
Reclaiming Oil and Gas Wells on Federal Lands: Estimate of Costs

February 2018

Prepared for:
Center for Western Priorities

FINAL REPORT

ECONorthwest
ECONOMICS • FINANCE • PLANNING

The Washburne Building
72 W. Broadway
Suite 206
Eugene, OR 97401
541.687.0051 ext. 5431

Acknowledgments

For over 40 years ECONorthwest has helped its clients make sound decisions based on rigorous economic, planning, and financial analysis. For more information about ECONorthwest, visit www.econw.com.

ECONorthwest prepared this report for the Center for Western Priorities. ECONorthwest is responsible for the content of this report. ECONorthwest staff prepared this report based on their general knowledge of resource economics, and on information derived from government agencies, private statistical services, the reports of others, interviews of individuals, or other sources believed to be reliable. ECONorthwest has not independently verified the accuracy of all such information, and makes no representation regarding its accuracy or completeness. Any statements nonfactual in nature constitute the authors' current opinions, which may change as more information becomes available.

For more information about this report:

Kristin Lee
lee@econw.com
The Washburne Building
72 W. Broadway
Suite 206
Eugene, OR 97401
541.687.0051 ext. 5431

Introduction

A number of studies have highlighted a need for BLM to adjust its bond requirements for operators of oil and gas wells on federal lands, primarily because the original bond amounts set in the 1950s and 1960s have never been adjusted—not even for inflation. A 2010 report by the U.S. GAO identified this as an issue for BLM to address when it noted that individual lease bonds were set at \$10,000 in 1960.¹ Adjusted for inflation, the individual lease bond would be approximately \$64,000 today, but it remains unchanged at the amount set 58 years ago.² Likewise, BLM’s statewide and nationwide bond minimums were last set in 1951 at \$25,000 and \$150,000, respectively.³ Again, adjusted for inflation, statewide bond minimums would be approximately \$186,000, and nationwide bonds would be approximately \$1,114,000 in today’s dollars.

These bonds are meant to ensure the lease terms are fulfilled, including covering reclamation costs (costs to plug the well and clean up the surrounding area) in the event that the operator abandons the well. Newer wells tend to be deeper and to cost more to reclaim than older, shallower wells. Many states have bonding requirements that reflect the relationship between rising reclamation costs and increasing well depth, with higher bond amounts required for deeper wells than for shallower wells.

In this report, we describe an analysis and estimate of the potential reclamation costs for the 94,096 producible wells on federal lands as of FY 2016. Based on the methods and assumptions we outline throughout this report, we find a potential \$6.1 billion in reclamation costs for these wells. The 2010 GAO analysis of BLM bond totals as of December 2008 stated that “oil and gas operators had provided 3,879 bonds, valued at \$162 million, to ensure compliance with lease terms and conditions for 88,357 wells.”⁴ Based on our analysis and the information from GAO, it appears likely that BLM faces potential reclamation liability for wells on federal lands that exceeds the value of the bonds it holds—possibly by a considerable amount.

¹ U.S. Government Accountability Office. 2010. *Oil and Gas Bonds: Bonding Requirements and BLM Expenditures to Reclaim Orphaned Wells*, GAO-10-245. Washington, DC. <http://www.gao.gov/assets/310/300218.pdf>.

² U.S. Bureau of Economic Analysis. 2017. Personal Consumption Expenditures: Chain-type Price Index [PCECTPI]. Federal Reserve Bank of St. Louis. <https://fred.stlouisfed.org/series/PCECTPI>. Accessed July 11, 2017.

³ US GAO. 2010.

⁴ US GAO. 2010.

Background

To estimate the potential reclamation costs of federal wells, we rely on a method used in a previous, 2015 study of reclamation costs for oil and gas wells in the state of Wyoming. That analysis focused on the relationship between reclamation cost and depth of well, with deeper wells requiring higher costs to reclaim.⁵

BLM has not responded to requests for detailed information (including data on well depths) on the current population of wells on federal lands. Without the information from BLM, we use other information—some already publicly available from BLM, other information from state and other federal sources—to develop reasonable assumptions about the wells on federal lands, including the potential reclamation costs.

Given the lack of detailed data from the BLM on oil and gas wells on federal lands, we relied directly on estimates from the Wyoming analysis of reclamation costs as well as other U.S. data. We rely on Wyoming data not only because they are readily available but also because more federal wells are located in Wyoming than in any other state. As of FY 2016, 34 percent of producible well bores (or approximately 32,000 wells) across all U.S. BLM land was contained in the state of Wyoming.⁶

⁵ Joyce, S. and J. Wirfs-Brock. 2015. “The Rising Cost of Cleaning Up After Oil and Gas.” Inside Energy. October. <http://insideenergy.org/2015/10/01/the-rising-cost-of-cleaning-up-after-oil-and-gas/>. Accessed March 8, 2017.

⁶ U.S. Department of the Interior, Bureau of Land Management. Oil and Gas Statistics. *Table 9 Producible Well Bores*. Available at: <https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/oil-and-gas-statistics>. Accessed June 22, 2017.

Analysis

As of FY 2016, BLM data show a total of 94,096 producible wells present on federal lands.⁷ In this analysis, we estimate the total reclamation costs for those wells. To do so, we use a method based on the relationship between reclamation costs and the depth of the well, with deeper wells requiring higher reclamation costs. Moreover, newer wells tend to be deeper than older wells, so newer wells will generally entail higher reclamation costs. This relationship between depth and cost is reflected in the bond rates set at the state (but not the federal) level. In most states, operators of deeper wells are required to pay higher bond amounts.⁸

In this analysis we begin by estimating the ages and depths of the existing producible wells on federal lands. Our estimates are based on a) the annual history of well spudding and b) estimates of well depth, which are based in turn on the estimated age of the well. Then, we estimate well reclamation costs based on well depth by relying on methods originally developed by researchers for the previous cost analysis of Wyoming wells.⁹

1. Number and Age of Existing Producing Wells on Federal Lands

As an initial step in the analysis, we estimate the ages of the existing population of 94,096 producible wells. With estimates of the year each well was spudded, we then apply data to estimate their depths (with the newer wells being deeper wells). To estimate the ages, we rely on data (shown in Figure 1) that specifies the number of federal wells spudded each year over the last 30+ years.

Not all new wells drilled in the past are still in existence today, as wells are eventually abandoned or otherwise taken out of production and closed and reclaimed. To estimate the ages of the current population of wells, we estimate how many of the well spuds from each year have been closed. The second column of Figure 1 identifies the total number of producible wells on federal lands for each year, rising from approximately 45,000 in FY 1985 to over 94,000 in FY 2016. The third column identifies the total new spuds (or wells bored) each year.

From FY 1985 to FY 2016, there were over 75,000 new spuds. Assuming all of the spuds became producible wells, 75,000 new wells (in addition to the 45,000 wells in existence at the start of the period) would have been operating over this time. The overall number of federal wells, however, increased by only about 49,000 by FY 2016, indicating that approximately 26,000 wells were closed during the period. The available BLM data do not indicate which wells were closed. Therefore, we also take steps to account for the closure and reclamation of wells over time

⁷ US DOI, BLM. 2017. (Table 9).

⁸ Most states tie bonding rates to well depth (e.g., WY, UT, NM, MT, CO), requiring higher bonds for deeper wells. See Appendix III of U.S. Government Accountability Office. 2010. *Oil and Gas Bonds: Bonding Requirements and BLM Expenditures to Reclaim Orphaned Wells*, GAO-10-245. Washington, DC. <http://www.gao.gov/assets/310/300218.pdf>.

⁹ Joyce, S. and J. Wirfs-Brock. 2015. "The Rising Cost of Cleaning Up After Oil and Gas." *Inside Energy*. October. <http://insideenergy.org/2015/10/01/the-rising-cost-of-cleaning-up-after-oil-and-gas/>. Accessed March 8, 2017.

based on reasonable assumptions we develop. To do so, we rely on data on well reclamation trends in Wyoming, using them to approximate the national trend in well reclamation.

Over 60 percent of orphaned wells that have been reclaimed in Wyoming were spudded earlier than 1985, and an average of 1.6 percent of the reclaimed orphaned wells were spudded each year from 1985 to 2008.¹⁰ This indicates that most reclamation has targeted older (and likely shallower) wells, which also tend to be less costly to reclaim. For this analysis, we assume that the experience at the federal level is similar to that in Wyoming—with older wells representing a majority of the wells that have been reclaimed.

Figure 1. Existing Population of Producible Wells on Federal Land, by Year

Fiscal Year	Total Producible Wells	New Spuds	FY 2016 Total Producible Wells by Estimated Spud Year
Pre-1985	unknown	unknown	29,304
FY 1985	45,226	1,468	1,035
FY 1986	46,738	1,553	1,120
FY 1987	47,367	1,023	590
FY 1988	49,081	1,526	1,093
FY 1989	51,472	1,231	798
FY 1990	50,562	1,827	1,394
FY 1991	51,193	1,783	1,350
FY 1992	52,926	1,214	781
FY 1993	53,647	1,541	1,108
FY 1994	53,900	1,630	1,197
FY 1995	55,020	1,452	1,019
FY 1996	56,327	1,410	977
FY 1997	56,793	1,736	1,303
FY 1998	65,104	2,352	1,919
FY 1999	57,687	1,619	1,186
FY 2000	58,620	2,861	2,428
FY 2001	60,873	3,448	3,015
FY 2002	61,835	2,871	2,438
FY 2003	65,389	2,957	2,524
FY 2004	63,370	2,702	2,269
FY 2005	50,292	1,742	1,309
FY 2006	77,257	4,708	4,275
FY 2007	79,972	5,343	4,910
FY 2008	86,642	5,044	4,611
FY 2009	85,330	3,267	3,267
FY 2010	89,637	3,166	3,166
FY 2011	90,452	3,260	3,260
FY 2012	92,583	3,022	3,022
FY 2013	93,598	2,413	2,413
FY 2014	94,778	2,544	2,544
FY 2015	94,484	1,621	1,621
FY 2016	94,096	847	847
Total	–	75,181	94,096

Source: ECONorthwest, based on producible well data from BLM and well spud data from the WOGCC's Legacy website.

¹⁰ Joyce and Wirfs-Brock. 2015.

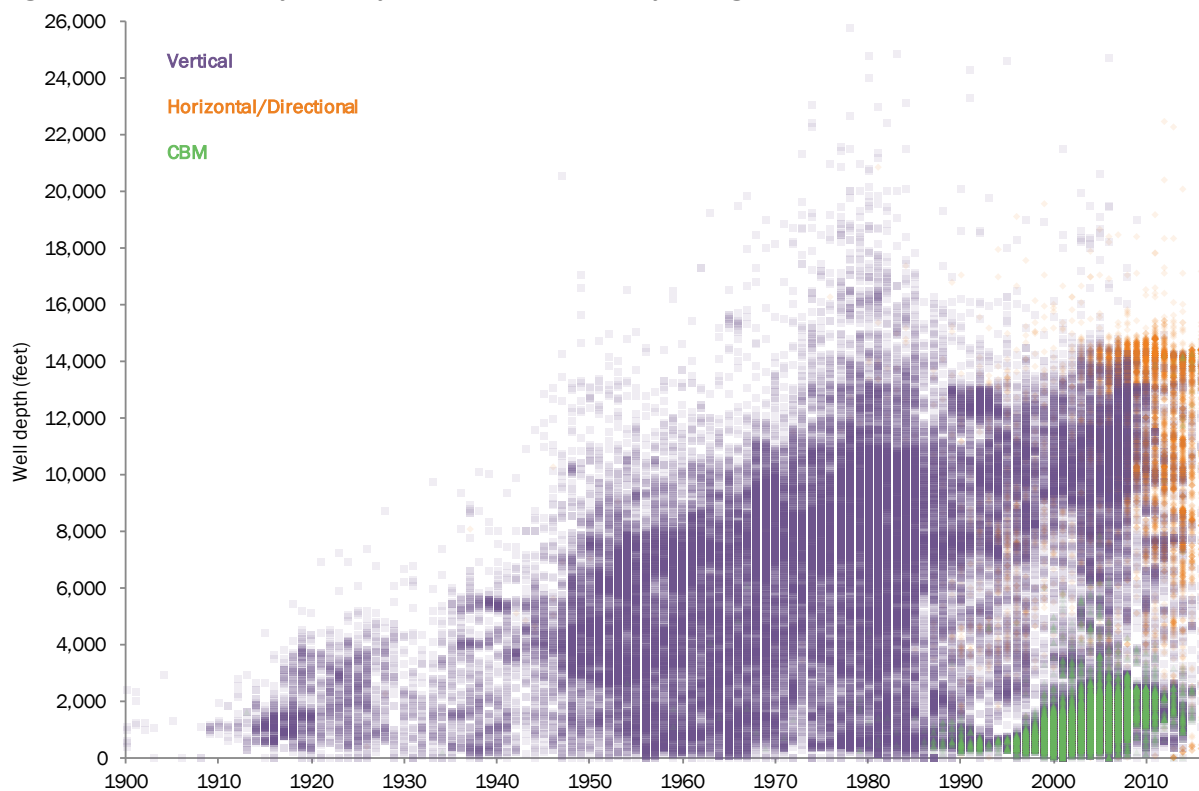
Next, we use the Wyoming data on the age of reclaimed orphaned wells to estimate the age of all federal wells that have been reclaimed between FY 1985 and FY 2016. Together with information on the number of federal wells spudded each year, we can then estimate the age of the remaining producible federal wells.

For example, using the Wyoming data we estimate that 60 percent of the federal wells that have been closed and reclaimed were spudded prior to FY 1985, and 1.6 percent of the closed and reclaimed federal wells were spudded each year from FY 1985 to FY 2008. We remove these estimates of reclaimed wells from each annual total of “new spuds.” For the pre-1985 total, we remove the estimate of pre-1985 wells reclaimed from the total wells in FY 1985. The result is an estimate of the age of the existing population of wells—that is, the number of existing wells (in FY 2016) that were drilled in 1990, 1991, 1992, and so on—shown in the last column of Figure 1.

2. Well Depth

We use the estimated age of the wells to approximate the average depth of the wells. Data from the Energy Information Association (EIA) shows the average depth of exploratory and development wells by year for the U.S. as a whole and indicates a trend toward deeper wells. We use these average well depths to represent the average depth of the current population of federal wells, by age of each well.

Figure 2. Well Depth by Well Type and Spud Year, Wyoming



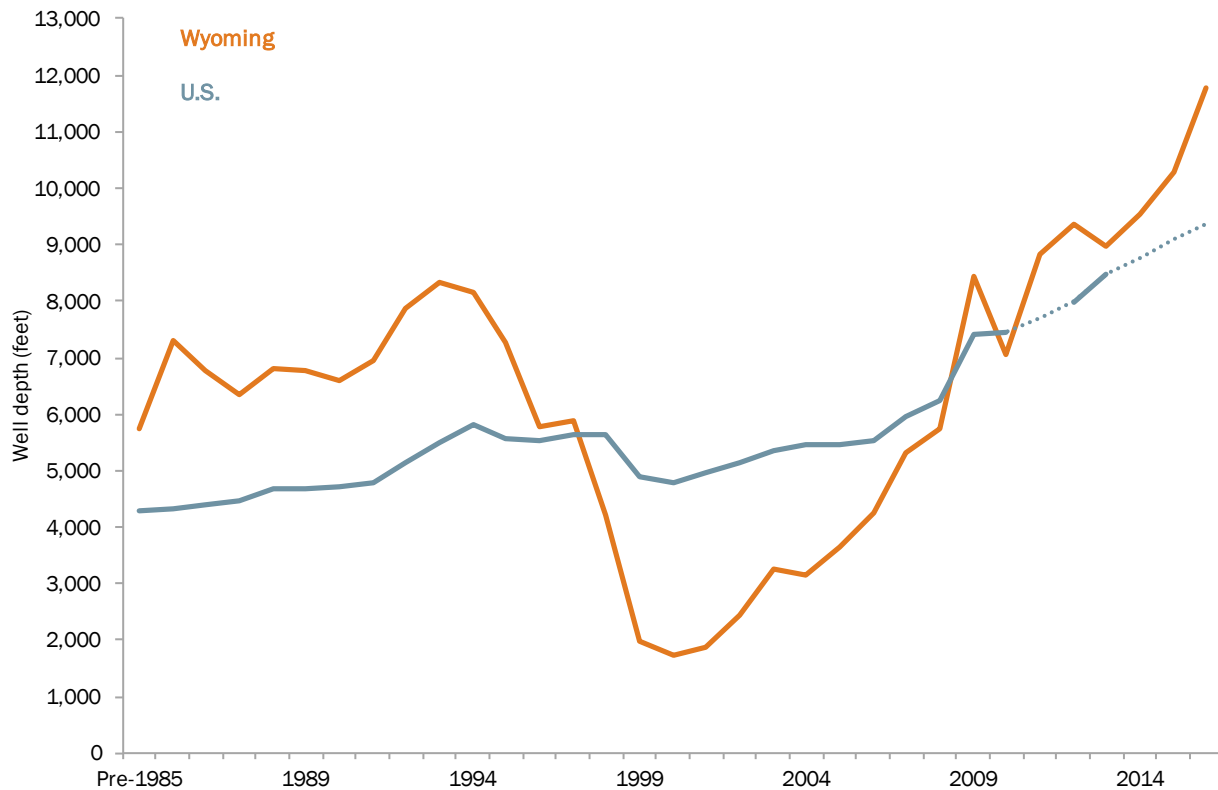
Source: ECONorthwest, based on well header data from the WOGCC's Legacy website.

More detailed data, again from Wyoming, illustrate the national trend that is evident in the broad EIA data. Figure 2 provides data from the Wyoming Oil and Gas Conservation Commission (WOGCC) on the depth of all oil and gas wells drilled in Wyoming since 1900.¹¹ It shows an overall trend toward deeper wells, with a period of heavier development of shallow coalbed methane wells shown in green. The horizontal/directional drilled wells (shown in orange) tend to be the deepest, and they represent the predominant type of well over the last five years or more.

¹¹ WOGCC. *Well Header Data 051517*. Available at: <http://wogcc.state.wy.us/urecordsMenu.cfm?Skip=%27Y%27&oops=ID21366>. Accessed May 16, 2017.

The national data indicate that the trend toward deeper wells holds true for the U.S. as a whole. Data on total well depth footage is available from the U.S. Energy Information Administration and the American Petroleum Institute.^{12, 13} Figure 3 compares average well depth in Wyoming with average well depth across the U.S. It shows that wells across the U.S. are also getting deeper over time. In this analysis, we use the average well depth for the U.S., by year, to estimate the depth of the existing producible federal wells based on their estimated age. For example, wells drilled in 1989 are, on average, 4,500 feet deep. Wells drilled in 2009 are, on average, 7,500 feet deep.

Figure 3. Average Well Depth of New Wells, by Year, Wyoming and U.S.



Source: ECONorthwest, based on WOGCC well header data as well as data from the Energy Information Agency and the American Petroleum Institute.

Note: Dotted lines represent extrapolated estimates due to data gaps.

¹² U.S. Energy Information Administration. 2012. Annual Energy Review. *Table 4.5 Crude Oil and Natural Gas Exploratory and Development Wells, 1949-2010*. September. Available at: <https://www.eia.gov/totalenergy/data/annual/showtext.php?t=ptb0405>. Accessed June 22, 2016.

¹³ Cikanek, Z. 2015. "API Survey: Efficient Wells Contribute to Rising Energy Security in the U.S." American Petroleum Institute. April. Available at: <http://www.api.org/news-policy-and-issues/news/2015/04/08/api-survey-efficient-wells-contribute-to>. Accessed June 22, 2016.

3. Reclamation Cost by Depth of Well

Although well depth is only one relevant factor affecting the reclamation cost of a well, a variety of research has identified a direct relationship between well depth and reclamation cost.^{14, 15} Reflecting that relationship, many states base required bond amounts on the depth of the well. For example, Utah's individual well bond rises from \$1,500 for a well less than 1,000 feet to at least \$60,000 for a well over 10,000 feet in depth. Wyoming requires a \$10,000 minimum bond for a well shallower than 2,000 feet and a \$20,000 minimum bond for wells deeper than 2,000 feet.¹⁶

To estimate the costs of reclaiming federal wells, we apply the method used in the 2015 study of Wyoming well reclamation costs using updated data. In the 2015 study, the analysts estimated reclamation costs using statistical analysis of reclamation costs and well depth. Specifically, the analysts used regression analysis, which is a statistical method for estimating one variable (in this case, reclamation cost) based on its relationship to one or more other variables (in this case, well depth).

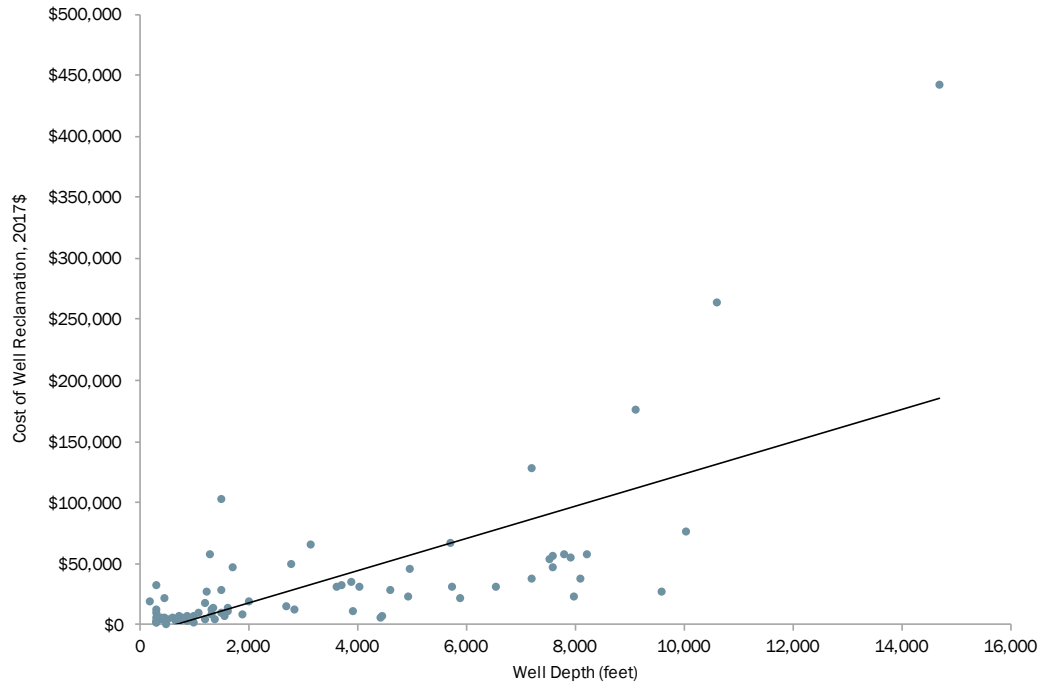
¹⁴ Joyce and Wirfs-Brock, 2015.

¹⁵ In a 2009 study in Wyoming, researchers used well depth as a factor in determining reclamation costs and found an average reclamation cost of approximately \$24,000 (in 2009 dollars) for Wyoming wells that existed circa 2009. Andersen, M., R. Coupal and B. White. 2009. Reclamation Costs and Regulation of Oil and Gas Development with Application to Wyoming. *Western Economics Forum, Spring 2009*. Laramie, WY: University of Wyoming Department of Agricultural and Applied Economics. Available at: <http://ageconsearch.umn.edu/bitstream/92846/2/0801005.pdf>. Accessed June 30, 2017.

¹⁶ US GAO. 2010.

The WOGCC collects detailed information on reclamation costs and individual wells. Figure 4 shows our updated analysis of the costs incurred to reclaim orphaned wells in Wyoming for wells of different depths. The trend line indicates that, on average, reclamation costs rise with increasing depth. For this analysis, we adjusted the reclamation costs to 2017 dollars.¹⁷ We use the results of this analysis to estimate the cost of reclaiming wells based on their depths.

Figure 4. Reclamation Cost by Well Depth, Wyoming



Source: ECONorthwest, based on Joyce and Wirfs-Brock, 2015.

Note: We removed one outlier from the dataset with an estimated reclamation cost of about \$511,000 (in 2017 dollars) for one well. Compared to Joyce and Wirfs-Brock (2015), ECO added five extra data points for well reclamation projects that took place between July 2014 and April 2015.

¹⁷ U.S. Census Bureau. 2017. North American Industry Classification System (NAICS). NAICS Code 213112 – Support Activities for Oil and Gas Operations. <https://www.bls.gov/ppi/data.htm>. Accessed June 30, 2017.

4. Estimates of Total Reclamation Costs for Producing Wells on Federal Lands

For this analysis, we rely on the methods and data used in the 2015 Wyoming study, which estimated well reclamation costs based on the depth of the wells. We updated the analysis in that study based on additional data available from the WOGCC, and we adjusted the costs to 2017 dollars. The Wyoming reclamation data are the most comprehensive we have found, and more federal wells are in Wyoming than in any other state. Therefore, we apply the results of our updated analysis of the relationship between reclamation costs and depth of wells in Wyoming to estimate the reclamation costs for all producing wells on federal lands.

Figure 5 illustrates the results of our analysis for wells of different depths. For example, a 2,000-foot deep well would cost an estimated \$17,700 to reclaim. An 8,000-foot deep well would cost an estimated \$96,700 to reclaim. The estimated average depth of the federal producing wells (based on the assumptions we outline in this report) is 5,600 feet. Based on our analysis, we find that wells of this depth have an estimated reclamation cost of \$65,000.

Figure 5. Estimated Reclamation Cost by Well Depth, Federal Land, in 2017 dollars

Well Depth (feet)	Estimated Reclamation Cost per Well
1,000	\$4,500
2,000	\$17,700
4,000	\$44,000
6,000	\$70,300
8,000	\$96,700
10,000	\$123,000

Source: ECONorthwest
Note: Values are rounded.

Figure 6 contains our estimates of the total costs to reclaim all producible wells on federal lands based on our updated results using the methods and data from the 2015 Wyoming study. In Figure 6, we divide the wells into groups based on the age of the wells. The results show that we estimate the older group of wells (spudded prior to 1997) are an average of 4,500 feet deep and would require an average of \$56,000 in estimated reclamation costs per well. The newest wells (spudded in 2013-2016) are deeper and, therefore, have higher potential reclamation costs. They are an estimated 8,800 feet deep on average and have an estimated reclamation cost of \$109,100 per well. The overall results show that the total estimated cost for the 94,096 wells is \$6.1 billion, based on an average well depth of 5,600 feet and an estimated average reclamation cost of \$65,000.

Figure 6. Estimated Reclamation Cost for Existing Producing Wells, Federal Land, in 2017 dollars

Wells by Spud Date	Number of Wells	Average Well Depth (feet)	Estimated Reclamation Cost per Well	Total Estimated Reclamation Cost
Prior to 1997	41,800	4,500	\$56,000	\$2,111,000,000
1997-2000	6,800	5,200	\$60,200	\$409,000,000
2001-2004	10,200	5,200	\$60,300	\$615,000,000
2005-2008	15,100	5,900	\$67,600	\$1,038,000,000
2009-2012	12,700	7,600	\$92,000	\$1,169,000,000
2013-2016	7,400	8,800	\$109,100	\$798,000,000
Total	94,100	5,600	\$65,200	\$6,140,000,000

Source: ECONorthwest
 Note: Values are rounded.

A number of other studies provide context for these findings:

- A 2009 study of reclamation of wells in Wyoming estimated the “current potential total outstanding reclamation costs for Wyoming as: ... \$2.61 billion.”¹⁸
- In the 2015 Wyoming study, the analysts calculated that, at approximately \$100,000 per well, Wyoming will need to pay approximately \$14.7 million to \$19 million to reclaim its newest and deepest wells.¹⁹
- In 2010 BLM estimated potential reclamation costs of \$1.7 million for 102 wells, or approximately \$17,000 per well.²⁰ Over half of the 102 wells were located in Oklahoma, where the statewide average depth for orphaned oil and gas wells is shallow (at approximately 1,250 feet) compared to the estimated average depth of the wells considered in this report (5,600 feet).²¹

¹⁸ Andersen, Coupal, and White, 2009.

¹⁹ Joyce and Wirfs-Brock, 2015.

²⁰ US GAO. 2010.

²¹ Oklahoma Corporation Commission, Oil and Gas Division. Oil and Gas Data Files. *Oil and Gas Orphaned Wells – All Districts (last updated 8-1-2017)*. Accessed August 9, 2017. <http://www.occeweb.com/og/ogdatafiles2.htm>.

- The GAO indicated that the cost BLM incurred to reclaim a set of 295 orphaned wells over the period 1988-2009 was \$3,800,000—or approximately \$13,000 per well. These wells were likely older and shallower than the average well considered in our analysis.²²
- The Pennsylvania Department of Environmental Protection estimates the cost to reclaim a 3,000-foot deep well is \$60,000, with some wells requiring costs over \$100,000.²³

²² US GAO. 2010.

²³ Mitchell, A. and E. Casman. 2011. "Economic Incentives and Regulatory Framework for Shale Gas Well Site Reclamation in Pennsylvania." *Environmental Science & Technology* 45(22):9506-9512. October.

Summary

Recent trends indicate that with each year, new oil and gas wells are drilled to greater depths, on average, than the year before. Moreover, available data on reclamation costs shows that costs rise as depth increases. This indicates that reclamation costs are rising over time. Indeed, many states tie bond amounts to well depth. In contrast, federal bond requirements for oil and gas wells were set in the 1950s and 1960s, and they do not vary according to well depth. They also have not been adjusted for inflation or for the real increase in costs due to changes in well depths and other factors.

The analysis we describe in this report is a first step in estimating the total potential reclamation costs of producible wells on federal lands. Based on methods developed first by other analysts and on a number of assumptions we make about the 94,096 producible wells on federal lands, we find a potential \$6.1 billion in reclamation costs for these wells. We reserve the right to update this analysis if additional information becomes available.

BLM has not responded to a request for information on the current bonds it holds, but a 2010 GAO analysis of BLM bond totals as of December 2008 stated that “oil and gas operators had provided 3,879 bonds, valued at \$162 million, to ensure compliance with lease terms and conditions for 88,357 wells.”²⁴ Based on our estimate, it appears likely that BLM faces potential well reclamation liability that exceeds the value of the bonds it holds—possibly by a considerable amount. Further, the disparity between federal bond requirements and reclamation costs is likely growing as average well depth increases.

²⁴ US GAO. 2010.