (1996a) Elwha River study. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars for an increase in 300 000 salmon. However, to apply this to the rest of the Pacific Northwest so as to calculate total passive use value, two further adjustments need to be made to this point estimate transfer.

To adapt this Washington household value to what households in the rest of the Pacific Northwest and California would pay, it is possible to make a downward adjustment based on a past survey (Loomis, 1996a), which compared Washington residents' WTP for salmon on the Elwha River to what households in the rest of the US would pay for the same increase in salmon on the Elwha River. Specifically, Washington household WTP was $73 annually while the rest of US households would pay $68 annually (Loomis, 1996a, p. 445). Dividing the $68 by $73 yields a downward adjustment ratio of 0.93, meaning households outside of Washington would pay 93 per cent of what a Washington household would pay. This 0.93 is an average adjustment and actually overstates the downward adjustment since the rest of US households included those in the eastern US where the ratio was 0.75. See Loomis (1999b) for a graph of the distance-WTP function for salmon.

The second adjustment is to multiply the value per household by the number of non-angler (e.g. non-user) households in California, Idaho, Oregon, Washington, and western Montana (our expanded definition of the Pacific Northwest for this study). Given the public good nature of restoring salmon in the Snake River, the total passive use value in the study area is the sum of passive use values held by non-user households in these states. This Pacific Northwest market area is quite conservative as it assumes that users and households in the rest of the United States receive no passive use values from restoring Snake River salmon, an unlikely situation.

Applying the 0.93 adjustment factor to the Washington value of $76.48 yields a value to the rest of Pacific Northwest residents of $71.12 in 1996 dollars. To calculate the total passive use value in the Pacific Northwest, we multiplied per household values by the respective non-user populations. We utilised non-user households, defined as non-fishing households from the US Fish and Wildlife Service's National

Survey of Hunting, Fishing and Wildlife Associated Recreation. In Washington, the number of non-fishing households was 1.4 million while it was 11.1 million for the rest of the Pacific Northwest. Therefore, passive use value for an additional 300 000 salmon was $110.3 million for Washington non-anglers, while for the rest of the Pacific Northwest it was $789.5 million, for a total of $899.7 million. Dividing the $899.7 million by the 300 000 additional salmon posited in the Elwha River survey, yields a value of $2,999 per salmon.

Applying this value per salmon to the increase in number of salmon with dam removal (alternative A4 minus A1) yields an annualised gain in passive use value of about $48.8 million per year over the 50 year project analysis time period. This is a reasonable and conservative benefit transfer. It is conservative because the Lower Snake River salmon are threatened and endangered while the salmon returning to the Elwha were not listed species at the time the survey was written. Thus, while the definition of the public good is not exactly equivalent between Elwha River and the Lower Snake River, the direction of the error is to underestimate the passive use values for the Lower Snake River's threatened and endangered salmon. This is a reasonable benefit transfer because the proposed action to increase salmon is dam removal in both the original Elwha River case study and the Snake River policy case. Finally, the change in number of salmon with the Elwha (around 300 000) is the closest match of the change in salmon likely to result from dam removal on the Lower Snake River (around 37 000). While the change in salmon on the Elwha River is about eight times that expected on the Lower Snake River, this further reinforces the conservative nature of the passive use value per fish calculated from the Elwha due to diminishing marginal existence values.

5.2 Transfer of Layton, Brown and Plummer Columbia River Choice Modelling Estimates

Because Layton et al. (1999) used a CM approach that yields a marginal value per salmon, it is possible to apply their point estimate directly. From the results of their statistical analysis a value per household for a one million increase in Eastern Washington/Columbia river migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the relative change from A1 to A4. The resulting value is $119 per household annually for each additional one million salmon and steelhead. This is a larger absolute increment in fish than A1 to A4, and will result in a very conservative estimate of the passive use values per fish. The same adjustment described above in the Elwha River study

was used to adjust the Washington household values to estimate the rest of the Pacific Northwest values. For the Layton et al. (1999) study, marginal value per salmon was $1,400 per salmon for the entire Pacific Northwest and California non-user households. If one uses the declining future baseline salmon population, and the additional associated gain of 250 000 salmon, the value per salmon is $10,172 for the entire Pacific Northwest and California non-user households.

The Layton et al. (1999) study illustrates the strength of CM for benefit transfer as compared to the Elwha CVM study. In the Layton et al. (1999) study households were explicitly valuing the number of salmon as a separate and distinct attribute. In the Elwha study, the number of salmon was an attribute but it was part of the overall dam removal and river restoration program. In some sense, calculating the marginal value per salmon from the Elwha CVM could overstate the WTP per salmon, as it attributes the entire program value to salmon. To the extent that the other attributes such as a free-flowing river have value separate from the salmon, the Elwha CVM derived fish values may overstate their true part-worths. As noted in the introduction this is not an inherent limitation of CVM, but rather it is a feature of having just one CVM scenario or program being valued in the CVM survey. If several CVM scenarios with different numbers of salmon were being valued then, a separate part-worth for salmon from the CVM could be accurately estimated.

In the Snake River case study, the value per fish calculated from the Layton et al. (1999) study is then applied to number of wild salmon and steelhead that would return with each EIS alternative to estimate the passive use values associated with each alternative. Using Layton, et al.'s (1999) first scenario of an assumed stable future salmon population baseline, the annualised gain from A1 to A4 is $22.8 million over the 50 year time period of analysis.

5.3 Meta Analysis Regression Approach

Rather than relying on point estimate transfers which imply a constant marginal value per fish, one could utilise meta analysis to improve the benefit transfer in two dimensions by: (a) use of more than one study, and (b) allow the marginal value per salmon to vary with the absolute increase in the number of salmon that each EIS alternative produces. The meta approach involves the statistical estimation of a WTP function for salmon using incremental passive use values per salmon calculated from the four studies of West Coast residents' WTP for increasing salmon populations discussed above. We obtained one estimate of value from the Olsen et al. (1991), Hanemann et al. (1991), and Loomis (1996a)

studies, and two from Layton et al. (1999) due to use of declining versus non-declining baseline salmon populations.

In order to arrive at commensurate passive use values per salmon from the different studies, several steps were necessary. The first was to calculate a marginal value per salmon from each study. This is straightforward with CM as this value is simply the attribute value. For the available CVM studies only one program was valued. For each program, the WTP was divided by the change in the number of salmon from baseline (the no payment status quo) to the number of salmon if the program is implemented. Then study values were updated for inflation. This value per salmon per household was aggregated upwards to account for the pure public good nature of passive use values in the Pacific Northwest. That is, multiplying the value per household, per fish by the number of households valuing that increment. The geographic area being used for all the economic analyses was residents of California, Idaho, Oregon, Washington and western Montana. Performing these steps for the Olsen et al. (1991) study yields a marginal value per salmon of $153 for the 2.5 million salmon increase (in 1996 dollars). For the Hanemann et al. (1991) study, the marginal value per salmon in the Pacific Northwest and California of $175,256 for the 14 900 salmon increase. As previously stated, the Loomis Elwha River study had a value of $2,999 for a 300 000 salmon increase.

A double log model fit the data best. The regression equation is:

Natural Log of Marginal Passive Use Values /Salmon in 4 state region =

$$24.953 - 1.315426 \text{ (Natural Log \# of Salmon)} \qquad (4.3)$$

T-statistics: (12.21) (-8.214)

The regression has an explanatory power of 95.7 per cent and the number of salmon is significant at the one per cent level, even given the limited degrees of freedom (dof=4). The negative sign on natural log of salmon indicates that marginal value per salmon decreases as the salmon population increases. This is as would be expected with a declining marginal benefit curve. This equation is then applied to the number of salmon in each EIS alternative in each time period to calculate the benefit estimates shown in Table 4.1.

Table 4. 1 Change in annual passive use value of Pacific Northwest non-user households for salmon by EIS alternative (in millions)

Alternative	Avg annual wild return during 50 yrs	Adapting Layton et al CM	Meta regression	Adapting Elwha River CVM
Baseline (A1)	67 116	-	-	-
Improved Transport (A2)	67 286	$25.0	$4.02	$5.39
System Improvements (A3)	66 288	-$657.0	-$31.08	-$1.41
Dam Removal (A4)	104 000	$22.8	$301.50	$48.80

6 APPLICATION OF BENEFIT TRANSFER APPROACHES TO LOWER SNAKE RIVER ALTERNATIVES

Using the point estimates from the Elwha River study, the Washington CM and the meta analysis function, the change in annual total passive use values with different levels of wild salmon and wild steelhead recovery is calculated. Data on population size of wild chinook salmon and wild steelhead associated with each alternative over the time period of analysis was obtained from PATH analyses provided by Shannon Davis (Radtke, Davis and Johnson, 1999). Application of this function to wild salmon and steelhead populations in alternative A1 is treated as the baseline or future without. The change in annual passive use values is then calculated for each of the three alternatives for an increase in wild salmon and steelhead populations.

Dam removal and restoration of natural river conditions (Alternative A4), is estimated by biologists to yield a 55 per cent higher run of wild salmon and wild steelhead and produces a $301 million average annual increase in passive use values using the meta regression equation. Given the reduction in wild salmon and steelhead run sizes of A3 from the baseline (A1), there is a reduction in passive use values for A3 of $31 million annually. These changes in aggregate passive use values are conservative estimates as it assumes no passive use value for households in the rest of the US outside of the study area, despite evidence from past surveys that such households do receive passive use values from salmon recovery and dam removal in the Pacific Northwest (Loomis, 1996a,b). The results of these calculations are displayed in Table 4.1 for all three benefit transfer approaches.

7 COMPARISON OF PASSIVE USE VALUES TO PROJECT COSTS

Excluding passive use values, the Corps of Engineers (COE, 2002) indicated there were negative net benefits to dam removal of $266.7 million annually. The costs of dam removal were dominated by foregone hydropower production, which was not completely offset by the gain in river recreation, including fishing. That fact that commercial and recreational fishing values for a threatened species are likely to be a small part of the initial benefits of salmon restoration is not surprising. It will take many years to rebuild the depleted salmon stocks to the levels where they can be removed from the Endangered Species List. It will be several decades before initial catch levels will produce significant economic benefits. Given the effect of discounting, these meager use values cannot overcome the upfront cost of dam removal and foregone hydropower.

However, it seems somewhat paradoxical to economically evaluate recovery of threatened and endangered species solely on their use value. The importance of passive use values in this case are simply too great to overlook. Yet, passive use values are not always the trump card. Only the meta analysis benefit transfer estimate of $301 million annually is large enough to change the outcome of the benefit-cost analysis. Using the Elwha River point estimate or Layton et al. (1999) CM benefit transfer estimates, the dam removal still has negative net benefits.

However, given the large variance in estimated benefits from using benefit transfer and the very high stakes in the policy decision, an original passive use value study would probably be justified. With literally millions of dollars at stake every year, and billions in present value, even a $250,000 passive use value study that could determine whether it is economically efficient or not to remove the dams would pay its investment back in less than a month. Unfortunately, benefit transfer was used in this real policy case not because of lack of money or time, but lack of political will. The ability of just one senator from one of the four states to block the passive use value study due to the mere possibility it might show dam removal was economically feasible (an outcome this senator was publicly against), indicates the symbolic as well as empirical importance of passive use values.

8 CONCLUSION

It is clear that passive use or existence value is a relevant value for decision making involving threatened and endangered salmon at risk in the Lower Snake River. The challenge in this study was to approximate these values based on the existing literature. Four studies, three of which valued salmon in the Pacific Northwest, were applied in three different ways to estimate the passive use values of increases in salmon populations in the Lower Snake River. The incremental passive use values for the increase in anadromous fish due to the dam breaching is ranges from a high of $301 million for households in the Pacific Northwest and California to a low of $23 million with a middle estimate of $49 million.

From a methodological perspective, this chapter has illustrated how CVM and CM approaches can be used for benefits transfer. In the meta regression benefit transfer approach the marginal values per salmon estimates from CVM and CM studies were utilised to estimate a WTP function.

This chapter also discussed the situations where CVM and CM can yield conceptually similar marginal values, and when this is not the case. Specifically, if a series of CVM willingness to pay questions are asked for programs that have differing levels of attributes, then marginal values for these attributes can be calculated. The calculation is similar to CM where the attribute coefficient is divided by the cost coefficient to yield a marginal value. However, when CVM is used to value just one program, calculation of a marginal value per unit for one of the attributes may overstate its marginal value as the entire value of the program change may be reflected in that attribute value.

Improvements in CM and CVM for increasing the accuracy of benefit transfer include allowing for declining marginal values per unit of attributes as the level of the attributes increases. Currently most CM and CVM studies provide constant marginal values per unit, which is equivalent to assuming a horizontal marginal benefit curve. This may be locally correct, but for large changes such as those in the Lower Snake River dam removal, the application of a constant marginal value may overstate the total benefits of an increase in the resource. Layton (2001) has demonstrated two refinements in empirical estimation of discrete choice models to allow for diminishing marginal value per unit of attribute. This can also be accomplished in CVM using quadratic terms in the WTP equation. These are important refinements to enhance the use of CM and CVM in future benefit transfers.

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APPENDIX 8-6

Project 6: Goleta Sanitary District, Wastewater Treatment Plant Upgrade

- *Assembly Bill 32, Global Warming Solutions Act of 2006*
- Passive Use Value of Wild Salmon

Assembly Bill No. 32

CHAPTER 488

An act to add Division 25.5 (commencing with Section 38500) to the Health and Safety Code, relating to air pollution.

[Approved by Governor September 27, 2006. Filed with Secretary of State September 27, 2006.]

LEGISLATIVE COUNSEL'S DIGEST

AB 32, Nunez. Air pollution: greenhouse gases: California Global Warming Solutions Act of 2006.

Under existing law, the State Air Resources Board (state board), the State Energy Resources Conservation and Development Commission (Energy Commission), and the California Climate Action Registry all have responsibilities with respect to the control of emissions of greenhouse gases, as de ned, and the Secretary for Environmental Protection is required to coordinate emission reductions of greenhouse gases and climate change activity in state government.

This bill would require the state board to adopt regulations to require the reporting and veri cation of statewide greenhouse gas emissions and to monitor and enforce compliance with this program, as speci ed. The bill would require the state board to adopt a statewide greenhouse gas emissions limit equivalent to the statewide greenhouse gas emissions levels in 1990 to be achieved by 2020, as speci ed. The bill would require the state board to adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions, as speci ed. The bill would authorize the state board to adopt market-based compliance mechanisms, as de ned, meeting speci ed requirements. The bill would require the state board to monitor compliance with and enforce any rule, regulation, order, emission limitation, emissions reduction measure, or market-based compliance mechanism adopted by the state board, pursuant to speci ed provisions of existing law. The bill would authorize the state board to adopt a schedule of fees to be paid by regulated sources of greenhouse gas emissions, as speci ed.

Because the bill would require the state board to establish emissions limits and other requirements, the violation of which would be a crime, this bill would create a state-mandated local program.

The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement.

This bill would provide that no reimbursement is required by this act for a speci ed reason.

The people of the State of California do enact as follows:

SECTION 1. Division 25.5 (commencing with Section 38500) is added to the Health and Safety Code, to read:

DIVISION 25.5. CALIFORNIA GLOBAL WARMING SOLUTIONS ACT OF 2006

PART 1. GENERAL PROVISIONS

Chapter 1. Title of Division

38500. This division shall be known, and may be cited, as the California Global Warming Solutions Act of 2006.

Chapter 2. Findings and Declarations

38501. The Legislature nds and declares all of the following:

(a) Global warming poses a serious threat to the economic well-being, public health, natural resources, and the environment of California. The potential adverse impacts of global warming include the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems.

(b) Global warming will have detrimental effects on some of California's largest industries, including agriculture, wine, tourism, skiing, recreational and commercial shing, and forestry. It will also increase the strain on electricity supplies necessary to meet the demand for summer air-conditioning in the hottest parts of the state.

(c) California has long been a national and international leader on energy conservation and environmental stewardship efforts, including the areas of air quality protections, energy ef ciency requirements, renewable energy standards, natural resource conservation, and greenhouse gas emission standards for passenger vehicles. The program established by this division will continue this tradition of environmental leadership by placing California at the forefront of national and international efforts to reduce emissions of greenhouse gases.

(d) National and international actions are necessary to fully address the issue of global warming. However, action taken by California to reduce emissions of greenhouse gases will have far-reaching effects by encouraging other states, the federal government, and other countries to act.

(e) By exercising a global leadership role, California will also position its economy, technology centers, nancial institutions, and businesses to bene t from national and international efforts to reduce emissions of greenhouse gases. More importantly, investing in the development of innovative and pioneering technologies will assist California in achieving the 2020 statewide limit on emissions of greenhouse gases established by this division and will provide an opportunity for the state to take a global economic and technological leadership role in reducing emissions of greenhouse gases.

(f) It is the intent of the Legislature that the State Air Resources Board coordinate with state agencies, as well as consult with the environmental justice community, industry sectors, business groups, academic institutions, environmental organizations, and other stakeholders in implementing this division.

(g) It is the intent of the Legislature that the State Air Resources Board consult with the Public Utilities Commission in the development of emissions reduction measures, including limits on emissions of greenhouse gases applied to electricity and natural gas providers regulated by the Public Utilities Commission in order to ensure that electricity and natural gas providers are not required to meet duplicative or inconsistent regulatory requirements.

(h) It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established pursuant to this division in a manner that minimizes costs and maximizes bene ts for California's economy, improves and modernizes California's energy infrastructure and maintains electric system reliability, maximizes additional environmental and economic co-bene ts for California, and complements the state's efforts to improve air quality.

(i) It is the intent of the Legislature that the Climate Action Team established by the Governor to coordinate the efforts set forth under Executive Order S-3-05 continue its role in coordinating overall climate policy.

Chapter 3. Definitions

38505. For the purposes of this division, the following terms have the following meanings:

(a) "Allowance" means an authorization to emit, during a speci ed year, up to one ton of carbon dioxide equivalent.

(b) "Alternative compliance mechanism" means an action undertaken by a greenhouse gas emission source that achieves the equivalent reduction of greenhouse gas emissions over the same time period as a direct emission reduction, and that is approved by the state board. "Alternative compliance mechanism" includes, but is not limited to, a

exible compliance schedule, alternative control technology, a process change, or a product substitution.

(c) "Carbon dioxide equivalent" means the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas, based on the best available science, including from the Intergovernmental Panel on Climate Change.

(d) "Cost-effective" or "cost-effectiveness" means the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential.

(e) "Direct emission reduction" means a greenhouse gas emission reduction action made by a greenhouse gas emission source at that source.

(f) "Emissions reduction measure" means programs, measures, standards, and alternative compliance mechanisms authorized pursuant to this division, applicable to sources or categories of sources, that are designed to reduce emissions of greenhouse gases.

(g) "Greenhouse gas" or "greenhouse gases" includes all of the following gases: carbon dioxide, methane, nitrous oxide, hydro uorocarbons, per uorocarbons, and sulfur hexa ouride.

(h) "Greenhouse gas emissions limit" means an authorization, during a speci ed year, to emit up to a level of greenhouse gases speci ed by the state board, expressed in tons of carbon dioxide equivalents.

(i) "Greenhouse gas emission source" or "source" means any source, or category of sources, of greenhouse gas emissions whose emissions are at a level of signi cance, as determined by the state board, that its participation in the program established under this division will enable the state board to effectively reduce greenhouse gas emissions and monitor compliance with the statewide greenhouse gas emissions limit.

(j) "Leakage" means a reduction in emissions of greenhouse gases within the state that is offset by an increase in emissions of greenhouse gases outside the state.

(k) "Market-based compliance mechanism" means either of the following:

(1) A system of market-based declining annual aggregate emissions limitations for sources or categories of sources that emit greenhouse gases.

(2) Greenhouse gas emissions exchanges, banking, credits, and other transactions, governed by rules and protocols established by the state board, that result in the same greenhouse gas emission reduction, over the same time period, as direct compliance with a greenhouse gas emission limit or emission reduction measure adopted by the state board pursuant to this division.

(*l*) "State board" means the State Air Resources Board.

(m) "Statewide greenhouse gas emissions" means the total annual emissions of greenhouse gases in the state, including all emissions of greenhouse gases from the generation of electricity delivered to and consumed in California, accounting for transmission and distribution line losses, whether the electricity is generated in state or imported. Statewide emissions shall be expressed in tons of carbon dioxide equivalents.

(n) "Statewide greenhouse gas emissions limit" or "statewide emissions limit" means the maximum allowable level of statewide greenhouse gas emissions in 2020, as determined by the state board pursuant to Part 3 (commencing with Section 38850).

Chapter 4. Role of State Board

38510. The State Air Resources Board is the state agency charged with monitoring and regulating sources of emissions of greenhouse gases that cause global warming in order to reduce emissions of greenhouse gases.

PART 2. MANDATORY GREENHOUSE GAS EMISSIONS REPORTING

38530. (a) On or before January 1, 2008, the state board shall adopt regulations to require the reporting and veri cation of statewide greenhouse gas emissions and to monitor and enforce compliance with this program.

(b) The regulations shall do all of the following:

(1) Require the monitoring and annual reporting of greenhouse gas emissions from greenhouse gas emission sources beginning with the sources or categories of sources that contribute the most to statewide emissions.

(2) Account for greenhouse gas emissions from all electricity consumed in the state, including transmission and distribution line losses from electricity generated within the state or imported from outside the state. This requirement applies to all retail sellers of electricity, including load-serving entities as de ned in subdivision (j) of Section 380 of the Public Utilities Code and local publicly owned electric utilities as de ned in Section 9604 of the Public Utilities Code.

(3) Where appropriate and to the maximum extent feasible, incorporate the standards and protocols developed by the California Climate Action Registry, established pursuant to Chapter 6 (commencing with Section 42800) of Part 4 of Division 26. Entities that voluntarily participated in the California Climate Action Registry prior to December 31, 2006, and have developed a greenhouse gas emission reporting program, shall not be required to signi cantly alter their reporting or veri cation program except as necessary to ensure that reporting is complete and veri able for the purposes of compliance with this division as determined by the state board.

(4) Ensure rigorous and consistent accounting of emissions, and provide reporting tools and formats to ensure collection of necessary data.

(5) Ensure that greenhouse gas emission sources maintain comprehensive records of all reported greenhouse gas emissions.

(c) The state board shall do both of the following:

(1) Periodically review and update its emission reporting requirements, as necessary.

(2) Review existing and proposed international, federal, and state greenhouse gas emission reporting programs and make reasonable efforts to promote consistency among the programs established pursuant to this part and other programs, and to streamline reporting requirements on greenhouse gas emission sources.

PART 3. STATEWIDE GREENHOUSE GAS EMISSIONS LIMIT

38550. By January 1, 2008, the state board shall, after one or more public workshops, with public notice, and an opportunity for all interested parties to comment, determine what the statewide greenhouse gas emissions level was in 1990, and approve in a public hearing, a statewide greenhouse gas emissions limit that is equivalent to that level, to be achieved by 2020. In order to ensure the most accurate determination feasible, the state board shall evaluate the best available scienti c, technological, and economic information on greenhouse gas emissions to determine the 1990 level of greenhouse gas emissions.

38551. (a) The statewide greenhouse gas emissions limit shall remain in effect unless otherwise amended or repealed.

(b) It is the intent of the Legislature that the statewide greenhouse gas emissions limit continue in existence and be used to maintain and continue reductions in emissions of greenhouse gases beyond 2020.

(c) The state board shall make recommendations to the Governor and the Legislature on how to continue reductions of greenhouse gas emissions beyond 2020.

PART 4. GREENHOUSE GAS EMISSIONS REDUCTIONS

38560. The state board shall adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources or categories of sources, subject to the criteria and schedules set forth in this part.

38560.5. (a) On or before June 30, 2007, the state board shall publish and make available to the public a list of discrete early action greenhouse gas emission reduction measures that can be implemented prior to the measures and limits adopted pursuant to Section 38562.

(b) On or before January 1, 2010, the state board shall adopt regulations to implement the measures identi ed on the list published pursuant to subdivision (a).

(c) The regulations adopted by the state board pursuant to this section shall achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from those sources or categories of

sources, in furtherance of achieving the statewide greenhouse gas emissions limit.

(d) The regulations adopted pursuant to this section shall be enforceable no later than January 1, 2010.

38561. (a) On or before January 1, 2009, the state board shall prepare and approve a scoping plan, as that term is understood by the state board, for achieving the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions from sources or categories of sources of greenhouse gases by 2020 under this division. The state board shall consult with all state agencies with jurisdiction over sources of greenhouse gases, including the Public Utilities Commission and the State Energy Resources Conservation and Development Commission, on all elements of its plan that pertain to energy related matters including, but not limited to, electrical generation, load based-standards or requirements, the provision of reliable and affordable electrical service, petroleum re ning, and statewide fuel supplies to ensure the greenhouse gas emissions reduction activities to be adopted and implemented by the state board are complementary, nonduplicative, and can be implemented in an ef cient and cost-effective manner.

(b) The plan shall identify and make recommendations on direct emission reduction measures, alternative compliance mechanisms, market-based compliance mechanisms, and potential monetary and nonmonetary incentives for sources and categories of sources that the state board nds are necessary or desirable to facilitate the achievement of the maximum feasible and cost-effective reductions of greenhouse gas emissions by 2020.

(c) In making the determinations required by subdivision (b), the state board shall consider all relevant information pertaining to greenhouse gas emissions reduction programs in other states, localities, and nations, including the northeastern states of the United States, Canada, and the European Union.

(d) The state board shall evaluate the total potential costs and total potential economic and noneconomic bene ts of the plan for reducing greenhouse gases to California's economy, environment, and public health, using the best available economic models, emission estimation techniques, and other scienti c methods.

(e) In developing its plan, the state board shall take into account the relative contribution of each source or source category to statewide greenhouse gas emissions, and the potential for adverse effects on small businesses, and shall recommend a de minimis threshold of greenhouse gas emissions below which emission reduction requirements will not apply.

(f) In developing its plan, the state board shall identify opportunities for emission reductions measures from all veri able and enforceable voluntary actions, including, but not limited to, carbon sequestration projects and best management practices.

(g) The state board shall conduct a series of public workshops to give interested parties an opportunity to comment on the plan. The state board shall conduct a portion of these workshops in regions of the state that have the most signi cant exposure to air pollutants, including, but not limited to, communities with minority populations, communities with low-income populations, or both.

(h) The state board shall update its plan for achieving the maximum technologically feasible and cost-effective reductions of greenhouse gas emissions at least once every ve years.

38562. (a) On or before January 1, 2011, the state board shall adopt greenhouse gas emission limits and emission reduction measures by regulation to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions in furtherance of achieving the statewide greenhouse gas emissions limit, to become operative beginning on January 1, 2012.

(b) In adopting regulations pursuant to this section and Part 5 (commencing with Section 38570), to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall do all of the following:

(1) Design the regulations, including distribution of emissions allowances where appropriate, in a manner that is equitable, seeks to minimize costs and maximize the total bene ts to California, and encourages early action to reduce greenhouse gas emissions.

(2) Ensure that activities undertaken to comply with the regulations do not disproportionately impact low-income communities.

(3) Ensure that entities that have voluntarily reduced their greenhouse gas emissions prior to the implementation of this section receive appropriate credit for early voluntary reductions.

(4) Ensure that activities undertaken pursuant to the regulations complement, and do not interfere with, efforts to achieve and maintain federal and state ambient air quality standards and to reduce toxic air contaminant emissions.

(5) Consider cost-effectiveness of these regulations.

(6) Consider overall societal bene ts, including reductions in other air pollutants, diversi cation of energy sources, and other bene ts to the economy, environment, and public health.

(7) Minimize the administrative burden of implementing and complying with these regulations.

(8) Minimize leakage.

(9) Consider the signi cance of the contribution of each source or category of sources to statewide emissions of greenhouse gases.

(c) In furtherance of achieving the statewide greenhouse gas emissions limit, by January 1, 2011, the state board may adopt a regulation that establishes a system of market-based declining annual aggregate emission limits for sources or categories of sources that emit greenhouse gas emissions, applicable from January 1, 2012, to December 31, 2020, inclusive, that the state board determines will achieve the maximum

technologically feasible and cost-effective reductions in greenhouse gas emissions, in the aggregate, from those sources or categories of sources.

(d) Any regulation adopted by the state board pursuant to this part or Part 5 (commencing with Section 38570) shall ensure all of the following:

(1) The greenhouse gas emission reductions achieved are real, permanent, quanti able, veri able, and enforceable by the state board.

(2) For regulations pursuant to Part 5 (commencing with Section 38570), the reduction is in addition to any greenhouse gas emission reduction otherwise required by law or regulation, and any other greenhouse gas emission reduction that otherwise would occur.

(3) If applicable, the greenhouse gas emission reduction occurs over the same time period and is equivalent in amount to any direct emission reduction required pursuant to this division.

(e) The state board shall rely upon the best available economic and scienti c information and its assessment of existing and projected technological capabilities when adopting the regulations required by this section.

(f) The state board shall consult with the Public Utilities Commission in the development of the regulations as they affect electricity and natural gas providers in order to minimize duplicative or inconsistent regulatory requirements.

(g) After January 1, 2011, the state board may revise regulations adopted pursuant to this section and adopt additional regulations to further the provisions of this division.

38563. Nothing in this division restricts the state board from adopting greenhouse gas emission limits or emission reduction measures prior to January 1, 2011, imposing those limits or measures prior to January 1, 2012, or providing early reduction credit where appropriate.

38564. The state board shall consult with other states, and the federal government, and other nations to identify the most effective strategies and methods to reduce greenhouse gases, manage greenhouse gas control programs, and to facilitate the development of integrated and cost-effective regional, national, and international greenhouse gas reduction programs.

38565. The state board shall ensure that the greenhouse gas emission reduction rules, regulations, programs, mechanisms, and incentives under its jurisdiction, where applicable and to the extent feasible, direct public and private investment toward the most disadvantaged communities in California and provide an opportunity for small businesses, schools, affordable housing associations, and other community institutions to participate in and bene t from statewide efforts to reduce greenhouse gas emissions.

PART 5. MARKET-BASED COMPLIANCE MECHANISMS

38570. (a) The state board may include in the regulations adopted pursuant to Section 38562 the use of market-based compliance mechanisms to comply with the regulations.

(b) Prior to the inclusion of any market-based compliance mechanism in the regulations, to the extent feasible and in furtherance of achieving the statewide greenhouse gas emissions limit, the state board shall do all of the following:

(1) Consider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution.

(2) Design any market-based compliance mechanism to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants.

(3) Maximize additional environmental and economic bene ts for California, as appropriate.

(c) The state board shall adopt regulations governing how market-based compliance mechanisms may be used by regulated entities subject to greenhouse gas emission limits and mandatory emission reporting requirements to achieve compliance with their greenhouse gas emissions limits.

38571. The state board shall adopt methodologies for the quanti cation of voluntary greenhouse gas emission reductions. The state board shall adopt regulations to verify and enforce any voluntary greenhouse gas emission reductions that are authorized by the state board for use to comply with greenhouse gas emission limits established by the state board. The adoption of methodologies is exempt from the rulemaking provisions of the Administrative Procedure Act (Chapter 3.5 (commencing with Section 11340) of Part 1 of Division 3 of Title 2 of the Government Code).

38574. Nothing in this part or Part 4 (commencing with Section 38560) confers any authority on the state board to alter any programs administered by other state agencies for the reduction of greenhouse gas emissions.

PART 6. ENFORCEMENT

38580. (a) The state board shall monitor compliance with and enforce any rule, regulation, order, emission limitation, emissions reduction measure, or market-based compliance mechanism adopted by the state board pursuant to this division.

(b) (1) Any violation of any rule, regulation, order, emission limitation, emissions reduction measure, or other measure adopted by the state board pursuant to this division may be enjoined pursuant to Section 41513, and the violation is subject to those penalties set forth in Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(2) Any violation of any rule, regulation, order, emission limitation, emissions reduction measure, or other measure adopted by the state board pursuant to this division shall be deemed to result in an emission of an air contaminant for the purposes of the penalty provisions of Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(3) The state board may develop a method to convert a violation of any rule, regulation, order, emission limitation, or other emissions reduction measure adopted by the state board pursuant to this division into the number of days in violation, where appropriate, for the purposes of the penalty provisions of Article 3 (commencing with Section 42400) of Chapter 4 of Part 4 of, and Chapter 1.5 (commencing with Section 43025) of Part 5 of, Division 26.

(c) Section 42407 and subdivision (i) of Section 42410 shall not apply to this part.

PART 7. MISCELLANEOUS PROVISIONS

38590. If the regulations adopted pursuant to Section 43018.5 do not remain in effect, the state board shall implement alternative regulations to control mobile sources of greenhouse gas emissions to achieve equivalent or greater reductions.

38591. (a) The state board, by July 1, 2007, shall convene an environmental justice advisory committee, of at least three members, to advise it in developing the scoping plan pursuant to Section 38561 and any other pertinent matter in implementing this division. The advisory committee shall be comprised of representatives from communities in the state with the most signi cant exposure to air pollution, including, but not limited to, communities with minority populations or low-income populations, or both.

(b) The state board shall appoint the advisory committee members from nominations received from environmental justice organizations and community groups.

(c) The state board shall provide reasonable per diem for attendance at advisory committee meetings by advisory committee members from nonpro t organizations.

(d) The state board shall appoint an Economic and Technology Advancement Advisory Committee to advise the state board on activities that will facilitate investment in and implementation of technological research and development opportunities, including, but not limited to, identifying new technologies, research, demonstration projects, funding opportunities, developing state, national, and international partnerships and technology transfer opportunities, and identifying and assessing research and advanced technology investment and incentive opportunities that will assist in the reduction of greenhouse gas emissions. The committee may also advise the state board on state, regional, national, and

international economic and technological developments related to greenhouse gas emission reductions.

38592. (a) All state agencies shall consider and implement strategies to reduce their greenhouse gas emissions.

(b) Nothing in this division shall relieve any person, entity, or public agency of compliance with other applicable federal, state, or local laws or regulations, including state air and water quality requirements, and other requirements for protecting public health or the environment.

38593. (a) Nothing in this division affects the authority of the Public Utilities Commission.

(b) Nothing in this division affects the obligation of an electrical corporation to provide customers with safe and reliable electric service.

38594. Nothing in this division shall limit or expand the existing authority of any district, as de ned in Section 39025.

38595. Nothing in this division shall preclude, prohibit, or restrict the construction of any new facility or the expansion of an existing facility subject to regulation under this division, if all applicable requirements are met and the facility is in compliance with regulations adopted pursuant to this division.

38596. The provisions of this division are severable. If any provision of this division or its application is held invalid, that invalidity shall not affect other provisions or applications that can be given effect without the invalid provision or application.

38597. The state board may adopt by regulation, after a public workshop, a schedule of fees to be paid by the sources of greenhouse gas emissions regulated pursuant to this division, consistent with Section 57001. The revenues collected pursuant to this section, shall be deposited into the Air Pollution Control Fund and are available upon appropriation, by the Legislature, for purposes of carrying out this division.

38598. (a) Nothing in this division shall limit the existing authority of a state entity to adopt and implement greenhouse gas emissions reduction measures.

(b) Nothing in this division shall relieve any state entity of its legal obligations to comply with existing law or regulation.

38599. (a) In the event of extraordinary circumstances, catastrophic events, or threat of signi cant economic harm, the Governor may adjust the applicable deadlines for individual regulations, or for the state in the aggregate, to the earliest feasible date after that deadline.

(b) The adjustment period may not exceed one year unless the Governor makes an additional adjustment pursuant to subdivision (a).

(c) Nothing in this section affects the powers and duties established in the California Emergency Services Act (Chapter 7 (commencing with Section 8550) of Division 1 of Title 2 of the Government Code).

(d) The Governor shall, within 10 days of invoking subdivision (a), provide written noti cation to the Legislature of the action undertaken.

SEC. 2 No reimbursement is required by this act pursuant to Section 6 of Article XIII B of the California Constitution because the only costs that

may be incurred by a local agency or school district will be incurred because this act creates a new crime or infraction, eliminates a crime or infraction, or changes the penalty for a crime or infraction, within the meaning of Section 17556 of the Government Code, or changes the de nition of a crime within the meaning of Section 6 of Article XIII B of the California Constitution.

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4. Stated Preference Benefit Transfer Approaches for Estimating Passive Use Value of Wild Salmon

John Loomis

1 SIMILARITY OF CHOICE MODELING AND CONTINGENT VALUATION METHODS FOR BENEFIT TRANSFER

As is well known both the contingent valuation method (CVM) and choice modelling (CM) are stated preference methods in that they ask individuals what they would do in a particular circumstance. Each method started from a different disciplinary tradition: CVM from natural resource economics and CM from marketing. More recently, the two methods are looking more and more indistinguishable. This is especially true of applications of choice methods for economic valuation as compared to marketing purposes. Specifically, while choice methods used to focus more on conjoint analysis using ratings or rankings, they are often now done using a discrete choice (select one alternative). Contingent valuation questioning format has also evolved from open-ended questions (what is the most you would pay), to a discrete choice format (would you pay $X, yes or no). Underlying the discrete choice CVM and CM is random utility theory (McFadden, 1974; Hanemann, 1984). The random utility theory relied upon by both CVM and CM partitions the utility an individual receives from some choice into deterministic (i.e. observable) and random (non-observable) components. Not only does discrete choice CVM and CM share the same utility theoretic foundation, but they share very similar empirical methods as well. Specifically, both approaches usually rely on some form of a logistic regression model to estimate the parameters from which benefit estimates are calculated.

In some respects, a series of dichotomous choice CVM questions asked to elicit WTP for various levels of a particular natural resource look very similar to the question format in CM. In Hoehn and Loomis

(1993) a series of dichotomous choice CVM questions were asked that allowed valuation of two different levels of wetlands protection, two different levels of waterfowl contamination control and an increase in the level of salmon protection. In the CM world, these would be three attributes, two with two levels and one with one level. In the CVM example, pooling these responses and including dummy variables for the levels of the attributes allows the researcher to calculate part-worths or marginal values for these attributes, similar to CM.

Loomis and duVair (1993) asked each respondent a series of dichotomous choice CVM questions about greater and greater reductions in risk. This allowed estimates of a willingness to pay (WTP) function with risk level as a variable. In this case, there was one attribute for which marginal values could be calculated. Cameron's (1988) reparameterisation of the logistic regression coefficients into marginal values or part-worths makes transparent that a series of dichotomous choice questions yields a WTP function quite comparable to that of CM. Just as in CM, in Cameron's reparamertisation the marginal values are calculated by dividing the attribute coefficient by the coefficient on cost. Specifically if the logistic regression is:

$$\log (Y/1\text{-}Y) = Bo - B1(\$Bid) + B2(A1) + B3(A2) + \ldots Bn(An) \qquad (4.1)$$

then the WTP equation is:

$$WTP = (Bo/B1) + [B2/B1](A1) + [B3/B1](A2) + \ldots [Bn/B1](An) \qquad (4.2)$$

Thus the part-worths or marginal WTP for one more unit of A1 is B2/B1 just like one would arrive at using CM. Thus if CVM is done using a series of questions with different quality levels, it can produce marginal values of attributes that can be used in benefit transfer like those from CM. It is only when CVM is used to value one program, that CVM becomes much more limited in its benefit transfer capability than CM.

With this demonstration of the similarity of the two methods in mind, we now turn to an example of using benefit transfer from CVM and CM for valuing passive use benefits of salmon in the Pacific Northwest. In this case study we are attempting to estimate a marginal value per salmon from the existing literature and apply it in a real world policy analysis on the Snake River in Washington. Some of the pitfalls of conducting such a benefit transfer are illustrated.

2 SETTING OF THE CASE STUDY AND NEED FOR THE PASSIVE USE VALUE ANALYSIS

Wild salmon populations are declining throughout the states of Idaho, Oregon and Washington, an area collectively known as the Pacific Northwest. This problem is particularly acute on the Columbia River and its largest tributary, the Snake River. This large river stretches from Idaho to Washington and had historically provided habitat for many different types of salmon. However, a series of four large hydroelectric dams built along the last 140 miles of the Snake River just up from its confluence with the Columbia River, essentially blocked off much of the Snake River in Idaho from migrating salmon. The four dams created 140 miles of nearly continuous slack reservoir water which makes downstream migration of young salmon very slow, delaying their migration to the ocean. While the dams have fish ladders, they are only partially effective at moving adult salmon upstream.

The cumulative influence of these dams resulted in the Snake River sockeye salmon being listed as endangered in 1991. Within a few years the chinook salmon and steelhead were listed as threatened under the Endangered Species Act (ESA). The National Marine Fisheries Service and US Army Corps of Engineers (the COE is the agency which operates the dams) are required by ESA to develop a plan to recover the species using any reasonable and prudent alternatives. Under the existing baseline situation (A1), the average annual return of wild salmon is 67 116 fish. One alternative (A4) is to remove the four large hydroelectric dams and restore a free-flowing river that would allow natural salmon migration. Another alternative (A2) is to maximise artificial transport of juvenile salmon around the dams through barging and trucking. Finally, another alternative (A3) is to make a series of minor system operating improvements at the dam to minimise young salmon intake in the turbines.

While all of these alternatives have costs in the millions of dollars, dam removal (A4) had an annualised direct costs and opportunity costs of foregone hydropower of over 300 million dollars. Unlike the few past dam removal efforts that focused on small or very old dams that had often outlived their usefulness, the four Lower Snake River dams are very large hydropower producers, and facilitated barge transportation from Washington into Idaho. In addition the dams are relatively new, being just 20-30 years old at the time when the analysis of dam removal was being studied. Yet dam removal was estimated by biologists to result in more than a 50 per cent increase in wild salmon and steelhead populations. However, being biologically the best, does not necessarily

translate into having positive net economic benefits, given the several hundred million dollar costs. The US Water Resources Council (1983) project evaluation guidelines require the Corps of Engineers to evaluate the net economic benefits of each alternative before selecting the preferred alternative.

3 IMPORTANCE OF PASSIVE USE VALUES IN ECONOMIC ANALYSIS OF ENDANGERED SPECIES

Dam removal will eliminate 140 miles of reservoir recreation and replace it with 140 miles of river recreation. Eventual recovery of the species and removal from the Endangered Species List will allow for improved salmon and steelhead fishing. But the economic justification for recovery of a threatened and endangered species probably does not hinge on future recreation use values which get heavily discounted at most interest rates. Rather, the economic justification probably hinges on the option, existence and bequest values that the general public has for wild salmon in the Snake River.

Avoiding extinction of endangered species is recognised as a source of existence or passive use values (Meyer, 1974; Randall and Stoll, 1983; Stoll and Johnson, 1984). Existence values are defined as the benefit received from simply knowing the resource exists even if no use is made of it. Free-flowing rivers were one of the first examples of such resources with existence values (Krutilla and Fisher, 1975). Essentially people who never plan to visit, raft, or fish these rivers may still pay something to have a free-flowing river. Wild stocks of Snake River sockeye and chinook salmon clearly fit into this picture. As noted by Olsen et al. (1991) in his existence value of salmon study 'Existence value as the value an individual (or society) places on the knowledge that a resource exists in a certain state is theoretically sound and can be measured for assessment within the resource decision making arena'. Passive use values are also public goods, in that these benefits can be simultaneously enjoyed by millions of people all across the region and the country (Loomis, 1996a).

Government agencies are increasingly including passive use values when evaluating actions that affect fisheries. Passive use values are often important, because many times the vast majority of the species affected by a project are non-game/non-sport species, or the population levels of the game species are so low that fishing is no longer allowed. However, due to limited time and budget, agencies often quantify passive use value through benefit transfer. For example, the US Environmental

Protection Agency, (2002) suggests that benefit transfer can be used to value threatened and endangered species when evaluating cooling water intake structures. The USDA Economic Research Service's economic analysis of salmon recovery efforts on the Snake River included estimates of passive use values drawn from the existing literature (Aillery et al., 1996). Nonetheless, passive use values have not been formally part of the COE's economic analysis. This may be due, in part, to the benefit-cost procedures which must be followed by the COE being originally written more than 20 years ago (US Water Resources Council, 1979), before measurement of passive use values had become common. These benefit-cost procedures are silent on measurement of passive use values, although they do allow for measurement of other categories of benefits as long as the procedures are documented and WTP is used. Passive use values are estimated using a method recommended by the US Water Resources Council for valuing recreation, but its use to measure passive use values has been controversial (Diamond and Hausman, 1996; McFadden, 1994). Nonetheless, using CVM to measure passive use values has been given a limited endorsement by a Blue-Ribbon panel chaired by two Nobel Laureate economists (Arrow et al., 1993).

In the Snake River case, the interagency Drawdown Economic Workgroup (DREW) guiding the COE economic analysis asked that passive use values be included in the benefit and cost summary in the economic analysis section of the Final Environmental Impact Statement. Therefore, passive use values were calculated to be included in that part of the overall economic analysis. DREW had originally requested an original passive use value survey, and such a survey was pre-tested. However, due to political pressure the COE decided passive use values for the Lower Snake River would be approximated based on existing passive use value estimates using a benefit transfer approach rather than a new survey as was originally proposed.

Before reviewing the specific studies on the economic value of salmon and free-flowing rivers, it is important to define benefit transfer. There are several closely related definitions of benefit transfer. A commonly referred to definition is provided by Boyle and Bergstrom (1992, p. 657) '..benefit transfer is defined as the transfer of existing estimates of nonmarket values to a new study [site] which is different from the study for which the values were originally estimated.'

4 EXISTING EMPIRICAL MEASUREMENTS OF PASSIVE USE VALUES FOR SALMON

A review of two large computerised economic databases (American Economic Association's EconLit and Environment Canada's recently developed Environmental Values Reference Inventory or EVRI) yielded four published studies, but only three of which presented original passive use values for salmon. These three are:

1. Olsen, Richards and Scott's 1991 article published in 'Rivers' on existence values for doubling the size of Columbia River Basin salmon and steelhead runs;
2. Loomis's 1996 article in 'Water Resources Research' on the economic benefits of increased salmon from removing the dams on the Elwha River in Washington state; and
3. Hanemann, Loomis and Kanninen's 1991 article published in 'American Journal of Agricultural Economics' on the benefits of increasing chinook salmon populations in the San Joaquin River in California.

An unpublished, stated CM discrete choice survey of Washington residents undertaken by Layton, Brown and Plummer (1999) was made available by the authors for this benefit transfer as well. To provide the reader with the salient details for the benefit transfer application, we summarise the studies below.

The Olsen et al. (1991) study involved a telephone interview of Pacific Northwest households, using an open-ended WTP question format. Their means of payment (i.e. payment vehicle) was an increase in the household electric bill. The change in salmon was a doubling from 2.5 million to 5 million salmon, for a net change of 2.5 million salmon. The response rate on the phone interviews was quite good at 72 per cent. The original study existence value is $26.52 per household amounting to $32.52 in 1996 dollars.

The Loomis (1996a) Elwha study used a mail questionnaire and a dichotomous choice WTP question format. An increase in federal taxes was the payment vehicle. The mail survey had a response rate of 68 per cent for Washington residents and 55 per cent for rest of US residents. Respondents were shown a bar chart in the survey indicating the increase in salmon population due to dam removal was approximately 300 000 fish. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars.

The Hanemann et al. (1991) study involved a combination phone contact, mail survey booklet and then phone interview of respondents

using the survey booklet. A dichotomous choice WTP question was used, with taxes as the means of payment. The resource was an increase from 100 chinook salmon to 15 000 chinook salmon for a net increase of 14 900 in the San Joaquin River in California. The combination phone-mail-phone survey had a 51 per cent response rate. The value per household was $181 in 1989 dollars or $222 in 1996 dollars.

The Layton, Brown and Plummer (1999) study was a CM survey that asked Washington residents to rate four different scenarios which involved five different stocks of fish species. These species included the species of relevance for the Snake River (Eastern Washington and Columbia River migratory fish) as well as freshwater species and Western Washington/Puget Sound freshwater, migratory and saltwater fish. This study was specifically designed to allow valuation of a wide variety of fish improvement scenarios in the state of Washington, similar to its application here to the Lower Snake River. Half the respondents received a survey that set a non-declining future fish population as the baseline future, and half received a baseline future that involved further declines if nothing is done. As expected, the stable or non-declining baseline results lower values per fish than the declining baseline, confirming the existence of diminishing marginal value of incremental gains in fish. Layton et al. (1999) found their estimated values per household were consistent with past passive use value studies of Loomis (1996a) and Olsen et al. (1991) using the non-declining future baseline. The use of the non-declining baseline is consistent with the interagency assumption of non-declining future salmon numbers, although other biologists using past trend data suggest continued future declines (Weber, 1999).

The survey by Layton et al. (1999) was conducted by mail and had a response rate of 68 per cent, which is quite good. The survey design included a budget reminder exercise which involved households having to determine how their household spending would change with a reduction in monthly income that was equal to the dollar amounts the households were asked to pay for the four different fish programs. Layton et al. (1999) analysed their data using a censored rank order logit model.

From the results of their statistical analysis, a value per household for a one million increase in Eastern Washington/Columbia River migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the percentage changes being evaluated in the COE Environmental Impact Statement (EIS) for the Lower Snake River. The resulting value is $119 per household annually for each additional one million salmon and steelhead.

5 BENEFIT TRANSFER APPROACHES AND ESTIMATES

Three approaches are used to transfer benefits from this existing literature to estimate the change in passive use value for salmon populations in the Lower Snake River: (a) point estimate transfer of a value per salmon per household from the most similar study is applied to the gain in salmon in the Lower Snake River; (b) value function transfer using the marginal value per fish from the stated CM study is applied to the gain in salmon in the Lower Snake River; (c) a mini-meta analysis regression function is estimated using the values per salmon, and this new value function is applied to the gain in salmon in the Lower Snake River.

While none of these approaches is perfect (which is why a Lower Snake River specific passive use value study was originally planned), each provides an indication of the likely range of the passive use values for increasing salmon populations. All of these approaches do a reasonable job of meeting the criteria for benefit transfer presented by Boyle and Bergstrom (1992). In particular, all of the original empirical studies used in the three approaches valued the same resource of interest in the Lower Snake River, namely, salmon. Three out of the four original empirical studies measure this value of salmon in the same state as the Lower Snake River (e.g. Washington). All the original studies, and all three of our benefit transfer approaches use the same valuation measure, e.g. WTP.

It should be noted that to the extent these existing studies do not perfectly match the policy setting on the Lower Snake River, the direction of error is in the conservative direction. That is, most of the source studies did not provide specific reference in their surveys to whether the salmon were listed as threatened or endangered species. The salmon in the Lower Snake River are listed as threatened and endangered. Had the surveys in the source studies been of threatened and endangered stocks, and this was pointed out to survey respondents, the resulting values per fish would have likely been higher. Thus, the existing value per salmon estimates are likely conservative measures of WTP to increase threatened and endangered stocks in the Lower Snake River. Second, most of the existing studies valued a larger increase than is being evaluated at the Lower Snake River. Given diminishing marginal existence values found in these studies and confirmed in other literature (Rollins and Lyke, 1998), the larger the increase in fish proposed in a survey, the smaller the marginal value per fish. Thus taking a marginal value per fish from a study that valued a large increment and applying it to a smaller increment on the Lower Snake River will underestimate the value of that smaller increment.

5.1 Value per Fish Estimate Transfer from the Elwha River CVM Study

Point estimate transfer is the simplest approach to calculate the passive use values for wild salmon in the Lower Snake River. The transfer can be performed by matching the change in wild salmon populations in the Lower Snake River alternatives A1 to A4 to an existing study which valued a similar size change in salmon, the Loomis (1996a) Elwha River study. The Washington residents' value was $73 per household in 1994 dollars or $76.48 in 1996 dollars for an increase in 300 000 salmon. However, to apply this to the rest of the Pacific Northwest so as to calculate total passive use value, two further adjustments need to be made to this point estimate transfer.

To adapt this Washington household value to what households in the rest of the Pacific Northwest and California would pay, it is possible to make a downward adjustment based on a past survey (Loomis, 1996a), which compared Washington residents' WTP for salmon on the Elwha River to what households in the rest of the US would pay for the same increase in salmon on the Elwha River. Specifically, Washington household WTP was $73 annually while the rest of US households would pay $68 annually (Loomis, 1996a, p. 445). Dividing the $68 by $73 yields a downward adjustment ratio of 0.93, meaning households outside of Washington would pay 93 per cent of what a Washington household would pay. This 0.93 is an average adjustment and actually overstates the downward adjustment since the rest of US households included those in the eastern US where the ratio was 0.75. See Loomis (1999b) for a graph of the distance-WTP function for salmon.

The second adjustment is to multiply the value per household by the number of non-angler (e.g. non-user) households in California, Idaho, Oregon, Washington, and western Montana (our expanded definition of the Pacific Northwest for this study). Given the public good nature of restoring salmon in the Snake River, the total passive use value in the study area is the sum of passive use values held by non-user households in these states. This Pacific Northwest market area is quite conservative as it assumes that users and households in the rest of the United States receive no passive use values from restoring Snake River salmon, an unlikely situation.

Applying the 0.93 adjustment factor to the Washington value of $76.48 yields a value to the rest of Pacific Northwest residents of $71.12 in 1996 dollars. To calculate the total passive use value in the Pacific Northwest, we multiplied per household values by the respective non-user populations. We utilised non-user households, defined as non-fishing households from the US Fish and Wildlife Service's National

Survey of Hunting, Fishing and Wildlife Associated Recreation. In Washington, the number of non-fishing households was 1.4 million while it was 11.1 million for the rest of the Pacific Northwest. Therefore, passive use value for an additional 300 000 salmon was $110.3 million for Washington non-anglers, while for the rest of the Pacific Northwest it was $789.5 million, for a total of $899.7 million. Dividing the $899.7 million by the 300 000 additional salmon posited in the Elwha River survey, yields a value of $2,999 per salmon.

Applying this value per salmon to the increase in number of salmon with dam removal (alternative A4 minus A1) yields an annualised gain in passive use value of about $48.8 million per year over the 50 year project analysis time period. This is a reasonable and conservative benefit transfer. It is conservative because the Lower Snake River salmon are threatened and endangered while the salmon returning to the Elwha were not listed species at the time the survey was written. Thus, while the definition of the public good is not exactly equivalent between Elwha River and the Lower Snake River, the direction of the error is to underestimate the passive use values for the Lower Snake River's threatened and endangered salmon. This is a reasonable benefit transfer because the proposed action to increase salmon is dam removal in both the original Elwha River case study and the Snake River policy case. Finally, the change in number of salmon with the Elwha (around 300 000) is the closest match of the change in salmon likely to result from dam removal on the Lower Snake River (around 37 000). While the change in salmon on the Elwha River is about eight times that expected on the Lower Snake River, this further reinforces the conservative nature of the passive use value per fish calculated from the Elwha due to diminishing marginal existence values.

5.2 Transfer of Layton, Brown and Plummer Columbia River Choice Modelling Estimates

Because Layton et al. (1999) used a CM approach that yields a marginal value per salmon, it is possible to apply their point estimate directly. From the results of their statistical analysis a value per household for a one million increase in Eastern Washington/Columbia river migratory fish (e.g. salmon and steelhead) was computed by the authors. This represents a 50 per cent increase in fish population, comparable to the relative change from A1 to A4. The resulting value is $119 per household annually for each additional one million salmon and steelhead. This is a larger absolute increment in fish than A1 to A4, and will result in a very conservative estimate of the passive use values per fish. The same adjustment described above in the Elwha River study

was used to adjust the Washington household values to estimate the rest of the Pacific Northwest values. For the Layton et al. (1999) study, marginal value per salmon was $1,400 per salmon for the entire Pacific Northwest and California non-user households. If one uses the declining future baseline salmon population, and the additional associated gain of 250 000 salmon, the value per salmon is $10,172 for the entire Pacific Northwest and California non-user households.

The Layton et al. (1999) study illustrates the strength of CM for benefit transfer as compared to the Elwha CVM study. In the Layton et al. (1999) study households were explicitly valuing the number of salmon as a separate and distinct attribute. In the Elwha study, the number of salmon was an attribute but it was part of the overall dam removal and river restoration program. In some sense, calculating the marginal value per salmon from the Elwha CVM could overstate the WTP per salmon, as it attributes the entire program value to salmon. To the extent that the other attributes such as a free-flowing river have value separate from the salmon, the Elwha CVM derived fish values may overstate their true part-worths. As noted in the introduction this is not an inherent limitation of CVM, but rather it is a feature of having just one CVM scenario or program being valued in the CVM survey. If several CVM scenarios with different numbers of salmon were being valued then, a separate part-worth for salmon from the CVM could be accurately estimated.

In the Snake River case study, the value per fish calculated from the Layton et al. (1999) study is then applied to number of wild salmon and steelhead that would return with each EIS alternative to estimate the passive use values associated with each alternative. Using Layton, et al.'s (1999) first scenario of an assumed stable future salmon population baseline, the annualised gain from A1 to A4 is $22.8 million over the 50 year time period of analysis.

5.3 Meta Analysis Regression Approach

Rather than relying on point estimate transfers which imply a constant marginal value per fish, one could utilise meta analysis to improve the benefit transfer in two dimensions by: (a) use of more than one study, and (b) allow the marginal value per salmon to vary with the absolute increase in the number of salmon that each EIS alternative produces. The meta approach involves the statistical estimation of a WTP function for salmon using incremental passive use values per salmon calculated from the four studies of West Coast residents' WTP for increasing salmon populations discussed above. We obtained one estimate of value from the Olsen et al. (1991), Hanemann et al. (1991), and Loomis (1996a)

studies, and two from Layton et al. (1999) due to use of declining versus non-declining baseline salmon populations.

In order to arrive at commensurate passive use values per salmon from the different studies, several steps were necessary. The first was to calculate a marginal value per salmon from each study. This is straightforward with CM as this value is simply the attribute value. For the available CVM studies only one program was valued. For each program, the WTP was divided by the change in the number of salmon from baseline (the no payment status quo) to the number of salmon if the program is implemented. Then study values were updated for inflation. This value per salmon per household was aggregated upwards to account for the pure public good nature of passive use values in the Pacific Northwest. That is, multiplying the value per household, per fish by the number of households valuing that increment. The geographic area being used for all the economic analyses was residents of California, Idaho, Oregon, Washington and western Montana. Performing these steps for the Olsen et al. (1991) study yields a marginal value per salmon of $153 for the 2.5 million salmon increase (in 1996 dollars). For the Hanemann et al. (1991) study, the marginal value per salmon in the Pacific Northwest and California of $175,256 for the 14 900 salmon increase. As previously stated, the Loomis Elwha River study had a value of $2,999 for a 300 000 salmon increase.

A double log model fit the data best. The regression equation is:

Natural Log of Marginal Passive Use Values /Salmon in 4 state region =

$$24.953 - 1.315426 \text{ (Natural Log \# of Salmon)} \qquad (4.3)$$

T-statistics: (12.21) (-8.214)

The regression has an explanatory power of 95.7 per cent and the number of salmon is significant at the one per cent level, even given the limited degrees of freedom (dof=4). The negative sign on natural log of salmon indicates that marginal value per salmon decreases as the salmon population increases. This is as would be expected with a declining marginal benefit curve. This equation is then applied to the number of salmon in each EIS alternative in each time period to calculate the benefit estimates shown in Table 4.1.

Table 4. 1 Change in annual passive use value of Pacific Northwest non-user households for salmon by EIS alternative (in millions)

Alternative	Avg annual wild return during 50 yrs	Adapting Layton et al CM	Meta regression	Adapting Elwha River CVM
Baseline (A1)	67 116	-	-	-
Improved Transport (A2)	67 286	$25.0	$4.02	$5.39
System Improvements (A3)	66 288	-$657.0	-$31.08	-$1.41
Dam Removal (A4)	104 000	$22.8	$301.50	$48.80

6 APPLICATION OF BENEFIT TRANSFER APPROACHES TO LOWER SNAKE RIVER ALTERNATIVES

Using the point estimates from the Elwha River study, the Washington CM and the meta analysis function, the change in annual total passive use values with different levels of wild salmon and wild steelhead recovery is calculated. Data on population size of wild chinook salmon and wild steelhead associated with each alternative over the time period of analysis was obtained from PATH analyses provided by Shannon Davis (Radtke, Davis and Johnson, 1999). Application of this function to wild salmon and steelhead populations in alternative A1 is treated as the baseline or future without. The change in annual passive use values is then calculated for each of the three alternatives for an increase in wild salmon and steelhead populations.

Dam removal and restoration of natural river conditions (Alternative A4), is estimated by biologists to yield a 55 per cent higher run of wild salmon and wild steelhead and produces a $301 million average annual increase in passive use values using the meta regression equation. Given the reduction in wild salmon and steelhead run sizes of A3 from the baseline (A1), there is a reduction in passive use values for A3 of $31 million annually. These changes in aggregate passive use values are conservative estimates as it assumes no passive use value for households in the rest of the US outside of the study area, despite evidence from past surveys that such households do receive passive use values from salmon recovery and dam removal in the Pacific Northwest (Loomis, 1996a,b). The results of these calculations are displayed in Table 4.1 for all three benefit transfer approaches.

7 COMPARISON OF PASSIVE USE VALUES TO PROJECT COSTS

Excluding passive use values, the Corps of Engineers (COE, 2002) indicated there were negative net benefits to dam removal of $266.7 million annually. The costs of dam removal were dominated by foregone hydropower production, which was not completely offset by the gain in river recreation, including fishing. That fact that commercial and recreational fishing values for a threatened species are likely to be a small part of the initial benefits of salmon restoration is not surprising. It will take many years to rebuild the depleted salmon stocks to the levels where they can be removed from the Endangered Species List. It will be several decades before initial catch levels will produce significant economic benefits. Given the effect of discounting, these meager use values cannot overcome the upfront cost of dam removal and foregone hydropower.

However, it seems somewhat paradoxical to economically evaluate recovery of threatened and endangered species solely on their use value. The importance of passive use values in this case are simply too great to overlook. Yet, passive use values are not always the trump card. Only the meta analysis benefit transfer estimate of $301 million annually is large enough to change the outcome of the benefit-cost analysis. Using the Elwha River point estimate or Layton et al. (1999) CM benefit transfer estimates, the dam removal still has negative net benefits.

However, given the large variance in estimated benefits from using benefit transfer and the very high stakes in the policy decision, an original passive use value study would probably be justified. With literally millions of dollars at stake every year, and billions in present value, even a $250,000 passive use value study that could determine whether it is economically efficient or not to remove the dams would pay its investment back in less than a month. Unfortunately, benefit transfer was used in this real policy case not because of lack of money or time, but lack of political will. The ability of just one senator from one of the four states to block the passive use value study due to the mere possibility it might show dam removal was economically feasible (an outcome this senator was publicly against), indicates the symbolic as well as empirical importance of passive use values.

8 CONCLUSION

It is clear that passive use or existence value is a relevant value for decision making involving threatened and endangered salmon at risk in the Lower Snake River. The challenge in this study was to approximate these values based on the existing literature. Four studies, three of which valued salmon in the Pacific Northwest, were applied in three different ways to estimate the passive use values of increases in salmon populations in the Lower Snake River. The incremental passive use values for the increase in anadromous fish due to the dam breaching is ranges from a high of $301 million for households in the Pacific Northwest and California to a low of $23 million with a middle estimate of $49 million.

From a methodological perspective, this chapter has illustrated how CVM and CM approaches can be used for benefits transfer. In the meta regression benefit transfer approach the marginal values per salmon estimates from CVM and CM studies were utilised to estimate a WTP function.

This chapter also discussed the situations where CVM and CM can yield conceptually similar marginal values, and when this is not the case. Specifically, if a series of CVM willingness to pay questions are asked for programs that have differing levels of attributes, then marginal values for these attributes can be calculated. The calculation is similar to CM where the attribute coefficient is divided by the cost coefficient to yield a marginal value. However, when CVM is used to value just one program, calculation of a marginal value per unit for one of the attributes may overstate its marginal value as the entire value of the program change may be reflected in that attribute value.

Improvements in CM and CVM for increasing the accuracy of benefit transfer include allowing for declining marginal values per unit of attributes as the level of the attributes increases. Currently most CM and CVM studies provide constant marginal values per unit, which is equivalent to assuming a horizontal marginal benefit curve. This may be locally correct, but for large changes such as those in the Lower Snake River dam removal, the application of a constant marginal value may overstate the total benefits of an increase in the resource. Layton (2001) has demonstrated two refinements in empirical estimation of discrete choice models to allow for diminishing marginal value per unit of attribute. This can also be accomplished in CVM using quadratic terms in the WTP equation. These are important refinements to enhance the use of CM and CVM in future benefit transfers.

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APPENDIX 8-7

Project 7: City of Guadalupe, Recycled Water Feasibility Study

This project does not require an appendix to this attachment.