CHAPTER 3

BENEFITS AND COSTS

Introduction

Benefits

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Summary

INTRODUCTION

Public policies are often examined relative to their overall costs and benefits. Such an examination provides a general view of the net economic impact of the policy. Applying that approach to the AQMP requires the full quantification of costs and benefits in dollars. Equipment and materials which are required to implement control measures are purchased and sold in markets, and their prices can thus be used to measure the costs of control measures. However, there is no direct way to measure benefits of clean air because clean air is not a commodity purchased or sold in a market. Placing a monetary value on reduced incidence of illness or loss of life is also difficult and more subjective than determining control equipment costs. This often results in incomplete assessments of benefits, thereby leading to the underestimation of benefits.

BENEFITS

Despite the uncertainty of assigning dollar figures to benefits it is apparent that clean air will result in significant benefits to the four-county region. Partial assessments can be made for the impact of better air quality on crop yields, visibility, materials, morbidity, and mortality. The full assessment of air quality benefits in dollars terms is, however, not possible until advances occur in the epidemiological and economic disciplines that will allow monetary estimates to be made for currently unquantifiable areas.

Quantified Benefits

It is well-documented that smog can result in short-term and chronic illness. Figure 3-1 illustrates this point. Numerous studies have demonstrated an association between illness and ambient air pollutants (Chestnut and Keefe, 1996b). Based on these studies and projected air quality data, the quantifiable health benefits of achieving the federal clean air standards have been estimated at about $904 million in 2010. This estimate is based on the quantification of only 11 percent of the identified potential health impact areas (Figure 3-2). Thus, it is a very conservative estimate.

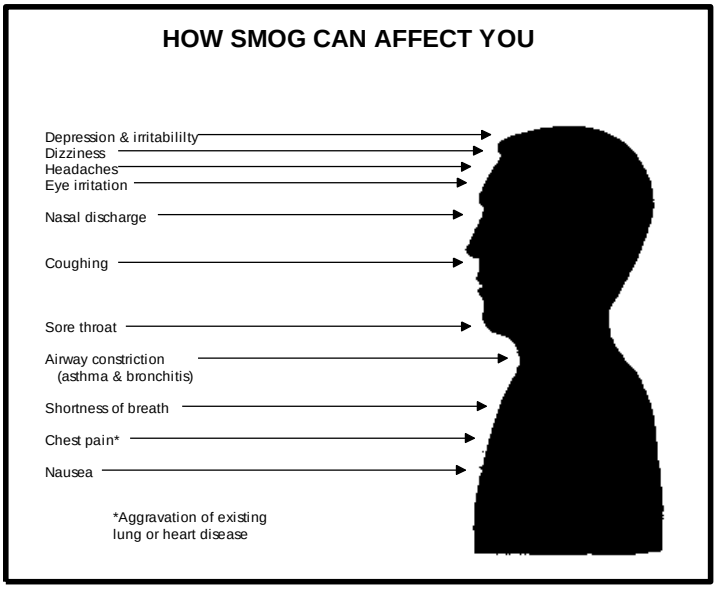

FIGURE 3-1

Smog Effects

The total average annual quantifiable benefits associated with implementing the draft 1997 AQMP are $1.692 billion between 1997 and 2010. The $1.692 billion figure represents the currently quantifiable benefit of moving beyond today's regulations to the level needed to meet federal standards. A breakdown of these benefits is shown in Table 3-1. The benefit ranges from $33 million for reduced damage to crops to $626 million for reduced morbidity and mortality.

TABLE 3-1

Quantifiable Benefits of Draft 1997 AQMP
(millions of 1993 dollars)

Benefit	Average Annual (1997-2010)
Reduction in Morbidity	$79
Reduction in Mortality	547
Increased Crop Yields	33
Visibility Improvement	473
Reduced Materials Expenditures	156
Congestion Relief	404
Total	$1,692

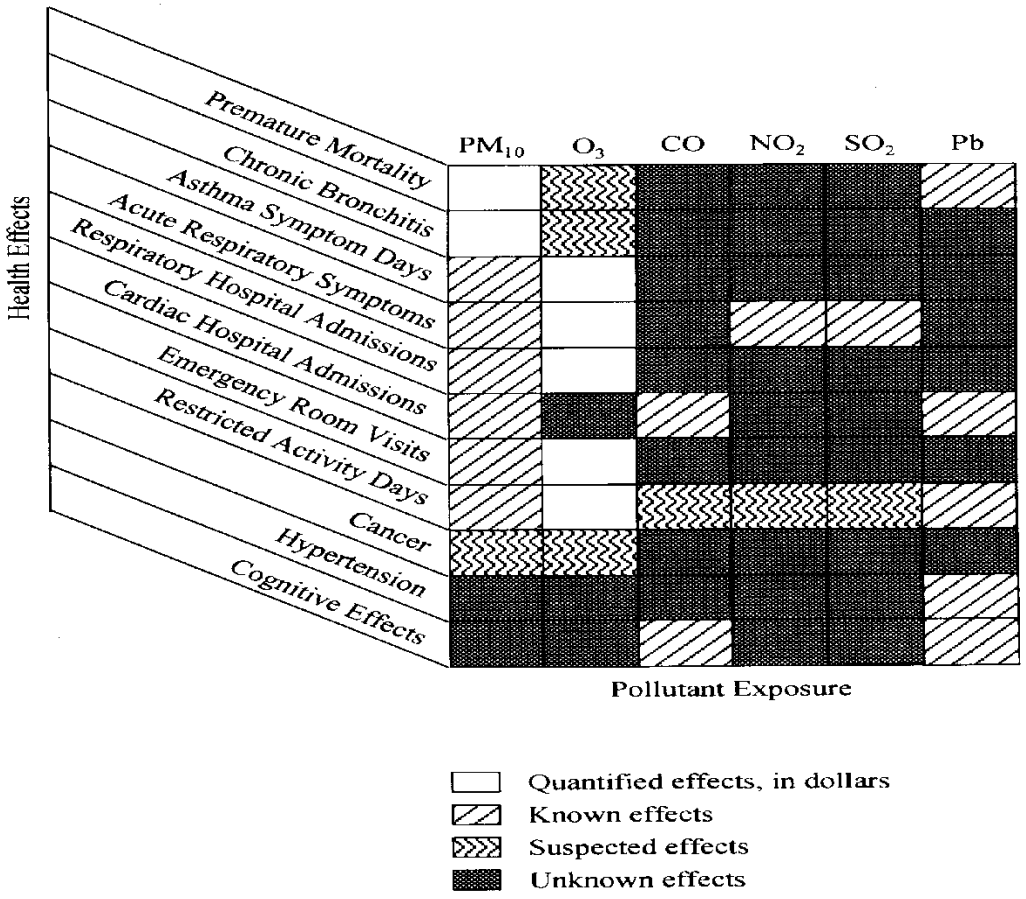

FIGURE 3-2

Health Effects of Criteria Pollutants

Health Benefit

The majority of the region's population is exposed to unhealthful air. Ozone can permanently scar lung tissue, cause respiratory irritation and discomfort and can make breathing more difficult during exercise. Children, the elderly, and persons who exercise heavily incur a higher rate of health effects. PM10 may cause effects as extreme as premature death as well as increased respiratory infection, asthma attacks, and other related effects. Groups that are most sensitive to the effects of PM10 are probably children, the elderly, and people with certain respiratory and heart diseases.

Table 3-2 shows the health benefit of improved air quality associated with the draft 1997 AQMP for ozone morbidity and PM10 morbidity and mortality relative to air quality without the draft Plan. The total health benefit of achieving the federal air quality standards for ozone and PM10 is projected to reach $904 million in 2010. On average, the annual benefit from 1997 to 2010 is approximately $626 million. If the mortality benefit for the improvements in PM10 between the federal and state standards as a result of implementing the 1997 AQMP is also accounted for, the

total mortality benefit will be approximately $4.5 billion annually, on average. Please refer to page A-4 of Appendix A for a description of the methodology used to quantify the health benefit. For future AQMP revisions, staff will analyze health benefits to the level of the state air quality standards to the degree feasible.

TABLE 3-2

Quantifiable Health Benefits
(millions of 1993 dollars)

Category	2000	2010	Average Annual (1997-2010)
Ozone Morbidity	$6	$78	$34
PM10 Morbidity	53	63	45
PM10 Mortality	608	763	547
Total	$667	$904	$626

Agricultural Benefit

Among the crops where ozone damage can be quantitatively assessed, melons, beans, and grapes are the most sensitive to ozone. Compliance with the federal ozone standard in the year 2010 is projected to increase the yields of 17 crops by $51.7 million annually, when compared with the air quality in 2010 without additional controls in place. The value of increased yields for the year 2000 is projected to be $25.1 million. Table 3-3 further disaggregates the value of annual increased yields by county.

TABLE 3-3

Cash Value of Increased Crop Yields
(millions of 1993 dollars)

County	2000	2010	Average Annual (1997-2010)
Los Angeles	$0.2	$0.3	$0.2
Orange	1.2	2.4	1.5
Riverside	16.4	42.0	24.7
San Bernardino	7.3	7.0	6.3
Total	$25.1	$51.7	$32.7

Visibility Aesthetic Benefit

According to the PM10 modeling analysis for the draft 1997 AQMP, the region is projected to reach compliance with the state visibility standard in 2010. Using the public's willingness to pay for visibility improvements as estimated through housing prices (Trijonis et al., 1985) and adjusted to reflect visibility aesthetics only (Loehman et al., 1994), improved visibility due to the draft 1997 AQMP amounts to about $109 million in 2000 and nearly $1.1 billion in 2010. The average annual visibility aesthetic benefit between 1997 and 2010 is projected to be $473 million. Table 3-4 shows the visibility aesthetic benefit by county.

TABLE 3-4

Visibility Aesthetic Benefit by County
(millions of 1993 dollars)

County	2000	2010	Average Annual (1997-2010)
Los Angeles	$76	$579	$265
Orange	22	270	117
Riverside	4	116	48
San Bernardino	7	99	43
Total	$109	$1,065	$473

Material Benefit

Quantifiable ozone and PM10 damages to residential and commercial materials include accelerated wear and breakdown of painted wood and stucco, and rubber products such as tires. In addition, PM10 exposure will lead to additional cleaning costs of residential and commercial properties.

Compliance with the federal ozone and PM10 standards in the year 2010 is expected to decrease costs for repainting, cleaning and replacing residential and commercial materials and surfaces by $254 million, when compared with the air quality in 2010 without additional controls in place. Table 3-5 shows material benefits by county for selected years.

TABLE 3-5

Material Benefit by County
(millions of 1993 dollars)

County	2000	2010	Average Annual (1997-2010)
Los Angeles	$77	$171	$103
Orange20	37	23	
Riverside	12	25	15
San Bernardino	11	22	14
Total	$120	$254	$155

Traffic Congestion Relief and Other Related Benefit

Compared with the 2010 baseline projections for daily vehicle miles, implementation of on-road control measures will reduce daily vehicle miles traveled (VMT) by 22.2 million miles, based on the 1994 travel survey (CTS/SCAG, 1994). Reductions in VMT can be translated into potential savings in vehicle operating costs. Table 3-6 shows the reduced vehicle operating costs for different types of vehicles in 2010. Of the over $1 billion saved in expenditures on vehicle operation and maintenance, 80 percent is related to passenger vehicles. The annual average reduced vehicle-related expenditures amount to $404 million from 1997 to 2010. Please see p. 3-8 for the benefit of reductions in vehicle hours traveled (VHT).

TABLE 3-6

Reduced Vehicle Operating and Maintenance Costs
by Type of Vehicle
(millions of 1993 dollars)

Type of Vehicle	2010	Average Annual (1997-2010)
Passenger	$827	$325
Medium-Duty Trucks	68	27
Heavy-Duty Trucks	133	52
Total	$1,028	$404

Unquantified Benefits

Areas in which benefits from improved air quality have been identified but not fully quantified include human health, building materials, plant life and livestock, and reductions in vehicle hours traveled. Each of these areas is discussed below.

Health Benefit

The quantifiable health benefits associated with improved air quality are assessed relative to reduced morbidity and mortality from ozone and PM10. The present state of knowledge does not allow all adverse health effects that have been identified to be measured and valued in dollars. Only 11 percent of the potential health impact areas (7 cubes out of 66 in Figure 3-2) can be quantified at this time. The contribution of ozone to premature death and to chronic bronchitis are two important impacts that are suspected, but have not been translated into dollar benefits.

It should be noted that many health effects cannot be valued in dollars because, for example, sufficient data are not available with which to establish a quantitative relationship between pollutant level and health effect. For some pollutants, projections of future air quality have not been made in sufficient detail to allow quantification of their health impacts. This is the case for the six health effects shown as "known effects" in Figure 3-2, which are effects of PM10, measured in daily concentrations. The daily PM10 UAM/LC (Urban Airshed Model with Linear Chemistry) model simulations have not been completely evaluated at this time to quantify these daily PM10-related health effects. The draft 1997 AQMP's daily PM10 projections are based on the peak 24-hour value of a year. Therefore, there is insufficient information on the 24-hour PM10 concentration for each day in future years to quantify the health effects. Consequently, an estimate of these unquantified health benefits is made using annual average PM10 concentration projections. This portion of the unquantified health benefit in 2010 is estimated at between $204 and $321 million. The annual average benefit over the 1997-2010 period is estimated at between $148 and $234 million. A significant portion of the full monetary benefit of improved health from better air quality remains unquantified, as can be seen by the remaining cubes in Figure 3-2.

Agricultural Benefit

There are several categories of crops where the effects of ozone have not been determined (e.g., dates, nectarines, peaches, walnuts, and plums). Based on studies conducted at the Los Angeles Arboretum, half of the plants tested showed visible improvements resulting from reduced ozone levels. In the four-county area, the nursery stock industry represented $367 million in wholesale sales in 1995. However, data limitations do not allow quantitative assessments from improved air quality for these plants.

In addition, air contaminants can also damage livestock, just as they do human beings. In 1995, the total value of livestock and livestock products in the four-county area amounted to $146 million and $776 million, respectively.

Material Benefit

In addition to the quantifiable materials damage caused by ozone and PM10, a link exists between ozone, sulfur dioxide, PM10, and nitrogen oxides and ferrous metal corrosion; erosion of cement, marble, brick, tile, and glass; and the fading of fabric and coated surfaces. The damages and conversely the potential benefits from reducing the exposure cannot currently be quantified and valued in dollars.

Traffic Congestion Relief and Other Related Benefits

Implementation of on-road control measures is projected to reduce daily VHT by 607,000 hours in 2010, as compared with the 2010 baseline projections for VHT. Savings resulting from reduced travel time are difficult to quantify due to the relative uncertainty of the value of time. However, lost time from congestion may translate into lost earnings. Based on a minimum hourly wage rate of $5.15, savings from reduced travel time are estimated at $1.1 billion in 2010.

COSTS

The cost of attaining clean air in the four-county area includes expenditures on control equipment, low-polluting materials, and infrastructure investments. To quantify these costs, the two-step methodology described in Chapter 1 was applied. The majority of these costs are estimated based on currently available technology. Advancements in technology could lower these costs, especially those associated with long-term measures.

Quantifiable Measures

The average annual control cost of the quantifiable control measures is projected to be $1.63 billion from 1997 to 2010. Table 3-7 shows the distribution of control costs for these measures among various industries. The share of these control costs relative to industry output is also presented in Table 3-7. Among all of the sectors, the construction (SICs 15-17) and retail trade (SICs 52-57, 59) sectors could incur relatively higher costs which amount to $82 million and $56 million, respectively. The control costs are less than one percent or of each industry's output for all the affected sectors except for the tobacco (SIC 21) sector. This is because a few measures affect almost all the industries in the Basin and the tobacco industry is relatively small compared to other industries in the Basin. As a result, the share of small costs in this industry’s overall production becomes relatively high.

The $962 million in control costs indicated for consumers mainly results from increased taxes to finance a number of construction and transit projects (TCM-01) and increases in vehicle registration fees from accelerate the retirement of old vehicles (M-01). Control measure TCM-01 is a part of the Regional Transportation Improvement Plan (RTIP) and is principally being proposed for mobility purposes.

TABLE 3-7

Average Annual Control Cost by Industry and
as a Percentage of Industry Output (1997-2010)

Industry (SIC)	Costs (millions of 1993 $)	Percent of Output
Lumber (24)	$13.64	0.50%
Furniture (25)	22.68	0.53%
Stone, Clay, etc. (32)	3.28	0.09%
Primary Metals (33)	3.31	0.11%
Fabricated Metal (34)	10.56	0.09%
Non-electric Machinery (35)	8.83	0.03%
Elect. Equipment (36)	8.84	0.05%
Motor Veh. (371)	2.40	0.06%
Rest of Transp. Equip. (372-379)	14.04	0.06%
Instruments (38)	9.83	0.04%
Misc. Manuf. (39)	2.89	0.09%
Food (20)	5.50	0.02%
Tobacco Manuf. (21)	0.72	4.22%
Textiles (22)	1.39	0.07%
Apparel (23)	8.89	0.09%
Paper (26)	2.30	0.03%
Printing (27)	7.47	0.06%
Chemicals (28)	3.46	0.03%
Petroleum Products (29)	2.03	0.05%
Rubber (30)	5.86	0.06%
Leather (31)	1.02	0.55%
Mining (10,12-14)	1.85	0.07%
Construction (15-17)	82.29	0.19%
Railroad (40)	1.19	0.07%
Trucking (42)	7.31	0.09%
Local/Interurban (41)	2.05	0.27%
Air Transp. (45)	3.62	0.04%
Other Transp. (44,46-47)	3.64	0.05%
Communication (48)	5.53	0.04%
Public Utilities (49)	3.29	0.04%
Banking (60)	10.59	0.06%
Insurance (63,64)	10.28	0.08%
Credit & Finance (61-62,67)	6.03	0.09%
Real Estate (65,69)	21.95	0.03%
Eating & Drinking (58)	38.13	0.22%

TABLE 3-7

(Continued)

Industry (SIC)	Costs (millions of 1993 $)	Percent of Output
Rest of Retail (52-57,59)	56.05	0.12%
Wholesale (50-51)	31.61	0.07%
Hotels (70)	7.31	0.19%
Personal Serv. & Repair (72,76)	11.70	0.10%
Private Household (88)	5.81	0.60%
Auto Repair/Serv. (75)	7.08	0.12%
Misc. Busi. Serv. (73)	35.79	0.10%
Amuse. & Recreation (79)	10.17	0.12%
Motion Pictures (78)	9.96	0.05%
Medical (80)	30.49	0.07%
Misc. Prof. Serv. (81,87,89)	32.15	0.10%
Education (82)	8.24	0.14%
Non-Profit Org. (83)	11.66	0.10%
Agri/Forest/Fish Serv. (07-09)	7.10	0.48%
Government*	66.80	
Consumers	962.41	
Total	$1631.01	

*There are no published dollar estimates for the output of the government sector.

Figure 3-3 shows the annual control costs of the quantified measures. The cost for the years 1994-1996 is entirely due to TCM-01 whose cost during this period represents money which has already been spent. The cost is not removed from the analysis because of inseparability of funding for multiple projects with different timeframes.

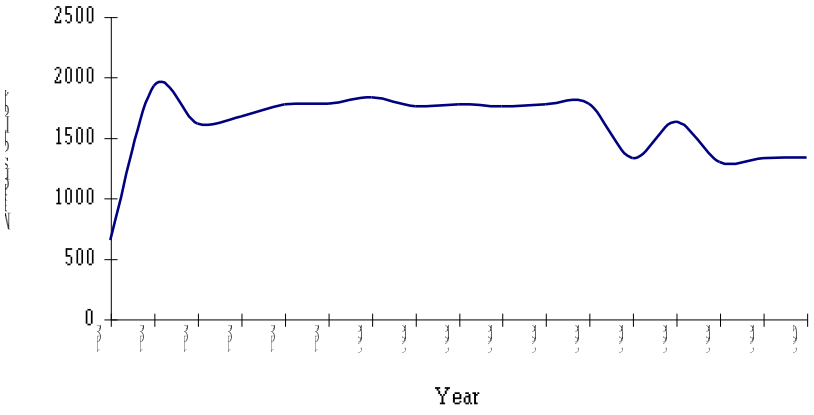

FIGURE 3-3

Control Cost by Year

Costs by County

Table 3-8 shows how the potential control costs are distributed among the four counties for the quantifiable measures. Los Angeles County could incur an annual cost of about $1.23 billion, or approximately 76 percent share of the total cost. This is because most of the affected emission sources are located in Los Angeles County.

TABLE 3-8

Average Annual Control Cost by County
(millions of 1993 dollars)

County	Control Cost
Los Angeles	$1,234
Orange	207
Riverside	81
San Bernardino	108
TOTAL	$1,631

The total may not equal the sum of individual counties due to rounding.

Unquantifiable Measures

Out of 45 control measures with quantifiable emission reductions in the draft Plan, 28 measures are quantified with costs. The 28 quantified control measures include 16 stationary, 7 on-road mobile, and 5 off-road mobile source measures. The average cost-effectiveness for stationary sources is about $1,477 per ton (in 1993 dollars) of pollutant reduced. The average cost-effectiveness for on-road and off-road mobile source measures is approximately $3,503 and $586 per ton, respectively.[1]

The cost of unquantified measures is estimated based on the average cost of quantified measures in dollars per ton of pollutant reduced and the projected annual emission reductions of unquantified measures. The calculation is performed for stationary sources, and on- and off-road mobile sources, respectively.

Table 3-9 shows the projected cost of unquantified measures by source category. These estimates are rough projections and actual costs could be lower or higher. On average, the total estimated cost for the unquantified portion of the Plan is projected to be $77.9 million between 1997 and 2010.

TABLE 3-9

Cost of Unquantified Measures
(1993 millions of dollars)

	2000	2010	Average Annual (1997-2010)
Stationary	10.9	116.8	51.3
On-road Mobile	0.0	54.8	21.5
Off-road Mobile	0.5	12.1	5.0
Total	$11.4	$183.7	$77.9

SUMMARY

The Urban Airshed Model and PM10 model project the attainment of the federal air quality standards of ozone in 2010 and PM10 in 2006, respectively. In 2010, the total quantified and unquantified health benefits of the draft Plan are predicted to reach $1.1 to $1.2 billion. The total benefit, in 2010, is estimated to be at $3.5 to $3.6 billion exceeding the projected cost of $1.5

[1] Control measures ATT-01 (Telecommunication), ATT-02 (Advanced Shuttle Transit), ATT-05 (Intelligent Transportation System), and TCM-01 (Transportation Improvements), which are part of the Regional Transportation Improvement Plan (RTIP), were not included in the calculation. This is because emission reductions data for these measures are not sufficient for the cost effectiveness calculation.

billion (Table 3-10). The total benefit of the Plan ($1.8 to $1.9 billion) also outweighs the total cost ($1.7 billion) on an average annual basis.

TABLE 3-10

Total Costs and Benefits of the Draft Plan
(millions of 1993 dollars)

	2000	2010	Average Annual (1997 - 2010)
Quantified Measure Costs	$1,835	$1,335	$1,631
Unquantified Measure Costs	11	184	78
Total Costs	1,846	1,519	1,709
Quantified Benefits	921	3,303	1,692
Unquantified Health Benefits	137 - 215	204 - 321	148 - 234
Total Benefits	1,058 - 1,136	3,506 - 3,623	1,840 - 1,926

It should be noted that the actual benefits clearly outweigh what has been estimated here. The quantified health benefits have not accounted for the improvements in PM10 and ozone beyond the federal standards and reduced adverse health effects due to reductions in other pollutants. Neither have reductions in vehicle hours traveled and damages to plants, livestock, and forests as a result of implementing the draft 1997 AQMP been quantified. When all these are considered, the estimated benefits will further outweigh the costs.

Further research is needed relative to quantifying the known health effects. Relative to costs, additional tools are needed to compare the differences between command-and-control regulations and market-based programs. Additional efforts will also be made to continue to quantify the costs associated with more control measures. Chapter 8 has a more detailed description of these proposed future actions relative to enhanced benefit and cost assessments.