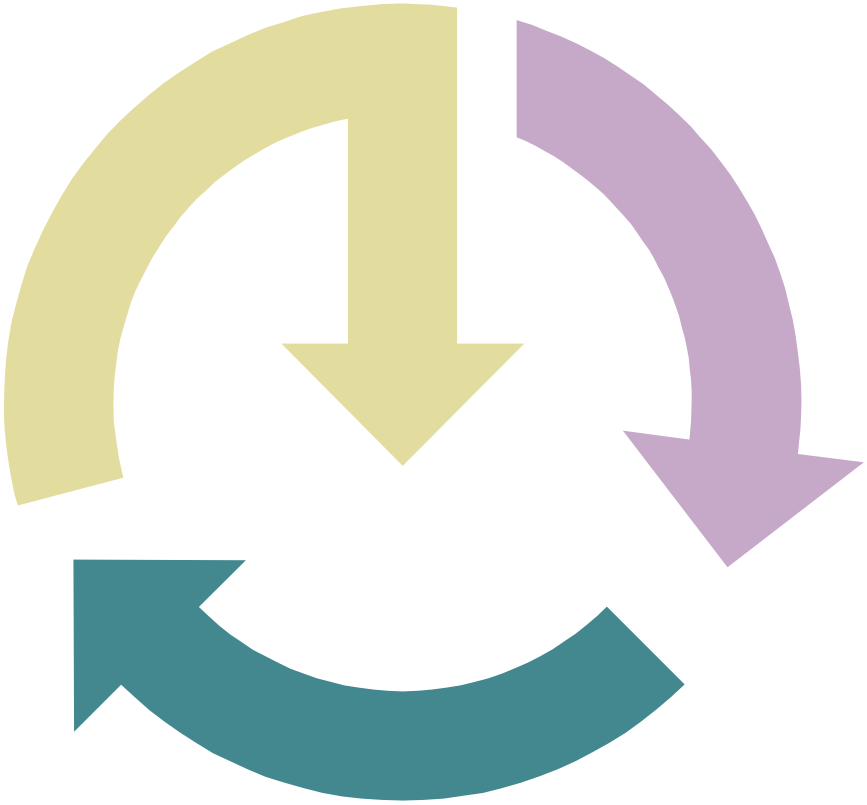
Environmental Conditions and Directions Study



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- Dennis Arfmann – Air Committee Chair, Colorado Association for Commerce and Industry (CACI)
- Charles Bedford – Nature Conservancy
- Fran King Brown – Southern Ute Indian Tribe, Environmental Programs Division
- Kerry Clough – USEPA Region 8 – Senior Management
- Teresa Donahue – Denver Dept. of Environmental Health (retired)
- Ellen Drew – Colorado Environmental Business Alliance
- Tom Dunlop – Dunlop Environmental Consulting, Inc.; Pitkin County Health Department (retired)
- Liz Gardner – Denver Water Board
- Heidi Van Genderen – University of Colorado at Denver Wirth Chair in Environmental and Community Development Policy
- Lorraine Grenado – Colorado People's Environmental and Ecological Network (COPEEN)
- Denise Hase – North East Health Departments
- Elise Jones – Colorado Environmental Coalition
- Jerry Kotas – U.S. Department of Energy
- Susan Lefever – Sierra Club
- Rich McClintock – Livable Communities Support Center
- Berny Morson – Rocky Mountain News
- John Nielsen – Land and Water Fund of the Rockies
- Jim Scherer – Chairman, Regional Air Quality Council; Former Regional Administrator, USEPA Region VIII; Former Director of Colorado Alliance for a Rapid Transit Solution (I-70)
- Chris Shaver – National Park Service
- Theo Stein – The Denver Post
- Wano Urbanos – San Juan Basin Health Department
- Regina Wicks – CoPirg
- Mitch Yergert – Colorado Department of Agriculture

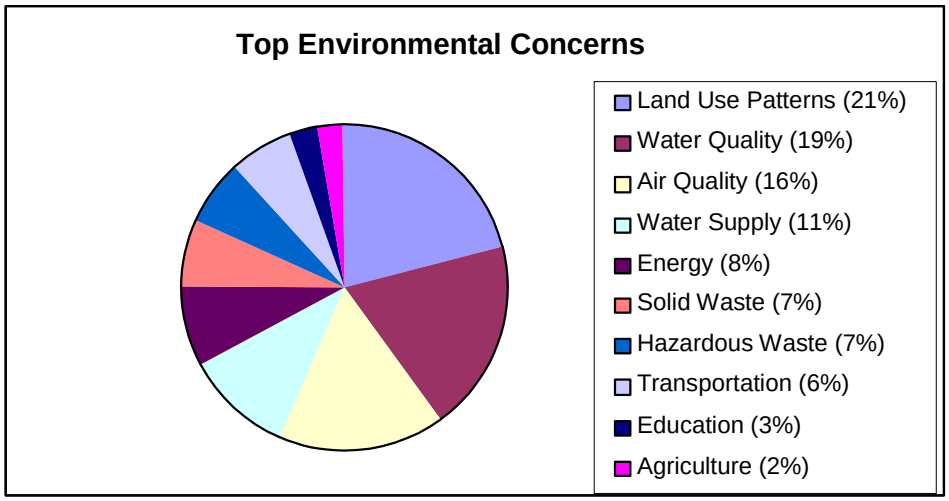
EXECUTIVE SUMMARY

The Governor's Pollution Prevention Advisory Board (PPAB) commissioned this Environmental Conditions and Directions Study (ECADS) to consider the State of Colorado's primary environmental issues. The fundamental goals of this study are to:

- Identify primary State environmental conditions;
- Prioritize overall PPAB objectives;
- Develop priorities for PPAB grants program so that return on investment is optimized;
- Assist in fulfilling PPAB's policy advising role;
- Use data to develop and support PPAB issue stances;
- Benchmark strategies for future data collection; and
- Identify gaps in the data.

Three project methods achieve the overall goals of this study: 1) benchmarking similar studies by other states, 2) collecting data, and 3) interviewing tactical stakeholders. The combined methods of data collection and expert interviews are intended to complement each other by augmenting quantitative data with human knowledge, expertise, and perspectives. PPAB votes determined the data sources and interviewees for the study.

According to expert interviews, the top environmental concerns in Colorado are summarized in the following chart:



Two important results of the expert interviews are as follows:

- Growth is foremost as the top environmental concern statewide.
- Water supply coupled with water quality is of greater concern than air quality.

Based on geographic trends, the Front Range has the most significant environmental concerns. The Western Slope has the least, but concerns are growing for this region's environmental conditions. Based on sector trends, compared to the 1993 pollution prevention priorities study, the contribution of industry and commerce towards many of the top Colorado environmental conditions are relatively small. More significant concerns are:

- Agriculture (accounts for 92 percent of total water use)
- Mobile sources (the largest source of Colorado's air pollution)
- Electricity generation and use (leading emitter of greenhouse gases)
- Mining (sector with greatest toxic release inventory (TRI) reported releases)

When considering future trends and predictions for top environmental conditions, expert interviewees note the following key points:

- The majority of respondents predict existing conditions to 'worsen.'
- Unknowns such as new chemicals, new contaminants, or new industries have great potential to change the current complexion of environmental issues.
- Existing conditions will be reprioritized (water supply and agriculture will shift to being the most significant issues in the next decade).

The ECADS overview by media was modeled and organized based on the top ten interview responses on Colorado environmental concerns. The media conditions with key highlights are summarized below:

1. Land use:

- Colorado is experiencing the third fastest state population growth in the country.
- Vehicle miles traveled are increasing 2.5 times faster than population due to sprawl.
- Agricultural land is decreasing at a more rapid rate than ever in state history.

2. Water quality:

    - Seven percent of the rivers and streams and five percent of the lakes and reservoirs have impaired water quality for at least one intended use.

    - All five of the aquifers tested since 1992 in the state are contaminated.

    - Groundwater in the state's industrialized areas is contaminated with volatile organic chemicals.

    - Continued loss of wetlands, and the resulting negative impact on wildlife habitat and ecosystems, remains a major concern.

3. Air quality:

    - From July 2000 to July 2001, urban and rural areas in Colorado maintained compliance with National Ambient Air Quality Standards for criteria pollutants.

    - Considerable data suggest that mobile sources are the most significant source of air pollution.

    - Unlike most states in the U.S., none of Colorado Department of Transportation's revenue is invested in public transportation. (Denver metro area was ranked the 7th most congested area for traffic in the U.S.).

4. Water supply:

    - Irrigation is by far the largest use of water in Colorado, followed by public supply, industry, and thermoelectricity.

    - Uses of groundwater, ranked in decreasing order, are irrigation, public supply, mining, and industry.

5. Energy use and climate change:

    - Of total fuel consumption (1.1 million MMBtu - 1999), electricity generation and transportation are primary consumers.

    - Colorado's CO_2 emission factor of 1.93 is relatively high compared to the U.S. average of 1.34 lb/kWh.

    - In Colorado, SO_x and NO_x emissions decreased during the 90s, but CO_2 increased by 1.9 percent.

- Renewable resources constitute 4 percent of Colorado's electrical energy yet Colorado is ranked 11th in the nation for wind-power potential.

6. Solid waste:

   - Coloradoans generated 6.2 lbs/person/day of trash; the National average is 4.4 lbs/person/day.

   - Colorado recycling is 36th in the nation, decreasing from 18 percent of waste generated in 1997 to a current rate of 10 percent.

7. Hazardous waste:

   - Colorado ranks 35th in hazardous waste generation.

   - About 90 percent of the hazardous waste is shipped out of state for disposal.

   - Three sectors reporting the most persistent, bioaccumulative, and toxic (PBT) chemical releases are mining, energy, and solvent recovery.

8. Public health:

   - Cumulative lifetime risk of cancer in Colorado for males is 1 in 2 and for females is 1 in 3.

   - Colorado has the second highest estimated prevalence of asthma of any state in the U.S.

Based on these environmental conditions and their geographic, historical, and predicted trends, several recommendations are provided by the expert interviewees for the PPAB:

Outreach:

- Increase visibility of the PPAB with the media and the public.

- Raise awareness on the most pressing environmental conditions identified through this study.

- Work on pollution prevention (P2) curriculum development in schools.

Technical Assistance:

- Hold recipients of technical assistance accountable and raise the bar so mediocre P2 performance is not rewarded.

- Develop mobile technical assistance for reaching rural areas and the western slope.

- Lead by example and integrate P2 into all aspects of state operations.

- Focus on environmental justice and populations most victimized by pollution.

Grant Priorities:

- Stay focused on providing the limited resources to traditional P2 projects.

- Continue to emphasize education and sustainable development.

- Consider funding grants to address the data gaps identified in this study.

- Consider leaving issues such as energy, transportation, and smart growth to larger organizations already addressing these topics[1].

Policy:

- Set a small number of priorities and really take action on them in policy at Colorado Department of Public Health and Environment (CDPHE) and legislation in the Assembly.

- Offer advice as a policy advisory board to elected and appointed officials on issues related to P2, such as transportation, energy, and recycling.

- Develop a more specific, comprehensive P2 and sustainable development policy that would require mandatory compliance by all state government agencies. This has been done in other states like New Jersey, Minnesota, and Oregon.

- Develop intradepartmental policies that begin the move toward a more sustainable regulatory structure by CDPHE, e.g., more cross-media approaches that ensure that P2 is the management tool of first choice.

Clearly, the breadth and scope of recommendations provided by the interviewees with regard to policy, grant priorities, and technical assistance and outreach cannot all be accomplished by the PPAB and its CDPHE P2 program staff alone. Several possible partnerships have also been provided by the interviewees for pooling resources and collaborating

[1] This recommendation is specific to grant priorities due to a limited grant funding pool. However, these topics remain very important for other PPAB endeavors, such as outreach and partnerships.

on specific projects. Specific recommendations for possible partnerships for the PPAB to investigate are included in Appendix A.

Finally, this report includes the following recommendations for future updates and enhancements to the ECADS project:

- Include more data sources beyond the 25 prioritized data sources voted on by the PPAB.
- Provide more in-depth analysis of individual data sources to better understand underlying root causes.
- Expand the data analysis to examine programs and activities addressing individual environmental conditions (to prioritize areas in greatest need of assistance and strategic partnerships).
- Include a public input and outreach component.
- Use normalization factors, such as population, to better characterize environmental conditions.
- Develop key environmental indicators to more rigorously monitor trends in environmental conditions in a report card fashion.
- Research federal or other funding sources that could support the next phase of ECADS.

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1.0 INTRODUCTION

In 1993 the Colorado Pollution Prevention Advisory Board (PPAB) commissioned a Study of Priorities for Pollution Prevention (P2) Activities. The purpose of this study was to collect and evaluate information on the amount of hazardous substances being used in Colorado as the basis for establishing P2 priorities. The 1993 report looked at various existing data sources and identified targeted industrial sectors, which were used as the focus for Colorado's P2 program in subsequent years. In the time since the original study, much effort and progress has been made to address P2 in the original targeted industrial sectors, and the PPAB has decided to set a new course for pollution prevention in Colorado. The effort in this most recent study expanded the scope of the 1993 report's inquiry beyond industrial considerations and sought perspectives beyond data and numbers, all with the intent of avoiding any preconceived results.

The PPAB will use the results for the purposes of setting and prioritizing new P2 objectives.

This updated Environmental Conditions and Directions Study (ECADS) is founded in the goals defined by the PPAB. Specifically, the study set out to generally define Colorado's primary environmental issues, including the impact of growth. The ECADS findings are intended not only to serve as a benchmark for future data collection, but also to identify important data that are <u>not</u> currently being collected. The PPAB will, in turn, use the results of this report to assist in fulfilling its policy advisory role and in justifying its positions. Furthermore, the PPAB will use the results for the purposes of setting and prioritizing new P2 objectives. Ultimately, these objectives will be the basis for funding future P2 activities in Colorado, including the P2 Grant Program.

Efforts of this study by The Brendle Group Team, including Tetra Tech and the project advisory members, used two basic approaches to address the project goals. First, relevant and pertinent data were identified and collected to provide a comprehensive look at the condition of Colorado's environment. Second, interviews of the PPAB and other tactical stakeholders were conducted to supplement the data with human expertise. Chapter 2 of this study describes the methods that were employed to conduct these two basic approaches. Methods described cover the efforts to benchmark this study with other states and/or organizations, collect data, and conduct interviews of key stakeholders. Chapter 3 discusses the current and predicted environmental conditions in Colorado as evidenced by the data. Finally, Chapter 4 discusses recommendations for the PPAB and other prospective partnering organizations, based on both recommendations received from expert interviewees and insights uncovered by the ECADS Team during the study effort.

2.0 PROJECT METHODS

Three project methods achieve the overall goals of this study: 1) benchmarking similar studies by other states, 2) collecting data, and 3) interviewing tactical stakeholders. This chapter describes the methods that were employed to conduct these three basic approaches.

2.1 BENCHMARK METHODS AND RESULTS

Benchmarking was an important initial phase to set the project's course.

Benchmarking was an important initial phase to set the project's course. The purpose of this initial phase was to gather existing models, tools, and lessons learned from other states with similar goals and scopes. The work of this phase built upon the research conducted by Neil Kolwey and Bob Duprey in their development of the 2001 PPAB proposal to conduct an Environmental Indicators and Pollution Prevention Priorities Study.

The following list summarizes the benchmarks that were collected and presented to the ECADS subcommittee at an initial kickoff meeting:

1. Chemical and Pesticides Results Measures
   Florida State University/U.S. Environmental Protection Agency (USEPA)
   http://www.pepps.fsu.edu/caprm/

2. Measures of Growth
   Maine Growth Council/Department of Energy Center of Excellence for Sustainable Development
   http://www.mdf.org/megc/growth02/

3. Minnesota Milestones
   Minnesota Office of Strategic and Long Range Planning/Department of Energy Center of Excellence for Sustainable Development
   http://www.mnplan.state.mn.us/mm/

4. Achieving the Oregon Shines Vision: The 2001 Benchmark Performance Report
   Oregon Progress Board/Department of Energy Center of Excellence for Sustainable Development
   http://www.econ.state.or.us/opb/

5. 20 Measures of Sustainability
   New Jersey Future/Department of Energy Center of Excellence for Sustainable Development
   http://www.njfuture.org/HTMLSrc/20meas.html

6. Core Environmental Indicators for Reporting on the State of the Environment
   Australian and New Zealand Environment and Conservation Council State of the Environment Reporting Task Force
   http://www.ea.gov.au/soe/publications/coreindicators.html

7. Economic and Environmental Ranking of Massachusetts' Economic Sectors, July 1998
   The Massachusetts Toxics Use Reduction Institute
   Report available only in hard copy.
   Contact: Dan Chiras, (303)674-9688

8. Sustainable Development in Colorado: A Background Report on Indicators, Trends, Definitions, and Recommendations
   Sustainable Futures Society
   Report available only in hardcopy.
   Contact: (970)934-3390

9. Protocol for Assessing Community Excellence in Environmental Health (PACE EH)
   National Association of City and County Health Organizations (NACCHO)
   http://www.naccho.org/prod87.cfm

10. America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network
    The Pew Charitable Trusts
    http://www.pewtrusts.com/ideas/index.cfm?issue=14
    (Follow link to "Grantee Reports")

Helpful information was collected throughout the review of these highlighted benchmarks, including methods to effectively communicate the results of indicator studies. The key issues and concepts identified for the purposes of the ECADS efforts included the following:

- Consider how wide to cast the net in terms of study scope, number of data sources, etc.
- Consider a phased approach to achieve all desired outcomes.
- Consider the subjectivity in data interpretation.
- Consider what level of public involvement, if any, is desired.
- Prioritize identified issues to achieve desired outcomes.
- Consider organizing data into sub-goals and/or indicators.
- Define when measurement is most appropriate and what method is most accurate.

- Maintain ongoing data collection for historical purposes and to report trends.

2.2 DATA COLLECTION – METHODS AND SOURCES

This section describes the methodology for collecting environmental conditions data for this project in four subject areas: 1) categories and sources of data collected for this project, 2) data collection, 3) data management, and 4) data limitations.

Environmental Conditions Data Categories and Sources

The Team determined potential environmental conditions data categories and sources through several resources:

- Conversations with experts in various environmental fields while preparing the proposal for this project
- Recommendations from the PPAB, the PPAB subcommittee, the Project Advisory Team, and representatives from the CDPHE P2 program
- Previous reports on environmental conditions in Colorado and similar reports from other states
- Internet research
- Individual references identified during the data collection process

To begin, the Team submitted a list of 40 potential data categories to the PPAB. The PPAB was asked to score the data categories it considered to be of most importance to describing environmental conditions in Colorado. The scoring criteria were as follows:

1 = Must be included in data collection
2 = Would be nice to have, as project budget and schedule allows
3 = Not necessary or outside the scope of this project

PPAB members submitted votes independently and the scores were tallied for each potential category. The average score was 1.59, and scores ranged from 1.0 to 2.4. Scores were recorded in a table and presented to the PPAB in a subsequent meeting. Table 2-1 summarizes the data categories ranked by the PPAB in descending order of priority. To accommodate project funding, the Team proposed and the PPAB agreed that the top 25 data categories would be investigated.

Table 2-1
Environmental Conditions Data
Preliminary Data Categories

NO.	PPAB RESPONSE AVERAGE	DATA
1	1	Mobile emissions • Vehicle miles traveled (VMT) trends • Regulated vehicle fleets • Public transportation use trends
2	1	• Direct discharges to surface water
3	1	• Publicly owned treatment works (POTW) effluent and waste
4	1	• Surface water quality
5	1.14	Stationary air emissions • Hazardous air pollutants (HAP) sources (major and minor) • Criteria pollutants
6	1.14	Ambient air quality • Criteria pollutants
7	1.14	• Toxic release inventory (TRI) releases
8	1.14	• Electrical power use and production
9	1.29	• Water use
10	1.29	• Population growth: by county, per capita, per household
11	1.33	• Stormwater loading estimates
12	1.36	• Large quantity hazardous waste generators (LQG), Small quantity hazardous waste generators (SQG), Conditionally exempt hazardous waste generators (CESQG) number and waste generation
13	1.43	• Groundwater quality
14	1.43	• Pesticide use
15	1.5	• Non point source runoff
16	1.57	• Persistent, bioaccumulative, or toxic (PBTs) chemical use and release
17	1.57	• Natural gas use and production
18	1.57	• Renewable energy production
19	1.57	• Land use, land loss, soil loss
20	1.57	• Wetlands: Existing acres, annual loss
21	1.6	• Agriculture loss to development
22	1.6	• Surface Water Quantity
23	1.6	• Ground Water Quantity
24	1.66	• Industrial discharges to POTW
25	1.66	• Household hazardous waste (HHW) collections
26 *	1.71	• Solid waste generation
27 *	1.71	• Recycled solid waste quantities
28 *	1.71	• State landfill capacity
29	1.79	• Active mining operations
30	1.8	• Open space
31	1.8	• Biodiversity data
32	1.86	• Abandoned mine sites
33	2	• Acid Rain
34	2	• Concentrated Animal Feeding Operations (CAFOs)
35	2	• Out-of-watershed water transfers
36	2.08	• Asthma rates • Cancer deaths (lung, other)

* The items denoted by an asterisk were also included in the study.

Data Collection

Using the top 25 items in Table 2-1 as master list of data desired for the project, the Team began gathering data from various sources, including the Internet, CDPHE, other government agencies, and individuals recommended by the PPAB. Data collection efforts focused on identifying the most recent existing information or reports that summarized the

categories of interest. The Team reviewed the data collected and when it found missing information, it searched for additional information to complete the research.

Data Management

Relevant sources were tracked and managed in a database that includes the following information:

- Data source (web site or contact name)
- Title of information collected
- Organization providing data
- Primary media addressed by the information source
- Interview notes (where applicable)
- Data review notes
- Details of contact information (name, address, phone number, e-mail address)

Data Limitations

Scope and funding parameters naturally influenced the level of data collection and analysis. Some caveats associated with data collection and analysis methodology are described below.

- Independent calculation, manipulation, or quantitative analysis of raw data was not performed. The Team sought data that had been analyzed and summarized by the source organization. In limited cases, data were presented in a slightly different format than in the source documents. For example, a table could be presented in the form of a pie chart for a more clear depiction of the data.

- The most recent data were always requested. Therefore, the dates of data presented vary. In addition, historical data sufficient to evaluate historical trends seldom were provided or were obtained in a format that required a level of effort that exceeded project budget.

- For each of the targeted data categories, the Team attempted to describe current conditions, historical trends, geographic aspects, and sector contributions. However, not all data sources provided the same breadth or depth of analysis in these areas. For this reason, there is some inconsistent level of detail provided for each targeted data category.

- Data associated with some targeted categories (for example, storm water loading estimates; public transportation use trends; solid waste recycled quantities, diversion rates, types of items recycled; confined animal feeding operation information) were not available. These data were not available because 1) the data have never been aggregated statewide for Colorado or 2) repeated efforts to contact data sources were unsuccessful.

- Consistent normalization (such as amount of pollution generated per capita) was not possible. Every data category had different sources, none of which had consistent authors or audiences. Manipulation of data to consistently present normalized data was beyond the scope of this project.

2.3 EXPERT INTERVIEWS – METHODS AND AUDIENCE

The purposes for interviewing PPAB members and other tactical stakeholders were to 1) help fill gaps in the data collection described in the previous section, 2) solicit perspectives outside the framework of data that are currently being published, and 3) conserve project resources by distilling potentially vast amounts of data into key summaries of environmental conditions. Some environmental impacts are hard to regulate and, therefore, it is harder to obtain good, related data. Expert perspectives reduce the risk of missing potentially significant threats to Colorado's environment that currently are not being measured.

Who was interviewed and how they were interviewed (whether in person, by phone, or using written or electronic surveys) was determined under the direction of the PPAB, its subcommittee and Project Advisory Team. Through a voting process, a list of interviewees was determined. In addition to tactical stakeholders throughout the State, the Project's Advisory Team and PPAB members were also interviewed.

The context of the interviews, including their content and questions, was determined in conversations between the PPAB, its ECADS subcommittee, and The Brendle Group. Table 2-2 lists the questions put forth to the participants and the corresponding report section where results are provided.

A total of 39 responses were received out of 49 requests, for a response rate of approximately 80 percent. This total includes responses from 12 of the 14 PPAB members, an 86 percent response rate. Appendix A.1 includes a list of all participants that were interviewed as part of this effort. Results of interviews and data are discussed in the following sections.

An overall response rate of approximately 80 percent resulted from all requested ECADS related interviews.

Table 2-2
Interview Questions and Report References

Question Number	Interview Question	Report Section
1	In your opinion, what are the top 2-5 most significant environmental conditions in Colorado, both in general and your own area of expertise?	**3.1**
2	What is the basis for this response (e.g., personal experience, data, anecdotal evidence, other)?	**3.1**
3	Is there data to support this question?	*****
4	What data isn't being collected that would help complete the picture of Colorado's environmental conditions?	**3.6**
5	How does growth affect these conditions?	**3.1**
6	What do you predict will be the future trend for these conditions?	**3.4**
7	What are the barriers to improving these environmental conditions?	**3.7**
8	Do you foresee any new environmental conditions/issues/concerns in the next 10 years that haven't already been identified?	**3.4**
9	What specifically can the PPAB do to address/alleviate these conditions (e.g., make it a grant priority, other technical assistance programs, policy, collaboration with particular organizations, statements of support, etc.)?	**4.1**

***** This question was used to assist in developing the project's data sources, described in Section 2.2. Results are not quantified in this report.

3.0 ENVIRONMENTAL CONDITIONS IN COLORADO

This chapter reports the results of data collection and expert interviews. The details of data collection are provided in Appendix B. Specifically, the environmental conditions listed in Table 2–1 each are described in terms of data source, historical trends, and geographic trends. Results are organized first by the most pressing environmental conditions according to expert interviews. The remainder of this chapter summarizes the detail of Appendix B, as well as interview comments. The conditions are then analyzed in terms of trends by geographic region, sector, future predictions, and media. Finally, data gaps and barriers towards improving environmental conditions are provided as a transition towards the possible solutions and recommendations provided in Chapter 4.

3.1 TOP CONCERNS ACCORDING TO EXPERT INTERVIEWS

Overall, interviews were critical to forming a more complete assessment of the state's environmental condition that data alone cannot provide.

First, the interviewees were queried about the Top 25 environmental conditions in Colorado, both in general and in their area of expertise. This first question of the survey was intended to be broad enough to allow the interviewees significant freedom in their responses, while focusing the quantity of the remarks to a limited number (25).

The following are key highlights of Question 1 from the expert interviews:

Growth is viewed as the top environmental concern statewide.

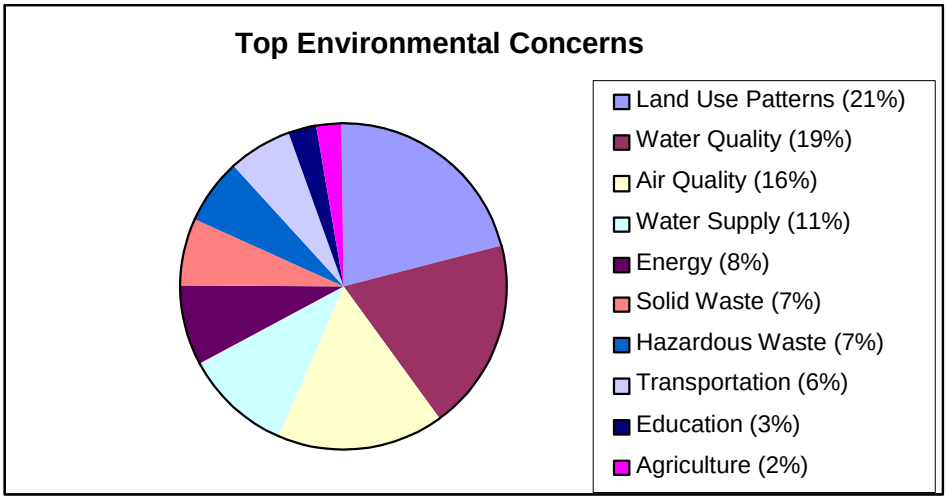
- Growth is foremost as the top environmental concern statewide. Virtually every interviewee touched on this issue in some capacity, typically as a general response versus opinions in their own field of expertise.

- Collectively, the combination of water supply and water quality is of greater concern than air quality. Respondents felt that air quality is generally adequately addressed through regulations and standards. Concern does remain over toxic emissions and the continued ability to meet standards because of population growth. However, respondents much more strongly felt that future water supply, and its impacts on water quality, is a great unknown. Water quality and quantity is of far greater concern due to decreasing quality of streams and groundwater, and again, the impact of growth on this resource.

- Other key conditions and concerns that frequently emerged throughout the interviews included agriculture, transportation, and lack of renewable energy and energy efficiency.

All responses of the first question were organized into ten topic areas. The results are shown in Figure 3-1.

Figure 3-1
Interview Question 1 Overall Responses



From the 37 expert interviews, a total of 208 responses to Question 1 were received. Although the question was open-ended, the responses tended to fall into the 10 categories shown in Figure 3-1. Of these 10 topics, 8 of the top concerns received responses that were considered sub-categories of the overall umbrella concern. Solid waste responses, for example, included responses that simply stated 'solid waste' as a top condition (and were then subsequently filed as 'general'). Responses filed as a subcategory included construction and household waste. To further explain and describe these top concerns, the sub-category responses are expanded in Tables 3-1 through 3-8.

Off all top concerns, land use patterns received the largest percentage of responses. As seen in the table below, the land use category includes natural resource use, forest management, sprawl, growth, etc. Although sprawl is a type or pattern of growth, it is listed as its own subcategory to demonstrate the number of responses that specified sprawl as a top environmental concern. Responses for this condition's sub-categories were as follows:

[Conditions of the current patterns of land use are] "permanent loss of biodiversity and valuable lands through irreversible, sprawling, development of valuable and fragile plains, agricultural and alpine ecosystems."

- Interview Response

Table 3-1
Land Use Patterns Responses

Condition	Sub-Category	Number of Responses
Land Use Patterns	Growth	11
	Sprawl	10
	Wildlife (habitat)	8
	General	7
	Overuse of Natural Resources	5
	Agriculture (loss)	2
	Forest Management	1
Condition Subtotal		**44**

"Water quality issues are significant, whether [it be] the salinity of the Colorado River affecting [the] Western Slope agriculture or groundwater pollution affecting suburban Denver drinking water."

- Interview Response

Water quality was the concern receiving the second largest percentage of responses. Responses to this concern included topics of ground- and surface-water quality, as well as others totaled in the following table.

Table 3-2
Water Quality Responses

Condition	Sub-Category	Number of Responses
Water Quality	General	15
	Groundwater	9
	Surfacewater	7
	Non-point Source	4
	Agricultural Impacts	4
Condition Subtotal		**39**

The third top concern overall was air quality. As seen in Table 3-3, the air quality category includes mobile sources, visibility, indoor air quality, agricultural impact, and forest fires.

Table 3-3
Air Quality Responses

Condition	Sub-Category	Number of Responses
Air Quality	General	21
	Mobile Sources	8
	Visibility	2
	Indoor Air Quality	1
	Agricultural Impacts	1
	Forest Fires	1
Condition Subtotal		**34**

Collectively, the combined conditions relating to water quality and supply received the greatest number of interview responses. While the water quality responses were previously detailed, Table 3-4 displays the responses that were received specific to the water supply conditions.

Table 3-4
Water Supply Responses

Condition	Sub-Category	Number of Responses
Water Supply	General	15
	Water Resource Allocation	7
Condition Subtotal		**22**

Water is the real gold of the planet and Colorado is facing water shortages.

- Interview Response

The sub-categories included as part of responses related to energy are shown in Table 3-5.

Table 3-5
Energy Responses

Condition	Sub-Category	Number of Responses
Energy	Industrial (oil/gas/coal)	9
	General	3
	Greenhouse Gas Emissions	3
	Household	2
Condition Subtotal		**17**

Solid waste was another one of the top 10 concerns. The sub-category breakouts related to solid waste are as follows:

Table 3-6
Solid Waste Responses

Condition	Sub-Category	Number of Responses
Solid Waste	General	10
	Construction	3
	Household	1
Condition Subtotal		**14**

"…the continued dependence on landfills. We have relatively inexpensive land, so building more landfills seems like the easy short-sighted thing…"

- Interview Response

The number of responses relating to solid waste was identical to that of hazardous waste. Responses from interviewed experts on both topics totaled 14 for each condition, or approximately 7 percent overall for each of the two conditions. The responses and sub-categories for Hazardous Waste are displayed in Table 3-7.

Table 3-7
Hazardous Waste Responses

Condition	Sub-Category	Number of Responses
Hazardous Waste	General	6
	Household	5
	Superfund Sites	2
	Government/Military	1
Condition Subtotal		**14**

The final concern with sub-categories was agriculture. As shown in the Table 3-8, responses relating to agriculture pertained to one of two areas: pesticides or animal waste.

Table 3-8
Agriculture Responses

Condition	Sub-Category	Number of Responses
Agriculture	Pesticides	4
	Animal Waste	1
Condition Subtotal		**5**

"One of the top environmental conditions is the virtually exclusive reliance on, even promotion of single occupancy, gasoline powered vehicles for all transportation needs."

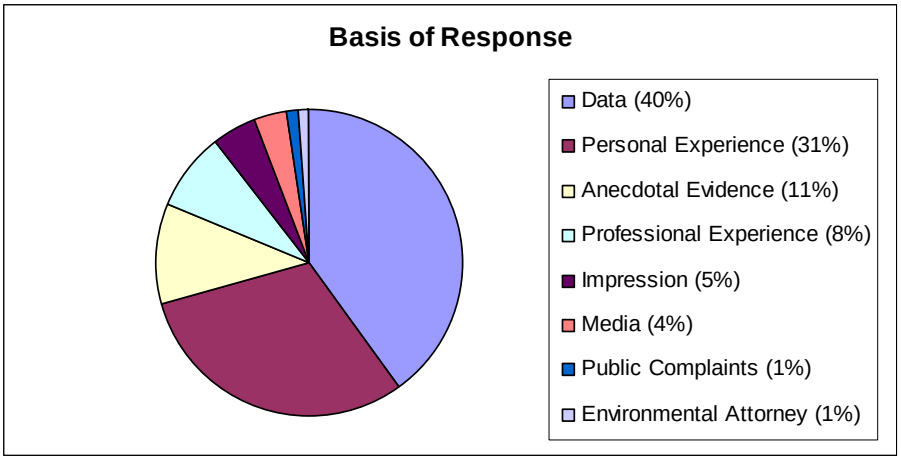
- Interview Response

Note that from Question 1, the final 2 of the top 10 concerns did not receive responses that could be organized into sub-categories and, thus, do not have an associated sub-category table. The two conditions included education (6 overall responses) and transportation (13 overall responses). Again, as shown previously in Figure 3-1, education and transportation received 3 and 6 percent of the overall responses, respectively.

The intent behind the second question of the expert interviews was to define and understand the attitudes and experiences underlying the expert's opinions of top environmental concerns. In particular, this question required the interviewees to state the basis for their responses on the state's top environmental conditions. While Figure 3-2 does show a diversity of backgrounds represented in the interview exercise, the majority of the responses (over 70 percent) clearly stem from direct data and personal experience.

As already viewed in the overall responses of Question 1, growth is a key issue on the minds of many Coloradoans. Indeed, growth and its wide-ranging effects were also on the minds of the Project Team, its Advisory Board, and the PPAB as the interview questions themselves were crafted. Question 5 was included in the survey to directly ask respondents about growth and, more specifically, how growth impacts the concerns they had highlighted as most significant to Colorado.

Figure 3-2
Interview Question 2 Overall Responses



Ultimately, when asked how growth affects the Top 25 environmental concerns in Colorado, 88 percent of interviewees stated that growth worsens the particular condition or conditions that they had highlighted.

The most common word used to describe Colorado's growth on the top environment conditions was "exacerbates". One participant summed up the most common sentiment by responding: "Growth is exacerbating virtually every environmental problem locally and internationally."

3.2 TRENDS BY GEOGRAPHIC REGION

This section summarizes the geographic aspects of the environmental data presented in Appendix B. The section is organized according to the following geographic regions: Eastern Plains, Front Range, Mountain Region, and Western Slope. The geographic region with the most environmental concerns in Colorado is the Front Range; the Western Slope has the least. However, there is a concern, by rural and Western Slope interviewees, that we have started to see a general spreading of pollution across the state caused primarily by uncontrolled growth and sprawl and that this pollution is causing loss of previously clean areas, decreasing cropland and wildlife habitat, and creating an overall negative impact on ecosystems and wildlife. All geographic regions experience some issues with air quality and water quality, although at varying degrees. Table 3-9 highlights the primary environmental conditions in each of Colorado's geographic regions.

Table 3-9
Environmental Aspects
By Geographic Region In Colorado

Geographic Region	Environmental Aspects
Eastern Plains	• The largest environmental issues facing the eastern plains are water supply and excessive sediment and nutrient loading to the surface water in the region. • Nine of the 10 counties with the most farmland are located in the eastern plains of Colorado. Irrigation, much of which occurs in the eastern plains, is responsible for 92 percent of the water demand in Colorado. • The Arkansas, Republican, and South Platte river basins, all located entirely or in part in the eastern plains, were not able to meet the consumptive water use needs for the area in 2000. • Shallow aquifers in the eastern plains are susceptible to nitrate and salt contamination from agricultural activities. • The criteria air pollutants of concern in the eastern plains areas are particulate matter (PM_{10}), carbon monoxide (CO), and nitrogen oxide (NO_x).
Front Range	• The Front Range is primarily experiencing environmental issues associated with population growth, sprawl, and industrial activity. • Most of the counties experiencing the highest population growth from 1990 to 2000 (Adams, Arapahoe, Elbert, El Paso, and Jefferson) are in the Front Range. • The primary criteria air pollutant concerns in the Front Range include CO, volatile organic compounds (VOCs), and NO_x (primarily from mobile, biogenic, and area sources, in that order). • Fort Collins is a non-attainment area for CO. • Groundwater contamination is a concern in urban areas, which are most prevalent in the Front Range where the groundwater may be contaminated with VOCs, particularly in the South Platte alluvium in south Adams County and near Rocky Mountain Arsenal. • Sediment and storm water contaminants are also a concern in urban areas. • The South Platte Basin was one of three watershed basins that were not able to meet the consumptive use needs for the area in 2000.

Table 3-9 (continued)
Environmental Aspects
By Geographic Region In Colorado

Geographic Region	Environmental Aspects
Front Range	• More than 85 percent of the hazardous waste in Colorado is generated in 10 counties, all of which are located along the Front Range, including Boulder, Jefferson, Denver, Arapahoe, and Pueblo counties. • Most of the Toxics Release Inventory (TRI) reporting facilities are located along the Front Range, along with some of the top persistent, bioaccumulative, and toxic (PBT) chemical releases. • Most of the electricity-generating power plants are located in the Front Range, and most of these plants primarily burn coal for electricity generation. • The central portions surrounding the city of Denver (as well as the Northwest corner of the state) have the highest cancer rates for men and women. • Denver and surrounding counties showed significantly higher rates of cancer for women than the Colorado average in 1995 to 1996.
Mountain Region	• Metals loading from mining in upper portions of watersheds, sediment loading associated with large-scale forest fires, and mountain town development are the primary issues affecting the mountain region surface water quality. • CO, VOCs, and PM_{10} are the criteria air pollutants of primary concern in the mountain region. • Regarding public health concerns, Park, Teller, and El Paso counties showed significantly higher rates of cancer than the Colorado average rate for men.
Western Slope	• The watersheds with the greatest water supply are located in the western slope. • Criteria air pollutants of greatest concern in the Western Slope are VOCs and CO. However, most of the VOCs are from biogenic sources. The primary source of CO in the Western Slope is from mobile sources.

Table 3-9 (continued)
Environmental Aspects
By Geographic Region In Colorado

Geographic Region	Environmental Aspects
Western Slope	• Some of the top PBT chemical releases occurred in the Northwest part of the state. A contributor to these releases is the largest power plant in the state located in Craig, with a net summer capability of 1,264 Mega Watts. This facility reported 2.6 pounds of dioxin and dioxin-like compounds, 237 releases of mercury and mercury compounds, and 0.2 pounds of Benzo(g,h,i)perylene. • The Northwest corner of the state, as well as the central portions surrounding the city of Denver, has the highest cancer rates for men and women. • The Northwest part of Colorado shows rates of cancer that are higher than the average Colorado rate for men 1995 to 1996 and 1997 to 1998.

3.3 OVERVIEW BY SECTOR

The ECADS project investigated a broad range of environmental condition categories, which were organized into seven groups: land use, water quality, water supply, air quality, energy use and climate change, solid waste, hazardous waste, and public health. An industrial sector analysis of these groups was difficult to perform because industrial sectors in the traditional sense are not the primary contributors to many environmental conditions of interest. Therefore, this section discusses the environmental aspects associated with 1) manufacturing industry and commerce, 2) agriculture, 3) vehicle use, 4) electricity generation and use, and 5) mining.

Industrial Manufacturing and Commerce

Industrial manufacturing and commercial facilities use electrical energy and water and generate air pollution, solid and hazardous waste, and wastewater. However, the contribution of industry and commerce to many of these environmental aspects is relatively small; highlights are summarized below:

- In 1999, industrial use of electricity was less than residential use (22 versus 31 percent); however, commercial uses accounted for 45 percent.

- Industry uses less than 8 percent of Colorado's water supply (groundwater and surface water).

- Point and area air emission sources (i.e., those associated with industrial and small business sources) accounted for approximately 31

percent of all criteria pollutant emissions in 1999 and 33 percent of total hazardous air pollutant (HAP) emissions in 1996.

- No data regarding industrial solid waste generation were readily available. Hazardous waste generation by industry is well known through regulatory reporting requirements. In 2000, five sectors contributed more than 90 percent of the total TRI releases in Colorado: metal mining (38 percent), electrical utilities that combust coal or used oil (31 percent), food and kindred products (9 percent), coal mining (9 percent), and primary metals industries (3 percent). Three sectors contributed more than 70 percent of the 3,700 pounds of PBT releases: mining (28 percent), energy (24 percent), and solvent recovery (19 percent).

- No information about household hazardous waste generation or collection were readily available; however, considering the growing number of households in Colorado (30.6 percent increase in population from 1990 to 2000), this sector may generate as much hazardous waste as the 163 regulated large quantity generators (LQG) in Colorado. For example, in 2000 approximately 6.5 million tons of municipal solid waste (MSW) was generated, excluding construction and demolition debris. If 1 percent of this quantity is hazardous, MSW contains more hazardous waste than the 49,190 tons generated by LQGs in 1999.

- Industry has relatively minor direct impact on surface water quality. The top three sources of surface water pollution are unknown, resource extraction, and urban and road runoff.

Agriculture

Agriculture is associated with a variety of environmental conditions including land use, water supply, and quality. In 1997, 49 percent of Colorado's 66 million acres were used for farms and ranches. Irrigation for agriculture accounts for 92 percent of Colorado's total water use. This significant water use also affects water quality; for example, portions of the Gunnison watershed do not meet selenium standards due to extensive irrigation with groundwater from selenium-rich Mancos Shale soils. Agriculture also impacts surface water through pesticide and fertilizer runoff and, in many cases, sedimentation. In 1996, Colorado farmers used 14 pounds of fertilizer and 2.8 pounds of pesticides per acre.

Mobile Sources

Mobile sources of air pollution (personal and commercial vehicles) are the largest source of air pollution in Colorado.

Mobile sources of air pollution (personal and commercial vehicles) are the largest source of air pollution in Colorado. Vehicle miles traveled (VMT), which represents personal vehicle use, is increasing approximately 2.5 times faster than population growth. In 2001, the Denver metro area was ranked the 7th most congested area for traffic in the U.S. In 1999, 1.24 million tons of CO were emitted from mobile sources, which was the

largest quantity of any criteria pollutants from any source (mobile, point, and area sources).

The next two largest quantities were NO_x from mobile sources (245,000 tons) and PM_{10} from area sources (183,000 tons). Mobile sources also generate 67 percent of the state's HAP emissions (35 percent of the 1996 total were from on-road and 32 percent of the 1996 total were from off-road mobile source emissions).

Electricity Generation and Use

(82 percent) of the state's electricity is produced by coal-fired power plants.

Electricity generation and use is a significant source of air pollution in Colorado. Most (82 percent) of the state's electricity is produced by coal-fired power plants, which released 36,000,000 tons of carbon dioxide (CO_2), 132,000 tons of NO_x, and 86,000 tons of SO_2 in 1999. According to the Department of Energy, when coal is burned, it emits 70 percent more carbon dioxide per Btu of energy produced than natural gas. In Colorado, total CO_2 emissions from coal-fired power plants are approximately 15 times greater than emissions from natural gas-fired power plants. CO_2 is of particular importance because it is a greenhouse gas associated with climate change. Due to Colorado's reliance on coal, its CO_2 emission factor of 1.93 lb/kWh is relatively high compared to the U.S. average of 1.34 lb/kWh. Electrical power plants are also major contributors to TRI releases in the state (31 percent of total reported in 2000) and to PBT releases in the state (24 percent of total reported in 2000), particularly for mercury and dioxin.

Overall, electric utilities were responsible for 47.5 percent of the CO_2 equivalent emissions in Colorado in 1990. Most of the 1,126,000 MMBtus of fuel consumed in Colorado in 1999 were used for electricity generation (34 percent) and transportation (32 percent).

Mining

New TRI reporting rules elevated metal mining to the sector with the greatest TRI-reported releases.

Mining operations in Colorado contribute to surface water pollution and TRI releases. Abandoned mining operations create conditions that produce acidic water capable of leaching metals into surface water. Water quality of stream segments in some water basins suggests compromised conditions for aquatic life due to elevated metals concentrations, particularly zinc, copper, and cadmium. New TRI reporting rules elevated metal mining to the sector with the greatest TRI-reported releases. For example, in 2000 three metal mining facilities reported 11.7 million pounds of releases, which represent 38 percent of the total TRI releases in Colorado. Two were hard metal mines where most of these releases are for naturally occurring metals left in rock after processing or after the rock is moved to gain access to ore. The third was a coalmine that takes ash back from a coal-fired power plant and disposes of the ash in the mine. Four coalmining facilities reported 2.7 tons of releases in 2000, which represents 3 percent of the TRI reported releases in Colorado in 2000.

3.4 FUTURE TRENDS AND PREDICTIONS

Question 6 of the interview was used to obtain information on future trends of current environmental conditions, while Question 8 was used to identify new environmental conditions that haven't yet been identified, either due to data gaps (see Section 3.6) or because they do not yet exist. Specifically, Questions 6 and 8 ask the following:

- Question 6: What do you predict will be the future trend for the top 25 environmental conditions (named by interviewees in Question 1)?
- Question 8: Do you foresee any new environmental conditions/issues/concerns in the next 10 years that have not already been identified?

"[Projecting on the future], the laws currently in place and the champions and environmental professionals currently dedicated will be successful in slowing the rate of deterioration, but not the ultimate, general direction."

- Interview Response

With these questions, the interviews not only help to develop a more complete understanding of the state's current environmental conditions, but also add supplemental perspectives for the future.

As a whole, 72 percent of respondents stated that the environmental conditions discussed would be worse in the future. One unifying theme from Question 8 is the sentiment that what is not being measured now will come to haunt Colorado as the significant environmental problems of the future. Namely, several interviewees expressed general concern over toxic pollutants in communities and homes that are not currently being measured or evaluated.

Seventy-two percent of interviewees predict that existing conditions will worsen in the future.

This general concern about what is not being measured, along with uncertainty over what the future holds, are the two underlying themes in the response to Question 8. Regarding future uncertainty, interviewees identified future environmental conditions associated with the following unknowns:

- How new chemicals will be used by our society and the unforeseen environmental impacts of new chemicals
- Unknown environmental contaminants, such as antibiotics in drinking water
- Unknown environmental problems related to new industries, such as technology and computer companies and their impacts on the environment.

"Our overly non-sustainable consumptive and wasteful approach is bound to lead to future problems."

Furthermore, interviewees see a re-prioritizing of existing environmental conditions in the 10-year horizon. Because of the top current environmental concern (land use and growth), interviewees expect that the water supply will shift to being one of the most significant issues in the next decade. Similarly, agriculture is also expected to rise to the top of the list of environmental concerns.

Water supply and agriculture are expected to rise to the top of the list of environmental concerns.

Predictions for agriculture include:

- Crop reductions due to micro-organisms/fragments
- Loss of agricultural lands
- Genetically modified foods/plants/animals
- "In general, the way in which the world's food is grown, processed and produced is the next "tobacco industry" type scandal. The unsustainable agricultural practices, the huge corporate confined animal feeding and production practices, the pesticides, hormones, and other additives along with distribution practices present a huge health hazard."
- "Animal rendering plants are being forced out of business due to loss of market on account of mad cow and other diseases. When they go, we will lose our ability to use/dispose of hundreds of tons per week of grease, blood, and carcasses. If disposed of properly, the expense will be another blow to the agriculture industry. Improper disposal will be an environmental nightmare."

Current world events have raised new concerns such as bioterrorism. Finally, one interviewee laments rising apathy as a root cause for future problems by describing the following issues: "Reduction in outreach to the elementary and middle school age kids and reduced participation by kids in these issues. More industry apathy about excelling in environmental performance due to spending reductions."

3.5 OVERVIEW BY MEDIA/CONDITION

This section organizes environmental conditions and trends for Colorado from collected data sources. This summary uses information collected for the target conditions (listed in Table 2-1), which are summarized individually in Appendix B. For the purpose of organizing environmental condition information, this section addresses each of the following categories (listed in descending priority based on expert interviews [see Section 3.21]):

- Land use
- Water quality
- Air quality
- Water supply
- Energy use and climate change
- Solid waste
- Hazardous waste
- Public health

3.5.1 Land Use

In 1997, 49 percent of Colorado's 66 million acres were used for farms and ranches, 41 percent for federal and state land, 8 percent was rural land, and the remaining 3 percent was developed.

The population in Colorado in 2000 was 4,301,261 with an average of 41.5 people per square mile. From 1990 to 2000, the population in Colorado increased by 30.6 percent, the third highest increase in the U.S. The 5 counties with the highest numeric population increase from 1990 to 2000 in descending order were Douglas, El Paso, Arapahoe, Jefferson, and Adams counties. Table 3-10 shows the projected population increase for the next 23 years.

Table 3-10
Colorado Population Projection

Year	Population	Increase from 2000
2005	4,468,000	3.7 percent
2015	4,833,000	11 percent
2025	5,188,000	17 percent

Another estimate from the Colorado state demographer is that the population in 2025 will be 6.5 million (34 percent increase from 2000 population).

From 1991 to 2000, the amount of land used for agriculture decreased from 32,800,000 acres to 31,600,000 acres, a decrease of 3.6 percent. During that same period, the average farm size decreased from 1,262,000 to 1,091,000 acres (a 13 percent decrease). Farmland is primarily located in 10 counties of the state. On average, from 1987 to 1997, agricultural land was converted to other uses at a rate of 140,000 acres per year. From 1992 to 1997, that rate was 270,000 acres per year. From 1959 to 1997, 6,153,000 acres (16 percent) of agricultural land was lost.

Uses of the land include urban and built-up lands (28,000 acres per year); open space, parks, and wildlife habitat; and low-density rural home sites and other non-agriculture uses of rural land. The decreasing acreage of land in farms is another sign of the impacts of growth and sprawl. The decreasing acreage of agricultural land impacts the environment because in Colorado most of the lost farmland is converted to suburban housing, which has been shown to be related to increased VMT and associated air quality concerns, as well as other environmental issues such as increased waste construction activities and increased electricity demand and use.

3.5.2 Water Quality

Colorado's surface water consists of 100,000 miles of river and streams and approximately 1,533 publicly owned lakes and reservoirs that are larger than 10 surface acres. Seven percent of the rivers and streams and

The majority of the causes (pollutants) and sources (activities, facilities, or conditions) for surface water contamination in Colorado are unknown.

5 percent of the lakes and reservoirs have impaired water quality for at least one intended use (aquatic life, water supply, recreation, or agriculture). The majority of the causes (pollutants) and sources (activities, facilities, or conditions) for surface water contamination in Colorado are unknown. Known causes of surface water contamination include metals, ammonia and organic enrichment, pH, pathogens, siltation, nitrate, and sulfate.

Sectors most significantly affecting surface water quality include mining operations for metals and coal, agriculture, and population growth in resort communities (creating the need for expanded infrastructure and increased nutrient loadings). Climate, hydrogeologic conditions, naturally occurring soluble minerals, and human activities are the primary factors affecting Colorado's groundwater quality.

Consistently throughout the five aquifers tested, the aquifers were contaminated with nitrates and pesticides.

Since 1992, all major aquifers located in agricultural areas of Colorado have been sampled if they 1) are shallow or unconfined, 2) are located in an area where agricultural chemicals are used, and 3) the alluvial or shallow bedrock aquifers are used for domestic water supply. Consistently throughout the five aquifers tested, the aquifers were contaminated with nitrates and pesticides. Groundwater in industrialized areas of the state, especially the South Platte alluvium and south Adams County, is contaminated with VOCs organic chemicals. The primary causes of organic groundwater contamination are listed below:

- Petroleum products from refineries and the former Stapleton International Airport
- Methane from oil and gas well or coal mines
- 8,000 underground storage tanks

Primary causes of inorganic groundwater contamination consists of the following:

- Sulfate and acid from coal mines
- Acid, zinc, copper, iron, manganese, cadmium, and molybdenum from ore mining
- Uranium, radium, thorium, strontium, cyanide, mercury, and copper from uranium mills
- Zinc, copper, cadmium, ion, and low pH from heap-leach gold mines

Approximately 1.5 percent (1 million acres) of Colorado is covered by wetlands. Over the last 2 centuries, wetland acreage in Colorado has decreased by 50 percent. Continued loss of wetlands and the resulting negative impact on wildlife habitat and ecosystems remains a major concern.

3.5.3 Air Quality

During the state's 2000/2001 fiscal year (July 2000 to July 2001), urban and rural areas in Colorado maintained compliance with National Ambient Air Quality Standards (NAAQS) for criteria pollutants (CO, ground-level ozone, PM_{10}, NO_x, SO_x, and lead). The exceptions to this compliance included isolated PM_{10} violations in Steamboat Springs, Alamosa, and Lamar due to blowing dust. Although in compliance in 1999 and 2000, Denver metro air quality was approaching the NAAQS for ozone and PM_{10}. In 1999, 1.24 million tons of CO were emitted from mobile sources, which was the largest quantity of any criteria pollutants from any source (mobile, point, and area sources). The next two largest quantities were NO_x from mobile sources (245,000 tons) and PM_{10} from area sources (183,000 tons). In the Western Slope, VOCs are the predominant criteria pollutant concern.

HAPs are also generated by mobile, point, and area sources. In 1996, 31,500 tons of HAPs were emitted: 2 percent from point sources, 31 percent from area sources, and 67 percent from mobile sources. For HAP emissions, mobile sources can be divided into on-road (35 percent of the 1996 total) and off-road (32 percent of the 1996 total) emissions.

Considerable data suggest that mobile sources are the most significant source of air pollution. In Colorado, VMT, which represents personal vehicle use, is increasing approximately 2.5 times faster than population growth. This phenomenon is closely related to land use and urban sprawl because VMT increases approximately two times as fast as population density declines. Increased VMT leads to spreading of air pollution over much larger areas, decreased visibility, loss of agriculture land and wildlife habitat, and overall negative impact on the environment. In 2001, the Denver metro area was ranked the 7th most congested area for traffic in the U.S. Unlike most states in the U.S., Colorado invested 0 percent of the Colorado Department of Transportation's revenue in its public transportation.

Considerable data suggest that mobile sources are the most significant source of air pollution.

3.5.4 Water Supply

Table 3-11 summarizes the water use in Colorado in 1995 according to the U.S. Geological Survey (USGS). At that time, Colorado's population was about 3,747,000 and used 3,690 gallons per day per person of fresh water. In that year in Colorado, 11 million gallons of wastewater were reclaimed per day, 3,770 million gallons were lost in conveyance per day, and 5,230 million gallons of fresh water were consumed per day.

Table 3-11
Total Water Use In Colorado (1995)

Water Source	Water Use*
Groundwater	2,270
Surface water	11,600
Total	13,800

*Values are withdrawals in million gallons/ day and include irrigation conveyance losses.

Irrigation is by far the largest use of water in Colorado at 12,700 million gallons per day (92 percent) of total water use.

Total water withdrawals in Colorado in 1995 totaled 13,800 million gallons per day, the fifth highest in the nation (4 percent of the nations water use). Irrigation is by far the largest use of water in Colorado at 12,700 million gallons per day (92 percent) of total water use. Irrigation uses 10,700 million gallons per day (92 percent) of the surface water. Of the remaining 8 percent (for both total water and surface water), the three highest users were public supply, industry, and thermoelectricity. Groundwater constitutes 18 percent of the water supply in Colorado. Irrigation is also the largest user of groundwater in Colorado at 2,020 million gallons per day (89 percent of groundwater use). Of the remaining 11 percent, the three highest users were public supply, mining, and industry.

In 2000, the total native supply of water in Colorado was 15,715,000 acre-feet and the consumptive use was 7,295,000 acre-feet. In 2030, the projected consumptive use is 7,620,000 acre-feet. Consumptive use is defined as the amount of water that is consumed and lost to the system while applying water to a beneficial use.

3.5.5 Energy Use And Climate Change

In 1999, total fuel consumption in Colorado was approximately 1.1 million MMBtu. Electricity generation and transportation consumed 34 and 32 percent of total use, respectively. Electricity generation is associated with significant air emission issues. For example, in Colorado, 82 percent of electricity is generated by combusting coal (nationally coal is used for 90 percent of electricity generation), which released over 36,000,000 short tons of carbon dioxide (CO_2), 132,000 tons of NO_x, and 86,000 tons of SO_2 in 1999. According to the Department of Energy, when coal is burned, it emits 70 percent more CO_2 per Btu of energy produced than natural gas. In Colorado, total CO_2 emissions from coal-fired power plants are approximately 15 times greater than emissions from natural gas-fired power plants. CO_2 is of particular importance because it is a greenhouse gas associated with climate change. Due to Colorado's reliance on coal, its CO_2 emission factor of 1.93 lb/kWh is relatively high compared to the U.S. average of 1.34 lb/kWh. Colorado's dependence on coal for electricity generation is softening as natural gas replaces coal in some areas. From 1990 to 1999, natural gas use for generating electricity in Colorado increased by approximately 14 percent per year. In Colorado, SO_x and NO_x emissions decreased during the 90s, but CO_2 increased by

1.9 percent. By sector, fuel use ranking in the 1990s has remained the same: 1) commercial, 2) residential, and (3) industrial.

In 1999, Colorado obtained 4 percent of its electrical energy from renewable sources (wind, solar, and hydro). The extent to which renewable energy sources are used in Colorado is relatively low given that Colorado is ranked 11th in the nation for wind-power potential. For example, the Energy Information Administration (EIA) estimates that, if fully developed, the state's energy needs could be met with wind power.

The U.S. Dpt. of Energy's (DOE) Energy Information Administration (EIA) estimates that, if fully developed, the state's energy needs could be met with wind power.

Colorado has one of the highest amounts of CO_2/kWh of electricity generated. Colorado's emissions factor is 1.93 lb CO_2/kWh, compared to the U.S. average of 1.34 lb CO_2/kWh. The power generation sector is responsible for a large share of greenhouse gas emissions (78 percent), because it burns primarily coal (which generates roughly twice the amount of CO_2/Btu as natural gas). Most of the fuel consumption sector contributions are attributable to electricity generation (34 percent) and transportation (32 percent). The fuel consumption for the power generation sector is allocated fairly evenly among industrial, commercial, and residential, based on their electricity use.

3.5.6 Solid Waste

There are 30 to 50 years of landfill life remaining in Colorado.

MSW is managed in 110 solid waste landfills located throughout the state. There are 30 to 50 years of landfill life remaining in Colorado. In 2000, approximately 21.8 million cubic yards of MSW were generated. Assuming 1 cubic yard weighs 600 pounds, Coloradoans generated 6.5 million tons of MSW in 2000, which was approximately 6.2 pounds per person per day (excluding construction and demolition debris). This generation rate represents a 22 percent increase from 1996, when the MSW generation rate was 5.01 pounds per person per day. An estimated national daily per capita MSW generation is 4.4 pounds per person per day.

Coloradoans generate about 6.2 pounds of MSW per person per day. The national average is 4.4 pounds per person per day.

Colorado's recycling rate is currently 10 percent of solid waste generated in Colorado. The national rate in the U.S. is 32 percent. In 1989 Colorado's recycling rate was 14 percent and in 1997 it had increased to 18 percent. Notably, the solid waste diversion rate data is of low quality because Colorado does not measure recycling/disposal of solid waste. However, by all estimations, Colorado is at the low end of the recycling scale nationally.

Colorado's recycling rate is currently 10 percent of solid waste generated in Colorado. The national rate in the U.S. is 32 percent. In 1989 Colorado's recycling rate was 14 percent and in 1997 it had increased to 18 percent. In 2000, it decreased to 10 percent.

3.5.7 Hazardous Waste

Colorado generates approximately 0.1 percent of the nation's hazardous waste (35th in a ranking of states) and contains 0.8 percent of the nation's large quantity generators (LQG). In 1999, 163 LQGs in Colorado created almost 50,000 tons of hazardous waste, 80 percent of which was generated by the top 5 generators. Most LQGs are located in Front Range cities from Pueblo to Boulder, and the top 10 facilities are

located in seven Front Range cities. Most of the hazardous waste (about 90 percent) is shipped out of state for disposal.

TRI data from 1999 indicate that 195 Colorado facilities reported releases of over 21 million pounds of toxic chemicals. However, 71 percent of this amount was released by industries new to the TRI, notably mining and electrical generation. Most of the reported TRI releases are naturally occurring metals left in rock after mineral processing. The other 29 percent of TRI releases was generated by manufacturing and federal facilities. For facilities that reported in 1988 and 1999, there was an overall decrease in TRI releases of 68 percent. In 2000, facilities were required for the first time to report releases of PBT chemicals. For this reason, no historic trends are available for PBT chemicals. Preliminary 2000 TRI data suggest that the three sectors generating the most PBTs are mining, energy, and solvent recovery.

Many counties and municipalities in Colorado sponsor some type of household hazardous waste (HHW) collection program or event; for example, an annual HHW roundup. HHW includes a wide variety of materials, such as waste paint, solvent, oils, and coolant; pesticides and fertilizers; cleaning chemicals; and batteries. Because HHW events are independent and locally operated, there is no centralized reporting or data processing to record statewide HHW collection.

3.5.8 Public Health

The cumulative lifetime risk of cancer in Colorado for males is 1 in 2 and for females is 1 in 3. From 1994 to 1998, 73,000 people were diagnosed with cancer in Colorado. Prostate cancer is the most common form of cancer among men (29 percent) and breast cancer the most common form among women (19 percent). Seventy-three percent of breast cancer cases can be attributed to environmental factors (tobacco smoke, alcohol, radiation, dietary habits, toxic chemicals, and viral infections). Geographically, the highest cancer rates occur in the central portions surrounding the city of Denver and the Northwest corner of the state.

Colorado has the second highest estimated prevalence of asthma of any state in the U.S., with an estimated 7.1 percent of the population (approximately 280,000 people) affected by the disease. The number of children with asthma more than doubled between 1980 and 1995. The diagnosis rate for children under 5 years old increased over 160 percent during that period.

"Data may need to be collected over a larger region and should be analyzed in a more integrated/ holistic manner…"

- Interview Response

3.6 DATA GAPS

Question 4 of the interview asks what data ***are not*** being collected that would help complete the picture of Colorado's environmental conditions. The responses to this question are helpful in understanding the limitations of the ECADS study as well as possible strategies for addressing these data gaps in future updates of the study.

Unlike many of the other survey questions, the responses to Question 4 tended to be unique responses that were not easily tallied into categories. Furthermore, some interviewees used Question 4 as a platform for discussing related data management issues, such as difficulties with data access and limitations with analysis tools and methods. A complete listing of the interview responses to Question 4 are provided in Appendix A.3, which is organized by the eight key conditions presented in Section 3.1 followed by issues related to data access and use.

One of the most significant results from asking this question is that the topic area with the most data gaps - land use (growth) – also happens to be the number one environmental concern among those interviewed. There is no statewide mapping or database of land ownership and uses. As a result, there is no associated analysis, such as the conversion of agricultural land to development, the ratio of greenfields developed to brownfields, etc. In addition, statewide data are lacking on the true costs and environmental impacts of development.

Another useful result from asking this question was to confirm the data gaps the Project Team encountered during the data collection process. For example, data on certain environmental conditions, such as solid waste and household hazardous waste, are being collected at the local level, but there is no statewide accounting for these topics. Similarly, very little data are being collected that look across topics to examine the connections between environmental media. An example from the Question 4 responses is the relationship between water supply and water quality.

"So many people are collecting data that goes into black holes."

- ***Interview Response***

Finally, the Question 4 responses helped to expand the discussion of data gaps to more broadly identify challenges associated with data use and interpretation. In particular, interviewees raised issues regarding data accuracy, public access to data, how to connect data to root causes, using data to make informed decisions, normalizing data to obtain impacts per person, using data to establish and monitor environmental indicators, and other challenges.

3.7 BARRIERS TO IMPROVING ENVIRONMENTAL CONDITIONS

An instrumental interview question asked interviewees their impressions of barriers to improving Colorado's top environmental conditions. This question not only aided identification of potential barriers, but also served as a basis for considering actions that could increase success.

Human factors are perceived as the main barriers, particularly short-term thinking with respect to personal behavior and public policy.

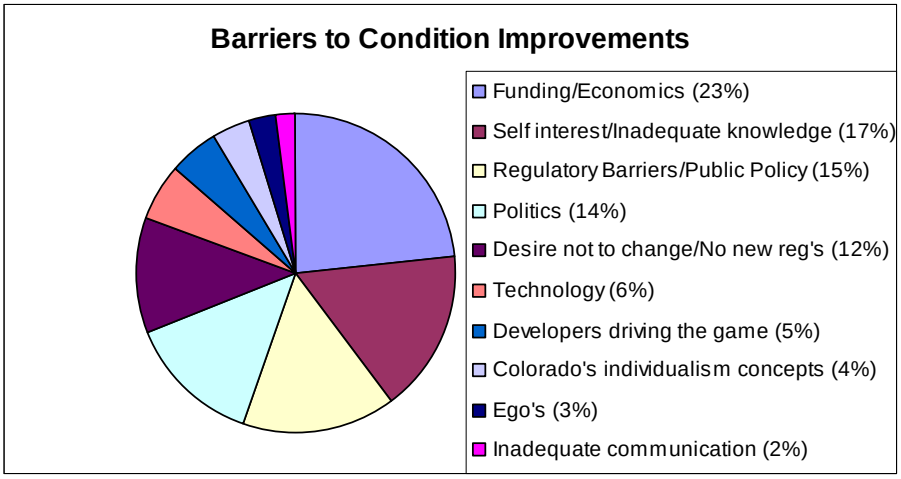
The following points are key highlights of Question 7 based on the expert interviews:

- Fundamentally, underlying human factors (versus technology and/or economic barriers) are perceived as the main barriers.

- A primary barrier to improving statewide environmental conditions is short-term thinking, both in terms of personal behavior and public policy.

Many common themes were observed in the responses to the question of barriers. The responses were organized into 10 general areas. These areas are shown in Figure 3-3.

Figure 3-3
Interview Question 7 Overall Responses



Although funding is the single most mentioned barrier, if the responses are categorized into the more generalized topics of human factors, public policy, economics, and technology, human factors emerge as the top barrier, with economics playing a less significant role. Specifically, the more generalized results are as follows:

- Human Factors: 38 percent
- Public Policy/Politics: 34 percent
- Economics: 23 percent
- Technology: 6 percent

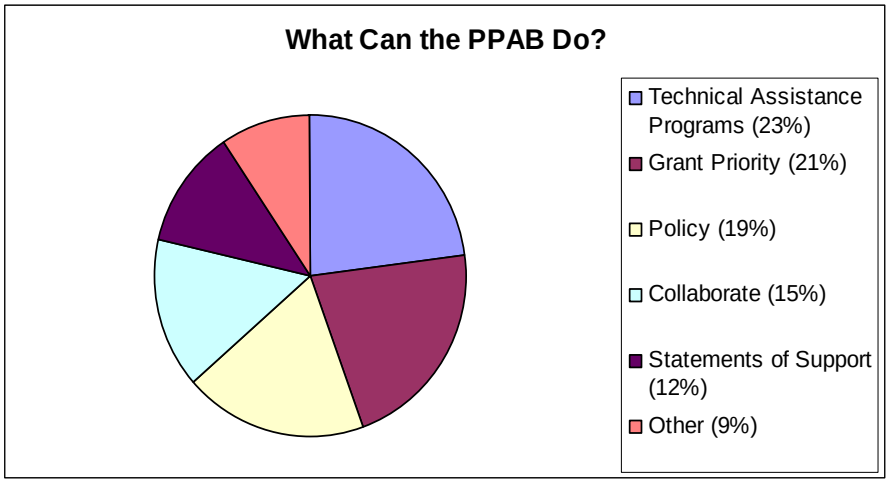
4.0 RECOMMENDATIONS

This chapter discusses recommendations for the PPAB and other prospective partnering organizations based on recommendations received from expert interviews (Section 4.1) and insights uncovered by the ECADS Team during the study effort (Section 4.2).

4.1 RECOMMENDATIONS FROM EXPERT INTERVIEWS

The final question of the interview asked for specific suggestions that the PPAB can act on to address the environmental conditions in the state. Again, the responses received on this topic fell into several identifiable categories and are represented in the pie chart of Figure 4-1.

Figure 4-1
Interview Question 9 Overall Responses



It is important to keep in mind that most of the interviewees have a limited working knowledge of the PPAB grant program, technical assistance, and outreach efforts. Therefore some of the recommendations are outside the scope of the PPAB or too large for the PPAB to take on alone. Even so, the recommendations are included in Appendix A of this report for other interested organizations to consider and to help identify specific points of collaboration with other organizations. Key highlights for each recommendation category are provided in the remainder of this section.

Technical Assistance and Outreach

A critical first step in outreach is to increase the visibility of the PPAB and its programs, followed by general outreach to the public in raising awareness of the most pressing environmental conditions identified

through this study. P2 curriculum development is also noted as a recommendation at all levels of education. As part of education and outreach, one recommendation was to develop white papers on key environmental issues in ways understandable to the public and policy makers, including recommendations for action.

In terms of technical assistance, interviewees believe that the PPAB should hold the recipients of P2 technical assistance accountable for reporting results and that the PPAB should raise its expectations and not reward mediocre performance in P2. From a geographic standpoint, mobile assistance would be helpful for reaching rural areas and the Western Slope. P2 technical assistance should explicitly include renewable energy and energy efficiency. Furthermore, the state should be a good example for P2 practices in its own operations if it intends to be a credible supplier of p2 outreach and technical assistance to other sectors. Finally, technical assistance should focus on environmental justice and the communities that are unfairly victimized by pollution.

"The PPAB should be more visible with the media and the public. People don't know who you are."

- Interview Response

Grant Priorities

Although interviewees provided several suggestions for grant priorities, there were also interviewees that felt such a small amount of money should stay focused on traditional P2 and that the larger grant ideas should be investigated as possible new collaborations with other grant programs. Some of the existing grant priorities were named (unknowingly by the interviewee) as suggestions for continued emphasis. Examples include consumer education, construction waste, and sustainable development. Many of the grant suggestions focused on funding studies to address the data gaps discussed in Section 3.4. Due to a limited grant funding pool, some interviewees felt that issues such as energy, transportation, and smart growth are better left to other organizations. A listing of specific grant program recommendations is included in Appendix A.

"Determine what is most important and develop a specific plan of action…"

- Interview Response

In terms of comparing these recommendations to the existing list of grant priorities used by the PPAB in its solicitation of grant proposals, Table 4-1 highlights interview results that are relevant to current grant priorities.

Table 4-1
Existing Grant RFP Comparison With ECADS Results

Current PPAB Grant Priority	Relevant ECADS Results
• Regulated and unregulated industries in metal mining, agriculture, wood products, furniture, chemical and allied products and others shown to have significant pollution.	• De-emphasize industrial sectors, but keep agriculture as a priority sector.
• Sources that have increased pollution because of growth in Colorado, including mobile sources and the construction sector.	• Mitigating growth impacts should remain a priority, particularly in the construction sector. However, some experts feel that transportation would be better addressed by other existing (and larger) programs.
• Individuals both as consumers of products and customers of business.	• Population growth and the lack of public awareness make this a continued high priority.
• Non-point sources of pollution (air, water, and solid waste) that are currently outside the regulatory framework, especially significant sources of impacts including but not limited to home lawn and auto care, golf courses, and shopping center sites.	• Generally, ECADS supports the continued emphasis on non-point sources outside the regulatory framework. The examples listed at left were not specifically substantiated nor denied by this study. However, other examples did come up, such as the recreation sector.
• Sources that could benefit from energy or water conservation measures.	• Concerns over future water supply have emerged as a high priority from ECADS. However, some interviewees feel that energy is better addressed by other organizations.
• Applications that demonstrate or implement sustainable practices, e.g., industrial ecology, renewable energy, sustainable design models, etc.	• ECADS results strongly support continued emphasis on sustainable development principles to mitigate current and future unknown conditions. Industrial ecology, as a specific example, was not strongly supported by the study results, but renewable energy was.

Policy

During the planning phases of the ECADS project, the PPAB indicated that two goals of the study were to assist the PPAB in fulfilling its

policy-advising role and to help justify PPAB stances on environmental issues facing the state. The comments from interviewees provide suggestions on policy issues for the PPAB to champion as well as general steps or advice for formulating the PPAB policy agenda. A listing of policy-related recommendations is included Appendix A, with key highlights summarized below:

- Set a small number of priorities and really take action on them in policy at CDPHE and legislation in the Assembly.
- Offer advice, as a policy advisory board, to elected and appointed officials on issues related to P2, such as transportation, energy, and recycling.
- The State of Colorado should develop a more specific comprehensive P2 and sustainable development policy that would be mandatory for state government. This has been done in other states like New Jersey, Minnesota, and Oregon.
- Develop intradepartmental policies that begin the move toward a more sustainable regulatory structure by CDPHE, e.g., more cross-media approaches that ensure that P2 is the management tool of first choice.
- Recommend that the State should walk the talk – i.e., full P2 implementation across all State agencies.
- Support mass transit projects as a policy matter.
- Promote more interaction with lawmakers to create laws that reward sustainability and self-reliance.

"Offer advice, as a policy board, to elected and appointed officials on issues related to P2."

- Interview Response

Collaboration

Clearly, the breadth and scope of recommendations provided by the interviewees with regard to policy, grant priorities, and technical assistance and outreach cannot all be accomplished by the PPAB and its CDPHE P2 program staff alone. Several possible partnerships have also been provided by the interviewees for pooling resources and collaborating together on specific projects. Specific recommendations for possible partnerships for the PPAB to investigate are included in Appendix A.

Statements of Support

Aside from partnerships and promoting policy, the PPAB can provide support to other organizations engaged in promoting topics of mutual interest. Specific opportunities for this strategy were not provided by the interviewees, but they generally did cite this stragey as a way of leveraging limited resources once a clear policy agenda has been developed.

"Don't stop with ECADs. Grow this (study) into an environmental index that is taken seriously by leadership, the media and the public."

- Interview Response

4.2 FUTURE UPDATE AND ENHANCEMENTS TO ECADS

The full documentation for this ECADS project includes all the information necessary to repeat the study in the future. For example, a database of contact information and notes regarding individual data sources has been developed. However, consistent with the key results of the benchmark analysis (see Section 2.1), there are areas of the study that could be enhanced should the study be expanded in a phased approach. Specifically, the areas that were identified during the course of the ECADS project for consideration as future enhancements include the following:

- Inclusion of more data sources beyond the prioritized data sources voted on by the PPAB
- More in-depth analysis of individual data sources to better understand underlying root causes
- A supplement to the data analysis that examines programs and activities addressing individual environmental conditions (to prioritize areas in greatest need of assistance and strategic partnerships)
- A public input and outreach component
- Use of normalization factors, such as population, to better characterize environmental conditions
- Development of key environmental indicators to more rigorously monitor trends in environmental conditions in a "report card" fashion
- Concerted review of federal or other funding sources that could support the next phase of ECADS

APPENDIX A

Expert Interview Information

ECADS List of Interviewees

Name	Affiliation
Arfmann, Dennis	Air Committee Chair, Colorado Association for Commerce and Industry (CACI)
Scherer, Jim	Chairman, Regional Air Quality Council; Former Reg. Adm. USEPA Region VIII; Former Director of Colorado Alliance for a Rapid Transit Solution (I-70)
Yergert, Mitch	Colorado Department of Agriculture
Cooper, Jill	Colorado Department of Public Health and Environment (PPAB, Ex-Officio)
Drew, Ellen	Colorado Environmental Business Alliance
Jones, Elise	Colorado Environmental Coalition
Brady, Robert	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Creamer, Dennis	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Dale, James	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Eye, Karen	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Feeder, Melissa	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Grice, Rick	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Hodge, Kermit	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Kostrzewa, Michael	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Kramer, Katherine	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Staub, Poppy	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Wiescamp, Cheryl	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Wrend, Julie	Colorado Governor's Pollution Prevention Advisory Board (PPAB)
Grenado, Lorraine	Colorado People's Environmental and Ecological Network (COPEEN)
Wicks, Regina	CoPirg
Donahue, Teresa	Denver Dept. of Environmental Health (retired)
Gardner, Liz	Denver Water Board
Dunlop, Tom	Dunlop Environmental Consulting, Inc.; Pitkin County Health Department (retired)
Burnap, Parry	Environmental Condition and Direction (ECADs) Advisory Team
Duprey, Bob	Environmental Condition and Direction (ECADs) Advisory Team
Kolwey, Neil	Environmental Condition and Direction (ECADs) Advisory Team
Clough, Kerry	EPA Region 8 – Senior Management
Nielsen, John	Land and Water Fund of the Rockies
McClintock, Rich	Livable Communities Support Center
Shaver, Chris	National Park Service
Bedford, Charles	Nature Conservancy
Hase, Denise	North East Health Departments
Morson, Berny	Rocky Mountain News
Urbanos, Wano	San Juan Basin Health Department
LeFever, Susan	Sierra Club
Brown, Fran King	Southern Ute Indian Tribe, Environmental Programs Division
Stein, Theo	The Denver Post
Kotas, Jerry	U.S. Department of Energy
Van Genderen, Heidi	University of Colorado at Denver Wirth Chair in Environmental and Community Development Policy

ECADS Sample Interview Form

Colorado Pollution Prevention Advisory Board (PPAB)

Environmental Conditions and Directions Study (ECADS)

ECADS Project Background

The PPAB was created by the Colorado Pollution Prevention Act of 1992 to provide strategic guidance and oversight in the implementation of the legislative mandate that "*the state policy of Colorado shall be that pollution prevention is the environmental management tool of first choice.*" PPAB members are appointed by the Governor. For more information about the PPAB and the Colorado Pollution Prevention Program, refer to http://www.coloradop2.org/cop2p.htm.

In 2001, the PPAB initiated the Environmental Conditions and Directions Study (ECADS) as a follow-up to a 1994 "Pollution Prevention Priorities Study". The purpose of ECADS is to identify PPAB priorities based on environmental conditions state-wide, in particular, conditions that can be improved through pollution prevention (P2). By definition, pollution prevention includes the conservation of resources, including energy and water, and the reduction of waste at the source, prior to recycling or treatment.

Interview Information	
Date of Interview:	
Interviewer:	
Interviewee:	
Affiliation:	
Address:	
City:	
Zip:	
Phone:	
Fax:	
Email:	

Interview Questions		
In your opinion, what are the top 2-5 most significant environmental conditions in Colorado:	**In your area of expertise?**	
	In general?	
What is the basis for this response (e.g., personal experience, data, anecdotal evidence, other)		

Is there data to support this condition? (Yes/No)	**If Yes, who is responsible for managing the data?**	
	How is the data accessed?	
What data isn't being collected that would help complete the picture of Colorado's environmental conditions?		
How does growth affect these conditions?		
What do you predict will be the future trend for these conditions?		
What are the barriers to improving these environmental conditions?		
Do you foresee any new environmental conditions/issues/concerns in the next 10 years that haven't already been identified?		
What specifically can the PPAB do to address/alleviate these conditions? **For example:** **i. Make it a grant priority** **ii. Other technical assistance programs** **iii. Policy** **iv. Collaborate with particular organizations (name them)** **v. Statements of support** **vi. Other (please specify)**		

ECADS Data Gaps Identified in the Interview Process

LAND USE

- A statewide database on ownership of land
- Smoke emissions from forest fires
- Biodiversity data - similar to habitat assessments
- Data on impacts of land use are not collected
- Impact of development on storm water management, habitat destruction, and how many acres of vacant brownfield land there is for every acre of greenfield developed.
- Land use and expected use; discover land available for protection; conversion of rural and undeveloped lands into subdivisions.
- Actual cost of urban sprawl, including all externalities such as pollution, land use and degradation, species' impact, waste use, increased travel time and resultant pollution, transportation costs.
- Growth - more sophisticated GIS mapping data that shows nexus between land use and transportation decisions and on impacts regarding the loss of open space and impacts on other resource issues such as air quality impacts. This will be helpful in developing state growth policies and whether urban growth boundary should be expanded.
- Cost of sprawl - data on the cost of urban sprawl. If we fully priced out current growth pattern, it would show a pattern that isn't fiscally sustainable.
- Conversion of agricultural land to sprawl - it would be a good idea to get a clear picture on the conversion rate relative to different types of development and what local state policies are contributing to these impacts.
- Public lands - more information on fire prevention activities because we have little understanding on how thinning and selective logging may impact ecological systems, including fire reduction and water quality.
- Impacts of population growth including impacts on wildlife, land erosion and watersheds.
- More data on habitat loss.
- There is a lack of data on the big picture. For example, if looking at streams or habitat, it is limited to one stream/area. Having a big picture gives a different perspective. For local land use issues hard to get big picture. For air and transportation there is data on the big picture.

WATER QUALITY

- Abandoned mines and water quality implications - we do not have good data on the number of mines and this poses the greatest threat.

- Solid analysis of the relationship between water quality and water supply. For example, recent studies have shown endocrine inhibitors in water. As water quality deteriorates, even in source water, the amount left for growth (at least at the current patterns of use) is less.

- Water quality under highly maintained landscapes to see what chemicals are infiltrating groundwater, and what, if any, damage is being caused.

AIR QUALITY

- Emissions from desert storms and urban blight (PM2.5) coming into the state
- Better corridor specific PM - 2.5 data
- Indoor air pollution from a variety of toxic chemicals
- Air monitors - in mountain basins with large emitters and along Front Range (other than Denver).
- Global impacts of automobiles - especially SUVs (e.g. emissions, gasoline consumption - dependency on foreign oil, tire wear, consumption of raw materials - steel, rubber, copper, etc).
- Long-term air quality studies and modeling
- Air quality benefits of mass transit

WATER SUPPLY

- Data on measurement of water usage, quantity available and savings from water conservation measures.
- The groundwater data collected is very “hit and miss”, not a comprehensive assessment.
- We need a better statewide understanding on how land development patterns are affecting quantity of waters available and into the future. Building beyond our water quantity limits for biosystems and aquifers.

ENERGY USE AND CLIMATE CHANGE

- I'm not sure that energy production is collected in a usable form. I would think the power plant air emissions are now available; not sure what data is available for storm water and mining.
- A big data gap out there is a credible analysis of the environmental benefits of substituting fossil energy with renewable energy and efficiencies. You can do it

with rough rules of thumb, but with integrated power plant systems, the analysis isn't being done. Some regional groups are trying to get a handle on that. Conversion factors don't take into play plant-level factors and how plants interact with the overall system. That information will help to craft better policy.

- There's no state agency responsible for collecting and disseminating energy data (and working on related state energy policy).
- A source of energy presently being discussed is coal bed methane, but the extraction process has a great impact on water (fracturing to release gas) and reinjection of water from formations back into ground. There is no good data on implications to drinking water supplies.
- There is lack of data on power plant emissions and mining operations especially heap leaching.
- Actual cost of development, production and use of nonrenewable resources, including all externalities.

SOLID WASTE

- The recycling community is sorely lacking numbers to track activities in solid waste management. There is no standard data collection system for recycling in Colorado.

HAZARDOUS WASTE

- Evaporation and runoff of chemicals at households and in agriculture
- Data on household hazardous waste disposal would be useful
- Toxic chemical data is needed that allows a mass balance to be done: what chemicals are coming into the state, where do they go and how is the environment impacted.

PUBLIC HEALTH

- More complete pictures of impacts of environmental pollution on human health and ecological health
- There is little effort to collect data on unhealthy home issues such as emergency room visits resulting from asthma attacks and assessing cause

ISSUES ASSOCIATED WITH DATA ACCESS AND USE

- Data isn't easily compiled due to privacy arrangements; data used during negotiation; Incompatible forms of collection; Incompatible forms of electronic recall and exchange.

- Biggest problem is the use and compilation of data so people can make decisions based on the data. So many people are collecting data that goes into black holes.
- Data has been collected, but not shared (I.e. Bureau of Reclamation and data on high alpine lakes pH)
- Data is not tied to possible causes
- Data may need to be collected over a larger region and should be analyzed in a more integrated/holistic manner - while we may be reducing pollution on worst days, are current strategies effective in preventing pollution increases over a larger area, in other words.
- Need more focus on reducing per capita contribution to overall pollution and waste.
- Need regular reports on how we are doing.
- Amount of emissions or pollution avoided that would be possible with doable lifestyle choice changes.
- Baseline data on the origin of the sources for air pollution.
- More of an analytical gap than a data gap, there seems to be good data on impacts of individual proposed power projects, but the piece that's missing that is really important is a kind of cumulative impact analysis of all the new sources coming in. One by one it may not look like a big deal, and they get approved/policies made on this basis. We need to step and look at the broader picture. Lack of cumulative impact analysis across a range of developments. A big gap in public policy.
- A (third party verified) "Sustainability Scorecard" would be useful: a compilation of the state of the state in terms of all resources and the manifestations of their use (energy, air quality, transportation, agricultural/open lands, the economy, public health; integrated community design etc.
- Enforcement: It is difficult to access data on enforcement and would be useful to have greater access.
- TRI has great information, but it is updated so infrequently it is not as useful as it could be.
- The question needs to be asked is the current data accurate? Can the public access it? Or, is it reported to the public? We seem to lack holistic information on impacts.

Recommendations from Interviewees

Technical Assistance and Outreach

- It's very important to conduct public education of the problems and involve people in the solutions.
- Technical assistance that is mobile would be helpful for the rural areas.
- Need western slope assistance for smaller sources.
- Need to stop rewarding mediocrity on pollution prevention; small measures are not enough; set higher expectations
- Bring the focus to specific problems by requesting reporting of problems and progress for specific environmental impacts. From this, a scorecard could be developed.
- Explicitly recognize and encourage Renewable Energy and Energy Efficiency as a P2 technology of choice.
- Use performance contracting to fully implement a comprehensive set of energy efficiency measures in all State buildings and facilities - then use some of the savings to invest in renewable energy to gain the multiple environmental benefits
- Implement renewable energy purchases/installations for State buildings - On-site generation (some PV) for visible demonstration of leadership
- Purchase renewable energy/or renewable energy credits (green tags) to offset an escalating percentage of State electricity use - 3 percent by 2005 or before; 8 percent by 2010 or before
- PPAB should work with all of the state's educational institutions to develop P2 curriculum, educational programs and industry assistance programs;
- Provide and support educational opportunities for citizens, businesses, and governmental agencies to help them understand impacts and find solutions to minimize these impacts
- Consensus development between other agencies and entities.
- Assisting a company as to how to solve environmental problems and stay lucrative.
- Show leadership in integrating various related program areas across state government and within state health.
- Produce white papers analyzing these issues in ways understandable to the public and policy makers, including recommendations for action.
- Identify private and public organizations using "best practices" and initiate very visible recognition of them.
- The PPAB should be more visible with the media and the public. People don't know who you are.
- There needs to be accountability. PPAB should suggest solutions to solve problems, such as tell the public how using wind power will cut pollution, how to recycle, etc.
- Look at causality - then focus on the right thing. Encouraging use of mass transit for example.

- Promote good practices such as recycling, proper disposal of hazardous waste, alternative energy and transportation
- Focus on environmental justice and the communities that are unfairly victimized by pollution. Don't give money to industry, who can afford to do their own studies, but instead do a set aside for non-profit group to do public outreach with educational programs.

Grant Priorities

- Educational activities should be a part of the grants program
- Influence transportation related decisions by making a grant priority, through statements of support and collaboration with other organizations such as the Regional Air Quality Council, DRCOG, Colorado Motor Carriers Association and CDPHE
- Include construction waste and consumer education in grant priorities.
- Grant priorities should help focus research and development of practical solutions.
- Performance incentives to track pollution/per capita; need specific goals and then track how we are doing
- Use the grant process to solicit only proposals that will address specified concerns, e.g., only solicit proposals from local governments and/or waste disposal entities that will pilot test programs for the reduction of per capita consumer waste production
- Areas definitely need to be grant priorities; particularly in the C&D recycling efforts, I think that a significant waste generator could be reduced with effective programs in place. 30 percent of a state waste-stream is a huge number and worthy of our attention.
- To the extent that there is grant money available, if they can get an agency within the state to do the cumulative impact analysis, that would be good.
- Make sustainable development a grant priority through education programs.
- Fund analyses of the potential impact of implementing a System Benefit Fund and a Renewable Portfolio Standard on the State economy and environment.
- Possibly for water quality and water use issues. Energy issues are better left to other agencies and the PUC. Smart growth and transportation issues are also better left to others.
- Pay for studies to support mass transit.
- Set more focused priorities. Determine what is most important and develop a specific plan of action. This has worked effectively to improve air quality in the state and achieve national air quality standards statewide.
- Fund grants that focus on collecting data on true costs, including externalities, regarding our energy and land use policies.

- Identify and promote grant priority opportunities available beyond this program to address issues and provide letters of support for those applying for the grants - for example, the Vasquez/I70 Superfund site in north Denver includes lead as a contaminant of concern; we know that the older housing stock in that area is likely to have lead based paint issues or other lead sources; the group could help identify grant opportunities through HUD or other sources and support Denver efforts to address non-Superfund sources of lead and identifying lead prevention education efforts as part of the program (healthy homes type issues)

Policy

- Set a small number of priorities and really take action on them in policy at CDPHE and legislation in the Assembly.
- Offer advice as a policy advisory board to elected and appointed officials that will allow resources to be used, but not be used up.
- It's essential that the state first identify its key environmental problems, put in place adequate and accessible data bases, develop an index for environmental indicators related to these problems and periodically publish status reports on trends, continuing problems and successes.
- The state of Colorado should develop a more specific comprehensive pollution prevention and sustainable development policy that would be mandatory to be followed by all of state government. This has been done in other states like New Jersey, Minnesota, and Oregon.
- Need to encourage markets for recycled products/renewable resources
- Policy development is most important in solving the issues of I-70 transportation and future water supply. Both require being somewhat "futuristic" and most of the policy makers tend to be reactive to today's crisis without any look at the future.
- Develop intradepartmental policies that begin the move toward a more sustainable regulatory structure by CDPHE, e.g., more cross-media approaches that ensure that pollution prevention is the management tool of first choice. As a subset of this activity, each of the divisions should begin to qualify and quantify cross-media transfers of pollution caused by a media-specific pollution control activity or device. E.g., where VOCs are removed from an air stream and placed into a water stream, sent to a wastewater treatment facility, and then evaporated as the water pollution control option, this should be described in terms of air benefit at front and back ends, water quality and quantity implications, and economics (capital investments and ongoing maintenance costs). Alternatives should be reviewed.

- Host a Sustainable Colorado summit with all of the executive agencies to identify which "indicators" are of the most important and will be tracked by all of Colorado government and then track through the year(s) the social, economic and environmental aspects of each of the chosen indicators. All of Colorado government should speak with one voice and be addressing the same concerns. By looking at social, economic, and environmental aspects of these indicators, by default we will be moving toward a more sustainable view of Colorado.
- Advise the governor and other policy makers in the state to support clean energy policy; for example, policies to support renewable energy development (e.g., tax credits to renewable energy portfolio) and encouraging pricing reform of PUCs.
- Work with state legislature on recommendations for growth and transportation policies.
- Focus on policy as it relates specifically to pollution prevention
- Recommend that the State should "walk the talk" - i.e. Full P2 implementation across all State agencies.
- Support mass transit projects as a policy matter.
- PPAB should examine the impact that reduced fees from successful waste disposal prevention efforts are resulting in negative impacts on CDPHE's Hazardous Waste Management Division ability to effectively operate its regulatory program. What alternatives are available to address this problem.
- Support statewide policies on growth, land use, resource conservation, alternative energy, and other environmentally protective policies.
- To whatever extent PPAB can get organizations and groups together to support environmental policy statewide.
- Growth - there has been very little leadership at state level on the issue of growth that resulted in meaningful changes and policy; there are opportunities for PPAB to play prominent role in addressing Colorado's growth problems. The obvious from traffic, land use patterns, and water quality. Can get involved in debate and provide data and recommendations to promote statewide growth policies and help make the like between pollution and sprawl.
- Energy - there is a huge opportunity to look at existing energy policies and explain why it does not make sense for pollution - let's invest in solar and wind and other energy technologies. Many opportunities for Colorado to continue to lead country on this issue. Dividends are economic and environmental. PPAB can take a lead in promoting and energy policy that focuses on pollution prevention.
- Make Pollution Prevention a political issue; that is, it needs to be seen as an essential part of living and working in Colorado.

- Increase outreach to that area of the population with the most time to impact change. The PPAB can drive change by mentoring and educating a board community base; providing technology grants, going out and recruiting and developing young champions, interacting with other groups (regulators/policy writers) to promote change.
- More interaction with lawmakers to create laws that reward sustainability and self-reliance.

Collaboration

- Work with Oil and Gas Conservation Commission to address impacts of oil, gas and energy development.
- Work with NAAQS to create voluntary prevention programs. Help to develop programs to reduce mobile source emissions
- Agriculture: NRCS, San Juan RC&D, Cattleman's Association
- Collaborate with the other Boards and commission at CDPHE
- Collaborate with groups such as the Green Business Roundtable that just started in Durango.
- Need to look at relationships with energy-efficient organizations through DOE/EPA Energy Star and U.S. Green Building Council's Leadership in Environmental & Energy Design (LEED) program to support growth in an environmentally -responsible fashion.
- Encourage partnering between interested partners to develop a vision and roadmap for specific problems (much like to the DOE Industry of the Future program)
- Try to engage some of the business community in some of these efforts, especially of those that have a stake in attracting people to Colorado for the quality of life factor. Engaging businesses is a key element of policy making at the state level. Expanding the PPP from reducing waste at own facilities, to supporting some of these proactive environmental and energy policies.
- Collaborate with existing organizations such as CSU, local county agencies and state programs to identify technical assistance programs that go beyond P2 and E2 - i.e. sustainability, conservation, etc.
- Collaboration - absolutely! With any and all from CU to CEBA to CSBN to BECC to all pertinent state agencies to...too many to mention.
- For water use issues, the Board could collaborate with the Ag Extension Services to promote best practices associated with water efficiency and pesticide and fertilizer use.
- PPAB should conduct more joint efforts/collaboration with the Pollution Prevention Partnership; perhaps set aside a portion of grant funds to be administered by the P2 partnership on specific projects.
- Work with water experts at DNR and Denver Water to develop a policy on sustainable development re: water. This will NOT be easy because of all the conflicting interests.

- Collaborate with other experts (American Water Works Assn. Research Foundation, Water Environment Federation, etc.) to develop op/ed articles to be published in the major newspapers in our state to educate the general public.

APPENDIX B

Environmental Conditions and Directions Study
Data Source Information