BEFORE THE PUBLIC UTILITIES COMMISSION OF COLORADO

Docket No. 10M-245E

IN THE MATTER OF COMMISSION CONSIDERATION OF PUBLIC SERVICE COMPANY OF COLORADO PLAN IN COMPLIANCE WITH HOUSE BILL 10-1365, "CLEAN AIR – CLEAN JOBS ACT"

ANSWER TESTIMONY OF LELAND B. DECK

September 17, 2010

Q. Please state your name, occupation, and business address.

A. My name is Leland B. Deck. I am a Managing Economist with Stratus Consulting Inc. Stratus Consulting is based in Boulder, Colorado; I work out of the Stratus Consulting office in Washington, DC. My business address is 1920 L Street NW, Suite 420, Washington, DC 20036.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of Western Resource Advocates (WRA).

Q. Have you previously testified before this Commission?

A. Yes, I testified before the Commission in 2008 on behalf of WRA in support of Public Service Company of Colorado's (PSCO's) application to replace the Cameo and Arapahoe coal units with a natural gas combined cycle plan at Arapahoe.

Q. Please describe your experience as an air pollution benefits analyst.

A. For over 20 years I have worked in the field of health and economic analysis of air pollution control programs. My primary professional area of activity has been in the field of benefits analysis of air pollution control programs, including economic benefits analysis, benefit-cost analysis, and health risk assessment. Much of my work has directly involved analysis of the health effects, and the economic value of those health effects, of reducing emissions from power plants that contribute to elevated concentrations of ambient ozone and particulate matter (PM) air pollution. Since entering the field of analyzing the health benefits of improving air quality, I have conducted air pollution health and economics benefits analyses for the U.S. Environmental Protection Agency (EPA); the Southern Appalachian Mountains Initiative; the Lake Michigan Air Directors Consortium (LADCO); the environmental regulatory agencies of Maryland, California, and North Carolina; the South Coast (Los Angeles) Air Quality Management District; the United Nations Intergovernmental Panel on Climate Change (IPCC); the environmental and health ministries of Canada, Mexico, Chile, Argentina, Brazil, and Saudi Arabia; and not-for-profit environmental research organizations.

Further details are included in my resume, which is provided as Attachment A.

Q. What is the purpose of your testimony?

A. I am presenting estimates of some of the most important health effects that will be avoided by reducing sulfur dioxide (SO_2) and nitrogen oxides (NOx) emissions from certain PSCO fossil-fueled electricity generation power plants directly effected by the Clean Air-Clean Jobs Act (HB 1365). I have estimated the health benefits of the emission reductions proposed by

PSCO in their Emission Reduction Plan (ERP). I have also estimated the additional health benefits that would occur if the emissions scenario recommended by WRA were implemented instead of the scenario preferred by PSCO. For simplicity, I am presenting the health effects of the emissions in only three scenarios:

- The basecase scenario identified in the ERP (Benchmark 1)
- PSCO's preferred plan (Scenario 6.1E)
- The plan recommend by WRA (Scenario 6H-Revised), as described in the testimony of WRA witness David Schlissel.

I present two sets of benefits:

- The benefits of reducing emissions from Benchmark 1 to Scenario 6.1E
- The additional benefits from further reducing emissions from Scenario 6.1E to Scenario 6H-Revised.

My health benefits analysis is limited to the health effects associated with changes in ambient fine particulate matter ($PM_{2.5}$) that will result from reducing SO_2 and NOx emissions at the PSCO power plants. My analysis does not include the important health benefits related to reducing ambient ozone levels, and lowering emissions of mercury and other toxic chemicals released by fossil-fueled electricity generation. Due to these omitted benefit categories, the benefit estimates I present underestimate the total health benefits of reducing emissions from the PSCO power plants included in the ERP.

I present the health benefits of the emission reductions in two forms. First, I present estimates of the economic value of the reductions in the $PM_{2.5}$-related cases of a range of $PM_{2.5}$-related health effects. I then present estimates of the economic benefits for each year covered by the ERP (2010 through 2046), as well as value summaries of the annual stream of benefits in each scenario. In addition, I present estimates of the number of cases of 13 different health effects related to $PM_{2.5}$ exposure, ranging in severity from premature mortality to asthma attacks and work loss days.

Q. Could you please summarize your conclusions?

A. Certainly. The reduced number of health related impacts of PSCO's preferred plan 6.1E over a business as usual approach (Benchmark 1) can be summarized a follows:

- The health benefits from implementing Scenario 6.1E instead of the Benchmark 1 plan occur over a 36 year period (2011 through 246), and will result in health benefits with a net present value of $590 million. The annual benefits vary year to year as the emission reductions occur at different plants. The maximum single year benefits are $70 million, and most of the benefits occur by 2032.
- These health benefits of adopting Scenario 6.1E include over the 36 year period avoiding a total of 95 deaths, 92 cases of non-fatal heart attacks (infarctions) or chronic bronchitis, 61 hospital admissions, 700 asthma attacks, 31,000 days with symptoms such as respiratory infections, and 5,000 lost work days.

Moving from PSCO's preferred plan 6.1E to WRA recommended Portfolio 6H-Revised, will provide the following additional health benefits;

- Additional health benefits with a net present value of $74 million. The maximum single year benefits are $24 million, and most of these additional benefits occur by 2022.
- The additional health benefits include a total of avoiding 12 additional deaths, 12 cases of non-fatal heart attacks or chronic bronchitis, 8 hospital admissions, 100 asthma attacks, 4,000 days with symptoms such as respiratory infections, and 600 lost work days.

The combined total health effect benefits of going from the Benchmark 1 case to the WRA recommended Portfolio 6H-Revised are;

- Total health benefits with a net present value of $655 million.
- Total health benefits avoiding 107 additional deaths, 103 cases of non-fatal heart attacks or chronic bronchitis, 8 hospital admissions, 800 asthma attacks, 34,000 days with symptoms such as respiratory infections, and 5,600 lost work days.

Q. How have you estimated the economic benefits of reducing SO_2 and NOx emissions in the three scenarios?

A. My analysis is based on a method developed by the EPA to estimate the benefits of reducing NOx and SO_x emissions from electricity generating units (EGUs). A journal article (Fann et al., 2009) by three staff members of EPA's Office of Air Quality Planning and Standards presents estimates of the value of $PM_{2.5}$-related health effects from emissions from different combinations of source categories and chemical species.

The Fann et al. (2009) estimates were derived from a statistical analysis of hundreds of systematic runs of the Community Multiscale Air Quality (CMAQ) Modeling System, a state-of-

the-art $PM_{2.5}$ and ozone model widely used by EPA and state governments for regulatory air quality modeling purposes. The results in Fann et al. are presented in a particularly useful form – the benefits per ton of emissions from 12 different source and chemical combinations. Furthermore, Fann et al. present separate benefit per ton ($/ton) estimates for nine different metropolitan areas of the country, as well as the national averages for all emissions. One of the metropolitan areas is the Denver-Ft. Collins area, which in the Fann et al. paper includes eight Colorado counties (Adams, Arapahoe, Boulder, Denver, Douglas, Jefferson, Larimer, and Weld counties). My analysis draws on two of their results – the Denver-Ft. Collins $/ton benefit estimates of reducing SOx emissions from EGUs and $/ton benefits for reducing NOx emissions from EGUs.

In 2010, EPA updated the entire set of $/ton numbers in Fann et al. to reflect certain changes made in 2010 in EPA's current methods of quantifying and valuing premature adult mortality. EPA provides the current set of $/ton numbers on their website (see www.epa.gov/air/benmap/bpt.html). In my analysis I use these current $/ton values on the EPA website.

The current EPA estimate of the value of reducing a ton of SO_x from EGUs in the Denver-Ft. Collins area in 2015 is $7,300. The value of reducing a ton of NOx from EGUs in Denver-Ft. Collins is $3,600. Because the Denver-Ft. Collins $/ton values change relatively little over time (Fann et al. and the EPA website provide estimates for 2015, 2020, and 2030), for simplicity I use the 2015 values to value emissions in all years in my analysis.

Three of the existing HB 1365 generating facilities included in the ERP, Arapahoe, Cherokee, and Valmont, are within the eight-county Denver-Ft. Collins area used by Fann et al. (2009). The new generating capacity at Fort St. Vrain used in Scenario 6H-Revised is also in that area. The Pawnee facility is in Morgan County, which is adjacent to the eight-county metropolitan region. Hayden, the fifth existing generating facility in the ERP, is in Routt County in northwestern Colorado. In my analysis, I applied the Denver area $/ton benefit estimates to all the emission reductions. While applying the Denver $/ton estimates to EGUs outside of the original eight-county Denver-Ft. Collins area increases the uncertainty in the value of the benefits of reducing emissions from Pawnee and Hayden facilities, the only alternative available in Fann et al. is to use the national average $/ton estimates. The Denver EGU SO_x $/ton estimate is the lowest among the nine metropolitan areas in Fann et al., and is less than 8% of their national average EGU SO_x $/ton estimate. The Denver EGU NOx $/ton estimate is 21% of their national average. Using EPA's national average $/ton estimates for the Pawnee and Hayden emissions would lead to a substantial overestimate of the benefits of reducing emissions at the Pawnee and Hayden facilities.

In order to estimate the benefits of reducing emissions, I used the estimated annual SO_x and NOx emissions provided by PSCO from each unit at the Arapahoe, Cherokee, Hayden, Pawnee, and Valmont facilities, as well as the new generating capacity included in the scenarios I examined. The annual unit-specific emission estimates were obtained from spreadsheet files provided in PSCO's responses to discovery requests, including PSCO's Peabody 5-2 response (for Benchmark 1 and Scenario 6.1E), and the WRA 2-6 response (for Scenario 6H, used to develop Scenario 6H-Revised). The emission estimates were for all years from 2010 to 2046, inclusive.

Q. What are the estimated values of the emission reductions?

A. I first calculated estimates of the value of the annual $PM_{2.5}$-related health *damages* from the total SO_x and NOx emissions emitted in each of the three scenarios. I then use these damage estimates to calculate the value of the annual health *benefits* of reducing emissions from the levels in Benchmark 1 to the levels in Scenario 6.1E, and similarly the health benefits of further reducing emissions from Scenario 6.1E to Scenario 6H-Revised. The benefit results for the emission reductions are provided in Table 1.

1 **Table 1 Estimated value of health benefits**

Year	Health benefits from reducing emissions (millions of dollars)	
	From Benchmark 1 to 6.1E	From Scenario 6.1E to 6H-Revised
2010	$0	$0
2011	$9	$0
2012	$45	$0
2013	$45	-$6
2014	$66	-$6
2015	$40	-$6
2016	$30	$6
2017	-$5	$4
2018	$40	$24
2019	$45	$22
2020	$44	$24
2021	$46	$23
2022	$45	$24
2023	$70	$0
2024	$68	-$1
2025	$30	-$1
2026	$31	-$1
2027	$29	-$1
2028	$29	$0
2029	$30	-$1
2030	$28	-$1
2031	$22	$0
2032	$6	-$1
2033	~$0	~$0
2034	~$0	~$0
2035	~$0	~$0
2036	~$0	~$0
2037	~$0	~$0
2038	~$0	~$0
2039	~$0	~$0
2040	~$0	~$0
2041	~$0	~$0
2042	~$0	~$0
2043	~$0	~$0
2044	~$0	~$0
2045	~$0	~$0
2046	~$0	~$0

In addition to the estimated annual damages and benefits, I also calculated the net present values (NPVs) of each stream of annual damages and benefits. I calculated each NPV for the entire planning period from 2010 through 2046.

In calculating the NPVs, I used a 3% discount rate that reflects the social rate of time preference (SRTP). The SRTP is a different concept, and has a different value, than the private discount rate that PSCO uses to calculate the NPV of fixed and variable costs. A 3% SRTP is widely used in environmental policy analysis to reflect the willingness of the typical individual to trade off receiving a certain benefit immediately, and receiving the same benefit one year later.

The three estimated NPVs of the damages and benefits are presented in Table 2.

Table 2 Net present values of damages and benefits

	Health damages from total emissions in each scenario (millions of dollars, 3% SRTP)			Health benefits from reducing emissions (millions of dollars, 3% SRTP)	
Year	Benchmark 1	Scenario 6.1E	Scenario 6H-Revised	From Benchmark 1 to 6.1E	From Scenario 6.1E to 6H-Revised
NPV 2010–2046	$2,420	$1,830	$1,760	$590	$74

Q. How did you estimate the number of cases of health effects avoided by reducing emissions?

A. EPA's benefit/ton values were originally estimated by first calculating the number of health effects that would be avoided by reducing a ton of emissions in a given metropolitan area, and then estimating the value of those health effects. The SO_x and NOx $/ton estimates are derived from estimating the avoided cases for 13 different $PM_{2.5}$-related health effects. The 13 $PM_{2.5}$-related health effects include:

- Adult and Infant Premature Mortality
- Chronic Bronchitis
- Myocardial Infarction (i.e., "heart attack")
- Hospital Admissions for Chronic Obstructive Pulmonary Diseases
- Hospital Admissions for Pneumonia
- Hospital Admissions for Asthma
- Hospital Admissions for Cardiovascular Diseases
- Hospital Emergency Room Visits for Asthma
- Acute Bronchitis
- Upper Respiratory Symptoms
- Lower Respiratory Symptoms
- Aggravation of Existing Asthma (i.e., asthma "attack")
- Work Loss Days

Two pieces of information are necessary to estimate the number of cases of each $PM_{2.5}$-related health effect inherent in EPA's NOx and SO_x $/ton values. The first piece of information needed

is the value of each $PM_{2.5}$-related health effect. The second piece of information is the share of the total $PM_{2.5}$ benefits that comes from each health effect.

The value of a case of health effect (known as a "unit value") is a concept that is often misunderstood. Economists' preferred method to determining unit values is to first estimate a typical individual's value to reduce a small risk of experiencing a particular health effect. For example, EPA derives the value of avoiding premature mortality from their estimate that a typical person is willing to pay approximately $8 to reduce the risk of dying in the next year by one in one million. If an environmental policy will produce a one in one million risk reduction for one million people, then the policy will reduce one expected death in a population of one million. In this simple example, the population would be willing to pay a total of $8 million to avoid the risk of one expected death. Economists refer to this $8 million unit value as the "value of a statistical life," and use it as the unit value for premature mortality.

For many health effects, willingness to pay measures of the value of reducing risks are unavailable. As an alternative, the unit value for health effects such as hospital admissions are derived from national health care data on the average cost of health care for a case of each health effect. Another alternative is to use the value of lost wages, which is the basis of the unit value for a work loss day. The unit value for other health effects use a combination of these methods. For example, the unit value for a nonfatal myocardial infarction (i.e., heart attack) is the sum of the medical costs of treatment, the expected wages lost during the recovery period, and any possible permanent reduction in future wages due to diminished productivity during the rest of the individual's working career.

The unit values used in EPA's $/ton numbers are presented in Table 3. The unit values are measured using 2006 prices.

Table 3 Health effect unit values

Health effect	Unit value
Infant Mortality	$8,700,000
Adult Premature Mortality	$8,000,000
Chronic Bronchitis	$500,000
Acute Myocardial Infarction	$100,000
Hospital Admissions, Cardiovascular	$28,000
Hospital Admissions, Respiratory	$14,000
Emergency Room Visits, Respiratory	$370
Work Loss Days	$120
Acute Bronchitis	$73
Acute Respiratory Symptoms	$59
Asthma Exacerbation	$53
Upper Respiratory Symptoms	$29
Lower Respiratory Symptoms	$18

In estimating the share of the total value that comes from each health effect, I also use information from other air pollution analyses. In all EPA benefit analyses of reductions in $PM_{2.5}$, by far the largest portion of the total benefits is from adult premature mortality. This single health effect typically accounts for over 95% of the total $PM_{2.5}$ health benefits. Chronic bronchitis and heart attacks each account for approximately 1% to 2%, and the remaining morbidity effects make up the rest. These shares of the total vary little from one analysis to the next if the same health effect relationships and unit values are used.

For this analysis, I derived specific information on the share of $PM_{2.5}$ benefits coming from each health effect from EPA's 2009 benefits analysis for the recent EPA proposal to revise the ozone National Ambient Air Quality Standard (NAAQS). EPA's 2009 ozone NAAQS benefits analysis

is an appropriate choice for information about the shares of total benefits for use in my analysis because the updated $/ton values currently on EPA's website are based on the same health-effect relationships and unit values used in the 2009 ozone NAAQS analysis. The specific shares are presented in Table 4.

Table 4 Share of total benefits for each health effect

Health effect	% share of total benefits
Infant Mortality	0.2%
Adult Mortality	96.9%
Chronic Bronchitis	1.6%
Acute Myocardial Infarction	0.9%
Hospital Admissions, Cardiovascular	0.1%
Hospital Admissions, Respiratory	< 0.1%
Emergency Room Visits, Respiratory	< 0.1%
Work Loss Days	0.1%
Acute Bronchitis	< 0.1%
Acute Respiratory Symptoms	0.2%
Asthma Exacerbation	< 0.1%
Upper Respiratory Symptoms	< 0.1%
Lower Respiratory Symptoms	< 0.1%

Q. What are the estimated reductions in the cases of health effects?

A. Using the methods I described, I estimated the number of cases of health effects in two ways. First, I calculated the number of cases associated with the emissions in each of the three alternative scenarios I examined (Benchmark 1, Scenario 6.1E, and Scenario 6H-Revised). These estimated cases are the annual health damages from the emissions in three scenarios. I then calculated the benefits, measured as reductions in the number of cases, from reducing emissions from Benchmark 1 to Scenario 6.1E, and then from further reducing emissions from Scenario 6.1E to Scenario 6H-Revised.

In order to simplify the presentation of the estimated number of cases, I reduced the presentation of the results from 13 individual health categories to six categories of health effects by combining:

- Adult and infant mortality into a single category
- The cases of chronic bronchitis and nonfatal myocardial infarctions into one category
- The three types of hospital visits (cardiovascular and respiratory hospital admissions, and emergency room visits for asthma) into one category
- Combining four types of symptom days (acute bronchitis and the three categories of respiratory symptoms) into one category.

The remaining two health effects (work loss days and asthma attacks) are also presented.

Tables 5 through 7 present the health damages from emissions in each of the three scenarios. Table 8 presents the benefits of reducing emissions between the Benchmark 1 and Scenario 6.1E, and Table 9 presents the benefits of reducing emissions between Scenario 6.1E and Scenario 6H-Revised.

Table 5 Health damages from emissions in Benchmark 1

Year	Adult and infant mortality	Chronic bronchitis and infarctions	Hospital admissions and Emergency Room visits	Symptom days	Asthma "attacks"	Work loss days
2010	33	32	21	10,600	240	1,730
2011	34	33	22	10,900	240	1,770
2012	32	31	20	10,300	230	1,680
2013	30	29	19	9,600	220	1,560
2014	31	30	20	9,900	220	1,610
2015	16	16	10	5,300	120	860
2016	14	13	9	4,400	100	710
2017	9	9	6	3,000	70	500
2018	12	12	8	3,900	90	630
2019	12	12	8	3,900	90	640
2020	13	12	8	4,100	90	660
2021	13	12	8	4,100	90	660
2022	13	12	8	4,100	90	670
2023	13	12	8	4,100	90	660
2024	13	12	8	4,100	90	660
2025	8	8	5	2,600	60	420
2026	8	8	5	2,500	60	410
2027	8	8	5	2,600	60	420
2028	8	8	5	2,500	60	410
2029	8	7	5	2,500	60	400
2030	8	7	5	2,500	60	400
2031	6	6	4	2,000	40	320
2032	4	4	2	1,200	30	200
2033	3	3	2	1,100	20	170
2034	3	3	2	1,000	20	160
2035	3	3	2	900	20	150
2036	3	3	2	1,000	20	160
2037	2	2	2	800	20	120
2038	2	2	1	700	20	110
2039	2	2	1	700	20	120
2040	2	2	1	700	20	110
2041	2	2	1	600	10	90
2042	< 1	< 1	< 1	49	1	8
2043	< 1	< 1	< 1	49	1	8
2044	< 1	< 1	< 1	49	1	8
2045	< 1	< 1	< 1	50	1	8
2046	< 1	< 1	< 1	49	1	8
Total	368	355	234	118,000	2,700	19,200

Table 6 Health damages of emissions in Scenario 6.1E

Year	Adult and infant mortality	Chronic bronchitis and infarctions	Hospital admissions and Emergency Room visits	Symptom days	Asthma "attacks"	Work loss days
2010	33	32	21	10,600	240	1,730
2011	33	32	21	10,500	240	1,710
2012	27	26	17	8,600	190	1,390
2013	24	24	16	7,900	180	1,280
2014	23	22	15	7,400	170	1,200
2015	12	11	7	3,700	80	600
2016	10	10	6	3,200	70	520
2017	10	10	6	3,200	70	530
2018	7	7	5	2,300	50	380
2019	7	6	4	2,200	50	350
2020	7	7	5	2,400	50	380
2021	7	7	5	2,300	50	370
2022	7	7	5	2,400	50	390
2023	4	4	3	1,300	30	220
2024	4	4	3	1,400	30	230
2025	4	4	3	1,400	30	230
2026	4	4	3	1,300	30	220
2027	4	4	3	1,400	30	230
2028	4	4	3	1,400	30	230
2029	4	4	3	1,300	30	210
2030	4	4	3	1,400	30	220
2031	3	3	2	1,100	20	180
2032	3	3	2	1,000	20	160
2033	3	3	2	1,100	20	180
2034	3	3	2	1,000	20	170
2035	3	3	2	1,000	20	160
2036	3	3	2	1,000	20	160
2037	2	2	2	800	20	130
2038	2	2	1	700	20	110
2039	2	2	2	800	20	130
2040	2	2	1	700	20	120
2041	2	2	1	600	10	90
2042	< 1	< 1	< 1	52	1	8
2043	< 1	< 1	< 1	51	1	8
2044	< 1	< 1	< 1	51	1	8
2045	< 1	< 1	< 1	53	1	9
2046	< 1	< 1	< 1	52	1	8
Total	273	263	174	88,000	2,000	14,300

Table 7 Health damages of emissions in Scenario 6H-Revised

Year	Adult and infant mortality	Chronic bronchitis and infarctions	Hospital admissions and Emergency Room visits	Symptom days	Asthma "attacks"	Work loss days
2010	33	32	21	10,600	240	1,730
2011	33	32	21	10,500	240	1,710
2012	27	26	17	8,600	190	1,390
2013	25	24	16	8,100	180	1,310
2014	24	23	15	7,600	170	1,240
2015	12	12	8	3,900	90	640
2016	9	9	6	3,000	70	490
2017	10	9	6	3,100	70	500
2018	4	4	3	1,400	30	230
2019	4	4	3	1,300	30	210
2020	4	4	3	1,400	30	230
2021	4	4	3	1,400	30	230
2022	4	4	3	1,400	30	230
2023	4	4	3	1,300	30	220
2024	5	4	3	1,400	30	240
2025	5	4	3	1,500	30	240
2026	4	4	3	1,400	30	220
2027	4	4	3	1,400	30	230
2028	4	4	3	1,400	30	230
2029	4	4	3	1,300	30	220
2030	4	4	3	1,400	30	230
2031	3	3	2	1,100	20	180
2032	3	3	2	1,000	20	170
2033	3	3	2	1,100	30	180
2034	3	3	2	1,000	20	170
2035	3	3	2	1,000	20	160
2036	3	3	2	1,000	20	170
2037	2	2	2	800	20	130
2038	2	2	1	700	20	110
2039	2	2	2	800	20	130
2040	2	2	1	700	20	120
2041	2	2	1	600	10	100
2042	< 1	< 1	< 1	70	2	11
2043	< 1	< 1	< 1	69	2	11
2044	< 1	< 1	< 1	70	2	11
2045	< 1	< 1	< 1	73	2	12
2046	< 1	< 1	< 1	70	2	11
Total	261	252	166	84,000	1,900	13,600

Note: sums may not total due to rounding

Table 8 Health benefits of reducing emissions from Benchmark 1 to Scenario 6.1E

Year	Adult and infant mortality	Chronic bronchitis and infarctions	Hospital admissions and Emergency Room visits	Symptom days	Asthma "attacks"	Work loss days
2010	0	0	0	0	0	0
2011	1	1	1	300	10	60
2012	5	5	3	1,800	40	290
2013	5	5	3	1,700	40	280
2014	8	8	5	2,500	60	410
2015	5	5	3	1,600	40	250
2016	4	3	2	1,200	30	190
2017	-1	-1	0	-200	0	-30
2018	5	5	3	1,600	40	260
2019	5	5	3	1,800	40	290
2020	5	5	3	1,700	40	280
2021	6	5	4	1,800	40	290
2022	5	5	3	1,700	40	280
2023	8	8	5	2,700	60	440
2024	8	8	5	2,600	60	430
2025	4	3	2	1,200	30	190
2026	4	4	2	1,200	30	190
2027	4	3	2	1,100	30	180
2028	4	3	2	1,100	30	180
2029	4	3	2	1,200	30	190
2030	3	3	2	1,100	20	180
2031	3	3	2	900	20	140
2032	1	1	< 1	200	10	40
2033	< 1	< 1	< 1	-27	-1	-4
2034	< 1	< 1	< 1	-26	-1	-4
2035	< 1	< 1	< 1	-32	-1	-5
2036	< 1	< 1	< 1	-39	-1	-6
2037	< 1	< 1	< 1	-28	-1	-5
2038	< 1	< 1	< 1	-25	-1	-4
2039	< 1	< 1	< 1	-35	-1	-6
2040	< 1	< 1	< 1	-27	-1	-4
2041	< 1	< 1	< 1	-17	0	-3
2042	< 1	< 1	< 1	-2	0	0
2043	< 1	< 1	< 1	-2	0	0
2044	< 1	< 1	< 1	-2	0	0
2045	< 1	< 1	< 1	-3	0	0
2046	< 1	< 1	< 1	-2	0	0
Total	95	92	61	31,000	700	5,000

Note: sums may not total due to rounding

Table 9 Health benefits of reducing emissions from Scenario 6.1E to Scenario 6H-Revised

Year	Adult and infant mortality	Chronic bronchitis and infarctions	Hospital admissions and Emergency Room visits	Symptom days	Asthma "attacks"	Work loss days
2010	0	0	0	0	0	0
2011	0	0	0	0	0	0
2012	0	0	0	0	0	0
2013	-1	-1	0	-200	-10	-40
2014	-1	-1	0	-200	-10	-40
2015	-1	-1	0	-200	-10	-40
2016	1	1	0	200	0	40
2017	0	0	0	200	0	30
2018	3	3	2	900	20	150
2019	3	3	2	900	20	140
2020	3	3	2	900	20	150
2021	3	3	2	900	20	140
2022	3	3	2	900	20	150
2023	~0	~0	~0	~0	~0	~0
2024	~0	~0	~0	~0	~0	~0
2025	~0	~0	~0	~0	~0	~0
2026	~0	~0	~0	~0	~0	~0
2027	~0	~0	~0	~0	~0	~0
2028	~0	~0	~0	~0	~0	~0
2029	~0	~0	~0	~0	~0	~0
2030	~0	~0	~0	~0	~0	~0
2031	~0	~0	~0	~0	~0	~0
2032	~0	~0	~0	~0	~0	~0
2033	~0	~0	~0	~0	~0	~0
2034	~0	~0	~0	~0	~0	~0
2035	~0	~0	~0	~0	~0	~0
2036	~0	~0	~0	~0	~0	~0
2037	~0	~0	~0	~0	~0	~0
2038	~0	~0	~0	~0	~0	~0
2039	~0	~0	~0	~0	~0	~0
2040	~0	~0	~0	~0	~0	~0
2041	~0	~0	~0	~0	~0	~0
2042	~0	~0	~0	~0	~0	~0
2043	~0	~0	~0	~0	~0	~0
2044	~0	~0	~0	~0	~0	~0
2045	~0	~0	~0	~0	~0	~0
2046	~0	~0	~0	~0	~0	~0
Total	12	12	8	4,000	100	600

Note: sums may not total due to rounding

Q. What materials have you reviewed to form your opinions and reach your conclusions?

A. The specific materials I have reviewed include:

- The PSCO *Clean Air-Clean Jobs Act Emissions Reduction Plan*, August 13, 2010 and the associated PSCO documents in Docket 10M-245E filed with the Plan.
- The responses by PSCO to the discovery requests of the various parties in this matter, especially discovery responses Peabody 5-2 and WRA 6-2.
- Fann, N., C.M. Fulcher, and B.J. Hubbell, "The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution," *Air Quality, Atmosphere and Health* 2009 Sep;2(3):169–176.
- "PM2.5 Benefit Per Ton Estimates," available at http://www.epa.gov/air/benmap/bpt.html, accessed September 2, 2010.
- U.S. EPA, 2010, "Summary of the updated Regulatory Impact Analysis (RIA) for the Reconsideration of the 2008 Ozone National Ambient Air Quality Standard (NAAQS)," available at http://www.epa.gov/ttn/ecas/regdata/RIAs/s1-supplemental_analysis_full.pdf, accessed September 2, 2010.

Q. Does this conclude your testimony?

A. Yes.

Attachment A

RESUME

Leland B. Deck, Ph.D.

Areas of Qualification

Environmental economics, human risk assessment, benefit-cost analysis, cost-effectiveness analysis, economic incentives, program analysis

Employment History

- Managing Economist, Stratus Consulting Inc., Washington, DC, 2006-present
- Abt Associates Fellow, Vice President, and Manager, Environmental Economics Practice, Abt Associates Inc., Bethesda, MD, 1992-2005
- Senior Economist, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC, 1987-1992
- Research Assistant, Maryland Bureau of Business and Economic Research, College Park, MD, 1984-1987
- Economics Intern, Maryland Department of Natural Resources Power Plant Siting Program, 1981-1982
- Instructor and Teaching Assistant, University of Maryland Department of Economics, 1979-1984

Education

- University of Maryland, College Park, Maryland. PhD, Economics, 1987
- University of Maryland, College Park, Maryland. MA, Economics, 1980
- Rensselaer Polytechnic Institute, Troy, New York. BS, Geology, 1975

Professional Experience

Dr. Deck is an internationally recognized expert in benefit-cost analysis and risk assessment of air pollution policies. Much of his work involves assessing the benefits, in medical, physical, and economic terms, of improving air quality. He is also an expert in the design and implementation of effective economic incentive programs for controlling air pollution. As Principal Investigator for multiple contracts with the U.S. Environmental Protection Agency (EPA), Dr. Deck conducted the detailed economic benefits analyses for a wide variety of air regulations, as well as helping EPA develop technical guidance on air pollution economic incentive programs and conducting economic analysis at EPA. In addition to EPA, he has prepared air pollution analyses for a wide range of other organizations, including the Intergovernmental Panel on Climate Change, the California Air Resources Board, the Federal Highway Administration, the Southern

Appalachian Mountain Initiative, the National Renewable Energy Laboratory, the Clean Air Task Force, the Environmental Integrity Project, and the national environmental ministries of Canada, Chile, Argentina, Saudi Arabia and Brazil.

Dr. Deck is presently a managing economist with Stratus Consulting. For 12 years, Dr. Deck was with the environmental research area of Abt Associates, where he managed the environmental economics practice. Previously, Dr. Deck was a senior economist with EPA, where he was awarded a Gold Medal for Exceptional Service for his economic analysis in a landmark settlement to improve air quality in the Grand Canyon National Park by controlling emissions from a nearby power plant.

Dr. Deck's experience includes the following:

Testimony in Support of Retiring Two Colorado Coal Fired Power Plants. Expert Report and testimony on behalf of Western Resource Advocates, on the health benefits associated with emission reductions from retiring units at the Arapahoe and Cameo power plants. Testimony supported a petition by Excel Energy, Inc. before the Colorado Public Utilities Commission (PUC Docket No O7A-447E) to retire units at the two power plants. 2008.

Expert Witness, North Carolina vs Tennessee Valley Authority. On behalf of the State of North Carolina, Dr. Deck prepared an expert report, "Economic Benefits Analysis of the Health Effects from Controlling Emissions from TVA Coal-Fired Power Plants" in a lawsuit brought by North Carolina in the US District Court, Western District of North Carolina. He testified at the trial in 2008.

The Potential Impact of Climate Change on Human Health Due to Changes in Ozone and Particulate Matter Air Quality (2007). For a project for the National Center for Energy Policy, Dr. Deck estimated the increased health effects that would result from the impact of modeled climate change impacts on ambient ozone and particulate matter levels in the United States.

South Coast (Los Angeles) 2007 Air Quality Management Plan (AQMP). Dr. Deck conducted the human health benefits analysis for the 2007 AQMP. This health and economic benefits analysis estimated the health effects from improving ozone and fine particulate matter concentrations throughout the greater Los Angeles metropolitan area. The analysis estimated the annual reduced incidence of air pollution-related health effects ranging from premature mortality to school absences, and the economic value of those benefits, for 2009 through 2023.

Lake Michigan Air Directors Consortium (LADCO) Benefit-Cost Analysis of Electricity Generating Unit Emission Reductions. Project Director for *Benefit Study of MRPO Candidate Control Options for Electricity Generation* (2006), which estimated the health and economic benefits of reducing power plant emissions in a five-state region. The study examined the net

benefits of proposed regional control programs operating simultaneously with the federal Clean Air Interstate Transport Rule (CAIR) emissions trading program.

BenMAP. Dr. Deck directed the development of BenMAP (the Environmental Benefits and Mapping Analysis Program, previously known as CAPMS) for EPA. Now in use throughout the world, BenMAP is a Windows©-based analytical software to estimate the health and economic benefits from changes in ambient air quality, including the incidence and value of avoiding a wide range of health effects, from work loss days to hospital admissions to premature mortality. BenMAP includes detailed spatial analysis and uncertainty/variability capabilities, providing careful analysis of environmental justice issues and the range of scientifically credible results. BenMAP was peer reviewed by EPA's Science Advisory Board and the National Academy of Sciences, and is publicly released and supported by EPA.

EPA Regulatory Analysis. Dr. Deck led the economic and health benefits analysis for the promulgation of a wide variety of EPA air regulations. These extensive analyses included regulations of power plants, mobile sources, the ozone and PM National Ambient Air Quality Standards, and ozone depleting substance emissions.

Legislative Analysis of Proposals to Control Power Plant Emissions. Dr. Deck conducted the economic and health benefits analysis for proposed Clean Air Act Amendments to reduce emissions from electricity generating stations. He prepared EPA's benefit analysis of the Bush Administration's proposed Clear Skies Initiative (2001) and the proposed Clear Skies Act (2003). He also prepared analyses of the major alternatives, including the Waxman (2001), Moynihan (2001), Carper (2003), and Jeffords (2003) bills.

Comprehensive Benefit-Cost Analysis of the Clean Air Act. Dr. Deck prepared the economic and health benefits analysis for EPA's comprehensive "Section 812" Reports to Congress on the benefits and costs of the Clean Air Act. The Section 812 Reports to Congress are widely cited as the most comprehensive, scientifically valid, and reliable benefit cost analyses of a major federal environmental program conducted.

Ancillary Benefits of Climate Change Programs. Dr. Deck was a leader in developing the analysis of the improvements in conventional air pollution that will occur if climate change emission policies are adopted. He has conducted analysis both in the United States and worldwide of the ancillary or "co-control" near-term health effects of ambient air quality improvements resulting from policies to reduce carbon emissions.

Expert Witness Report, U.S. Department of Justice. New Source Review enforcement case (Baldwin Power Plant, IL).

Peer Reviewer, Institute of Medicine. Peer reviewer for *Valuing Health for Regulatory Cost-Effectiveness Analysis*, Institute of Medicine of the National Academies (2006).

Emissions Trading Programs. Dr. Deck was EPA's Work Group Leader for the Economic Incentive Program Rules (1994), and directed the development of EPA's technical guidance "Improving Air Quality With Economic Incentives" (2001).

Risk Assessment. Dr. Deck directed the risk assessment for the 1997 and 2005 revisions to the particulate matter National Ambient Air Quality Standards.

Selected Papers, Publications, Testimony and Presentations

"Sensitivity of Air Pollution-Induced Premature Mortality to Precursor Emissions under the Influence of Climate Change" May 2010. *International Journal of Environmental Research and Public Health* (with Tagaris, E., Liao, K.-J., DeLucia, A.J., Amar, P., and Russell, A.G.).

" Potential impact of climate change on air pollution-related human health effects" July 2009, *Environmental Science and Technology* (with Tagaris, E., Liao, K.-J., DeLucia, A.J., Amar, P., and Russell, A.G.).

"Health Benefit Assessment Methods for the 2007 AQMP Socioeconomic Assessment." Prepared for South Coast Air Quality Management District. 2008.

"Supplemental Answer Testimony" and "Cross Answer Testimony". Petition for Waiver of Competitive Procurement Rules to Replace Cameo and Arapahoe Coal Units Public Service With a Natural Gas Combined Cycle Plan". Prepared for the Public Service Corporation of Colorado on behalf of the Western Resource Advocates. 2008.

"The Potential Impact of Climate Change on Human Health Due to Changes in Ozone and Particulate Matter Air Quality." Prepared for National Center on Energy Policy. 2007.

"Economic Benefits Analysis of the Health Effects from Controlling Emissions from Tennessee Valley Authority Coal-Fired Power Plants." Expert Report prepared for North Carolina Department of Justice, regarding State of North Carolina ex rel. Roy Cooper, Attorney General v. Tennessee Valley Authority, Civil Action NO. 1:06CV20 (Western District of North Carolina). 2006.

"Benefit Study of MRPO Candidate Control Options for Electricity Generation." Prepared for the Lake Michigan Air Directors Consortium. 2006.

"A Response to Comments Made in Sanhueza et al. (2003)" October 2004, *Journal of the Air and Waste Management Association* (with E. Post, D. McCubbin, A. Hallberg, K. Davidson, and B. Hubbell).

"Power Plant Emissions: Particulate Matter-Related Health Damages and the Benefits of Alternative Emission Reduction Scenarios." Prepared for the Clean Air Task Force. 2004.

"Preliminary Nonroad Landbased Diesel Engine Rule: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results." Prepared for the U.S. Environmental Protection Agency. 2003.

"Sense of Place and Stewardship: Focus Group Report" and "The Value of Visibility Improvements in the Southern Appalachian Mountains Region." Prepared for the Southern Appalachian Mountains Initiative. 2002.

"Particulate-Related Health Impacts of Eight Electric Utility Systems." Prepared for the Rockefeller Family Fund. 2002.

"An Assessment of the Health Risk Reductions Associated with Attainment of Alternative Particulate Matter Standards in Two U.S. Cities." October 2001. *Risk Analysis* (with E. Post, E. Smith, M. Wiener, K. Cunningham, and H. Richmond).

"An Application of an Empirical Bayes Estimation Technique to the Estimation of Mortality Related to Short-Term Exposure to Particulate Matter." October 2001. *Risk Analysis* (with E. Post and K. Larntz).

"The Particulate-Related Health Benefits of Reducing Power Plant Emissions." Prepared for the Clean Air Task Force. 2000.

Final Heavy Duty Engine/Diesel Fuel Rule: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results." Prepared for the U.S. Environmental Protection Agency. 2000.

"The 2018 [Visibility] Milestone Benefits Assessment: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results." Prepared for the U.S. Environmental Protection Agency. 2000.

"Climate Change and Ancillary Health and Environmental Impacts." Keynote address to the Climate Change Economic Analysis Forum, Assessment and Integration of Health and Environmental Impacts Workshop. Prepared for Environment Canada and the Canadian Energy Research Institute, Toronto, Canada. 2000.

"Co-control Benefits of Domestic Greenhouse Gas Control Policies." Presented at the Intergovernmental Panel on Climate Change's "Workshop on Assessing the Ancillary Benefits and Costs of Greenhouse Gas Mitigation Strategies," Washington, DC. 2000.

"Out of Sight: The Science and Economics of Visibility Impairment." Prepared for the Clean Air Task Force. 2000.

Final Tier II Rule: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results. Prepared for the U.S. Environmental Protection Agency. EPA 420-R-99-032. December 1999.

The Benefits and Costs of the Clean Air Act; 1990 to 2010. U.S. Environmental Protection Agency. EPA 410-R-99-001. 1999.

"Adverse Health Effects Associated with Ozone In the Eastern United States." Prepared for the Clean Air Task Force. 1999.

"Final Section 126 Rule: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results" Prepared for the U.S. Environmental Protection Agency. 1999.

"Tier II Proposed Rule: Air Quality Estimation, Selected Health and Welfare Benefits Methods, and Benefit Analysis Results." Prepared for the U.S. Environmental Protection Agency. 1999.

"Air Quality Estimation for the NOx SIP Call RIA," "Selected Health and Welfare Benefits Methods for the NOx SIP Call RIA," "Benefit Analysis Results of Selected Health and Welfare Endpoints for the NOx SIP Call RIA." Prepared for the U.S. Environmental Protection Agency. 1998.

"Baselines in EPA Economic Analyses." Prepared for the U.S. Environmental Protection Agency. 1998.

"Short-term improvements in public health and global-climate policies on fossil-fuel combustion." *The Lancet*, 1997 (by the Working Group on Public Health and Fossil Fuel Combustion).

The Benefits and Costs of the Clean Air Act; 1970 to 1990. U.S. Environmental Protection Agency. EPA 410-R-97-002. 1997.

"Summary of Public Comments on Proposed Revisions to the Ozone National Ambient Air Quality Standards; EPA Docket # A-95-58, Section IV-D." Prepared for the U.S. Environmental Protection Agency. 1997.

"Summary of Public Comments on Proposed Revisions to the Particulate Matter National Ambient Air Quality Standards; EPA Docket # A-95-54, Section IV-D." Prepared for the U.S. Environmental Protection Agency. 1997.

"Visibility at the Grand Canyon and the Navajo Generating Station." In *Economic Analyses at EPA; Assessing Regulatory Impact*, edited by Richard D. Morgenstern. Resources for the Future. 1997.

"Discounting in Environmental Policy Evaluation." April 1997. Prepared for the EPA Economic Consistency Workgroup (with F.L. Arnold and F.G. Sussman).

"An Approach to Assessing Health Risks from Particulate Matter in Two Cities." Presented at The Society for Risk Assessment Annual Meeting. December 1996.

"An Analysis of the Monetized Benefits Associated with National Attainment of Alternative Particulate Matter Standards in the Year 2007." Prepared for U.S. Environmental Protection Agency. July 1996.

"A Particulate Matter Risk Assessment for Philadelphia and Los Angeles." Prepared for U.S. Environmental Protection Agency. July 1996.

"§812 Retrospective Analysis: Quantifying Health and Welfare Benefits." Prepared for U.S. Environmental Protection Agency. May 1996.

Discussant, "Issues Concerning Tax, Fee and Subsidy-Based Programs," Air and Waste Management Association International Conference on Economic Incentives for Environmental Management. 1993.

"Benefits Transfer: How Good is Good Enough?," in *Benefits Transfer Procedures, Problems, And Research Needs*, U.S. Environmental Protection Agency (EPA 230-R-93-018) (with L.G. Chestnut). 1993.

"The Estimation of Consumer References for Attributes: A Comparison of Hedonic and Discrete Choice Approaches," *The Review of Economics and Statistics*, 1992 (with M.L. Cropper, N. Kishor, and K.E. McConnell).

"Economic Incentive Program Rules: Background and Issues," Public Information Document, Clean Air Act Section 182(g)(4). U.S. Environmental Protection Agency. 1991.

"Valuing Eastern Visibility: A Field Test of the Contingent Valuation Method," EPA Cooperative Agreement #CR-815183-01-3, 1991 (with G. McClelland, W. Schulze, D. Waldman, J. Irwin, D. Schenk, T. Stewart, and M. Thayer).

"Update of the U.S. Environmental Protection Agency's (EPA's) Visibility Protection Program," Presented at the Air and Waste Management Association Annual Meeting. 1991 (with D.S. Scott and A.G. Jacobs).

"Regulatory Impact Analysis of a Revision of the Federal Implementation Plan for the State of Arizona to Include SO_2 Controls for the Navajo Generating Station." 1990.

"Valuing Visibility: A Field Test of the Contingent Valuation Method [Denver Brown Cloud]," EPA Cooperative Agreement #CR-812054. 1990 (with J. Irwin, W. Schulze, G. McClelland, D. Waldman, D. Schenk, T. Stewart, P. Slovic, S. Lictenstein, and M. Thayer).

"Controlling Wintertime Visibility Impacts at the Grand Canyon National Park: Preliminary Benefit Cost Analysis," *Visibility and Fine Particles: Transactions of the Air and Waste Management Association International Specialty Conference*. 1989 (with R.D. Rowe and L.G. Chestnut).

"On the Choice of Functional Form for Hedonic Price Functions," *The Review of Economics and Statistics.* 1988 (with M.L. Cropper and K.E. McConnell).

"Should the Rosen Model Be Used to Value Environmental Amenities? Further Evidence," *Proceedings, Second Annual Conference on the Economics of Chesapeake Bay Management*. 1986 (with M.L. Cropper, K.E. McConnell, and T.T. Phipps).

"Should the Rosen Model Be Used to Value Environmental Amenities," presented at The American Economic Association Annual Meetings. 1985 (with M.L. Cropper, K.E. McConnell, and T.T. Phipps).

Expert Witness Testimony

"Economic Benefits Analysis of the Health Effects from Controlling Emissions from Tennessee Valley Authority Coal-Fired Power Plants." Expert Reports and testimony on behalf of the North Carolina Department of Justice, regarding State of North Carolina ex rel. Roy Cooper, Attorney General v. Tennessee Valley Authority, Civil Action NO. 1:06CV20 (Federal Court Western District of North Carolina). 2008.

"Supplemental Answer Testimony in Support of Retiring Two Colorado Coal Fired Power Plants." Expert Report and testimony on behalf of Western Resource Advocates, in support of a petition by Excel Energy, Inc. before the Colorado Public Utilities Commission to retire the Arapahoe and Cameo power plants. 2008.

"Monetary Impacts of Health Effects Resulting from Baldwin Power Plant Emissions." Expert Witness Report for the U.S. Department of Justice in U.S. v. Illinois Power Company & Dynegy Midwest Generation. 2002. Expert Witness Report.

Honors and Awards

Abt Associates Inc.

- Abt Associates Fellow. 2002. The Abt Associates Fellows are a group of senior Abt Associates researchers charged with assessing and enhancing the quality of Abt Associates' work. Selected for their substantial intellectual contributions to Abt Associates projects and demonstrated commitment to quality, the Fellows are instrumental in building the skills and expertise of other Abt Associates researchers and consultants.

- First Annual Daniel Bell Social Science Research Award for the outstanding research project at Abt Associates. 1997. Cited for the Particulate Matter Risk and National Economic Benefits Analysis projects for the U.S. Environmental Protection Agency.

U.S. Environmental Protection Agency

- Gold Medal for Exceptional Service
- Special Act Award
- Superior Performance Award (4 years)
- On-The-Spot Award (Three).

Professional Affiliations

- American Economic Association
- Association of Environmental and Resource Economics
- Air and Waste Management Association
- Society for Risk Assessment.

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF COLORADO

DOCKET NO. 10M-245E

IN THE MATTER OF COMMISSION CONSIDERATION OF PUBLIC SERVICE COMPANY OF COLORADO PLAN IN COMPLIANCE WITH HOUSE BILL 10-1365, "CLEAN AIR – CLEAN JOBS ACT"

AFFIDAVIT OF LELAND B. DECK

COMES NOW Leland B. Deck, of proper age and duly sworn, and states that the attached Testimony in the above-captioned matter was prepared by his or under his supervision and control and that it is true and correct to the best of his knowledge and belief, and would be the same if given orally under oath.

Leland B Deck

STATE OF District of Columbia)
) ss.
COUNTY OF _____)

PATRICIA M. DENNIS
NOTARY PUBLIC DISTRICT OF COLUMBIA
My Commission Expires September 14, 2011

SUBSCRIBED AND SWORN to before me this 14th day of September 2010.
Witness my hand and official seal.

My commission expires: September 14, 2011

Patricia M. Dennis
Notary Public

District of Columbia: SS
Subscribed and sworn to before me, in my presence,
this 14th day of September, 2010
Patricia M. Dennis
Notary Public, D.C.
My commission expires September 14, 2011