Exhibit 6

Susan Harvey Declaration

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF NEW MEXICO

DINÉ CITIZENS AGAINST RUINING OUR ENVIRONMENT, *et al*.,	)	Case No. 1:15-cv-0209
Plaintiffs,	)	
v.	)	DECLARATION OF SUSAN L. HARVEY
SALLY JEWELL, *et al*.,	)	
Defendants.	)	

I, Susan L. Harvey, of Eagle River, Alaska, United States, declare under oath that I have personal knowledge of the following:

1. I am over 18 years of age, and I am competent to testify.

2. I have been asked by the Diné Citizens Against Ruining Our Environment, San Juan Citizens Alliance, Wildearth Guardians, and Natural Resources Defense Council (Plaintiffs) to prepare a declaration to support a Motion for Preliminary Injunction regarding Case Number 1:15-cv-209 in the United States District Court, for the District of New Mexico.

3. I provide this declaration to support the Plaintiff's Motion for Preliminary Injunction.

4. This declaration addresses technical issues relevant to the Plaintiff's Motion for Preliminary Injunction. It is based on my review of documents filed in the case, data provided by the Plaintiffs, publically available information, as well as my professional opinion based on my training and experience in, and knowledge of, the petroleum industry. True copies of the documents referenced are attached to this declaration as Exhibits A through E.

I. Experience

5. I have over 28 years of experience as a Petroleum and Environmental Engineer. I am the owner of Harvey Consulting, LLC, which provides oil and gas, environmental, and regulatory compliance advice and training to clients. In the past, I held engineering and supervisory positions at Arco and BP Exploration. I hold a Bachelor of Science degree in Petroleum Engineering and a Master's degree in Environmental Engineering. A copy of my CV is attached to this declaration as Exhibit A.

6. I have worked on oil and gas projects in Alaska, New York, Pennsylvania, Ohio, West Virginia, Colorado, Texas, California, New Mexico, and Oklahoma, as well as in Canada, Australia, Russia, Greenland, Belize, and Norway. I have planned, engineered, executed, and managed onshore and offshore oil and gas exploration and production operations. I have been involved in the drilling, simulation, testing, and oversight of hundreds of oil and gas wells. As a consultant, I routinely provide technical review and advice on proposed oil and gas projects to identify improvements that would apply best technology and practices, improve safety, and reduce human health, environmental, and other impacts.

7. I have authored numerous technical reports related to oil and gas project construction, operation, and abandonment, including best practices for oil and gas well construction, air and water pollution abatement design and execution, environmental assessments of oil and gas projects, and oil spill prevention and response planning.

II. Case Background

8. To prepare this declaration, I reviewed the following materials:

a. Plaintiff's March 11, 2015 Complaint Case Number 1:15-cv-209 in the United States

District Court, for the District of New Mexico.

b. 2001 Reasonable Foreseeable Development Scenario (2001 RFD)[1] to support the 2003 Resource Management Plan and associated Environmental Impact Analysis (2003 RMP/EIS),[2] and related materials on the Bureau of Land Management (BLM) Farmington Field Office website.

c. 2014 Reasonable Foreseeable Development Scenario (2014 RFD) to support a proposed revision to the 2003 RMP/EIS, primarily to address current development of the Mancos Shale that was not included in the 2001 RFD Scenario or the 2003 RMP/EIS,[3] and related materials on the BLM Farmington Field Office website.

d. Environmental Assessments (EAs) and Findings of No Significant Impact (FONSIs) completed by the BLM Farmington Field Office from 2011 to April 2015 related to the oil and gas well construction, hydraulic fracture stimulation, well pad construction, road construction, pipeline construction, and new facility installation and expansion of existing facilities to develop Mancos Shale oil and gas resources.[4]

III. Mancos Shale Oil Exploration & Development Today Exceeds 2001 RFD Well Count

9. FONSIs approved by the BLM Farmington Field Office from 2011 to April 2015 for Mancos Shale exploration and development exceed the 2001 RFD well count.

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[1] Engler, T.W. (Petroleum and Chemical Engineering Department, New Mexico Institute of Mining and Technology), Oil and Gas Resource Development for San Juan Basin, New Mexico, A 20-year, Reasonable Foreseeable Development (RFD) Scenario Supporting the Resource Management Plan for the Farmington Field Office, Bureau of Land Management (hereinafter 2001 RFD).

[2] U.S. Department of the Interior, Bureau of Land Management, Farmington Resource Management Plan with Record of Decision, Farmington Field Office, Farmington, New Mexico, December 2003 (hereinafter 2003 RMP/EIS).

[3] Engler, T.W. (Petroleum and Chemical Engineering Department, New Mexico Institute of Mining and Technology), Reasonable Foreseeable Development (RFD) Scenario for Northern New Mexico for the Farmington Field Office, U.S. Department of Interior, Bureau of Land Management (hereinafter 2014 RFD).

[4] http://www.blm.gov/nm/st/en/fo/Farmington_Field_Office/ffo_document_library.html

10. The 2001 RFD provided a subsurface development scenario that included known and currently producing oil and gas reservoirs and provided an estimate for anticipated reservoir development over the next 20 years,[5] along with an estimated surface impact.[6]

11. Most stand-alone Mancos Shale Oil Wells were considered uneconomic in the 2001 RFD, except the southeastern portion of the basin. The 2001 RFD concluded existing Mancos Shale Oil wells (including the Gallup Sandstone reservoir which is part of the Mancos Shale Group) were producing less than 30 barrels of oil per well per month, were marginally economic, and were likely to be plugged and abandoned in the near future.[7] The 2001 RFD Scenario stated:

> *"…most existing Mancos Shale and Gallup Sandstone reservoirs are approaching depletion and are marginally economic. Most are not currently considered candidates for increased density development or further enhanced oil recovery operations. It is anticipated that many Mancos/Gallup wells will need to be plugged within the term of this RFD."*[8] *"Outside of the gas productive area, it is probable that Mancos/Gallup-only wells will be drilled to access the fracture Mancos oil play, primarily in the southeastern portion of the basin."*[9]

12. Outside the gas productive area, the 2001 RFD included the possibility of up to 300 Mancos Shale Oil exploration and production wells being drilled over the 20 year span.[10]

13. While Table 9.1 of the 2001 RFD lists a possible 300 Mancos Shale Oil well count, the narrative below Table 9.1 explained the 300 Mancos Shale Oil well count was further reduced by 25%, to 225, to account for commingling multiple zones into a single well. Commingling multiple zones into a single well reduces surface impacts and may make marginally economic

[5] 2001 RFD, Executive Summary, vi.
[6] 2001 RFD, Page 1.1.
[7] 2001 RFD, Page 5.25.
[8] 2001 RFD, Page 5.24.
[9] 2001 RFD, Page 5.27.
[10] "Outside of the gas productive area, it is probable that Mancos/Gallup-only wells will be drilled to access the fracture Mancos oil play, primarily in the southeastern portion of the basin. Predicted number of wells to be drilled over the twenty-year life of the RFD is 300 additional wells including development and exploration wells." 2001 RFD, Page 5.27.

wells viable. The 225 well count was further reduced to 180 to account for the proportion of wells on BLM's federal land.[11]

14. I created the table shown in Exhibit B using the 2001 RFD Table 9.1 information (the first two columns of data), and by expanding the table to show the 25% dual completion and commingling reduction, and to limit the well count to federal land (20% reduction). Exhibit B shows that BLM only anticipated a maximum upside well count of 180 Mancos Shale Oil wells.

15. While the 2001 RFD listed the 180 Mancos Shale Oil well count as an upside possibility, neither the 2001 RFD nor the 2003 RMP/EIS provided any detailed analysis or quantitative examination of how those wells might be developed or the resulting impacts.

16. At the time of the 2001 RFD, Mancos Shale Oil was developed using vertical wells, with most of the oil production being produced from the Gallup Sandstone reservoir (part of the Mancos Shale Group). Although the 2001 RFD speculated advances in directional/horizontal drilling might be used to develop shale reservoirs in the future, there was no quantitative analysis of the surface or subsurface impacts of drilling 180 stand-alone Mancos Shale Oil wells using directional/horizontal drilling. There was no quantitative analysis of the impacts of stimulating these 180 wells using multi-stage, large hydraulic fracture treatments. Nor was there a quantitative analysis of the surface facilities required (e.g. separators, tanks, pipelines) to support stand-alone Mancos Shale oil wells during the production phase. In sum, the 2001 RFD did not include a subsurface or surface impact analysis of the type or magnitude of wells currently being drilled into the Mancos Shale Oil today.

17. I created the table in Exhibit C to provide a list of Mancos Shale Oil wells that have been approved by the BLM Farmington Field Office during the period of 2011 to April 2015.

[11] 2001 RFD, Page 9.1.

Exhibit C shows that FONSIs have been approved for 241 Mancos Shale Oil wells as of May 1, 2015, out-pacing the highest predicted, upside well count of 180 wells, by 61 wells as of April 2015.

IV. Mancos Shale Gas Exploration & Development Today Exceeds 2001 RFD Well Count

18. Stand-alone Mancos Shale Gas wells were not anticipated in the 2001 RFD. The 2001 RFD concluded the gas prone section of the Mancos Shale, would only be developed as a secondary target for new infill wells drilled into the Dakota Sandstone on tighter 80 acre spacing. Table 9.1 of the 2001 RFD confirms stand-alone Mancos Shale gas wells were not anticipated. There is no incremental well count assigned to stand-along Mancos Shale gas wells in Table 9.1[12] Instead, the 2001 RFD anticipated the possibility of completing the Mancos Shale Gas zone in a Dakota Sandstone gas well if it was determined to be economic and gas production was commingled.[13] The impacts of directional/horizontal drilling of stand-alone Mancos Shale Gas wells and stimulation of those wells using large hydraulic fracture treatments was not anticipated, nor was the incremental surface pipeline, compression, separate well pads and roads, or other surface facility impacts of stand-alone Mancos Shale gas wells. The 2001 RFD Scenario stated:

> *"Given the probability that the Basin Dakota pool will undergo extensive increased density drilling in the next 20 years, there is an excellent potential for the Mancos to be further evaluated.* ***If it should prove to be even marginally productive, it could be commingled with the Dakota in a manner similar to the Lewis Shale/Mesaverde development projects underway.*** *It is possible a multi-TCF reserve might be realized in the next 20 years. This production would likely be achieved through addition of behind-pipe reserves in new and existing Dakota wells rather than drilling of new Mancos-specific wells."[14] [Emphasis added.]*

[12] 2001 RFD, Page. 9.1.
[13] 2001 RFD, Page 5.26.
[14] 2001 RFD, Page 5.26.

19. As summarized in Exhibit B, a total of 4,108 commingled Dakota & Mancos Shale Gas Wells was estimated. There were no stand-alone Mancos Shale Gas wells predicted.

20. I reviewed BLM EA's for the years 2011 to April 2015. The data shows that FONSIs have been approved for at least seven stand-alone Mancos Shale Gas wells as of April 2015, out-pacing the 2001 RFD. As explained further below, every stand-alone Mancos Shale Gas well produces an incremental surface impact that was not predicted in the 2001 RFD or evaluated in the 2003 RMP/EIS. While the current incremental stand-alone Mancos Shale Gas well count of seven wells is not large, the 2014 RFD anticipated a potential incremental well count of 2,000 more wells in the future, if gas prices support this economic development. The impacts of developing 2,000 new stand-alone Mancos Shale Gas wells would be significant and was not evaluated in either the 2001 RFD or the 2003 RMP/EIS.

V. 2014 RFD Scenario for Mancos Shale Exploration & Development Well Count

21. A new Reasonable Foreseeable Development Scenario was developed in 2014 (2014 RFD) to support a proposed revision to the 2003 RMP/EIS, primarily to address current development of the Mancos Shale that was not included in the 2001 RFD or the 2003 RMP/EIS.[15]

22. The 2014 RFD estimated 1,600 to 1,960 wells new Mancos Shale Oil wells in San Juan Basin, covering an area of over one million acres.[16] The 2014 RFD estimate exceeds the 2001 RFD Scenario and the 2003 RMP/EIS of 180 probable wells by 1,420 to 1,780 wells. The 2014 RFD estimated high, moderate, and low potential regions to develop the 1,600 (low side) to

[15] Engler, T.W. (Petroleum and Chemical Engineering Department, New Mexico Institute of Mining and Technology), Reasonable Foreseeable Development (RFD) Scenario for Northern New Mexico for the Farmington Field Office, U.S. Department of Interior, Bureau of Land Management (hereinafter 2014 RFD).
[16] 2014 RFD, Page 16.

1,960 (high side) estimate. The high potential region for Mancos Shale Oil development encompasses 200,500 acres. A 1,600 well count was based on five (5) new Mancos Shale Oil wells per section. The moderate potential region for Mancos Shale Oil development encompasses 211,900 acres. A 330 well count was based on one (1) new Mancos Shale Oil well per section. The low potential region for Mancos Shale Oil development encompasses 756,000 acres. The 30 well count was based on one (1) new Mancos Shale Oil well per township.[17]

23. Assuming the 180 probable wells (estimated in the 2001 RFD) would have been drilled in the high potential region on a spacing of five wells per section[18] (128 subsurface acres per well), those 180 wells would have only impacted a potential subsurface area of 23,040 acres. Therefore, the estimated subsurface impact area of 200,500 acres in the high potential region and over one million subsurface acres for all anticipated Mancos Shale Oil development (along with the corresponding surface impacts described further below) was not contemplated in 2001 RFD Scenario or the 2003 RMP/EIS.

24. The 2014 RFD estimated 2,000 stand-alone wells targeting Mancos Shale Gas in the basin center area near the Colorado border, with the pace of development being a function of gas price.[19] The 2014 RFD estimate exceeds the 2001 RFD Scenario and the 2003 RMP/EIS by 2,000 new stand-alone wells, because the prior assumption was no new stand-alone Mancos Shale Gas wells would be developed (as explained above).

[17] 2014 RFD, Page 16.
[18] A section is 640 acres.
[19] 2014 RFD, Executive Summary, Page 2 and Page 21.

VI. Impacts of Mancos Shale Exploration & Development Today Was Not Evaluated in the 2003 RMP/EIS

25. The Farmington Resource Management Plan with Record of Decision, and associated Environmental Impact Analysis was approved by BLM on December 2003 (2003 RMP/EIS).[20] The planning areas encompass the New Mexico portion of the San Juan Basin. The approved 2003 RMP/EIS selected Alternative D in its entirety, except that it incorporated a portion of Alternative B allowing oil and gas leasing with No Surface Occupancy in the Negro Canyon Specially Designated Area.[21] The 2003 RMP/EIS used the 2001 RFD Scenario as a basis.

26. FONSIs approved by the BLM Farmington Field Office from 2011 to April 2015, authorize oil and gas well construction, hydraulic fracture stimulation, well pad construction, road construction, pipeline construction, new facility installation and expansion of existing facilities to develop Mancos Shale oil and gas resources that cumulatively authorize Mancos Shale exploration and development exceeding the 2003 RMP/EIS.

27. The 2001 RFD and 2003 RMP/EIS focused on natural gas production from BLM lands in the San Juan Basin primarily from low permeability fractured Cretaceous reservoirs.[22] The 2001 RFD reported a gas production rate (as of July 2000) of 3 billion standard cubic feet of gas per day (Bscfd). Approximately half of the gas was produced from the Basin Fruitland coalbed methane pool, with the remaining gas production from the Mesaverde, Dakota, and Pictured Cliffs reservoirs.[23] The 2003 RMP/EIS examined continued development of predominately these same natural gas reservoirs over the next 20 years. The major gas producing reservoirs described

[20] U.S. Department of the Interior, Bureau of Land Management, Farmington Resource Management Plan with Record of Decision, Farmington Field Office, Farmington, New Mexico, December 2003 (hereinafter 2003 RMP/EIS).
[21] 2003 RMP/EIS, Page 1.
[22] 2001 RFD, Page 1.5.
[23] 2001 RFD, Page 2.5.

in Chapter 6 of the 2001 RFD did not include the Mancos Shale,[24] and the 2003 RMP/EIS did not examine any surface impacts of stand-alone gas wells drilled into the Mancos Shale. The 2011 RFD and 2003 RMP/EIS only examined possible Mancos Shale Gas development as a secondary target for wells drilled into the Dakota Sandstone, where those two zones might be commingled into a single well if economic, and speculated about a possible upside development of up to 180 Mancos Shale Oil wells (but did not quantitatively analyze its impact).

28. The 2003 RMP/EIS did not anticipate any substantial oil production from any reservoir, and certainly not the Mancos Shale. Existing Mancos Shale Oil wells were producing 30 barrels per month (less than one barrel per day). The 2003 RMP/EIS did not evaluate the surface impacts of drilling new Mancos Shale Oil wells, and the additional surface facilities required to develop those wells (e.g., separators, dehydrators, tanks, compressors, additional pipelines). Nor did the 2003 RMP/EIS evaluate the additional waste disposal impacts of drilling longer horizontal wells, using larger volumes of water for hydraulic fracturing or the air quality impacts of extended flaring during post-hydraulic fracturing well cleanup.

VII. Incremental Surface Impacts Not Examined

29. The 2003 RMP/EIS stated:

> *"Companies applying for permits to drill may be required to evaluate the use of new technology such as directional drilling from existing pads and other techniques in order to reduce surface disturbance… New drilling and completion strategies are expected to improve for directional and horizontal wells.* ***The advantages would be the potential for increased gas recovery, and the reduction in surface disturbance****. It is certain that advanced technologies will support development, but the impact is difficult to estimate. As an example, completion strategies of directional drilling, horizontal wells, and multi-laterals will reduce surface disturbance. Unknown at this time is the gas recovery for reservoirs in the San Juan Basin subject to this completion method"[25] [emphasis added].*

[24] 2001 RFD, Page 6.1.
[25] 2001 RFD, Page 1.4.

30. Therefore, the primary target for directionally drilled/horizontal wells was to develop gas resources in the Mesaverde Group and the Dakota Sandstone, not the Mancos Shale.[26] Chapter 7 of the 2001 RFD summarized the results of a year 2000 industry survey that "…indicated a willingness to drill and complete deviated wells, but little enthusiasm for horizontal wells with or without laterals."[27] The survey showed the primary target for deviated wells was the Mesaverde Group. However, the industry survey predominately planned vertical wells to be drilled. The survey estimated: 92.5-95% vertical wells, with 5-7.5% directional wells, and no horizontal wells.[28]

31. The other stated purpose for using directional/horizontal drilling was to reduce surface impacts. While directional drilling can reduce surface impacts in some circumstances (by co-locating several wells on a single well pad). The actual use of directional drilling for the Mancos Shale today has actually increased the surface impacts, because of the need for larger well pads to support larger drilling rigs to drill longer horizontal wellbores, and to support equipment to conduct large multi-staged hydraulic fracture treatments.

32. The 2001 RFD estimated each vertical well pad averages two acres and the associated road and pipeline interties requires one acre for a total of three acres per well.[29] The total surface impact area to develop 9,970 wells over a 20 year period in the San Juan Basin was estimated at of 16,151 acres.[30] The 2001 RFD only estimated surface impacts of drilling vertical wells.

33. The 2001 RFD estimated an additional surface impact of 3,600 miles of gas pipeline, for an estimated additional 11,716 acre surface disturbance. The combined total surface

[26] 2001 RFD, Page 7.4
[27] 2001 RFD, Page 7.1.
[28] 2001 RFD, Page 7.4.
[29] 2001 RFD, Page 1.3.
[30] 2001 RFD, Page 9.3.

disturbance (16,151 acres for vertical well pads and roads and 11,716 acres for gas pipelines) was estimated at 27,867 acres (approximately 2.8 acres per well). In total, the 2003 RMP/EIS only evaluated the surface impact of 2.8 acres per vertical well.

34. Only 180 stand-alone Mancos Shale Oil wells were estimated in the 2001 RFD with a surface impact of 2.8 acres per well (504 acres).

35. From 2011 to April 2015, a total of 241 Mancos Shale Oil well EAs have been approved with an average surface impact area of 5.2 acres per well, impacting a total surface impact area of 1,243 acres. This impact is 739 acres larger than estimated in the highest 2001 RFD upside case of 180 wells (504 acres).

36. Surface impacts estimated in the 2011 to April 2015 Mancos Shale Oil EA's completed by the BLM Farmington Field Office averaged 5.2 acres per well and ranged from 1.5 to 14.7 acres per well depending on the amount of additional road and pipeline impacts required to develop particular wells. This data almost doubled the surface impact estimated in the 2001 RFD and examined in the 2003 RMP/EIS. The EA's explain larger well pads are needed to accommodate the equipment required for large multi-stage hydraulic fracture stimulation treatments.[31] For example:

a. The Encana Oil and Gas (USA) Inc. Cluster 20 EA estimated 7.75 acres per well (77.5 acres for 10 wells).[32]

b. The Encana Oil and Gas (USA) Inc. December 2013 Lybrook Well EA estimated 8.4-9.0 acres per well.[33]

[31] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2015-0070, Logos Operating, LLC, April 2015, Page 17.
[32] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc., January 2015, Table 2-4.

c. The WPX Chaco Well EA estimated 6.25 acres per well (12.5 acres for two wells).[34]

37. The 2014 RFD estimates between 1,600 to 1,960 new wells will be drilled to produce Mancos Shale Oil. Using the 5.2 acre per well estimate for 1,600 to 1,960 new Mancos Shale Oil wells, results in an estimated incremental surface impact of 8,320 to 10,192 acres. Therefore, the net increase in surface impact would be 7,816 to 9,688 acres above the 2001 RFD.

38. No stand-alone Mancos Shale Gas wells were estimated in the 2001 RFD Scenario; it was assumed that additional Mancos Shale Gas development would only occur if commingled in a Dakota Sandstone well. Therefore, there was no surface impact attributed to Mancos Shale Gas wells in the 2001 RFD and 2003 RMP/EIS.

39. I reviewed the 2011 to April 2015 EAs completed by the BLM Farmington Field Office and found seven stand-alone Mancos Shale Gas wells were approved for a total of 32 acres of surface impact (5.3 acres per well).[35] This incremental surface impact was not examined in the 2003 RMP/EIS.

40. The 2014 RFD Scenario estimates 2,000 new stand-alone wells will be drilled to produce Mancos Shale Gas. Using the 5.3 acre surface impact area for recently approved stand-alone Mancos Shale Gas wells as a guide, I estimated the incremental surface impact of 2,000 new stand-along Mancos Shale Gas wells to be 10,600 acres. This potential cumulative surface impact was not examined in the 2003 RMP/EIS.

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[33] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 7.
[34] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0049, WPX Energy Production, LLC's, March 2014, Page 17.
[35] DOI-BLM-NM-F010-2012-26, DOI-BLM-NM-F010-2012-27, DOI-BLM-NM-F010-2012-195, DOI-BLM-NM-F010-2012-247, DOI-BLM-NM-F010-2013-0288, and DOI-BLM-NM-F010-2015-0093.

41. In total, the surface impacts of the 241 Mancos Shale Oil and seven (7) stand-alone Mancos Shale Gas wells approved 2011 to April 2015 is 1,275 acres (1,243 acres, and 32 acres, respectively). This impact is more than double the estimated surface impact (504 acres) estimated in the 2001 RFD. The predicted future impact in the 2014 RFD is 18,000 to 20,000 acres. The 2003 RMP/EIS did not examine the habitat loss and impacts of this actual impact or projected impact.

VIII. Air Quality Impacts of Well Construction

42. The 2001 RFD and 2003 RMP/EIS did not examine the incremental air quality impact of the additional 180 Mancos Shale Oil wells it listed as "probable." There was no estimate of the additional air pollution contributed during new well drilling, completion or production operations.

43. The 2003 RMP/EIS anticipated potential air quality impacts using a conservative analysis for Alternative D that provided a quantitative analysis of the impacts of drilling and producing vertical gas wells (primarily coal bed methane production and gas production from the Mesaverde and Dakota formations). Based on this analysis, the 2003 RMP/EIS concluded there was significant potential air quality impacts that required mitigation from vertical gas well development, including:

a. Potential violation of the 24-hour nitrogen dioxide New Mexico Ambient Air Quality Standard;

b. Potential exceedance of the nitrogen dioxide PSD Class II Increment;

c. Potential exceedance of the California short-term (Chronic) Hazardous Air Pollutant Reference Exposure Level for acrolein;

d. Assumed violation of the 8-hour ozone National Ambient Air Quality Standard;

e. Assumed exceedance of the nitrogen dioxide PSD Class I Increment within Mesa Verde National Park, Weminuche Wilderness Area, and San Pedro Parks Wilderness Area mandatory federal PSD Class I areas; and,

f. Assumed significant visibility impacts within Mesa Verde national Park, Weminuche Wilderness Area, and San Pedro Parks Wilderness Area mandatory federal PSD Class I areas.[36]

The 2003 RMP/EIS required air quality mitigation, including:

a. A maximum of four wells can be drilled concurrently in any given square mile, with each well no closer than one-half mile to another; and,

b. Additional mitigation required by the Clean Air Action Plan (July 1, 2004).[37]

44. I reviewed several of the air quality impact assessments for the Mancos Shale EA prepared by BLM's Farmington Field Office from 2011 to April 2015. The EAs I reviewed concluded the incremental impact of each individually proposed well, or cluster of wells, is not significant and would not exceed the National Ambient Air Quality Standards (NAAQS). However, each EA was a piecemeal assessment; the cumulative impact assessment that would be completed in EIS analysis was not done.

45. BLM's Farmington Field Office EA's (prepared 2011 to April 2015) use a standard air pollution impact estimate for drilling a horizontal Mancos Shale Oil well (based on 25 days of drilling) of 6.13 tons per year (tpy) oxides of nitrogen (NO_x), 1.64 tpy carbon monoxide (CO), 0.55 tpy volatile organic compounds (VOC), 2.54 tpy particulate matter of 10 microns or less

[36] 2003 RMP/EIS, Pages 12-13.
[37] 2003 RMP/EIS, Pages 14-15.

(PM_{10}), 0.29 tpy (particulate matter of 2.5 microns or less) $PM_{2.5}$, 0.11 oxides of sulfur (SO_2), 0.01 tpy methane (CH_4), and 671.54 tpy carbon dioxide (CO_2).[38,39,40]

46. BLM's Farmington Field Office EA's (prepared 2011 to April 2015) use a standard air pollution impact estimate for drilling a vertical Mancos Shale Oil well (based on 9 days of drilling) of 2.30 tpy NO_x, 0.63 tpy CO, 0.20 tpy VOC, 0.92 tpy PM_{10}, 0.12 tpy $PM_{2.5}$, 0.05 SO_2, .003 tpy CH_4, and 250.24 tpy CO_2.[41]

47. Exhibit D provides a comparison of the air pollution impact of drilling a horizontal well versus a vertical; there is a 242% to 333% increase in pollutant emissions, varying by pollutant type.

48. Exhibit D provides an estimate of the air pollution impact of the 241 Mancos Shale Oil wells that have been approved BLM EA's; including the 236 horizontal wells, and 5 vertical wells listed in Exhibit C. Using BLM's standard air pollution impact estimates described above, I computed air pollutant impacts of 1,458 tpy NO_x, 390 tpy CO, 131 tpy VOC, 604 tpy PM_{10}, 69 tpy $PM_{2.5}$, 26 SO_2, 2 tpy CH_4, and 159,735 tpy CO_2.

49. Exhibit D also provides an estimate of the cumulative air pollution impact if the 2014 RFD projection of 1,960 Mancos Shale Oil wells occurs of 12,015 tpy NO_x, 3,124 tpy CO, 1,078 tpy VOC, 4,978 tpy PM_{10}, 568 tpy $PM_{2.5}$, 216 SO_2, 20 tpy CH_4, and 1,316,218 tpy CO_2.

[38] Table 2-4, United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc., January 2015, Page 27.
[39] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 26.
[40] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0049, WPX Energy Production, LLC's, March 2014, Page 23.
[41] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0063, Logos Operating, LLC's, January 2014, Page 14.

IX. Incremental Flaring/Venting Impacts Not Examined

50. The 2003 RMP/EIS does not examine the noise, aesthetic, or air quality impacts of prolonged flaring or direct venting to atmosphere during well cleanup of Mancos Shale wells that are hydraulically fractured or the impacts of flaring during production operations.

51. Wells are typically flowed for a period ("flowback") after a hydraulic fracture stimulation treatment to clean-up the well. Gas from the well may be flared, vented, or green completion equipment may be used to minimize air pollution impacts. Flaring may also occur for safety or maintenance reasons during well production.

52. EPA estimates the average well vents 8,200 Mcf of natural gas during a well clean-up.[42] When nitrogen foam is used, the clean-up period can be longer and larger amounts of gas may be vented or flared to reduce the nitrogen content below the pipeline allowable impurity threshold. These impacts were not examined in the 2003 RMP/EIS.

53. The EA's prepared by the BLM Farmington Field Office for the period 2011 to April 2015 did not provide clear information on whether the wells will be flared, vented, or whether green completion units will be used for most of the wells. There air quality impact analysis was limited to a 25 day period to drill a horizontal well or a nine (9) day period to drill a vertical well. There was no incremental air pollutant estimate for emissions that would result from one to three weeks (or more) of venting or flaring during well flowback.

54. For example, for the Mancos Shale Oil EAs that I reviewed:

a. Two EAs for Encana Oil and Gas (USA) Inc. wells estimated flaring would occur for 24 hours per day during flowback, lasting 20 days because a nitrogen foam hydraulic

[42] Natural Resources Defense Council, Leaking Profits, March 2012, Page 6.

stimulation method was used.[43,44]

b. One EA for a Huntington Energy well identified the possibility of using a green completion to reduce flaring, as an option, not a commitment.[45] Otherwise, I did not find other operators proposing to use green completion equipment to reduce air impacts.

c. I didn't find any EAs that described use of mobile nitrogen rejection[46] unit for hydraulic fracture flow back treatment to reduce the lost value of flared of vented gas during flowback.

d. The remaining EAs did not specify the method used to clean-up the well or the potential environmental impacts of that choice.

55. If the 241 Mancos Shale Oil wells approved from 2011 to April, 2015, were flared or vented for 24 hours per day for 20 days each, that would equate to 4,820 days of flaring or venting (equivalent to flaring or venting a single well continuously for over 13 years).

56. The magnitude of emissions will vary by well depending on flow rate and the period of the flowback; however, these emissions can be significant. This impact was not estimated in the 2001 RFD or examined in the 2003 RMP/EIS.

57. Additionally, if number of wells anticipated in the 2014 RFD (1,600 to 1,960 wells) were flared or vented for 24 hours per day for 20 days each, that would cumulatively equate to

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[43] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0024, Encana Oil and Gas (USA) Inc, November 2013, Page 37.
[44] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0109, Encana Oil and Gas (USA) Inc., May 2014, Page 41.
[45] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0214, Huntington Energy, July 2014, Pages11-12.
[46] IACX Energy developed a mobile nitrogen rejection unit in 2010 for this purpose. See http://www.hvllc.com/news/iacx-energy-designs-and-operates-the-worlds-first-mobile-nitrogen-rejection-unit/, and http://iacx.com/nitrogen-rejection/.

32,000 to 39,200 days of flaring or venting (equivalent to flaring or venting a single well continuously for 88 to 107 years).

58. Eighty two (82) of the 241 Mancos Shale Oil wells (approximately 1/3) included a production flare; however, the other 205 EAs were silent on whether a production flare would be used or whether gas would be directly vented to atmosphere.

X. Incremental VOC and HAP Emissions During Production Operations

59. The 2001 RFD and 2003 RMP/EIS did not examine the incremental air quality impact of the 180 Mancos Shale Oil wells during production operations. For example, there was no estimate of the additional air pollution contributed from oil storage tank venting.

60. BLM's emission calculator estimates 0.12 tons of Volatile Organic Compound (VOC) and 0.012 tons of Hazardous Air Pollutants (HAPs) are vented per year for every barrel of oil produced.[47] BLM assumes each horizontal Mancos Shale Oil well is capable of producing 100 barrels of oil per day (bopd), and each vertical Mancos Shale Oil well is capable of producing 6 bopd.[48]

61. The potential emissions estimate for each horizontal Mancos Shale Oil well is 12 tons of VOC per year and 1.2 tons of HAPs. The potential emissions estimate for each vertical Mancos Shale Oil well is 0.72 tons of VOC per year and 0.072 tons of HAPs.

62. Therefore, each horizontal Mancos Shale Oil well produces 11.88 more tons of VOC and 1.13 more tons of HAPs than each vertical Mancos Shale Oil well per year. The amount of actual emissions vented to atmosphere will depend on tank size and if emission control is

[47] Table 2-4, United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc. Cluster 20, January 2015, Page 27.
[48] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0164, Logos Operating, LLC's, July 2014, Page 17.

triggered. EPA requires 95% emission control for oil storage tanks that individually emit over 6 tpy VOC. The amount of emission control achieved will depend on the number of tanks used for each well. A production facility designed with multiple tanks, each operating below the 6 tpy threshold, will emit more pollution than a facility with a single tank equipped with vapor recovery.[49,50] A number of the EA's included plans for two to four tanks per well pad. This approach could reduce the per tank emission rate below the 6 tpy threshold, providing the opportunity to avoid vapor recovery installation.

63. If emission control was not installed, the recently approved 241 Mancos Shale Oil Wells (236 horizontal and 5 vertical wells) could potentially emit, 2,836 tpy VOC and 284 tpy HAPs.

64. If the 1,960 new horizontal Mancos Shale Oil wells (estimated in the 2014 RFD) were developed, the cumulative incremental emissions of 23,520 tpy VOC and 2,352 tpy HAP are possible.

XI. Impact of Water Used to Drill and Hydraulically Fracture Mancos Shale Oil Wells

65. Neither the 2003 RMP/EIS nor 2001 RFD included estimates of the amount of water that might be used to drill and hydraulically fracture a Mancos Shale Oil well. These impacts weren't analysed, because at the time these studies were completed, horizontal wells were not commonly drilled into the Mancos Shale Oil, nor were multi-stage, large hydraulic fracture treatments used.

[49] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 26.
[50] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0049, WPX Energy Production, LLC's, March 2014, Page 23.

66. The 2014 RFD compared water use for hydraulic fracturing for vertical and horizontal Mancos Shale wells. Water used to hydraulically fracture a horizontal well ranged from five to 10 times more water than a vertical well. A hydraulic fracture in a vertical well is typically 105,000 gallons (0.33 acre-feet) for the Dakota; 150,000 gallons (0.46 acre-feet) for the Mesaverde; and 207,000 gallons (0.63 acre-feet) for the Gallup. A multi-stage hydraulic fracture in a horizontal Mancos Shale well is typically over 1,020,000 gallons (3.13 acre-feet).[51] The 2014 RFD did not provide data on the amount of water used to construct the well (drilling portion).

67. The 241 Mancos Shale Oil well EAs, approved 2011 to April 2015, contained inconsistent data on the amount of water used for drilling and hydraulically fracturing a Mancos Shale Oil well.

a. EAs for Encana's wells indicated use of nitrogen foam and reported 1,200,000 to 1,300,000 gallons[52,53] of freshwater would be required to drill and hydraulically fracture each well.

b. EAs for WPX's wells (years 2012-2014) indicated 1,000,000 gallons of freshwater was required to drill each well, with no specificity on the amount of water required to hydraulically fracture each well.

c. EA's for WPX's 2015 wells indicated 1,000,000 gallons of freshwater was required to drill and hydraulically fracture each well.

[51] 2014 RFD, Page 22.
[52] Table 2-4, United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc., January 2015, Page 31.
[53] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 25.

d. All EAs for WPX's wells were silent on whether nitrogen foam would be used to reduce freshwater use.

68. Nitrogen is typically mixed with water and other additives to form a foam liquid containing 52% to 99% nitrogen gas. The 2014 RFD Scenario states that Mancos Shale wells drilled since 2010 have been typically hydraulically fractured using a 70Q foam stimulation treatment (70% nitrogen by volume and 30% water).[54]

69. The 2014 RFD reports that on average, approximately one million gallons of water is required to hydraulically fracture a Mancos/Gallup horizontal well in the San Juan Basin and approximately 96% of those wells are hydraulically fractured using 70Q foam, with some wells achieving 30% fracturing fluid recycling.[55]

70. However, of the 241 Mancos Shale Oil well EAs that I reviewed, only Encana reported using nitrogen foam. The EA's where Encana planned to use nitrogen foam equated to 121 of the 241 wells (approximately half the wells). The EAs for the other operators did not indicate planned use of nitrogen foam, meaning more water would be required for those wells.

71. As explained above, Encana's applications to drill horizontal Mancos Shale Oil wells and hydraulically fracture those wells using a 70Q foam stimulation treatment report 1,000,000 gallons of freshwater is required to drill and drill and hydraulically fracture each well. Therefore, it appears the EA's prepared for WPX's Mancos Shale Oil wells are either under-predicting the total amount of freshwater required to drill and fracture treat each well or the WPX EA's are not reporting the intended use of nitrogen foam. This is important to understand because while

[54] 2014 RFD, Page 24.
[55] Engler, T., Overview of Hydraulic Fracturing in New Mexico, New Mexico Legislative Finance Committee meeting, July 9, 2014.

nitrogen foam will reduce freshwater requirements, the use of nitrogen foam typically requires a longer well clean-up and higher air pollution impacts.

72. Nitrogen gas has been used for many years to stimulate shale formations because nitrogen gas is inert and non-damaging to the shale, and reduces or eliminates clay swelling, clay migration, and the formation of oil/water emulsions.[56] Hydraulic fracture stimulations using nitrogen foam use less water, result in less damage to the shale formation, and improved hydrocarbon productivity.

73. The overall cost of a nitrogen foam hydraulic fracture stimulation treatment can be less than a high volume water based hydraulic fracture stimulation (especially in areas where water procurement costs are high) because less water is used in the treatment, and there is less water waste to dispose of at the end of the treatment.[57] However, in some cases nitrogen foam costs can be higher in areas where service companies don't routinely supply or store nitrogen or specialized equipment for this purpose. Liquid nitrogen must be trucked to the wellsite, is warmed using a vaporizer, and is pumped into the well. A truck engine powers the high pressure pump, and an auxiliary diesel engine typically powers a direct-fired vaporizer.[58] Injection of nitrogen foam requires more surface pump pressure than water.

74. The 2003 RMP/EIS did not examine the use of one million or more gallons of water per well to drill and conduct hydraulic fracture stimulation treatment in any type of well in the San Juan basin. Therefore, the environmental impact of using large quantities of water (one million or more gallons of water per Mancos Shale well) was not considered.

[56] Gottschling, J.C., Royce, T.N., Shuck, L.Z., Nitrogen Gas and Sand; A New Technique for Stimulation of Devonian Shale, SPE Paper No. 12313, May 1985.
[57] Ferus Wellsite Cryogenic Solutions, http://www.ferus.com/products-services/products/nitrogen-n2/.
[58] Superior Well Services, Nitrogen as a Fracturing Fluid, 2010.

75. The 2014 RFD asserts overall water use in the San Juan basin will not increase for future years over the baseline water use level since 2005; however, the 2014 RFD Scenario does not include sufficient information to make this case.

76. The 2014 RFD includes Figure 24, a "Frac Water Use" Chart that estimates the combined water use for vertical wells (in the Dakota, Mesaverde and Gallup) and water use for horizontal wells drilled into the Mancos Shale.[59] The chart assumes a drastic reduction in the number of vertical wells drilled and hydraulically fractured, relying on a trend line drawn only from 2013 data (50 acre-feet), ignoring the higher water use rate for vertical wells in prior years. Figure 24 data show the average water use for vertical wells for the period of 2005 to 2013 was 160 acre-feet, not the 50 acre-feet estimate used for future year projections for 2014 to 2016. Additionally, Figure 24 assumes 50 to 64 horizontal wells will be drilled in the Mancos Shale per year using 155 to 200 acre-feet per year. If the 160 acre-feet average for vertical wells is added to the 200 acre-feet estimate for horizontal Mancos Shale wells, the total anticipated water use could be as high as 360 acre-feet per year, more than doubling the historic water use. Even if the more recent trend of water use from 2010 to 2013 for vertical wells is used (80 acre-feet), the combined water use projected for 2014 to 2016 of 280 acre-feet, exceeds the vertical well water use by over a factor of three.

77. Using the 2014 RFD average of 200,000 gallons for hydraulically fracturing a vertical Mancos Shale well, compared to at least 1,000,000 gallons to hydraulically fracturing a horizontal Mancos Shale Oil well, I computed a conservative estimate of water use that was not considered in the 2001 RFD or 2003 RMP/EIS.

[59] 2014 RFD, Page 23.

a. If 180 vertical Mancos Shale Oil wells were hydraulically fractured using 200,000 gallons of water each, a total of 36 million gallons of freshwater would be required.

b. If 241 horizontal Mancos Shale Oil wells were hydraulically fractured using 1,000,000 gallons of water each, a total of 241 million gallons of freshwater would be required.

c. Using the 2014 RFD estimate of 1,600 to 1,960 more wells, the freshwater requirements cumulatively escalate to 1.6 to 2.0 billion gallons.

XII. Drilling Muds & Cuttings Waste Volume Impacts for Horizontal Mancos Shale Wells

78. The 2001 RFD and 2003 RMP/EIS did not examine the increase in drilling mud and drill cutting waste volume generated by drilling a horizontal Mancos Shale well versus a vertical well.

79. The total measured depth for a horizontal well (10,000' to 12,000') is more than double the measured depth of a vertical well (5,000' to 5,500'). This means the amount of drilling muds and cuttings waste generated from each well is approximately double the volume. The impact of this larger waste volume was not examined in the 2003 RMP/EIS.

80. Additionally, a number of the EAs prepared by the BLM Farmington Field Office from 2011 to April 2015 anticipate the use of oil based drilling mud[60] to drill the horizontal portion of the wellbore in the Mancos Shale wells. Water based mud would be used to drill the vertical section of the well, and the mud system would be switched to oil based mud for the horizontal wellbore section. Two mud systems results in more overall waste per well. This was not considered in the 2001 RFD or 2003 RMP/EIS.

[60] For example, see United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc., January 2015, Page 13.

81. If a spill of oil based drilling mud were to occur during on-site mixing of the drilling mud, there is the potential for an increased hydrocarbon spill risk at the well pad that was not contemplated in either the 2001 RFD Scenario or the 2003 RMP/EIS.

XIII. Mancos Shale Oil Production Facility Impacts

82. The 2001 RFD estimated 180 Mancos Shale Oil wells on BLM land. It does not appear the 2001 RFD or the 2003 RMP/EIS examined the surface facility impacts of those 180 new Mancos Shale Oil wells. There was no discussion in either document about the type of surface equipment needed to produce oil. Both documents primarily focused on gas production in the San Juan Basin. For example, Chapter 9 of the 2001 RFD discussed the incremental gas pipeline and wellhead compression facility requirements, but did not describe any incremental impacts associated with oil production.[61]

83. The 2014 RFD estimates between 1,600 to 1,960 new wells will be drilled to produce Mancos Shale Oil for an incremental well count of 1,420 to 1,780 wells.

84. The 2014 RFD now anticipates 1.5 billion barrels of oil recoverable from the Mancos Shale by drilling and hydraulically fracturing stand-alone Mancos Shale wells.[62] The 2001 RFD Scenario and 2003 RMP/EIS did not anticipate or examine impacts of potential development of 1.5 billion barrels of oil from the Mancos Shale.

85. The 2001 RFD stated 146 million barrels of oil were already produced from the Mancos Shale (which includes the Gallup Sandstone formation) and that the Mancos Shale and Gallup Sandstone were both "approaching depletion and are marginally economic."[63] The 2001 RFD explained most Mancos Shale Oil wells were producing less than one barrel per day (30

[61] 2001 RFD, Page 9.3.
[62] 2014 RFD, Executive Summary, Page 1.
[63] 2014 RFD, Page 5.24.

barrels per month). The 2001 RFD did not include a future oil production estimate for the 180 oil production from the Mancos Shale Oil wells it listed as "probable."

86. Recent Mancos Shale Environmental Assessments (EA) estimate production facilities on each well pad would include separators, aboveground condensate and produced water tanks compressors and production flares (in some cases).[64] Therefore, there would be several thousand more separators, tanks, compressors, and flares required than anticipated in the 2001 RFD and 2003 RMP/EIS, along with increased noise and air pollution impacts from this incremental equipment.

XIV. Drilling and Completion Noise Impacts for Horizontal Mancos Shale Wells

87. Drilling noise impacts for each horizontal well exceed the 2001 RFD Scenario and 2003 RMP/EIS impact estimates because each horizontal Mancos Shale well takes longer to drill, and is stimulated using a multi-stage hydraulic fracture treatments will take longer than a vertical well, and produce more noise. When nitrogen foam stimulation methods are used, flowback can last weeks longer than hydraulic fracture using water in a vertical well.

88. Drilling vertical Mancos Shale wells typically takes 8-10 days.[65] A water based hydraulic fracture may require a few days to implement and flowback.

89. Drilling a horizontal well takes longer than a vertical well, because the total length of the well is longer requiring more drilling time. Drilling a horizontal Mancos Shale well typically

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[64] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc., January 2015, Page 14.
[65] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2013-0063, Logos, December 2012, Page 10.

takes approximately two to three weeks[66] and some wells over four weeks (30 days)[67] working 24 hours per day.

90. Completing a multi-stage hydraulic fracture treatment in a horizontal well takes longer than a single hydraulic fracture treatment in a vertical well. Recent Mancos Shale EAs estimate completing a multi-staged hydraulic fracture in a directional/horizontal Mancos Shale well takes approximately one to three weeks.[68,69]

91. Equipment required to drill a Mancos Shale Oil well includes a drilling rig and associated power generation, closed-loop system and tanks for collecting cuttings and drilling mud, mud shakers, offices and sleeping facilitates, lighting systems, toilet facilities and trash collection.[70]

92. When nitrogen foam hydraulic fracture stimulation methods are used, there will be more noise associated with larger nitrogen compressors and vaporizer equipment, and a longer flaring period to clean up the well and reduce the nitrogen content to a level below the pipeline specification. Therefore, the noise impacts for the 180 Mancos Shale Oil wells included in the 2001 RFD Scenario will be substantially higher than predicted.

93. Additionally, the 2014 RFD estimates 1,420 to 1,780 wells more Mancos Shale Oil wells than the 2001 RFD, and 2,000 more stand-alone Mancos Shale Gas wells.

[66] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 15.
[67] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0029, WPX Energy Production, LLC's, November 2013, Page 9.
[68] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 15.
[69] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 9.
[70] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page.15.

94. Cumulative and incremental noise impacts on human and wildlife receptors for 3,420 to 3,780 more wells, totaling 10,000 to 26,000 weeks of drilling and completion noise was not examined in the 2001 RFD Scenario or 2003 RMP/EIS.

XV. Habitat Fragmentation and Loss

95. The 2001 RFD and 2003 RMP/EIS did not examine the incremental impact of the additional 180 Mancos Shale Oil wells on habitat fragmentation and loss."

96. Habitat fragmentation and loss can be significant when new well pads, roads, and pipelines are constructed to support Mancos Shale Oil development.

97. For example, the Encana Oil and Gas (USA) Inc. Cluster 20 EA included 10 new wells. Initial development of these 10 wells was estimated to directly impact 77.5 acres, and required vegetation removal from 62.6 acres of currently undisturbed area. BLM estimated indirect wildlife habitat loss would affect 1,276 acres around the project.[71] In this case, the area impacted by indirect wildlife habitat loss was over 16 times the area of actual physical disturbance.

98. In another example, the Encana Oil and Gas (USA) Inc. December 2013 Lybrook EA, included two new wells directly impacting 17.31 acres of currently undisturbed area. BLM estimated indirect wildlife habitat loss would affect 532 acres around the project.[72] In this case, the area impacted by indirect wildlife habitat loss was over 31 times the area of actual physical disturbance.

99. Therefore, a large area around each project that suffers from habitat fragmentation and loss was not accounted for in the 2001 RFD or 2003 RMP/EIS, and the cumulative impact of the

[71] Table 2-4, United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0272, Encana Oil and Gas (USA) Inc. Cluster 20, January 2015, Page 37.
[72] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 30.

241 recently approved Mancos Shale Oil wells was not assessed in the recently approved EAs because each well or cluster of wells in considered individually.

100. Exhibit E summarizes data from the 241 Mancos Shale Oil well EAs approved in 2011 to April 2015. The total impacted area for these wells was 1,243 acres, with 51 new road miles, and 87 miles of new pipeline. This equates to total surface impact of 5.2 acres, 0.21 road miles, and 0.36 miles of pipeline per well.

101. Using the average surface impact of 5.2 acres, 0.21 road miles, and 0.36 miles of pipeline per well, estimated above, I estimated the cumulative impact of 1,960 Mancos Shale Oil wells (estimated in the 2014 RFD). The cumulative impact would amount to over 10,000 acres, 412 new road miles, and 706 new miles of pipeline.

102. Mancos Shale EAs estimate the impact duration of these newly approved projects to be 30 to 50 years.[73,74] Therefore, habitat fragmentation and loss will have multi-decade impacts.

XVI. Traffic Impacts

103. The 2003 RMP/EIS did not contain a comprehensive assessment of truck traffic impacts; nor did it provide any specific quantitative assessment of the traffic impacts from the drilling and stimulation of 180 horizontal Mancos Shale Oil wells.

104. Traffic impacts associated with drilling and operating a Mancos Shale Oil well includes drilling rigs, large tractor-trailers, construction equipment, water trucks, drilling and production equipment and supplies, tanks, and pick-up trucks.

[73] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 19.
[74] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 9.

105. BLM's EA's for Encana Mancos Shale Oil wells estimated the following number of round trips required for drilling one well on one pad: 40 (construction), 354 (drilling), 1,240 (well completion), 489 (well testing), 180 (pipeline tie construction), and 257 (reclamation).[75,76]

106. In total, each new Mancos Shale Oil well will require over 2,300 round trips for each well. The majority of the traffic (over 1,200 of the 2,300 trips per well) is associated with multi-stage hydraulic fracture stimulation treatment. Therefore, the amount of truck traffic required for each new horizontal Mancos Shale Oil well is approximately double the amount of traffic would have occurred for a vertical well.

XVII. Potential for Surface and Groundwater Contamination

107. Groundwater contamination by hydraulic fracturing fluids is a reasonably foreseeable impact that requires mitigation. Well construction failures, engineering design flaws, human error, mechanical malfunctions, and chemical spills all are reasonably foreseeable events, and have occurred at other shale oil and shale gas operations.

108. The 2011 RFD and 2003 RMP/EIS did not examine the potential for surface and groundwater contamination from hydraulic fracturing in the Mancos Shale. Subsequent EA's prepared by the BLM have identified this issue, but decided not to analyze the risks in the EA.

[75] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0175, Encana Oil and Gas (USA) Inc., May 2014, Page 43.
[76] United States Department of the Interior, Bureau of Land Management, Environmental Assessment DOI-BLM-NM-F010-2014-0004, Encana Oil and Gas (USA) Inc., December 2013, Page 40.

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct to the best of my knowledge. 28 U.S.C. § 1746.

Executed on May 8, 2015

Eagle River, Alaska

Susan L. Harvey

The exhibits to the Declaration of Susan L. Harvey are:

Exhibit	**Description**
A	Curriculum Vitae of Susan L. Harvey
B	Mancos Shale Predicted Well Count in 2001 RFD
C	Mancos Shale Oil Well Count 2011 to April 2015
D	Potential Air Pollution Impacts of Mancos Shale Oil Development
E	Potential Surface Impacts of Mancos Shale Oil Development

Exhibit A: Harvey Declaration

HARVEY CONSULTING, LLC.

Susan Harvey has over 28 years of experience as a Petroleum and Environmental Engineer, working on oil and gas exploration and development projects. Ms. Harvey is the owner of Harvey Consulting, LLC, a consulting firm providing oil and gas, environmental, regulatory compliance advice and training to clients. Ms. Harvey held engineering and supervisory positions at both Arco and BP including Prudhoe Bay Engineering Manager and Exploration Manager. Ms. Harvey has planned, engineered, executed and managed both on and offshore exploration and production operations, and has been involved in the drilling, completion, stimulation, testing and oversight of hundreds of wells in her career. Ms. Harvey's experience also includes air and water pollution abatement design and execution, best management practices, environmental assessment of oil and gas project impacts, and oil spill prevention and response planning.

Ms. Harvey has worked on oil and gas projects in Alaska, New York, Pennsylvania, Ohio, West Virginia, Colorado, Texas, New Mexico, California, and Oklahoma, as well as in Canada, Australia, Russia, Greenland, Belize, and Norway. Ms. Harvey has authored numerous technical reports related to oil and gas project construction, operation, and abandonment, including best practices for oil and gas well construction, air and water pollution abatement design and execution, environmental assessments of oil and gas projects, and oil spill prevention and response planning. Ms. Harvey holds a Master of Science in Environmental Engineering and a Bachelor of Science in Petroleum Engineering.

Education Summary:

Environmental Engineering
Masters of Science
University of Alaska Anchorage

Petroleum Engineering
Bachelor of Science
University of Alaska Fairbanks

Consulting Services:

- Oil and gas, environmental, regulatory compliance advice and training
- Oil spill prevention and response planning
- Air pollution assessment and control

Employment Summary:

2002-Current	Harvey Consulting, LLC., Owner
2005-Current	Harvey Fishing, LLC., Co-owner
2002-2007	University of Alaska at Anchorage Environmental Engineering Graduate Level, Adjunct Professor
1999-2002	State of Alaska, Department of Environmental Conservation Environmental Supervisory Position
1996-1999	Arco Alaska Inc. Engineering and Supervisory Positions held
1989-1996	BP Exploration (Alaska), Inc. Environmental, Engineering, and Supervisory Positions held
1987-1989	Standard Oil Production Company *(purchased by BP in 1989)*, Engineering Position
1985-1986	Conoco, Production Engineer and New Mexico Institute of Mining and Technology Petroleum Research & Recovery Center, Laboratory Research Assistant

Harvey Consulting, LLC
PO Box 771026 Eagle River, Alaska 99577
Email:sharvey@mtaonline.net; Phone: (907) 694-7994; Fax: (907) 694-7995

Employment Detail:

2002-Current **Harvey Consulting, LLC.**
Owner of consulting business providing oil and gas, environmental, regulatory compliance and training to clients.

2005-Current **Harvey Fishing, LLC.**
Co-owner and operator of a commercial salmon fishing business in Prince William Sound Alaska.

2002-2007 **University of Alaska at Anchorage**
Environmental Engineering Graduate Level Program, Adjunct Professor Air Pollution Control.

1999-2002 **State of Alaska, Department of Environmental Conservation**
Environmental Supervisory Position
Industry Preparedness and Pipeline Program Manager, Alaska Department of Environmental Conservation, Division of Spill Prevention and Response. Managed 30 staff in four remote offices. Main responsibility was to ensure all regulated facilities and vessels across Alaska submitted high quality Oil Discharge Prevention and Contingency Plans to prevent and respond to oil spills. Staff included field and drill inspectors, engineers, and scientists. Managed all required compliance and enforcement actions.

1996-1999 **Arco Alaska Inc.**
Engineering and Supervisory Positions held
Prudhoe Bay Waterflood and Enhanced Oil Recovery Engineering Supervisor. Main responsibility was to set the direction for a team of engineers to design, optimize and manage the production over 120,000 barrels of oil per day from approximately 400 wells and nine drill sites, from the largest oil field in North America. Responsible for six concurrently operating drilling and workover rigs.

Prudhoe Bay Satellite Exploration Engineering Supervisor for development of six new Satellites Oil Fields. Main responsibility was to set the direction for a multidisciplinary team of Engineers, Environmental Scientists, Facility Engineers, Business Analysts, Geoscientists, Land, Tax, Legal, and Accounting. Responsible for two appraisal drilling rigs.

Lead Engineer for Arco Western Operating Area Development Coordination Team. Lead a multi-disciplinary team of engineers and geoscientists, working on the Prudhoe Bay oil field.

1989-1996 **BP Exploration (Alaska), Inc.**
Environmental, Engineering, and Supervisory Positions held
Senior Engineer Environmental & Regulatory Affairs Department. Main responsibilities included: air quality engineering, technical and permitting support for Northstar, Badami, Milne Point Facilities and Exploration Projects.

Senior Engineer/Litigation Support Manager. Duties included managing a multidisciplinary litigation staff to support the ANS Gas Royalty Litigation, Quality Bank Litigation and Tax Litigation. Main function was to coordinate, plan and organize the flow of work amongst five contract attorneys, seven in-house attorneys, two technical consultants, eight expert witnesses, four in-house consultants and twenty-two staff members.

Senior Planning Engineer. Provided technical, economic, and negotiations support on Facility, Power, Water and Communication Sharing Agreements. Responsibilities also included providing technical assistance on recycled oil issues, ballast water disposal issues, chemical treatment options, and contamination issues.

Production Planning Engineer. Coordinated State approval of the Sag Delta North Participating Area and Oil Field. Resolved technical, legal, tax, owner and facility sharing issues. Developed an LPG feasibility study for the Endicott facility.

Reservoir Engineer. Developed, analyzed and recommended options to maximize recoverable oil reserves for the Endicott Oil Field through 3D subsurface reservoir models, which predicted fluid movements and optimal well placement for the drilling program. Other duties included on-site wellbore fluid sampling and subsequent lab analysis.

Production Engineer. North Slope field engineering. Duties included design and implementation of wireline, electric line, drilling and rig completions, well stimulation, workovers and well testing programs.

1987-1989 **Standard Oil Production Company, Production Engineer**
Production Engineer. North Slope field engineering. Duties included design and implementation of wireline, electric line, drilling and rig completions, well stimulation, workovers and well testing programs.

Engineering Internship, Barry Waterflood Oklahoma City OK.

1986 **Conoco, Production Engineer**
Production Engineer. Engineering Internship, Hobbs New Mexico.

1985-1986 **New Mexico Institute of Mining and Technology**
Petroleum Research & Recovery Center
Laboratory Research Assistant, Enhanced Oil Recovery, Surfactant Research.

Exhibit B: Harvey Declaration

Mancos Shale Predicted Well Count in 2001 RFD

Table 9.1, 2001 RFD Scenario Well Count Adapted by Harvey			
Formation/Reservoir	**Predicted Subsurface Development Well Count**	**25% dual completion and commingling reduction (well count)**	**80% on Federal land (well count)**
San Jose, Nacimiento, Ojo Alamo	100	75	60
Farmington Sandstone	-	-	-
Fruitland Sand	176	132	106
Fruitland Cole	2,964	2,223	1,778
Pictured Cliffs	1,432	1,074	859
Chacra	323	242	194
Mesaverde, Lewis	4,374	3,281	2,624
Dakota, Mancos (gas)	6,846	5,135	4,108
Mancos (oil)	300	225	180
Entrada	80	60	48
Pennsylvanian	20	15	12
Total	**16,615**	**12,461**	**9,969**

Exhibit C: Harvey Declaration

Mancos Shale Oil Well Count 2011 to April 2015

BLM Environmental Assessments, Farmington Field Office, Data Compiled by Harvey

Data Compiled By Harvey from BLM Environmental Assessments 2011 to 2015					
BLM Environmental Assessment (EA) Number	Date	Company Name	Unit	Mancos Shale Oil Wells	Well Type
DOI-BLM-NM-F010-2011-0192	Apr-11	Robert L. Bayless	Oil Well Project	1	Directional
DOI-BLM-NM-F010-2012-0060	Nov-11	Encana	Meadows	1	Not specified
DOI-BLM-NM-F010-2012-0064	Jan-12	Encana	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2012-0094	Jan-12	Encana	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2012-0105	Feb-12	Encana	Bisti	1	unclear
DOI-BLM-NM-F010-2012-0182	May-12	Burlington	Huerfano	2	Horizontal
DOI-BLM-NM-F010-2012-0189	May-12	Robert L. Bayless	Horseshoe Gallup	1	Horizontal
DOI-BLM-NM-F010-2012-0198	May-12	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2012-0268	Jun-12	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2012-0391	Mar-13	Encana	Escrito	2	Horizontal
DOI-BLM-NM-F010-2012-0410	Nov-12	Encana	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2013-0002	Dec-12	Logos	Logos	1	Vertical
DOI-BLM-NM-F010-2013-0012	Apr-13	Encana	Lybrook	6	Horizontal
DOI-BLM-NM-F010-2013-0062	Dec-12	Logos	Logos	1	Vertical
DOI-BLM-NM-F010-2013-0063	Dec-12	Logos	Logos	3	Vertical
DOI-BLM-NM-F010-2013-0065	Nov-12	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2013-0080	Nov-12	WPX	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2013-0081	Dec-12	Encana	Good Times	8	Horizontal
DOI-BLM-NM-F010-2013-0095	Feb-13	Encana	Escrito		Pipeline Expansion
DOI-BLM-NM-F010-2013-0096	Jan-13	Encana	Good Times	1	Horizontal
DOI-BLM-NM-F010-2013-0103	Dec-12	Encana	Good Times	1	Horizontal
DOI-BLM-NM-F010-2013-0105	Dec-12	Encana	Escrito	4	Horizontal
DOI-BLM-NM-F010-2013-0115	Dec-12	Encana	Escrito	2	Horizontal
DOI-BLM-NM-F010-2013-0144	Jan-13	WPX	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2013-0162	Jan-13	WPX	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2013-0169	Sep-13	Encana			Pipeline Expansion
DOI-BLM-NM-F010-2013-0177	Jan-13	XTO	Martin	1	Horizontal
DOI-BLM-NM-F010-2013-0181	Jun-13	Encana	Escrito		Pipeline Expansion
DOI-BLM-NM-F010-2013-0182	Mar-13	Encana	Lybrook		Pipeline Expansion
DOI-BLM-NM-F010-2013-0219	Feb-13	Encana	Escrito	1	Horizontal
DOI-BLM-NM-F010-2013-0225	Jul-13	Encana	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2013-0242	May-13	Encana	Escrito	1	Horizontal
DOI-BLM-NM-F010-2013-0259	Nov-13	Encana	Good Times		Pipeline Expansion
DOI-BLM-NM-F010-2013-0324	May-13	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2013-0332	Jul-13	SG Interests	Chaco	1	Horizontal
DOI-BLM-NM-F010-2013-0356	Jul-13	Encana	Escrito	1	Horizontal
DOI-BLM-NM-F010-2013-0358	Jul-13	Encana	Lybrook & Gallow	3	Horizontal
DOI-BLM-NM-F010-2013-0393	Aug-13	WPX	Chaco	3	Horizontal
DOI-BLM-NM-F010-2013-0414	Aug-13	Encana	Escrito	2	Horizontal
DOI-BLM-NM-F010-2013-0473	Sep-13	Encana	Escrito	4	Horizontal
DOI-BLM-NM-F010-2013-0531	Sep-13	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2013-0535	Sep-13	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2014-0004	Dec-13	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2014-0005	Nov-13	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0008	Dec-13	Encana	Good Times	2	Horizontal
DOI-BLM-NM-F010-2014-0012	Nov-13	Hunt	Regina	1	Horizontal

Exhibit C: Harvey Declaration

Mancos Shale Oil Well Count 2011 to April 2015

BLM Environmental Assessments, Farmington Field Office, Data Compiled by Harvey

Data Compiled By Harvey from BLM Environmental Assessments 2011 to 2015					
BLM Environmental Assessment (EA) Number	**Date**	**Company Name**	**Unit**	**Mancos Shale Oil Wells**	**Well Type**
DOI-BLM-NM-F010-2014-0024	Nov-13	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2014-0029	Nov-13	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0039	Jan-14	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2014-0049	Mar-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0057	Jan-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2014-0063	Jan-14	Logos	Warner	2	Vertical
DOI-BLM-NM-F010-2014-0065	Jan-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0080	Feb-14	WPX	Chaco	6	Horizontal
DOI-BLM-NM-F010-2014-0088	Mar-14	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2014-0089	Mar-14	Encana	Lybrook	6	Horizontal
DOI-BLM-NM-F010-2014-0101	Mar-14	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2014-0102	Apr-14	Encana	Escrito	3	Horizontal
DOI-BLM-NM-F010-2014-0107	Mar-14	Encana	Lybrook	3	Horizontal
DOI-BLM-NM-F010-2014-0109	May-14	Encana	Gallo	5	Horizontal
DOI-BLM-NM-F010-2014-0114	Mar-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0117	Jul-14	WPX	Chaco	3	Horizontal
DOI-BLM-NM-F010-2014-0120	Apr-14	Encana	Lybrook	9	Horizontal
DOI-BLM-NM-F010-2014-0122	Apr-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0145	May-14	Encana	Escrito	6	Horizontal
DOI-BLM-NM-F010-2014-0148	Jun-14	Encana	Lybrook	8	Horizontal
DOI-BLM-NM-F010-2014-0158	May-14	WPX	Chaco	3	Horizontal
DOI-BLM-NM-F010-2014-0162	Jun-14	Logos	Heros	3	Horizontal
DOI-BLM-NM-F010-2014-0164	Jul-14	Logos	Heros	3	Vertical
DOI-BLM-NM-F010-2014-0175	May-14	Encana	Lybrook	6	Horizontal
DOI-BLM-NM-F010-2014-0178	May-14	Encana	Gallo	1	Horizontal
DOI-BLM-NM-F010-2014-0180	Jun-14	Logos	Aztec	2	Horizontal
DOI-BLM-NM-F010-2014-0183	Jun-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2014-0187	Jun-14	Logos	Katie	2	Horizontal
DOI-BLM-NM-F010-2014-0191	Jun-14	Encana	Escrito	4	Horizontal
DOI-BLM-NM-F010-2014-0214	Jul-14	Huntington	CLU	2	Horizontal
DOI-BLM-NM-F010-2014-0224	Jul-14	Logos	Dilectione	2	Horizontal
DOI-BLM-NM-F010-2014-0233	Jul-14	WPX	Chaco	1	Horizontal
DOI-BLM-NM-F010-2014-0246	Aug-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2014-0250	Sep-14	Encana	Lybrook	2	Horizontal
DOI-BLM-NM-F010-2014-0254	Sep-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0261	Aug-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2014-0262	Sep-14	Logos	Dilectione	2	Horizontal
DOI-BLM-NM-F010-2014-0272	Jan-15	Encana	Lybrook & Gallo	10	Horizontal
DOI-BLM-NM-F010-2014-0274	Sep-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2014-0292	Oct-14	Encana	Escrito & Good Times	6	Horizontal
DOI-BLM-NM-F010-2014-0293	Jan-15	Encana	Good Times	4	Horizontal
DOI-BLM-NM-F010-2014-0294	Oct-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2015-0007	Nov-14	WPX	Chaco	3	Horizontal
DOI-BLM-NM-F010-2015-0015	Nov-14	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2015-0028	Nov-15	WPX	Lybrook	1	Horizontal
DOI-BLM-NM-F010-2015-0036	Nov-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2015-0039	Jan-15	WPX	Chaco		Extend Pipeline Corridor
DOI-BLM-NM-F010-2015-0045	Jan-15	WPX	Chaco	2	Horizontal
DOI-BLM-NM-F010-2015-0060	Jan-14	WPX	Chaco	4	Horizontal
DOI-BLM-NM-F010-2015-0066	Feb-15	Encana	Pinon	4	Horizontal
DOI-BLM-NM-F010-2015-0070	Apr-14	Logos	Brannon	2	Horizontal
DOI-BLM-NM-F010-2015-0082	Mar-15	WPX	Chaco		Extend Pipeline Corridor
DOI-BLM-NM-F010-2015-0088	Mar-15	Encana	Escrito	1	Horizontal
DOI-BLM-NM-F010-2015-0102	Apr-15	WPX	Chaco	2	Horizontal
			Total Well Count	**241**	**Total**

Exhibit D: Harvey Declaration

Comparison of Air Pollution Impacts Estimated in 2001 RFD for Mancos Shale Oil Well Count
To Air Pollution Impacts of Mancos Shale Oil Well EAs Approved 2011 to May 1, 2015
To Cumulative Future Air Pollution Impacts of Mancos Shale Oil Wells Predicted in 2014 RFD
BLM Environmental Assessments, Farmington Field Office, Data Compiled by Harvey

Data Compiled By Harvey from BLM Environmental Assessments 2011 to 2015									
Well Type	**Well Construction (days)**	**NOx (tpy)**	**CO (tpy)**	**VOC (tpy)**	**PM10 (tpy)**	**PM2.5 (tpy)**	**SO2 (tpy)**	**CH4 (tpy)**	**CO2 (tpy)**
Horizontal Well	25	6.13	1.64	0.55	2.54	0.29	0.11	0.01	671.54
Vertical Well	9	2.30	0.63	0.20	0.92	0.12	0.05	0.003	250.24
Percentage Increase		267%	260%	275%	276%	242%	220%	333%	268%

Well Type	**Mancos Shale Oil Well Count**	**NOx (tpy)**	**CO (tpy)**	**VOC (tpy)**	**PM10 (tpy)**	**PM2.5 (tpy)**	**SO2 (tpy)**	**CH4 (tpy)**	**CO2 (tpy)**
2011-2015 EA Horizontal Mancos Shale Oil Wells	236	1,447	387	130	599	68	26	2	158,483
2011-2015 EA Vertical Mancos Shale Oil Wells	5	12	3	1	5	1	0	0	1,251
Total	241	1,458	390	131	604	69	26	2	159,735

Well Type	**Mancos Shale Oil Well Count**	**NOx (tpy)**	**CO (tpy)**	**VOC (tpy)**	**PM10 (tpy)**	**PM2.5 (tpy)**	**SO2 (tpy)**	**CH4 (tpy)**	**CO2 (tpy)**
2014 RFD (High Side Well Count) Horizontal Mancos Shale Oil Wells	1960	12,015	3,214	1,078	4,978	568	216	20	1,316,218

Exhibit E: Harvey Declaration

Surface Impacts of Mancos Shale Oil Well EAs Approved 2011 to April, 2015
Potential Cumulative Future Surface Impacts of Mancos Shale Oil Wells Predicted in 2014 RFD
BLM Environmental Assessments, Farmington Field Office, Data Compiled by Harvey

Data Compiled By Harvey from BLM Environmental Assessments 2011 to 2015								
BLM Environmental Assessment (EA) Number	Date	Company Name	Unit	Mancos Shale Oil Wells	Well Type	Total Impact Area (Acres)	Acres/Well	New Road (feet)
DOI-BLM-NM-F010-2011-0192	Apr-11	Robert L. Bayless	Oil Well Project	1	Directional	1.5	1.5	-
DOI-BLM-NM-F010-2012-0060	Nov-11	Encana	Meadows	1	Not specified	3.8	3.8	610
DOI-BLM-NM-F010-2012-0064	Jan-12	Encana	Lybrook	1	Horizontal	4.0	4.0	25
DOI-BLM-NM-F010-2012-0094	Jan-12	Encana	Lybrook	1	Horizontal	6.9	6.9	1,078
DOI-BLM-NM-F010-2012-0105	Feb-12	Encana	Bisti	1	unclear	9.0	9.0	1,633
DOI-BLM-NM-F010-2012-0182	May-12	Burlington	Huerfano	2	Horizontal	12.7	6.3	2,537
DOI-BLM-NM-F010-2012-0189	May-12	Robert L. Bayless	Horseshoe Gallup	1	Horizontal	1.9	1.9	820
DOI-BLM-NM-F010-2012-0198	May-12	Encana	Lybrook	2	Horizontal	8.5	4.2	825
DOI-BLM-NM-F010-2012-0268	Jun-12	Encana	Lybrook	2	Horizontal	9.4	4.7	5,288
DOI-BLM-NM-F010-2012-0391	Mar-13	Encana	Escrito	2	Horizontal	14.7	7.4	730
DOI-BLM-NM-F010-2012-0410	Nov-12	Encana	Lybrook	1	Horizontal	3.5	3.5	1,305
DOI-BLM-NM-F010-2013-0002	Dec-12	Logos	Logos	1	Vertical	3.2	3.2	207
DOI-BLM-NM-F010-2013-0012	Apr-13	Encana	Lybrook	6	Horizontal	45.0	7.5	61,448
DOI-BLM-NM-F010-2013-0062	Dec-12	Logos	Logos	1	Vertical	3.3	3.3	207
DOI-BLM-NM-F010-2013-0063	Dec-12	Logos	Logos	3	Vertical	10.1	3.4	522
DOI-BLM-NM-F010-2013-0065	Nov-12	Encana	Lybrook	2	Horizontal	14.7	7.4	2,905
DOI-BLM-NM-F010-2013-0080	Nov-12	WPX	Lybrook	1	Horizontal	6.7	6.7	3,984
DOI-BLM-NM-F010-2013-0081	Dec-12	Encana	Good Times	8	Horizontal	27.1	3.4	480
DOI-BLM-NM-F010-2013-0095	Feb-13	Encana	Escrito		Pipeline Expansion	5.7		
DOI-BLM-NM-F010-2013-0096	Jan-13	Encana	Good Times	1	Horizontal	5.4	5.4	1,567
DOI-BLM-NM-F010-2013-0103	Dec-12	Encana	Good Times	1	Horizontal	5.7	5.7	108
DOI-BLM-NM-F010-2013-0105	Dec-12	Encana	Escrito	4	Horizontal	23.4	5.9	9,081
DOI-BLM-NM-F010-2013-0115	Dec-12	Encana	Escrito	2	Horizontal	13.9	7.0	193
DOI-BLM-NM-F010-2013-0144	Jan-13	WPX	Lybrook	1	Horizontal	4.7	4.7	1,215
DOI-BLM-NM-F010-2013-0162	Jan-13	WPX	Lybrook	1	Horizontal	4.9	4.9	2,344
DOI-BLM-NM-F010-2013-0169	Sep-13	Encana			Pipeline Expansion	20.1		
DOI-BLM-NM-F010-2013-0177	Jan-13	XTO	Martin	1	Horizontal	2.0	2.0	-
DOI-BLM-NM-F010-2013-0181	Jun-13	Encana	Escrito		Pipeline Expansion	17.3		
DOI-BLM-NM-F010-2013-0182	Mar-13	Encana	Lybrook		Pipeline Expansion	12.2		
DOI-BLM-NM-F010-2013-0219	Feb-13	Encana	Escrito	1	Horizontal	7.9	7.9	1,673
DOI-BLM-NM-F010-2013-0225	Jul-13	Encana	Lybrook	1	Horizontal	10.4	10.4	870
DOI-BLM-NM-F010-2013-0242	May-13	Encana	Escrito	1	Horizontal	11.6	11.6	2,786
DOI-BLM-NM-F010-2013-0259	Nov-13	Encana	Good Times		Pipeline Expansion	1.4		
DOI-BLM-NM-F010-2013-0324	May-13	WPX	Chaco	1	Horizontal	5.1	5.1	275
DOI-BLM-NM-F010-2013-0332	Jul-13	SG Interests	Chaco	1	Horizontal	14.7	14.7	13,381
DOI-BLM-NM-F010-2013-0356	Jul-13	Encana	Escrito	1	Horizontal	8.8	8.8	161
DOI-BLM-NM-F010-2013-0358	Jul-13	Encana	Lybrook & Gallow	3	Horizontal	17.7	5.9	4,901
DOI-BLM-NM-F010-2013-0393	Aug-13	WPX	Chaco	3	Horizontal	14.3	4.8	808
DOI-BLM-NM-F010-2013-0414	Aug-13	Encana	Escrito	2	Horizontal	14.1	7.0	2,705
DOI-BLM-NM-F010-2013-0473	Sep-13	Encana	Escrito	4	Horizontal	23.2	5.8	1,281
DOI-BLM-NM-F010-2013-0531	Sep-13	WPX	Chaco	1	Horizontal		Pad, road and pipeline p	
DOI-BLM-NM-F010-2013-0535	Sep-13	WPX	Chaco	1	Horizontal	5.5	5.5	235
DOI-BLM-NM-F010-2014-0004	Dec-13	Encana	Lybrook	2	Horizontal	17.4	8.7	4,768
DOI-BLM-NM-F010-2014-0005	Nov-13	WPX	Chaco	2	Horizontal	10.4	5.2	737
DOI-BLM-NM-F010-2014-0008	Dec-13	Encana	Good Times	2	Horizontal	9.2	4.6	2,460
DOI-BLM-NM-F010-2014-0012	Nov-13	Hunt	Regina	1	Horizontal	9.8	9.8	3,535

Exhibit E: Harvey Declaration

Surface Impacts of Mancos Shale Oil Well EAs Approved 2011 to April, 2015
Potential Cumulative Future Surface Impacts of Mancos Shale Oil Wells Predicted in 2014 RFD
BLM Environmental Assessments, Farmington Field Office, Data Compiled by Harvey

Data Compiled By Harvey from BLM Environmental Assessments 2011 to 2015								
BLM Environmental Assessment (EA) Number	**Date**	**Company Name**	**Unit**	**Mancos Shale Oil Wells**	**Well Type**	**Total Impact Area (Acres)**	**Acres/Well**	**New Road (feet)**
DOI-BLM-NM-F010-2014-0024	Nov-13	Encana	Lybrook	2	Horizontal	16.2	8.1	4,386
DOI-BLM-NM-F010-2014-0029	Nov-13	WPX	Chaco	2	Horizontal	5.5	2.8	-
DOI-BLM-NM-F010-2014-0039	Jan-14	WPX	Chaco	1	Horizontal	6.1	6.1	1,822
DOI-BLM-NM-F010-2014-0049	Mar-14	WPX	Chaco	2	Horizontal	12.5	6.3	314
DOI-BLM-NM-F010-2014-0057	Jan-14	WPX	Chaco	4	Horizontal	12.2	3.1	1,733
DOI-BLM-NM-F010-2014-0063	Jan-14	Logos	Warner	2	Vertical	11.3	5.6	4,865
DOI-BLM-NM-F010-2014-0065	Jan-14	WPX	Chaco	2	Horizontal	19.0	9.5	2,257
DOI-BLM-NM-F010-2014-0080	Feb-14	WPX	Chaco	6	Horizontal	17.7	3.0	2,101
DOI-BLM-NM-F010-2014-0088	Mar-14	WPX	Chaco	1	Horizontal	5.5	5.5	30
DOI-BLM-NM-F010-2014-0089	Mar-14	Encana	Lybrook	6	Horizontal	21.8	3.6	662
DOI-BLM-NM-F010-2014-0101	Mar-14	WPX	Chaco	1	Horizontal	5.8	5.8	30
DOI-BLM-NM-F010-2014-0102	Apr-14	Encana	Escrito	3	Horizontal	14.5	4.8	60
DOI-BLM-NM-F010-2014-0107	Mar-14	Encana	Lybrook	3	Horizontal	34.0	11.3	8,857
DOI-BLM-NM-F010-2014-0109	May-14	Encana	Gallo	5	Horizontal	25.9	5.2	76
DOI-BLM-NM-F010-2014-0114	Mar-14	WPX	Chaco	2	Horizontal	5.4	2.7	124
DOI-BLM-NM-F010-2014-0117	Jul-14	WPX	Chaco	3	Horizontal	13.4	4.5	1,331
DOI-BLM-NM-F010-2014-0120	Apr-14	Encana	Lybrook	9	Horizontal	57.4	6.4	12,749
DOI-BLM-NM-F010-2014-0122	Apr-14	WPX	Chaco	2	Horizontal	6.1	3.1	179
DOI-BLM-NM-F010-2014-0145	May-14	Encana	Escrito	6	Horizontal	54.9	9.2	5,616
DOI-BLM-NM-F010-2014-0148	Jun-14	Encana	Lybrook	8	Horizontal	19.3	2.4	1,075
DOI-BLM-NM-F010-2014-0158	May-14	WPX	Chaco	3	Horizontal	7.5	2.5	30
DOI-BLM-NM-F010-2014-0162	Jun-14	Logos	Heros	3	Horizontal	13.5	4.5	2,398
DOI-BLM-NM-F010-2014-0164	Jul-14	Logos	Heros	3	Vertical	13.5	4.5	4,260
DOI-BLM-NM-F010-2014-0175	May-14	Encana	Lybrook	6	Horizontal	21.4	3.6	1,177
DOI-BLM-NM-F010-2014-0178	May-14	Encana	Gallo	1	Horizontal	5.7	5.7	2,190
DOI-BLM-NM-F010-2014-0180	Jun-14	Logos	Aztec	2	Horizontal	11.0	5.5	4,064
DOI-BLM-NM-F010-2014-0183	Jun-14	WPX	Chaco	4	Horizontal	10.4	2.6	12,338
DOI-BLM-NM-F010-2014-0187	Jun-14	Logos	Katie	2	Horizontal	8.7	4.3	2,027
DOI-BLM-NM-F010-2014-0191	Jun-14	Encana	Escrito	4	Horizontal	11.8	3.0	1,461
DOI-BLM-NM-F010-2014-0214	Jul-14	Huntington	CLU	2	Horizontal	14.8	7.4	1,793
DOI-BLM-NM-F010-2014-0224	Jul-14	Logos	Dilectione	2	Horizontal	6.3	3.2	473
DOI-BLM-NM-F010-2014-0233	Jul-14	WPX	Chaco	1	Horizontal	Facilities described in DOI-BLM-NM-F		
DOI-BLM-NM-F010-2014-0246	Aug-14	WPX	Chaco	4	Horizontal	6.9	1.7	550
DOI-BLM-NM-F010-2014-0250	Sep-14	Encana	Lybrook	2	Horizontal	9.7	4.8	1,553
DOI-BLM-NM-F010-2014-0254	Sep-14	WPX	Chaco	2	Horizontal	13.7	6.9	235
DOI-BLM-NM-F010-2014-0261	Aug-14	WPX	Chaco	2	Horizontal	Facilities described in DOI-BLM-NM-F		
DOI-BLM-NM-F010-2014-0262	Sep-14	Logos	Dilectione	2	Horizontal	5.1	2.5	22
DOI-BLM-NM-F010-2014-0272	Jan-15	Encana	Lybrook & Gallo	10	Horizontal	77.5	7.8	14,256
DOI-BLM-NM-F010-2014-0274	Sep-14	WPX	Chaco	4	Horizontal	5.8	1.5	1,601
DOI-BLM-NM-F010-2014-0292	Oct-14	Encana	Escrito & Good Times	6	Horizontal	24.5	4.1	1,616
DOI-BLM-NM-F010-2014-0293	Jan-15	Encana	Good Times	4	Horizontal	18.0	4.5	3,729
DOI-BLM-NM-F010-2014-0294	Oct-14	WPX	Chaco	2	Horizontal	13.0	6.5	4,029
DOI-BLM-NM-F010-2015-0007	Nov-14	WPX	Chaco	3	Horizontal		on existing pad	
DOI-BLM-NM-F010-2015-0015	Nov-14	WPX	Chaco	2	Horizontal	13.1	6.6	11,290
DOI-BLM-NM-F010-2015-0028	Nov-15	WPX	Lybrook	1	Horizontal	7.3	7.3	1,590
DOI-BLM-NM-F010-2015-0036	Nov-14	WPX	Chaco	4	Horizontal	5.7	1.4	702
DOI-BLM-NM-F010-2015-0039	Jan-15	WPX	Chaco		Extend Pipeline Corridor	9.4		
DOI-BLM-NM-F010-2015-0045	Jan-15	WPX	Chaco	2	Horizontal	8.1	4.1	2,018
DOI-BLM-NM-F010-2015-0060	Jan-14	WPX	Chaco	4	Horizontal	11.3	2.8	1,733
DOI-BLM-NM-F010-2015-0066	Feb-15	Encana	Pinon	4	Horizontal	17.1	4.3	140
DOI-BLM-NM-F010-2015-0070	Apr-14	Logos	Brannon	2	Horizontal	11.8	5.9	789
DOI-BLM-NM-F010-2015-0082	Mar-15	WPX	Chaco		Extend Pipeline Corridor	0.7		
DOI-BLM-NM-F010-2015-0088	Mar-15	Encana	Escrito	1	Horizontal	5.7	5.7	453
DOI-BLM-NM-F010-2015-0102	Apr-15	WPX	Chaco	2	Horizontal	7.4	3.7	842
			Total Well Count	**241**	**Total**	**1,243**		**267,313**
							miles	**51**