THE ENERGY-WATER NEXUS: WATER REGULATION IN THE WAKE OF MEXICO’S HYDROCARBON REFORM

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* J.D., University of Houston Law Center, 2017. This Comment received the Stephen T. Zamora Award for Outstanding Comment in U.S.-Mexican Relations. The author thanks her family and friends for their support and encouragement. The author also thanks Professor Jacqueline Weaver for her mentorship and guidance, as well as the tireless efforts of Kalina Dalal and the HJIL team.
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I. INTRODUCTION

Water catalyzed political change throughout Mexican history: from ancient water management in Tenochtitlan (the area known today as Mexico City), to the 1910 revolutionaries demanding access to sanitary water in the capital city, to the early years of oil exploration in the desert, water has been a guiding force for Mexican policy makers.\(^1\) Mexico has produced oil since the time of the Aztecs and Maya, who used petroleum to color fabrics and make glue.\(^2\) Given that water is a key input for petroleum drilling, water has been an important concern for Mexico in developing its petroleum reserves.

In 1868, commercial oil production began in the state of Veracruz.\(^3\) Beginning in 1938, when President Lázaro Cárdenas del Río expropriated foreign oil companies, Petróleos Mexicanos (PEMEX) conducted all petroleum exploration, exploitation, refining, and marketing in Mexico.\(^4\) Decades of dysfunction, corruption, and decreasing production and profits, combined with soaring high oil prices on the global market, however, created the ripe conditions for a politically and economically expedient Constitutional amendment.\(^5\) On December 20, 2013,

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1. See Michael Johns, THE CITY OF MEXICO IN THE AGE OF DÍAZ 43-47 (1997) (detailing the history of Mexico City’s constant flooding problems and constant struggle to provide sanitary water to its citizens).


3. Id.


Mexico amended Articles 25, 27, and 28 of its Constitution to establish new industry structures for oil, gas, and electricity. The reforms created by the Constitutional amendments, which overhauled the hydrocarbon, electricity, and financial industries, are broad and far-reaching. The changes relevant to the reforms include the following. First and foremost, the reforms maintain state ownership of subsoil hydrocarbon resources. For the first time in 75 years, however, private companies are allowed to take ownership of the resources once they are produced. Second, the reforms transformed PEMEX into a productive state enterprise with the legal, contractual, and fiscal autonomy necessary to contract with private companies for shale oil and gas exploration. Third, the four federal regulatory entities that oversee the hydrocarbons

5064469/AEM_MEXICO’S_BI-NATIONAL_ENERGY_COMMITTEE_.pdf [http://perma.cc/VCD7-5BBG]. Other reasons underlying the reform include an underdeveloped hydrocarbon infrastructure, lack of investment in research and development, high import rates of gasoline, and weak GDP growth. For an analysis of economic factors underlying Mexico’s energy reform, see ADRIAN LAJOUS, MEXICAN ENERGY REFORM 4, 10-11 (2014). These energy reforms were “aimed at reversing oil and gas production declines.” SEELKE ET AL., supra note 4.


7. According to the U.S. Department of Energy’s Energy Information Administration (EIA), the reforms will have an extraordinary impact on Mexico’s oil production. The EIA’s long-term oil production projections increased from 2.9 million barrels per day in 2013 to 3.7 million barrels per day in 2040. SEELKE ET AL., supra note 4, at 4, 10.


9. SEELKE ET AL., supra note 4, at 5; POSADAS & BUONO, supra note 8, at 5 (“[The reform] modified the legal nature of PEMEX so that the company can freely engage in public-private contractual and services agreements, including licensing contracts, production sharing contracts, utility sharing agreements, and any combination thereof.”).

10. SEELKE ET AL., supra note 4, at 4.
industry—the Ministries of Energy and Finance, the National Hydrocarbons Commission (CNH), and the Energy Regulatory Commission—were strengthened. Additionally, the government created a new entity, the National Agency for Industrial Safety and Environmental Protection (ASEA). Following the constitutional amendments, which outlined the general structure of the reform, secondary laws were enacted to fill in the gaps.

While there is an abundance of material analyzing the strength and promise offered by Mexico’s hydrocarbon reform, there is a relative dearth for the same information regarding water resources. According to water policy expert Regina Buono, Energy has long enjoyed a high degree of awareness by the public; prices are watched carefully—made easily available via newspapers, television, and prominent websites—and advances have been made in energy efficiency. In contrast, water has not benefited from the same kind of attention and lacks any real incentives—commercial or political—for conservation and efficient use.

This Comment seeks to provide an overview of the existing laws governing water consumption in the oil and gas industry and to prescribe recommendations for amending the aquatic regulatory framework in light of the recent oil and gas reforms. Specifically, how will the government regulate water sourcing for oil and gas activities? How will unconventional onshore drilling affect Mexican groundwater resources? In Section I, I will explore the history of hydrocarbon production in Mexico and the new

11. Id.
12. Id.
13. Id. at 5.
15. At the time of this writing, the Mexican Congress has not yet passed the General Law on Water, which was mandated by the amendment to Article 4 of the Mexican Constitution to address the implementation of the human right to access water in Mexican law. Constitución Política de los Estados Unidos Mexicanos [CPEUM], art. 4, DOF 05-02-1917, últimas reformas DOF 29-01-2016 (Mex.).
energy-water nexus framework created by the reformed hydrocarbon laws. In Section II, I will take a closer look at the regulatory framework governing groundwater sourcing for hydraulic fracturing fluids. In Section III, I will investigate the potential solutions for water sourcing to meet the increased demand for water used to hydraulically fracture shale formations.

II. HYDROCARBON REGULATION IN MEXICO: NEW DEVELOPMENTS

A. The PEMEX Era: 1938-2013

From 1938 until December 20, 2013, Mexico regulated petroleum production according to Article 27 of the Mexican Constitution. In 1958, Mexico created a PEMEX monopoly by promulgating the “Petroleum Law.” This law defined the regulatory framework of petroleum fields under Article 27 of the Constitution. During this time, PEMEX functioned as Mexico’s national oil company. PEMEX, along with its subsidiaries, were regarded as “decentralized public entities of the federal Mexican government entrusted by the Nation to carry out the oil

16. “Hydrocarbon law” will be used to generally describe the legal changes in Mexico after the amendments to Articles 26 and 27 of the Mexican Constitution, including the secondary laws passed in the same field.

17. Hydraulic fracturing is commonly referred to as “fracking” or “fracing.” It is an unconventional drilling technique used to extract oil and gas from tight shale oil and gas formations by fracturing the shale with high-pressure fluids pumped into the wellbore. AM. PETROLEUM INST., HYDRAULIC FRACTURING: UNLOCKING AMERICA’S NATURAL GAS RESOURCES 7-8 (2017), http://www.api.org/-/media/Files/Oil-and-Natural-Gas/Hydraulic-Fracturing-primer/Hydraulic-Fracturing-Primer.pdf [http://perma.cc/563B-8DYT].


19. Ley Reglamentaria del Artículo 27 Constitucional en el Ramo del Petróleo [LRACRP], DOF 29-11-1958, últimas reformas DOF 28-11-2008, ley abrogada 11-08-2014 (Mex.); see History of Petróleos Mexicanos, supra note 4 (providing a timeline of PEMEX’s history, specifically the enactment of the “Petroleum Law” in 1958). The “Petroleum Law” was enacted in 1959 during the administration of President Ruiz Cortines. PEMEX’s national monopoly was not fully established until President Cortines took office. López-Velarde & Vasquez, supra note 2, at 155.

20. López-Velarde & Vasquez, supra note 2, at 155.

21. Id. at 159.
and gas industry.”

B. The Constitutional Amendment Age: December 20, 2013 to Present.

On December 20, 2013 Mexico amended Articles 25, 27, and 28 of its Constitution, creating a paradigm shift in Mexico’s oil and gas industry. In addition to the broad reforms made to the oil and gas industry, these Constitutional amendments delegated authority to several government agencies to promulgate secondary laws to fill in the regulatory gaps affected by the amendments. Under Article 25, “the public sector shall be in charge, in an exclusive manner, of the strategic areas.” Under Article 28, strategic areas include activities of exploration and production of oil and other hydrocarbons, which “are considered of public interest and public order, and thus will have preference over any other activity implying the use of the surface and subsoil.” The state shall encourage and protect economic activities carried out by private parties and shall provide the conditions required so that the private sector’s development contributes to national economic development,

22. Id.

23. See Shannon Young, American Media Misses the Story on Mexican Oil Reform, TEX. OBSERVER (Feb. 10, 2014, 8:00 AM), https://www.texasobserver.org/american-media-misses-story-mexican-oil-reform/ ("The opening of Mexico’s oil and gas fields to private companies is perhaps the country’s most significant economic change since the implementation of the North American Free Trade Agreement (NAFTA) two decades ago.")


25. CPEUM, art. 25, DOF 05-02-1917, últimas reformas DOF 29-01-2016 (Mex.) (“El sector público tendrá a su cargo, de manera exclusiva, las áreas estratégicas que se señalan en el artículo 28, párrafo cuarto de la Constitución, manteniendo siempre el Gobierno Federal la propiedad y el control sobre los organismos y empresas productivas del Estado que en su caso se establezcan.”).

promoting competitiveness and implementing a national policy for industrial sustainable development that includes sectorial and regional aspects, according to the terms set forth by this Constitution.27

It is hard to overstate the significance of these amendments to the Mexican Constitution because of the opportunities for shale oil and gas production.28 These amendments to Articles 25, 27, and 28 were a watershed moment in history for oil and gas development in Mexico; not only were these changes revolutionary for the petroleum industry, but they also run deep into the heart of what Mexico means to its people. PEMEX has long been linked to “Mexicanity” and feelings towards its national identity and sovereignty.29 In contrast, PEMEX today is a state productive enterprise whose purpose is “to create economic value and increase Mexico’s income.”30 The passage of the hydrocarbon reform marked a turning point, opening Mexico’s oil industry to private and foreign investment for the first time in 75 years.31 Until these reforms, PEMEX was the

27. Decreto por el que se Reforman y Adicionan Diversas Disposiciones de la Constitución Política de los Estados Unidos Mexicanos, en Materia de Energía, DOF 20-12-2013 (Mex.), translated in Hydrocarbons Law, LUIS RAELE (Mar. 15, 2016), https://luisraele.com/category/energy/ [http://perma.cc/QGJ7-FX4V]; see CPEUM, art. 25 para. 3 (“El Estado planeará, conducirá, coordinará y orientará la actividad económica nacional, y llevará al cabo la regulación y fomento de las actividades que demande el interés general en el marco de libertades que otorga esta Constitución.”).

28. LAJOUS, supra note 5, at 4 (“Mexico’s energy reforms provide a historic opportunity to revitalize its ailing energy sector and bolster the overall economy.”); see also THOMAS TUNSTALL ET AL., ECONOMIC IMPACT AND LEGAL ANALYSIS OF THE SHALE OIL AND GAS ACTIVITIES IN MEXICO 6 (2015) (observing the importance of shale prospects in Mexico and the beneficial implications of the development of these resources).

29. Shalanda H. Baker, Mexican Energy Reform, Climate Change, and Energy Justice in Indigenous Communities, 56 NAT. RESOURCES J. 369, 371-72, 372 n. 13 (2016); SEEELKE ET AL., supra note 4 (“Upon its creation in 1938, Pemex became a symbol of national pride . . . Oil remains deeply tied to Mexican nationalism.”); see also López-Velarde & Vasquez, supra note 2, at 155 (“[The story of PEMEX] was considered a shining moment in the history of Mexico, a story that every school child in Mexico learns.”).


sole entity managing the petroleum extraction operations across Mexico. Opening the Mexican upstream industry to private investment is a complex process that has been divided into separate rounds, or stages of development. While PEMEX will continue to be a key player in the Mexican oil sector, foreign investment and international technical expertise will generate development of offshore deepwater areas and onshore unconventional development.

However, these energy reforms have been tumultuous for PEMEX. In February 2016, the CEO of PEMEX, Emilio Lozoya, resigned after PEMEX reported 12 straight quarterly losses and its worst quarterly result in its history, amounting to a $10.2 billion loss. Upon announcing Lozoya’s resignation and naming Jose Antonio Gonzalez Anaya as his successor, the President of Mexico, Enrique Peña Nieto, explained that Gonzalez, and PEMEX in general, have two main challenges moving forward: ‘‘To accelerate the transformation of PEMEX to take maximum advantages of the opportunities offered’ by the opening of the country’s oil industry to investments, as well as to ‘achieve financial and productive strengthening at a time of low oil prices.’’ There is another critical, but overlooked, challenge

of-new-law/2014/04/19/1951ba0c-e8ff-452d-84bd-d488f730991c_story.html [http://perma.cc/9NKS-HPZY].


33. LAJOUS, supra note 5, at 16.

34. Id. at 4; see CPEUM, art. 27, DOF 05-02-1917, últimas reformas DOF 29-01-2016 (Mex.) This paper will only focus on the onshore development.

35. See SEELKE ET AL., supra note 4, at 9-10, 22.


37. Williams, supra note 36.

38. Id. The Public Registry of Water Rights (Registro Público de Derechos de Agua) is in charge of national water rights registration. Registro Público de Derechos de Agua
that those seeking to develop Mexican reserves will face: where and how shale producers will obtain water resources.\textsuperscript{39}

\textbf{C. Water Permitting}

The Mexican Constitution states that the ownership of the waters within the boundaries of national territory is vested originally in the Nation.\textsuperscript{40} Accordingly, only Mexicans by birth or naturalization and Mexican companies have the right to acquire ownership of water or obtain concession for exploitation.\textsuperscript{41} The State, however, may grant the same right to foreigners under the stipulated terms of Article 27.\textsuperscript{42}

The National Water Commission, or CONAGUA, is in charge of preserving Mexico’s national waters and granting permits for the use of surface and groundwater.\textsuperscript{43} In order to obtain a surface water permit to use national waters, an applicant must submit an application, pay a fee, and obtain an Environmental Impact Statement issued by the Secretary of the Environment and Natural Resources (SEMARNAT).\textsuperscript{44} Permit approval requires “that there is availability of groundwater in the aquifer where the permit is requested in accordance with the Official Mexican Norms NOM-011-CNA-2000.”\textsuperscript{45}

\textsuperscript{39} See \textsc{Posadas \& Buono}, \textit{supra} note 8, at 7 (stating that the majority of water-consuming gas production is anticipated to occur in the drier regions of Mexico).

\textsuperscript{40} \textsc{CPEUM}, art. 27, DOF 05-02-1917, últimas reformas DOF 29-01-2016 (Mex.) (“La propiedad de las tierras y aguas comprendidas dentro de los límites del territorio nacional, corresponde originariamente a la Nación, la cual ha tenido y tiene el derecho de transmitir el dominio de ellas a los particulares constituyendo la propiedad privada.”).

\textsuperscript{41} \textsc{Tunstall et al.}, \textit{supra} note 28, at 77.

\textsuperscript{42} \textit{Id}; \textsc{CPEUM}, art. 27.

\textsuperscript{43} \textsc{Tunstall et al.}, \textit{supra} note 28, at 77.

\textsuperscript{44} \textit{Id.} at 78.

\textsuperscript{45} \textit{Id.} at 78 tbl.22. According to the Mexican National Water Act, the existence of annual surface water availability is a condition for the authorization of new concessions or assignments in a basin. The Mexican Official Standard NOM-011-CAN-2000 provides the procedure for determining availability of national waters. Silva-Hidalgo, Humberto, et al., “Metodología para la determinación de disponibilidad y déficit de agua superficial en cuencas hidrológicas: Aplicación al caso de la normativa mexicana,” Tecnología y Ciencias del Agua, vol. 4, núm 1, enero-marzo de 2013; \textit{see also} HUMBERTO
groundwater permit requires a similar process.46

D. The New Agency: National Agency for Industrial Safety and Environmental Protection (ASEA)

On August 11, 2014, the Official Daily of the Mexican Federation published the Executive Order issuing the Ley de los Órganos Reguladores Coordinados en Materia Energética (Law of the Coordinated Regulatory Entities in the Area of Energy).47 The Executive Order established the National Agency for Industrial Safety and Environmental Protection (ASEA), the new federal regulatory agency governing industrial safety and environmental protection regulations in the hydrocarbon sector.48 ASEA began operations on March 2, 2015 with the purpose of protecting “the people, the environment, and facilities of the hydrocarbons sector through the regulation and supervision of: (i) industrial safety and operational safety; (2) dismantling activities and abandonment of facilities, and (iii) wastes and polluting emissions.”49 In other words, ASEA is charged with the environmental protection of the hydrocarbons sector through comprehensive control of wastes and polluting emissions.

Surprisingly, however, ASEA’s control of wastes and polluting emissions does not include pollution to national waters.50 Instead, the National Water Commission (CONAGUA)
continues to regulate water pollution and oversee the permitting and regulation of water, as it did prior to the hydrocarbon reforms.\textsuperscript{51} So far, it is unclear how much meaningful planning has occurred in regard to regulation of energy sector water uses. CONAGUA’s 2014-2018 National Water Plan (PNH 2014-2018), acknowledges that “[w]ater is a part of every sector in Mexico.”\textsuperscript{52} “In this context, the PNH 2014-2018 is a long-term planning instrument that charts the way forward and defines the elements needed to achieve water security and sustainability in Mexico.”\textsuperscript{53}

The PNH 2014-2018 lists its fifth major objective as “ensur[ing] sustainable water availability for agricultural irrigation, energy, industry, tourism and other economic and financial activities.”\textsuperscript{54} While CONAGUA’s multi-sectoral approach is an important first step, the plan lacks any reference to the substantial water consumption that is inevitable in Mexico’s new era of shale development.\textsuperscript{55} One of two strategies

\begin{itemize}
\item \textsuperscript{51} Id. The National Water Commission regulates onshore, fresh water pollution whereas the Secretariat of Marine regulates offshore, marine waters. \textit{Id.} Secretary Carlos de Regules defended the decision to separate water from the rest of the environmental regulations stating, “The decision to have a different custodian for water resources is an appropriate decision . . . Whenever these regulations are related to war, CONAGUA will be part of this regulation.” Emily Pickrell, \textit{Bloomberg BNA Interview with Mexico’s New Energy Regulator, Carlos de Regules, BLOOMBERG BNA} (Aug. 21, 2015), http://news.bna.com/clln/display/batch_print_display.adp?searchid=29251979
\item \textsuperscript{52} FED. GOV’T OF MEX., NATIONAL WATER PLAN 2014-2018, at 15 (2014).
\item \textsuperscript{53} Id.
\item \textsuperscript{54} Id. at 73.
\item \textsuperscript{55} According to a 2014 study by Texas A&M University, hydraulic fracturing in the Eagle Ford used 620 million cubic meters (164 billion gallons) of groundwater annually. Aquifers in the region were being drawn down at a rate 2.5 times faster than their recharge rates . . . If developers used the same amount of water for fracking a comparable number of wells in northern Mexico as they do in Texas, that amounts to nearly one-third of the 1.96 billion cubic meters (517 trillion gallons) of water currently used each year for all purposes in Coahuila, according to CONAGUA.
\end{itemize}

presented to achieve this fifth objective is “[t]o use water sustainably to promote development in areas with water availability.”\textsuperscript{56} Since hydrocarbon extraction is limited by a location’s geologic potential, and the most productive formations underlie some of Mexico’s most arid and water-stressed areas, it is unclear how promoting development in areas with water availability is possible in relation to the hydrocarbon sector.\textsuperscript{57}

So far, most critics of the reforms have focused on the potential for failure in the implementation of the reforms rather than the drafting of the Constitutional amendments and secondary laws themselves. For example, separation of water regulation from general environmental protection in the hydrocarbons sector may cause coordination problems between water and environmental regulatory bodies.\textsuperscript{58}\textsuperscript{59} According to Miriam Grunstein, a professor and researcher at Universidad Autónoma de Nuevo León in Mexico, the Constitutional reforms require careful regulatory coordination.\textsuperscript{59} She warns against potential conflicts of interest that the reforms may create for the SEMARNAT, who is both the head of the CRE (the regulator) and the president of the board of directors of PEMEX (one of the largest companies being regulated).\textsuperscript{60}

Similarly, according to environmental consultant Ricardo Montijo, Mexico’s energy reforms “feature a strong environmental commitment [including] [c]ompliance commitments feat[uring] regulatory oversight funding for enforcement personnel and penalties for non-compliance.”\textsuperscript{61} Whether the regulators properly implement the regulations, however, remains a concern for both academics and investors.

\textsuperscript{56} FED. GOV’T OF MEX., \textit{supra} note 52, at 73.
\textsuperscript{57} POSADAS & BUONO, \textit{supra} note 8, at 7.
\textsuperscript{58} See \textit{id.} at 4 (pointing out that in promulgating energy laws, lawmakers prioritize energy development; however, the Constitution imposes a fundamental requirement to provide water to all people).
\textsuperscript{60} \textit{Id.} at 12.
\textsuperscript{61} Ricardo Montijo, \textit{Mexico’s New Energy Landscape: Opportunities and Environmental Compliance}, 15 WIRE, no. 1, 2015, at 12, 13.
alike. One way the national legal framework may fail is that it does not address the local arrangements that govern the allocation of water to each water region. According to Luis Serra, the Chief Executive of the Energy Initiative at the Instituto Tecnológico de Estudios Superiores de Monterrey, while Mexico’s existing environmental laws are sufficient, the proper implementation of these laws will pose a more significant struggle.

III. GROUNDWATER SOURCING

A. Shale Development by the Numbers

Shale development will be one of the primary areas of new development in the next ten years. The U.S. Energy Information Administration estimates that Mexico’s shale resources, with 545 trillion cubic feet of shale gas, ranks sixth largest among global reserves. Mexico’s marine-deposited, source-rock shale is distributed onshore along its eastern coast, flanking the Gulf of Mexico. The Burgos, Sabinas, Tampico, Tuxpan, and Veracruz shale gas reservoirs provide significant potential for Mexico’s onshore shale development.


63. Serra, supra note 62, at 21-22.

64. SeeElke et al., supra note 4, at 12.


66. U.S. ENERGY INFO. ADMIN., TECHNICALLY RECOVERABLE SHALE OIL AND SHALE GAS RESOURCES: MEXICO, at II-1 tbl.II-1 (2015) [hereinafter SHALE ASSESSMENT MEXICO]. Figure 1 shows the geographic locations of Mexico’s most productive basins for shale oil and gas.

67. Id. at II-7.
The Burgos Basin, which contains an estimated 343 tcf and 6.3 billion barrels of risked, technically recoverable shale gas and shale oil resource potential, offers the most potential. The Burgos Basin is also the best-documented area for development. Conveniently for foreign operators, the Burgos Basin is a southern extension of the well-developed Eagle Ford Shale in southern Texas.

68. Id. at II-2.
69. Id.
70. Id. at II-9.
Figure 1. Eastern Mexico’s Onshore Shale Oil & Shale Gas Resources

Production expectations are ambitious. By the numbers, as of 2014, PEMEX anticipated drilling up to 155 exploratory shale wells in the Burgos and Tampico Basins (75 and 80 shale wells, respectively) by the end of 2015. Former PEMEX CEO, Adrian Lajous, argued, however, that the government’s production

71. Id. at II-1 fig.II-1.
target of 3.0 million barrels per day (bpd) by 2018 is ambitious and unlikely to be achieved.\textsuperscript{73}

Meeting these goals is unlikely, due to the amount of foundational work that the government needs to set before significant development can occur. First, the government must establish regulatory and environmental protection measures.\textsuperscript{74} Second, it must address water management issues that arise along with shale development.\textsuperscript{75} Third, it must expand the limited existing infrastructure, including pipelines and roads.\textsuperscript{76} Fourth, it must grapple with the high cost of production relative to the current low price of oil.\textsuperscript{77} Additionally, “Mexico’s potential development of its shale gas and shale oil resources could be constrained by several [other] factors, including potential limits on upstream investment, the nascent capabilities of the local shale service sector, and public security concerns in many shale areas.”\textsuperscript{78} Further, PEMEX’s initial shale exploration wells are very expensive ($20-25 million per well) and yield only modest initial gas flow rates (approximately 3 million ft\(^3\)/day per well, with a steep decline).\textsuperscript{79} Therefore, the targeted development of onshore resources is ambitious, but likely will encounter delays.

\textbf{B. Water Availability in Mexico}

According to a collaborative coverage by the Wilson Center’s Mexico Institute and Circle of Blue, a nonprofit organization,

\begin{itemize}
\item \textsuperscript{73} See \textit{Lajous}, \textit{supra} note 5, at 11 (“A detailed . . . analysis of the 25 largest fields . . . does not identify sufficient incremental net production gains that would allow PEMEX to reach this target and recent presentations to investors do not identify which specific fields will add volumes.”).
\item \textsuperscript{74} \textit{Seelke et al.}, \textit{supra} note 4, at 12.
\item \textsuperscript{75} Id.
\item \textsuperscript{76} Id.
\item \textsuperscript{77} Id.
\item \textsuperscript{78} \textit{Shale Assessment Mexico}, \textit{supra} note 66, at II-2.
\item \textsuperscript{79} Id.
\end{itemize}
“[n]ot nearly enough... planning for energy development has included the industry’s demand for water.”\(^{80}\) In an effort to fast-track shale production, water sourcing often seems to take a back seat.\(^{81}\) Even if the best regulations are implemented, Mexico will still face significant water problems in the regions with the most hydrocarbon production potential because the Burgos and Sabinas shale plays are located in areas with extremely high water stress.\(^{82}\)

For example, the Mexican state of Coahuila overlies part of the shale-rich Burgos Basin. It is also one of the driest regions in the Americas.\(^{83}\) Even without the confounding effects of massive water withdrawals from the state’s aquifers, which are necessary to hydraulically fracture shale gas and oil wells, Coahuila faces a water deficit.\(^{84}\) In 2012, Mexico suffered a severe drought.\(^{85}\) The northern states, which offer the largest potential reserves, experienced the worst drought and is the region with the lowest average water reserves.\(^{86}\) In these areas, access to fresh water is already limited due to the amount of fresh water needed to irrigate crops, like grain and alfalfa, and care for livestock.\(^{87}\) In 2013, the United Nations Food and Agriculture Organization identified water scarcity as the “most

\(^{80}\) Schneider, supra note 55. According to a study by the University of Texas in 2011, “water demand for fracking in the most heavily drilled [Texas] Eagle Ford region amounts to 30 to 50 percent of all water in those counties.” Id.

\(^{81}\) Posadas & Buono, supra note 8, at 7.

\(^{82}\) Id. at 6; Paul Reig et al., Global Shale Gas Development: Water Availability and Business Risks fig.ES2 (2014), https://www.wri.org/sites/default/files/wri14_report_shalegas.pdf [http://perma.cc/5NK5-U46R].


\(^{84}\) See Schneider, supra note 55 (stating that the use of water to irrigate crops and care for livestock has resulted in water deficits for the certain Coahuila cities).


\(^{86}\) Id.

\(^{87}\) See Schneider, supra note 55 (providing a general discussion of many of the problems local farmers currently face as a result of the fresh water competition).
pressing problems related to water management in Mexico.”

Figure 2. Water Stress and Use in Coahuila

C. What Is at Stake?

According to a recent survey of experts in government, industry, academia, and nongovernmental organizations


(NGOs), out of the possible 264 potential risks caused by shale development, 12 risks were selected by all of the expert groups. Of these risks, nine of them involve potential risks to surface and/or groundwater quality. The consensus among experts regarding the significant threat fracking poses on water quality is significant, as it demonstrates that water sources are a critical resource that must be thoroughly and carefully regulated in order to preserve sources despite the competing uses of industry, society, and the environment alike.

D. The Changing Landscape of Water Regulation

Water-conscious changes to government regulatory measures are necessary to implement Mexican energy reform in light of its water scarcity. In response to concerns about the impact of hydraulic fracturing for shale oil and gas, the Mexican government has shown interest in ensuring that its petroleum resources are developed in an environmentally responsible way. According to Carlos de Regules, the executive director of ASEA, the goal of the new ASEA is to guarantee safety and environmental protections while also offering legal certainty to the oil and gas industry. This regulatory structure, according to Regina Buono, is reasonable, but treacherous. “Though interdependent, water and energy are managed via different institutional frameworks, policymaking processes, and governance structures, which can complicate communication and cooperation between the sectors.” To some extent, the government considers water supply a piece of the energy development puzzle. Last year, CONAGUA declared that no new permits for water withdrawals in Coahuila’s twenty-eight

91. Id. Seven risks involved surface water quality (lakes, rivers, and streams) and two involved groundwater quality (underground aquifers).
92. SEEELKE ET AL., supra note 4, at 17.
93. Pickrell, supra note 51.
95. Schneider, supra note 55.
existing aquifers would be available for developers of shale oil and gas wells.\textsuperscript{96} Similarly, surface waters from the Rio Grande River are not available for fracking purposes because its flows are already over-allocated.\textsuperscript{97}

Due to CONAGUA’s restrictions on water used for fracking, shale developers must rely on alternate sources of water supplies in order to develop their investments. In May 2014, while presenting PNH 2014-2018, CONAGUA General Director David Korenfeld said CONAGUA has been developing rules for water use in hydraulic fracturing during shale oil and gas extraction since the reforms in 2013.\textsuperscript{98} According to Korenfeld, “[n]ot one liter of water will be taken away from a city, not one liter will be taken away from the production of food. Fracking will be considered an industrial use and regulated under the industrial water use rules.”\textsuperscript{99} Notwithstanding, treated water and salt water could be used for fracking.\textsuperscript{100} Korenfeld added that CONAGUA will be responsible for monitoring the amount of water used in fracking operations, approving permits for well drilling, and ensuring that works do not interfere with potable groundwater sources, and dismissed concerns about water availability, saying that operation would require only a small percentage of supplies.\textsuperscript{101} He stated, “I want to be very clear: CONAGUA is concerned with the use of water in a comprehensive way. For us, fracking means another use, and we are going to see it in that way, as we have been doing for industry, trade, cities, and human consumption.”\textsuperscript{102} In general, fracking is not permitted to displace the needs for other purposes, including human consumption.\textsuperscript{103}

\textsuperscript{96} Id.
\textsuperscript{97} Id.
\textsuperscript{100} Id.
\textsuperscript{101} Id.
\textsuperscript{102} Conagua Creating Rules to Regulate Water Use in Fracking, supra note 98.
\textsuperscript{103} Id.
The need for strong regulators to oversee the hydrocarbons sector is essential for the success of the energy reform. However, regulatory agencies still face significant obstacles, including budget austerity, transparency, coordination, and—most prominently—water scarcity. ASEA, for example, has a relatively small budget and workforce compared to its broad responsibilities to monitor and enforce environmental laws in the energy sector. Therefore, to ensure success, the Mexican government should provide sufficient resources to support monitoring and enforcement actions and should offer competitive wages to discourage corruption.

E. Managing Water Scarcity with Government Management Plans

Water scarcity in the regions with the most potential for shale production may stymie or delay investment. Existing agricultural and industrial uses of water have already placed significant stresses on the limited water resources in the northeast Mexican deserts. Shale plays in the region will confound the existing scarcity because each unconventional well requires 4 to 5 million gallons of fresh water to drill and fracture.

On March 4, 2015, the Mexican Environmental Ministry announced its first recommendations for protecting water in light of the anticipated increase in hydraulic fracturing techniques, which were the first of their kind in Mexico.

104. See Seelke et al., supra note 4, at 12, 21-22.
105. Posadas & Buono, supra note 8, at 21.
106. Id.
107. See Schneider, supra note 55 (arguing that because Conagua will not issue permits for the use of groundwater, fracturing water requirements “can only be met by uncertain and expensive supplies,” resulting in large expenses for energy companies wishing to tap into Coahuila’s “potential treasure chest”).
108. Id.
110. Emily Pickrell, Mexico Begins Foray into Fracking Rules with Focus on Guidelines to Protect Water, BLOOMBERG BNA (Mar. 16, 2015), https://www.bna.com/
SEMARNAT recommended that 90 percent of the water used in hydraulic fracturing come from recycled water and that monitoring be adopted to ensure that nearby aquifers are not contaminated.\textsuperscript{111} Although these recommendations are novel, they are not without their problems. The immediate problem is that the recommendations are not binding.\textsuperscript{112} More broadly, the PNH 2014-2018 does not take into account the longstanding local arrangements that largely govern water allocation.\textsuperscript{113} Furthermore, although the Mexican Ministry of Energy (SENER) requires parties wishing to develop hydrocarbons to provide SENER with a social impact evaluation in order to obtain permits and the authorization necessary to begin the project, it is not enough to protect the rural communities and farmers who rely on the limited water resources.\textsuperscript{114} For now, energy development plans lack sufficient planning for the increased industrial demand for water.\textsuperscript{115}

IV. Potential Solutions

CONAGUA says “not a drop of potable water for a single city” will be used for fracking.\textsuperscript{116} Simply put, water must come

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\textsuperscript{112} Pickrell, supra note 110.

\textsuperscript{113} See id. (observing that there have been no mentions of indigenous communities when discussing regulations that provide human rights protections).

\textsuperscript{114} See Gabriel Peña Mouret, An Overview of the Impacts of Electricity, Oil, and Gas Reform in Mexico, in CORPORATE LAW CLIENT STRATEGIES IN LATIN AMERICA *7 (2015), Westlaw 1264575 (stating that the social impact evaluation must include the identification, characterization, prediction, and valuation of the social impacts that could arise from their activities, as well as their respective mitigating measures); see also Emilio Godoy, Mexican Government Ignores Social Impact of Energy Projects, INTER PRESS SERV. NEWS AGENCY (Dec. 23, 2015), http://www.ipsnews.net/2015/12/mexican-government-ignores-social-impact-of-energy-projects/ [http://perma.cc/5SWF-M5L3] (discussing that although social impact assessments are required to be presented to the energy minister, the energy ministry is assigning contracts without the assessments being completed, defeating the purpose of the requirement).

\textsuperscript{115} See Schneider, supra note 55 (“Not nearly enough of Coahuila’s planning for energy development has included the industry’s demand for water.”).

\textsuperscript{116} Conagua Creating Rules to Regulate Water Use in Fracking, supra note 98.
from another source and developers must turn to alternate sources. Producers still have several options to develop the newly available resources, but the certainty and cost of the alternatives remain looming questions for investors. Some potential solutions are addressed below.

A. Purchase Permits from Existing Users

According to Carlos Gutiérrez-Ojeda, head of the groundwater division of the Mexican Institute of Water Technology, the first and easiest option is for energy developers, “to buy existing groundwater use permits from farmers, industry, or other users.” Although this is the easiest option, it poses a significant threat to the social stability of areas where water will be reallocated to fracking uses. Alejandro Posadas and Regina Buono warn against inciting social conflict by allocating water in water-scarce areas for use in oil and production: “[T]he Mexican government would do well to consider the potential impact of allocating large volumes of water for hydraulic fracturing operations and design and implement laws and policies that will help to lessen tensions between stakeholders and avert conflict.”Given that there is a significant potential for social unrest when private parties transfer or government entities grant water permits to oil and gas operators, purchasing permits from existing users may present an easy but treacherous option. Therefore, this option should be considered alongside the other potential sources of water for petroleum development.

B. Discover and Tap New Aquifers

Deep groundwater sources that are currently unknown and untapped may exist. The Mexican government could fund research to characterize and measure brackish water

117. Schneider, supra note 55.

118. See id. (arguing that the water deficit suffered in Mexico’s potentially most productive regions, including Coahuila, combined with the “momentous and era-changing” changes brought by the hydrocarbon reforms, will lead to a confrontation between water users).

119. POSADAS & BUONO, supra note 8, at 20.
resources. As fracking technologies develop, operators are able to utilize water with higher salt content while maintaining well productivity. Utilizing brackish water is a potential source for industrial users since national water authorities are more likely to issue permits to tap brackish groundwater supplies that are not currently used by cities, farms, or industries. On the other hand, accessibility and quality of brackish water resources may make transportation and treatment uneconomic for operators. Nevertheless, Mexico should implement cautious regulations to prevent environmental damage caused by brine mining and disposal.

C. Recycle and Treat Wastewater

Another option for developers working in water-stressed areas is to recycle and treat wastewater. Oil and gas producers can recycle water used in the drilling, fracking, and production processes to reduce the total amount of water used to extract hydrocarbons. Recycling water has the dual benefit of reducing the need to acquire new water for operations as well as decreasing the amount of contaminated water that is disposed of in injection wells. Although the cost of recycling continues to fall as technology advances, the Mexican government should promote the increased reliance on recycling to minimize industrial uses of water. Regulations in Texas to boost conservation, recycling, and reuse of liquid and solid water produced by nonconventional drilling operations have been successful. Mexico should model any regulations on recycling provisions of Chapter 122 of the Texas Natural Resources Code, which encourages operators to explore innovative solutions to

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120. Id. at 23.
121. Id.
122. Schneider, supra note 55.
123. POSADAS & BUONO, supra note 8, at 23.
124. Id.
125. Id. at 22-23.
126. Id. at 22.
127. See id. at 22-23 (observing a high level of recycled water in daily production following the increase in recycling efforts by companies participating in the 2014 Texas Railroad Commission symposium).
water sourcing limitations while also providing clear environmental standards and defined waste ownership guidelines.\textsuperscript{128}

Wastewater from municipal and industrial treatment plants can also be treated to decrease the amount of water necessary to develop Mexico’s shale plays.\textsuperscript{129} Although this option relies on a known source of water, it has significant drawbacks that may outweigh its potential benefit. First, the total amount available from current treatment plants is at least 80 percent less than what the energy industry will require.\textsuperscript{130} Additionally, diverting the water to fracking jobs will consume water that is currently temporarily withdrawn, used, treated, and then discharged into streams and rivers.\textsuperscript{131} Withdrawing the water without returning it will lead to increased consumption; therefore, this type of diversion could negatively affect the already water-stressed areas by reducing flows to streams.\textsuperscript{132} This consumption could harm aquatic ecosystems and downstream users more than temporary withdrawal of the current water system.\textsuperscript{133} Advances in technology are lowering the cost and energy used to recycle water, which makes this option more appealing to investors.\textsuperscript{134}

D. Use Water from the Gulf of Mexico

Another solution to the water scarcity problem is to pump water from the Gulf of Mexico and use new pipelines to transport it hundreds of kilometers to areas where drilling

\begin{footnotes}
\item[128] See \textsc{Tex. Nat. Res. Code Ann.} §§ 122.002-003 (West 2013) (governing oil and gas waste transfers to parties that will treat the waste and make it available for subsequent beneficial use).
\item[129] Schneider, \textit{supra} note 55.
\item[130] \textit{Id.}
\item[131] \textit{Id.}
\item[132] \textit{Id.}
\item[133] Until three decades ago, longstanding farming communities in Coahuila were set “amid a thriving oasis where vineyards and orchards of peaches, pomegranates, and walnuts were irrigated with water drawn from clear, spring-fed streams and pools.” Now, those oases and surface water sources, in general, are drying it due to a lack of sustainable water management. \textit{Id.}
\item[134] \textsc{Posadas & Buono}, \textit{supra} note 8, at 22.
\end{footnotes}
is occurring. 135 This solution would require seawater to be desalinated before using it, along with the construction of a treatment plant near the Gulf of Mexico or at the terminus of the pipeline near the drilling zones. 136 In general, water researcher Regina Buono argues, “[t]echnological solutions such as desalination or better water treatment can make important inroads on [problems caused by increases in energy consumption and water demand], but these options tend to make the acquisition of usable water more expensive and more energy intensive.” 137

The nexus between water and energy underlies the cost-benefit analysis for each of these potential solutions. The quantity, quality, location, cost, and competing uses of water resources make it difficult, but not impossible, to strike the right balance within the energy-water nexus. With respect to piping water from the Gulf of Mexico, water quantity is abundant, but the quality, distance, and energy-intensive treatment processes make the solution less viable under current conditions.

V. CONCLUSION

This is an exciting and important time for Mexico’s political and economic landscape. Since the December 2013 Constitutional amendments, Mexico has dramatically overhauled its hydrocarbon industry and regulatory framework to transform PEMEX from an underperforming monopolistic government entity into a competitive state enterprise that must compete alongside foreign companies who invest in Mexico’s significant shale oil and gas reserves. 138 According to the Congressional Research Service, “[t]he recently enacted energy reforms have the potential to boost energy production and

135. Schneider, supra note 55.
136. Id.
138. MEXICO ENERGY REFORM: EXECUTIVE SUMMARY, supra note 6, at 6; López-Velarde & Vasquez, supra note 2, at 177-78; Melissa Raciti-Knapp et al., What You Need to Know About Mexico’s Energy Reform, LEXOLOGY (Sept. 30, 2014), http://www.lexology.com/library/detail.aspx?g=f0ec7cba-a5f2-43a4-8e21-48e19557dbb9 [http://perma.cc/L9WG-EKBZ]; Young, supra note 23.
improve economic competitiveness in Mexico, but implementing them in a meaningful way may prove difficult.”

Many questions remain regarding exactly how the Mexican government will regulate surface and groundwater resources. Simply drafting and enacting water regulations will not end the uncertainty because questions also remain about coordination among the various regulatory entities, primarily ASEA and CONAGUA. Further, it is unclear how the national government, which controls the national water resources, will work with the local governments that control access to those water resources. Most importantly, who is going to lose? Given that groundwater is a finite resource, someone or something will have to give up its usage in order to transfer the right to industrial consumers. It is critical that the Mexican federal, state, and local governments create a workable solution that is amenable to all stakeholders, including but not limited to, energy developers, communities, and the environment. With access to water as a human right guaranteed by the Constitution, together with the mandate to enact a new General Law on Water and new regulations governing petroleum extraction activities, Mexico has a remarkable opportunity to transition from a water administration model based on engineering as a tool to a model that is aimed toward long-term accessibility policies based on sustainability. Until secondary laws are fully developed and the new shale development has time to mature, we will not know what the future holds for water resources.

Fortunately, there are some things that are certain. First, water will continue to influence political decision-making, just as it has throughout Mexico’s history. Second, unconventional onshore drilling will further stress the already scarce

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139. Seelke et al., supra note 4, at 22.
140. Posadas & Buono, supra note 8, at 11.
141. CPEUM, art. 4, DOF 05-02-1917, últimas reformas DOF 29-01-2016 (Mex.).
143. See López-Velarde & Vasquez, supra note 2, at 176-77 (discussing the large amount of water required for fracturing and how Mexico will need to establish “sensible” environmental regulations while still incentivizing development in order to enter the industry).
groundwater resources in northeastern Mexico. And finally, where there is money to be made and hydrocarbons to produce, oil companies will find a way to extract the resources.144

144. American energy companies have already invested more than $80 billion since 2008 in the Eagle Ford, which is across the border from the Burgos basin. Goldman Sachs estimated in 2014 that developing Mexico’s shale oil and gas reserves will require an estimate $1.02 trillion. Schneider, supra note 55.