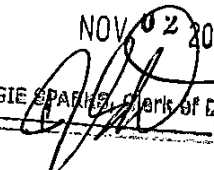


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FILED

NOV 02 2022
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MONTANA FIRST JUDICIAL DISTRICT COURT
LEWIS AND CLARK COUNTY

RIKKI HELD, ET AL., PLAINTIFFS, v. STATE OF MONTANA, ET AL., DEFENDANTS.	Cause CDV-2020-307 Hon. Kathy Seeley DEFENDANTS' EXPERT WITNESS DISCLOSURE
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Pursuant to this Court's June 15, 2022, scheduling order and Mont. R. Civ. P. 26(b)(4), Defendants State of Montana, et al. withdraw all previously disclosed expert and hybrid witnesses and provide the following expert witness disclosure:

1. Judith Curry, PhD.
CFAN – Climate Forecast Applications Network, LLC
Reno, NV

Judith Curry, PhD. is a Professor Emerita and former Chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Dr. Curry is currently President and co-founder of Climate Forecast Applications Network (CFAN). Dr. Curry's opinions and conclusions are set forth in her expert report attached as **Exhibit A**. Dr. Curry's opinions are based on her knowledge and expertise as set forth in her CV, as well as her review of the pleadings, discovery, and expert reports. Dr. Curry's CV is attached as Appendix A to her report and sets forth her qualifications as an expert. Discovery is ongoing in this matter; thus, Dr. Curry's opinions may be altered or amended based on new testimony and evidence. Accordingly, Defendants reserve the right to supplement this expert disclosure based on any new information.

2. **Terry L. Anderson, Ph.D.**
269 E. Hodgeman Rd.
Bozeman, MT 59178

Terry L. Anderson, Ph.D., has a B.S. in Business Administration from the University of Montana, M.S. in Economics from the University of Washington, and Ph.D. in Economics from the University of Washington. Dr. Anderson's opinions and conclusions are set forth in his expert report attached as **Exhibit B**. Dr. Anderson's opinions are based on his knowledge and expertise as set forth in his CV, as well as his review of the pleadings, discovery, and expert reports. Dr. Anderson's CV is attached as **Exhibit C** and sets forth his qualifications as an expert. Discovery is ongoing in this matter; thus, Dr. Anderson's opinions may be altered or amended

based on new testimony and evidence. Accordingly, Defendants reserve the right to supplement this expert disclosure based on any new information.

HYBRID WITNESSES

Defendants note that the below individuals are employees of the Montana Department of Environmental Quality who possess knowledge regarding the facts alleged in this case, as well as specialized training that allows them to formulate opinions regarding those factual allegations. They have not been specially retained for litigation purposes. Rather, they are mixed fact and expert—or “hybrid”—witnesses. *See Norris v. Fritz*, 2012 MT 27, ¶ 22, 364 Mont. 63, 270 P.3d 79. As such, full disclosures, including written reports, are not required. *Id.* at ¶ 32 (citation omitted). Defendants disclose the identity of these mixed fact and expert witnesses and a summary of their proposed testimony so as to prevent unfair surprise or prejudice. *Id.* at ¶ 33 (citation omitted).

3. Chris Dorrington
DEQ Director
1520 E. 6th Avenue
Helena MT, 59601

Chris Dorrington, Director for the Montana Department of Environmental Quality (“DEQ”), will give fact and expert testimony regarding topics raised in Plaintiffs’ Complaint at ¶¶ 87–89, 92–93, 118(g)–(i), (k). Director Dorrington’s professional CV is attached as **Exhibit D**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Director Dorrington may have factual knowledge and expertise in a number of subject areas, including

but not limited to public policy, DEQ's internal functioning, permitting generally and past permits issued, air, energy, mining, past legislation, some of the panels/councils/studies discussed by Plaintiffs, fossil fuels, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for DEQ, DEQ's budget and staff. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

4. Sonja Nowakowski
DEQ Division Administrator: Air, Energy, and Mining
1520 E. 6th Avenue
Helena MT, 59601

Sonja Nowakowski, Division Administrator Air Energy and Mining for the Montana DEQ, will testify regarding topics raised in Plaintiffs' Complaint at ¶¶ 87–90, 92–93, 118(g)–(m), 192, 194. Ms. Nowakowski's professional CV is attached as **Exhibit E**, and she may testify to any of the experiences or opine on the subjects contained therein. As a result of her positions at DEQ and formerly at the Legislature, her education, and her professional experience, Ms. Nowakowski may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy, DEQ's internal functioning, permitting generally and past permits issued, air, energy, mining, past legislation, some of the panels/councils/studies discussed by Plaintiffs, fossil fuels generally, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for DEQ, DEQ's budget and staff, any of the topics included below for the individuals she supervises, including those in the Air, Energy, and Mining Division. Because

discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

5. Dave Klemp
1520 E. 6th Avenue
Helena MT, 59601

Dave Klemp will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 87–90, 92–93, 118(j)–(k), and 192. Mr. Klemp's professional CV is attached as **Exhibit F**, and he may testify to any of the experiences or opine on the subjects contained therein. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

6. Julie Merkel
DEQ Permitting Services Section Supervisor
1520 E. 6th Avenue
Helena MT, 59601

Julie Merkel, Permitting Services Section Supervisor for the Montana DEQ, will testify regarding topics raised in Plaintiffs' Complaint at ¶¶ 90, 118(j)–(k). Ms. Merkel's professional CV is attached as **Exhibit G**, and she may testify to any of the experiences or opine on the subjects contained therein. As a result of her positions at and before DEQ, her education, and her professional experience, Ms. Merkel may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy regarding air quality, the Permitting Section of the AQB, air quality permits and past permits issued, compliance, air quality generally, past legislation regarding air, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority and ability to regulate or analyze climate change, what climate change analysis would require for the AQB, air quality analysis methods, greenhouse

gasses, emissions and pollutants, DEQ's oil and gas well registration program, federal and Montana air quality standards and regulations. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

7. Craig Henrikson
DEA Air Quality Engineering Scientist
1520 E. 6th Avenue
Helena MT, 59601

Craig Henrikson, Air Quality Engineering Scientist for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 118(j)–(k). Mr. Henrickson's professional CV is attached as **Exhibit H**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. Henrickson may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy regarding air quality, the Air Quality Bureau (AQB) at DEQ and its functioning, air quality permits and past permits issued, permit compliance, air quality generally, past legislation regarding air, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority and ability to regulate or analyze climate change, what climate change analysis would require for the AQB, social cost of carbon and other air quality analysis methods, greenhouse gasses, emissions and pollutants, climate change science, federal and Montana air quality standards and regulations. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

8. Ed Warner
DEQ Air Quality Engineering Scientist
1520 E. 6th Avenue
Helena MT, 59601

Ed Warner, Air Quality Engineering Scientist for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 90, 118(j). Mr. Warner's professional CV is attached as **Exhibit I**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. Warner may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy regarding air quality, the Permitting Section of the AQB, air quality permits and past permits issued, permit compliance, air quality generally, past legislation regarding air, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for the AQB, air quality analysis methods, greenhouse gasses, emissions and pollutants, Federal and Montana air quality standards and regulations. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

9. Dan Lloyd
DEQ Energy Bureau Chief
1520 E. 6th Avenue
Helena MT, 59601

Dan Lloyd, Energy Bureau Chief for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 191–194. Mr. Lloyd's professional CV is attached as **Exhibit J**, and he may testify to any of the

experiences or opine on the subjects contained therein. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

10. Bob Smith
DEQ Coal Mining Section Supervisor
1520 E. 6th Avenue
Helena MT, 59601

Bob Smith, Coal Mining Section Supervisor for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 92–93, 118(g)–(i), (k). Mr. Smith's professional CV is attached as **Exhibit K**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. Smith may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy, planning, and development regarding coal mining, the Coal Section at DEQ and its functioning, coal mining permits and past permits issued, compliance, coal mining generally, past legislation regarding coal, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for the Coal Section, the Coal Section's budget and staff, federal and Montana coal regulation, history of coal mining and coal policy/regulation in Montana. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

11. Dan Walsh
DEQ Mining Bureau Chief
1520 E. 6th Avenue
Helena MT, 59601

Dan Walsh, Mining Bureau Chief for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 87–89, 92–93, 118(g)–(i), (k). Mr. Walsh's professional CV is attached as **Exhibit L**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. Walsh may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy, planning, and development regarding mining and air compliance, the Mining Bureau at DEQ and its functioning, mining and air permits and past permits issued, air compliance generally, past legislation regarding mining and air, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for the Mining Bureau, the Mining Bureau's budget and staff, Federal and Montana mining and air regulation, history of mining and air policy/regulation in Montana, mining for minerals required for "clean/alternative/renewable" energy." Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

12. **Rebecca Harbage**
DEQ Public Policy Director
1520 E. 6th Avenue
Helena MT, 59601

Rebecca Harbage, Public Policy Director for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 90–91, 93, 118(g), (i)–(k), (m). Ms. Harbage's professional CV is attached as **Exhibit M**, and she may testify to any of the experiences or opine on the subjects contained therein. As

a result of his positions at and before DEQ, her education, and her professional experience, Ms. Harbage may have factual knowledge and expertise in a number of subject areas, including but not limited to environmental public policy, planning, and development, past legislation involving DEQ, the Major Facilities Citing Act (MFSA) and the Montana Environmental Policy Act (MEPA), permits and projects related to MFSA and MEPA, compliance, MFSA and MEPA budget, staff, policies and procedures, Environmental Impact Statements (EISs) and Environmental Assessments (EAs), DEQ's authority to regulate and/or consider climate change, the history of MFSA and MEPA. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

13. Craig Jones
DEQ MEPA-MFSA Coordinator
1520 E. 6th Avenue
Helena MT, 59601

Craig Jones, MEPA-MFSA Coordinator for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 90–91, 93, 118(g), (i)–(k), (m). Mr. Jones's professional CV is attached as **Exhibit N**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. Jones may have factual knowledge and expertise in a number of subject areas, including but not limited to environmental public policy, planning, and development, past legislation involving MFSA and MEPA, MFSA and MEPA generally, specific permits and projects related to MFSA and MEPA, compliance, MFSA and MEPA budget, staff, policies and procedures, some of the specific permits and EA/EIS's listed

by Plaintiffs in their Complaint and discovery requests, Environmental Impact Statements (EISs) and Environmental Assessments (EAs), DEQ's authority to regulate and/or consider climate change, the history of MFSA and MEPA. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

14. Martin VanOort
DEQ Mining Environmental Scientist
1520 E. 6th Avenue
Helena MT, 59601

Martin VanOort, Mining Environmental Scientist for the Montana DEQ, will give fact and expert testimony regarding topics raised in Plaintiffs' Complaint at ¶¶ 87–89, 93, 118(g)–(i), (k). Mr. VanOort's professional CV is attached as **Exhibit O**, and he may testify to any of the experiences or opine on the subjects contained therein. As a result of his positions at and before DEQ, his education, and his professional experience, Mr. VanOort may have factual knowledge and expertise in a number of subject areas, including but not limited to public policy, planning, and development regarding mining and air compliance, the Mining Bureau at DEQ and its functioning, mining and air permits and past permits issued, air compliance generally, past legislation regarding mining and air, some of the panels/councils/studies discussed by Plaintiffs, DEQ's authority to regulate or analyze climate change, what climate change analysis would require for the Mining Bureau, the Mining Bureau's budget and staff, federal and Montana mining and air regulation, history of mining and air policy/regulation in Montana, mining for minerals required for "clean/alternative/renewable" energy." Because discovery is

ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

15. Will Rosquist
PSC Regulatory Division Administrator
1701 Prospect Ave.,
Helena MT, 59601

Will Rosquist, Regulatory Division Administrator for the Montana Public Service Commission (“PSC”), will give fact and expert testimony regarding Plaintiffs’ claims that the PSC’s actions in effectuating the statutes being challenged either promote or lead to a use of resources and a collection of economic activities that are harmful to Montana’s economy at large. Mr. Rosquist’s professional CV is attached as **Exhibit P**, and he may testify to any of the experiences or opine on the subjects contained therein. Because discovery is ongoing in this matter, Defendants reserve the right to amend or update this list of subjects.

16. Defendants reserve the right to supplement this expert witness disclosure as additional information is discovered and to call any expert named by any other party in this litigation, including Plaintiffs.


17. Defendants reserve the right to disclose and call any expert needed for foundation, impeachment or rebuttal necessary to refute the testimony of experts disclosed by any other party.

DATED this 31st day of October, 2022.

AUSTIN KNUDSEN
Montana Attorney General

DAVID M.S. DEWHIRST
Solicitor General

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Assistant Attorney General



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CERTIFICATE OF SERVICE

I certify a true and correct copy of the foregoing was delivered by email to the following:

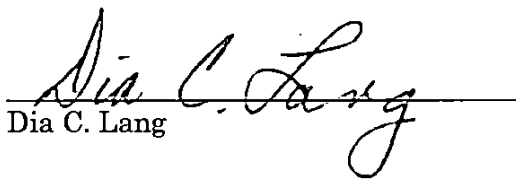
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Date: October 31, 2022



Dia C. Lang

Report of Judith Curry, PhD

I submit this report to the Montana First Judicial District Court of Lewis and Clark County, with regards to Rikki Held et al. versus the State of Montana et al. as an expert witness for the State of Montana on the topics of climate change and the energy transition. The facts and data that I considered in forming my opinions are available from public sources and cited in this report.

Executive Summary

This report responds to the Plaintiffs' claims that:

- the release of greenhouse gases from fossil fuel emissions into the atmosphere is already triggering a host of adverse consequences in Montana;
- the threats posed by fossil fuels and the climate crisis are existential;
- Montana's energy system should transition to a portfolio of 100% renewable energy by 2050.

My report provides evidence that supports the following conclusions:

- The climate-related concerns observed by the Plaintiffs are well within the range of historical natural weather and climate variability, with worse occurrences of weather and climate extremes observed during the early 20th century.
- Plaintiffs' concerns about climate change in the 21st century are greatly exaggerated, and not consistent with the most recent assessment reports and research publications.
- In 2021, Montana ranked 10th among U.S states in terms of the share of electricity generated from renewables, about 52%. There are significant problems with a portfolio of 100% renewable energy for Montana by 2050.
- Emissions from fossil fuels generated in Montana provide a miniscule contribution to global greenhouse gas emissions and do not influence directly Montana's weather and climate.

Qualifications

I am Professor Emerita and former Chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. I am currently President and co-founder of Climate Forecast Applications Network (CFAN).

I received a Ph.D. in Geophysical Sciences from the University of Chicago in 1982. Prior to joining the faculty at Georgia Tech, I held faculty positions at the University of Colorado, Penn State University and Purdue University. My published research spans a variety of topics including climate dynamics of the Arctic, climate dynamics of extreme weather events, cloud microphysics and climate feedbacks, climate sensitivity and scenarios of future climate variability, and reasoning about climate uncertainty. I have been elected to the rank of Fellow of the American Meteorological Society, the American Association for the Advancement of Science, and the American Geophysical Union. I have previously served on the NASA Advisory Council Earth Science Subcommittee, the Department of Energy's Biological and Environmental Research

Advisory Committee (BERAC), the National Academies Climate Research Committee and the Space Studies Board, and the National Oceanic and Atmospheric Administration (NOAA) Climate Working Group. My company CFAN translates cutting-edge weather and climate research into forecast products that support the mitigation of weather and climate risk, on timescales from days to decades.

Additional information can be found at:

<http://curry.eas.gatech.edu/>
<http://www.cfanclimate.net/>
<http://judithcurry.com/about/>

My particular qualifications relevant to this Report include:

- Extensive published research on the topics of climate dynamics and change
- My expertise on these topics is supported by my invitations to provide Congressional testimony twelve times since 2006.
- My company CFAN supports the energy sector with extended-range probabilistic forecasts of temperature extremes, severe convective weather, hurricanes, fire weather and renewable energy. CFAN's climate scenario projections and impact assessments support power plant siting and investment decisions, insurance decisions, electric power demand, and severe weather vulnerability.
- I have provided consulting services to numerous electric utility providers on topics related to weather variability and climate change, and the pros and cons of various energy sources in context of climate change and political frameworks.
- I have authored a book entitled "Climate Uncertainty and Risk" that is in press at Anthem Press.

My complete curriculum vitae is included in Appendix A.

1. Weather and climate variability in Montana

Montana has a highly variable climate and is subject to weather extremes. The Plaintiffs attribute recent adverse weather and climate conditions to human-caused climate change associated with fossil fuel emissions. These impressions of the Plaintiffs do not hold up to scrutiny against Montana's historical weather and climate records.

1.1 Concerns of plaintiffs about the current climate

Concerns of the individual Youth Plaintiffs on pages 5-26 of the Complaint are generally related to concerns about climate change impacts on their physical and psychological health and safety, challenges to family and cultural foundations, economic deprivations, and degrading and depleting natural resources. Their specific weather- and climate-related concerns are summarized as follows:

- Variability in river levels and stream flow, ranging from drought to flood
- Summertime warm temperatures in rivers and streams that impact fish
- Reduced water availability for livestock during summer

- Severe hail storm
- Trees and large animals under stress from disease carrying insects that are surviving warmer winters
- Wildfires
- Reduced winter snow pack
- Abnormally wet, cold and muddy weather
- Extreme summer heat
- Disappearance of glaciers in Glacier National Park

Impacts of “Climate Disruption” in Montana provided on pages 57-75 of the Complaint are summarized as:

- Increase in temperatures from 2-3°F between 1950 and 2015
- More heat waves
- Snow is melting earlier in spring
- Days above 90 °F have increased by 20 days between 1970 and 2015
- Warmer springs and delay of frost in fall
- Reduced irrigation capacity
- Decreasing snowpack
- Melting glaciers

1.2 Historical context

By considering only data since 1950 and 1970, the Plaintiffs have erroneously assumed that recent adverse weather and climate conditions in Montana are unusual, and have inferred that they are caused by fossil fuel emissions. The slow increase in average temperature for Montana has not translated into an increase in weather/climate extremes. Ancestors of the Youth Plaintiffs living in the 19th and early 20th century encountered weather and climate extremes that are as bad as, or worse than, those that have been encountered by the Youth Plaintiffs.

Here are Montana’s historical record temperature and precipitation extremes:

- Hottest temperature: 117°F, Medicine Lake, 7/5/1937 and Glendive 7/20/1893¹
- Record hottest years: 1934 and 2015²
- Record driest year: 1931, avg precipitation 12.62 inches³
- Record wettest year: 1927, avg precipitation 26.15 inches⁴
- Precipitation record for 24 hours: Circle (Springbrook), 6/20/1921, 11.50 inches⁵
- Worst floods: 1908, 1948, 1964, 1978, and 2011⁶

The NOAA State Climate Summary for Montana (2022) provides an up-to-date summary of Montana’s climate.⁷

While the two decades in the 21st century have overall been the warmest for Montana since 1900, there has been no trend in weather and climate extremes. Average winter temperatures show an overall increase, although comparably warm years were observed from the 1920-50s. The warmest summer temperatures were in the 1930s. In terms of annual average temperature, 2015 is tied with 1934 for the hottest year on record.⁸

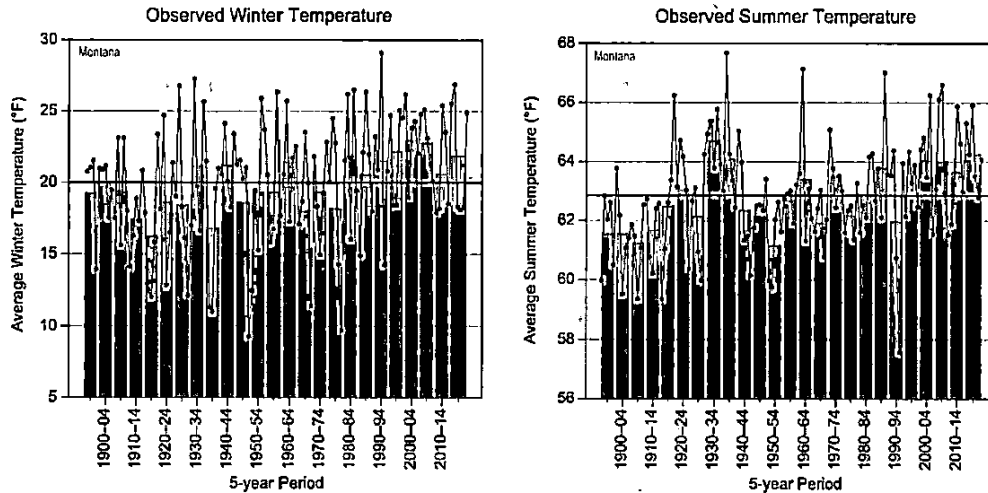


Figure 1.1 – Reprint of Figure 4a-b from Frankson et al. 2022 – (left) winter (December-February) and (right) summer (June-August) average temperature from 1895 through 2020. Dots represent annual values, bars show 5-year averages and horizontal lines show long term averages.⁹

The number of very hot days (≥ 95 °F) and warm nights (≥ 70 °F) was highest in the 1930s.

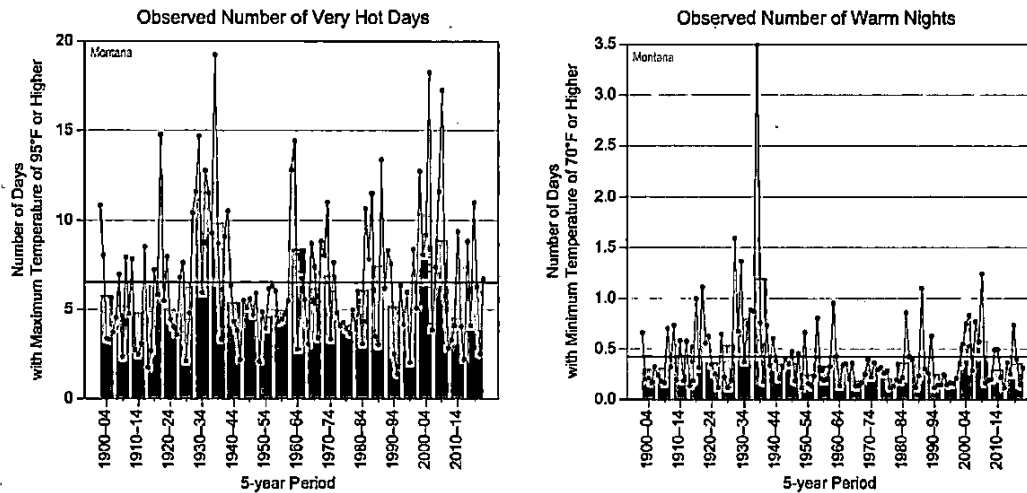


Figure 1.2 – Reprint of Figure 2a-b from Frankson et al. 2022 – (left) very hot days (≥ 95 °F) and (right) very warm nights (≥ 70 °F) 1900 through 2020. Dots represent annual values, bars show 5-year averages and horizontal lines show long term averages.¹⁰

The number of very cold days (maximum temperature ≤ 0 °F) shows an overall decline, although the low numbers since 2005 are comparable to the low numbers in the 1940s.

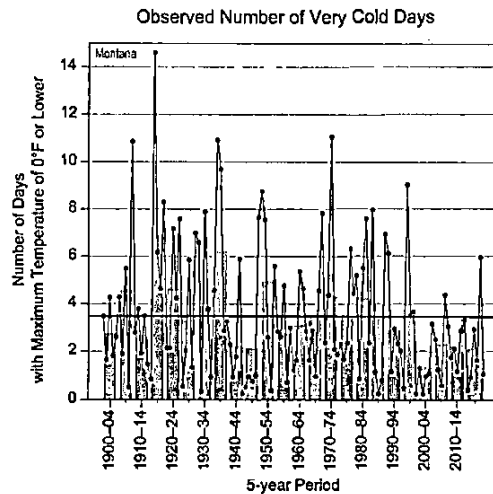


Figure 1.3 – Reprint of Figure 3 from Frankson et al. 2022 – very colds days (maximum temperature ≤ 0 °F) 1900 through 2020. Dots represent annual values, bars show 5-year averages and horizontal lines show long term average.¹¹

There is no overall trend in annual precipitation, although there is substantial year-to-year variability. The lowest values were observed in the 1930's. In terms of extreme precipitation events, there is no trend.¹²

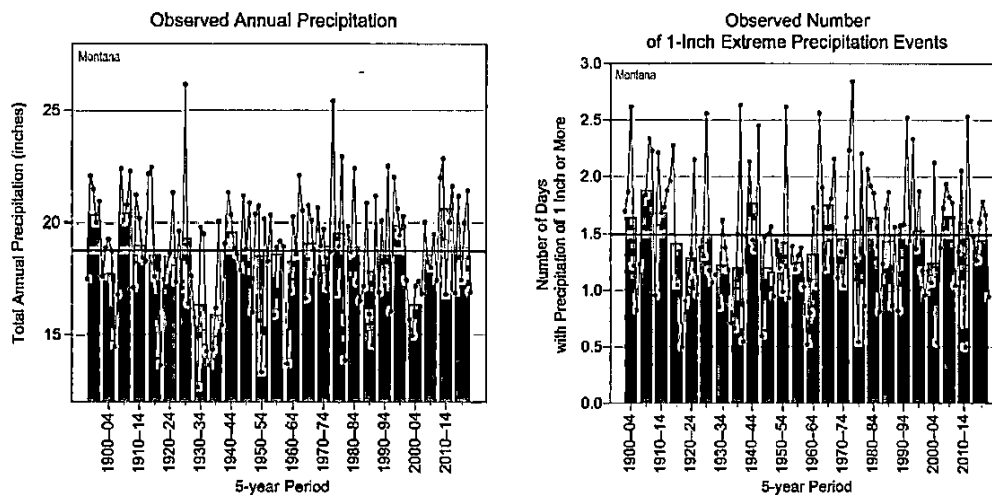


Figure 1.4 – Reprint of Figure 2c-d from Frankson et al. 2022 – (left) observed annual precipitation and (right) extreme precipitation events (≥ 1 inch) 1900 through 2020. Dots represent annual values, bars show 5-year averages and horizontal lines show long term averages.¹³

Since 1970, there have been as many as 200 snow measuring sites across Montana, most of which are in the western mountain area. Currently there are about 90 active daily sites in the state measuring snow water equivalent, with about 50% of these sites extending back 50 years. There has overall been a declining trend in April snowpack in Montana during the period 1955-2016, as cited in the Complaint. However, since 2016, most of the last 7 years have shown normal to above normal spring snowpack across Montana. This behavior reflects the variable nature of climate on both seasonal and decadal scales as well as the potential limitations of inferring causal mechanisms when analyzing short periods of data.

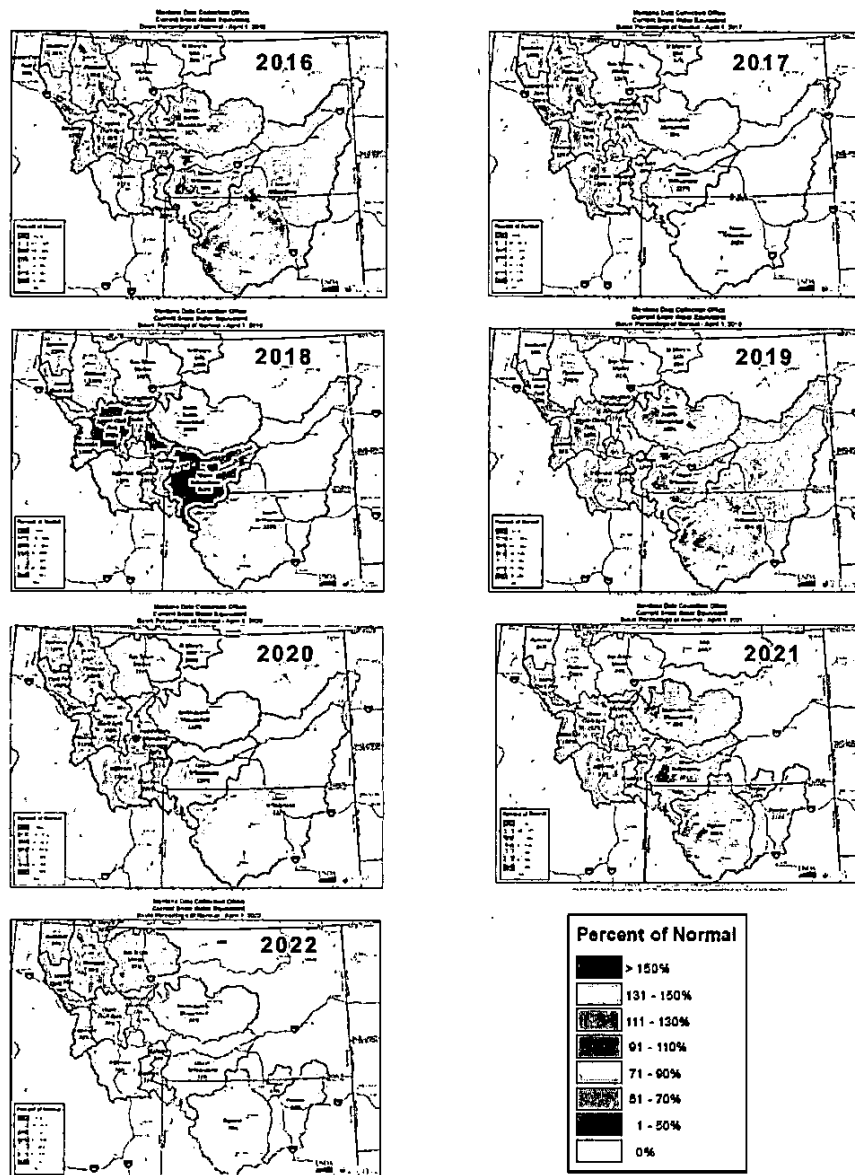


Figure 1.5 – April 1st snow water equivalent estimates produced by National Resources Conservation Service with data from the Montana Snow Survey Program from 2016 through 2022.¹⁴

To extend understanding of past snowpack behavior, paleoclimate records have been developed to supplement the modern data pool. These records include lake sediment and tree ring data. An important study focused on the American West was published in 2011, providing a data record over 500 years.¹⁵ This length of record revealed climate variability on century scales including features like The Little Ice Age. The study also demonstrated more short-term climatic features that show different anomalies between the northern and southern Rockies. Of particular relevance, the study identified a snow drought during the 1930s in the Greater Yellowstone Region that is similar to low values seen toward the end of the 20th century.

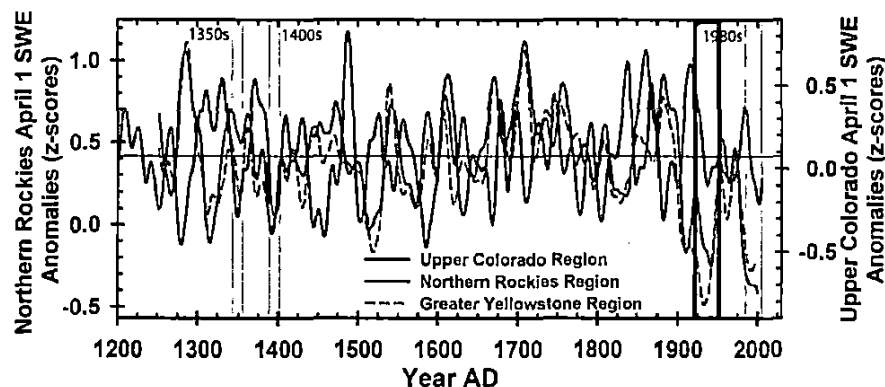


Fig. 3. Decadal-scale antiphasing of the N-S snowpack dipole and periods of synchronous snowpack decline. The 20-year splines of the regional average snowpack anomalies highlight antiphasing and variability at decadal scales. The shaded bars highlight periods of synchronous snowpack decline.

Figure 1.6 – Reprint of Figure 3 from Pederson et al. 2011 with the addition of red box to denote period of phase lock that includes the 1930s.

The first surveys of glaciers in Glacier National Park began in the 1880s, with most of the focus on the two largest glaciers – Grinnell and Sperry. A 2017 publication issued by the U.S. Geological Survey entitled Status of Glaciers in Glacier National Park includes a table of the areal extent of named glaciers in the Glacier National Park since the Little Ice Age (LIA) with markers at LIA, 1966, 1998, 2005 and 2015.¹⁶ Analysis of these data show:

- A ~50% loss from LIA to 1966 (~115 years), averaging a loss of ~4.5% per decade.
- Additional ~12% loss from 1966-98 (32 years), averaging a loss of ~3.7% per decade.
- Additional ~4.75% loss from 1998-2015 (27 years), averaging a loss of ~1.75% per decade.

Much of the glacier loss occurred prior to 1966, when fossil-fueled warming was minimal. The percentage rate of glacier loss during this early period exceeded the percentage rate of loss observed in the 21st century.

Looking much further back, Glacier National Park was virtually ice free 11,000 years ago.¹⁷ Glaciers have been present within the boundaries of present-day Glacier National Park since about 6,500 years ago.¹⁸ These glaciers have varied in size, tracking climatic variations, but did not grow to their recent maximum size until the end of the Little Ice Age, around 1850. An 80-year period (~1770-1840) of cool, wet summers and above-average winter snowfall led to a rapid growth of

glaciers just prior to the end of the Little Ice Age.¹⁹ So, the recent loss of glacier mass must be understood in light of the fact the glaciers reached their largest mass for the past 11,000 years during the 19th century.

Devastating forest fires are not a new phenomenon in and around Montana. Forest fires have always been a part of nature, and they can certainly create conditions that are inhospitable in the short term for all life including humans. Science has confirmed the overall benefit and necessity of the occurrence of forest fires. While recent high-profile fires and seasons serve as a reminder of the potential destructive impact, the region's highest profile forest fire remains the 1910 Big Blowup fire which destroyed over three million acres including the elimination of entire towns like Taft, MT.²⁰ The 1910 fire reshaped the U.S. Forest Service,²¹ leading to a focus on fire suppression with a primary goal to defeat all forest fires.²² This led to the 10 am rule in 1935 that meant all fires spotted on any day had to be controlled by the following day at 10 am.²³

While defeating fire is certainly a noble goal, questions began to arise as to whether this behavior "followed the science."²⁴ Over time the U.S. Forest Service has begun to rethink its behavior, recognizing that new approaches such as prescribed burns, fuel elimination and controlled wildfires are more appropriate.²⁵ Recent research is validating this approach and recognizing that more frequent smaller fires in forests likely result in the most healthy forests, water ecosystems and biodiversity.²⁶

With regards to the Plaintiff's concerns about hail storms, the recent Intergovernmental Panel on Climate change 6th Assessment Report (IPCC AR6) concludes: "There is low confidence in past trends in characteristics of severe convective storms, such as hail and severe winds, beyond an increase in precipitation rates."²⁷

1.3 Summary

The Plaintiffs' concerns about extreme weather and climate conditions reflect natural weather and climate variability, rather than fossil-fuel driven climate change. The extreme conditions encountered by the youth Plaintiffs are not exceptional in context of historical conditions back to 1900. Trends since 1950 or 1970 that are cited in the Complaint fail to consider conditions that were as bad as or worse than the current conditions during the first half of the 20th century.

2. Concerns about the future climate

The Plaintiffs have concerns about the future climate that are highly exaggerated relative to projections in recent assessment reports.

2.1 Concerns of Plaintiffs

The Complaint cites specific concerns of the Youth Plaintiffs about the future:

- "Sariel is worried that her and her community's activities, practices, and beliefs of cultural significance will be entirely lost if climate change continues. Sariel is distraught when thinking about her future and if she will have one."^{28 29}

- “Georgi sometimes has feelings of despair and hopelessness; she has invested years into a snow-based sport, but understands that snow and the sport may not exist in her future.”³⁰
- “Witnessing climate change impacts occur around her is devastating emotionally to Grace and she is anxious about her future and fearful that her generation may not survive the climate crisis. Grace has doubts about whether she would want to have her own children given her anxieties about the future.”³¹
- “[Eva] is distressed that the climate crisis will worsen if action is not immediately taken.”³²
- “Olivia values her family and would like to have and raise children of her own, but she questions whether this is even an option in a world devastated by the climate crisis. She fears that if she has children they, or their children, would suffer or starve. Imagining the future that she will inherit, or that her children would live in, and the current suffering that the climate crisis is already causing her and others is a heavy burden for her to carry,¹ and Olivia feels heartbroken and desperate.”³³

The Complaint further cites the following concerns:

- “There is an overwhelming scientific consensus that human-caused climate disruption is occurring and is dangerous to humans and other life and ecosystems on which humans depend.”³⁴
- “The threats posed by fossil fuels and the climate crisis are existential.”³⁵
- “Atmospheric CO₂ is the primary forcer of climate change” [on timescales of hundreds of thousands of years, Figure 5].³⁶
- “Unless GHGs are reduced to meet science-based targets, climatic tipping points, such as massive species extinction and rapid ice sheet disintegration, will be reached and the Earth will cross a point of no return after which catastrophic climate change impacts will be unavoidable and irreversible. The continued GHG emissions from fossil fuels will further disrupt Earth's climate system and that, in turn, will impose profound and mounting risks of ecological, economic, and social collapse.”³⁷
- “By mid-century, when the Youth Plaintiffs will be adults, models project that the annual average daily maximum temperature in Montana will increase by approximately 4.5-6.0 °F, a temperature increase that would imperil human civilization. By the end of the century, models predict that the annual average daily maximum temperature in Montana will increase by approximately 5-10 °F.”³⁸

2.2 Recent assessments of 21st century climate scenarios

This Section refers to the following recent assessment reports:

- Intergovernmental Panel on Climate Change 5th and 6th Assessment Report (IPCC AR5 2013; IPCC AR6 2021)
- UN Framework Convention on Climate Change (UNFCCC) Reports
- International Energy Agency (IEA) Global Energy Review
- 4th U.S. National Climate Assessment (2017)

2.2.1 How much warming?

The temperature projections for the 21st century from the IPCC AR6 are provided below.

Table 2.1 Projected changes in global surface temperature for three 20-year time periods for five emissions scenarios. Temperature differences are relative to the baseline period 1850–1900. Changes relative to the recent reference period 1995–2014 may be calculated approximately by subtracting 1.5 °F, the best estimate of the observed warming from 1850–1900 to 1995–2014 (IPCC AR6 Summary for Policy Makers (SPM) Table SPM.1; note that temperatures have been converted from °C to °F for the convenience of the reader).³⁹ Changes relative to 2020 can be obtained by subtracting 2 °F

Scenario	Near term, 2021–40		Mid-term, 2041–60		Long term, 2081–2100	
	Best estimate (°F)	Very likely range (°F)	Best estimate (°F)	Very likely range (°F)	Best estimate (°F)	Very likely range (°F)
SSP1–1.9	2.7	2.2 to 3.1	2.9	2.2 to 3.6	2.5	1.8 to 3.2
SSP1–2.6	2.7	2.2 to 3.2	3.1	2.3 to 4.0	3.2	2.3 to 4.3
SSP2–4.5	2.7	2.2 to 3.2	3.6	2.9 to 4.5	4.9	3.8 to 6.3
SSP3–7.0	2.7	2.2 to 3.2	3.8	3.1 to 4.7	6.5	5.0 to 8.3
SSP5–8.5	2.9	2.3 to 3.4	4.3	3.4 to 5.4	7.9	5.9 to 10.3

The numbers cited by the Plaintiffs of 4.5-6.0 °F warming by mid-century and 5-10 °F by the end of the 21st century relate to emissions scenario SSP5-8.5 (roughly equivalent to RCP8.5 in the previous IPCC AR5 that is cited by the Plaintiffs), relative to the reference period 1850-1900.

RCP8.5 and SSP5-8.5 are extreme emissions scenarios that are now generally regarded as implausible. The IPCC AR6 states:

“In the scenario literature, the plausibility of the high emissions levels underlying scenarios such as RCP8.5 or SSP5–8.5 has been debated in light of recent developments in the energy sector.”⁴⁰

The 8.5 emissions scenarios can only emerge under a very narrow range of circumstances, comprising a severe course change from recent energy use. Both the RCP8.5 and the SSP5–8.5 scenarios have drawn criticism owing to the assumptions around future coal use, requiring up to 6.5 times more coal use in 2100 than today—an amount larger than some estimates of economically-recoverable coal reserves.⁴¹

Table 2.2 compares the SSP emissions scenarios used in the IPCC AR6 in terms of gigatons of CO₂ emitted per year, for the year 2050. For reference, emissions in 2021 are about 36 gigatons of carbon dioxide (GtCO₂) per year.⁴² The UNFCCC objective is net zero emissions by 2050.⁴³

The International Energy Agency (IEA) has provided more realistic scenarios of future emissions that are now widely being used in decision and policy making (Table 2.1).⁴⁴ Policies to reduce emissions that have actually been implemented are described in a scenario referred to as STEPS,

which projects continued emissions through 2050 at the rate of about 36 GtCO₂ per year. The trajectory that would be achieved if all countries met their current commitments under the Paris Agreement is referred to as APC, which projects emissions declining to about 22 GtCO₂ per year by 2050.⁴⁵ The implication of the IEA STEPS scenario is that maintaining the policies that have already been implemented would result in global carbon dioxide emissions out to 2050 that are similar to what they are in 2021.

Table 2.2: GtCO₂/yr emissions by 2050 under different SSP scenarios.^{46 47}

Scenario	GtCO ₂ /yr
SSP5–8.5	82
SSP4–6.0	48
SSP2–4.5	42
SSP4–3.4	20
SSP1–2.6	18
IEA STEPS	36
IEA APC	22

The IEA analysis indicates that the world is entering an extended plateauing of emissions. For climate change to 2050, SSP2–4.5 and SSP4–3.4 are the most likely of the IPCC scenarios to serve as a baseline and should be the focus of impact assessments and policy planning.⁴⁸

The most striking aspect of the comparison between the IPCC and IEA scenarios is the strong divergence of the extreme emissions scenario SSP5–8.5 (and RCP8.5) from the IEA scenarios, with the 8.5 emissions values more than twice as high as the IEA STEP scenario at 2050. It is difficult to overstate the importance of the shift in expectations for future emissions that is represented by the difference in the new IEA scenarios versus RCP8.5. The IPCC, the U.S. National Climate Assessment and a majority of published papers have centered their analyses on RCP8.5 as a reference scenario against which climate impacts and policies are evaluated.⁴⁹

International climate policy negotiations under the UN Framework Convention for Climate Change (UNFCCC) no longer considers RCP8.5 in its negotiations, as per the COP26 in 2021.⁵⁰

While there is growing acceptance that the RCP8.5 and SSP5-8.5 scenarios are implausible, temperature projections associated with the RCP8.5 projections are featured prominently in the Expert Report written by Steven Running and Cathy Whitlock. Every future climate outlook graphic presented in sections B5-B9 as well as the entire set of projections included in Attachment 6 include, sometimes exclusively, RCP8.5-based projections.

Further, climate model simulations used in the IPCC AR6 to project the amount of warming in the 21st century (Table 2.1) are not providing the full range of scenarios of plausible climate outcomes. Two recent journal publications have found that climate models are too sensitive to increasing CO₂,^{51 52} and that more likely values of warming are on the lower part of the *very likely* range in Table 2.1 (or even lower). The climate model simulations used in the IPCC AR6 include very limited scenarios of volcanic eruptions and solar variability. Further, the climate models have

inadequate representations of solar indirect effects and multi-decadal to century-scale variations in the large-scale ocean circulations. All of the components of natural variability point to cooling during the period 2020 to 2050. Individually these terms are not expected to be large. However when summed, their magnitude approaches, or could even exceed, the magnitude of the emissions-driven warming for the next three decades.⁵³

The bottom line is that we do not know how the climate of the remainder of the 21st century will evolve. We are bound to be surprised, particularly by unpredictable natural climate variability.

2.2.2 *Is warming dangerous?*

The Plaintiffs make the following assertions:

- “There is an overwhelming scientific consensus that human-caused climate disruption is occurring and is **dangerous** to humans and other life and ecosystems on which humans depend.”⁵⁴
- “The threats posed by fossil fuels and the climate crisis are **existential**.”⁵⁵

As described in Section 1.2, detecting any change in extreme weather or climate events associated with fossil-fuel driven global warming is very difficult against the background of natural weather and climate variability. The concern about dangers is largely hypothetical and in the future, based on climate model simulations. Once the RCP8.5/SSP5-8.5 scenarios are eliminated, any future “dangers” from climate change, however subjectively defined, become much diminished.

The issue of “dangerous” relates to societal values and psychological perceptions of risk, about which science has little to say. To avoid making value judgments, the IPCC does not define a level at which climate change becomes dangerous. The IPCC Assessment Reports refer to “reasons for concern.” There is no truly objective determination of the level at which climate change becomes dangerous, or how we should compare the climate risk with other risks.

The 1992 UN Framework Convention on Climate Change (UNFCCC) Treaty states as its objective: “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent **dangerous** anthropogenic interference with the climate system.”⁵⁶ Despite the treaty aimed at preventing dangerous anthropogenic interference with the climate system, the UNFCCC has avoided and then struggled to provide a definition of dangerous.

It wasn’t until 2010 that clarification of “dangerous” was provided by UN international negotiators: “In 2010, governments agreed that emissions need to be reduced so that global temperature increases are limited to below two degrees Celsius.”⁵⁷ The 2 °C (3.6 °F) target is relative to pre-industrial temperatures, which presupposes that the warming observed to date since the mid-19th century (at the end of the Little Ice Age) is contributing to climate danger. The scientific validity of the two-degree target has been questioned. The two-degree limit has evolved in a somewhat *ad hoc* and contradictory fashion: policy makers have treated it as a scientific finding, and scientists treat it as a political issue.⁵⁸ The 2 °C target was not so much a policy goal but rather a political motivation, reflecting “a mindset that is common to the entire exercise: to create maximum pressure for action.”⁵⁹

Apart from the arbitrariness of the 2 °C (3.6 °F) threshold of danger since preindustrial times (with 1.1 °C, or 2 °F, already having occurred), best estimates of future emissions, climate sensitivity to CO₂ and natural climate variability (Section 2.1) indicate that we will likely be close to, or within, the 2 °C target by 2100, based on our current understanding.⁶⁰

So, how dangerous has warming been in recent decades? A recent study quantified the changes in socio-economic vulnerability, expressed as fatalities over exposed population and economic losses, to climate-related hazards between 1980 and 2016.⁶¹ A clear decreasing trend in both human and economic vulnerability was found, with global average mortality and economic loss rates dropping by 6.5 and nearly 5 times over the past 40 years. Vulnerability to weather and climate extremes decrease with wealth and human development. Brian O’Neill, one of the lead architects of the Shared Socioeconomic Pathways (SSPs) developed for the IPCC AR6, stated:

“There isn’t, you know, like a Mad Max scenario among the SSPs [emissions scenarios], we’re generally in the climate-change field not talking about futures that are worse than today.”⁶²

Apart from the objective facts about a risk, our interpretation of those facts is ultimately subjective. Risk science makes a clear distinction between professional judgments about risk versus the public perception of risk. A person’s subjective judgement or appraisal of risk can involve social, cultural and psychological factors. No matter how strongly we feel about our perceptions of risk, we often get risk wrong. Understanding the psychology of risk perception is important for rationally managing the risks that arise when our subjective risk perception system gets things dangerously wrong.⁶³ The cultural theory of risk proposes that individual views on risk are filtered through cultural world views about how society should operate.⁶⁴

Even if the initial harm is small, the social risk may be greatly amplified by the collective response or irrational behaviors of individuals. The response to climate risk, driven by apocalyptic and extinction rhetoric, has arguably crossed the threshold to actually increasing the social risk associated with climate change.

2.3 Harm to children from apocalyptic climate change rhetoric

Numerous academic studies have highlighted the psychological health effects of climate change on children and young adults, including elevated levels of anxiety, depression, post-traumatic stress disorder, increased incidences of suicide, substance abuse, social disruptions including increased violence, and a distressing sense of loss. I have personally received emails from children and young adults suffering from such effects.^{65 66}

As described in the previous sections of this Report, there is little basis in the IPCC assessments for a level of alarm that would induce such psychological effects. The apocalyptic and misleading rhetoric surrounding climate change is arguably the driving impetus of the adverse psychological health effects.

In context of a complex scientific and political debate, there are strong incentives to raising the alarm about climate change. Media gets more clicks and views with alarming stories. Activist campaigners get attention and funding. Researchers who position themselves in the mainstream of

apocalyptic rhetoric receive media attention, professional recognition from increasingly activist professional societies, and greater funding opportunities. Politicians that emphasize alarming climate scenarios seek the authority to distribute significant resources to fix the problem according to their own political values.

Are the adverse psychological impacts on children and young adults merely collateral damage of the complex debate on climate change, or are children being used as political tools? It is well known that children are fostering climate change concern among their parents,^{67 68} providing a motivation for apocalyptic messaging targeted at children and young adults.

Public school districts are adopting curricula on climate change that portrays climate change only in context of human causes and as a peril beyond dispute, emphasizing worst case scenarios. Further, there is an explicit objective that students should respond through activism.⁶⁹ The materials used in these curricula include those from UNESCO Office for Climate Education⁷⁰ and the North American Association for Environmental Education,⁷¹ as well as materials provided by advocacy groups such as the Sierra Club.⁷²

- Kristen Hargis of the North American Association for Environmental Education states: “There are a lot of resources out there that are ... helping students draft policies as well, and getting them involved from the beginning. And this is what we want to see, this whole-institution approach where we’re creating this culture of climate action.”⁷³
- The Director-General of UNESCO, Audrey Azoulay, states: “Climate change, which results from our own behaviour, is the greatest threat to our common existence. Education is an essential tool to empower young people to take action for a more sustainable future.”⁷⁴ The website for the UNESCO Office for Climate Education states: “These resources aim at promoting action”⁷⁵

The “K12 Climate Action Plan” was published by the Aspen Institute. The Commission that prepared this report includes: Randi Weingarten, President of the American Federation of Teachers; Becky Pringle, President of the National Educational Association; John King, U.S. Secretary of Education (Obama Administration); Christine Todd Whitman, EPA Administrator (Bush Administration) and former NJ Governor; Linda Darling-Hammond, President of the California State Board of Education; Pedro Martinez, Superintendent of the San Antonio Independent School District. Their stated mission and beliefs:⁷⁶

- “MISSION: Our mission is to unlock the power of the public K-12 education sector to be a force for climate action, solutions, and environmental justice to help prepare children and youth to advance a more sustainable, resilient, and equitable society.”
- “BELIEFS: We believe today’s children and youth will be essential in the fight against climate change, and we must empower children and youth with the knowledge and skills to build a more sustainable, resilient, and equitable world.”

Additional statements of note:⁷⁷

- “Advocacy and the media will help build the narrative for supporting our schools in moving toward climate action, solutions, and environmental justice.”

- “In fact, education has been identified as an underutilized social tipping point needed for decarbonization — the process of phasing out reliance on carbon across all parts of the economy.”

The presentation of climate change to children is far more alarming and less nuanced than what adults are exposed to. Stories of the coming climate apocalypse have become commonplace in schools, textbooks, churches, movies and even children’s books. A prominent example is the book “Our House Is on Fire: Greta Thunberg’s Call to Save the Planet,”⁷⁸ a picture book aimed at ages 3-8. The book’s overarching message is summed by this statement in the book: “There might not be a world to live in when she grows up. What use is school without a future?”⁷⁹

Media targeted at teens and young adults portrays relentless doom. The 2018 U.N. warning that governments need to take action on climate change within 12 years led Rep. Alexandria Ocasio-Cortez to incorrectly conclude that millennials fear “the world is gonna end in 12 years if we don’t address climate change.”⁸⁰ The website of the U.K.-based group Extinction Rebellion warns that “societal collapse and mass death are seen as inevitable by scientists and other credible voices.”⁸¹

The world’s teens and young adults seem to have gotten the message: A 2021 study polled 10,000 people between the ages of 16 and 25 from numerous different countries, and found that over half thought that humanity was “doomed” because of climate change. Further, there is an explicitly political message being fed to teens and young adults as evidenced by this finding from the study: “Climate anxiety and distress were correlated with perceived inadequate government response and associated feelings of betrayal.”⁸²

However, there is growing alarm about alarmism among climate activists. There is a fierce debate about whether more pessimistic messaging energizes people to fight climate change or causes them to conclude the world is doomed and tune out, leading us down a path of inaction.⁸³

Some voices are suggesting that we would all be better off if we dialed down the hyperbole about climate change. Kate Marvel, climate scientist at Columbia University and science communicator: “This message of ‘We’re all going to die, how dare you say there might be something we can do’ ... that’s just not supported by the science.” “There are so many futures between doomed and fine.” “I’m not saying we can all rest, and I’m not saying we live in the best of all possible worlds. But one can have a sense of optimism by working towards a solution.”⁸⁴

Some serious journalists admit that they have been misled. Journalist David Wallace-Wells published a book in 2019 entitled *The Uninhabitable Earth*. His article in the New York Magazine with the same title has the subtitle: “Famine, economic collapse, a sun that cooks us: What climate change could wreak—sooner than you think.”⁸⁵ This book describes some extreme scenarios that are worth contemplating, but they do not add up to an uninhabitable Earth, or even a place that would be an awful place to live. Subsequent to publication of his book, David Wallace-Wells made this statement: “Anyone, including me, who has built their understanding on what level of warming is likely this century on that RCP8.5 scenario should probably revise that understanding in a less alarmist direction.”⁸⁶ (see Section 2.2 of this Report).

The responsibility of adults is to teach children and young adults how to solve problems effectively, not to preach the end of the world. Adults also need to help children become more resilient. The book *The Coddling of the American Mind* describes how parents' attempts to promote their kids' emotional well-being often instead makes them more emotionally fragile.⁸⁷ Apart from ill-advised parenting, children and young adults are being used as tools in a national and international political campaign. Blaming this unfortunate situation of psychological stress on a changing climate is incorrect, and the use of this situation to achieve political goals is arguably acting to reinforce the childrens' psychological injuries.

2.4 Summary

The climate "catastrophe" isn't what it used to be. Circa 2013 with publication of the IPCC AR5 Report, RCP8.5 was regarded as the business-as-usual emissions scenario, with expected warming of 4 to 5 °C (7.2 to 9 °F) by 2100. Now there is growing acceptance that RCP8.5 is implausible, and RCP4.5 is arguably the current business-as-usual emissions scenario. Only a few years ago, an emissions trajectory that followed RCP4.5 with 2 to 3 °C (3.6 to 5.4 °F) warming was regarded as climate policy success. As limiting warming to 2 °C (3.6 °F) seems to be in reach (now deemed to be the "threshold of catastrophe"),⁸⁸ the goal posts were moved in 2018 to reduce the warming target to 1.5 °C (2.7 °F).⁸⁹ Climate catastrophe rhetoric now seems linked to extreme weather events, most of which are difficult to identify any role for human-caused climate change in increasing either their intensity or frequency.

3. Montana's electric power systems

Montana is the U.S. state with the third lowest population density, ranking behind Wyoming and Alaska. Geographically, Montana is one of northern most states in the nation as well as one of the coldest. Montana's economy is largely based on its natural resources: agriculture and ranching; oil, gas, coal, mineral extraction; lumber; and tourism. Montana ranks 11th in overall energy consumption per capita, but ranks 1st in residential energy use per capita owing to cold wintertime temperatures.⁹⁰ Montana has nearly one-third of U.S. recoverable coal reserves,⁹¹ and coal currently provides approximately 43% of its electricity.⁹² Montana also has abundant renewable energy resources: for 2021, Montana ranked 10th in the U.S. in terms of electricity generated from renewables at roughly 52%.⁹³

This section addresses the feasibility of a rapid transition to 100% renewable energy, as articulated in the Complaint and the Expert Report of Mark Jacobson.

3.1 Montana's renewable energy resources

Montana has abundant renewable energy resources, but their modes of variability are far from optimal for providing 24/365 electricity owing to the climatological and weather variability of the renewable resources.

3.1.1 Hydropower

The infancy of hydropower in America began in the early 1880s. Within the first two years of statehood, Montana's first hydropower facility would go live in Great Falls.⁹⁴ Hydropower has remained a critical resource within the state and as of June 2022 was the source of over 54% of Montana's electricity generation.⁹⁵ Montana is the seventh-largest producer of hydroelectric power in the nation.⁹⁶ However, hydropower comes with challenges that cap its benefits.

There is a strong seasonal cycle in the availability of water available for Montana's hydroelectric production. The peak season for generation is from early spring through mid-summer, during which time snowmelt drives the highest water levels in most of Montana's streams and rivers. On longer time scales, there are fluctuations from climate regimes such as El Niño/La Niña. These factors can influence availability levels throughout the year and from year-to-year.

As can be seen in Figure 3.1, these factors can result in annual and seasonal variances that deviate significantly from the mean. For instance, a pronounced drought and warm spring in 2017 resulted in suppressed peak season behavior. The year 1937 saw values well below the mean throughout the entire year. Lost production can also occur during heavy streamflow seasons such as those experienced in 1975 and 2011 that cannot be fully leveraged. Some short-term extreme behavior can be partially regulated via regulating flow from existing reservoirs, but flood and drought management do not always coincide with optimal hydropower production.

While hydroelectric power has been a critical element of Montana's energy portfolio, it is unlikely to increase meaningfully. Costs associated with large hydropower facilities along with potential environmental and ecological impacts would likely limit future expansion.

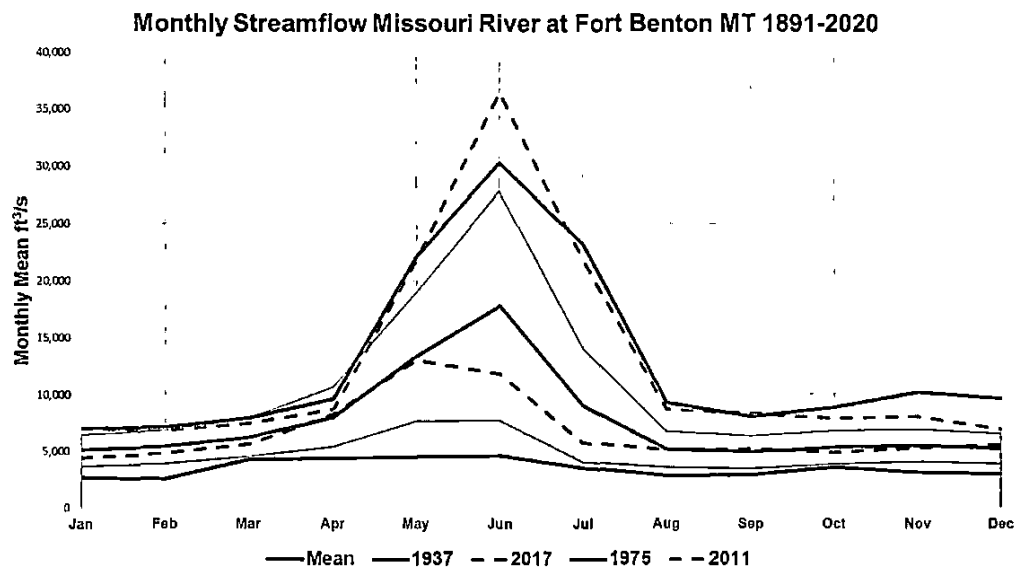


Figure 3.1 – Missouri River monthly mean streamflow at Fort Benton, MT. Mean and +/-1 standard deviation (blue shaded) for years 1891 to 2020 along with representative strong (green) and weak (red) streamflow scenarios. Graphic based on data from USGS.⁹⁷

3.1.2 Solar Power

Solar power generation has traditionally focused in the southwestern portion of the U.S., where low latitudes deliver year-round long days combined with sunny skies that create an optimal situation for solar power. As can be seen in mapping developed by the National Renewable Energy Laboratory (Figure 3.2), much of Montana receives the lowest classification of solar irradiance.⁹⁸ Most effective solar power generation is achieved when the sun's light arrives perpendicular to the receiving solar panel. Higher latitudes require more panel tilt to achieve better production, leading to increased spacing between panels and angles that are not always conducive to rooftop installations.

Weather elements also reduce solar potential in Montana, including cloud cover that decreases the amount of sun reaching the panels and snowpack which may cover the panels. This has meant that traditional single angle installations are effective only during summer. Historical costs associated with solar panel installations have limited the potential of such seasonally-targeted installations in Montana.

The capacity for solar energy in Montana will never reach that seen in the more southern states. Advancements in adjustable tilt installations, bifacial panels and energy storage technologies could provide increased opportunity for solar power installations in the future.

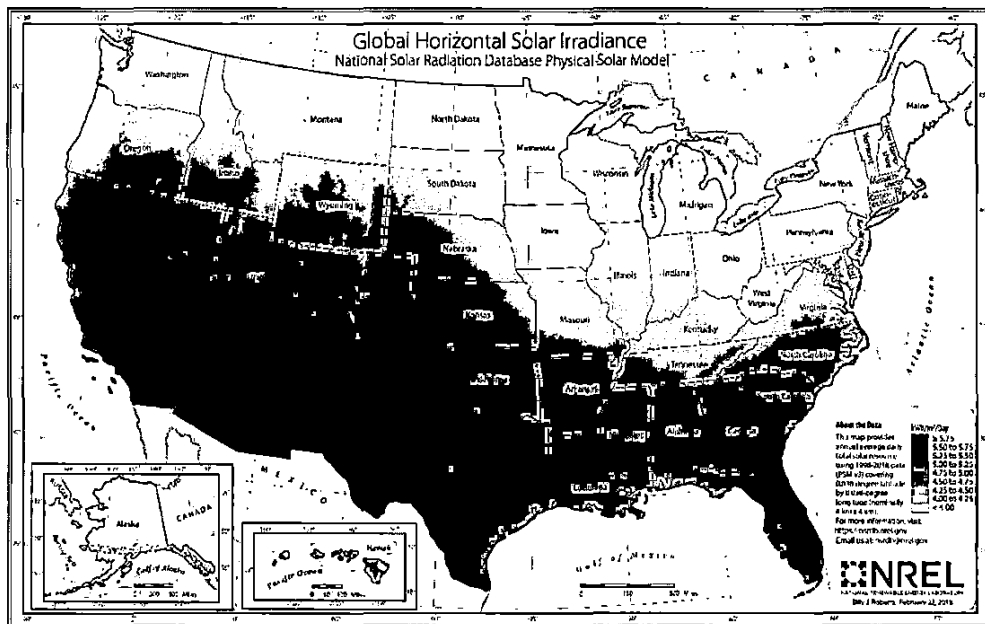


Figure 3.2 – US Global Horizontal Solar Irradiance map developed by the National Renewable Energy Laboratory (NREL).

3.1.3 Wind Power

Like hydropower, harnessing the wind for energy production has been viable for over a century. Wind power requires distributed large-scale installations and electricity transmission infrastructure located relative to high wind regions. Montana's wind energy production has increased sevenfold between 2006 and 2020,⁹⁹ and Montana's electric grid mix currently includes 11.5% wind power.¹⁰⁰

In general, wind speeds in Montana peak in strength during winter with a lull in summer. Wind is complementary to hydropower during much of the year, excluding late summer when both are at the lower end of their annual production cycle. However, wind energy is susceptible to periods of relative stilling that can last decades.^{101 102} An extreme seasonal wind drought occurred in early 2015 that set records across much of the western U.S.^{103 104}

Aside from the mountainous areas in the western portion of Montana, much of the state contains areas that rank high for wind power potential. Existing installations have struck a balance of positioning in areas of high average wind speed and proximity to transmission lines. A recent development is wind turbines that sit higher than the 80-meter standard of the last two decades. As can be seen in analysis by NREL (Figure 3.3), Montana has strong average wind speeds at the 100-meter level and while not all locations sit near Montana's existing transmission network (Figure 3.3 inset), there is certainly opportunity to cost effectively add additional wind energy production.

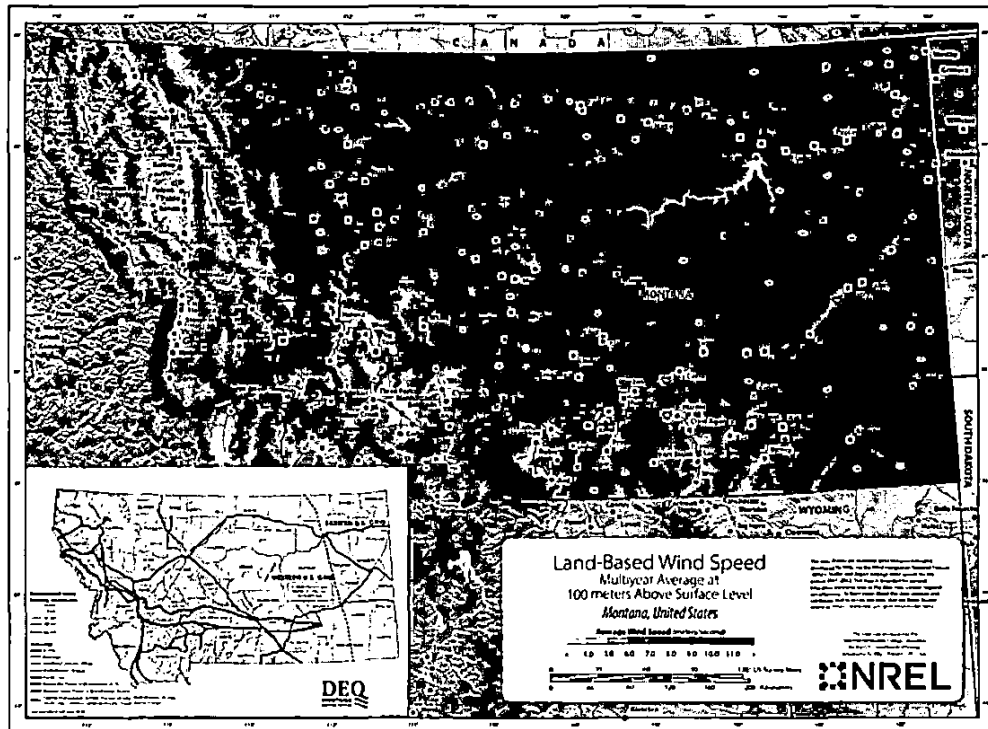


Figure 3.3 – NREL developed 100-meter average wind speeds for the state of Montana.¹⁰⁵ Insert is the network of Montana's electric grid transmission lines as provided by the Montana Department of Environmental Quality.¹⁰⁶

The key issue is the variability and intermittency of the renewable energy sources, ranging from intermittency on time scales of minutes, diurnal variations, variations from weather systems, seasonal cycles, interannual variability and even decadal-scale variability.

Mark Jacobson's Expert Report proposes to address this intermittency/variability using electricity storage in batteries, pumped hydroelectric storage (PHS) and hydroelectric dams. Current battery technology can provide electricity storage on time scales of minutes to hours, and long-term utility-scale energy storage using batteries may be infeasible. Green hydrogen is a possibility for energy storage, but this requires substantial research and development before it can be considered for large-scale applications for energy storage.

The Gordon Butte PHS project is being designed to take advantage of the unique geological features to create a new PHS facility within Montana. While this is very promising technology and a recent NREL study shows technical PHS potential within Montana,¹¹³ the Gordon Butte PHS has even been described as a "spotted, multicolor unicorn" by the CEO of Absaroka Energy who is developing Gordon Butte.¹¹⁴ These projects can take over a decade to come to fruition and much of the process is outside the purview of Montana. For example, Gordon Butte began permitting with the federal government in 2013,¹¹⁵ is being funded by a Danish group of investors,¹¹⁶ and is not anticipated to be online until 2029.¹¹⁷

Mark Jacobson's plan also relies on the WECC transmission grid to keep the grid stable in Montana. Montana currently exports about 40% of its electricity, primarily to Oregon and Washington.¹¹⁸ When weather and climate conditions are sufficiently adverse that Montana would need to import electricity, it is likely that much of the western U.S. would also be impacted by the same weather conditions and would also be looking to import electricity.

Consider the following scenario, which can be expected to occur multiple times each winter with varying magnitudes and durations. "Arctic outbreaks" periodically bring exceptionally cold temperatures to large regions of the continental U.S., even in this era of global warming. An exceptionally cold outbreak occurred during February and March 2019, with similar outbreaks in 2014 and 2017. In February 2019, average temperature departures from normal in Montana were as much as 27 to 28 °F below normal, with Great Falls at the heart of the cold. Temperatures did not rise above 0 °F on 11 days and dropped to 0 °F or below on 24 nights. While the cold in February was remarkable for its persistence, the subsequent Arctic blast in early March 2019 delivered the coldest temperatures. Almost two dozen official stations in Montana broke monthly records, with an all-time record state low temperature for March of -46 °F.¹¹⁹

While Arctic outbreaks generally impact the northern Great Plains states the worst, the spatial extent of these outbreaks can be very large. The cold outbreak during February 2021 that impacted Montana also covered half of the U.S. and extended down to Texas, where massive power outages ensued that resulted in considerable loss of life.¹²⁰

In addition to exceptional power demand for residential heating during such Arctic outbreaks, any power generation from renewables is at a minimum during such periods. Montana's solar and hydropower capacity are at their lowest during winter. While winter winds are generally strong, the Arctic cold air outbreaks are accompanied by large regions of high pressure that are called

cold-core anticyclones (note: Arctic cold air outbreaks and the formation of cold-core anticyclones was the topic of my PhD thesis).^{121 122} The nature of these circulations is that wind speeds are very low within the high pressure system, resulting in very low amounts of wind power production. The large horizontal scale of these high pressure systems indicates that the WECC transmission grid is not going to be of much help if much of the region is also suffering from cold temperatures and low winds.

Providing sufficient power for Montana during such an Arctic outbreak with 100% renewable energy requires hugely infeasible amounts of energy storage. Apart from the possibility of advanced geothermal energy, there seems to be no options other than nuclear or fossil fuels to produce the needed amounts of energy under these conditions. Renewable-only energy for Montana is an exceptionally challenging and costly endeavor, and the proposal put forward by Marc Jacobson is little more than a fairy tale, particularly on the proposed time scales and with available technology.

3.3 Challenges of the mid-21st century energy transition

For the past two centuries, fossil fuels have fueled the progress of humanity, improved standards of living and increased the life span for billions of people.¹²³ In the 21st century, a rapid transition towards eliminating CO₂ emissions has become an international imperative for climate change mitigation under the auspices of the UNFCCC Paris Agreement.

Currently there is rapid technological innovation across all domains of the global energy sector. Innovation is transforming every part of the modern energy system, including long-distance transmission and power grid control, energy storage, residential heating, electric vehicles, and remarkable progress in advanced designs for nuclear power. In context of carbon management (carbon capture and storage, direct air capture), rapid technological innovation is also underway.

3.3.1 Status of the energy transition

The U.S. electricity system began transitioning two decades ago. The old system was characterized by a relatively small number of large generators that were connected to a transmission grid. There were baseload and peak generators to accommodate variations in weather-driven demand. Coal reserves guaranteed an inexpensive supply of fuel if demand was high or there were supply or cost issues with natural gas.

Over the past two decades, the electricity system has connected enormous numbers of smaller generators from wind and solar to the grid. Weather-driven variations now occur in both supply and demand, which are managed by demand response, storage, overcapacity, and interconnections with neighboring systems. Wind and solar power have developed synergistically with natural gas power plants (and to a lesser extent coal), since it is easy to turn gas power plants off and on to balance the intermittent energy supplies from wind and solar.

The realization is growing that countries and states face substantial economic and geopolitical risks if they reduce production of fossil fuel-based energy under the assumption that renewables can quickly replace them. Premature retirements of baseload generating units, such as coal and nuclear

plants, combined with the intermittency of wind and solar as power sources, have seriously impaired grid resiliency and reliability in some regions and countries. These risks have been emphasized by Russia's war on Ukraine, with the ensuing gas and oil shortages and price spikes, leading to political pressures to abandon green energy pledges and return to coal and burn biomass. The energy transition has been further disrupted by supply-chain problems, declining government subsidies and an affordability crisis for materials needed for wind, solar and batteries.

There are substantial institutional and structural barriers in the U.S. that are slowing down or preventing wind and solar generating capacity from being quickly integrated into transmission grids. The U.S. transmission grid has been growing very slowly in recent decades, at a pace that is a fraction of that required for net-zero emissions plans. Transmission and renewable energy projects are being blocked across the country by landowners, consumer and environmental groups. Even when all relevant parties agree to proceed with new transition lines, the cost allocation process can take years.¹²⁴ A further challenge is that utilities and grid operators need to analyze the impacts of new generating projects when added to the grid.¹²⁵

In the U.S., electric vehicles (EVs) are rapidly growing in popularity, but it is becoming increasingly difficult to actually purchase an EV. Tesla CEO Elon Musk said his electric-car factories are "losing billions of dollars" as global supply-chain disruptions and challenges in battery manufacturing constrain the company's ability to scale up production.¹²⁶ According to the CEO of Rivian, a manufacturer of electric adventure vehicles: "All the world's cell production combined represents well under 10% of what we will need in 10 years...meaning 90% to 95% of the battery supply chain does not exist."¹²⁷

The net outcome of the energy transition to date is that in 2022, very few of the world's countries are on track to meet their emissions reductions commitment. Further, the shortages and price spikes in the global natural gas and oil supply caused by Russia's war on Ukraine and supply chain issues for materials have demonstrated the current fragility of the transition and the importance of maintaining the capacity to burn natural gas and coal.

3.3.2 Competing values in the energy transition

The overall vision for future energy systems as per the IPCC AR6 WGIII Report is predicated around net-zero emissions, with energy systems having the following characteristics: (1) electricity systems that produce no net CO₂ or remove CO₂ from the atmosphere; (2) widespread electrification of end uses; (3) substantially lower use of fossil fuels; (4) use of hydrogen, bioenergy, and ammonia in sectors less amenable to electrification; (5) more efficient use of energy; (6) greater energy system integration across regions and components; and (7) use of CO₂ removal technologies.¹²⁸ It is noted here that the IPCC vision is far less constraining and restrictive than the vision put forward by Mark Jacobson in his Expert Report.

A more holistic vision for future energy systems considers a broader range of values plus potential dangers and risks associated with the transition. Table 3.1 provides a list of relevant values and the associated risks or dangers to be considered while envisioning electric power systems humans will want and need to thrive during the 21st century.

Table 3.1 Values and risks/dangers associated with electric power systems.¹²⁹

Values	Risks / Dangers
Abundant	Structural inadequacies to meet energy needs
Reliable	Catastrophic power cuts in the face of weather extremes
Secure	Subject to supply shocks (availability, cost); cyberattacks
Clean	Pollution from emissions, mining; ecosystem and human health concerns
Food & Water	High cost and/or lower food supply; competition for scarce water resources
Local Control	Loss of autonomy; loss of economic opportunity
Minimal Land Use	Interference with other land use priorities and ecosystems
Minimal Material Use	Scarcity of rare minerals; scope and scale of mining; supply chain issues
No CO ₂ emissions	Long-term concerns about adverse impacts of climate change

On this list, the key values for the state of Montana seem to be abundance, reliability, security and clean in terms of conventional pollution.¹³⁰ In context of this Complaint, it seems we need to add the value of “urgency” of reducing CO₂ emissions to allay the dangers of psychological injuries to the Youth Plaintiffs. We should also add “coal on tribal lands” to allay concerns of the Crow Nation, who is actively seeking to develop the coal resources on their land.¹³¹ The Crow Nation's coal and resource assets are worth an estimated \$27 billion, making it among the largest coal owners worldwide. “Resource tribes depend on the development of their resources to create better tomorrows for our children,” states Conrad Stewart, director of energy and water for the Crow Nation of Montana.¹³² One wonders whether the children of the Crow Nation are suffering psychological injuries from the prospect of continued poverty from being unable to benefit from the natural resources on their land.

Prioritizing and balancing these values and concerns is what the political process is for. Rather than focusing on the single value of CO₂ emissions reductions, wise policy seeks to balance the competing objectives. Focusing only on one goal without due attention to other major goals can result in worsening conditions for all goals.

In considering the energy transition, we need to acknowledge that the world, including Montana, will need much more energy in the future than it is currently consuming. Apart from supporting human development and emergence from poverty, more electricity can help reduce our vulnerability to the weather and climate: air conditioners and cleaners, water desalination plants, irrigation, vertical farming operations, water pumps, and environmental monitoring systems. Further, abundant electricity is key to innovations in advanced materials, advanced manufacturing, artificial intelligence, blockchain, robotics, photonics, electronics, quantum computing and others that are currently unforeseen or unimagined.

The energy choices are fossil fuels (with carbon capture and removal as needed), renewable energy and nuclear energy. Of these three choices, nuclear has the greatest potential to provide the very large amounts of energy that we will need through the 21st century with minimal impact on the environment. Different countries and locales will use different combinations of these energy sources based upon their climate, local resources, power needs, and sociopolitical preferences.

3.3.3 Managing Transition Risk: Electric Power Systems

The tightly integrated system of systems that provides the backbone for advanced economies—power, transport, telecommunications, health services, logistics, payments, emergency services, public information—all depend on electricity. The rapid transition of electric power systems away from fossil fuels to meet net-zero emissions targets is introducing substantial new risks to electric power systems. A transition of the electric power system that produces reduced amounts of electricity, less reliable electricity and/or more expensive electricity to achieve net-zero goals would be a tourniquet that restricts the lifeblood of modern society, hampering development and thwarting sustainability efforts.

The Russian war on Ukraine provides a stark conflict between net-zero emissions goals versus immediate needs for abundant, reliable and secure energy. The dangers from inadequate, unreliable and insecure electricity supply are well known and becoming increasingly apparent as European and other countries struggle with inadequate natural gas supplies that they had been receiving from Russia. By contrast, the dangers from CO₂ emissions are much more uncertain, with a long time horizon and a far weaker knowledge base. The debate is then between imposition of certain, intolerable risks from the rapid transition away from fossil fuels, versus the highly uncertain long-term, future impacts from climate change.

This conflict can be resolved by relaxing the time horizon for the 21st century energy transition (including reducing CO₂ emissions) and maintaining energy abundance, reliability and security through the energy transition. Yes, CO₂ emissions are a problem and should be reduced, but not as an urgent problem that trumps the need for abundant, reliable and secure sources of energy for the global population or the population of Montana.

The low feasibility and high costs of reaching net-zero emissions targets by 2050 while maintaining energy security and reliability are at the heart of the debate over allowing near-term net-zero targets to dominate future energy systems. Attempts to speed up the transition away from fossil fuels by restricting the production of fossil fuels and new generating plants has backfired, with increasing power shortages during extreme weather and by making many countries reliant on Russia's fossil fuels.

The long time horizons of the transition and uncertainties about both the technologies that will be available and future climate impacts are best handled by adaptive risk management. Adaptive risk management includes learning from trial and error and incorporating changes in the technologies and knowledge base over time.¹³³

The 21st century energy transition can be facilitated with minimal regrets by:

- Accepting that the world will continue to need and desire much more energy.
- Accepting that we will need more fossil fuels in the near term to maintain energy security and reliability and to facilitate the transition in terms of developing and implementing new, cleaner technologies.
- Continuing to develop and test a range of options for energy production, transmission and other technologies that address goals of lessening the environmental impact of energy production, CO₂ emissions and other societal values (Table 3.1).

- Using the next two to three decades as a learning period with new technologies, experimentation and intelligent trial and error, without the restrictions of near-term targets for CO₂ emissions.

In the near term, laying the foundation for abundant, secure, inexpensive and clean electricity is substantially more important than trying to stamp out fossil fuel use. A practical and humane transition focuses on developing and deploying new sources of clean energy. A practical and humane transition does not focus on eliminating electricity from fossil fuels, since we will need much more energy to support the materials required for renewable energy and battery storage and building nuclear power plants, as well as to support electric vehicles and heat pumps.

Coal production in the U.S. declined by one third between 2000 and 2019.¹³⁴ However, since 2021 coal production has risen sharply to meet surging global coal demand.¹³⁵ Coal's current demand is largely driven by the shortages and high prices of natural gas.¹³⁶ The EIA says the increase in coal generation is unlikely to continue in the long term due to continued power plant retirements and competition from other generation alternatives like natural gas.¹³⁷ The long-term future of U.S. coal production (including Montana's) and global demand will depend on geopolitics, macroeconomics and technology developments.

The push for weather-based renewable energy (wind, solar, hydro) such as Mark Jacobson's proposal seems somewhat ironic. One of the main motivations for transitioning away from fossil fuels is to avoid the extreme weather that is alleged to be associated with increasing CO₂ levels. So why subject our energy supply to the vagaries of water droughts and wind droughts, icing and forest fires?

4. Role of Montana in mitigating climate change

A central tenet of the Complaint is apparent in this paragraph:

“Importantly, there can be prompt redress for Youth Plaintiffs' psychological injuries with declaratory and/or injunctive relief. If the Court granted declaratory relief, it would help redress Youth Plaintiffs psychological injuries by making it clear that their fears were understood by the judiciary and by restoring their confidence that there is recourse for government conduct that violates their constitutional rights—it would give them hope and restore their confidence in their government. Injunctive relief would also provide redress for Youth Plaintiffs psychological injuries because they would then know that their government was taking meaningful action to respond to the dangers posed by the climate crisis.”¹³⁸

Apart from the issues described in earlier sections of this report, this paragraph reflects three mistaken assumptions:

- Global reductions in fossil fuel emissions will meaningfully influence Montana's climate on the time scale of the 21st century.
- Reduction of emissions from Montana would result in a meaningful fraction of global emissions.
- The two Montana laws challenged by the Plaintiffs meaningfully contribute to Montana's climate change.

With regards to Montana's CO₂ emissions, based on 2019 estimates Montana produces 0.63% of U.S. emissions and 0.09% of global emissions.^{139 140} CO₂ is a well-mixed gas in the atmosphere, and local CO₂ emissions do not influence the local climate. The premise behind the UN treaties and agreements on climate change is that reducing global emissions is required to stabilize the global climate, with the implicit assumption that reducing CO₂ emissions will rapidly decrease atmospheric CO₂ and improve regional climates. Reducing 0.09% of global emissions will not make a meaningful difference in atmospheric CO₂ or improve Montana's climate.

The Plaintiffs seem to assume that the two laws they challenge are responsible for a significant percentage of Montana's GHG emissions. Even if this were the case, it would not make any noticeable difference in the global amount of atmospheric CO₂ or in Montana's climate. Simply put, Montana is powerless on its own to influence the global or its local climate.

It is a substantial scientific challenge to understand how atmospheric CO₂ will evolve in response to emissions reductions, and how the fast and slow elements of the climate system will respond. The vagaries of the carbon cycle, in combination with natural climate variability, makes it difficult to identify a measurable change in the evolution of global warming in response to emissions reduction. Inertia in the ocean and ice sheets along with natural internal variability of the climate system will delay the emergence of a discernible response of the climate in the 21st century even to strong CO₂ emissions reductions.¹⁴¹

Even with large reductions in carbon emissions, a corresponding significant shift in surface temperature evolution is not anticipated until decades later.¹⁴² It is unclear how the climate will evolve after net-zero emissions is achieved. To address this issue, the Zero Emissions Commitment Model Intercomparison Project (ZECMIP) used multiple Earth System Models to investigate how the climate system including the carbon cycle will respond 50 years after an immediate cessation of CO₂ emissions.¹⁴³ The models exhibit a wide variety of behaviors, with some models continuing to warm for decades to millennia while others cool. Carbon uptake by both the ocean and the terrestrial biosphere is shown to be important in counteracting the warming effect created by reduction in ocean heat uptake anticipated decades after emissions cease. This response is difficult to constrain primarily given the high uncertainty in the effectiveness of ocean carbon uptake.¹⁴⁴

The bottom line is that there is substantial inertia in the global carbon cycle and the climate system. Even if emissions are successfully reduced/eliminated, it takes time for the CO₂ concentration in the atmosphere to respond to the emissions reduction and it takes time for the climate to respond to the change in atmospheric CO₂ concentration. There is substantial uncertainty regarding how much time this will take – we may not see much of a beneficial change to the climate before the 22nd century even if emissions are successfully eliminated, particularly against the background of large natural climate variability.

Climate change is an ongoing predicament.¹⁴⁵ Even if CO₂ and other GHG emissions are eliminated, natural climate variability and inevitable surprises will provide ongoing challenges that require continuing adaptation by communities and states. The 21st century energy transition will be driven by politics, economics and technological developments, with each state and community responding in a different way that best balances their values and perceived risks and opportunities.

5. Conclusion

Climate change and its interactions with humans and their societies are exceedingly complex issues. The misidentification of climate change as a “crisis” and the ensuing precautionary mandate to rapidly eliminate the use of fossil fuels is creating new risks associated with an energy supply that is not adequate for Montana’s cold winter temperatures.

Our hubristic aspirations for control fail to acknowledge the wickedness and systemic aspects of the climate change problem and its proposed solutions. We can seek to lower our emissions, but we should not pretend that we are controlling the climate.¹⁴⁶

This Complaint reflects an unfortunate cycle of:

- Psychological injuries of the Youth Plaintiffs associated with unjustified apocalyptic rhetoric about climate change targeted at children and young adults.
- The rhetoric in the media and political motivations that blames these adverse weather events and environmental changes on fossil fuel companies and government inaction.
- Further validation of the Youth Plaintiffs’ concerns and psychological distress through this Complaint, which is largely driven by the adults in these childrens’ lives (particularly for the 2-year old Plaintiffs).
- Demands that are being made of the Defendants that would have no material impact on the weather and climate of Montana, but that would allegedly lessen the anxiety and psychological injuries being suffered by the Youth Plaintiffs that have been triggered by unjustified apocalyptic rhetoric about climate change.

The Plaintiffs challenge two laws: the codified “State Energy Policy” and a 2011 amendment to the Montana Environmental Policy Act (MEPA) that cabins environmental review to intra-Montana impacts. It is my understanding of the Complaint that the only relief available to Plaintiffs moving forward is an order from the court declaring these two statutes unconstitutional and enjoining them.

Based on the evidence presented in this report, the Plaintiffs’ challenge of these two laws is based on the following mistaken assumptions and assertions:

- *Plaintiffs*: the release of greenhouse gases from fossil fuel emissions into the atmosphere is already triggering a host of adverse consequences in Montana. *Section 1 of this Report* demonstrates that the climate-related concerns observed by the Plaintiffs are well within the range of historical natural weather and climate variability, with worse occurrences of weather and climate extremes observed during the early 20th century.
- *Plaintiffs*: the future threats posed by fossil fuels and the climate crisis are existential. *Section 2 of this Report* demonstrates that the Plaintiffs’ concerns about climate change in the 21st century are greatly exaggerated, and not consistent with the most recent assessment reports and research publications.

- *Plaintiffs:* Montana's fossil-fuel based emissions are causing harm to Montana and the world. *Section 4 of this Report* demonstrates that emissions from fossil fuels generated in Montana provide a miniscule contribution to global greenhouse gas emissions and do not influence directly Montana's weather and climate.
- *Plaintiffs:* to avoid the alleged existential threat of climate change, Montana's energy system should transition to a portfolio of 100% renewable energy by 2050. *Section 3 of this Report* demonstrates that Montana's energy mix already has a larger than average share of renewables relative to other states in the U.S., and that a rapid transition to 100% renewable energy on the timescale of 2030 or 2050 risks substantial adverse impacts on the reliability and security of Montana's energy supply.

Elimination of the two laws challenged by the Plaintiffs would have essentially no impact on the climate of Montana, even if their elimination in fact acted to reduce Montana's emissions.

Signed this 27th day of October, 2022 in Reno, Nevada



Judith Curry

APPENDIX A

JUDITH A. CURRY

GENERAL INFORMATION

Education

1982 Ph.D. The University of Chicago, Geophysical Sciences
1974 B.S. cum laude Northern Illinois University, Geography

Professional Experience

2016-present Professor Emerita, School of Earth and Atmospheric Sciences
Georgia Institute of Technology

2006-present President, Climate Forecast Applications Network, LLC

2002-2016 Professor, School of Earth and Atmospheric Sciences
Georgia Institute of Technology

2002-2014 Chair, School of Earth and Atmospheric Sciences
Georgia Institute of Technology

1992-2002 Professor, University of Colorado-Boulder
Department of Aerospace Engineering Sciences
Program in Atmospheric and Oceanic Sciences
Environmental Studies Program

1989-1992 Associate Professor, Department of Meteorology, Penn State

1986-1989 Assistant Professor, Dept of Earth and Atmospheric Sciences, Purdue University

1982-1986 Assistant Scientist, Dept of Meteorology, University of Wisconsin-Madison

Awards/Honors

2017 Top 50 Women in STEM – Best Schools

2011 Graetzinger Moving School Forward Award, Georgia Tech

2007 Fellow, American Association for the Advancement of Science

2006 Best Faculty Paper Award, Georgia Tech Sigma Xi

2004 Fellow, American Geophysical Union

2002 NASA Group Achievement Award for CAMEX-4

2002 Green Faculty Award, University of Colorado

1997 Elected Councilor, American Meteorological Society

1995 Fellow, American Meteorological Society

1992 Henry G. Houghton Award, the American Meteorological Society

1988 Presidential Young Investigator Award, the National Science Foundation

Professional Activities (since 2000)

World Meteorological Organization / International Council of Scientific Unions / International Ocean Commission / World Climate Research Programme

- Global Energy and Water Experiment (GEWEX) Radiation Panel (1994-2004)
- GEWEX Cloud System Studies (GCSS) Science Steering Group (1998-2004)
- Chair, GCSS Working Group on Polar Clouds (1998-2004)
- Chair, GEWEX Radiation Panel SEAFLUX Project (1999-2004)
- Steering Committee, IGAC/SOLAS Air-Ice Chemical Interactions (2003-2006)
- Science Steering Group, Arctic Climate System (ACSYS) Programme (1994-2000)

National Research Council – National Academies

- Space Studies Board (2004-2007)
- Climate Research Committee (2003-2006)
- Panel: A Strategy to Mitigate the Impact of Sensor Descopes and De-manifests on the NPOESS and GOES-R Spacecraft (2007-2008)
- Committee to review CCSP SAP 1.1 Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences (2007)

U.S. Federal Agencies

- DOE Biological & Environmental Research Advisory Committee (BERAC) (2012-2015)
- Earth Science Subcommittee, NASA Advisory Council (2009-2013)
- Search Committee, NSF Director for Geoscience (2007)
- External Advisory Board, NCAR Atmospheric Technology Division (2004-2006)
- Science Board, DOE ARM Climate Reference Facility, (2008-2011)
- External Review Committee, COSIM Program, Los Alamos National Laboratory (2007)
- NOAA Climate Working Group (2004-2009)

Professional Societies

- Executive Committee, American Physical Society Topical Group on Physics of Climate (2013-2016)
- Member, Fellows Committee, American Geophysical Union (2013-2014)
- Executive Committee of the Council, American Meteorological Society (1998-2000)
- Councilor, American Meteorological Society (1997-2000)

RESEARCH

Books

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- Curry, J.A. and P.J. Webster, 1999: *Thermodynamics of Atmospheres and Oceans*. Academic Press, London, 467 pp (second edition under contract).
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Expert Report
of
Terry L. Anderson
Senior Fellow, Hoover Institution, Stanford University
Professor Emeritus, Montana State University

This report was written at the request of the State of Montana Attorney General's Office and is based on my professional expertise as an economist.¹ My qualifications include a Bachelor of Science Degree in Business Administration from the University of Montana (1968), a MS Degree in Economics (1991) and a Ph. D. Degree in Economics (1992), both from the University of Washington. Since 1997, I have been a Senior Fellow and am currently the John and Jean DeNault Senior Fellow at the Hoover Institution, Stanford University. I began teaching in the Department of Agricultural Economics and Economics at Montana State University in 1992 and retired from there in 1999 as a Professor Emeritus. I was a Senior Fellow with the Property and Environment Research Center (PERC), Bozeman, MT, from 1980 to 2014 and president of PERC from 2012 to 2014. I have also been a visiting scholar at Oxford University, England, the University of Basel, Switzerland, and the University of Canterbury, New Zealand, and a Fulbright Fellow at the University of Canterbury, New Zealand. Most of my teaching and research has been focused on natural resource and environment policy, and I have received numerous teaching and research awards for that work. That research includes publishing hundreds of professional journal articles and 42 books. The most recent of those books is *Adapt and be Adept: Market Responses to Climate Change* (Hoover Institution Press, 2020). I currently reside in Bozeman, Montana, where I enjoy the benefits of Montana's clean and healthful environment. I have attached a copy of my CV as Exhibit 1 to my expert report.

¹ The author thanks his research assistant, Dylan Granum, Mathematics and Economics student at Montana State University, for his excellent work in gathering and analyzing data.

I. Overview

This report was written in response to Plaintiffs' Expert Disclosures, in particular those of Richard Barrett on behalf of the Youth Plaintiffs in the case dated 30 September 2022 (hereafter referred to as *Report*). That report attempts to support the claims of the Youth Plaintiffs that two Montana statutes, the Montana Environmental Protection Act and the State Energy Policy, adversely affect the plaintiffs' Montana constitutional right to a "clean and healthful environment." It argues that these statutes:

1. promote greenhouse gas (GHG) emissions, especially CO₂, from Montana sources, which then cause global climate change;
2. do not correctly account for the benefits and costs of those policies;
3. promote GHG emissions that adversely affect the environment of the state and the globe, causing "grave injuries to Plaintiffs (*Report*, p. 4 (21)), and "causing substantial degradation and depletion of Montana's environment and natural resources" (*Report*, p. 4 (21)); and
4. discourage other states and nations from reducing their emissions and thus lead to a race to the bottom in climate change policy.

My expert report critically examines the economics and data regarding each of these claims.

II. Montana's Contribution to Climate Change

Because the plaintiffs' claim of harm is due to global climate change, it is important to put Montana's contribution to global greenhouse gas emissions, regardless of whether they are due to Montana statutes, into a global perspective.

In 2020, total global GHG emissions were 34.8 [38]GtCO₂.² Of that amount, Montana emitted approximately 26.2 million metric tons³ of CO₂ (0.0262 Gt). Therefore, Montana

² Viewed on 10 October 2022 at <https://www.co2.earth/global-co2-emissions>.

³ Viewed on 10 October 2022 at <https://www.eia.gov/environment/emissions/state/>.

contributed 8.621e-4 percent or 0.08621 percent to global GHG emissions in 2020. Given that Montana's emissions account for only 0.0007634 percent of global GHG emissions, the state's policies have virtually no effect on global climate change and no effect on the welfare of Montana's citizens, other than the contribution that fossil fuel production makes to the state's economy, and that effect is a benefit to Montana's citizens.

A. Montana's Fossil Fuel Emissions Declining

Moreover, between 2005 and 2020, CO₂ emissions from fossil fuel combustion in Montana decreased by 21 percent.⁴ This reduction was driven mainly by a 35 percent reduction in electrical power production from fossil fuels. It is difficult to determine how the state's energy policies have contributed to this decline, but certainly some amount of the decline is due to state regulations that have reduced GHG emissions. Hence, whatever plaintiffs' claims are that Montana's energy policies are causing or contributing to global warming, those claims must be offset by policies that have reduced Montana's emissions and reduced global climate change.

To further put Montana's GHG emissions into perspectives, Appendix Table 1 show emissions by sector and source between 2019 and 2022. Using the U.S. Energy Information Administration projects for the Intermountain Region, the table projects Montana emissions by sector and source from 2022 to 2030 and shows the percentage change. Note that carbon emissions for every sector—residential, commercial, industrial, transportation, and electric power—are projected to decline through 2030, and the total projected CO₂ emissions reduction for all fuels (coal, oil, natural gas, and other) is 11.5 percent between 2019 and 2030.

⁴ Viewed on 15 September 2022 at https://deq.mt.gov/files/deqadmin/climate/2020-09-09_montanaclimatesolutions_final.pdf.

B. Montana's Emissions have a Minimal Effect on Global Climate

The plaintiffs' claims that Montana's energy policies are causing them harm due to climate change is implausible given how little Montana contributes global carbon emissions. Using the middle-of-the-road estimates of global emissions, the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC) predicts that global temperatures will rise by 7.4°F by 2100. Assuming that Montana joined all the rich countries in eliminating fossil fuel use by 2100—a very unlikely target—the increase in global temperature associated with zero global GHG emissions would be reduced by only 0.8°F, meaning global temperature would increase by 6.6°F by 2100.⁵

Now suppose that only the United States, including Montana, but no other nations reduced GHG emissions to zero by 2100, the increase in global temperature would be reduced by a mere 0.33°F by the century's end, meaning global temperature would increase by 7.07°F by 2100.

Further assume that the other 49 states reduced their use of fossil fuel to zero by 2100, while Montana kept its emissions at 2020 levels. Thus Montana would be contributing nothing to potential global temperature reductions, making it a “free rider,” to use Richard Barrett's words (*Report*, p. 9 (302)). How much difference would Montana's “free ride” make to global warming by 2100?

To estimate the difference, I divided Montana's total in 2020 (26.2 million metric tons)⁶ by the US total in 2020 (4,592 million metric tons)⁷ to estimate Montana's share of US emission—0.57 percent—and assumed that Montana did nothing between 2020 and 2100 to reduce its GHG emissions. (Note that the assumption that Montana will do nothing is not consistent with the State's

⁵ Bjorn Lomborg, *False Alarm* (Basic Books, 2020), 41-42.

⁶ Viewed on 10 October 2022 at <https://www.eia.gov/environment/emissions/state/>.

⁷ Viewed on 25 October 2022 at <https://www.eia.gov/environment/emissions/state/excel/table1.xlsx>.

significant recent emissions reductions.) In other words, the globe would lose Montana's contribution associated with US reductions by 2100.

$$\text{Montana's Lost Contribution by 2100} = 0.33^{\circ}\text{F} \times 0.57 = 0.019^{\circ}\text{F}$$

Hence, the increase in global temperatures by 2100 would be approximate 0.349°F rather than 0.33°F . In other words, if Montana undertook all of the cost to the state in the form of lost benefits from fossil fuel production, Montana's efforts would reduce the predicted 2100 increase of 7.4°F to 7.38°F .

In short, Montana's energy or environmental policies have virtually no effect on global or local climate change because Montana's GHG contribution to the global total is trivial.

IV. Life Expectancy as a Measure of "Clean and Healthful Environment"

The *Report's* claims that Montana's environmental and energy policies are depriving the youth plaintiffs of their "right to a clean and healthful environment" are based mainly on estimates of the effect of climate change on snowpack, water flows, wildlife populations, etc., but they provide no measure of harm to the state's citizens.

According to the OECD,⁸ "Live Expectancy at birth is one of the most frequently used health status indicators. Gains in life expectancy at birth can be attributed to a number of factor, including rising living standards, improved lifestyles, and better education, as well as greater access to quality health services. Using an Overlapping Generations Model, researchers from the Institute for the Study of Labor (IZA) in Bonn, Germany,⁹ found "a positive correlation between longevity and environmental quality, both in the long run and along the transition path." Based on

⁸ Viewed on 25 October 2022 at <https://data.oecd.org/healthstat/life-expectancy-at-birth.htm#:~:text=Life%20expectancy%20at%20birth%20is%20one%20of%20the%20most%20frequently,access%20to%20quality%20health%20services>.

⁹ Viewed on 25 October 2022 at <https://data.oecd.org/healthstat/life-expectancy-at-birth.htm#:~:text=Life%20expectancy%20at%20birth%20is%20one%20of%20the%20most%20frequently,access%20to%20quality%20health%20services>.

these conclusions, life expectancy at birth of Montana's citizens provides a causal link between the environment and health. As seen in Appendix Figure 1, life expectancy at birth in Montana has been climbing since 1950. Moreover, the trend in Montanan's life expectancy is not different from that of the United States as a whole and no different from other states that have constitutional or statutory requirements that states must provide citizens with healthy environments. It should be noted that the general upward trend in life expectancy is directly related to rising incomes, and incomes in Montana likely will rise less if the state pursues policies that limit fossil fuel use.

V. Accounting for the Social Benefits and Costs of Climate Change

The expert report filed on behalf of the Youth Plaintiffs attempts to apply the economic methodology based on the idea that the private benefits and private costs from the use of coal, oil, and gas do not take full account of the social costs that are external to market transactions. Putting aside the question of whether there is a connection between Montana policies regarding GHG emissions and the citizens' constitutional right to a clean and healthful environment, the expert's application of "benefit-cost analysis" is faulty for two reasons. First, it does not use standard economic reasoning based on *additional or marginal* benefits and *additional or marginal* costs. Second, it does not account for the potential additional social benefits of climate change; in other words, GHG emissions have marginal social benefits as well as marginal social costs.

Consider Mr. Barrett's statements about how benefits and costs are calculated. The report asks, "does the economic (market) value of an additional unit of fossil fuel produced (i.e., the price, P_{FF} , of an additional ton of coal, barrel of oil, etc.) exceed, or fall short of, the private (PC_{FF}) plus the social cost (SC_{FF}) incurred in producing it?" (*Report*, p. 6 (299)). Note that the adjective, "additional," is applied to private benefits and costs, but not to the social benefits. In economic parlance, the proper comparison for a benefit-cost calculation is to compare the *marginal benefits*

with the *marginal costs*. Under the assumption that the coal market is perfectly competitive, meaning that Montana fossil fuel producers take the price as given from the global market, it is reasonable to infer that P_{FF} is an accurate measure of the marginal private benefit of an additional unit of fossil fuel production, and PC_{FF} is an accurate estimate of the *marginal* private costs on an additional unit of fossil fuel production.

A. Social Benefits of Carbon

To give a full benefit-cost evaluation of carbon, however, it is necessary to include potential social benefits that are not included in P_{FF} . The report asserts that “Increasing temperatures have and will cause significant, measurable economic damages, including, but not limited to, reduced human health and labor productivity, rising sea levels with associated damage to coastal communities and infrastructure, and impaired agricultural productivity and food availability” (*Report*, p. 4 (297)). Obviously rising sea levels are not a relevant cost to Montana, and food availability is dependent on global production, not just Montana’s production. The *Report* continues saying that “climate change will reduce Montana’s crop yields by as much as 25% [and] will reduce the productivity of the rangeland cattle industry by 20%” (*Report*, p. 5 (298)).

The report does not even attempt to estimate the positive effects that climate change may have on agricultural productivity and on human health, locally and globally. This is another glaring problem with Barrett’s analysis. Warmer temperatures are causing cropping patterns to change around the world, and Montana farmers and ranchers are likely to follow and gain from this adaptation. A study by Conservation International,¹⁰ published in the, forecasts that wine production in California may drop by 70 percent and regions along the Mediterranean by as much as 85 percent over the next fifty years. The silver lining is that vintners will adapt by moving their

¹⁰ Viewed 7 June 2022 at <https://www.pnas.org/doi/10.1073/pnas.1210127110>.

grape production north, some predicting it will even move to places such as Montana, Wyoming, and Michigan, noted for their severe winters.¹¹ Canadian biologist John Pedlar¹² sees more people in southern Ontario “trying their hand at things like peaches a little farther north from where they have been trying.” This is consistent with the US Department of Agriculture’s Plant Hardiness Zone Map,¹³ which shows tolerant zones moving north. These predictions suggest that Montana agriculture could benefit from global warming by producing crops more valuable than current crops. Such potential benefits are not mentioned in the *Report*.

Other benefits from climate change are benefits resulting from lower ocean transportation costs due to less ice, greater agricultural output in northern climes due to higher temperatures, more species in areas where the climate is warmer, and, most importantly, fewer temperature related human deaths because cold kills more than heat. As Matt Ridley, scientist and journalist, points out,¹⁴ “climate change has done more good than harm so far and is likely to continue doing so for most of this century. This is not some barmy, right-wing fantasy; it is the consensus of expert opinion.”

A study by Professor Richard Tol, Sussex University in England, published in the *Journal of Economic Perspectives* (2009)¹⁵ concludes that climate change in the past century has improved human welfare by 1.4 per cent of global economic output. Depending on how long the benefits will exceed the costs, he finds that the percentage increase will be 1.5 per cent by 2025, will be 1.2 percent by 2050, and will not turn negative until around 2080. In his benefit-cost calculations, Mr. Barrett **assumes** that the price captures the full social value, but this assumption

¹¹ Viewed 7 June 2022 at <https://qz.com/1108814/the-improbable-new-wine-countries-that-climate-change-is-creating>.

¹² Viewed 7 June 2022, quoted in <https://academic.oup.com/bioscience/article/64/4/341/247944>.

¹³ Viewed 7 June 2022 at <https://www.npr.org/sections/thesalt/2012/01/25/145855948/gardening-map-of-warming-u-s-has-plant-zones-moving-north>.

¹⁴ Viewed 7 June 2022 at <https://www.spectator.co.uk/article/why-climate-change-is-good-for-the-world>.

¹⁵ Viewed 18 June 2022 at <https://www.aeaweb.org/articles?id=10.1257/jep.23.2.29>.

misses the potential for social benefits to exceed private benefits when fossil fuels are put into production processes along with labor, capital, and other resources. It is entirely conceivable that the value of the total product exceeds the sum of the input costs (prices), i.e. economic rents are generated. To understand this in another way, suppose that fossil fuels were immediately banned so that alternative energy had to make up the loss. As the people of Texas discovered in the winter of 2022, it was nearly impossible to make up for the loss of fossil fuel used to generate electricity. The far higher costs in the absence of fossil fuel are rents that are lost. By focusing only on the social cost side and ignoring the social benefit, it is not possible to conclude that “the additional unit of fossil fuel produced is wasteful.”

In his chapter titled “Hydrocarbons are Here to Stay” (in Anderson 2021, 43-44), Mark Mills concludes that

Over the past two centuries—the rise of the hydrocarbon era—society has seen a radical collapse in the share of an economy’s GDP devoted to acquiring fuel and food. . . . More wealth is always required to build resilience and adaption into society infrastructures and thus protect civilization from any and all of nature’s attacks—including, but far from limited to future climate changes regardless of the proximate cause.

The value of the resilience and adaptation that results from fossil fuels is not totally captured in P_{FF} . Adding that value into the benefit cost calculations can easily tip the efficiency scales in the direction of fossil fuels.

The important take-away from this discussion is that the Mr. Barrett’s expert report, which totally ignores the social benefits of climate change, is not an accurate depiction of the social costs and benefits of GHG emissions **even if Montana’s laws allowed policy makers to take account of costs and benefits outside the state.** If the plaintiffs’ claims that Montana policies contribute to climate change and global warming were correct, it is conceivable that Montana’s GHG policies

make Montana citizens better off. The youth plaintiffs aren't worried about starvation, but pursuing drastic global policies to reduce GHG emissions will leave them poorer. In short, curtailing fossil fuel production in Montana will add few environmental benefits to the state's citizens, but will reduce the potential for increasing incomes for the youth who must leave that state in search of better paying jobs.

B. Social Cost of Carbon

Just as there are social benefits not captured in P_{FF} , there are social costs not captured in PC_{FF} . For that reason, Mr. Barrett focuses on the social cost of carbon (SCC). To be sure, calculating the SCC is complicated and politically contentious. Nonetheless, economists agree that estimates of SCC must be based on an integrated assessment model (IAM) in order to simulate time paths for the atmospheric CO₂ concentration, its impact on temperature, and resulting reductions in GDP. Even if scientific debates over what is the best IAM could be settled, the economic effects of the time paths and the GDP reductions have and will continue to fill economic journals.

Mr. Barrett identifies four modules that go into SCC: the socioeconomic and emissions trajectory module; the climate module; the damages module; and the discounting module. The latter two are of utmost importance to economists, and it is no surprise that economists do not agree on how climate change translates into economic damage or on how to discount future damages (or benefits) into present value.

The most recent and best summary of where economics stand on these two modules is provided by MIT economist, Robert Pindyck, "The Social Cost of Carbon Revisited."¹⁶ After surveying experts and trimming outliers and focusing on experts who expressed a high degree of

¹⁶ Viewed on 5 October 2022 at <https://www.sciencedirect.com/science/article/abs/pii/S0095069617307131?via%3Dihub>.

confidence in their answers, he finds the SCC to be between \$80 to \$100/mt, a range that is well below Mr. Barrett's \$125 SCC. Using Barrett's emission coefficient (e) and his P_{FF} and applying Pindyck's recent survey of economists and scientists estimates of the SCC, changes the conclusion regarding the economic efficacy of fossil fuels. Recall that these calculations take no account of possible social benefits of using fossil fuels beyond the price.

- Coal—At a SCC of \$100 and \$80, respectively, the social costs of coal are \$201.40 or \$162.12, respectively, compared to Barrett's estimate of \$252. Taking the P_{FF} of coal to be \$21 (Barrett), coal does not pass benefit-cost muster, mainly because coal is so cheap.
- Oil—Similarly, the social cost of oil is \$47 and \$37.60, respectively, compared to Barrett's estimate of \$59. Taking the P_{FF} of oil to be \$45 (Barrett), oil nearly passes at the upper end of SCC and clearly passes at the lower end.
- Natural Gas—Similarly, the social cost of natural gas is \$6.05 and \$4.84, respectively, compared to Barrett's estimate of \$7.56. Taking the P_{FF} to be \$5.50 (Barrett), natural gas passes benefit-cost muster at both the upper and lower ends of SCC.

VI. Adverse Effects of Climate Change to Montana's Environment

The Report asserts that Montana statutes in question here contribute to such things as wildfires, air quality, water flows, and recreational opportunities, to mention a few. It is implausible that Montana environmental and fossil fuel regulations are contributing to these claims via climate change because Montana's contributions to global GHG emissions are so small. Furthermore, GHG emissions are not the only cause of environmental problems. For example, claiming that smoke from wildfires is the result of Montana statutes ignores the smoke that comes from states to our West, especially California. And claiming that all the costs of Montana wildfires are the result of the statutes in question ignores other factors—for example forest management (or

mismanagement)—that contribute to those costs. Air quality is much more related to local emissions rather than CO₂. In the Missoula valley, for example, it was emissions from the pulp mill that cause poor air quality and that problem was fixed with stricter air quality standard. Finally, recreational opportunities go far beyond snow in the mountains and water in fishing streams, both of which have been sufficient to attract increasing numbers of skiers, snowmobilers, and fishers. Public hunting and fishing access has been a priority for the DFWP and most wildlife populations, especially elk, are at all-time highs.

The expert scientists claim that it is “critical that GHG emissions are reduced immediately, particularly in light of the young ages of the Plaintiffs in this case” (*Report*, p. 8 (25)). Referring back to Montana’s contribution of GHG to the global atmosphere, this claim is hard to justify. Nonetheless, it is obvious that some of the costs claimed by the plaintiffs are the result of factors other than MEPA and the State Energy Policy.

VII. Is there a Race to the Bottom or to the Top?

One of the benefits of federalism is that it allows states to determine the best fit of policies to the citizens of each state. Some have argued that this will result in a race to the bottom with environmental policy as states try to compete for business based on more lenient and less costly regulations. One of the main reasons that we would **not** expect a race to the bottom with climate policy is that virtually all environmental policies follow what is called the “environmental Kuznets Curve,” named after Nobel Laureate Simon Kuznets.¹⁷ were the first to note the relationship between economic growth and environmental quality. What they found and what was further elaborated on by economist Bruce Yandle¹⁸ is that the relationship between growth and environmental quality may be negative in early stages of growth—i.e. more growth leads to less

¹⁷ Viewed 13 June 2022 at <https://www.jstor.org/stable/2118443?seq=1>.

¹⁸ Viewed 13 June 2022 at https://www.independent.org/pdf/tir/tir_09_2_3_yandle.pdf.

environmental quality—but it becomes positive as wealthier citizens demand and get more environmental quality. Hence, rather than there being a “race to the bottom” with environmental policy, there is a “race to the top,” and this is evident in a number of environmental regulations from dissolved oxygen in water to deforestation. This also explains why richer countries are taking more action than poorer countries to curb carbon emissions.

Part of the economic rationale for the “race to the bottom” theory is that environmental emissions are not confined to the home jurisdiction where emissions may occur, and this is especially the case with carbon emissions which instantly become part of the global commons. The claim is that there will be a “tragedy of the commons,” thus explaining why the marginal social cost of GHG emissions are greater than the marginal private costs. As noted above, however, Montana’s carbon emissions have a negligible effect on its own citizens as well as on neighboring jurisdiction—local, state, national, or international. This provides a rationale for why the 2011 Montana legislature specifically amended MEPA to provide that policy makers should **not** take account of costs outside the state’s borders. Simply put, there are no significant spillover costs to take into account regarding Montana’s contributions to GHG, but there are private costs to the state that would certainly result from Montana’s inability to capture the value of *in situ* fossil fuels. Hence, Montana’s GHG policies will have benefits that outweigh the costs because the costs are negligible. This is contrary to the *Report’s* claim that there are reciprocal costs that justify accounting for putting the social cost of carbon into the policy equation..

The expert *Report* contends that Montana needs to take the lead by implementing policies that reduce GHG emission because “it is neither realistic nor reasonable to expect other states to behave in that way if Montana does not.” (*Report*, p. 9 (302)). This is a value judgment, not a statement grounded in any economic theory, the authors expertise. Economics has no way of

calculating what is or is not “realistic” or “reasonable” for others to do. Indeed, to the contrary, undertaking policies to reduce CO2 emissions in order to slow climate change would not be a rational move for the state because it has costs without benefits.

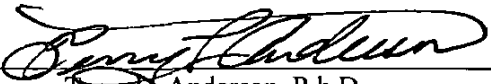
As further evidence of “realistic and responsible,” behavior the *Report* cites a study that calculates an international “climate reciprocity ratio” of 6.1 to 6.8 (*Report*, 9 (302)). The ratio implies that for every ton the United States pledged to reduce its emissions under the Paris Agreement other countries will *pledge* to reduce their aggregate emissions by six times more. These correlation estimates do not suggest a causation resulting from reciprocity. As the expert report admits, “Thus, if [emphasis added] reciprocity has an important influence on the formulation of climate policies, and in my opinion it does [emphasis added], Montana should adopt policies that will serve its economic interest for other states and nations to reciprocate – in this case, the use of a global SCC” (*Report*, p. 9 (302)). There is no basis in economic reasoning to support this opinion. The Report makes no attempt to defend its claim that Montana's state policies will be influential on other states and countries. It is a naked assumption, unsupported by any empirical evidence. especially in light of the fact that Montana's share of national or global emissions and that its population is small compared to the nation or the world. What reason is there to think the state's actions will influence other political jurisdictions?

CONCLUSION

Montana's statutes under question in this case—2011 amendments to MEPA and the State Energy Policy—may or may not result in net increases in GHG emissions. It is clear, however, that these two statutes cannot possibly be contributing significantly to climate change because Montana's aggregate emissions were only 0.0007643 percent to global GHG emissions in 2020. Additionally, the economic estimates of the SCC are trending downward because adaptation to

climate change is reducing the likelihood that those costs will be significant.¹⁹ It is implausible that the two state laws in question here are adversely affecting the welfare of its citizens, youth or older. Combining Montana's trivial effect on climate change with upper-bound estimates of SCC is not the path to a clean and healthy environment or to a vibrant economy.

Dated October 28, 2022.


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¹⁹ See Pindyck, viewed on 5 October 2022 at <https://www.sciencedirect.com/science/article/abs/pii/S0095069617307131?via%3Dihub>.

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Appendix Table 1

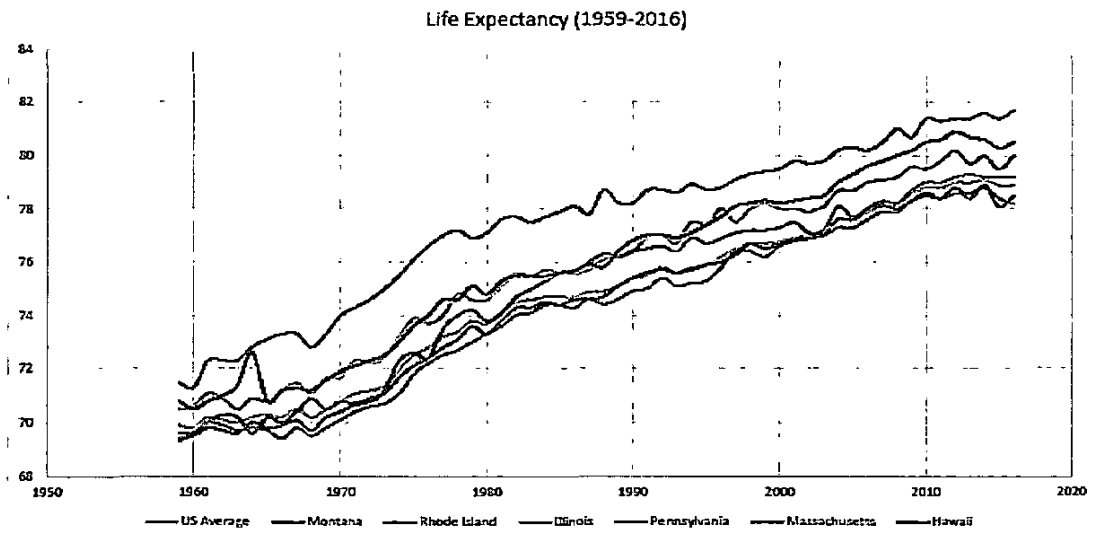
MT CO₂ emissions projections
by sector (MMmt CO₂)

	2019	2030	% Change
Total residential	86.809	65.345	-24.72%
Total commercial	79.21	61.084	-22.96%
Total industrial	107.37	104.62	-2.55%
Total transportation	135.99	131.33	-3.43%
Total electric power	169.66	121.22	-28.55%

MT CO₂ emissions projections
by fuel source (MMmt CO₂)

	2019	2030	% Change
Petroleum	161.26	158.53	-1.69%
Natural Gas	126.46	128.172	1.35%
Coal	121.63	75.510	-37.92%
Other	0.1111	0.1771	59.41%
Total	409.46	362.386	-11.50%

Appendix Figure 1



When the green amendment was ratified

MT: 1972

MA: 1972

PA: 1971

RI: 1987 (very limited green amendment)

HI: 1978

IL: 1970 (conflicting answers, many sources say PA and MT were first states to ratify a green amendment)

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- ▶ Adjunct Professor, Stanford Graduate School of Business (2002-2008). Course: *Environmental Entrepreneurship*
- ▶ Executive Director, PERC, Bozeman, MT, 1995-2012
- ▶ Professor, Department of Agricultural Economics and Economics, Montana State University, Bozeman, 1981-1999, now Professor Emeritus
- ▶ Visiting Professor, Clemson University, 1987-1988
- ▶ Associate Professor, Department of Agricultural Economics and Economics, Montana State University, Bozeman, 1976-1980
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PUBLICATIONS:

Books:

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- ▶ Anderson, Terry L., and Mark Liffman. 1996. Making "Crown Jewels" Pay. *Rocky Mountain News*, 1 September.
- ▶ Anderson, Terry L. 1995. How the Government Keeps Indians in Poverty. *Wall Street Journal*, 22 November.
- ▶ Anderson, Terry L. 1994. Home on the Range for Wolves. *Christian Science Monitor*, 14 April.
- ▶ Anderson, Terry L. 1993. Bootleggers and Baptists Keep Free Trade at Bay. *Detroit News*, 30 April.
- ▶ Anderson, Terry L. 1993. The Forests and the Fees. *New York Times*, 28 June.
- ▶ Anderson, Terry L. 1993. Recreationists are Getting the Real Free Lunch. *Bozeman Daily Chronicle*, Letter to the Editor, 31 October.
- ▶ Anderson, Terry L. 1993. Positive Incentives for Saving Endangered Species (with Jody J. Olsen). In *Building Economic Incentives Into the Endangered Species Act*, ed. Wendy E. Hudson. Washington, D.C., *Defenders of Wildlife*, October.
- ▶ Anderson, Terry L. 1992. Wolves in the Marketplace. *Wall Street Journal*, 12 August.
- ▶ Anderson, Terry L. 1991. Zimbabwe Makes Living with Wildlife Pay. *Wall Street Journal*, 25 October.
- ▶ Anderson, Terry L., and Donald Leal. 1990. Welfare Trees and Welfare Fish. *Fly Fisherman*, January.
- ▶ Anderson, Terry L. 1989. American Indians Stifled by Government Control. *Detroit News*, 9 August.
- ▶ Anderson, Terry L. 1989. Keeping Yellowstone's Buffalo Roaming at Home. *Wall Street Journal*, 22 May.
- ▶ Anderson, Terry L. 1989. Trumpeting Water Markets. *Orvis News* (24), 7 October.
- ▶ Anderson, Terry L. 1988. New Zealand's Privatizers Face Racial Roadblock. *Wall Street Journal*, 10 August.
- ▶ Anderson, Terry L., and Donald Leal. 1988. A Private Fix for Leaky Trout Streams. *Fly Fisherman*, June.
- ▶ Anderson, Terry L. 1987. Camped Out in Another Era. *Wall Street Journal*, 15 January.
- ▶ Anderson, Terry L. 1986. Private Trails to Public Benefits. *Detroit News*, 23 April.
- ▶ Anderson, Terry L., and Jane S. Shaw. 1985. The Grass Isn't Always Greener in a Public Park. *Wall Street Journal*, May 28.
- ▶ Anderson, Terry L. 1985. Thy River's Keeper. *Orvis News* (20), 2 March.
- ▶ Anderson, Terry L. 1984. Water Is Now a Fighting Word. *USA Today*, 30 January.
- ▶ Anderson, Terry L. 1983. The Water Policy Sinkhole. *Inquiry*, October.
- ▶ Anderson, Terry L. 1983. Water Needn't Be a Fighting Word. *Wall Street Journal*, 30 September.

SPEAKING ENGAGEMENTS AND PARTICIPATION IN CONFERENCES:

- ▶ Speaker, on "Semantic Traps," Gruter Institute Squaw Valley Conference 2016, Innovation in the Spotlight: The Role of Institutions in Innovation and Innovation in Institutions, (Book forthcoming) May 23 - 27, 2016.

- ▶ Panelist, on Community, Culture, and Conservation: Sustaining Landscapes and Livelihoods, Colby College, Waterville, Maine, April 8, 2016.
- ▶ Speaker, on “Wilderness is Not Priceless,” University of Montana 2016 Wilderness Issues Lecture Series, February 17, 2016.
- ▶ Speaker, on “Free Market Environmentalism,” Federalist Society, Missoula MT, February 16, 2016.
- ▶ Panelist, honoring Nobel Laureate, Douglass North; Lecturer on Free Market Environmentalism for the Next Generation, Trinity College, Hartford, CT, February 4, 2016.
- ▶ Co-director, “Environmental Policy in the Anthropocene,” Sponsored by the Property and Environment Research Center, (PERC) and Searle Foundation, Bozeman, MT, December 3-5, 2015.
- ▶ Speaker, Seminar, The Law and Economics Association of New Zealand, Wellington, New Zealand, November 24, 2015.
- ▶ Speaker, Annual Condliffe Lecture, the University of Canterbury, Christchurch, New Zealand, November 17, 2015.
- ▶ Speaker, “Unlocking the Wealth of Indian Nations: Lessons from the Past for the Future,” James Madison College, Michigan State University campus LECD lecture series, November 10, 2015.
- ▶ Speaker, The Fund for American Studies 2015 Leadership Conference, received the Gary Walton Prize for Excellence in Teaching Economics, October 24, 2015.
- ▶ Speaker, “This Land is Your Land...Or Is It?,” Black Mountain Institute and presented with the support of the Eleanor Kagi Foundation, September 24, 2015.
- ▶ Co-director, “Wildlife Conservation, Trade, and Property Rights,” Sponsored by the Property and Environment Research Center, (PERC) and Searle Foundation, Bozeman, MT, July 26-28, 2015.
- ▶ Director, “Property Rights, Entrepreneurship, and the Environment: A Program for Enviropreneurs,” Sponsored by the Property and Environment Research Center, (PERC) and Liberty Fund, Bozeman, MT, July 7-10, 2015.
- ▶ Panelist, “Current Status and Future of Environmental Law,” Heritage Foundations’ Spring Legal Strategy Forum, Seattle, WA, May 5-7, 2015.
- ▶ Speaker, New York University, commissioned paper presentation funded by the Goodrich Foundation, New York, NY, March 1, 2015.
- ▶ Lecturer, University of Santa Barbara, Bren School of Environmental Science and Management Isla Vista, CA, February 1, 2015.
- ▶ Speaker Hoover Institution Donor’s Retreat, “Fracking and Getting Your Fracks Right,” Stanford University Stanford, CA, April 20, 2015.
- ▶ Attended, Dallas Safari Club Annual Meeting, Dallas, TX, January 15-17, 2015.
- ▶ Speaker, “Environmental Entrepreneurs,” Sponsored by Montana State Extended University Wonderlust Friday Forum Series, Bozeman, MT, January 9, 2015.
- ▶ Speaker, “Advanced Institute on Property Rights and Environmental Economics,” Sponsored by Mason Judicial Education Program, George Mason University, Duck Key, FL, December 10–14, 2014.
- ▶ Co-director, “Workshop For Law Professors On Environmental Economics of Wildfire Policy,” Sponsored by Property and Environment Research Center, (PERC) and George Mason University of Law, George Mason University, Duck Key, FL, December 6– 10, 2014.
- ▶ Co-director, “The Politics and Economics of Wildfire Policy,” Sponsored by Property and Environment Research Center, (PERC) and Bren School of Environmental Science and Management, University of California, Santa Barbara, CA, October 26 – 28, 2014.
- ▶ Speaker, “Dynamic Ecology and Dynamic Economics: The Foundation of Austrian Environmental Economics,” 2014 Lone Mountain Forum, Dynamic Environmentalism: Ecology, Economics and Law, (LEC) at George Mason University School of Law, Fairfax, VA, October 10, 2014.
- ▶ Speaker, 2014 inaugural PERC Policy Forum, (LEC) at George Mason University School of Law, Fairfax, VA, October 9, 2014.

- ▶ Participant, "Emerging Asia and the Future of Liberty," The Mont Pelerin Society General Meeting 2014 Hong Kong, Hong Kong, August 31 – September 5, 2014.
- ▶ Speaker, "Towards a Positive Environmentalism for Canada, Realizing Economic and Environmental Abundance Through Innovative Approaches to Sustainable Use," University of Calgary, Calgary, AB, Canada, June 24, 2014.
- ▶ Speaker, "Free Market Environmentalism, Tragedy of the Commons, The Coase Theorem, Property Rights and Environmental Entrepreneurs," Law and Economics Center (LEC) at George Mason University School of Law as the Economics Institute for Judges, Steamboat Springs, CO, June 23, 2014.
- ▶ Speaker, "Free Market Environmentalism: Hats Matter, Entrepreneurship, Property Rights, and Markets, The Evolution of Property Rights, There Ain't No Such Thing as an Externality OR Coase vs. Pigou: Transaction Costs or Technical Difficulties, Real Markets vs. Trading Schemes," Law and Economics Center (LEC) at George Mason University School of Law as the Thirtieth Economics Institute for Law Professors, Steamboat Springs, CO, June 20-21, 2014.
- ▶ Speaker, "Realizing Economic and Environmental Abundance Through Innovative Approaches to Sustainable Use" presented at symposium Towards a Positive Environmentalism for Canada, University of Calgary School of Public Policy, Alberta, Canada, CO, June 12, 2014.
- ▶ Participant, "Workshop on Understanding Innovation," Gruter Institute for Law and Behavioral Research, Stanford Law School, Stanford University, Palo Alto, CA March 24, 2014.
- ▶ Speaker, Presenter, Property Rights, Externalities and Pollution, "The Ends of Capitalism Conference," New York University School of Law, Classical Liberal Institute, New York, NY, February 26 and 27, 2014.
- ▶ Commentator, "The Unique Contributions of Armen Alchian, Robert Bork, and James Buchanan to the George Mason University School of Law," Law and Economics Center (LEC) at George Mason University School of Law as the Third Annual Henry G. Manne Law & Economics Conference, Arlington, VA, November 7-8, 2013.
- ▶ Speaker, "Green or Growing," Bush Institute Energy Conference, George W. Bush Presidential Center, 2943 SMU Boulevard, Dallas, TX, September 12, 2013.
- ▶ Speaker, "Fracking, Should We Fret or Bet," Economics Institute for Law Professors Conference Stanford Donors Conference, Four Seasons Hotel, Jackson Hole, CO, August 1, 2013.
- ▶ Speaker, "Free Market Environmentalism: Hats Matter; Entrepreneurship, Property Rights, and Markets; The Evolution of Property Rights; There Ain't No Such Thing as an Externality OR Coase vs. Pigou; Real Markets vs. Trading Schemes," Economics Institute for Law Professors Conference, Park Hyatt Beaver Creek Resort and Spa, Avon, CO, July 12-13, 2013.
- ▶ Speaker, "Water, the Next Scarce Resource," Wall Street Journal ECO:nomics Conference, Bacara Resort and Spa, Santa Barbara, CA, March 20-22, 2013.
- ▶ Speaker, "The Not So Wild West: Property Rights on Frontier American Indian Economies-Past, Present and Future," "Free Market Environmentalism: Breaking the Shackles of Regulation," Wabash College Lecture, Crawfordsville, IN, March 19, 2013.
- ▶ Speaker, "Free Market Environmentalism Lecture," "Tragedy of the Commons; Coase Theorem Lecture," "Property Rights and Environmental Entrepreneurs Lecture," Doubletree Hotel, Orange, CA, March 9-11, 2013.
- ▶ Speaker, "Free Market Environmentalism," Sheraton Palo Alto Hotel, Palo Alto, CA, March 1-3, 2013. ▶ Speaker, "Free Market Environmentalism: The Other Path," co-sponsored by PERC and Liberty Fund, Antigua, Guatemala, January 22-29, 2013.
- ▶ Speaker, "Breaking the Shackles of Regulation," Discussion Club Lecture, Saint Louis, MO, January 16, 2013.
- ▶ Speaker, "Reconciling Economics and Ecology: A Dynamic View of Markets and Nature," University of Missouri-Saint Louis, MO, January 16, 2013.

- ▶ Co-Director, “Culture, Institutions, and Economic Development: Applications to American Indians,” co-sponsored by PERC and Liberty Fund, December 9 - 11, 2012.
- ▶ Speaker, “Free Market Environmentalism,” “Tragedy of the Commons,” and “Property Rights and Environmental Entrepreneurs,” George Mason Economics Institute for Law Professors, Coral Gables, Florida, December 2, 2012.
- ▶ Speaker, “Water Rights and Water Markets,” University of Arizona Federalist Society, Tucson, November 8, 2012.
- ▶ Speaker, “The Not So Wild Wild West: Lessons for Modern Resource Management” and “Join the Green Tea Party,” West Texas A&M University, Canyon, October 22 - 23, 2012.
- ▶ Speaker, “Enviropreneurship: The Next Generation of Solutions,” CU Entrepreneurship Scholars Retreat, University of Colorado, Boulder, October 20, 2012.
- ▶ Speaker, “Reconciling Economics & Ecology: The Case for Free Market Environmentalism,” Bastiat Society, Colorado Springs, Colorado, October 18, 2012.
- ▶ Director, “Reconciling Economics and Ecology: The Foundation of Environmental Optimism,” PERC Conference Center, Bozeman, Montana, October 8 - 9, 2012.
- ▶ Speaker, “Free Market Environmentalism Applied to Law Students,” George Mason University School of Law Federalist Society, Arlington, Virginia, October 4, 2012.
- ▶ Speaker, “Conference on the Law and Economics of Indian Country Economic Development,” sponsored by Federal Reserve Bank of Minneapolis, August 27, 2012.
- ▶ Participant, Free Market Environmentalism Workshop VIII “Financial Contracting, Transaction Costs, and Environmental Amenities,” directed by Dino Falaschetti, co-sponsored by PERC and Searle Freedom Trust, PERC Conference Center, Bozeman, Montana, July 30 - August 3, 2012.
- ▶ Speaker, “Property Rights, Economics, and the Coase Theorem” and “Environmental Economics,” George Mason Economics Institute for Law Professors, the Stanley Hotel, Estes Park, Colorado, July 20 - 21, 2012.
- ▶ Keynote speaker, “The Green Tea Party,” Washington Policy Center’s Center for the Environment 10th Annual Environmental Policy Conference, The Westin, Seattle, Washington, June 7, 2012.
- ▶ Director, “Reconciling Ecology and Economics: Processes and Property Rights,” co-sponsored by PERC and Liberty Fund, April 29 - May 2, 2012.
- ▶ Participant, Free Market Environmentalism Workshop IX, “The Political Economy of Environmental Collapse,” directed by Andy Hanssen and Rob Fleck, co-sponsored by PERC and Searle Freedom Trust, Clemson University, Clemson, South Carolina, April 13-15, 2012.
- ▶ Speaker, “On the Poorest 1 Percent,” sponsored by Provocative Lecture Series, Spring 2012, San Jose State University, San Jose, California, March 19, 2012.
- ▶ Keynote speaker, “Resource Management—Transatlantic Experiences—New Ideas and Innovative Solutions for Developing Nations?” sponsored by Friedrich Naumann Foundation, San Francisco, California, March 16-18, 2012.
- ▶ Speaker, “Free Market Environmentalism,” “Tragedy of the Commons,” and “Property Rights and Environmental Entrepreneurs,” George Mason Economics Institute for Law Professors, Chapman University, Orange, California, March 11, 2012.
- ▶ Co-directed the Free Market Environmentalism Workshop VII, “The Wealth of Indian Nations,” sponsored by PERC, Lewis and Clark College, Portland, Oregon, November 2011.
- ▶ Participant in the Ratio Colloquium “Property Rights, the Conditions for Enterprise and Economic Growth”, Stockholm, Sweden, June 16 - 18, 2011.
- ▶ Director of conference on “Application of FME Principles to Native American Issues,” co-sponsored by PERC and Liberty Fund, June 2011.
- ▶ Participated in a debate organized by the Intercollegiate Studies Institute entitled “Should the Government Regulate the Environment” Santa Clara University, California, April 7, 2011.
- ▶ Participant in *Symposium on Wildfire, Economics, Law, and Policy*, University of Arizona, November 12, 2010.

- ▶ Director, Workshop on “Water Markets: Why Not More?” PERC workshop series on *Property Rights, Markets, and the Environment*, Bozeman, Montana, August 31–September 2, 2009.
- ▶ Director, PERC’s 2nd annual Lone Mountain Summit, Bozeman, Montana, November 5-8, 2007.
- ▶ Director, PERC’s 1st annual Lone Mountain Summit, Bozeman, Montana, September 20-21, 2006.
- ▶ Co-director, PERC Conference on “Market Forces in the Changing World of Fish and Wildlife Management,” Dundee, Illinois, July 28-31, 2005.
- ▶ Co-director, PERC Forum on “The Wealth of Nature: Maximizing It or Dissipating It?,” Pray, Montana, April 14-17, 2005.
- ▶ Co-director, PERC Conference on “Resolving Conflicts in the Klamath Basin,” Portland, Oregon, June 8, 2004.
- ▶ Co-director, PERC-Stanford Graduate School of Business Forum on “Contracting for the Environment,” Mountain Sky Guest Ranch, Montana, September 18-21, 2003.
- ▶ Co-director, PERC Kinship Conservation Institute, Bozeman, Montana, June 3-30, 2001.
- ▶ Co-director, PERC Political Economy Forum on “A Critique of Free Market Environmentalism,” Lone Mountain Ranch, Big Sky, Montana, March 31-April 2, 2001.
- ▶ Director, Conference on “Norms: Nature and Nurture in the Pursuit of Liberty,” March 22-25, 2001.
- ▶ Director of PERC Program for Young Scholars, Montana State University Campus, Bozeman, Montana, June 23-25, 2000.
- ▶ Co-director of PERC-Hoover Institution conference on “The Law and Economics of Property Rights,” May 15-16, 2000.
- ▶ Co-director of Hoover Institution conference on “The Greening of U.S. Foreign Policy,” October 1998.
- ▶ Director of conference on “Human Nature and the Value of Cooperation,” sponsored by Liberty Fund, March 1998.
- ▶ Director of conference on “Free Market Environmentalism: A Critical Appraisal,” sponsored by Liberty Fund, December 1996 and December 1997.
- ▶ Director of conference on “The Question of Liberty in the Interpretation of the History of the American West,” sponsored by Liberty Fund, 1993.
- ▶ Director of conference on “Property Rights, Constitutions, and Indian Economies,” sponsored by the Political Economy Research Center, June 1989.
- ▶ Director of conference on “Trust Relations and Individual Responsibility,” sponsored by Liberty Fund, December 1987.
- ▶ Director of annual Seminar for Congressional Staff Members sponsored by the Political Economy Research Center, 1985-1994.
- ▶ Lecturer at seminar on “New Institutional Economics,” University of Aix, Aix-en-Provence, France, September 1986.
- ▶ Director of public conference on “Western Resources in Transition: The Public Trust Doctrine and Property Rights,” May 1986.
- ▶ Senior Lecturer at Clemson University Liberty Fund Symposium, July 1986.
- ▶ Director of public conference on “Rethinking Montana’s Tax System: Possibilities for Reform,” May 1986.
- ▶ Director of conference on “Perspectives on Entrepreneurship,” sponsored by Liberty Fund, January 1984.
- ▶ Participant in seminar on the New Institutional Economics sponsored by the West German National Science Foundation, Mettlach, Germany, June 1983.
- ▶ Participant in conference on “Constitutional Economics,” sponsored by the Heritage Foundation, Washington, DC, November 1982.
- ▶ Speaker at “Economics Institute for Public Interest Lawyers,” sponsored by Law and Economics Center, University of Miami, January 1982.
- ▶ “The Political Economy of a Transfer Society,” sponsored by Liberty Fund, September 1980.

- ▶ “The Methodology of the Social Sciences and the Future of Freedom,” sponsored by Liberty Fund, October 1980.
- ▶ “The Environmental Costs of Bureaucratic Government,” sponsored by Liberty Fund, 1978.
- ▶ Participant in First Legal Institute for Economists sponsored by the Law and Economics Center, University of Miami.
- ▶ “The Colonization of a Western State.” Co-editor of a symposium on this topic funded by the Montana Committee for the Humanities. Proceedings published as a special edition of *Western Wildlands*, 1976.
- ▶ “Private Rights and Public Regulation: Historical Roots and Montana Dilemmas Today.” Project director of a lecture series on this topic funded by the Montana Committee for the Humanities, 1975.

Awards:

- ▶ First Annual Gary Walton Award for Leadership in Economic Education, The Fund for American Studies Annual Leadership Conference, Colorado Springs, Colorado, October 23, 2015.
- ▶ Environmental Innovator Award for helping promote innovative and effective approaches to environmental sustainability, 10th Annual Environmental Policy Conference and Lunch, Washington Policy Center, Seattle, Washington, June 7, 2012.
- ▶ Winner of the first Addington Prize in Measurement offered by the Fraser Institute for "Sovereignty, Credible Commitments, and Economic Prosperity on American Indian Reservations" by Terry Anderson and Dominic Parker, June 14, 2011.
- ▶ Liberalni Institute Annual Award, Prague, Czech Republic for "Contribution to the Proliferation of Liberal Thinking, and Making Ideas of Liberty, Private Property, Competition, and The Rule of Law Come True," March 28, 2011.
- ▶ Awarded the Friedrich Von Wieser Memorial Prize for excellence in economic education, Prague Conference on Political Economy, directed by CEVRO Institute, Prague, Czech Republic, March 25, 2011.
- ▶ Templeton Freedom Awards, A Program of the Atlas Economic Research Foundation presented the Templeton Freedom Prize for Excellence in Promoting Liberty in Social Entrepreneurship, First Place 2007.
- ▶ Sir Anthony Fischer International Memorial Award, a Program of the Atlas Economic Research Foundation presented to PERC for *The Not So Wild, Wild West* by Terry L. Anderson and Peter J. Hill, April 25, 2005.
- ▶ Sir Anthony Fischer International Memorial Award, a Program of the Atlas Economic Research Foundation presented to PERC for *Free Market Environmentalism* by Terry L. Anderson and Donald R. Leal, May 18, 1992.

PERSONAL INFORMATION:

Children: Sarah and Peter
Spouse: Monica Lane Guenther
Date of Birth: August 15, 1946
Citizen: United States
Interests: Archery Hunting (taken lion, bear, and Cape buffalo with bow), fishing, skiing, horseback riding, skiing, and travel

Christopher J. Dorrington

PROFESSIONAL EXPERIENCE

STATE OF MONTANA, DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

DIRECTOR

JAN 2021 – PRESENT

- Executive leader responsible of the development, performance, direction, safety and motivation of 400+ environmental science, engineering, financial, business, and IT professionals.
- Maintain and perform cost control, labor/overhead planning, forecasting, budgeting, accounting, engineering and science, capital planning, with extensive resource, program & project planning, and execution on \$100M annual budget.
- Lead and direct agency legislative efforts on matters including statewide natural resource and energy policy and fiscal impacts. Managing issues, topics, policies, agendas and developing and maintaining relationships to accomplish this.
- Develop and maintain key stakeholder relationships representing varied interests and backgrounds, beliefs.
- Resolve and solve emergent needs and challenges, using collaborative approaches to reach consensus, but not always.
- Conceive, develop, and implement complex multi-year, multi-stakeholder, fiscally challenging public policy.
- Provide executive agency litigation input, direction and response in partnership with legal leadership
- Metrics-driven customer service approach using clear performance targets, novel to state government

STATE OF MONTANA, DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

DIVISION ADMINISTRATOR – AIR, ENERGY, AND MINING

JUNE 2016 – JAN 2021

- Executive leader of ~ 85 science, engineering and business professionals in air quality, energy, and mining disciplines.
- Permit and regulate hard rock, coal and opencut (sand & gravel) mining operations.
- Develop, implement legislation and testify during session on matters including statewide policy and fiscal impacts.
- Develop and maintain key stakeholder relationships representing different interests and backgrounds, beliefs.
- Provide information and support for Montana's energy policy, production, transportation, conservation and efficiency, including renewable energy evaluation, development and deployment.

STATE OF MONTANA, DEPARTMENT OF TRANSPORTATION (MDT)

JAN 2006 – JUNE 2016

TRANSPORTATION PLANNING – STATEWIDE MULTIMODAL PLANNING BUREAU CHIEF

NOV 2013 – JUNE 2016

TRANSPORTATION PLANNING – DATA & STATISTICS BUREAU CHIEF

JUN 2012 – NOV 2013

STATEWIDE REST AREA PRIORITIZATION PLAN – AUTHOR, STRATEGIST & COORDINATOR

MAR 2008 – JUNE 2016

RAIL, AIR QUALITY & SPECIAL STUDIES SECTION SUPERVISOR

APR 2011 – NOV 2012, JUNE 2013 – NOV 2013

PLANNING SYSTEMS SECTION SUPERVISOR

NOV 2006 – APR 2011

TRANSPORTATION PLANNER

JAN 2006 – NOV 2006

- For 10.5 years, I led teams of transportation professionals of increasing breadth, depth and complexity moving quickly from transportation planner – section supervisor – bureau chief.
- Thought leader for diverse technical projects and programs for statewide and urban area transportation policy, planning, and program management, data and statistics, and specialty transportation areas to include – air quality, economics, rail, highway, bicycle and pedestrian transportation modes.
- Work disciplines include policy creation, fiscal analysis, planning, economics and modeling.
- Interpret, understand and apply state and federal laws and regulations, policies then generate state business policies, process, and task assignments to implement changes.
- Led the division in supporting leadership for all legislative responses, detailed technical & financial analysis, EPP.
- Establish, maintain and improve relationships with agency leaders and staff, external stakeholders through collaborative discussion, issue identification and proactive problem solving at the lowest level possible.
- Rest area program manager developing a ground-up asset strategy, maintaining partnerships, conducting coordination meetings, research, and some consultant contracts then prioritizing and allocating \$5M annual investment strategy. Resulted in 2012 Governor's Excellence award for the creation and management of revolutionary MT rest area asset strategy.

SYNERGY BUILDERS, INC. – HELENA, MT

Nov 2004 – Nov 2005

CONSTRUCTION SUPERINTENDENT

Feb 2005 – Nov 2005

CONSTRUCTION LABORER

Nov 2004 – Feb 2005

- Solely responsible for leading day-to-day organization, project management, production and direction of up to 10 direct-reporting staff and up to 15 subcontractors and staff, at up to 3 simultaneously-operating construction sites.
- Extensive project development and planning to include resource needs, allocation and tracking of budgeted material, labor, change order, shipping, handling costs, emerging issues awareness and resolution.

Christopher J. Dorrington

WADDELL & REED – HELENA, MT

APRIL 2003 – NOV 2004

FINANCIAL ADVISOR, OFFICE LEAD

- Provide detailed and often complex financial planning in the areas of budget development and tracking, debt management and mitigation, asset allocation and analysis, wealth development and management, tax strategies, retirement planning and preparation, risk assessment and management, estate analysis, planning and strategies, and timely plan implementation to meet the specific needs of individuals and businesses.
- Maintain strict office and individual regulatory adherence with State (Office of State Auditor), Federal (Securities Exchange Commission (SEC) & National Association of Securities Dealers (NASD), and corporate standards for licensing, securities, insurance, and fee-based financial services.
- Generate and achieve challenging, attainable office and personal goals. 3 new advisors Q4 2004. First-year advisors on track for incentive bonuses, 2nd year advisors on track for trip reward and first level bonus minimum.
- Perform in public speaking engagements to include Montana Governor's Annual Conference on Aging (2003 & 2004), group presentations to local organizations, state and federal employees, businesses, community events.
- Successfully passed Series 6, 63, 65 tests first try.

ILX LIGHTWAVE CORPORATION – BOZEMAN, MT

JULY 1998 – NOV 2002

APPLICATION SALES ENGINEER III/ WEST REGIONAL ACCOUNT MANAGER

- Manage and motivate staff to achieve sales forecast and revenue targets and maintain/increase productivity.
- Increased West Regional sales in yr. 2001/2002 by >120% to \$7.7M; 2000/2001 by >200% to \$6.5M; and delivered only domestic regional revenue increase 2001 Q4/Q3. Travel up to 60% for on-site technical meetings, training, etc.
- Quickly and concisely relay photonic test and measurement solutions (e.g. laser manufacturing parametric testing).
- Demonstrate and explain test equipment application, operation, and technology to assess and close complex sales.
- Conduct technical research, market studies, providing new or enhanced product ideas, identifying emerging markets and points of existing strength or weakness to capitalize on strategic opportunities.
- Review and enhance internal product development processes for continuous improvement, ISO9000.

EDUCATION

MASTER OF ART – TRANSPORTATION POLICY, OPERATIONS & LOGISTICS (TPOL)

GEORGE MASON UNIVERSITY, SCHOOL OF PUBLIC POLICY

ARLINGTON, VA – MAY 2010

- #1 graduating student in 2010 TPOL class – May 2010. Cumulative GPA – 3.94 : 36 semester credits
- Outstanding Student of the Year, George Mason University – US DOT University Transportation Centers 2011
- George Mason TPOL program – Malcom P. McLean Transportation Award recipient
- Advanced public policy education in transportation planning, regulation, operations and logistics

BACHELORS OF SCIENCE – MECHANICAL ENGINEERING

GONZAGA UNIVERSITY, SCHOOL OF ENGINEERING AND APPLIED SCIENCE

SPOKANE, WA – MAY 1998

- Graduated from School of Mechanical Engineering in May 1998
 - Fully ABET-accredited Mechanical Engineering curriculum with broad liberal arts. Accomplished in 4 years
 - State or Federal work-study participant each of 4 college years, averaging 20-30 hrs per week
-

Work History

Montana DEQ – Air, Energy, and Mining Division

04/2021--Present

Division Administrator

- Supervise three bureaus and roughly 90 employees, including scientists, engineers, and policy analysts. DEQ values – leadership, accountability, customer service, communication, efficiency, excellence, and decision making drive our work.
- Member of Senior Leadership Team. Provide overall vision, direction, leadership, and management to the Division.
- Represent the Division in various situations, including internal and external stakeholder groups and legislative activities. Develop and maintain internal and external working relationships, acting on behalf of and representing the division and agency.
- Actively manage resources, including Division budget.
- Direct and plan division strategic plans in alignment with agency goals and objectives. Consider current and future program needs and operations to identify opportunities to make change.

Montana Legislature – Office of Research and Policy Analysis

10/2016—04/2021

Research Director for Legislative Office of Research and Policy Analysis

- Supervise eight researchers covering health and human services, economic affairs, state administration and veterans' affairs, revenue, local government, education, criminal justice, and web design and development.
- Participate in six-member management team to maintain key business functions for the Legislative Services Division.
- Responsible for planning, organizing resources, delegating responsibilities, leading others to efficiently execute plans, and evaluating plan effectiveness.
- Responsible for reviewing research and analysis completed by office and conducting additional research and analysis on issues ranging from transportation to energy.
- Draft legislation and amendments for legislators.
- Assist with staffing of standing, interim, and administrative committees.

Sonja Nowakowski

406-444-0496 | Sonja.Nowakowski@mt.gov

Montana Legislature – Legislative Environmental Policy Office

09/2006 – 10/2016

Research Analyst for Legislative Environmental Policy Office-- Legislative Services

- Draft legislation and amendments for legislators with a focus on energy and environment. Analyze legislation for constitutional compliance, compliance with federal requirements, and legal format.
- Research and analyze energy and environmental issues.
- Staff the Natural Resources and Energy Standing Committees. Track bills assigned to committee, amendments, hearings, and committee action.
- Staff the Energy and Telecommunications Interim Committee and assist with staffing the Montana Environmental Quality Council; plan agendas, develop committee work plans.
- Communicate with stakeholders, legislators, and the general public to help them understand issues, policies, rules, and regulations.
- Complete research and analysis based on the assignments from the Montana Legislature. Write and design research materials for legislative committees.
- Write and design informational publications for the public and citizen-legislators on environmental and energy issues.

Great Falls Tribune

02/2001 – 09/2006

Natural Resources Reporter

- Natural resources reporter responsible for reporting in-depth newspaper stories every month. Completed enterprise reporting covering local, state, and national natural resource stories.
- Planned story outlines and adhered to strict deadlines. Gathered and analyzed information for the public on topics about safeguarding our natural resources and protecting human health.
- Received numerous Montana Newspaper Association Awards and quarterly Gannett awards.

Education

- B.A. University of Montana
- Journalism with minor in political science

Job Related Training

- Council of State Governments Legislative Management Group – West, 2016-present
- Legislative Web Content Working Group, 2009-2012
- Montana Environmental Policy Act (MEPA), Training 2011, 2013
- Montana Professional Development Center, Basics of Management Training Program 2011
- National Conference of State Legislatures, Research and Training Programs, Professional Development – 2009, 2013, 2016, 2018
- Council on State Governments – West, Analysis and Energy Training 2011

Professional Publications

- **Powering Down: Decommissioning Energy Facilities in Montana – 2020**
<https://leg.mt.gov/content/Committees/Interim/2019-2020/EOC/Meetings/july-2020/hj38final-report-draft-july2020.pdf>
- **SJ 5: Coal in Montana: Changing Times Challenging Times – 2018**
<https://leg.mt.gov/content/Committees/Interim/2017-2018/EOC/Meetings/Sept-2018/sj5final-report.pdf>
- **Net Metering in Montana – 2016** <https://leg.mt.gov/content/Committees/Interim/2015-2016/Energy-andTelecommunications/Meetings/Sept-2016/SJ12DraftReport.pdf>
- **A Citizen’s Guide to Montana Energy Law: An Overview of Laws Related to Energy Generation, Transmission, and Consumption in Montana -- 2014**
<http://leg.mt.gov/content/Publications/Environmental/2014-citizen's-guide.pdf>
- **Understanding Energy in Montana: A Guide to Electricity, Natural Gas, Coal, Petroleum, and Renewable Energy Produced and Consumed in Montana – 2014**
(Established in conjunction with DEQ’s Energy Office)
<http://leg.mt.gov/content/Publications/Environmental/2014-understanding-energy.pdf>
- **Renewables Rewards and Risks: A Look at the Impacts of Montana’s Renewable Portfolio Standard – 2014**
<http://leg.mt.gov/content/Publications/Environmental/2014-sjr6-rps-report-etic.pdf>

David Klemp

Air Quality Bureau Chief - Retired

Helena, Montana | 406-227-9252 | daveklemp1@gmail.com

SUMMARY

Air quality professional with experience in state government and the private sector. Professional focus on leadership, program development, and project management. Technical background includes extensive engagement in air quality permitting, compliance, enforcement, planning and monitoring activities for the Department of Environmental Quality.

PROFESSIONAL EXPERIENCE

Air Quality Bureau Chief

Montana Department of Environmental Quality, Helena, Montana

December 2007 – July 2021

- Provided overall vision, direction, and management to the Air Bureau and programs within.
- Developed innovative approaches and solutions to challenges faced by Bureau/Agency programs.
- Engaged with stakeholders to cultivate support for Department initiatives.
- Coordinated Bureau activities with those of other bureaus, divisions, and departments.
- Participated in and directed policy initiatives, including engagement with the Legislature and the various Governors' Offices.
- Implemented and or directed projects of high priority to the Department.

Air Quality Permitting Section Supervisor

Montana Department of Environmental Quality, Helena, Montana

JANUARY 2000 – December 2007

- Provided leadership and direction related for the development of the air quality permitting program and for the issuance of all air quality permits.
- Coordinated Section activities with those of the other sections within the Air Quality Bureau and with those of other bureaus, divisions, and departments.
- Managed large-scale and complex projects.
- Trained employees in the section to issue air quality permits.

Air Quality Engineer

Montana Department of Health and Environmental Sciences/Department of Environmental Quality, Helena, Montana

December 1992 – January 2000

- Performed senior level review of air quality permit applications and issued air quality permits for facilities in the state.
- Performed on-site evaluations of industrial facilities, off-site evaluations of reports for determination of compliance with rules and permit conditions.
- Participated in enforcement activities for air quality violations.
- Lead permit engineer from December 1995 to January 2000.

Environmental Consultant

Environmental Science and Engineering, Butte, Montana

May 1990 – December 1992

- Performed various sampling and analysis activities related to the Anaconda/Opportunity Superfund Site and at the Exxon Refinery in Billings, Montana.

Engineering Assistant and Maintenance

Montana Resources, Butte, Montana

JUNE 1987 – May 1992

- Provided assistance in the areas of planning and engineering for the mine, including compiling data requested by governmental agencies.
- Performed various maintenance activities at the mine.

EDUCATION

M.S. Environmental Engineering May 1994

Montana College of Mineral Science and Technology, Butte, Montana

B.S. Engineering Science May 1991

Montana College of Mineral Science and Technology, Butte, Montana

PROFESSIONAL AFFILIATIONS AND TRAINING

Numerous affiliations and trainings completed during my tenure with the Department of Environmental Quality.

Julie Merkel

5824 Danas Point Drive

Helena, MT 59602

(406)444-3626

Objective

Working at the Montana Department of Environmental Quality has offered me the opportunity to learn, interpret, implement, and communicate state and federal regulations and policy related to the State Air Quality Program. Collaboration with a variety of groups to build and cultivate internal and external alliances and develop an effective and transparent program. Meeting for decision making purposes, speaking about technical issues, and presenting information included groups such as the general public, stakeholders, special interest groups, consultants, industry representatives, upper management, staff, the media, legal advisors, the Board of Environmental Review, and federal and state representatives. Tact, courtesy, alertness, and good judgment in developing messages, facilitating an open exchange of opinions, negotiating, and reaching constructive conclusions.

Work Experience

Montana State DEQ – Air Permitting Section Supervisor

October 6, 2012 to Present

- ◆ Lead permitting staff to demonstrate an understanding of the Montana Air Quality Program including minor and major source permitting, as well as compliance and enforcement implications
- ◆ Guide staff in the decision making process for permitting minor sources, prevention of deterioration permitting, and those sources subject to Title V of the Clean Air Act (CAA)
- ◆ Implement air pollution laws, regulations and policy on both the state and federal levels as they pertain to air permitting and compliance
- ◆ Present technical issues to a variety of audiences, such as public meetings, Board of Environmental Review, Clean Air Act Advisory Committee, and other public interest group meetings
- ◆ Effectively participate in management level decision making for implementation of the Montana Air Program
- ◆ Communicate effectively, both orally and written, with professional staff, supervisors, attorneys, facility representatives, special interest groups, and members of the public regarding implementation requirements of new and existing regulations and associated guidance
- ◆ Assist attorneys with writing technical aspects of documents including summary judgment responses to appeals, enforcement actions, and rule changes
- ◆ Lead permitting staff to clearly understand new and existing regulations and recognize when a Montana state rule change is required
- ◆ Assist permitting staff to understand and implement requirements of enforcement actions including administrative orders and consent decrees
- ◆ Prepare presentations to educate a variety of audiences on new state and federal regulations, permit appeals, and other topics of interest
- ◆ Work with attorneys and staff in the development of strategy to defend permit appeals
- ◆ Research legislative issues and determine how the Bureau would be affected

Montana State DEQ - Air Quality Scientist

March 1, 2001 to October 5, 2012

- ◆ Review proposals, make independent decisions and write technical permits for facilities in power generation, wood products, agricultural, mining, incineration and oil & gas industries
- ◆ Conduct technical reviews of permits and associated compliance evaluation reports
- ◆ Conduct compliance inspections at a variety of facilities and prepare associated full compliance evaluation reports
- ◆ Demonstrate knowledge of air pollution laws, regulations, and policy on both the state and federal levels
- ◆ Communicate effectively, both orally and written, with professional staff, supervisors, facility representatives, and members of the public
- ◆ Mentor and assist co-workers with permit related issues for implementation of Montana's Air Permitting Program
- ◆ Serve as the technical lead on rule-making committees
- ◆ Serve as lead on implementing the Open Burning Program which included establishing budgets, determining fees, and working with state and federal agencies
- ◆ Communicate extensively with federal land managers, state land managers, industry representatives, and the general public regarding regulations and requirements
- ◆ Hire and mentor interns
- ◆ Research legislative issues and determine how the Bureau would be affected

Broadwater Athletic Club - Personal Fitness Trainer

November 1999 to March 2002

- ◆ Design fitness programs for a variety of clients. This included assessment of the client's needs, and assistance in formulating achievable goals, and basic nutrition counseling
- ◆ Instruct fitness equipment orientation courses for clients

Bison Engineering, Inc. – Industrial Hygienist

October 1992 to June 1993

- ◆ Instructed asbestos training courses, performed asbestos site assessment and monitoring
- ◆ Precision assessments on opacity monitors
- ◆ Conduct audits and calibrations of meteorological stations, and opacity, small particle, and SO₂ monitors
- ◆ Perform data analysis and assist in writing protocols and technical reports

Cyprus Minerals– Industrial Hygienist

Summer 1991

- ◆ Revised safety guidelines manual, and established a basis for an industrial hygiene manual
 - ◆ Assisted with small particle sampling on various Cyprus Minerals properties
-

Education

Montana College of Mineral Science and Technology (1990 to 1993)

Butte, Montana

MS, Industrial Hygiene

University of Montana (1983 – 1989)

Missoula, Montana

BS, Recreation Management and Forestry

Craig Henrikson

Degrees/Licensure/Professional Certificates

My educational and professional background include a Bachelors Degree in Chemical Engineering from Montana State University (1989); a Masters Degree in Civil Engineering from the University of Minnesota (2005); current registration as a Professional Engineer in Montana and Certified Safety Professional (CSP) (retired status).

Work History

State of Montana – Air Quality Bureau

Senior Environmental Engineer, P.E. 6/11- Present

Permit engineer within the bureau responsible for permit assignments including minor and major sources and both Montana Air Quality Permits and Title V Operating Permits. I have also worked on a project initiative related to permitting compressor engines. This project has been a perfect example of working within a subgroup of CAAC and the stakeholders that would be most affected by any regulatory changes. I have also been a member of DEQ's Clean Power Plan working on understanding the significance of the 111(d) proposed greenhouse gas rule. Helping to draft DEQ's White Paper and continuing to support efforts as EPA continues to evaluate how to move forward with whatever details are finalized. Also staffed Governor Bullocks Climate Solution Council (2020-2021) initiative which produced the equivalent of a Climate Action Plan for Montana.

Morrison-Maierle

Senior Municipal Engineer, P.E. 12/07 – 6/11 3 yr 6 mo

Wrote preliminary engineering reports and technical memorandums for clients. Performed engineering designs for water/wastewater/odor control/emission control projects. In my most recent years at Morrison-Maierle (MMI), I served as a project manager on a number of projects. These included mine water treatment, odor and VOC control, and municipal wastewater treatment. I also supported projects on the Oglala Sioux - Pine Ridge Reservation involving water infrastructure improvements. I was the project manager for the Missoula Odor Control project. This was a project that was an outcome of a compliance order from the Missoula City/County Health Department. The conclusions and recommendations from that study are largely being implemented under a construction project in Missoula.

Morrison-Maierle

Design Engineer, P.E. 07/06 – 12/07 1 yrs 6 mo

During this initial couple of years at MMI, I primarily worked on water and wastewater projects including both municipal and industrial clients. This included specific tasks related to developing scope and fee estimates for various projects. It also included working to track projects for financial performance. Being new to MMI during this period, I worked as a task manager supporting larger projects. I also attempted to stay involved with emission control and odor projects that came along. This included a number of small projects with 3M, working on small consulting projects with their Tonawanda, New York Facility. This included consultation on their emission control processes.

3M Company

Advanced Engineering Specialist 06/02 – 07/06 4 yr 1 mo

Responsible for environmental and safety related to the design and operation of both existing and new emission control equipment. Reviewed thermal oxidizer proposals, and consulted on 3M solvent recovery systems. Provided consultation on 3M engineering standards related to inert gas ovens, flammable solvent handling, gas trains, and wastewater systems. Supported work on a special project related to "wet air oxidation" which involved a new technology for 3M with high pressure and high temperature conditions. During this period, I also helped investigate incidents including fires, explosions and spills. I also helped

Craig Henrikson

document facility action items and worked with business management to agree on corrective action and timing.

3M Company

Senior Engineering Specialist 06/99 – 06/02 3 yr

Responsible for technical review of emission control equipment both in U.S. and international related to modifications of existing and new equipment. This involved consultation for environmental performance and evaluation of safety programs on these processes. Conducted process hazard analyses on numerous processes across 3M. This involved helping facilities develop process safety information data packages prior to conducting site visits. Leading these process safety reviews to demonstrate OSHA compliance.

3M Company

Technical Supervisor 12/96 – 06/99 2 yrs 7 mo

Responsible for directing sixteen technical personnel including engineers and technicians. Directed these activities for compounding, coating, solvent recovery, slitting and converting departments. These departments represented the "wet end" operations because they involved departments handling flammable solvents. Coordinated all technical projects to support the technical needs of the facility. This included developing objectives for engineers, and conducting performance reviews on a semi-annual basis. It also included capital forecasting for each of these departments on an annual basis as well as continuous reporting of department results for each of these departments. During a portion of this period, I also served as the compounding production supervisor responsible for a production staff operating a 4-shift operation with approximately 40 employees total.

3M Company

Solvent Recovery Supervisor 08/94-12/96 2 yr 4 mo

Over this period I was the solvent recovery supervisor. Responsible for a team of production operators, a trainer and day to day operation of the solvent recovery process. Responsible for capital forecasting, production reporting and maintaining cost controls for the process. In this role, I was responsible for all aspects of the solvent recovery option. This included planning for all maintenance activities, scheduling additional resources to accommodate larger project efforts.

3M Company

Engineer to Senior Engineer to Lead Engineer 06/89-08/94 5 yr 3 mo

Over this period I was a coating engineer, magnetic film product engineer, solvent recovery engineer, and a lead engineer with supervisory responsibility. Provided technical support for a large solvent recovery system which basically was a small refinery recovering solvents and purifying them for re-use at the manufacturing plant. Responsible for reporting malfunctions and shutdowns to the Minnesota Pollution Control Agency. This facility operated 24/7 typically with only a week of downtime spread out over the year.

Ed Warner

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Clancy, Montana 59634
phone: 406-410-1410
email: ewarnerusa@yahoo.com

Education

Bachelor of Science Degree – Industrial &
Management Engineering

Experience*June 2013 – Present*

Montana Department of Environmental Quality – Air Quality Bureau – Air, Energy & Mining Division, Helena, Montana

Lead Engineer – Permitting Services Section

- I am the lead resource for the regulated community and general public for navigating the air quality permitting program in Montana. These include air quality pre-construction permits, Title V Operating Permits, and registration programs.
- I provide customer service for the regulated community and general public regarding air quality issues and programs.
- I have participated in the permitting of several mobile data centers, from coordinating pre-application meetings to preparation and review of air quality permits.
- I review all of the air quality permits before they are issued for technical accuracy and consistency.
- I am the permitter for the largest source of emissions in Montana, the Colstrip Steam Electric Station operated by Talen Energy, LLC. I helped review and approve their continuous particulate matter emissions monitoring methodology. Several of my suggestions for improving the quality of the regression analysis and compliance demonstration were implemented by Talen Energy, LLC in their Title V Operating Permit.
- I developed a registration program for portable sources in Montana. This program benefits this sector of the regulated community by providing them with a streamlined regulatory process to operate in Montana while maintaining and even improving the protection of air quality. The program allows these sources to operate within 15 days of registration rather than the 90 days that it took via the conventional permitting program.
- I assist other Bureaus in public meetings to represent the Air Quality Bureau.

January 2009 – June 2013

Montana Department of Environmental Quality – Air Resources Management Bureau – Permitting and Compliance Division, Helena, Montana

Environmental Engineer - Air Permitting Section

- Performed the administrative and professional functions necessary for issuing air quality permits and compliance programs in Montana.
- Established criteria for acceptable air pollution control equipment and practices, also known as Best Available Control Technology (BACT) analysis.
- Developed emission inventories.
- Issued Montana Air Quality Permits (MAQP) and Title V Operating Permits.
- Developed working knowledge of many state and federal environmental statutes, regulations, policies, and guidelines.
- Project Leader for the Compressor Engine Workgroup tasked with developing strategies for addressing continuous compliance issues with natural gas compressor engines.
- I was one of the primary contacts for developing the permitting process within the ARMB Workflow software, a software tool used by the Department for tracking work processes.

April 2002 – December 2008

Aspen Consulting & Testing, Inc., Helena, Montana
Project Engineer – Environmental Testing and Consulting Services

- Performed data analysis, reduction, compilation, and presentation for source testing activities and report production.
- Performed air quality testing on emission sources following established Environmental Protection Agency (EPA) Federal Reference Methods, including tests for particulate matter (PM and PM₁₀), opacity, moisture content, nitrogen oxides (NO_x), carbon monoxide (CO), and formaldehyde.
- Coordinated and managed all laboratory procedures for EPA particulate matter testing.
- Project Manager of numerous emissions testing campaigns.
- Performed field audits for ambient air monitoring instruments for PM₁₀ and PM_{2.5}.
- Certified by the Certified Mold Inspectors & Contractors Institute to do mold testing, mold problem inspection, and mold investigation.
- Prepared and submitted documents and reports for clients and state regulatory agencies.

July 2001– February 2002

Signal Processing Technologies, Colorado Springs, Colorado

Reliability & Failure Analysis Engineer – Quality Assurance Department

- My job performance as Product Engineer with this company identified me as an ideal candidate for this position and the Quality Assurance Manager actively recruited me for the job.
- Coordinated reliability and accelerated life testing on new products. Researched and implemented equations for determining failure rate (FR), mean time between failures (MTBF), and failure in time (FIT). These equations were then added to the SPT Quality Handbook.
- Responsible for failure analysis of customer returned material. Corresponded with outside resources when external failure analysis was necessary.
- Generated Failure Analysis Reports and Reliability Qualification Reports that are presented to customers.

January 2001 – July 2001

Signal Processing Technologies, Colorado Springs, Colorado

Sustaining Product Engineer

- Managed several product lines. My primary product responsibility was for the largest volume and highest income-producing product in the company.
- Responsible for maintaining and improving test yields with all of my products.

June 2000 – December 2000

SCI – Plant 22, Fountain, Colorado

Process Engineer

- Designed line layouts for assembly operations. Worked with assembly line workers to develop efficient assembly stations for maximizing product throughput.
- Wrote work instructions for assembly line workers.

Education

1995–2000

Montana State University, Bozeman, Montana

B.S., Industrial & Management Engineering

- Graduated with a 3.8 GPA for my department.
- Alpha Pi Mu Industrial Engineering Honor Society member
- Tutored introduction to static mechanics and mechanics of materials engineering courses.
- Tutored introductory Spanish.

Additional Skills

Microsoft Office programs such as Excel and Word.

I can speak basic Spanish. I learned the language through five years of formal education, as well as having travelled in Spain and Mexico.

Interests

I am an avid cyclist, snowboarder, and outdoor enthusiast. I also enjoy cooking and traveling for recreation.

Daniel Lloyd

36 S. Alta St. | Helena, MT 59601 | lloydaniel@gmail.com | (319) 331-5699

PROFESSIONAL EXPERIENCE

Bureau Chief

2020-Current Montana Department of Environmental Quality Helena, MT

- Manager of the Montana State Energy Office at the Department of Environmental Quality.
- Responsible for management of state, federal and private funds to support access to reliable, affordable, and clean energy in Montana.
- Coordinated and collaborated with state and regional stakeholders including utilities, non-governmental organizations, elected officials, and federal officials to represent Montana's interests.

Project Manager

2019-2020 Absaroka Energy Bozeman, MT

- Led development of a proposed pumped storage hydro development including landowner negotiations, consultant selection/management, and off-take discussions.
- Developed project timelines, communication strategy, and state/federal regulatory protocols.
- Responded to utility request for proposals, analyzed potential acquisition of renewable projects, and provided regulatory guidance.

Section Supervisor

2017- 2019 Montana Department of Environmental Quality Helena, MT

- Managed the Energy Planning and Renewables section of the Montana Energy Office.
- Participated in utility, state, and regional energy planning, policy, and development processes.
- Developed policies and administrative rules to implement energy policies related to wind decommissioning and bonding, energy grant and loan programs, and energy emergency planning.

Business Development Specialist/Policy Advisor

2013-2017 Montana Governor's Office Helena, MT

- Coordinated statewide business retention, expansion, and recruitment efforts.
- Provided technical assistance to private businesses and communities on financing, infrastructure, and workforce development.
- Provided policy and technical recommendations to the governor on economic development issues, especially related to energy and technology.

Energy Development Specialist

2010-2013 Montana Department of Commerce Helena, MT

- Provided financial, workforce development, and regulatory assistance to developers of energy projects in Montana.
- Promoted Montana's energy resources through creation of marketing materials and face-to-face meetings.

EDUCATION

2006 **University of Notre Dame**
Bachelor of Business Administration, *Cum Laude*
Minor: Science, Technology, & Values

Notre Dame, IN

CERTIFICATIONS & ASSOCIATIONS

2020-Current **Western Green Hydrogen Initiative**
Co-chair

2020-Current **National Association of State Energy Officials**
Board Member and Central Region representative

2018-2019 **Western Interstate Energy Board Member**
Appointed by Governor Bullock to represent Montana

2016 **Leadership Montana Participant**

2013 **National Development Corporation**
Certified Economic Development Finance Professional

Robert D. Smith

Experience

January 2021 to present Montana Department of Environmental Quality Helena, MT

Coal Section Supervisor

- Manage a diverse staff of engineers, hydrologists, biologist, soils scientist, and vegetation ecologist.
- Coordinate all permitting activities within the Coal Program.
- Oversee, assign, and reviewing the work of engineers, hydrologists, biologist, soils scientist, and vegetation ecologist.
- Presenting rules changes to the Board of Environmental Review.
- Developing letters, EAs, and general correspondence to be sent to operators, the public and upper management.
- Conduct and review environmental inspections for compliance of state of Montana regulations within the coal mines throughout Montana.
- Provide compliance assistance to the coal mine operators as well as coal prospecting operations in Montana.
- Present at public meetings.

March 2011 to January 2021 Montana Department of Environmental Quality Helena, MT

Coal Section Permit Coordinator

- Coordinate all permitting activities within the Coal Program.
- Oversee, assign, and reviewing the work of engineers, hydrologists, biologist, soils scientist, and vegetation ecologist.
- Presenting rules changes to the Board of Environmental Review.
- Developing letters, EAs, and general correspondence to be sent to operators, the public and upper management.
- Conduct and review environmental inspections for compliance of state of Montana regulations within the coal mines throughout Montana.
- Conduct the review for archaeology studies and mitigations associated with coal mining activities as well as general review of all permitting applications.
- Provide compliance assistance to the coal mine operators as well as coal prospecting operations in Montana.
- Present at public meetings.

January 2007- March 2011 – January 2007 Montana Department of Environmental Quality Helena, MT

Environmental Enforcement Specialist

- Provided formal enforcement for solid waste, hazardous waste, junk vehicles and open cut violations (gravel pits).
- Provided expert testimony for solid waste, hazardous waste and junk vehicle cases.

406-439-2848•robemit343@hotmail.com

Robert D. Smith

- Conducted inspections for citizen complaints involving unpermitted entities.
- Provided DEQ oversight for spills from mobile sources, including determination of sampling protocols and final clean-up criteria.

June 2001 – June 2003

ATC Associates, Inc.

Tempe, AZ

Staff Scientist

- Conducted numerous Phase I ESAs throughout Arizona and New Mexico.
- Conducted mold inspections, indoor air quality studies, lead based paint surveys, soil sampling, ground water sampling and many other studies as assigned.
- Provided safety and health expertise for the office including preparing and reviewing all site specific health and safety plans for many project sites.

January 2000 – June
2001

LEGEND Technical Services, Inc.

Fargo, ND

Industrial Hygienist

- Conducted safety and health oversight of the reconstruction of the Grand Forks Air Force Base runway project. Duties included daily safety audits, conducting site specific safety training, and new employee safety training.
- Conduct asbestos abatement oversight, inspections, clearances, and project designs.
- Conducted mold inspections, indoor air quality studies, lead based paint surveys, soil sampling, ground water sampling and many other studies as assigned.
- Provided safety and health expertise for the office including preparing and reviewing all site specific health and safety plans for many projects.

June 1998 – August
1998 and June 1999-
August 1999

Columbia Falls Aluminum Company

Columbia Falls, MT

Safety and Health Intern

- Conducted accident investigations as well as near miss investigations.
- Conducted heat stress monitoring for all tasks within the aluminum plant and wrote a heat stress program for Columbia Falls Aluminum Company.
- Surveyed the facility for all confined spaces and determined which spaces were permit required confined spaces.
- Conducted personal exposure monitoring for numerous contaminants including dust, coal tar pitch, fluoride, and noise.

Education

September 1995 -
December 1999

University of North Dakota

Grand Forks, ND

BS Occupational Safety and Environmental Health

- Emphasis in Industrial Hygiene, Safety, and Waste Management
-

406-439-2848•robesmit343@hotmail.com

Robert D. Smith

Certifications/Trainings

Inexperienced Minor MSHA 20 hour

Hazardous Waste Operations and Emergency Response (HAZWOPER)

NIOSH 582

Basics of Management

References

References are available on request.

Dan Walsh

1520 East Sixth Avenue, Helena, MT 59620 ● (406) 444-6791 ● dwalsht@mt.gov

Education

BS Environmental Engineering
Montana Tech of the University of Montana
December 1995

Licenses/Certifications

Licensed Engineer-in-Training, State of Montana, October 1995

Major Accomplishments

- Development/Coordination/Implementation of DEQ's Mining Bureau
- Successfully lead the Hard Rock Mining Bureau
- Coordination and co-development of Hard Rock Mining Guidance Manual
- Coordination and co-development of Air Compliance Guidance Manual
- Successfully lead the Air Compliance Section
- Provided technical review of air permitting documents, air compliance documents, and mining documents

Work History

July 2021 to Present

Montana Department of Environmental Quality, Helena, Montana
Mining Bureau Chief

April 2017 to July 2021

Montana Department of Environmental Quality, Helena, Montana
Hard Rock Mining Bureau Chief

September 2004 to April 2017

Montana Department of Environmental Quality, Helena, Montana
Air Compliance Section Supervisor

March 2000 – September 2004

Montana Department of Environmental Quality, Helena, Montana
Lead Preconstruction Permit Engineer – Air Permitting Section

December 1997 – March 2000

Montana Department of Environmental Quality, Helena, Montana
Environmental Engineer Specialist – Air Permitting Section

August 1996 – December 1997

Bison Engineering, Inc., Helena, Montana
Staff Engineer

Significant Mining Permits Issued and Issues Addressed:

- Golden Sunlight Mine Permit (No. 00065) Amendment No. 017
- Tintina Montana Inc. Permit No. 00188
- Montana Resources Permit (No. 00030) Amendment No. 010
- Stillwater Mining Co. – East Boulder Permit (No. 00149) Amendment No. 003
- Comprehensive 5-Year Bond Review/Approvals

Significant Air Quality Permits Issued:

- *Roundup Power Project (MAQP #3182-00) (PSD - New)*
- *Roundup Power Project (MAQP #3182-00 (Case-by-case MACT Determination)*
- *Roseburg Forest Products, MAQP #2303-08 (PSD – Lookback)*
- *Plum Creek Timber Company – Columbia Falls, MAQP #2667-09 (PSD – Major Modification)*
- Numerous major/minor permit actions reviewed
- *Roseburg Forest Products Title V Operating Permit No. OP2303-00 (Initial Issuance)*

Significant Compliance/Enforcement Activity:

- Montana Tunnels Mining, Inc. Consent Order MB-MM-22-01
- Westmoreland Resources Inc. – Absaloka Coal Mine (C1985005) Cessation Order and Corresponding Termination of Cessation Order
- Involvement in numerous violation determinations and corresponding resolution
- Involvement in numerous enforcement actions and corresponding resolution

Professional Training Courses:

- Mine Design, Operations, & Closure Conference 2017-2022
- Society for Mining, Metallurgy and Exploration Annual Conference, February 2020
- Lean Green Belt, November 2019
- OSHA HAZWOPER, Thru April 2021
- Monitoring Compliance Test and Source Test Observations, April 2016
- Environmental Law for First Responders, October 2014
- Joint Engineers Conference, November 2015
- Joint Engineers Conference, November 2014
- Effective Permit Writing, October 2013
- Advanced NSR/PSD, October 2013
- Basic NSR/PSD, October 2013
- Advanced Inspector Training, July 2013
- ICS for Single Resource and Initial Action Incident, April 2013

- Introduction to Incident Command, November 2012
- ETA Visible Emissions Evaluator, October 2012 (most recent)
- Ability to Pay Training, May 2012
- Hydrogen Sulfide Training, March 2012
- GasFindIR Infrared Camera Training Course, April 2008
- NSR Reform Workshop, May 2005
- BACT Determination Workshop, June 2004
- BACT Determination Workshop, April 2003
- CARB Industrial Boilers, June 2002
- CARB Observing Source Tests, June 2002
- CARB Continuous Emission Monitoring, June 2002
- CARB Volatile Organic Compound Control Devices, June 2002
- Advanced NSR Workshop, February 2001
- Smoke Management Techniques, January 2000
- Smoke Modeling, March 1999
- PERMITS Air Dispersion Modeling, September 1998
- CARB Baghouses, June 1998
- CARB Stationary Internal Combustion Engines, June 1998
- CARB Electro Static Precipitators, June 1998
- CARB Hot Mix Asphalt Facilities, June 1998
- The Fundamentals of Ambient Air Monitoring, March 1997
- ETA Visible Emissions, October 1996 (Classroom)
- 40-Hour HAZWOPER Training, February 1995
- Air Pollution Control Orientation Course, February 1995
- Introduction to Ambient Air Monitoring, February 1995
- Basic Air Pollution Meteorology, April 1994

Rebecca A Harbage

CONTACT

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Helena, MT
[linkedin.com/in/rharbage](https://www.linkedin.com/in/rharbage)

EDUCATION

Master of Community and Regional Planning, 2013

University of Oregon

Bachelor of Arts, History, 2007

Barnard College, Columbia University

SKILLS

Strategic Planning

Project Management

Communication & Outreach

Public Speaking

Leadership

RECENT EXPERIENCE

PUBLIC POLICY DIRECTOR

Montana Dept. of Environmental Quality | Helena, MT | Aug. 2019 – Present

- Member of senior leadership team and directly involved in communications and public relations on all high-profile issues across the agency.
- Supervise six direct reports working in the areas of communications, public outreach, tribal and cultural resources, public records, and the Montana Environmental Policy Act.
- Regularly interface with the press, stakeholders, legislators, tribes, and local government.
- Developed and maintained web presence for Governor Bullock's Climate Solutions Council. Participated in Council and work group meetings and oversaw the public comment process as well as final editing of the Climate Solutions Plan.

AIR QUALITY PLANNER IV

Montana Dept. of Environmental Quality | Helena, MT | Sep. 2013 – Aug. 2019

- Led efforts to engage stakeholders through the Montana Clean Air Act Advisory Committee. Organized, facilitated, and presented at quarterly meetings.
- Led the team developing a permit-by-rule program for sand and gravel equipment. Gained stakeholder buy-in and successfully got rules adopted through the Montana Board of Environmental Review.
- Led the team developing a state plan under the regional haze requirements of the federal Clean Air Act. Established project timelines and milestones, organized outreach efforts, prioritized daily tasks, and provided updates to management and stakeholders.
- Co-chaired the Western Regional Air Partnership Regional Haze Planning Work Group.
- Lead planner on the multi-disciplinary team assigned to develop a state plan under the federal Clean Power Plan. Analyzed federal policy, developed implementation options, and presented on potential compliance pathways.

PROJECT COORDINATOR

Community Planning Workshop, University of Oregon | Eugene, OR | Sep. 2012 – Jun. 2013

- Managed a team of graduate students providing technical assistance to four small Oregon cities working to meet federal Clean Water Act requirements.
- Developed strategies for implementing best practices related to surface water runoff in coordination with local steering committees, including development code amendments, a riparian ordinance, and an outreach and education plan.

COMMUNITY LEADERSHIP

City of Helena Zoning Commission

Chair, Mar. 2019 – Present

Vice Chair, Jun. 2017 – Mar. 2019

Commissioner, Apr. 2015 – Jun. 2017

Montana Commission on Community Service

Chair, Oct. 2021 – Present

Vice Chair, Oct. 2017 – Oct. 2021

Commissioner, Aug. 2016 – Oct. 2017

CRAIG JONES

2625 Cody Dr, East Helena, Montana · (406) 459-5769
CraJones1@gmail.com

Analytical, organized and detail-oriented accountant with GAAP expertise and experience in the full spectrum of public accounting. Collaborative team player with ownership mentality and a track record of delivering the highest quality strategic solutions to resolve challenges, propel business growth.

EXPERIENCE

2014 TO PRESENT

SENIOR MONTANA ENVIRONMENTAL POLICY ACT (MEPA)/MAJOR FACILITY SITING ACT (MFSA) COORDINATOR

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, HELENA, MONTANA

My essential functions are implementing the requirements of the Major Facility Siting Act (MFSA) and ensuring the Department follows the Montana Environmental Policy Act (MEPA). The MFSA portion of my job is to be the lead worker in assisting applicants and stakeholders in a complex and controversial permitting process of linear facilities. The MEPA duties are to be the project manager in leading the Environmental Impact Statement (EIS) process with Department staff, the applicant, other State or Federal agencies, and contract officer managing third-party contractors. I'm expected to be an expert in the implementation of MEPA and a resource for other staff when conducting MEPA documents. A component of conducting the MEPA activities is interpreting complex and technical scientific information can be presented in a MEPA document. The goal of these MEPA documents is to present potential impacts as required under MEPA in a transparent and understandable manner for all stakeholder groups.

2012-2014

LEAD MAJOR FACILITY SITING ACT COORDINATOR

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, HELENA, MONTANA

My duties included implementing the requirements of the Major Facility Siting Act (MFSA) for the Department. The duties included being a project manager for highly controversial linear facilities such as transmission lines and pipelines. I was the lead worker for the MFSA program with stakeholders, the applicant, and contractors for all MFSA projects. I was tasked with managing interdisciplinary environmental resource teams to meet the requirements of MFSA for project.

2007-2012

ENVIRONMENTAL SCIENCE SPECIALIST IN THE MAJOR FACILITY SITING ACT PROGRAM

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY, HELENA, MONTANA

I was part of interdisciplinary team in permitting linear projects under the Major Facility Siting Act (MFSA) for the Department. These linear projects were transmission lines and pipelines in the State of Montana. I was charged with engaging with concerned stakeholders in projects and gathering current land use data for the MFSA process.

EDUCATION

JUNE 2007

BACHELOR OF ARTS, POLITICAL SCIENCE, CARROLL COLLEGE
HELENA, MT

Martin Van Oort

2210 East Sixth Avenue, Helena, MT 59601 ● (406) 459-2754 ● mdvanoort@yahoo.com

Hydrologist

My interest in geology, hydrology, and hydrogeology in particular, is based in my curiosity. Beneath our feet lies a mystery, of which we can only catch small glimpses. The location, arrangement, and composition of geologic materials made clear only at surface outcrops, or by limited borings or excavations. The physical and chemical properties of rocks and sediments interacting in a multitude of ways with the water they contain. The groundwater moving, although often nearly imperceptibly slowly, from recharge to discharge. Groundwater and surface water interacting at and shaping the surface of the earth. The activities of man leaving footprints in the water, some subtle, others blatant.

An intuitive thinker I am adept at recognizing trends and patterns. I view each project as a puzzle, which I enjoy solving. I am organized and methodical, with a tendency for perfectionism. I approach problems by breaking them down to fine details, then assembling those details to form a complete picture. I have a reserved and quiet personality, but I am confident to offer my technical expertise in any forum.

CORE COMPETENCIES

- ***Data Management, Analysis, and Presentation***

I have managed and analyzed numerous environmental datasets for facility investigations, modeling projects, and landfill and coal mine monitoring. I am an expert at compiling data and ensuring quality control in large databases. Organizing data and displaying it in graphs and maps to facilitate analysis has been a part of nearly every project I have worked on. I believe that a picture truly is worth a thousand words, and well-conceived, creatively designed, and professionally presented illustrations are essential to communicate the story each dataset has to tell. I am proficient with MS Excel, MS Powerpoint, and ArcGIS, and have working knowledge of MS Access and EQUIS. I have also used Tecplot and MVS.

- ***Technical Writing***

I have prepared many technical reports both alone and in collaboration with colleagues. These have ranged from my Master's thesis, to groundwater modeling reports, field investigation reports, and hydrologic assessments for landfill and mine permitting. I also have written sections for EA's and worked on EIS's. As a regulator I have written and contributed to many review letters in response to submittals from the regulated community and also responses to public comments. I have also written and contributed to both internal and external guidance documents. I am proficient with MS Word and OpenOffice Writer.

- ***Groundwater Modeling***

I am experienced with both steady-state and transient flow and transport models. I have completed entire modeling projects from conceptualization to reporting, worked on modeling

projects begun or completed by others, and adapted existing models for additional applications. I have also reviewed many groundwater models as a peer and as a regulator. I am most experienced with MODFLOW, MODPATH, and MT3D/RT3D, but also have experience with PEST and Feflow. I have experience with both GWVistas and GMS.

- ***Field Geology***

I have experience with many geologic and environmental field procedures. I have conducted low-flow and traditional purge groundwater sampling, collected surface water samples, and collected both surface and subsurface soil samples. I have measured groundwater levels using electric tape, sonic meters, and dataloggers, and performed stream flow measurements. I have performed both slug- and pump-tests utilizing pressure transducers and analyzed the data using Aqtesolv. I have overseen drilling and installation of monitoring wells using both hollow-stem auger and air-rotary techniques, and described lithology from split-spoons, cores, and drill cuttings. I have supervised Geoprobe investigations utilizing membrane interface probes, electrical conductivity logging, soil coring, and groundwater grab sampling; test pit excavations for describing soils and locating contaminant source areas; and geophysical investigations for utility clearance including EM, RF, and GPR.

- ***Regulatory Compliance***

I am experienced in reading and interpreting laws and rules. I have reviewed many license and permit applications for compliance with regulations. I have met frequently with applicants and their consultants to provide guidance on meeting the requirements necessary to obtain a license or permit. I also have performed many compliance inspections at landfills and coal mines. I have interacted with employees of regulated entities, from equipment operators and laborers, to scientists and engineers, to foremen, managers, and company executives, providing them information on how best to comply with laws and rules. I have worked with enforcement specialists and legal staff in resolving violations and assisted lawyers with responding to legal challenges. I have served as an expert witness and offered expert testimony in depositions and hearings. I also interact with citizens' groups and local landowners to provide information and investigate complaints.

- ***Leadership***

As the senior hydrologist in the Coal Section I have worked in a mentorship role for new hydrologists. I also provide advice and reviews for other section hydrologists, engineers, and ecologists on regulatory and technical subjects. As the Inspection Coordinator for the Coal Section I facilitate scheduling of monthly field inspections of mine permits by I I staff to ensure inspections meet statutory and rule requirements. In this coordinator role I determine and assign inspection priorities so that inspections are consistent and comprehensive. I review and approve inspection reports by staff, determine appropriate compliance measures and timelines, and make recommendations to the Section Supervisor on formal enforcement actions when required.

PROFESSIONAL EXPERIENCE

Montana Department of Environmental Quality, Mining Bureau, Coal Section
May 2013 - Present
Hydrologist

- Review coal mine permit applications, amendments, and revisions; including Probable Hydrologic Consequences determinations and groundwater model reports, and provide deficiency comments for permittees.
- Prepare Cumulative Hydrologic Impact Assessments (a detailed and comprehensive analysis of hydrologic impacts of mining) for coal mine permit written findings.
- Assist in preparation of Environmental Assessments and review and edit Environmental Impact Statements prepared by third party contractors.
- Review, suggest alterations, and approve mine Monitoring and Quality Assurance Plans for hydrologic monitoring, and review annual and semi-annual hydrology data reports.
- Review bond release applications, and conduct on site evaluations of reclamation for compliance with bond release requirements.
- Conduct coal mine inspections for compliance with the laws and rules.
- Investigate and prepare findings for complaints related to potential mining impacts.
- Serve as an expert witness in appeals of permit decisions.

September 2019 - Present

Inspection Coordinator

- Coordinate scheduling of monthly mine inspections by 11 Coal Section staff.
- Conduct pre-inspection meetings with staff outlining priorities for inspection
- Conduct post-inspection meetings with staff to determine necessary steps for compliance and review and approve inspection reports.
- Make recommendations to Section Supervisor for referral of violations to Enforcement.

Montana Department of Environmental Quality, Waste and Underground Tank Management Bureau, Solid Waste Section

September 2008 – May 2013

Groundwater Hydrologist

- Reviewed solid waste facility license applications and provided comments for licensees.
- Assisted in preparation of Environmental Assessments.
- Reviewed landfill groundwater sampling and analysis plans, routine monitoring results and statistical analyses, and corrective action plans.
- Reviewed landfill methane monitoring plans and results.
- Conducted solid waste facility inspections for compliance with the laws and rules.
- Wrote a sampling and analysis plan for an abandoned landfill, conducted routine groundwater and methane monitoring, performed statistical analyses of groundwater monitoring data, and prepared groundwater monitoring reports.
- Contracted a well driller to install new monitoring wells at an abandoned landfill and supervised drilling and well installation.
- Performed hydrologic evaluations of septic tank pumper land application sites.

GeoTrans, Inc., Sterling, VA

October 2005 – September 2008

Project Hydrogeologist

- Field manager and site safety officer for RCRA investigation to characterize soil and groundwater contamination at active chemical plant. Responsible for performing and/or supervising all work done on site by GeoTrans and subcontractors. Field work included

utility clearance, GeoProbe® investigations, soil borings, monitoring well installation and development, slug testing, groundwater and soil sampling, and trench excavation, and was performed over a period of two years.

- Performed 8-hour aquifer tests for residential water wells and participated in 72-hour aquifer tests for municipal water supply wells. Assisted with aquifer test data collection using pressure loggers and analysis of aquifer test results using Aqtesolv.
- Reviewed sampling reports and statistical analyses of sampling results for closure of a facility with radioactive contamination.
- Designed, constructed, and/or calibrated groundwater flow and transport models and prepared or assisted in preparing modeling reports for several projects. Primarily used MODFLOW, MODPATH, MT3D/RT3D with Groundwater Vistas for pre- and post-processing, also used PEST, Feflow, and Bio1D. Projects included:
 - Uranium transport model using kinetic sorption package to estimate plume cleanup times
 - Transient model for a highly variable aquifer in hydraulic contact with the Mississippi River including particle tracking to estimate contaminant travel time to potential receptors
 - Four species reactive transport model for evaluation of potential for offsite contaminant migration following contaminant recovery system shutdown
 - Stochastic steady state model using multiple kriged hydraulic conductivity distributions and particle tracking to estimate advective travel times for contaminants
 - Finite element model to evaluate potential pumping scenarios for optimizing contaminant plume capture

The Ohio State University, Columbus, OH

September 2001 – August 2005

Research Assistant

- Performed research for thesis project: designed, constructed, and calibrated a transient flow model of quarry dewatering to demonstrate the potential for impacts on private wells in area in support of an Ohio Department of Natural Resources (ODNR), Division of Mineral Resource Management investigation. Accompanied ODNR personnel on site visits to quarry and assisted with water level measurements in private wells.
- Designed and created graphics and animations from transient transport model results; wrote macros to batch process model results to create animation videos in TecPlot visualization software.

Teaching Assistant

- Instructor for introductory geology labs, prepared and presented short introductions to exercises, assisted students during work, graded complete exercises, assisted with field trips, and proctored exams.

Macatawa Area Coordinating Council, Holland, MI

November 2000 – May 2001

GIS Internship

- Operated the Geographical Information System for a small metropolitan planning organization.
- Created maps to support transportation and environmental planning.

- Used Avenue scripting language for ArcView to create a custom aerial photo viewing system.

Hope College, Holland, MI

June 1998 – April 2001

Research Assistant

- Surveyed Lake Michigan barrier sand dunes using plane table and alidade; located, mapped, and described paleo-soils; collected paleo-soil samples for carbon dating; and presented results of research at scientific symposia and conferences.

Teaching Assistant

- Assisted students during geology labs, graded lab and classroom exercises, and proctored exams.

EDUCATIONAL BACKGROUND

The Ohio State University, Columbus, OH

August 2005

- Master of Science in Geological Sciences, *summa cum laude*
- Emphasis in Hydrogeology
- Thesis: "Numerical Modeling of the Effects of Dewatering at Seaway Quarry, Lucas County, Ohio"

Hope College, Holland, MI

May 2001

- Bachelor of Science in Geology, *magna cum laude*
- Minor in Environmental Science

Training

- HAZWOPER 40hr General Site Worker
- MSHA Certified: Surface, Coal, Metal, and Non-metal mines

WILLIAM ROSQUIST

426 Monroe Ave. Helena, MT 59601 | (406) 437-8070 | warosquist@gmail.com

Education – Economics / University of Montana / June 1990

Graduated with honors

Graduate studies in microeconomics and advanced econometrics

Professional Experience

Montana Public Service Commission

Regulatory Division Administrator / January 2016 – Present

- Manage team of fourteen analysts, pipeline safety engineers, and railroad safety inspectors
- Manage Division workload, make staff assignments, and evaluate performance
- Set Division goals and objectives and monitor performance
- Work with staff to analyze utility rate applications and other regulatory matters
- Recruit and train Division staff
- Member of agency coordinating team responsible for day-to-day operation of the agency

Montana Public Service Commission

Economics and Rate Design Bureau Chief / July 2010 – January 2016

- Manage team of three economic analysts
- Supervise Bureau productivity, set standards for work products, and evaluate performance
- Coordinate Bureau activities with other bureaus and divisions within the agency
- Work with Bureau staff to analyze utility rate applications, long range resource plans, and other regulatory matters
- Oversee preparation of economic analyses requested by the Public Service Commission

Montana Public Service Commission

Utility Rates and Economic Analyst / January 1991 – July 2010

- Analyze rate applications from electric natural gas and telecommunications utilities
- Evaluate methods of cost analysis and pricing using economic theory and agency policies
- Provide advice to the Public Service Commission from economic and public interest perspectives
- Develop and implement policies and rules for integrated least-cost resource planning for electric utilities
- Evaluate methods and policies to implement the federal Public Utility Regulatory Policies Act
- Collaborate with staff from other bureaus and divisions within the agency
- Represent the Public Service Commission before the Montana Legislature as needed

U.S.D.A Forest Service

Intern / January 1990 – June 1990

- Assist forest economist with economic studies
- Analyze benefits and costs of alternative timber sale methods
- Analyze cost-effectiveness of post timber sale treatment methods
- Apply linear regression and other econometric and statistical tools
- Prepare written reports and present study results to forest managers

Professional Education

- Rutgers University Center for Research in Regulated Industries, Advanced Workshop in Regulation and Competition (2007)
- National Association of Regulatory Utility Commissioners, Portfolio Management Workshop, Washington, D.C. (2000)
- Wisconsin Public Utility Institute, Antitrust in Energy Markets, University of Wisconsin Law School (2000)
- Lawrence Berkeley Laboratory, Advanced Integrated Resource Planning seminar, University of California, Berkeley (1994)
- Public Utility Research and Training Institute, Advanced Course on Externalities and Public Utilities, University of Wyoming (1992)
- National Association of Regulatory Utility Commissioners, Annual Regulatory Studies Program, Michigan State University (1991)