PETITION

of

Xiuhtezcatl Martinez, Itzcuauhtli Rosky-Martinez, Charlotte Buren-Hanley, Sonora Binkley, Aerielle Deering, Trinity Carter, Jamirah Duhamel, and Emma Bray

to the

Colorado Oil and Gas Conservation Commission
and
Colorado Department of Natural Resources

For promulgation of a rule to suspend the issuance of permits that allow hydraulic fracturing until it can be done without adversely impacting human health and safety and without impairing Colorado's atmospheric resource and climate system, water, soil, wildlife, other biological resources.

Xiuhtezcatl Martinez
[redacted]

Itzcuauhtli Rosky-Martinez
[redacted]

Charlotte Buren-Hanley
[redacted]

Sonora Binkley
[redacted]

Aerielle Deering
[redacted]

Trinity Carter
[redacted]

Jamirah DuHamel
[redacted]

Emma Bray
[redacted]

November 15, 2013

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Matthew Lepore, Director
Colorado Oil and Gas Conservation Commission
1120 Lincoln St, Room 801
Denver, CO 80203

Mike King, Executive Director
Colorado Department of Natural Resources
Executive Director's Office
1313 Sherman Street, Room 718
Denver, CO 80203

Re: For promulgation of a rule to suspend the issuance of permits that allow hydraulic fracturing until it can be done without adversely impacting human health and safety and without impairing Colorado's atmospheric resource and climate system, water, soil, wildlife, other biological resources.

REQUEST FOR ADOPTION OF A RULE

Pursuant to Colorado Revised Statutes, "[a]ny interested person shall have the right to petition for the issuance, amendment, or repeal of a rule."[1] Furthermore, Colorado Oil and Gas Conservation Commission regulations state that, "[a]ny person may petition the Commission to initiate rulemaking.[2]

The Petitioners respectfully request that the Colorado Oil and Gas Conservation Commission and Colorado Department of Natural Resources (hereinafter collectively referred to as "Commission") promulgate a rule or rules (see Appendix I for language of proposed rule and Appendix II for proposed statement of basis and purpose) that require the Commission to take the following steps in order to protect the health and safety of Colorado's residents and the integrity of Colorado's atmospheric resource and climate system, water, soil, wildlife, other biological resources, upon which all Colorado citizens rely for their health, safety, sustenance, and security:

(1) Evaluate the impacts of oil and gas drilling on trust resources and human health according to the best available science before issuing any permits for oil or gas drilling or exploration;
(2) Adopt a climate recovery plan by March 15, 2014, based on the best available science that fulfills the Commission's duty to protect trust assets from impairment;

[1] C.R.S. 24-4-103(7).
[2] 2 CCR 404-1, 529(b).

(3) Publish annual reports, which must be verified by an independent third-party, on statewide greenhouse emissions from the oil and gas industry on the Commission's website for public review;
(4) Adopt any necessary policies or regulations necessary to implement the proposed actions detailed in sections (1), (2), and (3) above.

Petitioner Xiuhtezcatl Martinez is a 13-year-old youth activist and is the Youth Director of Earth Guardians. Xiuhtezcatl was selected for the Campaign for a Presidential Youth Council to advise the President of the United States on the perspectives of youth. He has worked with Boulder City Council members, County Commissioners, senators and congresspeople, and has collaborated with over 50 environmental organizations. Xiuhtezcatl considers climate change to be the greatest man-made disaster in the history of our existence and is worried about how climate change is contributing to warmer summers, droughts, wildfires, loss of wildlife, and problems with pine beetles. Fracking is another important issue that Xiuhtezcatl is worried about because it requires the pumping millions of gallons of groundwater and releases methane into the atmosphere, which exacerbates climate change. Xiuhtezcatl is especially concerned about the waste water from fracking which contains numerous chemicals that pollute the air and water and make people, including people that Xiuhtezcatl knows and has worked with, very sick. He is very concerned with how Colorado's legislatures and Governor are handling fracking. Xiuhtezcatl thinks that the legislatures and the Governor have an official responsibility to protect the people of Colorado and protect their health and safety but feels as if they are putting the interests of the natural gas industry before the best interest of Coloradans. When Xiuhtezcatl is not working to protect the environment, he enjoys playing soccer, spending time outside and in the forest with friends, hiking in the mountains, swimming, and playing games with friends. In order to reduce his impact on the environment, Xiuhtezcatl bikes or walks to school, buys local and organic foods, recycles and composts, refuses to buy plastic water bottles, and hang dries his clothes.

Petitioner Itzcuauhtli Rosky-Martinez is a 9-year-old youth activist and member of Earth Guardians. He was awarded the Peace Maker of the Year Award in 2012. Itzcuauhtli has participated in numerous rallies, events, and conferences; he was the youngest speaker at the Rio+20 UN Summit side events. He sees climate change as a man-made disaster affecting many people, plants, and animals. Itzcuauhtli is working to protect the environment because he knows that we are facing major environmental problems, such as droughts and wildfires, but adults are not doing enough to protect the planet. He is fighting for clean air and clean water to ensure that they are available for future generations. For fun, Itzcuauhtli likes to climb trees, walk around his neighborhood, explore new places, play soccer, and rap. He does various things to minimize his impact on the environment, such as use reusable containers, recycle, compost, walk instead of drive, and conserve water and electricity. When thinking about the future, he wants to be able to tell his kids that they will have a great future; he doesn't want them to have to grow up in a world like the one we live in now.

Petitioner Charlotte Buren-Hanley is a 10-year-old youth activist and member of Earth Guardians. She is concerned about climate change and fracking, especially with how

climate change is warming the planet and causing many negative impacts on the environment. Charlotte does various things to try and reduce her impact on the environment, such as riding her bike to school, using reusable containers for her lunch, recycling, and not buying food products with excessive packaging. In her free time, Charlotte enjoys swimming, riding her bike, and reading books outside. Charlotte thinks that Colorado's state government could be doing much more to address environmental issues, including fracking, in Colorado.

Petitioner Sonora Binkley is a 9-year-old youth activist and member of Earth Guardians. She is particularly concerned about fracking because it is polluting water, endangering the future of youth like herself, and because it is not sustainable. Sonora does various things to protect the environment and minimize her impact, such as turning off lights that are not being used, recycling, composting, and using discarded materials when making art projects. In her free time, Sonora enjoys climbing trees, playing soccer, reading books, and singing. When Sonora grows up she does not want to have to worry about fracking, air pollution, or water pollution; she wants these serious environmental problems to be solved so that her children, grandchildren, and great-grandchildren can enjoy the mountains, swim in clean water, and enjoy the trees. When she is older, Sonora would like to travel around the world helping countries address air and water pollution, protect wildlife, and fight fracking. She believes that the state has earned an "F" in fulfilling its responsibilities to protect Colorado and its residents because the state is allowing activities, such as fracking, that are endangering human health and polluting the Earth.

Petitioner Aerielle Deering is a 15-year-old youth activist and member of Earth Guardians. She believes that climate change is causing our Earth to go out of balance and causing environmental systems to collapse. Aerielle does not see fracking as a step forward or as an effective bridge fuel between fossil fuels and clean energy because fracking produces methane and has other adverse impacts that are harmful for the environment. She is particularly concerned that people are ignoring serious issues like fracking and climate change and that people think climate change is something that may only be a future threat while she sees it as a current and immediate threat. Aerielle has noticed the impacts of climate change in Colorado with rising temperatures and especially with larger, more destructive fires. The fact that for three years in a row there have historic, record-breaking fires in Colorado is particularly scary for Aerielle. She is troubled by the fact that Colorado's government still allows fracking despite all the evidence that it is adversely affecting the environment and people's health and she feels that the state is putting the profits of the gas companies before her future. For fun, Aerielle rides her bike, camps in the mountains, and writes songs.

Petitioner Trinity Carter is an 11-year-old youth activist and is a member of Earth Guardians. She is concerned about how climate change is causing the temperature of the Earth to rise and that if the temperatures continue to rise, the planet may not be able to sustain life. Trinity is especially concerned about how fracking and climate change will affect water resources and is worried that in the future, wars could be fought over water resources. Trinity has visited parts of Colorado where fracking is occurring and was very

troubled and saddened by what she saw – she couldn't even imagine what it would be like to live in a place where fracking was happening so close to where you live. In her free time, Trinity enjoys playing outside, swimming, and baking. In order to minimize her impact on the environment, she walks or bikes to school, uses reusable water bottles and lunch bags, turns off lights that are not being used, and is careful not to waste water.

Petitioner Jamirah DuHamel is a youth activist who cares about climate change because it is affecting so many things negatively like the animals, people, the water, air and land. He feels that it is really important to protect our atmosphere and restrict fracking, because by protecting our atmosphere we are protecting our future. By restricting fracking, we not only protect our future but we protect the future of generations to come.

Emma Bray is concerned about fracking because it poses a threat to our water, our air, our community, and our planet. Fracking is a largely unregulated industry in the state of Colorado. There are only 25 inspectors who are overseeing over 79,000 wells all over Colorado. The regulating laws state that every well needs to be inspected annually which is logistically and physically impossible with the number of inspectors. Emma is opposed to fracking because of the many threats it poses to the environment. One major threat is water sanitation. This has proven to be a big issue in the recent flooding that occurred in September 2013. In these floods, oil and gas tanks were damaged, and containment ponds were destroyed which resulted in contamination of our water supply. Even before the floods, there were leaks, spills and damage during fracking. These resulted in surface and groundwater contamination. Fracking has also affected air quality. Air quality is very poor around industrial sites. Fracking uses millions of gallons of water during each frack. If these gallons of fresh water are added up, the number of gallons used in the United States is in the trillions. We do not have enough water to supply this industry and still have a clean, reliable water source for the population. Another devastating effect of fracking is its contribution to climate change. Methane and other pollutants being released into the atmosphere are contributing to an increase in earth's temperature. The warming of the earth is causing the melting of the ice caps and other devastating natural disasters such as floods, drought, fires and hurricanes. Emma is also opposed to fracking because recent studies have shown that fracking and its pollutants have negative effects on humans and animals. People who live near frack sites are experiencing fatigue, headaches, migraines, nose bleeds, and multiple other neurological and respiratory problems. If we want our environment to be clean and healthy, we need to stop this rapidly growing industry. We need to get together and make the right decisions for ourselves and our future.

The petitioners are youth, who represent the youngest living generation of public trust beneficiaries, and have a profound interest in ensuring that the climate remains stable enough to ensure their right to a livable future. A livable future includes the opportunity to drink clean water and abate thirst, to grow food that will abate hunger, to be free from imminent property damage caused by extreme weather events, and to enjoy the abundant and rich biodiversity on this small planet. The petitioners request the promulgation of the regulation herein proposed in order to protect their interest in a livable future, and an inhabitable Colorado.

I. **STATEMENT OF REASONS**: The Commission should grant this petition and promulgate the proposed rule for the following reasons:

A. THE SCEINCE UNEQUIVOCALLY SHOWS THAT HYDRAULIC FRACTURING IS ADVERSELY IMPACTING HUMAN HEALTH AND IMPAIRINING COLORADO'S ATMOSPHERE, WATER, SOIL, AND WILDLIFE RESOURCES.

Human Health Impacts of Hydraulic Fracturing

1. The fluids used for hydraulic fracturing are a serious threat to human health and the environment. The fluids contain harmful chemicals including volatile organic compounds such as benzene, toluene, xylenes, and acetone.[3]

2. One study found that 75% of the chemicals used for hydraulic fracturing could affect people's skin, eyes, other sensory organs, and their respiratory and gastrointestinal systems.[4] The same study found that approximately 40 to 50% of the chemicals used could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys.[5] Additionally, 37% of the chemicals used could affect the endocrine system and 25% could cause cancer and mutations.[6] Benzene was the largest contributor to cancer risk for people living near a well.[7]

3. Spills of hydraulic fracturing are common. Pits and tanks storing wastewater frequently spill or leak, fluids spill and leak when they are transported by truckers, and there are even reports of truckers dumping untreated wastewater into the environment.[8] During the hydraulic fracturing process, the fluid is also prone to spilling on the ground.[9]

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[3] U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA), Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources, EPA/600/R-11/122 (Nov. 2011).

[4] Theo Colborn et al., *Natural Gas Operations for a Public Health Perspective*, 17 HUMAN AND ECOLOGICAL RISK ASSESSMENT 1039 (2011) (hereinafter Colborn 2011).

[5] *Id.*

[6] *Id.*

[7] Lisa McKenzie et al., *Human Health Risk Assessment of Air Emissions form Development of Unconventional Natural Gas Resources*, SCI. TOTAL ENVIRON at 5 (2012), doi:10.1016/j.scitotenv.2012.02.018.

[8] Nicholas Kusnetz, *North Dakota's Oil Boom Brings Damage Along with Prosperity* 4, PROPUBLICA (June 7, 2012) (hereinafter *Kusnetz, North Dakota*); E&E NEWS, *Ohio Man Pleads Not Guilty to Brine Dumping* (Feb. 15, 2013).

[9] Natural Resources Defense Council (NRDC), *Water Facts: Hydraulic Fracturing can potentially Contaminate Drinking Water Sources* 2 (2012), *available at*

4. In addition to the added chemicals, hydraulic fracturing mobilizes naturally occurring toxicants such as heavy metals, volatile organics, and radioactive compounds and returns them to the surface.[10]

5. According to a Colorado study, people living within a half-mile of oil and gas hydraulic fracturing operations were exposed to air pollutants five times over the federal hazard standard.[11] Among the chemicals detected in the study were trimethylbenzenes, aliphatic hydrocarbons and xylenes.[12]

Impacts of Hydraulic Fracturing on Water Resources

6. Colorado is a semi-arid state with limited water resources. Hydraulic fracturing uses a tremendous amount of water, as much several million gallons of water each time a well is fracked.[13] This significant demand for water resources can lower the water table with adverse effects for biodiversity and local ecosystems while also reducing the amount of water available for local communities and households.[14]

7. A recent report by the State of Colorado projected that by 2015 hydraulic fracturing water demands will be 18,700 acre-feet.[15] That is enough water to meet the yearly water needs for between 44,200 and 66,400 families.[16]

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http://www.nrdc.org/water/fracking-drinking-water.asp; Food & Water Watch, *The Case for a Ban on Fracking* 5 (2012), *available at* http://www.foodandwaterwatch.org/reports/the-case-for-a-ban-on-gas-fracking/.

[10] Michelle Bamberger & Robert Oswald, *Impacts of Gas Drilling on Human and Animal Health*, 22(1) SCIENTIFIC SOLUTIONS 51, 53 (2012).

[11] Mark Jaffe, *CU Denver study links fracking to higher concentration of air pollutants*, *available at* http://www.denverpost.com/breakingnews/ci_20210720/cu-denver-study-links-fracking-higher-concentration-air (last visited Apr. 9, 2013)

[12] *Id.*

[13] Pennsylvania Alliance for Clean Water and Air, FAQ's on hydraulic fracturing, *available at* http://www.pacwa.org/FAQ- Photos.html (last visited Mar. 22, 2013).

[14] International Energy Agency, *Golden Rules for the Golden Age of Gas*, 31-32 (2012).

[15] Colorado Division of Water Resources, Colorado Water Conservation Board, and Colorado Oil and Gas Conservation Commission, *Water Sources and Demand for Hydraulic Fracturing of Oil and Gas Wells in Colorado from 2010 through 2015*, *available at* http://cogcc.state.co.us/Library/Oil_and_Gas_Water_Sources_Fact_Sheet.pdf (last visited Apr. 10, 2013).

[16] Western Resource Advocates, *Fracking Our Future: Measuring Water and Community Impacts*, http://www.westernresourceadvocates.org/frackwater/ (last visited Apr. 10, 2013) (hereinafter Western Resource Advocates 2013).

8. Water used for hydraulic fracturing is 100% consumptive. The wastewater cannot be returned to streams because it is of such poor quality.[17]

9. Hydraulic fracturing poses numerous threats to groundwater, which it can contaminate in various ways. The injection of hydraulic fracturing wastewater underground can lead to leaks, which contaminate groundwater.[18] Additionally, fluid from fracked wells can migrate through natural and newly created fractures to underground aquifers.[19]

10. Surface water contamination occurs from polluted surface water runoff from well pads, surface spills, leaking pits, erosion and sedimentation from increased truck traffic and road construction, and improper waste disposal.[20]

11. Accidents that result in spills and leaks of hydraulic fracturing fluid are common in Colorado. There have been at least 1,800 spills, leaks and releases from fracked wells in Weld County and at least 46 in Larimer County since 1992.[21] PDC Energy has been involved in 260 oil and gas spills since 2005.[22] There were 206 chemical fluid spills in 2008 alone, which were connected to 48 cases of suspected water contamination.[23]

Impacts of Hydraulic Fracturing on Wildlife

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[17] *Id.*

[18] Kusnetz, North Dakota; Abraham Lustgarten, *Polluted Water Fuels a Battle for Answers*, PROPUBLICA (2012), *available at* http://www.propublica.org/article/polluted-water-fuels-a-battle-for-answers; Abraham Lustgarten, *Injection Wells: The Poison Beneath Us*, PROPUBLICA (2012), *available at* http://www.propublica.org/article/injection-wells-the-poison-beneath-us.

[19] Tom Myers, *Potential Contaminant Pathways from Hydraulically Fractured Shale to Aquifers* (Feb. 2012), *available at* http://catskillcitizens.org/learnmore/Fracking-Aquifers.pdf.

[20] Western Resource Advocates 2013; Sally Entrekin *et al.*, *Rapid Expansion of Natural Gas Development Poses a Threat to Surface Waters*, 9 FRONT ECOL ENVIRON 503, 507 (2011).

[21] Bobby Magill, *Data Points to Environmental, Health Impact of Fort Collins-Area Fracking Accident*, *available at* http://www.coloradoan.com/article/20130213/NEWS01/302130028/Data-points-environmental-health-impact-Fort-Collins-area-fracking-accident (last visited Apr. 9, 2013).

[22] *Id.*

[23] Christopher Bateman, *A Colossal Fracking Mess: The Dirty Truth Behind the New Natural Gas*, *available at* http://www.vanityfair.com/business/features/2010/06/fracking-in-pennsylvania-201006 (last visited Apr. 9, 2013).

12. Wastewater from hydraulic fracturing, because it has picked up mineral salts, can attract wildlife such as deer, grouse, and turkeys to drink from it.[24] Ducks and other birds will land in pits containing wastewater from hydraulic fracturing.[25] Often times, wildlife exposed to the wastewater die, usually from respiratory failure.[26]

13. The construction of roads to well sites causes disturbances to wildlife habitat and habitat fragmentation that can cause significant deterioration in population numbers over time.[27]

14. Roads and gravel platforms at well sites increase runoff, which often carries silt and toxic chemicals and pollutes the water wildlife relies on and can cause a decline in fish populations.[28] Roads and vehicle traffic also increase road kill.[29]

Impacts of Hydraulic Fracturing on Air Pollution and Climate Change

15. Hydraulic fracturing is particularly bad for air pollution and air quality. Hydraulic fracturing emits large amounts of air pollutants, many of which are toxic. This air pollution is an important contributor to climate change and also poses a threat to human health.

16. It has been estimated that 37% of the chemicals found at fracked wells are volatile.[30] Air emissions from hydraulic fracturing occur during the mixing of hydraulic fracturing chemicals as well as during the storage of hydraulic fracturing fluid when it returns to the surface.[31]

17. Hydraulic fracturing emits a significant amount of methane, which is an important contributor to ground-level ozone.[32] One study found that, "[r]educing

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[24] Jeremy Heiman, *Drilling, Wildlife Often Don't Mix*, *available at* http://www.valley-journal.com/article/20081204/NEWS/812039974/1010/NONE%26parentprofile=1 (last visited Apr. 9, 2013).
[25] *Id.*
[26] *Id.*
[27] *Id.*
[28] *Id.*
[29] *Id.*
[30] Colborn 2011 at 8.
[31] Ed Eckerle et al., *Draft Staff Report on Proposed Rule 1148.2 – Notification and Reporting Requirements for Oil and Gas Wells and Chemical Suppliers*, 15 (Jan. 2013), *available at* http://www.aqmd.gov/rules/proposed/1148-2/PR1148-2_DraftStaffReport.pdf.
[32] U.S. Environmental Protection Agency, *Oil and Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews Proposed Rule*, 76 Fed. Reg. 52,738 (Aug. 23, 2011), *available at* http://www.epa.gov/ttn/atw/oilgas/fr23au11.pdf.

anthropogenic CH_4 [methane] emissions by 50% nearly halves the incidence of U.S. high-O_3 events . . . ."[33]

18. Scientists found that ozone-forming air pollution along the Colorado Front Range in 2012 was twice the expected amount and their research suggests that oil and gas development is the main cause.[34]

19. Methane is an important contributor to global climate change. The global warming potential for methane is roughly 33 times that of carbon dioxide over a 100-year time frame and 105 times that of carbon dioxide over a 20-year time frame.[35] The EPA has estimated that "oil and gas systems are the largest human-made source of methane emissions and account for 37% of methane emissions in the United States or 3.8% of the total greenhouse gas emissions in the United States."[36]

20. The production phase of natural gas operations generates the largest amount of methane but emissions also occur during the processing, transmission, and distribution phases. Wells that are fracked release an especially large amount of methane.[37] Fracked wells release 40 to 60 more methane gas than conventional gas wells.[38]

21. A recent study estimated that in 20 years, methane will contribute 44% of the greenhouse gas load in the United States and 17% of that portion would come from natural gas operations.[39] Methane traps 20 to 25 times more heat in the

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[33] Arlene Fiore et al., *Linking Ozone Pollution and Climate Change: The Case for Controlling Methane*, 29 GEOPHYS. RES LETTERS 19 (2002).
[34] Mead Gruver, *Study: Colorado oil-gas pollution tops expectations*, *available at* http://www.aspentimes.com/article/20120209/NEWS/120209809/1077&ParentProfile=1058 (last visited Apr. 9, 2013).
[35] Robert Howarth, et al., *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations,* 106(4) CLIMACTIC CHANGE 679, 685 (2011) (hereinafter Howarth 2011).
[36] U.S. Environmental Protection Agency, *Natural Gas STAR Program, Basic Information, Major Methane Emission Sources and Opportunities to Reduce Methane Emissions, available at* http://www.epa.gov/methane/gasstar/basic-information/index.html last accessed Nov. 8, 2013); *see also* Gabrielle Petron, et al., *Hydrocarbon Emissions Characterization in the Colorado Front Range: A Pilot Study*, 117 JOURNAL OF GEOPHYSICAL RESEARCH (2012).
[37] Howarth 2011; *see also* Jinsheng Wang, et al., *Reducing the Greenhouse Gas Footprint of Shale*, 39(12) ENERGY POLICY 8196 (2011).
[38] Mark Fischetti, *Fracking Would Emit Large Quantities of Greenhouse Gases*, *available at* http://www.scientificamerican.com/article.cfm?id=fracking-would-emit-methane (last visited Apr. 9, 2013).
[39] *Id.*

atmosphere than carbon dioxide.[40] An increase in fracking-related methane emissions could undermine efforts to reduce carbon dioxide and other greenhouse gases.[41]

22. All the emissions generated during the fracking process, including emissions from the thousands of truck trips required, means that natural gas obtained by fracking is worse than drilling for oil and may even be worse than coal in terms of total greenhouse gas emissions.[42]

B. THE SCIENCE UNEQUIVOCALLY SHOWS THAT ANTHROPOGENIC CLIMATE CHANGE IS OCCURRING AND IS THREATENING THE STABILITY OF THE GLOBAL CLIMATE.[43]

24. According to the United States Global Change Research Program[44], global warming is occurring and adversely impacting the Earth's climate.[45] The present rate of global heating is occurring as a result of human activities that release heat-trapping greenhouse gases ("GHGs") and intensify the Earth's natural greenhouse effect, at an accelerated rate, thereby changing Earth's climate.[46] This abnormal

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[40] *Id.*
[41] *Id.*
[42] Christopher Bateman, *A Colossal Fracking Mess: The dirty truth behind the new natural gas*, *available at* http://www.vanityfair.com/business/features/2010/06/fracking-in-pennsylvania-201006 (last visited Apr. 9, 2013).
[43] For more on the science of climate change see James Hansen et., *Climate Change and Intergenerational Justice: Rapid Reduction of Carbon Emissions Required to Protect Young People, Future Generations and Nature* (accepted for publication in Proceedings of the National Academy of Sciences) (attached to this petition for rulemaking and incorporated herein).
[44] "The U.S. Global Change Research Program ("USGCRP") coordinates and integrates federal research on changes in the environment and their implications for society." The organization's vision is to produce "[a] nation, globally engaged and guided by science, meeting the challenges of climate and global change." The organization is comprised of "[t]hirteen departments and agencies [that] participate in the USGCRP…steered by the Subcommittee on Global Change Research under the Committee on Environment and Natural Resources, overseen by the Executive Office of the President, and facilitated by an Integration and Coordination Office." http://www.globalchange.gov/about.
[45] UNITED STATES GLOBAL CHANGE RESEARCH PROGRAM (USGCRP), GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 13 (2009) *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf [hereinafter *Global Climate Change Impacts*] ("Human activities have led to large increases in heat-trapping gases over the past century. Global average temperature and sea level have increased, and precipitation patterns have changed.").
[46] *Id.* ("The global warming of the past 50 years is due primarily to human-induced increases in heat-trapping gases."); DEUTSCHE BANK GROUP CLIMATE CHANGE ADVISORS, CLIMATE CHANGE: ADDRESSING THE MAJOR SKEPTIC ARGUMENTS 9

climate change is unequivocally human-induced[47], is occurring now, and will continue to occur unless drastic measures are taken to curtail it[48]. Climate change is damaging both natural and human systems, and if unrestrained, will alter the planet's habitability.[49]

25. According to the United States Environmental Protection Agency ("EPA"), "[T]he case for finding that *greenhouse gases in the atmosphere endanger public health and welfare is compelling and, indeed, overwhelming*."[50] The EPA further stated in April 2009 that "[t]he evidence points ineluctably to the conclusion that *climate change is upon us* as a result of greenhouse gas emissions, that *climate changes are already occurring that harm our health and welfare, and that the effects will only worsen over time in the absence of regulatory action*."[51]

26. Human beings have benefited from living on a planet that has been remarkably hospitable to human existence and provided conditions that are just right for human life to expand and flourish.[52] The Earth is a "Goldilocks" planet with an atmosphere that has fewer GHGs than that of Venus (which is too hot), and more than that of Mars (which is too cold), which is just perfect for the life that has developed on planet Earth.[53]

(September 2010) *available at* http://www.dbcca.com/dbcca/EN/_media/DBCCAColumbiaSkepticPaper090710.pdf; Intergovernmental Panel on Climate Change (IPCC), *IPCC Fourth Assessment Report: Climate Change 2007 (AR4)*, 1.1 (2007) *available at* http://www.ipcc.ch/publications_and_data/ar4/syr/en/mains1.html#1-1.

[47] USGCRP, *Global Climate Change Impacts* at 12 (2009).

[48] *Id*. ("Future climate change and its impacts depend on choices made today."); IPCC, *AR4* 1.1 (2007) ("Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level.").

[49] USGCRP, *Global Climate Change Impacts* at 12 (2009) ("Thresholds will be crossed, leading to large changes in climate and ecosystems.").

[50] Proposed Endangerment Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18886, 18904 (Apr. 24, 2009)(to be codified in 40 C.F.R. Chapter 1) (emphasis added).

[51] *Id*.

[52] John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007) ("The earth's climate system can be thought of as an elaborate balancing act of energy, water, and chemistry involving the atmosphere, oceans, ice masses, biosphere, and land surface.").

[53] JAMES HANSEN, STORMS OF MY GRANDCHILDREN 224-225 (2009); *See* John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN at 23.

27. GHGs in the atmosphere act like a blanket over the Earth to trap the heat that it receives from the sun.[54] More GHGs in the atmosphere means that more heat is being retained on Earth, with less heat radiating back out into space.[55] Without this greenhouse effect, the average surface temperature of our planet would be 0°F (-18°C) instead of 59°F (15°C).[56] Scientists have understood this basic mechanism of global warming since the late-nineteenth century.[57]

28. Human beings have significantly altered the chemical composition of the Earth's atmosphere and its climate system.[58] We have changed the atmosphere and Earth's climate system by engaging in activities that produce, or release GHGs in to the atmosphere.[59] Carbon dioxide ("CO_2") is the primary GHG, and there is evidence that its emissions are largely responsible for the current warming trend.[60] Although much of the excess carbon dioxide is absorbed by the oceans, plants and forests, the increase of GHG concentrations resulting from historic and present human activities has altered the Earth's ability to maintain the delicate balance of energy between that which it receives from the sun and that which it radiates back out into space.[61]

29. The current CO_2 concentration in our atmosphere is over 390 ppm[62] (compared to the pre-industrial concentration of 280 ppm) and is quickly approaching the dangerous level of 400 ppm.[63] Current atmospheric GHG concentrations are likely

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[54] John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN at 22.
[55] *Id.* at 16-17.
[56] *Id*. at 17.
[57] *See id*. at 35 (describing the efforts of Swedish chemist Svante Arrhenius).
[58] Naomi Oreskes, *The Scientific Consensus on Climate Change*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 65, 93 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007) ("We have changed the chemistry of our atmosphere, causing sea level to rise, ice to melt, and climate to change. There is no reason to think otherwise.").
[59] *Id*.
[60] *See* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 217-231 (2008).
[61] John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007).
[62] NOAA, Atmospheric CO_2 : Monthly & Annual Mean CO_2 Concentrations (ppm), March 1958 – Present, *available at* http://co2now.org/Current-CO2/CO2-Now/Current-Data-for-Atmospheric-CO2.html (showing an annual mean atmospheric CO_2 concentration of 391.57 for the year 2011).
[63] IPCC, *AR4* at 37 ("The global atmospheric concentration of CO_2 increased from a pre-industrial value of about 280ppm to 379ppm in 2005."); National Science and

the highest they have been in the last 800,000 years.[64]

30. Concentrations of other GHGs in the atmosphere have also increased from human activities. Atmospheric concentrations of methane, for example, have increased nearly 150% since the pre-industrial period.[65] Concentrations of nitrous oxide have also increased.[66]

31. Humans not only continue to add GHGs into the atmosphere at a rate that outpaces their removal through natural processes,[67] but the current and projected CO_2 increase, for example, is about one hundred times faster than has occurred over the past 800,000 years.[68] This increase has to be considered in light of the lifetime of greenhouse gases in the atmosphere. In particular, a substantial portion of every ton of CO_2 emitted by humans persists in the atmosphere for as long as a millennium or more.[69] The current concentrations of GHGs in the atmosphere

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Technology Council, *Scientific Assessment of the Effects of Global Change on the United States* 2 (May 2008) [hereinafter *Scientific Assessment*], *available at* http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf ("The globally averaged concentration of carbon dioxide in the atmosphere has increased from about 280 parts per million (ppm) in the 18th century to 383 ppm in 2007."); Environmental Protection Agency ("EPA"), *Technical Support Document for Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act* 17 (December 9 2009) [hereinafter *TS Endangerment Findings*].

[64] Dieter Lüthi et al., *High-resolution carbon dioxide concentration record 650,000-800,000 years before present* 453 Nature 379, 379-382 (May 2008) *available at* http://www.nature.com/nature/journal/v453/n7193/full/nature06949.html (prior to this publication it was accepted atmospheric CO_2 record extended back 650,000 years, but now research indicates that the record can be extended 800,000 years, or two complete glacial cycles).

[65] EPA, *TS Endangerment Findings* at 18 ("The global atmospheric concentration of methane has increased from a pre-industrial value of about 715 parts per billion (ppb) to 1732 ppb in the early 1990s, and was 1782 ppb in 2007 – a 149% increase from pre-industrial levels.").

[66] *Id*. at 19.

[67] *Id*. at ES-2 ("Atmospheric GHG concentrations have been increasing because anthropogenic emissions have been outpacing the rate at which GHGs are removed from the atmosphere by natural processes over timescales of decades to centuries.").

[68] Dieter Lüthi et al., *High-resolution carbon dioxide concentration record 650,000-800,000 years before present,* 453 NATURE 379, 379-382 (May 2008) *available at* http://www.nature.com/nature/journal/v453/n7193/full/nature06949.html.

[69] James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 220 (2008); *See also* EPA, *TS Endangerment Findings* at 16 ("Carbon cycle models indicate that for a pulse of CO_2 emissions, given an equilibrium background, 50% of the atmospheric increase will disappear within 30 years, 30% within a few centuries, and the last 20% may remain in the atmosphere for thousands of years.");

therefore, are the result of both historic and current emissions.

32. One key observable change is the rapid increase in recorded global surface temperatures.[70] As a result of increased atmospheric GHGs from human activities, based on fundamental scientific principles, the Earth has been warming as scientists have predicted.[71] The increased concentrations of greenhouse gases in our atmosphere, primarily CO_2,[72] have raised global surface temperature by 1.4°F (0.8°C) in the last one hundred to one hundred fifty years.[73] In the last thirty years, the acceleration of change has intensified as the Earth has been warming at a rate three times faster than that over the previous one hundred years.[74]

33. Because of year-to-year variations in these thermometer readings, as with daily readings, scientists compare temperature differences over a decade to determine patterns.[75] Employing this decadal scale, the surface of the planet has warmed at a

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John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 11, 29 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007) ("Since CO_2 has a lifetime of over one hundred years, these emissions have been collecting for many years in the atmosphere.").

[70] National Science and Technology Council, *Scientific Assessment* at 51; IPCC, *AR4* at 30; USGCRP, *Global Climate Change Impacts* at 19; EPA, *TS Endangerment Findings* 26-30; National Aeronautics and Space Administration (NASA) & Goddard Institute for Space Studies (GISS), *Global Surface Temperature*, http://climate.nasa.gov/keyIndicators/#globalTemp (illustrating the change in global surface temperatures) (last visited Apr. 7, 2011).

[71] IPCC, *AR4* at 39; USGCRP, *Global Climate Change Impacts* at 13; EPA, *TS Endangerment Findings* at 48.

[72] EPA, *Climate Change – Science*, *available at* http://epa.gov/climatechange/science/index.html (August 19, 2010) (last visited Apr. 7, 2011); EPA, *TS Endangerment Findings* at ES-1-2.

[73] EPA, *TS Endangerment Findings* at ES-2 ("Global mean surface temperatures have risen by 1.3 ± 0.32°F (0.74°C ± 0.18°C) over the last 100 years."); *See* J. Hansen et al., NASA & GISS, *Global Surface Temperature Change* (August 3, 2010); NASA, *Climate Change: Key Indicators*, http://climate.nasa.gov/keyIndicators (last visited Apr. 7, 2011); John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007).

[74] EPA, *TS Endangerment Findings* at 32 ("U.S. average annual temperatures (for the contiguous United States or lower 48 states) are now approximately 1.25°F (0.69°C) warmer than at the start of the 20th century, with an increased rate of warming over the past 30 years. The rate of warming for the entire period of record (1901–2008) is 0.13°F (0.072°C) per decade while the rate of warming increased to 0.58°F (0.32°C) per decade for the period 1979–2008."); USGCRP, *Global Climate Change Impacts* at 9.

[75] IPCC, *AR4* at 40.

rate of roughly 0.3 to 0.4°F (0.15 to 0.2°C) per decade since the late 1970s.[76] Global mean surface temperature has been decidedly higher during the last few decades of the twentieth century than at any time during the preceding four centuries.[77] Global surface temperatures have been rising dramatically since 1951, and 2010 tied for the hottest year on record.[78]

34. The dramatic increase of the average global surface temperature is alarming. By comparison, the global surface temperature during the last Ice Age was about 9°F (5°C) cooler than today.[79] It has become quite clear that the past several decades present an anomaly, as global surface temperatures are registering higher than at any point in the past 400 years (and for the Northern Hemisphere the past 1,000 years).[80]

35. The IPCC has observed that "[w]arming of the climate system is unequivocal."[81] The United States EPA has recognized the scientific consensus that has developed on the fact of global warming and its cause; that the Earth is heating up due to human activities.[82]

36. Changes in many different aspects of Earth's climate system over the past century are consistent with this warming trend: based on straightforward scientific

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[76] *See* NASA, *Climate Change: Key Indicators*, *Global Land-Ocean Temperature Index*, http://climate.nasa.gov/keyIndicators/#globalTemp (last visited Apr. 7, 2011).

[77] The National Academies Press (Board on Atmospheric Sciences and Climate), *Surface Temperature Reconstructions for the Last 2,000 Years* 3 (2006), *available at* http://www.nap.edu/catalog.php?record_id=11676.

[78] NASA, *Global Climate Change – Global Surface Temperature*, http://climate.nasa.gov/keyIndicators/index.cfm#globalTemp (last visited Apr. 10, 2011) ("Global surface temperatures in 2010 tied 2005 as the warmest on record."); NASA, *Global Climate Change*, http://climate.nasa.gov/ (last visited Apr. 10, 2011) ("January 2000 to December 2009 was the warmest decade on record.").

[79] James E. Hansen & Makiko Sato, *Paleoclimate Implications for Human-Made Climate Change* 5 (January 18, 2011), *available at* http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf (last visited Apr. 10, 2011).

[80] USGCRP, *Global Climate Change Impacts* at 19.

[81] IPCC, *Summary for Policymakers*, *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, at 1, 3, 22, 31 (S. Solomon et al. eds. 2007).

[82] EPA, *TS Endangerment Findings* at ES-2 ("Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. … Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in *anthropogenic* GHG concentrations.") (emphasis added).

principles, human-induced GHG increases lead not only to warming of land surfaces[83], but also to the warming of oceans[84], increased atmospheric moisture levels[85], rises in the global sea level[86], and changes in rainfall[87] and atmospheric air circulation patterns that affect water and heat distribution.[88]

37. As expected (and consistent with the temperature increases in land surfaces), ocean temperatures have also increased.[89] This has led to changes in the ocean's ability to circulate heat around the globe; which can have catastrophic implications for the global climate system.[90] The average temperature of the global ocean has increased significantly despite its amazing ability to absorb enormous amounts of heat before exhibiting any signs.[91] In addition, the most significant indicator of the planet's energy imbalance due to human-induced GHG increases, is the long-term increase in global average ocean heat content over the last 50 years, extending down to several thousand meters below the ocean surface.[92]

38. As predicted, precipitation patterns have changed due to increases in atmospheric moisture levels and changes in atmospheric air circulation patterns; just another indicator that the Earth is warming.[93] As the Earth warms, moisture levels are expected to increase when temperature increases because warmer air generally holds more moisture.[94] In more arid regions, however, higher temperatures lead to greater evaporation.[95]

39. These changes in the Earth's water cycle increase the potential for, and severity of, severe storms, flooding and droughts.[96] Storm-prone areas are already experiencing a greater chance of severe storms, and this will continue.[97] Even in arid regions, increased precipitation is likely to cause flash flooding, and will be

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[83] IPCC, *AR4* at 30.
[84] *Id*. at 72.
[85] USGCRP, *Global Climate Change Impacts* at 18; B.D Santer et al., *Identification of human-induced changes in atmospheric moisture content*, 104 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, 15248, 15248-15253 (Sept. 25, 2007).
[86] IPCC, *AR4* at 30.
[87] USGCRP, *Global Climate Change Impacts* at 18, 44.
[88] *Id.* at 42.
[89] IPCC, *AR4* at 30; EPA, *TS Endangerment Findings* at ES-2.
[90] USGCRP, *Global Climate Change Impacts* at 26.
[91] UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP), CLIMATE CHANGE SCIENCE COMPENDIUM 2009 at 26 (UNEP/Earthprint, 2009).
[92] S. Levitus et al., *Global ocean heat content 1955-2008 in light of recently revealed instrumentation problems* 36 J. GEOPHYSICAL RES. LETTERS L07608 (Apr. 2009).
[93] USGCRP, *Global Climate Change Impacts* at 13, 17, 21, 36, 42, 74.
[94] EPA, *TS Endangerment Findings* at 111.
[95] *Id*.
[96] *Id*.
[97] *Id*. at 120-121; USGCRP, *Global Climate Change Impacts* at 27.

followed by drought.[98]

40. These changes are already occurring: Droughts in parts of the midwestern, southeastern, and southwestern United States have increased in frequency and severity within the last fifty years, coincident with rising temperatures.[99] In 2009, more than half of the United States received above normal precipitation; yet the southwestern United States (Arizona in particular) had one of its driest periods.[100]

41. Based on the laws of physics and the past climate record, scientists have concluded that precipitation events will increase globally, particularly in tropical and high latitude regions, while decreasing in subtropical and mid-latitude regions,[101] with longer periods between normal heavy rainfalls.[102]

42. Other changes consistent with climate modeling resulting from global warming have been observed not just in the amount, intensity, and frequency of precipitation but also in the type of precipitation.[103] In higher altitude and latitude regions, including in mountainous areas, more precipitation is falling as rain rather than snow.[104] With early snow melt occurring because of climate change, the reduction in snowpack can aggravate water supply problems.[105] In Northern Europe and the northeastern United States, a change in air currents – caused by the warming Arctic – brought severe snowstorms during the winters of 2009-2010 and 2010-2011.[106]

43. As expected global sea levels have also risen.[107] Sea levels have been rising at an average rate of 3.1 millimeters per year based on measurements from 1993 to 2003.[108] Though sea levels rose about 6.7 inches over the last century; within the

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[98] EPA, *TS Endangerment Findings* at 115.
[99] *Id*. at 145, 143, 148.
[100] *State of the Climate, 2009* at S138.
[101] EPA, *TS Endangerment Findings* at ES-4, 74.
[102] EPA, *TS Endangerment Findings* at 74.
[103] *Id*. at ES-2.
[104] USGCRP, *Global Climate Change Impacts* at 18, 45.
[105] *Id*. at 33

[106] NOAA, *Arctic Report Card: Update for 2010*, (Dec. 10, 2010) (last visited Apr. 7, 2011) http://www.arctic.noaa.gov/reportcard/atmosphere.html; NOAA, *The Future of Arctic Sea Ice and Global Impacts*, http://www.arctic.noaa.gov/future/index_impacts.html#event; *See also* Climate Science Watch, *Climatologist Ben Santer on the attribution of extreme weather events to climate change*, (December 29, 2010) (last visited Apr. 9, 2011) http://climateprogress.org/2010/12/29/ben-santer-attribution-extreme-weather-events-to-climate-change/#more.

[107] USGCRP, *Global Climate Change* Impacts, at 9; EPA, *TS Endangerment Findings* at ES-3; IPCC, *AR4* at 30.
[108] IPCC, *AR4* at 30.

last decade, that rate has nearly *doubled*.[109] Rising seas, brought about by melting of polar icecaps and glaciers, as well as by thermal expansion of the warming oceans, will cause flooding in coastal and low-lying areas.[110] The combination of rising sea levels and more severe storms creates conditions conducive to severe storm surges during high tides.[111] In coastal communities this can overwhelm coastal defenses (such as levees and sea walls), as witnessed during Hurricane Katrina.[112]

44. Sea level is not uniform across the globe, because it depends on variables such as ocean temperature and currents.[113] Unsurprisingly, the most vulnerable lands are low-lying islands, river deltas, and areas that already lie below sea level because of land subsidence.[114] Based on these factors, scientists have concluded that the threats to the United States from rising seas are the most severe on the Gulf and Atlantic Coasts.[115] Worldwide, hundreds of millions of people live in river deltas and vulnerable coastlines along the southern and western coasts of Asia where rivers draining the Himalayas flow into the Indian and Pacific Oceans.[116]

45. In a comprehensive review of studies on sea level rise in the 21st century published by the British Royal Society, researchers estimated the probable sea level rise for this century between .5 and 2 meters (1 ½ to 6 ½ feet), continuing to rise for several centuries after that, depending on future CO_2 levels and the behavior of polar ice sheets.[117]

46. The IPCC estimates a 0.6-meter rise in sea level by 2100 under a worst-case scenario that does not include contributions from the accelerated flow of major ice sheets.[118] Some scientists predict a 2-meter rise in sea level by 2100 if present

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[109] NASA, *Climate Change: How Do We Know?*, *Sea Level Rise* (last visited Apr. 9, 2011) http://climate.nasa.gov/evidence/#no4 (citing J.A. Church & N.J. White, *A 20th Century Acceleration in Global Sea Level Rise* (2006) 33 Geophysical Research Letters, L01602, doi: 10.1029/2005GL024826).

[110] EPA, *TS Endangerment Findings* at ES-7; USGRCP, *Global Climate Change Impacts* at 62-63.

[111] USGCRP, *Global Climate Change Impacts* at 109; EPA, *TS Endangerment Findings* at 75.

[112] EPA, *TS Endangerment Findings* at 86, 118.

[113] USGCRP, *Global Climate Change Impacts* at 25-26, 37.

[114] EPA, *TS Endangerment Findings* at 121.

[115] *Id*. at 128; USGCRP, *Global Climate Change Impacts* at 57.

[116] EPA, *TS Endangerment Findings* at 159; IPCC, *AR4* at 52.

[117] R.J. Nicholls et al., *Sea-level rise and its possible impacts given a 'beyond 4°C world' in the twenty-first century*, PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY 161-181, 168 (2011).

[118] IPCC, *AR4* at 45.

trends continue.[119] "Today, rising sea levels are submerging low-lying lands, eroding beaches, converting wetlands to open water, exacerbating coastal flooding, and increasing the salinity of estuaries and freshwater aquifers."[120] The impacts of rising sea levels can be seen in many coastal locations across the nation; along the Florida coast for instance, sea level is rising about 1 inch every 11-14 years.[121] This seemingly small rise in ocean levels is contributing to massive erosion, causing many homeowners to remove beachfront property, and has lead to a decline in the recreational value of beaches.[122] Other coastal states (such as Maryland and Louisiana) are also experiencing wetland loss due to rising sea levels.[123] Scientists have predicted that wetlands in the Mid-Atlantic region of the United States cannot withstand a 7-millimeter per year rise in sea levels.[124]

47. As expected, mountain glaciers, which are the source of freshwater for hundreds of millions of people, are receding worldwide because of warming temperatures.[125] Today, Glacier National Park in Montana has twenty-five glaciers larger than twenty-five acres, down from one hundred and fifty in 1850.[126] The year 2009 marked the 19th consecutive year in which glaciers lost mass.[127] Mountain glaciers are in retreat all over the world, including Mt. Kilimanjaro in Africa, the Himalayas, the Alps (99% in retreat), the glaciers of Peru and Chile (92% in retreat), and in the United States.[128] In the Brooks Range of northern Alaska, all of the glaciers are in retreat and in southeastern Alaska 98% are in retreat.[129]

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[119] M. Vermeer & S. Rahmstorf, *Global Sea Level Linked to Global Temperature*, 106 PROC. NATL. ACAD. SCI. 21527, 21531 (2009).
[120] USCCSP, *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region* [hereinafter *Coastal Sensitivity to Sea-Level Rise*] 2 (Jan. 2009), *available at* http://www.epa.gov/climatechange/effects/coastal/pdfs/ccsp_front.pdf.
[121] EPA, *Saving Florida's Vanishing Shores* (March 2002) *available at* http://www.epa.gov/climatechange/effects/coastal/saving_FL.pdf.
[122] *Id*.
[123] USCCSP, *Coastal Sensitivity to Sea-Level Rise* at 3-4.
[124] *Id*. at 4.
[125] *See TS Endangerment Findings* at 111 ("Glaciers throughout North America are melting, and the particularly rapid retreat of Alaskan glaciers represents about half of the estimated loss of glacial mass worldwide.").
[126] United States Geological Survey (Northern Rocky Mountain Science Center), *Retreat of Glaciers in Glacier National Park* (June 2010), http://www.nrmsc.usgs.gov/research/glacier_retreat.htm.
[127] National Oceanic and Atmospheric (NOAA), *State of the Climate in 2009*, 91 BULL. AMER. METEOR. SOC. at S13 (2010).
[128] L. Thompson, *Climate Change: The Evidence and Our Options*, 33 THE BEHAVIOR ANALYST No. 2 (Fall) 153, 155-160 (2010); USGRCP, *Global Climate Change Impacts* at 18.
[129] L. Thompson, *Climate Change: The Evidence and Our Options*, 33 THE BEHAVIOR ANALYST No. 2 (Fall) 153, 158 (2010).

48. Although a minor contribution to sea level rise, the melting of mountain glaciers is particularly serious in areas that rely on snow melt for irrigation and drinking water supply.[130] In effect, a large snow pack or glacier acts as a supplemental reservoir or water tower, holding a great deal of water in the form of ice and snow through the winter and spring and releasing it in the summer when rainfall is lower or absent.[131] The water systems of the western United States (particularly in California) and the Andean nations of Peru and Chile, among other places, all heavily rely on these natural forms of water storage.[132] In addition to providing a more reliable water supply, the storing of precipitation as ice and snow helps moderate potential flooding.[133]

49. Yet as temperatures warm, not only will these areas lose this supplemental form of water storage, but also severe flooding is likely to increase (because when rain falls on snow, it accelerates the melting of glaciers and snow packs).[134] Ice is melting most dramatically at the poles.[135] Sea ice in the Arctic oceans is expected to decrease and may even disappear entirely in coming decades.[136] During the summer of 2012, Arctic sea ice shrank an unprecedented 18% against the prior record set in 2007 to a record low of 3.41m sq km.[137] The loss of summer sea ice leads to unusual warming of the atmosphere over the Arctic, which in turn impacts weather patterns in the northern hemisphere and leads to persistent extreme weather such as flooding, droughts, and heatwaves.

50. Beginning in late 2000, the Jakobshavn Isbrae Glacier (which has a major influence over the mass of the Greenland ice sheet), lost significant amounts of

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[130] IPCC, *AR4* at 49.
[131] *See* L. Thompson, *Climate Change: The Evidence and Our Options*, 33 THE BEHAVIOR ANALYST No. 2 (Fall) 153, 164 (2010).
[132] *See Id*. at 155 – 160, 164.
[133] EPA, *TS Endangerment Findings* at 111; USGRCP, *Global Climate Change Impacts* at 64.
[134] EPA, *TS Endangerment Findings* at 111.
[135] L. Thompson, *Climate Change: The Evidence and Our Options*, 33 THE BEHAVIOR ANALYST No. 2 (Fall) 153, 160 (2010) ("[P]olar ice sheets are slower to respond to temperature rise than the smaller mountain glaciers, but they too, are melting. . . . The loss of ice in the Arctic and Antarctic regions is especially troubling because these are the locations of the largest ice sheets in the world.").
[136] EPA, *TS Endangerment Findings* at 120; USGCRP, *Global Climate Change Impacts* at 20-21 ("Studies published after the appearance of the IPCC Fourth Assessment Report in 2007 have also found human fingerprints in the increased levels of atmospheric moisture (both close to the surface and over the full extent of the atmosphere), in the decline of Arctic sea ice extent, and in the patterns of change in Arctic and Antarctic surface temperatures.").
[137] National Snow & Ice Data Center (Sept. 19, 2012), http://nsidc.org/news/press/2012_seaiceminimum.html

ice.[138] In August of 2010, an enormous iceberg (roughly ninety-seven square miles in size) broke off from Greenland.[139] Nine Antarctic ice shelves have also collapsed into icebergs in the last fifty years, (six of them since 1996).[140] An ice shelf roughly the size of Rhode Island collapsed in 2002, and an ice bridge collapsed in 2009, leaving an ice shelf the size of Jamaica on the verge of shearing off.[141] The 2002 collapse of the Larsen Ice Shelf, which had existed for at least 11,000 years, was "unprecedented in respect to both area and time."[142] The "sudden and complete disintegration" of the Larsen Ice Shelf took a *mere 35 days*.[143]

51. During the 2007-melt season, the extent of Arctic sea ice (frozen ocean water) declined precipitously to its lowest level since satellite measurements began in 1979.[144] By the end of 2010 Arctic sea ice was at the lowest level in the satellite record for the month of December.[145]

52. Arctic sea ice plays an important role in stabilizing the global climate, because it reflects back in to space much of the solar radiation that the region receives.[146] In contrast, open ocean water absorbs much more heat from the sun, thus, amplifying

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[138] GARY BRAASCH & BILL MCKIBBEN, EARTH UNDER FIRE 18-20 (2009); *See also* J.E. Box et. al., (NOAA) *Greenland*, ARCTIC REPORT CARD at 55 (Oct. 2010) ("A clear pattern of exceptional and record-setting warm air temperatures is evident at long-term meteorological stations around Greenland.").
[139] NASA Earth Observatory, *Ice Island Calves Off Petermann Glacier* (Aug. 2010), http://earthobservatory.nasa.gov/NaturalHazards/view.php?id=45112&src=eorss-nh.
[140] Alister Doyle, *Antarctic Ice Shelf Set to Collapse Due to Warming*, Reuters (Jan. 19, 2009) http://www.reuters.com/article/idUSTRE50I4G520090119.
[141] NASA Earth Observatory, *Wilkins Ice Bridge Collapse* (Apr. 2009), http://earthobservatory.nasa.gov/IOTD/view.php?id=37806.
[142] U.S. Geological Survey, *Coastal-Change and Glaciological Map of the Larsen Ice Shelf Area, Antarctica: 1940-2005* at 10 (2008) http://pubs.usgs.gov/imap/2600/B/LarsenpamphletI2600B.pdf
[143] *Id*. at 10.
[144] National Snow and Ice Data Center (NSDIC), Press Release, *Arctic Sea Ice Shatters All Previous Record Lows* (Oct. 1, 2007), http://nsidc.org/news/press/2007_seaiceminimum/20071001_pressrelease.html (last visited Apr. 9, 2011); EPA, *TS Endangerment Findings* at 27 ("Average arctic temperatures increased at almost twice the global average rate in the past 100 years.").
[145] NSIDC, *Repeat of a negative Arctic Oscillation leads to warm Arctic, low sea ice extent*, ARCTIC SEA ICE NEWS & ANALYSIS, (Jan. 5, 2011), http://nsidc.org/arcticseaicenews/2011/010511.html (last visited Apr. 9, 2011).
[146] EPA, *Climate Change Indicators in the United States*, 45 (2010), *available at* http://www.epa.gov/climatechange/indicators/pdfs/ClimateIndicators_full.pdf [hereinafter *Climate Change Indicators*]; *See also* EPA, *TS Endangerment Findings* at 40.

human-induced warming and creating an increased global warming effect.[147] As arctic sea ice decreases the region is less capable of stabilizing the global climate and may act as a feedback loop (thereby aggravating global warming).[148]

53. Scientists have also documented an overall trend of sea-ice thinning.[149] The year 2010 also marked a record-low, spring snow cover in the Arctic since satellite observations first began in 1966.[150]

54. Similarly, there has been a general increase in permafrost temperatures and permafrost melting in Alaska and other parts of the Arctic (particularly in the last five years).[151] Scientists in Eastern Siberia and Canada have documented substantial methane releases as the permafrost melts.[152] Because much of the Arctic permafrost overlays old peat bogs, scientists believe (and are concerned) that the melting of the permafrost[153] may release methane that will further increase global warming to even more dangerous levels.[154]

55. Changes in these different aspects of Earth's climate system over the last century tell a coherent story: the impacts we see today are consistent with the scientific understanding of how the climate system should respond to GHG increases from human activities and how the Earth has responded in the past (reflected in such evidence as: ice cores that have trapped air from thousands and even a few million years ago, tree rings and seabed sediments that show where sea level was thousands and even millions of years ago).[155] Collectively, these changes cannot be explained as the product of natural climate variability or a tilt in the Earth's axis alone.[156] A large human contribution provides the best explanation of observed climate changes.[157]

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[147] EPA, *Climate Change Indicators* 52 (2010); USGCRP, *Global Climate Change Impacts* at 39.
[148] EPA, *Climate Change Indicators* 46 (2010).
[149] NOAA, *State of the Climate in 2009* at S114.
[150] NOAA, *Land*, ARCTIC REPORT CARD 29 (Oct. 2010), *available at* http://www.arctic.noaa.gov/reportcard/ArcticReportCard_full_report.pdf.
[151] *Id*.
[152] NOAA, *State of the Climate in 2009* at S116.
[153] USGCRP, *Global Climate Change Impacts* at 139, 142 ("The higher temperatures are already contributing to . . . permafrost warming.").
[154] *See* IPCC, *4.4.6 Tundra and Arctic/Antarctic* Ecosystems, CLIMATE CHANGE 2007: FOURTH ASSESSMENT REPORT, WORKING GROUP II, IMPACTS, ADAPTATION, AND VULNERABILITY 231 (2007).
[155] USGCRP, *Global Climate Change Impacts* at 26.
[156] *Id*.
[157] Susan Solomon et al., *Irreversible climate change due to carbon dioxide emissions,* 106 PNAS 1704, 1704 – 1709 (Feb. 10, 2009), *available at* www.pnas.org/cgi/doi/10.1073/pnas.0812721106 (last visited Apr. 9, 2011).

56. These well-documented and observable impacts from the changes in Earth's climate system highlight that the current level of atmospheric CO_2 concentration has already taken the planet into a danger zone.[158] The Earth will continue to warm in reaction to concentrations of CO_2 from past emissions as well as future emissions.[159] Warming already in the pipeline is mostly attributable to climate mechanisms that slowly heat the Earth's climate system in response to atmospheric CO_2.[160]

57. The Earth's oceans play a significant role in keeping our atmospheric climate in the safe-zone.[161] The oceans constantly absorb CO_2 and release it back into the atmosphere at rates that maintain a balance.[162] Because we now release so much CO_2, the oceans have absorbed about one-third of the CO_2 emitted from human activity over the past two centuries.[163] This capacity has slowed global warming, but at a cost: the added CO_2 has changed the chemistry of the oceans, causing the oceans' average surface pH (a measurement of hydrogen ions) to drop by an average of .11 units.[164] Although this may seem relatively small, the pH scale is logarithmic, so that a reduction of only one unit means that the solution has in fact become ten times more acidic.[165] A drop of .1 pH units means that the concentration of hydrogen ions in seawater has gone up by 30% in the past two centuries.[166] If CO_2 levels continue to rise to 500 ppm, we could see a further drop of .3 pH units by 2100.[167]

58. Ocean acidification harms animals that use calcium to build their shells, as well as single-celled organisms that are an essential part of the marine food chain.[168] This is because the acidified waters affect the structural integrity and survival of shell-building marine organisms such as corals and shellfish by effectively robbing them of the key chemical (carbonate ion) they need to build their skeletons.[169] It also adversely impacts some kinds of algae and single-celled organisms that use

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[158] USGCRP, *Global Climate Change Impacts* at 23.
[159] EPA, *TS Endangerment Findings* at 26.
[160] FRED PEARCE, WITH SPEED AND VIOLENCE: WHY SCIENTISTS FEAR TIPPING POINTS IN CLIMATE CHANGE 101-104 (Beacon Press 2007); IPCC, *AR4* at 72.
[161] *See* EPA, *TS Endangerment Findings* at 16, 38.
[162] IPCC, *AR4* at 72.
[163] Inter-Agency Report, *Impacts of Ocean Acidification* at 1; *See also TS Endangerment Findings* at 38 ("[T]he total inorganic carbon content of the oceans increased by 118 ± 19 gigatonnes of carbon (GtC) between 1750 and 1994 and continues to increase.").
[164] EPA, *TS Endangerment Findings* at 38; Inter-Agency Report, *Impacts of Ocean Acidification* at 1.
[165] HARVEY BLATT, AMERICA'S ENVIRONMENTAL REPORT CARD 158 (MIT Press 2005).
[166] A. Ridgewell & D. Schmidt, *Past constraints on the vulnerability of marine calcifiers to massive carbon dioxide release*, 3 NATURE GEOSCIENCE 196, 196-200 (2010).
[167] IPCC, *AR4* at 52.
[168] EPA, *TS Endangerment Findings* at 38.
[169] USGCRP, *Global Climate Change Impacts* at 85.

calcification processes for survival.[170] Some of these organisms comprise magnificent natural features, such as the White Cliffs of Dover.[171] Coral reefs are major habitats for ocean fauna; and calcifying algae and plankton are key components of the marine food chain.[172]

59. About 55 million years ago, the ocean absorbed a large amount of CO_2, likely due to a release of methane from the ocean floor that caused the Earth's temperatures to rise several degrees and led to the extinction of many species worldwide.[173] The absorption of so much CO_2 also led to the death of calcifying organisms on the seafloor.[174] It took over 100,000 years for the ocean to regain its normal alkalinity.[175] The current of level of CO_2 being taken in by the ocean decreases the ability of coral and other calcium-based marine life to produce their skeletons, which affects the growing of coral and thus coral reefs.[176] Other marine life, such as algae, also exhibit a reduced growing ability.[177] Thus, ocean acidification can disrupt the food chain, give non-calcium based creatures a competitive advantage, and limit the geographic reach of calcium based creatures.[178] In experiments, "[c]oral reef organisms have not demonstrated an ability to adapt to decreasing carbonate saturation state."[179] Finally, this disruption to the food web "could substantially alter the biodiversity and productivity of the ocean."[180]

60. The warming of oceans also contributes to the bleaching of corals.[181] Corals contain a tiny alga that provides them with food and that accounts for their color.[182]

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[170] *Id.*
[171] Carl Zimmer, *An Ominous Warning on the Effects of Ocean Acidification*, Yale Environment360, (Feb. 15, 2010), *available at* http://e360.yale.edu/feature/an_ominous_warning_on_the__effects_of_ocean_acidification/2241/ (last visited Apr. 9, 2011).
[172] EPA, *Coral Reef Biological Criteria: Using the Clean Water Act to Protect a National Treasure* 3-1 (July 2010), *available at* http://www.epa.gov/bioindicators/pdf/EPA-600-R-10-054_CoralReefBiologicalCriteria_UsingtheCleanWaterActtoProtectaNationalTreasure.pdf (last visited Apr. 9, 2011).
[173] [173] James C. Zachos et al., *Rapid Acidification of the Ocean During the Paleocene-Eocene Thermal Maximum*, 308 SCIENCE 1611, 1611-1615 (June 10, 2005).
[174] *Id.*
[175] *Id.*
[176] Inter-Agency Report, *Impacts of Ocean Acidification* at 69.
[177] "Many of these organisms are important components of the marine food web." *Id.*
[178] *Id.*
[179] *Id.*
[180] *Id.*
[181] EPA, *TS Endangerment Findings* at 103; USGCRP, *Global Climate Change Impacts* at 148.
[182] USGCRP, *Global Climate Change Impacts* at 84, 151-52; *See* EPA, *TS Endangerment Findings* at 138.

When the oceans warm, the algae give off toxins, and the corals, in order to survive the toxin, expel the algae, thereby bleaching the coral.[183] If the water temperature does not fall enough to permit algae to survive within the coral without releasing the toxin, the corals will eventually die.[184] There have been several severe episodes of coral bleaching in recent years.[185] With continued warming, the coral may not be able to survive.[186]

61. Changes in water supply and water quality will also impact agriculture in the US.[187] Additionally, increased heat and associated issues such as pests, crop diseases, and weather extremes, will all impact crop and livestock production and quality.[188] For example, climate change in the United States has produced warmer summers, enabling the mountain pine beetle to produce two generations of beetles in a single summer season, where it had previously only been able to produce one; in Alaska, the spruce beetle is maturing in one year when it had previously taken two years.[189] The expansion of the forest beetle population has killed millions of hectares of trees across the United States and Canada and resulted in millions of dollars lost from decreased timber and tourism revenues.[190]

62. Agriculture is extremely susceptible to climate changes and higher temperatures generally reduce yields of desirable crops while promoting pest and weed[191] proliferation.[192] Global climate change is predicted to decrease crop yields, increase crop prices, decrease worldwide calorie availability, and by 2050 increase

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[183] USGCRP, *Global Climate Change Impacts* at 84, 151-52.
[184] *See id*.
[185] *Id*. at 84.
[186] *Id*.
[187] USGCRP, *Global Climate Change* Impacts at 126; *See* United States Department of State (USDS), *U.S. Climate Action Report 2010, Fifth National Communication of the United States of America Under the United Nations Framework Convention on Climate Change* [hereinafter *U.S. Climate Action Report*] 87 (June 2010) *available at* http://www.state.gov/documents/organization/140636.pdf.
[188] USDS, *U.S. Climate Action Report* at 87.
[189] U.S. Climate Change Science Program (USCCSP), *Weather and Climate Extreme in a Changing Climate, Regions of Focus: North America, Hawaii, Caribbean, and U.S. Pacific Islands* [hereinafter *Weather and Climate Extremes*] 15 (June 2008) *available at* http://www.climatescience.gov/Library/sap/sap3-3/final-report/sap3-3-final-all.pdf.
[190] *Id*.
[191] USCCSP & USDA, *The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity*, in *Synthesis and Assessment Product 4.3* at 59 ("Many weeds respond more positively to increasing CO_2 than most cash crops, . . . Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at CO_2 levels that likely will occur in the coming decades.").
[192] International Food Policy Research Institute, *Food Policy Report: Climate Change-Impacts on Agriculture and Costs of Adaptation* vii (Oct. 2009).

child malnutrition by 20%.[193] Climate change threatens global food security and so any effort to mitigate global warming is effectively promoting a secure food supply.[194]

63. Glacial and ice cap melting is one of the major causes of global sea level change.[195] When glaciers and ice caps melt, this adds water to the ocean.[196] Another cause is that as ocean water warms, it expands and takes up more space; therefore, ocean warming "has been observed in each of the world's major ocean basins, and has been directly linked to human influences."[197]

64. Human-caused fossil fuel burning and the resulting climate change are already contributing to an increase in asthma, cancer, cardiovascular disease, stroke, heat-related morbidity and mortality, food-borne diseases, and neurological diseases and disorders.[198] The World Health Organization has concluded, "the health effects of a rapidly changing climate are likely to be overwhelmingly negative".[199] Climate change is not only expected to affect the basic requirements for maintaining health (clean air and water, sufficient food, and adequate shelter) but is likely to present new challenges for controlling infectious disease and even "halt or reverse the progress that the global public health community is now making against many of these diseases."[200]

65. As the 2010 Russian summer heat wave graphically demonstrated, heat can destroy crops, trigger wildfires, exacerbate air pollution, and cause increased illness and deaths.[201] Similar impacts are occurring across the United States: the "number and frequency of forest fires and insect outbreaks are increasing in the interior West, the Southwest, and Alaska. Precipitation, streamflow, and stream temperatures are increasing in most of the continental United States. The western

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[193] *Id*.
[194] *Id*. at ix ("Climate change will pose huge challenges to food-security efforts. Hence, any activity that supports agricultural adaptation also enhances food security.").
[195] M. Sharp & G. Wolken, *Glaciers Outside Greenland*, *in* ARCTIC REPORT CARD 48 (Oct. 18, 2010).
[196] USGCRP, *Global Climate Change Impacts* at 18.
[197] *Id*.
[198] *See* The Center for Health and the Global Environment, Harvard Medical School, *Climate Change Futures: Health, Ecological, and Economic Dimensions* (Nov. 2005) *available at* eetd.lbl.gov/emills/pubs/pdf/climate-change-futures.pdf; USGCRP, *Global Climate Change Impacts* at 96-98.
[199] World Health Organization, *Climate and Health Fact Sheet* (July 2005), http://www.who.int/globalchange/news/fsclimandhealth/en/index.html.
[200] World Health Organization, *Protecting Health from Climate Change: Connecting Science, Policy, and People* 02 (2009), *available at* http://www.who.int/globalchange/publications/reports/9789241598880/en/index.html.
[201] *See* NOAA Earth System Research Lab, *The Russian Heat Wave 2010*, (Sept. 2010) http://www.esrl.noaa.gov/psd/csi/moscow2010/.

United States is experiencing reduced snowpack and earlier peaks in spring runoff. The growth of many crops and weeds is being stimulated. Migration of plant and animal species is changing the composition and structure of arid, polar, aquatic, coastal, and other ecosystems."[202] Up to 30% of the millions of species on our planet could go extinct following just a few tenths of a degree warming above present.[203] Large wildfires in the Western US have quadrupled in recent years, a result of hotter temperatures and earlier snowmelt that contributes to dryer soils and vegetation.[204]

66. Similarly, climate change is already causing, and will continue to result in, more frequent, extreme, and costly weather events (such as hurricanes).[205] The annual number of major tropical storms and hurricanes has increased over the past 100 years in North America, coinciding with increasing temperatures in the Atlantic sea surface.[206]

67. The changing climate also raises national security concerns, as "climate change will add to tensions even in stable regions of the world."[207] The United States may experience an additional need to accept immigrant and refugee populations as droughts increase and food production declines in other countries.[208] Increased extreme weather events (such as hurricanes) will also present an increased strain on foreign aid and call for military forces.[209] For instance, by 2025, 40% of the world's population will be living in countries experiencing significant water shortages, while sea-level rise could cause displacement of tens, or even hundreds, of millions of people.[210]

68. Paleoclimate data provides sobering evidence that major climate change can occur in decades, and that the consequences would be much more severe, and even disastrous, if a 2°C (3.6°F) change occurs over decades rather than hundreds of

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[202] EPA, *TS Document* at 41 (*citing* USCCSP, Backlund et. al., 2008a).
[203] IPCC, *AR4*, *Working Group II: Impacts, Adaptation and Vulnerability- Magnitude of Impact*, *available at* http://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmsspm-c-15-magnitudes-of.html.
[204] USGCRP, *Global Climate Change Impacts* at 95.
[205] *Id*. at 27 ("Many types of extreme weather events, such as heat waves and regional droughts, have become more frequent and intense during the past 40 to 50 years.").
[206] National Science and Technology Council, *Scientific Assessment* at 7.
[207] The CNA Corporation, Military Advisory Board, *National Security and the Threat of Climate Change* 7 (2007), *available at* http://securityandclimate.cna.org/report/SecurityandClimate_Final.pdf (last visited Apr. 10, 2011).
[208] *Id*.
[209] *Id*.
[210] *Id*. at 16.

years.[211]

69. There are at least three reasons that the present, human-induced global warming is particularly significant. First, past global warming and cooling of a similar magnitude occurred before human civilization existed.[212] Second, global warming is happening far more rapidly than in past occurrences[213], giving both humans and other forms of life only a short time to adapt to the changes. Human civilization and the crops and foods on which it depends have developed within a very narrow set of climatic conditions.[214] With the human population so large, with civilization so complex, centered around coastal cities, and dependent on water supplies fed by distant ice and snow melt, and with the great disparities in wealth between and within countries and regions, it will be nearly impossible to adapt to all of the climate change impacts in the quick time-frame in which they will occur.[215]

70. Third, and perhaps most importantly, the climate change we are now experiencing is caused largely by human activity.[216] This means that unlike with respect to past climate change events, by changing our activities humans can mitigate or even halt this warming before it causes catastrophic and irreversible effects.[217] Stopping, or at least greatly curtailing, the activities that discharge greenhouse gases into the air, such as the burning of fossil fuels and deforestation, and encouraging activities that remove CO_2 from the atmosphere (such as reforestation), can greatly reduce and even end global warming and its accompanying consequences within the

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[211] *See* James E. Hansen & Makiko Sato, *Paleoclimate Implications for Human-Made Climate Change* (Jan. 18, 2011), *available at* http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf (last visited Apr. 10, 2011).

[212] *See* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 217-231 (2008).

[213] *Id*.

[214] J. Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts* 15, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN (Joseph F. DiMento & Pamela Doughman eds., MIT Press 2007).

[215] *See generally* United States Agency International Development (USAID), *Adapting to Climate Variability and Change: A Guidance Manual for Development Planning* (August 2007) (discussing difficulty of adapting to climate change) http://pdf.usaid.gov/pdf_docs/PNADJ990.pdf; *See also* USGCRP, *Global Climate Change Impacts* at 12 ("Climate change will combine with pollution, population growth, overuse of resources, urbanization, and other social, economic, and environmental stresses to create larger impacts than from any of these factors alone.").

[216] *See* USGCRP, *Global Climate Change Impacts* at 20; EPA, *TS Endangerment Findings* 47-51; IPCC, *AR4* at 39.

[217] USGCRP, *Global Climate Change Impacts* at 107 ("By mid-century and beyond, however, today's emissions choices would generate starkly different climate futures: the lower the emissions, the smaller the climatic changes and resulting impacts.").

lifetimes of today's children.[218]

71. To protect Earth's climate for present and future generations, we must restore Earth's energy balance. The best available science shows that if the planet once again sends as much energy into space as it absorbs from the sun, this will restore the planet's climate equilibrium.[219] Scientists have accurately calculated how Earth's energy balance will change if we reduce long-lived greenhouse gases such as carbon dioxide.[220] Humans have altered Earth's energy balance[221] and are currently causing a planetary energy imbalance of approximately one-half watt[222]. We would need to reduce atmospheric carbon dioxide concentrations by about 40 ppm, in order to increase Earth's heat radiation into space by one-half watt, if other long-lived gases stay the same as today.[223] We must reduce atmospheric carbon dioxide concentration to 350 ppm to avoid the threats contained herein.[224]

72. The best available science also shows that to protect Earth's natural systems, average global surface heating must not exceed 1°C this century.[225] To prevent

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[218] *See Id*. at 12 ("Future climate change and its impacts depend on choices made today.").
[219] John Abatzoglou et al., *A Primer on Global Climate Change and Its Likely Impacts*, *in* CLIMATE CHANGE: WHAT IT MEANS FOR US, OUR CHILDREN, AND OUR GRANDCHILDREN 11, 15-22 (Joseph F. C. DiMento & Pamela Doughman eds., MIT Press 2007).
[220] JAMES HANSEN, STORMS OF MY GRANDCHILDREN 166 (2009) ("Also our best current estimate for the planet's mean energy imbalance over the past decade, thus averaged over the solar cycle, is about +0.5 watt per square meter. Reducing carbon dioxide to 350 ppm would increase emission to space 0.5 watt per square meter, restoring the planet's energy balance, to first approximation.").
[221] IPCC, *AR4* at 37 ("[T]he global average net effect of human activities since 1750 has been one of warming, with a radiative forcing of +1.6 [+0.6 to +2.4] W/m^2.").
[222] D.M. Murphy et. al., *An observationally based energy balance for the Earth since 1950* 114 J. GEOPHYSICAL RES. LETTERS D17107 (Sept. 2009).
[223] JAMES HANSEN, STORMS OF MY GRANDCHILDREN 166 (2009); *See* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 217-231 (2008).
[224] *See* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 217 (2008) ("If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, Paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm.").
[225] James E. Hansen & Makiko Sato, *Paleoclimate Implications for Human-Made Climate Change* (Jan. 18, 2011), *available at* http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf (last visited Apr. 10, 2011); *See also* IPCC, *AR4* at 48 ("For increases in global average temperature exceeding 1.5 to 2.5°C and in concomitant atmospheric CO_2 concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions and shifts in species' geographical ranges, with predominantly

global heating greater than 1°C, concentrations of atmospheric CO_2 must decline to less than 350 ppm this century.[226] However, today's atmospheric CO_2 levels are over 390 ppm[227] and are rising.

73. Atmospheric CO_2 levels are currently on a path to reach a climatic tipping point.[228] Absent immediate action to reduce CO_2 emissions, atmospheric CO_2 may reach levels as high as about 1000 ppm[229] and a temperature increase of up to 5°C by 2100.[230] Life on Earth as we know it, is unsustainable at these levels.

74. Atmospheric CO_2 concentrations will decrease if people stop (or greatly reduce) their burning of fossil fuels.[231] The environmental harms and threat to human health and safety as described above can only be avoided if atmospheric CO_2 concentrations are immediately reduced. Any more delay risks irreversible and unacceptable consequences for youth and future generations.

75. Fossil fuel emissions must decrease rapidly if atmospheric CO_2 is to be returned to a safe level in this century.[232] Improved forestry and agricultural practices can provide a net drawdown of atmospheric CO_2, primarily via reforestation of degraded lands that are of little or no value for agricultural purposes, returning us to 350 ppm somewhat sooner.[233] However, the potential of these measures is limited. Immediate and substantial reductions in carbon dioxide emissions are required in order to ensure that the youth and future generations of children inherit a planet that is inhabitable.

76. Because most fossil fuel CO_2 emissions will remain in the surface carbon reservoirs for millennia, it is imperative that fossil fuel CO_2 emissions be rapidly terminated, if atmospheric CO_2 is to be returned to a safe level in this century.[234]

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negative consequences for biodiversity and ecosystem goods and services, e.g. water and food supply.").

[226] *See* James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. J. 217, 217-231 (2008); JAMES HANSEN, STORMS OF MY GRANDCHILDREN (2009).

[227] CO_2Now, *Earth's CO_2 Homepage*, Atmospheric CO_2 for March 2011, http://co2now.org/ (last visited Apr. 10, 2011).

[228] JAMES HANSEN, STORMS OF MY GRANDCHILDREN 224 – 230, 260 (2009).

[229] IPCC, *AR4* at 66-67.

[230] IPCC, *AR4* at 46.

[231] HARVEY BLATT, AMERICA'S ENVIRONMENTAL REPORT CARD xiii (MIT Press, 2005) ("How can we stop this change in our climate? The answer is clear. Stop burning coal and oil, the sources of nearly all the carbon dioxide increase.").

[232] James E. Hansen et al., *Target Atmospheric CO_2: Where Should Humanity Aim?* 2 OPEN ATMOS. SCI. 217, 217 (2008) (discussing the need to reduce atmospheric carbon dioxide concentration to 350 ppm).

[233] *Id*. at 227.

[234] *See id*. at 211.

The failure to act promptly will not only increase the costs of future reductions, it will have irreversible adverse effects on the youth and all future generations, as detailed above.

77. To have the best chance of reducing the concentration of CO_2 in the atmosphere to 350 ppm by the end of the century and avoid heating over 1 degree Celsius over pre-industrial temperatures, the best available science concludes that atmospheric carbon dioxide emissions need to begin to decline at a global average of 6% per year between 2013 and 2050 and 5% per year through 2100. In addition, carbon sequestering forests and soils must be preserved and replanted to sequester an additional 100 gigatons of carbon through the end of the century.[235] Waiting until 2020 to reduce carbon dioxide emissions would require annual reductions of at least 15% to return atmospheric concentrations to 350 ppm by 2100.

78. A zero-CO_2 U.S. energy system can be achieved within the next thirty to fifty years without acquiring carbon credits from other countries. In other words, actual physical emissions of CO_2 from fossil fuels can be eliminated with technologies that are now available or reasonably foreseeable. This can be done at reasonable cost by eliminating fossil fuel subsidies and creating annual and long-term CO_2 reduction targets. Net U.S. oil imports can be eliminated in about 25 years, possibly less. The result will also include large ancillary health benefits from the significant reduction of most regional and local air pollution, such as high ozone and particulate levels in cities, which is mainly due to fossil fuel combustion.[236]

79. Experts state that approaches to transition to a renewable energy system and to phase out fossil fuels by about 2050 include: A single national cap on fossil fuel use that declines to zero by 2050 or a gradually rising carbon tax with revenues used to promote a zero-CO_2 emissions energy system and to mitigate adverse income-distribution effects; increasingly stringent efficiency standards for buildings, appliances, and motor vehicles; elimination of subsidies for fossil fuels, nuclear energy, and biofuels from food crops coupled with investment in a vigorous and diverse research, development and demonstration program (including smart grid and storage technologies, electrification of transportation, stationary fuel cells for combined heat and power, biofuels from aquatic weeds like microalgae, use of aquatic weeds like microalgae in integrated gasification combined cycle plants, and use of hydrogen-fueled passenger aircraft); banning new coal-fired power plants; adoption of a policy that would aim to have essentially carbon-free state, local, and federal governments, including almost all

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[235] *See* James E. Hansen et al., *Scientific Case for Avoiding Dangerous Climate Change to Protect Young People and Nature* (July 9, 2012) http://pubs.giss.nasa.gov/abs/ha08510t.html.; *See also Amicus Curiae* Brief of Dr. James Hansen in *Alec L. v. Jackson*,*

[236] Arjun Makhijani, Carbon-Free, Nuclear-Free: A Roadmap for U.S. Energy Policy (IEER Press and RDR Books, 2007); Declaration of Arjun Makhijani in Support of *Alec L. v. Jackson*, http://ourchildrenstrust.org/sites/default/files/Makhijani%20Dec.pdf.

of their buildings and vehicles by 2030; and adoption of a gradually increasing renewable portfolio standard for electricity until it reaches 100 percent by about 2050.[237] The Commission should fully consider these measures in achieving its own annual emissions reduction measures to transition off of fossil fuels.

80. Many of the facts stated in the above paragraphs are also supported by top experts from around the world who have submitted expert testimony to the U.S. District Court in the federal lawsuit *Alec L. v. Jackson.* These expert declarations by the late Dr. Paul Epstein, Ove Hoegh-Guldberg, Sivan Kartha, Pushker Kharecha, David Lobell, Jonathan Overpeck, Camille Parmesan, Stephan Rahmstorf, Steven Running, Kevin Trenberth and Lise Van Susteren are all available at http://ourchildrenstrust.org/page/91/expert-declarations and such testimony is incorporated herein by reference.

C. CLIMATE CHANGE IS ALREADY OCCURRING IN THE STATE OF COLORADO AND IS PROJECTED TO SIGNIFICANTLY IMPACT THE STATE IN THE FUTURE.

Rising Temperatures

81. In the past 30 years, the average temperature in Colorado has increased by about 2°F.[238] Climate models predict that by 2050, average summer temperatures in Colorado will rise by an additional 5°F and winter temperatures will rise by 3°F. Climate projections show fewer extreme cold winter months and more strings of consecutive warm winters.[239]

82. Due to rising temperatures, the microclimate of the mountains is expected to migrate upward in elevation and the Desert Southwest microclimate is expected to progress up into the valleys of the Western Slope. By 2050, the January climate of the Eastern Plains of Colorado is expected to shift northward by around 150 miles.[240]

83. Temperature change varies with altitude; higher altitudes experience greater increases in temperatures. For example, the average annual temperature in Fort Collins has increased by 4.1°F while the average temperature in the Arkansas River Valley has increased by 0.5°F.[241] Colorado is warming faster than both the

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[237] *See id*.
[238] Andrea J. Ray et al., CLIMATE CHANGE IN COLORADO: A SYNTHESIS TO SUPPORT WATER RESOURCES MANAGEMENT AND ADAPTATION 1 (2008) *available at* *http://wwa.colorado.edu/publications/reports/WWA_ClimateChangeColoradoReport_2008.pdf* [hereinafter *Climate Change in Colorado*].
[239] *Id.*
[240] *Id.*
[241] The Center for Integrative Environmental Research ("CIER"), ECONOMIC IMPACTS OF CLIMATE CHANGE ON COLORADO 6 (2008) *available at*

global and U.S. average.[242]

84. Colorado's cities will be especially vulnerable to temperature increases due to the heat island effect.[243]

85. Longer-lasting and more intense heat waves will deplete electricity supplies as more people use air conditioning, increasing the risk of brownouts and blackouts. This could become even more problematic as the timing of river flows decreases the capacity of hydroelectric systems.[244]

Impacts to Water Resources

86. In 2004, Denver Mayor John Hickenlooper said, "the most significant threat to our economic security is not having a secure future water source."[245] However, Colorado's water sources are severely threatened by climate change.

87. Snowmelt produces 70% to 86% of the flow of the Colorado River, which supplies water to 25 million Americans.[246] Researchers found "the fully allocated Colorado system to be at the brink of failure, wherein virtually any reduction in precipitation over the Basin, either natural or anthropogenic, will lead to the failure to meet mandated allocations."[247]

88. Less of the precipitation Colorado receives is falling as snow, which has led to a decrease in snow pack and earlier melting in the Rocky Mountains.[248] The snowpack is decreasing by as much as 80% in some parts of Colorado and the spring melt is occurring earlier and earlier.[249] Between 1978 and 2004, the spring pulse of melting show has shifted two weeks earlier.[250] As a result, stream flows will likely decrease, there may be less water in Colorado's reservoirs, and summer

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http://www.cier.umd.edu/climateadaptation/Colorado%20Economic%20Impacts%20of%20Climate%20Change.pdf [hereinafter *Economic Impacts of Climate Change on Colorado*].

[242] *Id.*

[243] *Id.*

[244] UNITED STATES GLOBAL CHANGE RESEARCH PROGRAM ("USGCRP"), GLOBAL CLIMATE CHANGE IMPACTS IN THE UNITED STATES 13 (2009) *available at* http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf [hereinafter *Global Climate Change Impacts*].

[245] Stephen Saunders & Maureen Maxwell, *Climate Disruption in the West* at 4.

[246] *Id.* at 11.

[247] *Id.* at 18.

[248] *Id.* at 6.

[249] *Id.* at 10.

[250] Andrea J. Ray et al., *Climate Change in Colorado* at 2.

and fall water stresses will likely be a growing concern.[251] These changes will have profound consequences for water use, especially as Colorado's growing population demands more water and hotter temperatures and earlier springs require more irrigation.

89. Climate projections show a precipitous decline in snowpack below 8200 feet and modest declines in snowpack above 8200 feet.[252] The snowpack is an essential contributor to groundwater and so reduced snowpack could lead to a decline in groundwater supplies.[253]

90. Overall drier conditions and an increase in the likelihood of late-summer droughts are expected to increase and intensify for much of the state under warmer climate conditions. Models predict that drought will likely become more severe, and even if there is an increase in precipitation, it will not be enough of an increase to keep pace with the increase in evaporation. Droughts will be exacerbated by a decline in snowmelt run-off from the mountains.[254]

91. As soil becomes less permeable due to the arid weather and rain falls in more sporadic heavy events, flooding may increase.[255] Flooding may also increase because a warmer climate means that warmer air can hold more moisture, which means that thunderstorms can be more intense.[256]

92. As water levels in streams and rivers decline, more aquatic species are likely to be listed as endangered and threatened species, which could lead to strict water restrictions being imposed under the Endangered Species Act.[257]

Impacts to Wildlife and Habitat

93. Colorado's biodiversity and native species will suffer from warmer temperatures and other climatic changes. The composition and density of forests will change; animals like bears may migrate north while other animals may migrate up in elevation; cold-water trout populations will suffer; and pests and insects will

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[251] Tim P. Barnett et al., *Human-Induced Changes in the Hydrology of the Western United States*, 319 SCIENCE 1080 (2008); N.S. Christensen & D.P. Lettenmaier, *A Multimodal Ensemble Approach to Assessment of Climate Change Impacts on the Hydrology and Water Resources of the Colorado River Basin*, 3 HYDROLOGY & EARTH SYS. SCI. 3727 (2007); Phillip W. Mote, *Climate-Driven Variability and Trends in Mountain Snowpack in Western North America*, 19 J. CLIMATE 6209, 6209 (2006).
[252] Andrea J. Ray et al., *Climate Change in Colorado* at 29.
[253] Stephen Saunders & Maureen Maxwell, *Climate Disruption in the West* at 1.
[254] Andrea J. Ray et al., *Climate Change in Colorado* at 38.
[255] CIER, *Economic Impacts of Climate Change on Colorado* at 7.
[256] Andrea J. Ray et al., *Climate Change in Colorado* at 38.
[257] Stephen Saunders & Maureen Maxwell, *Climate Disruption in the West* at 7.

expand their range.[258]

94. Climate change increases the likelihood of wildlife extinction because invasive species out-compete native species; diseases spread; the timing of seasons change, which impacts migration and hibernation schedules; and temperature changes alter the range where wildlife can survive. While some species can survive by migrating, isolated populations and alpine species are in particular danger of extinction.[259]

95. White-tailed ptarmigan numbers in Rocky Mountain National Park have been cut in half in the past two decades and their numbers are expected to continue to decline as temperatures continue to rise. Ptarmigan's rely on the imperiled tundra habitat and depend on snow to survive.[260] Earlier springs are causing ptarmigans to hatch significantly earlier than they did in 1975, which is problematic because less food is available for the young to survive in the early spring.[261]

96. Colorado's forests are particularly vulnerable to climate change. Pests, diseases, and forest fires will all thrive under warmer climate conditions with adverse impacts for Colorado's forests.[262] For example, the mountain pine beetle, which benefits from a shorter winter, killed 1.2 million alpine trees in 2004 and 1.5 million lodgepole pine trees since 1996.[263]

97. The combination of hotter temperatures and drought conditions in the Four Corners region has resulted in substantial die-off of piñon pine trees across 4,600 square miles of piñon-juniper woodland.[264]

98. As a result of more arid weather, longer growing seasons, and more dead trees, catastrophic forest fires will become more prevalent in Colorado in the future.[265] Between 1900 and 1999, the average amount of Forest Service land that burned annually was around 450,000 acres.[266] Between 2000 and 2002 the average was over 1 million acres.[267] Fires already cost millions of dollars to control and the

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[258] CIER, *Economic Impacts of Climate Change on Colorado* at 10.
[259] Stephen Saunders et al., LOSING GROUND: WESTERN NATIONAL PARKS ENDANGERED BY CLIMATE DISRUPTION 11 (2006) *available at* http://www.nrdc.org/land/parks/gw/gw.pdf [hereinafter *Western National Parks Endangered*].
[260] *Id.*
[261] *Id.* at 12.
[262] CIER, *Economic Impacts of Climate Change on Colorado* at 9.
[263] *Id.*
[264] USGCRP, *Global Climate Change Impacts* at 131.
[265] CIER, *Economic Impacts of Climate Change on Colorado* at 7.
[266] *Id.* at 9.
[267] *Id.*

costs associated with fires will likely increase in the future.[268]

99. Scientists predict that a 2.9°F increase in temperature in the West could increase the number of fires by 50 to 92% and increase the amount of land burned by as much as 140%.[269] In Rocky Mountain National Park, scientists predict that fires spreading over 10 acres could increase by 30 to 90%.[270]

100. An increase in wildfire threatens cultural resources in western national parks and can destroy archaeological site and artifacts. For example, in Mesa Verde National Park, a 1996 fire irreparably damaged a 1,000 year-old Native American petroglyph.[271]

101. The unique tundra in Rocky Mountain National Park is expected to be adversely impacted by climate change. Scientists project that for each degree of warming, the treeline in the park would encroach onto the tundra by 250 feet. A 5°F increase in temperature would eliminate half the tundra habitat.[272]

102. The forests in Mesa Verde National Park are especially vulnerable to climate change. Trees are becoming stressed by drought and rising temperatures, which makes it easier for invasive species to take over. Drought in recent years has eliminated nearly half of the ponderosa pines and fragmented the piñon-juniper woodlands.[273]

Pest and Insect Outbreaks

103. As climate change disrupts natural ecosystems, invasive plants are likely to spread. Invasive plants thrive in disturbed areas because they are adaptable and can reproduce quickly.[274]

104. Climate change in the United States has produced warmer summers, enabling the mountain pine beetle to produce two generations of beetles in a single summer season, where it had previously only been able to produce one.[275]

105. The expansion of the forest beetle population has killed millions of acres of tress

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[268] *Id.* at 10.
[269] Saunders et al., *Western National Parks Endangered* at 16.
[270] *Id.* at 17.
[271] *Id.* at 14.
[272] *Id.* at 5.
[273] *Id.* at 7.
[274] *Id.* at 9.
[275] U.S. CLIMATE CHANGE SCIENCE PROGRAM (USCCSP), WEATHER AND CLIMATE EXTREME IN A CHANGING CLIMATE, REGIONS OF FOCUS: NORTH AMERICA, HAWAII, CARIBBEAN, AND U.S. PACIFIC ISLANDS 15 (June 2008) *available at* http://www.climatescience.gov/Library/sap/sap3-3/final-report/sap3-3-final-all.pdf.

across the United States and Canada and resulted in millions of dollars lost from decreased timber and tourism revenues.[276]

Human Health Impacts

106. Rising temperatures and carbon dioxide concentration increase pollen production and prolong the pollen season in a number of plants with highly allergenic pollen, aggravating asthma and allergies.[277] Increased amounts of allergenic plant pollens and some soil fungi, and dust clouds containing particles and microbes from expanding deserts compound the effects of air pollutants and smog from burning fossil fuels to exacerbate asthma.[278]

107. Colorado's residents will not be immune from the increased incidences and spreading range of infectious diseases like cholera, malaria, Lyme disease, and West Nile virus.[279]

108. An increase in ground-level ozone, which can cause respiratory illnesses such as asthma, could increase as a result of warmer summer temperatures.[280]

109. Reduced water supplies can threaten human health as they cause an increased concentration of bacteria, pesticides, algae, and other harmful contaminants.[281]

Economic Impacts

110. Some of the worst economic impacts of climate change in Colorado will be borne by tourism industry, particularly the ski industry, which generates around $2 billion worth of revenue annually.[282]

111. Ongoing GHG emissions at or above current levels will cause a decline in Colorado's mountain snowpack for the winter recreation industry. Earlier springs will result in shorter ski seasons. Decreases from 40 to 90% are likely in end-of-season snowpack.[283] Warmer temperatures could produce wet snow avalanches, which would require ski resorts to close as much as six weeks earlier by the end of the century.[284] This could easily render the ski resorts unprofitable. With less snow, ski resorts may have to rely on artificial snowmaking, driving up costs and

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[276] *Id.*
[277] USGCRP, *Global Climate Change Impacts* at 89.
[278] *Id.* at 9.
[279] *Center for Global Health and Environment, Climate Change Futures* at 32-53.
[280] CIER, *Economic Impacts of Climate Change on Colorado* at 12.
[281] *Id.*
[282] *Id.* at 7.
[283] USGCRP, *Global Climate Change Impacts* at 133.
[284] *Id.*

consuming more water.[285]

112. Tourists to Colorado visit the state's wilderness areas, national and state parks, and other recreational areas. As these areas are impacted by climate change, the roughly $9 billion these areas generate in revenue annually will also be affected.[286]

113. As temperatures increase and fires become more common, visitations to national parks will likely decline, resulting in lost revenues for Colorado. For example, in 2000, fires that burned in Mesa Verde National Park led to closures of the park for three weeks and cut visitation for the summer months in half.[287]

114. Climate change is expected to adversely impact Colorado's agricultural sector, which was valued at $4.5 billion in 2002. Irrigation costs will be driven up as longer summers and warmer temperatures increase the need for irrigation. Livestock production will be affected as animals are affected by heat stress. This may encourage a shift in grazing activities northward.[288]

D. THE PUBLIC TRUST DOCTRINE DEMANDS THAT COLORADO ACT TO PRESERVE THE ATMOSPHERE AND PROVIDE A LIVABLE FUTURE FOR PRESENT AND FUTURE GENERATIONS OF COLORADO RESIDENTS.

115. The citizens of Colorado, including Petitioners, have a right to a healthy atmosphere and stable climate.

116. A court in the State of Texas recently held that pursuant to the Texas Constitution, all natural resources, including the air and atmosphere, are trust assets and must be protected by the state.[289] Similarly, a New Mexico court has recently denied a motion to dismiss a suit against the governor and the state for violating its public trust duties to protect the atmosphere. That case will be proceeding on the merits to determine if the state has complied with its trust duties to protect the atmosphere when repealing regulations that address greenhouse gas emissions.[290]

117. There is no greater duty of parents than to provide for the protection and safety of their children. Likewise, there is no greater duty of our government than to ensure the protection and safety of its citizens, both born and yet to be born. As described above, the Earth's atmosphere is what has allowed humans to exist and flourish on

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[285] *Id.*
[286] CIER, *Economic Impacts of Climate Change on Colorado* at 8.
[287] Saunders et al., *Western National Parks Endangered* at 17.
[288] *Id.* at 11.
[289] *See Angela Bonser-Lain v. Texas Commission on Environmental Quality*, Cause No. D-1-GN-11-002194 (on review of denial of petition for rulemaking) http://ourchildrenstrust.org/sites/default/files/Texas-letter-ruling_0.pdf
[290] http://ourchildrenstrust.org/sites/default/files/Order%20Denying%20Motion%20to%20Dismiss.pdf

this planet. But human activity has allowed the atmospheric equilibrium to become imbalanced, and now human life on Earth is in grave danger.

118. The atmosphere, essential to human existence, is an asset that belongs to all people. The public trust doctrine requires that as a trustee, Colorado and the Governor, through the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources, hold vital natural resources in *trust*, for both present and future generations of its citizens. These resources are so vital to the well-being of all people, including the citizens of Colorado, that they must be protected by this distinctive, long-standing judicial principle. The atmosphere, including the air, is one of the most crucial assets of our public trust.

119. The public trust doctrine holds government responsible, as perpetual trustee, for the protection and preservation of the atmosphere for the benefit of both present and future generations. Today the citizens of Colorado are confronted with an atmospheric emergency. Thus, it is incumbent upon the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources to uphold its public trust obligation to the people of Colorado and initiate rulemaking in accordance with this petition.

120. If the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources, as trustees of the atmosphere (an essential and fundamental resource that belongs to all citizens of Colorado), do not take immediate and extraordinary action to protect, preserve, and bring the Earth's atmosphere back into balance, then children in Colorado and countless future generations of children will suffer continually greater injuries and damaging consequences. If we, as a society, want to protect and keep the world safe for our children, including here in Colorado, then the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources must immediately accept their fiduciary responsibility as mandated by their trustee obligation and adopt the rule proposed herein.

121. The public trust imposes a legal obligation on the Commission to affirmatively preserve and protect the citizen's trust assets from damage or loss, and not to use the asset in a manner that causes injury to the trust beneficiaries, be they present or future. The sovereign trustee has an affirmative, fiduciary duty to prevent waste, to use reasonable skill and care to preserve the trust property, and to maintain trust assets. The duty to protect the trust asset means that the Commission must ensure the continued availability and existence of healthy trust resources for present and future beneficiaries. This duty mandates the development and utilization of the trust resource in a manner consistent with its conservation and in furtherance of the self-sufficiency of the State of Colorado.

122. Colorado's fiduciary duty in this instance is defined by scientists' concrete prescriptions for carbon reductions. Scientists have clearly expressed the minimum carbon dioxide reductions that are needed, and requisite timelines for

their implementation. Colorado may not disclaim this fiduciary obligation, and is subject to an ongoing mandatory duty to preserve and protect this atmospheric trust asset.

123. The youth in Colorado are already experiencing serious environmental, economic, physical, emotional and aesthetic injuries as a result of the Colorado government's actions and inactions. If Colorado fails to regulate and continues to contribute to this atmospheric crisis, then these injuries will only intensify and expand. A failure to immediately take bold action to protect and preserve Earth's safe climate-zone will cause irreparable harm to the citizens of Colorado and others. Immediate state action is imperative.

124. Once certain tipping points of energy imbalance and planetary heating have been exceeded, we will not be able to prevent the ensuing harm. A failure to act soon may cause the collapse of the Earth's natural systems resulting in a planet that is largely unfit for human life. The responsibility to protect and preserve the atmosphere for the citizens of Colorado is the duty of the Commission. This mandate requires the Commission to protect and preserve that which belongs to all of its citizens and not to allow uses of those assets in a way that causes injury and damage to its citizen beneficiaries.

125. If sovereign governments, including the Commission, do not immediately react to this crisis and act swiftly to reduce greenhouse gas emissions being released into the atmosphere, the environment in which humans and other life on Earth has thrived, will no longer exist. If Colorado does not act immediately to reduce greenhouse gas emissions into the atmosphere, the youth of Colorado and future generations of Colorado resident's children will face a planet that may be largely uninhabitable.

126. Colorado must protect and preserve the planet for its children and future generations. The United States, and the State of Colorado, must lead the way and reduce its greenhouse gas emissions. The United States, including Colorado, not only has a large responsibility for currently harming the atmosphere, but it has the capacity and the technology to reduce emissions, as well as the will and obligation to protect its citizens. The rest of the world is looking to the United States to lead this effort. Without Colorado's action the catastrophic collapse of natural systems is inevitable.

127. The shared atmosphere is a natural resource vital to human health, welfare, and survival. Atmospheric health is essential to all survival. Our atmosphere is a fundamental natural resource entrusted to the care of our governments, and the State of Colorado, in trust, for its preservation and protection as a common property interest. As a co-tenant trustee of this shared asset, the Commission has a fiduciary, and perpetual, affirmative duty to preserve and protect the atmosphere for the present citizens and future generations of Colorado, as beneficiaries of this trust asset.

According to Dr. James Hansen and other renowned scientists, "[w]e have a planetary climate crisis that requires urgent change to our energy and carbon pathway to avoid dangerous consequences for young people and other life on Earth."[291] Climate change is the environmental legal and policy challenge for the 21st century.[292] Two recent events in Colorado serve as a stark reminder of the need for the Commission to take immediate action to address hydraulic fracturing and climate change: first, the record setting fires in Colorado during the summer of 2013, and second, the record-setting floods in Boulder, Larimer, and El Paso Counties in September 2013.

During the summer of 2013, the Black Forest wildfire, which started on June 11 near Colorado Springs, became most destructive fire in Colorado's history.[293] The Black Forest wildfire destroyed 486 homes, killed two people, and forced thousands of people to flee.[294] In becoming the most destructive fire in Colorado's history, the Black Forest wildfire broke the record set just one year earlier by the Waldo Canyon wildfire. The Waldo Canyon wildfire, which also burned near Colorado Springs, destroyed 347 buildings, killed two people, and caused $353 million in damages.[295] Wildfires are only becoming more common and destructive in Colorado as a result of climate change. Climate change is contributing to drought conditions and hotter summer weather – the ideal conditions for wildfires.[296] Climate change is also causing warmer winters, which contributes to the spread of pine beetles that leave fire-prone dead trees in their wake.[297] Due to climate change, these unusual weather conditions are becoming the new norm, meaning the potential for increasingly destructive wildfires in Colorado will only increase unless steps are taken to adequately address climate change.

In September 2013, torrential rainfall led to massive flooding that inundated Boulder,

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[291] James Hansen et., *Climate Change and Intergenerational Justice: Rapid Reduction of Carbon Emissions Required to Protect Young People, Future Generations and Nature* 32-33 (accepted for publication in Proceedings of the National Academy of Sciences) (attached to this petition for rulemaking and incorporated herein).

[292] Climate Change and The Law (Chris Wold, David Hunter, Melissa Powers), preface p.1

[293] Kate Simmons, *Is Climate Change Affecting Colorado wildfires?,* NATIONAL CATHOLIC REPORTER (June 13, 2013), http://ncronline.org/blogs/eco-catholic/climate-change-affecting-colorado-wildfires.

[294] *Black Forest Fire Destroyed 486 Homes, Caused More Than $85 Million In Damage*, HUFFINGTON POST (July 10, 2013), http://www.huffingtonpost.com/2013/07/10/black-forest-fire_n_3572931.html.

[295] Bob Ward, *Colorado Wildfires are Linked to Global Warming*, HUFFINGTON POST (June 19, 2013) http://www.huffingtonpost.com/bob-ward/colorado-pine-beetles-wildfires_b_3453706.html.

[296] Alan Boyle, *Beetles to Blame for Colorado's Fires? Blame Climate Change Instead*, NBC NEWS (June 25, 2013), http://www.nbcnews.com/science/beetles-blame-colorados-fires-blame-climate-change-instead-6C10438158.

[297] *Id.*

Larimer, and El Paso Counties. The 15 inches of rain received in three days in Boulder was more than the previous precipitation record in Boulder for a whole month.[298] While climate change may not have caused this extreme weather event, it likely made it worse than it would have been otherwise.[299] As climate change increases air temperatures, the air can carry more water vapor than it used to, which can lead to more frequent and more destructive extreme rainfall events.[300] Climate scientists say with considerable confidence that extreme weather events, like the one in the Boulder area, will be more common with a hotter planet and that climate change probably contributed to a percent of the rainfall.[301] More generally, it is "very well established scientifically" that a warming planet will lead to more extreme rainfall events.[302] Making matters worse, droughts and wildfires, which are also on the rise due to climate change, make the impacts of extreme rainfall events even more damaging.[303] Droughts harden the soil and make it less absorbent of rainwater while wildfires remove vegetation that can slow down rainfall.[304] With climate change causing an increase in droughts, extreme precipitation events, and wildfires, extreme flooding events in Colorado will likely become more common and more destructive in the future unless the Commission acts now.

The September floods also caused widespread damages to oil and gas wells in Colorado.[305] Thousands of fracking wells, abandoned pits, and old toxic spills were compromised by the flooding.[306] The leaks, spills, water and soil contamination, and other harms caused by damaged wells is just one more indication that fracking is an extremely dangerous activity that is responsible for hazardous conditions for workers and the environment and that it is not being properly regulated.

Therefore, for the aforementioned reasons and on the ground of C.R.S. 24-4-103(7), which enables any interested person or group to petition directly for rulemaking on

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[298] Brian Howard, *Amid Drought, Explaining Colorado's Extreme Floods*, NATIONAL GEOGRAPHIC (Sept. 14, 2013), http://news.nationalgeographic.com/news/2013/09/130913-colorado-flood-boulder-climate-change-drought-fires/ (hereinafter *Amid Drought, Explaining Colorado's Extreme Floods*).

[299] *Colorado Flooding: Did Climate Change Play A Role In Recent Disaster?,* HUFFINGTON POST (Sept. 14, 2013), http://www.huffingtonpost.com/2013/09/14/colorado-flooding-climate-change_n_3926284.html.

[300] *Id.*

[301] Chris Mooney, *Did Climate Change Worsen the Colorado Floods?*, MOTHER JONES (Sept. 18, 2013), http://www.motherjones.com/environment/2013/09/climate-colorado-floods-causation.

[302] *Id.*

[303] *Amid Drought, Explaining Colorado's Extreme Floods*

[304] *Amid Drought, Explaining Colorado's Extreme Floods*

[305] See Appendix III for images of the destruction that the flooding caused to oil and gas wells.

[306] Matt Ferner, *Does A Fracking Disaster Lurk Under Colorado's Floodwaters?*, HUFFINGTON POST (Sept. 20, 2013), http://www.huffingtonpost.com/2013/09/17/colorado-floodwaters-cove_n_3941958.html.

particular regulatory proposal, we hereby submit our petition for proposed regulations of hydraulic fracturing in order to protect our health and safety, air, water, soil, wildlife, and other natural resources.

Under the nationwide Atmospheric Trust Litigation, we are here to ask for the rulemaking of a scientifically viable climate recovery plan to prevent further increases in greenhouse gas emissions and to compel immediate government actions to reduce greenhouse gas emissions from the oil and gas industry. We require Colorado's government to manage and protect vital, precious, natural resources for the common benefits of all Colorado's citizens. Governments are responsible for protecting the common resources we rely on for our survival, our children and future generations.

And so, for the reasons above, it is with utmost respect that petitioners Xiuhtezcatl Martinez, Itzcuauhtli Rosky-Martinez, Charlotte Buren-Hanley, Sonora Binkley, Aerielle Deering, Trinity Carter, Jamirah Duhamel, and Emma Bray hereby submit this petition on behalf of themselves, the citizens of the State of Colorado, and present and future generations of minor children. The petitioners respectfully request that the Commission (in order to fulfill its fiduciary duties) promulgate a rule that requires the Commission to take the necessary steps (outlined herein) to protect the integrity of Earth's climate and Colorado's vital natural resources, including the air, water, soil, and wildlife, public trust resources upon which all Colorado residents rely for their health, safety, sustenance, and security.

Petitioners also respectfully request a public hearing on this rulemaking petition, and the opportunity to meet with and present their petition to the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources. Should the petition be denied, Petitioners request a written decision explaining how the Commission is complying with its Constitutional and statutory, public trust obligation to protect the atmospheric and other vital natural resources, and what level of protection it believes is necessary to protect the people of Colorado.

Please provide a copy of all correspondence regarding this Petition to Petitioners and to our partner non-profit organization Our Children's Trust, P.O. Box 5181, Eugene, OR, 97405 and by email to meg@ourchildrenstrust.org.

Sincerely,

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Xiuhtezcatl Martinez

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Itzcuauhtli Rosky-Martinez

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Charlotte Buren-Hanley

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Sonora Binkley

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Aerielle Deering

_____
Trinity Carter

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Jamirah Duhamel

_____
Emma Bray

On Behalf of Petitioners
November 15, 2013

APPENDIX I: Proposed Rule

Mandatory Review Before Issuing Oil and Gas Fracking Permits

(1) The Colorado Oil and Gas Conservation Commission ("Commission"), as a trustee of Colorado's atmosphere, water, wildlife, and land resources, has an affirmative duty to protect and ensure the continued availability of these trust assets. Pursuant to the Oil and Gas Conservation Act (Title 34, Article 60), the Commission has a responsibility to ensure that oil and gas hydraulic fracturing does not impair these trust resources or adversely impact human health.

(2)(a) Consistent with this directive, before issuing any permits for the drilling of a well for oil and gas, the Commission shall evaluate the impacts of oil and gas drilling and exploration on trust resources and human health according to the best available science.

(b) Before issuing any permits for the drilling of a well for oil and gas, the Commission shall consider how all greenhouse gas emissions from the extraction, processing, transportation, distribution, and combustion of oil and gas cumulatively affects climate change and global warming.

(c) The Commission shall not issue any permits for the drilling of a well for oil and gas unless the best available science demonstrates, and an independent, third-party organization confirms, that drilling can occur in a manner that does not cumulatively, with other actions, impair Colorado's atmosphere, water, wildlife, and land resources, does not adversely impact human health, and does not contribute to climate change.

(3) In order to protect Colorado's atmosphere, water, wildlife, and land resources, the Commission shall work with other state agencies to adopt a state climate recovery plan by March 15, 2014, based on the best available science that fulfills the Commission's duty to protect trust assets from impairment. The state climate recovery plan shall inform and guide permitting decisions by the Commission.

(4) Consistent with this directive, the Commission shall:

(a) Publish annual reports on statewide greenhouse gas emissions from the oil and gas industry on the Commission's website for public review. These reports must include an accounting and inventory for each and every substantial source of greenhouse gas emissions from Colorado's oil and gas industry, including, extraction, processing, transportation, distribution, combustion, and other emissions sources. This inventory and accounting must be verified by an independent, third-party. Annual reports must be posted to the Commission's website and be made publicly available no later than January 31 of each year, beginning in the year 2014.

(b) By December 31 of each year, beginning in 2014, the Commission must report to the governor and the appropriate committees of the Senate and House of Representatives the total emissions of greenhouse gases from the oil and gas industry for the preceding year. The Commission shall ensure that reporting rules allow it to develop

a comprehensive inventory of emissions of greenhouse gases from all sectors of the oil and gas industry, including extraction, processing, transportation, distribution, combustion, the estimated emissions related to the future combustion of the oil and gas, and other emissions sources.

(5) “Best available science” as stated herein means scientific information that has a high degree of excellence and authenticity, which includes sound logic, good judgment, evidence, and reasoning from a reliable source. Best available science should adhere to a methodology that minimizes subjectivity while gaining scientific knowledge. Science that originates from oil and gas industry-funded scientists must be supported by other reliable sources of science that do not have a financial stake in the outcome of any permitting decisions by the Commission. When the science is underdeveloped and has not reached a degree of excellence, the precautionary principle shall apply until it can be adequately demonstrated that the atmosphere, water, wildlife, and land resources will be protected.

(6) To the extent that any rule in this section conflicts with any other rule in effect, the more stringent rule, favoring full disclosure of emissions and protection of the atmosphere, water, wildlife, and land resources, governs.

APPENDIX II: Proposed Statement of Basis and Purpose

Colorado emits more greenhouse gases, including carbon dioxide, methane, and aerosols, than 174 countries in the world.[307] Greenhouse gases are responsible for anthropogenic climate change. The oil and gas sector in Colorado is an important contributor to greenhouse gas emissions. Colorado has a responsibility to take actions at the state level to reduce emissions of these pollutants in order to minimize the adverse impacts of climate change. Greenhouse gas emissions in the oil and gas sector are emitted from the extraction, processing, transportation, and combustion of the oil and gas. Additionally, oil and gas extraction, processing, transportation, and combustion threatens public health and safety, pollutes and degrades water quality, harms wildlife, degrades the land, and contaminates soil.

Colorado's youth bear the burden of living in a state where their air, water, wildlife, and land are impaired from the impacts of oil and gas extraction. These youth, as well as future generations, have a profound interest in ensuring that Colorado's natural resources are protected and the climate remains stable enough to ensure their right to a livable future. A livable future includes the opportunity to drink clean water and abate thirst, to grow food that will abate hunger, to be free from imminent property damage caused by extreme weather events, and to enjoy the abundant and rich biodiversity on this small planet.

The youth in Colorado are already experiencing serious environmental, economic, physical, emotional and aesthetic injuries as a result of the Colorado government's actions and inactions. If Colorado fails to regulate and continues to contribute to this atmospheric crisis, then these injuries will only intensify and expand. A failure to immediately take bold action to protect and preserve Colorado's air, water, wildlife, and land will cause irreparable harm to the citizens of Colorado and others. Immediate state action is imperative.

The Colorado Oil and Gas Conservation Commission ("Commission") and Colorado Department of Natural Resources ("DNR") have a fiduciary duty to protect Colorado's atmosphere, water, wildlife, and land resources for present and future generations. Under the public trust doctrine, the state of Colorado, including the Commission and DNR, have a fiduciary duty to protect these trust assets from damage or loss and to not use the asset in a manner that causes injury to the trust beneficiaries, present and future. In addition to the Commission's and DNR's responsibilities under the public trust doctrine, the Oil and Gas Conservation Act, Title 34, Article 60, includes specific protections for these trust assets.

Section 34-60-102 states:

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[307] Stephen Saunders & Maureen Maxwell, LESS SNOW, LESS WATER: CLIMATE DISRUPTION IN THE WEST 21 (2005), http://www.rockymountainclimate.org/website%20pictures/Less%20Snow%20Less%20Water.pdf

> It is declared to be in the public interest to foster the responsible, balanced development, production, and utilization of the natural resources oil and gas in the state of Colorado in a manner *consistent with the protection of public health, safety, and welfare, including protection of the environment and wildlife resources*…. (emphasis added).

Section 34-60-105(1) states:

> The commission has jurisdiction over all persons and property, public and private, necessary to enforce the provisions of this article, and has the power to make and enforce rules, regulations, and orders pursuant to this article, and *to do whatever may reasonably be necessary to carry out the provisions of this article*. (emphasis added).

Section 34-60-106(1) states:

> The commission also has the authority to require: … (f) That no operations for the drilling of a well for oil and gas shall be commenced without first giving to the commission notice of intention to drill *and without first obtaining a permit from the commission, under such rules and regulations as may be prescribed by the commission*…. (emphasis added).

Section 34-60-106(2) states:

> The commission has the authority to regulate: … (d) Oil and gas operations so as *to prevent and mitigate significant adverse environmental impacts on any air, water, soil, or biological resource* resulting from oil and gas operations *to the extend necessary to protect public health, safety, and welfare, including protection of the environment and wildlife resources*, taking into consideration cost-effectiveness and technical feasibility. (emphasis added).

These sections of the Oil and Gas Conservation Act give the Commission authority to require permits for oil and gas operations and to regulate oil and gas operations to ensure that they do not cause adverse environmental impacts or adversely impact human health. Currently however, there are significant adverse health and safety impacts occurring as a result of the oil and gas operations in Colorado and significant adverse environmental impacts on air, water, soil, and other biological resources.

Even when taking into consideration cost-effectiveness and feasibility of regulations, the Commission has a clear responsibility to act to regulate the oil and gas industry. The cost of the harm that the oil and gas industry is causing to human health and the environment is so enormous is it hard to quantify. These costs include medical bills, damage caused by increasing wildfire and other extreme storms, greater expenses for transporting and purifying water, lost revenues from the tourism industry and agricultural sectors,

expenses for cleaning up oil and gas spills and leaks, the financial strain and damages caused by droughts and floods, and many other economic costs. These costs far outweigh any costs that may be associated with greater regulations of the oil and gas sector.

As to the issue of technical feasibility, oil and gas should not be extracted from Colorado until it can be done in a manner that does not impair public health or the environment. If the technology does not currently exist for oil and gas to be extracted and consumed in a manner that is safe, oil and gas extraction should not occur until it is feasible to have an oil and gas industry that is not a threat to human health and does not impair Colorado's air, water, wildlife, and land.

The Colorado Oil and Gas Conservation Commission and the Department of Natural Resources have authority to regulate oil and gas operations so as to protect human health and the environment. In order to ensure that present and future generations of Colorado's residents can enjoy Colorado's air, water, wildlife, land, the Colorado Oil and Gas Conservation Commission and the Department of Natural Resources need to act to regulate the oil and gas industry so that is does not impair these invaluable trust assets.

APPENDIX III[308]

[308] The pictures in Appendix III are just a few images documenting the impacts of the September 2013 flooding on oil and gas wells in Colorado. These, and other images, can be found at http://www.fractivist.blogspot.com/.


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