

UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

ALGONQUIN GAS TRANSMISSION, LLC) DOCKET NUMBER: CP14-96

MOTION OF WEST ROXBURY INTERVENORS FOR A REHEARING

Now come a group of intervenors from the West Roxbury, adjacent neighborhoods of Boston and the Town of Dedham who, pursuant to Rule 713 of the Commission's Rules of Practice and Procedure, file this timely request for rehearing of the decision of the Federal Energy Regulatory Commission on March 3, 2015 to issue a certificate to Algonquin Gas Transmission, LLC (Algonquin). That certificate, pursuant to Section 7(c) of the Natural Gas Act, was issued to permit Algonquin to construct and operate the Algonquin Incremental Market (AIM) Project. As grounds therefor, the intervenors state:

Statement of the Facts

1. The Algonquin AIM Project consists of approximately 37.4 miles of pipeline and related facilities in New York, Connecticut and Massachusetts, and an additional 81,620 horsepower of compression at sites in New York, Connecticut and Rhode Island.¹
2. The Order Issuing the Certificate authorizes Algonquin, a wholly owned subsidiary of Spectra Energy Corporation, to "install approximately 4.1 miles of 16-inch-diameter pipeline and ad approximately 0.8 miles of 24-inch- diameter pipeline off its existing 1-4 System Lateral in Norfolk and Suffolk Counties, Massachusetts."² The geographic areas affected by this order include the Towns of Westwood and Dedham and the West Roxbury neighborhood of Boston.

¹ *Algonquin Gas Transmission LLC*, Order Issuing Certificate and Approving Abandonment, 150 FERC ¶61,163 (March 3, 2015) ("Certificate Order").

² Order at page 2.

3. In addition, the FERC's order authorizes Algonquin to "construct a new meter station at milepost (MP) 4.2 of the proposed West Roxbury Lateral to deliver natural gas to Boston Gas Company in Suffolk County, Massachusetts (West Roxbury Meter Station)" and "to modify 24 existing meter stations in New York, Connecticut, and Massachusetts."³ "Algonquin estimates that the West Roxbury Lateral facilities will cost \$95,293,105."⁴

1. Community Profile and Impact

4. West Roxbury is a densely settled urban neighborhood in the southwest part of the City of Boston.⁵ The neighborhood encompasses 4.61 square miles, 4.56 of which consists of land and 0.5 of water. 30,246 residents live in the neighborhood, or approximately 4.9% of Boston's total population of 617,594.⁶ 47.6% of the residents are male and 52.14 % female with 22.1% who are sixty years of age or older.⁷ There are 13,042 units of housing.⁸

5. Four Boston Public Elementary Schools - the Ludwig van Beethoven Elementary School, the William Ohrenberger School, the Joyce Kilmer K-8 School, and the Patrick Lyndon K-8 School - are located in West Roxbury, as is the West Roxbury Education Complex. The Joyce Kilmer School is the only majority white school located in the district. The minority enrollment

³ Order at page 4.

⁴ Order, at page 4, n.5.

⁵ "The proposed West Roxbury Lateral would be located in densely developed urban neighborhood." Final EIS, at 2-19.

⁶ City of Boston Neighborhood Profile, Boston Redevelopment Authority.

⁷ U.S. Census Bureau and Boston Redevelopment Authority, *American Community Survey, West Roxbury Neighborhood* (May, 2013).

⁸ U.S. Census Bureau and Boston Redevelopment Authority, *American Community Survey, West Roxbury Neighborhood* (May, 2013).

in these schools range from a low of 39.7% at that school to 88% at the West Roxbury Education Complex.⁹

6. Two Catholic elementary schools, Holy Name Parish School and St. Theresa of Avila School, are located in West Roxbury.¹⁰ Catholic Memorial School, an all boys middle and high school, is located on Baker Street within blocks of the proposed West Roxbury Lateral pipeline.

7. “The Roxbury Latin School is an independent boys’ private day school in the West Roxbury section of Boston, serving about 300 boys in grades seven through twelve (about 100 from the City of Boston. The school is open year-round, hosting several programs during the summer for students. The school’s academic and athletic facilities total about 120 acres. The West Roxbury Lateral would be located about 15 feet from the boundary of the school property along Centre Street .”¹¹

8. “The St.Theresa of Avila School is a private Catholic school in the West Roxbury section of Boston serving 300 to 400 students age three to eighth grade commuting to the school from several surrounding parishes and towns. The St. Theresa of Avila Parish is located adjacent to the school and faces Centre Street. The West Roxbury Lateral terminates at an interconnection with National Grid’s facilities north of the intersection of Centre Street and Spring Street... about 295 feet southwest of the school and parish property.”¹²

⁹ Massachusetts Department of Education profiles for 2014-2015.

¹⁰ Final EIS 4-170.

¹¹ Final EIS 4-170.

¹² Final EIS 4-170-171.

9. In addition, the proposed West Roxbury Lateral Pipeline would impact the Deutsches Altenheim, a facility that includes a 133 bed skilled nursing home facility, 62 assisted living residences, a 30 client adult day health program,[that] provides a full spectrum of care to seniors, from short-term rehabilitation, long-term care, outpatient rehabilitation, and a state-of-the-art Alzheimer's/memory care unit. It employs over 300 full time and part time staff. Located at 2220-2222 Centre Street in West Roxbury since 1914, Deutsches Altenheim shares boundaries with the Roxbury Latin School, a number of single-family residences, and a large open-pit quarry (the West Roxbury Crushed Stone Co.). The only access for staff, visitors, vendors, ambulances, and other emergency vehicles to our busy campus is by way of Centre Street, the proposed location of the new high-pressure natural gas pipeline.¹³

10. The vast majority of West Roxbury's businesses are located on or near Centre Street in West Roxbury. In addition, Centre Street and Washington Street serve as vital traffic connectors that serve as conduits for the daily movement of commuters and goods from suburban towns to Boston proper.

11. "Construction of the AIM Project will result in temporary to short-term increases in traffic levels due to the construction workforce commuting to the project area, as well as the movement of construction vehicles and delivery of equipment and materials to the construction work area. In-street construction will also occur along the West Roxbury Lateral."¹⁴

12. "In-street construction will affect traffic in the project area along the West Roxbury

¹³ See Exhibit 1 attached hereto, a letter of concern sent by the nursing home's Board of Trustees to Spectra's local attorneys.

¹⁴ Order, at page 32.

Lateral in Massachusetts, and may affect on-street parking and use of sidewalks adjacent to the roadways.”¹⁵

13. “Similarly, the intersection of Spring Street and Centre Street generally operates acceptably throughout the day under existing conditions. During construction of the West Roxbury Lateral, however, the northbound Centre Street right-turn lane will be blocked off temporarily. This will be limited to only one phase of four traffic management phases planned for this location. Nonetheless, lengthy delays will occur on the northbound Centre Street approach to the intersection affected .”¹⁶

14. “During pipeline construction within 0.25 mile of the area identified...impacts associated with increased traffic, noise and dust, as well as impacts on visual resources could occur; however, the impacts would be temporary and limited to the time of construction.”¹⁷

15. “Construction of the AIM Project will occur within 50 feet of 332 residential structures and 94 non-residential structures. The majority of the residences identified are located along the West Roxbury Lateral, including many within 10 feet.”¹⁸

16. “The West Roxbury Crushed Stone Quarry is located adjacent to the West Roxbury Lateral and West Roxbury Meter Station, along Grove Street from MPs 4.2 to 4.4 in West Roxbury, Massachusetts.”¹⁹

¹⁵ Order, at page 32.

¹⁶ Order, at page 32.

¹⁷ Final EIS 4-154

¹⁸ Order, at page 27.

¹⁹ Order, at page 22.

17. “The proposed West Roxbury M&R Station would be sited on a wooded property located across the street from an active rock quarry. It would be bounded by residential properties to the north, south, and west and there is a residence immediately adjacent to the proposed facility off of Centre Street.”²⁰

18. “While the West Roxbury Lateral will *require* new permanent pipeline easements, the majority of the new pipeline will be located within streets or public property, and therefore will not require new pipeline easement on individual private properties. Most of the aboveground facilities associated with the project will modify existing facilities on properties owned by Algonquin.”²¹

19. “The West Roxbury Lateral crosses a portion of the Charles River Basin, a state-designated aquifer...”²²

20. “The West Roxbury Lateral would cross the Mother Brook reservation along Washington Street and Post Lane in Dedham. The proposed pipeline would be installed within Washington Street and would pass above the culvert that carries Mother Brook under Washington Street.”²³

21. “Construction on Washington Street would temporarily disrupt access to Mary Draper Playground on Washington Street.”²⁴

²⁰ Final EIS 4-174.

²¹ Order, at page 34.

²² Final EIS 4-28.

²³ Final EIS 4-169.

²⁴ Final EIS 4-168

2. Concerns Expressed by State and Local Agencies, Elected Officials and West Roxbury Residents

22. The Mayor of the City of Boston, members of the Boston City Council, and Massachusetts state and federally elected legislators have publicly expressed their concerns about the proposed West Roxbury Lateral to FERC.²⁵

23. In addition, many West Roxbury residents and abutters to the proposed West Roxbury Lateral have attended public meetings, expressed their concerns in public comments on FERC's docket in this proceeding and filed motions to intervene in this proceeding.

24. These residents have been joined by a number of West Roxbury neighborhood and civic organizations.

25. In general, the concerns of residents and abutters have focused on safety, environmental and health issues, along with traffic and quality of life concerns.²⁶

26. Equally important, however, a number of commentators, residents and intervenors skeptics question whether Algonquin/Spectra - and the affiliated gas utilities that have an common economic interest in the construction of the West Roxbury Lateral - have, in fact, met their burden to show a need for the AIM project based upon existing and projected demand for natural gas.

27. Other residents and commenters have raised significant concerns about FERC's anecdotal, piecemeal approach to natural gas regulation, and its inability to create a comprehensive, systematic set of policies that would uniformly address issues of natural gas

²⁵ See the comments and responses from FERC entered on Docket CP14-96 and also Exhibit 2, Massachusetts Siting Board Reply To FERC, at page 8.

²⁶ See, for example, Exhibit 3 attached hereto, transcript of a public hearing conducted by the Massachusetts DPU on December 3, 2014.

permitting, planning, and the environmental and human costs. The current feudal-like regulatory system and process enables gas companies and utilities, their shareholders' demands, and their substantial financial, political and legal resources to drive the decision-making process in their best interests.

28. Finally, other commenters and critics challenge the lack of transparency, openness, and accountability of the Federal Energy Regulatory Agency and question whether FERC operates as an agency that actually promotes the public interest, as it is expected to do.²⁷

Statement of the Issues

FERC's order, if not reconsidered or stayed, will have profoundly deleterious effects upon the public safety, health and quality of life in West Roxbury, both in the short and long term, and will exacerbate existing environmental problems such as existing methane emissions caused by leaking natural gas all over the metropolitan Boston region. FERC's authorization of a certificate that permits Algonquin to proceed with the AIM project and to construct the West Roxbury Lateral raises the following issues :

1. Did FERC fail to address issues of public safety in its order and in its final EIS?
2. Did FERC fail to address the full scope of environmental and health concerns in its order and final EIS?
3. Did FERC fail to address legal concerns under the Massachusetts Constitution posed by Algonquin's proposed exercise of easements over existing public lands?
4. Did FERC abdicate its statutory responsibility to require that Algonquin Gas

²⁷ 15 U.S. Code§ 719 (a) Necessity of regulation in public interest .

Transmission, LLC show a compelling need for the proposed project based upon current and projected needs for Natural Gas ?

5. Did FERC fail to discharge its statutory obligation to regulate in the public interest?

Argument

1. FERC Has Failed to Seriously Address the Issue of Public Safety as It Affects the West Roxbury Community

The Energy Facilities Siting Board of the Commonwealth of Massachusetts, as early as September 29, 2014, expressed a number of public safety concerns to FERC after its review of the Draft Environmental Impact Statement prepared as part of Algonquin's application.

First, the Siting Board communicated concerns about the West Roxbury Lateral raised by the public that (a) that the pressure at the proposed West Roxbury metering and regulating station of 750 pounds per square inch was too high given the location of the station in a densely settled residential area; (b) that the shut-off time in case of accident (potentially 90 seconds) was too long; (c) that ten miles is too great a distance between shut-off valves; (d) that the Project requires gas pipeline welds that will eventually require inspection, and inspection of welds is too infrequent to ensure safety along gas pipeline routes; (e) that the safety of pipelines installed in streets with heavy trucking is questionable; and (f) that, *in the event of a pipeline explosion, the estimated blast radius of 300 feet would also affect surrounding residences by the fire that accompanies an explosion at a natural gas pipeline.* The Siting Board requested that FERC specifically address each of these safety concerns in its next EIS.²⁸

²⁸ Exhibit 2, Massachusetts Siting Board Reply To FERC, at page 4.

Second, the Siting Board also expressed concerns about the proximity of the proposed pipeline and its metering and regulating station, both of which would be located within feet of the West Roxbury quarry (“West Roxbury Crushed Stone”), an active quarry where blasting occurs on a regular basis. The Siting Board noted that Algonquin had provided a geotechnical review of the impact on the project of blasting activity at West Roxbury Crushed Stone. The consultant hired by Algonquin conceded that two existing water lines and one existing gas line are located between the proposed pipeline and West Roxbury Quarry. The Siting Board observed, however, that the report did answer to the question whether whether blasting at the quarry had ever damaged these pipelines and emphasized that this information sought was essential and needed to be included in the next EIS.²⁹

Third, since Algonquin’s proposed pipeline would pass along Centre Street adjacent to the West Roxbury quarry, the Siting Board reminded FERC and Algonquin of an act recently passed by the Massachusetts Legislature: Effective October 1, 2014, this law, the Siting Board stated, is directly relevant to operation of West Roxbury Crushed Stone and the alignment of the pipeline. Section 7 of Chapter 149 provides:

Notwithstanding any general or special law to the contrary, explosive material, as defined in 527 CMR 13.03, shall not be used to fire a blast in any blasting operation at a site primarily used as a source of mined products from the earth if such site is within 500 feet of a natural gas pipeline or metering and regulation station without written approval by the department of public utilities.

The Siting Board noted that the term “explosion” under 527 CMR 13.03 is broadly inclusive such that whatever the quarry uses for blasting would most likely qualify by definition as an explosive material for regulatory purposes. The Siting Board further noted that, although some portions of the quarry may lie outside the 500 foot radius established by Section 7, sections of the

²⁹ Exhibit 2, Massachusetts Energy Siting Board Reply To FERC, at page 4.

proposed pipeline would come within 500 feet of the West Roxbury Crushed Stone property line, as does the Metering and Regulating Station (M&R station). The Siting Board emphasized that, although FERC was not bound by state law in this instance, the same was not true for the owners of the quarry, who are subject to the provisions of the Massachusetts law.³⁰

Finally, the Siting Board recommended that, in addition to a review of the quarry and pipeline safety concerns already noted, both FERC and Algonquin: “(1) analyze whether the planned siting of the pipeline and M&R station might result in a violation of Massachusetts Acts of 2014, Chapter 149, Section 7 by West Roxbury Crushed Stone in the course of its blasting operations; and (2) consider the physical safety consequences posed by such blasting activities, including the advisability of siting of the M&R station and any segments of the proposed pipeline within 500 feet of the Quarry property line. The Siting Board emphasizes that - regardless of whether the Project would result in the Quarry’s blasting activities violating Massachusetts Acts of 2014, Chapter 149, Section 7 – it is important to ensure that the Project is sited so that its location is consistent with the continued operation of the Quarry.”³¹

In its final Environmental Impact Statement, FERC dismissed the Siting Board’s first set of concerns about pipeline safety and the danger of a natural gas explosion in a densely settled urban neighborhood . Without any explanation, without citing any supporting data, and after apparently relying solely upon the assurances of Algonquin, FERC claimed that “The pipeline and aboveground facilities associated with the AIM Project would be designed, constructed, operated, and maintained to meet or exceed the Pipeline and Hazardous Materials Safety Administration’s *Minimum Federal Safety Standards* in 49 CFR 192 and other applicable federal

³⁰ Exhibit 2, Massachusetts Siting Board Reply To FERC, at pages 6-7.

³¹ Exhibit 2, Massachusetts Siting Board Reply To FERC, at page 7.

and state regulations. The regulations include specifications for material selection and qualifications; minimum design requirements; and protection of the pipeline from internal, external, and atmospheric corrosion. By designing and operating the Project in accordance with the applicable standards, the Project would not result in significant increased public safety risk.”³²

Consistent with its unwillingness to explain the basis for the conclusions contained in its final EIS, FERC acknowledged that the West Roxbury Lateral terminated at an interconnection with National Grid’s facilities north of the intersection of Centre Street and Spring Street, about 295 feet southwest of the St. Theresa of Avila School and parish property but insisted that “The Project would not have any permanent impact on the school or parish”³³ and that the project impact on St. Theresa of Avila School “would be temporary and limited to the period of active construction.”³⁴

In addition, although FERC conceded that the West Roxbury Lateral would be located about 15 feet from the boundary of Roxbury Latin School along Centre Street, and acknowledged that “users of the baseball field may experience temporary noise and visual impacts during the construction period,” it found that the West Roxbury Lateral “would not have any permanent impact on the school itself.”³⁵

³² Final EIS - ES 8.

³³ Final EIS 4-170-171.

³⁴ Final EIS ES-6. FERC did not require Algonquin to address the issue of whether it would occupy any of property of St. Theresa of Avila School, Roxbury Latin School, or any public school such as the Beethoven, Kilmer or Lyndon School during construction of the pipeline.

³⁵ Final EIS 4-170.

FERC, despite the Siting Board's requests, was equally unresponsive and evasive in addressing the Siting Board's concerns about the public safety hazards posed by permitting Algonquin Gas Transmission to lay a 24 inch diameter pipeline with 750 psi of pressure in a heavily traveled street and building a Metering and Regulating Station and within feet of an active quarry where blasting still occurs on a daily basis. It claimed only that, "Prior to the Draft EIS , FERC considered several alternatives for the West Roxbury Lateral" and "We determined that none of the route or site alternatives or variations would offer environmental advantages over the project."³⁶

FERC also accepted at face value the integrity and accuracy of the third-party consultant that Algonquin hired to justify its proposal to lay the pipeline and to build an M&R station next to an active quarry: "Algonquin also retained the services of a local third-party geotechnical consultant. Further blasting at the quarry would not damage the pipeline since it would be constructed five feet below grade."³⁷ Not surprisingly, the geo-environmental consultant - whose report Algonquin paid for - agreed with Algonquin and concluded that "the components of the M&R station would not be any more sensitive to vibration disturbance or damage than the underground pipeline; and that ground vibrations from blasting at the quarry would not be disruptive to or damaging to the M&R Station."³⁸

Lastly, FERC dismissed the legal effect of M.G.L. c, 149 § 7, as cited by the Mass. Energy Facilities Siting Board, that prohibits any blasting or use of explosive materials within 500 feet of a natural gas pipeline or metering station. Its order did not mention the potential legal

³⁶ Final EIS ES-10.

³⁷ Final EIS 4-5.

³⁸ Final EIS 4-6.

conflict caused by M.G.L. 149§ 7, or address the legal consequences that, if not resolved, would effectively amount to a condemnation of the quarry property. In its final EIS, FERC also declined to weigh into the obvious conflict and concluded that it needn't address the issue since "There is already an existing natural gas pipeline (distribution line) closer to the quarry than the proposed AIM Project Facilities. Therefore, any conflict with quarry operations associated with this new project already exists. The AIM Project would not create any new conflict that the quarry does not already have to address."³⁹

FERC's attempts to minimize and to dismiss the Siting Board's concerns about public safety expressly ignore the provisions of 49 CFR § 192.317 that have been promulgated to protect the public from hazards related to transportation of natural and other gas by pipelines. That federal regulation requires, first, that the "(a) The operator must take all practicable steps to protect each transmission line or main from washouts, floods, unstable soil, landslides, or other hazards that may cause the pipeline to move or to sustain abnormal loads. In addition, the operator must take all practicable steps to protect offshore pipelines from damage by mud slides, water currents, hurricanes, ship anchors, and fishing operations."

Secondly, "(b) Each aboveground transmission line or main, not located offshore or in inland navigable water areas, must be protected from accidental damage by vehicular traffic or other similar causes, either by being placed at a safe distance from the traffic or by installing barricades." It is difficult to comprehend how a 24 inch diameter pipeline with 750 psi of pressure, laid in a bed of dirt and gravel, subject to vagaries of heavy rain and shifting soil, beneath a heavily traveled thoroughfare, that passes within feet of an active quarry could possibly comply with the provisions of 49 CFR § 192.317.

³⁹ Final EIS 4-6.

FERC's seeming refusal to address the well-documented dangers posed by expanded natural gas pipelines has left residents and local officials perplexed and disappointed. A report prepared for Massachusetts Senator Markey, in July of 2013, warned that "Americans also remain at risk from gas Explosions and other safety hazards caused by leaky natural gas pipelines. *From 2002 to 2012, almost 800 significant incidents on gas distribution pipelines, including several hundred explosions, killed 116 people, injured 465 others, and caused more than \$800 million in property damage.*"⁴⁰

Joseph M. Lovett, a West Virginia environmental lawyer, in commenting on the proposed West Roxbury Lateral to the *Boston Globe*, agreed that West Roxbury residents have clear reason to be concerned. "The opportunity for accidents will always be there," Lovett said. "Natural gas lines fail all over the country."⁴¹

Lastly, according to an article in *Energy Security*, the threat of a terrorist attack on natural gas pipelines is very real.⁴² In its Order and in its Final EIS, FERC did not address this issue, nor did it require, as a condition of its permit, that Algonquin address this very real concern in a post 9-11 environment or to make contingency provisions.

Instead, in its Final EIS, FERC touts the economic benefits of the proposed Algonquin Gas Transmission Project and notes the large number of public services - including police and fire departments - along the proposed AIM project route.⁴³ However, FERC's oblique

⁴⁰ Exhibit 4 attached hereto, "America Pays For Gas Leaks," July, 2013, at page 1.

⁴¹ Meghan E. Irons "West Roxbury Gas Pipeline Proposal Draws Fire," *Boston Globe* January 18, 2015.

⁴² "Pipeline Sabotage is Terrorist's Weapon of Choice," *Energy Security*, March 28, 2005.

⁴³ Final EIS 4-182-183.

assurances of pipeline security and safety ring hollow. "Algonquin would operate and maintain the newly constructed pipeline facilities in the same manner as they currently operate and maintain their existing systems in compliance with PHMSA regulations provided in 49 CFR 192, the FERC guidance at 18 CFR 380.15, and the maintenance provisions in Algonquin's E&SCP. Algonquin would add three full-time permanent workers for operation of the proposed and modified facilities."⁴⁴

As the federal inspector and overseer for the safe operation of natural gas pipelines, PHMSA admits that it is one of the smallest agencies within the Department of Transportation, has a huge mission to oversee more than 2.6 million miles of our nation's pipelines. Jeffrey Wiese, the nation's top oil and gas pipeline safety official, has publicly conceded that the regulatory process he oversees is "kind of dying." Wiese told several hundred oil and gas pipeline compliance officers that his agency, the Pipeline and Hazardous Materials Administration (PHMSA), has "very few tools to work with" in enforcing safety rules even after Congress in 2011 allowed it to impose higher fines on companies that cause major accidents. "Do I think I can hurt a major international corporation with a \$2 million civil penalty? No," he said.⁴⁵

The fact that PHMSA's inspection habits and enforcement abilities are questionable heightens the concerns West Roxbury and neighboring communities about the safety of the West Roxbury Lateral. Even if PHMSA is able to inspect the pipelines, it is not clear that the agency

⁴⁴ Final EIS 2-41.

⁴⁵ News Marcus Stern and Sebastian Jones, "Pipeline Safety Chief Says His Regulatory Process Is 'Kind of Dying'" Inside Climate News, Sept. 11, 2013 .
<http://insideclimateneWS.org/news/20130911/exclusive-pipeline-safety-chief-says-his-regulatory-process-ind-dying>

is able to enforce needed safety measures. This in turn leads to additional concerns about the extent to which Spectra Energy will be held accountable over time for the safety of the pipeline.

Notwithstanding FERC's assurances, which strike many as glib or perfunctory, the agency has failed to provide any answers to the question of what would happen in the event of a catastrophic gas explosion in West Roxbury? What would be the human, economic and environmental costs to West Roxbury, the City of Boston and to adjacent communities? How and in what ways would Algonquin Gas Transmission, LLC be held to account? And who, other than presumably the first responders, citizens and taxpayers of Boston and Massachusetts would be bear the burden of responding to such an event?

FERC's seemingly utter indifference to the public safety issues posed by the construction and operation of a highly pressured natural gas pipeline passing through a densely settled urban neighborhood is unconscionable, inexplicable, reckless and irresponsible. It is also impossible to square this with its statutory responsibility under 15 U.S. Code§ 719(a) that "Federal regulation in matters relating to the transportation of natural gas and the sale thereof in interstate and foreign commerce is necessary in the public interest."

2. FERC Has Failed to Seriously Address Environmental and Health Concerns that Directly Affect West Roxbury in its Order and Final EIS

FERC released its final Environmental Impact Statement on January 23, 2015. One day before an article appeared in the *Boston Globe* newspaper that described a study conducted by a group of scientists led by Harvard University researchers.⁴⁶ The study documented that the amount of methane leaking from natural gas pipelines, storage facilities, and other sources in the Boston area was as much as three times greater than previously estimated - a loss that

⁴⁶ David Abel, Leaks in Boston area gas pipes exceed estimates," *Boston Globe*, January 22, 2015.

contributed to the region's high energy costs and adds potent greenhouse gases to+ the atmosphere. The authors of the study noted that the leaks would yield enough gas to heat as many as 200,000 homes a year and are valued at \$90 million a year.⁴⁷

The *Globe* article reported that the study - the first of its kind to quantify methane emissions from natural gas leaks in an urban area - also suggested that regulators were substantially underestimating the amount of the nation's methane emissions - and that methane is 20 times more powerful than carbon dioxide, meaning small amounts of the heat-trapping gas can have a significant impact on global warming.

“We were surprised to find that emissions are as high as they seem to be,” said Steven Wofsy, a lead author of the study and professor of atmospheric chemistry at Harvard’s School of Engineering and Applied Sciences. “Once we understand where they come from, we can find ways to reduce them in a cost-effective way.”

The study, published in the *Proceedings of the National Academy of Sciences*, relied on measurements from September 2012 to August 2013 taken by laser spectrometers at Copley Square, Boston University, Nahant, and the Harvard Forest in Petersham. The instruments found about 300,000 metric tons of natural gas leaks - about 2.7 percent of all natural gas delivered to the region. State and federal authorities had previously estimated that 1.1 percent of natural gas was being lost to leaks from a range of sources in the area, including homes, businesses, and electricity generation facilities.

According to the EPA, natural gas production and transportation systems were the second largest anthropogenic source of methane in the U.S. in 2012, accounting for approximately twenty three percent of national methane emissions. Production and transportation systems also

⁴⁷ The Harvard study is attached hereto as Exhibit 5.

emit significant carbon dioxide, accounting for almost one percent of national emissions in 2012.

In addition, the downstream combustion of natural gas in power plants and other applications releases carbon dioxide, nitrogen oxides, and other harmful air pollutants.⁴⁸

FERC, in its order and in its Final EIS, failed to acknowledge the polluting effects of methane in Boston caused by leaking gas lines and the adverse affects of methane gas as a known *carcinogen* detrimental to public health, although the existence of the methane leaks was widely reported in the media more than two years earlier - as was the underlying study led by Boston University scientists - who mapped and measured the underlying gas leaks.⁴⁹ Rather than address the impact of this known environmental and public health hazard, FERC simply echoed the corporate mantra of Algonquin Gas Transmission, its corporate parent, Spectra, to assure the public that all was well and the adverse environmental impact of the AIM Project and its West Roxbury lateral component would be negligible.

Similarly, traffic, noise, concerns about congestion and the impact of the West Roxbury Lateral are barely mentioned in FERC's order and in the Final EIS, and when, and if, discussed, minimized. "During pipeline construction within 0.25 mile of the area identified... impacts associated with increased traffic, noise and dust, as well as impacts on visual resources could occur; however, the impacts would be temporary and limited to the time of construction."⁵⁰

⁴⁸ U.S. Environmental Protection Agency, "Clean Energy: Natural Gas" (last updated Sep. 25, 2013), (estimating that natural gas -fired power plants releases, on average, 1135 pounds of carbon dioxide and 1.7 pounds of nitrogen dioxide per MWh of electricity generated).

⁴⁹ "Mapping urban pipeline leaks: Methane leaks across Boston," *Environmental Pollution*, November, 2002. That underlying study is attached to this motion as Exhibit 6.

⁵⁰ Final EIS 4-154.

Further, “Along the West Roxbury Lateral, the pipeline would primarily be placed within streets in the vicinity of residential and commercial areas. Algonquin would use the in-street construction method to install the pipeline within roadways. The work area would be isolated from road and pedestrian traffic, and traffic controls would be used to allow traffic to bypass the work area. No trenches would be left open overnight. *With the exception of the end of the pipe, which would be left exposed within the trench, the pipe trench would be backfilled at the end of the day*, and the open trench containing the exposed ends of the pipe would be plated. The work would be accomplished so that emergency vehicles would be able to pass and homeowners would be able to access their driveways. Algonquin has developed an acceptable Traffic Management Plan for the West Roxbury Lateral as well as acceptable site-specific residential construction plans for residences within 50 feet of the construction right-of-way (see sections 4.9.5 and 4.8.3, respectively).”⁵¹

Finally, “The proposed West Roxbury M&R Station would be sited on a wooded property located across the street from an active rock quarry. It would be bounded by residential properties to the north, south, and west and there is a residence immediately adjacent to the proposed facility off of Centre Street. Algonquin would maintain an existing wooded buffer along the entire western portion of the property as well as portions on the north and south sides of the site. Although maintaining a wooded buffer around the M&R station would provide substantive visual screening, the location of the site in a dense residential area could result in some visual impacts. Therefore, **we recommend that: Prior to construction of the West Roxbury M&R Station, Algonquin should file with the Secretary, for review and written**

⁵¹ Final EIS 4 -275.

approval of the Director of OEP, a detailed site-specific landscaping plan for mitigation of visual impacts at the station.”⁵²

FERC has also accepted at face value Algonquin’s assurances that it could be trusted as a faithful steward of the environment and that there would be no detrimental effects upon existing bodies of water, wet lands or watershed protection areas in or near West Roxbury. Yet at the same time, FERC’s Final EIS acknowledged that “The West Roxbury Lateral would cross the Mother Brook reservation along Washington Street and Post Lane in Dedham. The proposed pipeline would be installed within Washington Street and would pass above the culvert that carries mother brook under Washington Street.”⁵³ “Mother Brook was originally dug in 1639 to deliver water from the Charles River to the Neponset River...the brook is now used as part of a flood-control system that diverts water from the Charles River to the Neponset River.”⁵⁴ Also, the Final EIS noted that “The West Roxbury Lateral crosses a portion of the Charles River Basin, a state-designated aquifer...”⁵⁵ However, FERC assures us, “No wetlands would be affected in...Massachusetts.”⁵⁶

3. FERC Has Failed to Seriously Address Legal Concerns under the Massachusetts Constitution Posed by Algonquin’s Proposed Exercise of Easements over Existing Public Lands

The issue of access and the easements that Algonquin Gas Transmission, LLC proposes to exercise over existing public lands, including public roads and rights-of-way, also received

⁵² Final EIS 4-174.

⁵³ Final EIS 4-169.

⁵⁴ Final EIS 4-168.

⁵⁵ Final EIS 4-28.

⁵⁶ Final EIS 4-61.

scant attention from FERC. The Final EIS concedes that construction on Washington Street would cause temporarily disrupt access to Mary Draper Playground on Washington Street.⁵⁷

With respect to the West Roxbury Quarry Urban Wild, the Final EIS concluded: “The Project would have no direct impact on the urban wild lands. During the construction period, temporary visual and noise impacts on recreational users of the urban wild could occur but would be minor relative to the existing character of the area, due to the presence of the active quarry, the dense existing residential development in the area, and the fact that only a small, narrow portion of the urban wild is adjacent to the Project area.”⁵⁸

The Final EIS fails to appreciate the extent of legal issues that the proposed West Roxbury Lateral present when viewed within the context of environmental issues and public health. Article 97 to the Massachusetts Constitution was adopted, in relevant part, to guarantee the public “The right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose.” Article 97 further requires that “lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a two thirds vote, taken by yeas and nays, of each branch of the general court.”

The interpretation of this constitutional provision has been broadly construed and arguably includes all easements on public lands, including public roads. “Land originally acquired for limited or specific public purposes is thus not to be excluded from the operation of

⁵⁷ Final EIS 4-168.

⁵⁸ Final EIS 4-170.

the two-thirds roll-call vote requirement for lack of express invocation of the more general purposes of Article 97.”⁵⁹

The Final EIS adopted Algonquin Gas Transmission’s claim that it could identify only one possible Article 97 issue: “Algonquin has conducted a review of possible Article 97 lands crossed by the West Roxbury Lateral. Algonquin’s review suggests that Gonzalez Field in the Town of Dedham (see above) is subject to Article 97.”⁶⁰ In point of fact, however, the proposed West Roxbury Lateral, in addition to interfering with the public’s access to identified public lands above, and their use and enjoyment by the public, would also require the Algonquin to convert the use of its existing easements along Washington and Centre Streets and West Roxbury from a low gas-pressure pipeline with 100 psi of pressure to a 24 inch diameter pipeline with 750 psi of pressure, which is arguably a new use. In addition, Algonquin/Spectra would require the grant of a new easement at the intersection of Spring and Centre Streets to enable its transmission facility to link up to that of National Grid (Boston Gas).

It is settled law that an easement is a taking and when granted may only be used for the original, specific use intended. Hence, the proposed use of existing easements on public lands and the proposed link at Spring and Centre Street, contrary to Algonquin’s denial, do raise Article 97 issues, especially where, as here, the public policies that inform the article are entirely consistent with existing federal environmental statutes that FERC is charged with enforcing.

Admittedly, the Natural Gas Act, 15 U.S.C. § 717(a) and (b), grants broad authority to FERC to regulate interstate pipelines and facilities, and has been held by federal courts to

⁵⁹ See the *Opinion of the Massachusetts Attorney General*, 1-1-73 and *Mahajan v. Department of Environmental Protection*. 464 Mass. 604; 9844 N.E.2d 821; 201313 Mass. LEXIS 47 (2013). These documents are attached as Exhibits 7 and 8 to this motion.

⁶⁰ Final EIS 4-171.

preempt state regulations that impact upon the location, construction, operation, and maintenance of natural gas pipeline.⁶¹ Nevertheless, a potential conflict exists between the guarantees of Article 97 and the extent of any preemption that Congress intended to grant under the Natural Gas Act exists. That conflict raises important and as yet unaddressed questions under the Tenth, Fifth and Fourteenth Amendments to the U.S. Constitution : (1) May a privately-owned corporation condemn or alienate public lands when, as here, the need for the project has not been clearly shown? (2) In addition, may a private, for- profit corporation Algonquin condemn private and public lands where FERC has not required that Algonquin guarantee that the gas that flows through the proposed West Roxbury Lateral - paid for by the rate-payers and consumers of Massachusetts - will not ultimately be liquified and shipped from Maine or from Halifax, Nova Scotia to Europe?⁶²

4. FERC Has Abdicated Its Statutory Responsibility to Require that Algonquin Gas Transmission, LLC Show a Compelling Need for the Proposed Project Based upon Current and Projected Needs for Natural Gas

The natural gas industry and their lobbyists appear have successfully persuaded the New England Governors, other public officials at large and FERC itself that, without the AIM Project, New England will suffer from a severe shortage of natural gas in the immediate or near future and that because of increasing demand, capacity must be increased significantly. This proposition is not supported by the existing evidence and it smacks of pure propaganda:

(1) As discussed above, two scientific studies show that the amount of methane

⁶¹ *Schneiderwind v. ANP Pipeline Co.*, 485 U.S. 293 (1988) and *ANR Pipeline v. Iowa State Commerce Comm'n*, 828 F.2d 465(8th Cir. 1987).

⁶² See Exhibit 9 attached hereto, a map that shows the integration on natural gas pipelines that will be created as a result of the West Roxbury lateral and the partnership of Spectra Energy, Eversource Energy and National Grid.

leaking from natural gas pipelines, storage facilities, and other sources in the Boston area was as much as three times greater than previously estimated - a loss that has contributed to the region's high energy costs and adds potent greenhouse gases to the atmosphere. The article stated that the authors of the study noted that the leaks would be enough to heat as many as 200,000 homes a year with natural gas and that the value of gas lost was in excess of \$90 million a year.⁶³

(2) As the EPA reported, natural gas production and transportation systems were the second largest anthropogenic source of methane in the U.S. in 2012, accounting for approximately twenty three percent of national methane emissions. Production and transportation systems also emit significant carbon dioxide, and accounted for almost one percent of national emissions in 2012. In addition, the downstream combustion of natural gas in power plants and other applications releases carbon dioxide, nitrogen oxides, and other harmful air pollutants.⁶⁴

(3) As the study prepared for Senator Markey has observed, "American consumers are paying billions of dollars for natural gas that never reaches their homes, but instead leaks from aging distribution pipelines...Gas distribution companies in 2011 releasing 69 billion cubic feet of natural gas to the atmosphere, almost enough to meet the state of Maine's gas needs for a year and equal to the annual carbon dioxide emissions of about six million automobiles."⁶⁵

⁶³ "Mapping urban pipeline leaks: Methane leaks across Boston," *Environmental Pollution*, November, 2002, attached to this motion as Exhibit 6 and "Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts." *Proceedings of the National Academy of Science*, February 17, 2015, attached as Exhibit 5 to this motion for a rehearing.

⁶⁴ U.S. Environmental Protection Agency, "Clean Energy: Natural Gas" (last updated Sep. 25, 2013), (estimating that natural gas -fired power plants releases, on average, 1135 pounds of carbon dioxide and 1.7 pounds of nitrogen dioxide per MWh of electricity generated).

⁶⁵ Exhibit 4 attached hereto, "America Pays For Gas Leaks," July, 2013, at page 1. That study cites to a 2011 EPA Study, "Inventory of U.S. Greenhouse Emissions and Sinks:1990-2103." April, 2013.

FERC has uncritically accepted Algonquin's evidence for the need for increased natural gas capacity, but has ignored other, independent economic studies other that have more carefully examined the relationship between capacity, gas leaks and existing use and demand. FERC has also neglected to consider other existing and available sources of natural gas such as liquified natural gas to meet existing and projected energy needs. In an article that appeared in the *Boston Globe* on March 23, 2015,⁶⁶ Frank Katulak, chief executive of Distrigas, stated "We already have the infrastructure in place...We absolutely are an alternative to new pipelines. There's no need for major changes or new fees to pay for new pipelines." The article reported that Distrigas' LNG terminal, located in Everett, Massachusetts, is running at about 50 percent capacity, despite a 60 percent increase in LNG shipments this year. A U.S. Energy Department graph that accompanied the article showed that between 2009 and 2014, LNG imports into the U.S. declined from 54.4 billion cubic feet to 8.0 billion feet.⁶⁷

Before it issued its Final EIS and its order, FERC also failed to consider the effect of alternative energy sources - such as solar and wind - upon future natural gas demand. A report released by the DOE in February of this year called into question the gas industry's justification for increased pipeline construction: In its Key Finding 1 , the DOE stated that, "Diverse sources of natural gas supply and demand will reduce the need for additional interstate natural gas pipeline infrastructure" and Key Finding 2 that "Higher utilization of existing interstate natural gas pipeline infrastructure will reduce the need for new pipelines. The U.S. Pipeline system is not

⁶⁶ Jay Fitzgerald, "Pipeline opponents say LNG is underutilized."

⁶⁷ See Exhibit 10 attached hereto.

fully utilized because the flow patterns have evolved with changes in supply and demand.”⁶⁸

The primary responsibility of any public regulatory agency, given the evidence that shows pervasive gas leaks of billions of cubic feet of natural gas, would be to suspend all permits until the natural gas industry took steps to curb emissions and to replace aging pipelines. Instead, it appears that FERC has chosen rather than to rubber-stamp a proposal that increases gas-line capacity without considering other feasible measures that could satisfy existing and future demand. Because FERC ignored that responsibility, it also did not consider the positive impacts that conservation, and existing alternative sources of energy could have in the short-term while awaiting the development of more robust solar, wind, geothermal and kinetic technologies along with enhanced renewable battery-storage units.

The Commission’s failure to take into account the impact of the Atlantic Bridge project in its evaluation of the public convenience and necessity of the AIM project violates the Natural Gas Act and *City of Pittsburgh v. FPA*, 237 F.2d 741 (D.C. Cir. 1955), which holds that the Commission may not “close its eyes” to the impact that future expansion may have for the cost or need of the immediate proposal before the Commission.

Segmentation of the project is also incompatible with Commission’s Certificate Policy Statement, *Certification of New Interstate Natural Gas Pipeline Facilities*, 88 FERC ¶61,227 (1999) which requires the Commission to find a need for the project, and discourages overbuilding and duplication of facilities. Presently, PHMSA, on its website, reports that there are more than 2.2 million miles of natural gas pipelines that crisscross the Untied States. Without a comprehensive big picture view of the project as a whole, the Commission could not make the

⁶⁸ “Natural Gas Infrastructure Implications of Increased Demand from the Electric Power Sector,” U.S. Department of Energy, February, 2015 , at page v. See Exhibit 11, attached hereto.

required findings under the *Certificate Policy Statement*. Until and unless FERC adopts a systematic, comprehensive policy to address natural gas permitting as part of a nationwide, uniform system, it should revoke its certification and place the present Algonquin AIM Project on hold.

5. FERC Has Failed To Discharge Its Statutory Obligation to Regulate in the Public Interest.

FERC is legally required to exercise its regulatory authority under the Natural Gas Act in accordance with 15 U.S. Code § 719 (a) “*Necessity of regulation in public interest*” in which the U.S. States Congress “declared that the business of transporting and selling natural gas for ultimate distribution to the public is affected with a public interest, and that Federal regulation in matters relating to the transportation of natural gas and the sale thereof in interstate and foreign commerce is necessary in the public interest.”

From the outset, the administrative process that culminated in the instant certification order was flawed and lacked transparency. A January 5, 2015 letter to FERC from West Roxbury resident and the chairperson of West Roxbury Saves Energy, Rickie Harvey, aptly sums up the experiences of intervenors in this motion for a rehearing. Ms. Harvey stated, “We are writing in regard to Spectra's Algonquin Incremental Market (AIM) expansion project, docket #CP14-96-000, and in particular in regard to the portion of the AIM project designated as the West Roxbury Lateral.” The letter continued:

As the deadline for the Final Environmental Impact Statement approaches, we feel compelled to go on record with our objections to a process that has not been transparent and that has not considered adverse impacts to an existing residential neighborhood in locating a high-pressure transmission lateral as part of AIM. It also has not truly considered alternatives to the local supply requests. And, further, it has not taken into account the cumulative impacts of related projects.

In addition, our requests for health and safety information and/or reviews in regard to placing a high-pressure line and M&R station in a densely populated neighborhood and adjacent to an active, blasting quarry have gone unaddressed.

In conclusion, we believe that the AIM project requires further study and information prior to approval. However, if FERC feels it must approve the AIM project, then we request that you sever the West Roxbury Lateral, as it is not integral to the project and its sole purpose is to provide gas to one local distribution company without identifying reasonable alternatives.⁶⁹

Ms. Harvey's legitimate concerns about the lack of transparency, openness and FERC's seeming rush to judgment were confirmed and underscored when, just one day before FERC issued its certification order, the Environmental Protection Agency issued its review of the Final EIS.⁷⁰ The EPA raised a number of environmental issues that neither FERC nor Algonquin satisfactorily considered but, because FERC has issued its final order, without reconsideration, those concerns will not be addressed by the EPA, by FERC or by the public at large.

As part of its oversight and regulation of the natural gas permitting process, FERC is obliged to review all natural gas pipeline permit applications in conformity with all existing U.S. environmental laws and regulations and, if a permit application is found to be non-compliant, to deny certification. FERC has failed to do so in this proceeding.

The instant administrative proceeding shows that FERC adopted, uncritically and with little independent expert analysis or investigation, the assurances of Algonquin Gas Transmission and the natural gas lobby about the need and safety of the AIM Project. Algonquin Gas Transmission and its corporate parent- Spectra Energy Corporation - have been controlling the outcome of the instant permit process from the outset, although their combined environmental

⁶⁹ See Exhibit 12 attached hereto.

⁷⁰ See Exhibit 13 attached hereto.

track records show that these two entities are little better than serial offenders.⁷¹ According to the *Boston Globe*, U.S. Department of Transportation data shows that Spectra has amassed more than a \$350,000 in fines for failure to inspect transmission lines; Spectra's Texas Eastern Transmission LP company has been fined \$361,900 since 2006; and Algonquin Gas Transmission LLC paid \$154,000 in fines for

failing to inspect transmission line valves, retain records of internal corrosion for five years, and check pressure regulating stations.⁷²

The contest between Algonquin Transmission and the public in this proceeding has pit the public at an extreme disadvantage, given the financial resources of Spectra and the natural gas lobby as a whole. Although the process that FERC oversees purports to ensure a kind of parity between the interests of those that benefit from the certification process - the natural gas industry and its shareholders - and the interests of citizens who are burdened, the contest is invariably unequal. One is reminded of the observation of Anatole France, "The law, in its majestic equality, forbids the rich as well as the poor to sleep under bridges, to beg in the streets, and to steal bread."

FERC's endorsement of the AIM Project and the West Roxbury Lateral Component, in light of the facts discussed above, is indefensible. In addition, its certification undermines the public's confidence in the regulatory process and gives credence to the criticisms leveled by Robert Kennedy, Jr. and others who have suggested that FERC is little less than a rogue agency and a shill for the natural gas industry.

⁷¹ *The Vancouver Sun* in a February 21, 2015 article by Larry Pynn and Chad Skeleton described Spectra Energy as the province of British Columbia's worst polluter.

⁷² Meghan E. Irons "West Roxbury Gas Pipeline Proposal Draws Fire," *Boston Globe* January 18, 2015.

Conclusion

The Federal Regulatory Agency, in order to ensure the integrity of its process, to assuage concerns about its independence and impartiality as a federal regulatory agency, and to protect the public interest, as charged, must, as a matter of law, and in the interests of fundamental justice and equal access to the law, reconsider its decision to issue a certification and allow a rehearing on the merits.

WHEREFORE, based upon above-stated concerns, these intervenors request that their motion for a rehearing be granted.

Respectfully submitted,

/s/ Paul Nevins
 Paul L. Nevins, individually and as the attorney
 for the intervenors identified below

Certification of List of Intervenors Who Have Joined in this Motion

The undersigned certifies that he has been retained and requested to file this motion for a rehearing on behalf of the individuals and organizations listed below who have previously intervened in this administrative proceeding:

Matthew Butler
 Charles River Spring Valley Neighborhood Association
 Conservation Law Foundation
 Foundation for a Green Future, Inc.
 Rickie Harvey, Chair, West Roxbury Saves Energy
 Virginia Hickey
 Paul Horn
 David Ludlow
 Mary McMahon
 Paul Nevins
 Alexandra Shumway
 Karen Weber

/s/ Paul L. Nevins
 Paul L. Nevins

Certificate of Compliance

The undersigned hereby certifies that this document, filed through the- E-filing system on April 2, 2015, will be sent electronically to the registered participants as identified on the notice of Electronic Filing .

/s/ Paul L. Nevins
Paul L. Nevins

**Exhibit 1 to West Roxbury Motion for
Rehearing: Nursing Home Concerns**

Deutsches Altenheim

EDELWEISS VILLAGE  GERMAN CENTRE  SENIOR PLACE

Jon N. Bonsall, Esq.
Keegan Werlin LLP
265 Franklin Street
Boston, MA 02110

March 11, 2015

Re: Spectra Energy Algonquin Gas Transmission LLC, FERC Docket No. CP14-96-000

Dear Mr. Bonsall,

We are writing on behalf of the Board of Directors of Deutsches Altenheim, Inc., with respect to the proposed West Roxbury lateral pipeline connection to the Algonquin Incremental Market (AIM) Project in New England. Deutsches Altenheim, a nonprofit organization, comprising a 133 bed skilled nursing home facility, 62 apartment assisted living residence, and 30 client adult day health program, provides a full spectrum of care to seniors, from short-term rehabilitation, long-term care, outpatient rehabilitation, to a state-of-the-art Alzheimer's/memory care unit. We employ over 300 full time and part time staff. In addition, we often host civic, professional, or social events open to the public.

Located and operating at 2220–2222 Centre Street in West Roxbury since 1914, Deutsches Altenheim shares boundaries with the Roxbury Latin School, a number of single-family residences, and a large open-pit quarry (the West Roxbury Crushed Stone Co.). The only access for staff, visitors, vendors, ambulances, and other emergency vehicles to our busy campus is by way of Centre Street, the proposed location of the new high-pressure natural gas pipeline. While we take no position on the pros and cons of natural gas as an energy source or the need for more pipelines, the safety and wellbeing of our residents and staff is our top priority. We are convinced that the proposed West Roxbury lateral pipeline would increase the risk of a serious incident along Centre Street, especially given the routine blasting, excavation and high gross weight trucking at the nearby quarry. Any pipeline-related event, which would effectively block us from implementing our disaster evacuation plan, would have a tragic outcome.

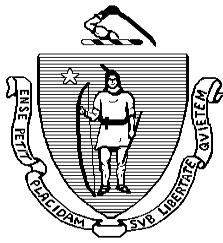
The Board of Directors has the fiduciary responsibility to act in the best interest of our residents and staff. The Board members take this responsibility very seriously. We therefore oppose the location of the pipeline as currently proposed and urge Spectra to seek alternative routes.

Sincerely,


Genevieve MacLellan, President
Board of Trustees


Gregory Karr, CEO

**Exhibit 2 to West Roxbury Motion for
Rehearing: Siting Board Concerns**



THE COMMONWEALTH OF MASSACHUSETTS
ENERGY FACILITIES SITING BOARD
ONE SOUTH STATION
BOSTON, MA 02110
(617) 305-3525

DEVAL L. PATRICK
GOVERNOR

September 29, 2014

VIA ELECTRONIC FILING

Kimberly D. Bose, Secretary Federal Energy Regulatory Commission 888 First Street, N.E. Washington, DC 20426	Jon N. Bonsall, Esq. Keegan Werlin, LLP 265 Franklin Street Boston, MA 02110 COUNSEL TO ALGONQUIN GAS TRANSMISSION, LLC
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Re: Algonquin Gas Transmission, LLC, Docket No. CP14-96-000

Dear Ms. Bose and Mr. Bonsall:

The Massachusetts Energy Facilities Siting Board (“Siting Board”) appreciates the opportunity to review and comment on the draft environmental impact statement (“Draft EIS”) prepared by the staff of the Federal Energy Regulatory Commission (“FERC”) for the Algonquin Incremental Market Project (“AIM Project” or “Project”). The Siting Board’s comments incorporate public concerns about the Project expressed in response to the Draft EIS in written comments and at a public forum. The Project, as proposed by Algonquin Gas Transmission, LLC (“Algonquin” or “Company”), would expand Algonquin’s existing pipeline system from an interconnection at Ramapo, New York to deliver up to an additional 342,000 dekatherms per day of natural gas transportation service to the Connecticut, Rhode Island, and Massachusetts markets.¹ This letter addresses the Massachusetts portion of the AIM Project known as the West Roxbury Lateral (“WRL”).

¹ The transportation path for the AIM Project encompasses a substantial portion of the Algonquin system from receipt points at Ramapo, New York, and Mahwah, New Jersey, near the western end of the system, to Everett, Massachusetts, near the eastern end.

I. INTRODUCTION

Algonquin is a wholly owned subsidiary of Spectra Energy (“Spectra”). With the AIM project, Algonquin seeks to expand its existing pipeline system in New York, Connecticut, Rhode Island, and Massachusetts. FERC is reviewing the AIM Project under its regulations in compliance with the Natural Gas Act (“NGA”) and the National Environmental Policy Act (“NEPA”).

The Siting Board is an independent board of the Commonwealth of Massachusetts with a statutory mission to ensure a “reliable energy supply for the Commonwealth with a minimum impact on the environment at the lowest possible cost.” G.L. c. 164, § 69H. The Siting Board is required by regulation in 980 C.M.R. § 7.07(9)(a) to intervene when an interstate natural gas pipeline company applies to FERC to construct or modify pipeline facilities within Massachusetts. FERC has allowed the Siting Board’s petition to intervene in the instant case, Algonquin Gas Transmission, LLC, Docket No. CP14-96-000.

In the pre-filing phase of the Project, the Siting Board conducted a site visit to the primary and the alternative pipeline routes and held its own public comment hearing regarding the WRL.² In addition, the Board participated in FERC-facilitated teleconferences addressing the Massachusetts portion of the Project. In the Project filing phase, the Siting Board staff have monitored filings and public comments posted for the AIM Project on the FERC website. Most recently, Siting Board staff attended a September 8, 2014 meeting held by FERC in the WRL area to hear public comments on the Draft EIS.

II. PROPOSAL

The Project will include the construction of approximately 37.6 miles of pipeline facilities, modifications to six existing compressor stations (resulting in the addition of 81,620 horsepower of compression), modification to 24 existing metering and regulating (“M&R”) stations, and the construction of three new M&R stations. As a result of these changes, the maximum design capacity of the expanded Algonquin system will increase from approximately 2.6 billion cubic feet per day to 2.9 billion cubic feet per day.

The WRL includes installation of 4.9 miles of new pipeline in the towns of Westwood and Dedham and in the West Roxbury section of Boston. Of the 4.9-mile total, 4.09 miles of

² The Siting Board previously submitted written comments during the pre-filing phase of this case on October 15, 2013, and on December 13, 2013. The October 15 letter addressed comments submitted on line and made at the FERC public scoping meeting held on October 3, 2013. The December 13 letter addressed twelve Draft Resource Reports filed pursuant to FERC regulations by Algonquin and included a summary of comments made at a public hearing on the AIM Project held December 3, 2013, by the Siting Board.

pipeline would be 16 inches in diameter and 0.81 miles would be 24 inches in diameter.³ Algonquin would also construct two new M&R stations in Massachusetts in connection with the AIM Project, one in West Roxbury and the other in Freetown (the Assonet M&R station). Modifications would be made to existing M&R stations located in Freetown, New Bedford, Middleborough, Brockton, Norwood, Needham, Wellesley, and Medford. The WRL would originate in Westwood and be sited within or near Route 1 (aka Providence Highway) in Dedham, and within or near Washington Street, Grove Street, and Centre Street in West Roxbury.

III. COMMENTS ON FERC'S DRAFT EIS

As required by regulation, FERC has distributed a Draft EIS for the AIM Project and anticipates issuing a Final EIS at the end of 2014. In connection with issuance of the Draft EIS FERC staff have also held public meetings in each of the four states along the Project route. The Siting Board staff have reviewed the Draft EIS and attended the associated public hearing held by FERC in Massachusetts on September 8, 2014. Comments at the public hearing focused on three broad areas of concern: (1) the safety of the Project; (2) alternatives to the Project; and (3) process issues related to planning for the Project. Potential traffic impacts of Project construction and impacts to commercial and residential areas were also subjects of considerable interest at the hearing. The following discussion summarizes public comments in Massachusetts on the Draft EIS and additional observation by the Siting Board, with particular focus on the WRL.

A. Pipeline Alignment and Traffic

The Siting Board agrees with comments by the legal representative for Legacy Place, a commercial center along the Project route and an intervenor in this proceeding. Counsel for Legacy Place notes that, although not indicated in the Draft EIS, Algonquin has shifted its pipeline alignment from the north side of Route 1 to the south side, the roadway where Algonquin would construct a significant segment of the WRL. The Siting Board joins Legacy Place in favoring this shift as a way to limit driveway crossings and disturbance to contaminated sub-soils along the roadway shoulder. If well planned, construction of the Project along this modified alignment would minimize traffic impacts. The Siting Board favors the pipeline alignment on the south side of Route 1, but reserves its final determination on this issue until additional information becomes available in the revised Draft EIS.⁴

³ The length of the WRL has changed since distribution of Algonquin's Draft Resource Reports, which listed the WRL as 4.9 miles long. The Draft EIS describes the WRL as 5.1 miles in length. Algonquin's September 19, 2014 Supplemental Information (at 1) filing indicates that the total length of the WRL as currently planned is 4.9 miles.

⁴ As part of its review process, FERC responds to comments and/or revises the Draft EIS before issuing a Final EIS. The Siting Board asks that FERC make specifics of the identified Algonquin pipeline realignment available at its earliest possible convenience.

The Siting Board anticipates that planned nighttime construction in commercial areas along Route 1 will also contribute to minimizing traffic impacts. While the Siting Board supports nighttime construction in commercial areas, we recommend daytime construction off Route 1 in residential areas as overnight construction noise would be disruptive. The Company states that it will coordinate any work during peak traffic periods, 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m., with the Massachusetts Department of Transportation (“MassDOT”) and the communities of Westwood, Dedham, and/or West Roxbury. Given the necessity for daytime construction in residential areas, the Siting Board notes that it is imperative that the Company implement this coordination with MassDOT as planned.

Appendix G of the Draft EIS (the Traffic Management Plan) addresses rush hour traffic management and coordination of traffic management with local authorities. The Siting Board recommends that it also address construction crew parking.

B. Safety

With respect to safety, the proximity of the Project to various sensitive receptors is of concern in the community. The close proximity of the pipeline to Gonzalez Field in Dedham at the intersection of High Street and East Street has garnered particular attention, as has the installation depth of the pipeline. Both Algonquin and FERC have continued to examine pipeline routing at Gonzalez Field with a view to reducing Project impacts at this location. The Draft EIS included a realignment of the originally proposed pipeline route at Gonzalez Field.⁵ FERC required that Algonquin supply supplemental information for its pipeline at Gonzalez Field in the form of a site-specific construction plan to be filed prior to the end of the Draft EIS comment period. Algonquin recently (September 19) provided the supplemental information requested by FERC for Gonzalez Field; however, Algonquin’s filing described additional changes between the WRL at locations MP 2.42 to MP 2.67 (Gonzalez Field), raising the possibility that the current alignment is not the final one. The Siting Board further notes that the September 19th filing did not entirely resolve safety concerns associated with the Gonzalez Field alignment of the pipeline.

The Siting Board therefore asks that FERC closely review any information on the Gonzalez Field pipeline segment that Algonquin submits subsequent to its September 19th filing, as will the Siting Board. The Siting Board also urges FERC to require that, in burying pipelines through playing fields, the Company meet and exceed standard safety protocols for street installations of pipeline. The Company should examine the possibility of deeper-than-minimum

This will allow Siting Board review and comment on the realignment with sufficient time for incorporation of any resulting changes in the EIS.

⁵ See the Draft EIS at Table 3.5.4-1.

burial of pipeline and also undertake extra monitoring to maintain the integrity of in-field pipeline segments over the life of the Project.

Gonzalez Field, St. Teresa Parish, and The Roxbury Latin School are not the only sensitive receptors requiring special attention along the WRL. The Siting Board notes that Algonquin developed Residential Construction Plans (“RCPs”) to address impacts on residences within 50 feet of the construction work areas and to inform affected landowners of proposed measures to minimize disruption. FERC, however, has found these plans to be unacceptable. Therefore, FERC has recommended that Algonquin provide revised RCPs that incorporate and address any comments received from affected landowners and also incorporate additional measures to minimize effects prior to construction.

The Siting Board is concerned that the 50 foot limit is inadequate. Rather, the Board requests that all owners of property within 250 feet of the construction work areas be consulted in connection with the drafting of the revised RCPs. The Siting Board further recommends that, upon receipt of Algonquin’s revised RCPs, that FERC confer with landowners of property located within 250 feet of the construction work areas as well as with Algonquin to ensure that the updated RCPs meet both landowner requests to the extent practicable and FERC specifications. The Siting Board further urges that FERC condition any RCP approval for the WRL with the requirement that Algonquin submit proof, following construction, that all residential areas are restored to preconstruction conditions or as specified in written landowner agreements.

Additional WRL-related safety issues raised by the public include: (1) that the pressure at the meter station (750 pounds per square inch) is too high given the location of the station in a residential area; (2) that shut-off time in case of accident (potentially 90 seconds) is too long; (3) that ten miles is too great a distance between shut-off valves; (4) that the Project requires gas pipeline welds that will eventually require inspection, and inspection of welds is too infrequent to ensure safety along gas pipeline routes; (5) that the safety of pipelines installed in streets with heavy trucking is questionable; and, (6) that in the event of a pipeline explosion, the estimated blast radius of 300 feet would also affect surrounding residences in the fire that accompanies an explosion at a natural gas pipeline. The Siting Board asks that the next version of the EIS specifically address each of these safety concerns.

The safety of pipeline construction near blasting at the West Roxbury Crushed Stone Quarry (“West Roxbury Crushed Stone” or “Quarry”) is also at issue. A related concern is the proposed location across the street from the Quarry of a new M&R station. The siting of the pipeline and the M&R station near the Quarry is the subject of Section III.C, below.

C. Issues Related to West Roxbury Crushed Stone

1. General Issues

The planned route of the AIM pipeline along Centre Street exacerbates existing residential concern about the location of West Roxbury Crushed Stone and its blasting activities for gravel mining. Neighbors of the Quarry assert that blasting occurs frequently and has caused damage at their properties; they anticipate possible damage to the Algonquin pipeline as well. The proposed siting of the West Roxbury M&R station for the Project across the street from the Quarry only increases community misgivings about the proximity of the Quarry. Residents report that icy winter conditions have previously led to local traffic and commercial vehicles accessing the Quarry sliding out of control at this location. They worry about such accidents being even more dangerous given the proposed location of the M&R station.

The Siting Board notes that Algonquin has provided a geotechnical review of the impact on the Project of blasting activity at West Roxbury Crushed Stone. The report states that two existing water lines and one existing gas line are located between the proposed pipeline and West Roxbury Quarry. The report does not state, however, whether blasting at the Quarry has ever damaged these pipelines. Such information is essential and the Siting Board requests that it be included in the next version of the EIS.

The Siting Board also notes that public comments about West Roxbury Crushed Stone made in conjunction with review of the Draft EIS suggest that the Quarry may close in the near future. The Siting Board is interested in the likelihood that this closure will occur and the resultant potential impact on traffic flow associated with filling and/or closing the Quarry, and alternative siting options within the Quarry for the M&R station. Given this interest, the Siting Board asks that FERC require Algonquin to prepare an analysis that includes information on future plans for the Quarry, including a timeline for these plans, and any proposed repurposing of the site. As part of this analysis, Algonquin should indicate the activities involved in Quarry repurposing (e.g., filling in the Quarry) and how they would affect the Project pipeline and the M&R station.

Even if West Roxbury Crushed Stone is not closed in the near future, the Siting Board would welcome a review of the M&R station siting process to ensure that any preferred alternative to the proposed location is not overlooked. In addition, the Siting Board strongly recommends that FERC require that Algonquin meet with the owners of West Roxbury Crushed Stone and with nearby residents. The purpose of meeting would be to develop collaboratively a site-specific construction plan for the Quarry and M&R station location as well as a site-specific noise and vibration mitigation and management plan for the neighborhood.

2. Issues Specific to New Massachusetts Legislation

The Siting Board draws the attention of FERC and Algonquin to an act recently passed by the Massachusetts Legislature: Massachusetts Acts of 2014, Chapter 149. This new law,

effective as of October 1, 2014, appears directly relevant to operation of West Roxbury Crushed Stone and the alignment of the pipeline. Section 7 of Chapter 149 states:

Notwithstanding any general or special law to the contrary, explosive material, as defined in 527 CMR 13.03, shall not be used to fire a blast in any blasting operation at a site primarily used as a source of mined products from the earth if such site is within 500 feet of a natural gas pipeline or metering and regulation station without written approval by the department of public utilities.

The term “explosion” under 527 CMR 13.03 is broadly inclusive such that whatever the Quarry uses when blasting would most likely qualify by definition as an explosive material for regulatory purposes. The Siting Board notes that although some portions of the Quarry may lie outside the 500 foot radius established by Section 7, it is certainly the case that sections of the proposed pipeline come within 500 feet of the West Roxbury Crushed Stone property line, as does the M&R station. Although FERC is not bound by state law in this instance, the same is not true of the Quarry, to which the provisions of the referenced Massachusetts law are applicable.

The Siting Board recommends, in addition to review of Quarry and pipeline safety concerns already noted, that FERC and Algonquin: (1) analyze whether the planned siting of the pipeline and M&R station might result in a violation of Massachusetts Acts of 2014, Chapter 149, Section 7 by West Roxbury Crushed Stone in the course of its blasting operations; and (2) consider the physical safety consequences posed by such blasting activities, including the advisability of siting of the M&R station and any segments of the proposed pipeline within 500 feet of the Quarry property line. The Siting Board emphasizes that – regardless of whether the Project would result in the Quarry’s blasting activities violating Massachusetts Acts of 2014, Chapter 149, Section 7 – it is important to ensure that the Project is sited so that its location is consistent with the continued operation of the Quarry.

D. Visual Impacts

Visual impacts of the M&R station, though less controversial than other potential station impacts, may nonetheless warrant remedy. In the Draft EIS at 4-170, FERC concludes that the M&R station would have minimal visual impact based on Algonquin’s statement that it would maintain an existing wooded buffer on the entire west side of the M&R station site as well as along parts of the north and south sides of the parcel. There is, however, no evidence beyond Algonquin’s representation on which to base a conclusion as to the station’s likely visual impact. Algonquin has not yet provided a site plan or a landscaping plan for the M&R station, despite an earlier Siting Board request to obtain such documents.

E. Process Issues

1. Remarks on Process by Members of the Public

Process issues associated with the Draft EIS have also elicited public comment in Massachusetts. Concern about process was very evident at the September 8, 2014 FERC hearing on the Draft EIS. A number of speakers objected that the public hearing focused on the portion of the Project in Massachusetts only rather than on the Project in its entirety. The lack of design information for the M&R station across the street from West Roxbury Crushed Stone was a source of dissatisfaction as was the handling of public notification regarding the Project, public comment hearings, and the Draft EIS. A repeated observation was that the timing of the public comment hearing for the Draft EIS (on the evening before state primary elections) inhibited public participation. In connection with this scheduling issue, several individuals asked FERC to hold an additional public hearing and to extend the comment period on the Draft EIS for the WRL. Commenters suggested that having access to electric utility representatives and representatives of the Project together would be helpful. Many voiced criticism of the public outreach and participation process by Algonquin and FERC.

2. Remarks on Multiple Topics by Public Officials

Four public officials attended, or sent representatives to, the September 8, 2014 FERC public hearing. Henry Cohen represented Boston City Councilor Michelle Wu; Christopher Rusk represented Boston Mayor Martin Walsh. Officials attending the public hearing included Boston City Councilor Matthew O'Malley and Massachusetts State Representative Edward Coppinger.

- Councilor Wu's comments, as relayed by Mr. Cohen, addressed the lack of notification, process, safety, and need for the project.
- Mayor Walsh's comments, as relayed by Mr. Rusk, centered on the safety hazards presented by the pipeline and the diminished quality of life that would be caused by construction in heavily populated West Roxbury. Mr. Rusk also stated that Mayor Walsh had written to FERC to request that Monday night's hearing be postponed because the next day, Tuesday, was primary day. As a consequence, many of the Commonwealth's politicians and its most politically active citizens had other engagements on Monday night. Finally, Mayor Walsh requested that FERC hold another public meeting.
- Matthew O'Malley, the Boston City Councilor for the district that includes West Roxbury, asserted that the process of notification was inadequate, and he also requested that FERC hold another meeting.

- Edward Coppinger, a state representative whose district includes all of West Roxbury, complained of inadequate notice of the proposed pipeline construction and he also requested that FERC hold another public meeting. In addition, Rep. Coppinger stated that when the Company consulted with the elected officials, he assumed that it would follow up by consulting with the general public. He was disappointed that the Company did not do so.

3. Additional Comments on Process

The Siting Board notes that Board of Selectmen and neighborhood meetings held by Algonquin approximately a week before FERC's September 8 meeting on the Draft EIS provided initial exposure to the AIM Project for some residents. The Siting Board very much supports neighborhood meetings as a tool to inform residents and to collect their feedback on this and other Projects under FERC purview. The Siting Board recommends, however, that such meetings occur at an earlier stage of the process to improve the timing, quality, and completeness of communication between residents and Project developers.

IV. CLOSING COMMENTS

The Project has undergone significant development from the pre-filing stage to publication of the Draft EIS. The Siting Board appreciates the efforts of FERC staff and the Company to address comments submitted during the FERC Project pre-filing process by members of the Massachusetts public and by Siting Board staff. The Siting Board looks forward to examining the revision of the Draft EIS that incorporates the requests and comments above. The Siting Board will continue to monitor electronic filings in Algonquin Gas Transmission, LLC, Docket No. CP14-96-000 through FERC's refinement of its Draft EIS and issuance of its Final EIS, anticipated in mid-December 2014.

Sincerely yours,



Robert J. Shea
Presiding Officer

cc: Mr. Douglas Sipe (FERC)
Ms. Maggie Suter (FERC)

**Exhibit 3 to West Roxbury Motion for
Rehearing: Public Hearing**

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December 13, 2013

Mark D. Marini, Secretary
Department of Public Utilities
One South Station, 5th Floor
Boston, MA 02110

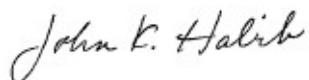
Re: National Grid, D.P.U. 13-157

Dear Secretary Marini:

On behalf of Boston Gas Company and Colonial Gas Company d/b/a National Grid (the “Company”), please find enclosed the Company’s supplemental response to Record Request-DPU-2 filed on December 6, 2013.

Thank you for your attention to this matter.

Very truly yours,



John K. Habib

Enclosures

Cc: Service List, D.P.U. 13-157

Boston Gas Company and Colonial Gas Company
d/b/a National Grid
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Record Request DPU-2 (Tr. at Vol. 1, p. 52)

If the Department wants to suggest any changes to the lateral project, will the AIM project be affected at all? In that context, please calculate the cost per dekatherm if the West Roxbury lateral were sized for 50,000/day.

Supplemental Response

Please find attached the December 3, 2013 public hearing transcript of the Massachusetts Energy Facilities Siting Board (“EFSB”) which includes public comment on the proposed West Roxbury Lateral (Attachment RR-DPU-2). The transcript includes comments addressed to the EFSB and the Federal Energy Regulatory Commission seeking to minimize the construction impacts associated with the West Roxbury Lateral, including traffic and congestion (see e.g. Attachment RR-DPU-2, at 24-25, 38). These comments reinforce the Company’s perspective that constructing the West Roxbury Lateral at the proposed size of 100,000 Dth/day now is preferable to constructing the Lateral at half that capacity now, and then having to construct new capacity in the near future along the same route, giving the permitting obstacles and environmental impacts that would be associated with constructing the Lateral in stages.

Original Response

The Precedent Agreement between Boston Gas and Algonquin addresses the expansion on the mainline and construction of the West Roxbury lateral on a fully integrated basis. The Company does not have the contractual right to unilaterally separate those two aspects of the overall project.

Pursuant to Section 7(b)(ii) of the Precedent Agreement (the “Agreement”), the Company’s obligations under the service agreements are subject to the Company’s receipt and acceptance, by December 1, 2013¹, of approval of the Massachusetts Department of Public Utilities. If this condition precedent is not satisfied, the Company has the right, pursuant to Section 9(b), to terminate the Agreement. If the Company, or any other Shipper of the Project terminates, Algonquin has the right to adjust the reservation rate, subject to a cap, for the remaining Shippers. The combined participation of Boston Gas and Colonial Gas is approximately one-third of the total Project volume, and such termination would presumably have a significant (upward) impact on allocation of costs to remaining Shippers of the Project.

¹ The Company has requested that Algonquin extend the date set forth in Section 7(b)(ii) of the Agreement to February 1, 2014.

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A decision to require National Grid to downsize the West Roxbury lateral would have significant cost impacts to customers in the future, particularly in comparison to the small amount of costs that would be eliminated by reducing the pipe size. The Company needs deliverability of 100,000 Dth per day into this area of the system over the next several years and will utilize 30,000 Dth per day upon the in-service date of the contract. The only reason that the 100,000 Dth per day will not be immediately leveraged for the benefit of the system on the in-service date is that there are certain infrastructure upgrades that must be installed on a sequenced basis to distribute the gas from the Lateral across the Boston Gas distribution system. These infrastructure upgrades cannot be completed unless and until the Lateral is in-service. From the point the Lateral is placed in-service, the Company will work to complete those upgrades on the distribution system so that access to the needed supplies (100,000 Dth per day) is achieved.

If only 50,000 Dth is constructed at this point, the Company will have to upgrade the facility within a short time of its installation. However, it is highly unlikely that there would be an opportunity to permit and relay new pipeline through the towns of Westwood, Dedham and West Roxbury once this project is completed. Even if such a project were permitted, the cost would be equivalent to installing a brand new lateral and likely would be much greater due to the fact there would be existing gas facilities in place. Therefore, it is unclear to the Company how it would meet the existing need in the system if this lateral is not constructed at this time with a sufficient pipe size.

If the West Roxbury lateral were sized for 50,000/day, the Company estimates that the cost differential would be in the range of \$1.8 million in reduced pipeline and meter station costs, which represents a small fraction of the overall cost of the lateral (see Exh. EDA-JEA-2, at page 39 of 54 **CONFIDENTIAL**). The cost of meeting the need through a separate project at a later date would be many multiples of this amount, costing customers a much greater amount than it would if addressed at this point in time. Sizing the lateral to a maximum of 50,000 Dth per day is an extremely shortsighted proposition given this cost differential.

In addition, the reliability improvements that will be available as a result of the project will accrue *as of the in-service date* of the project because the West Roxbury Lateral will be interconnected with the Algonquin "I" system. Should there be operational issues on the Algonquin "J" system, delivering 38 percent of the gas to the Boston area, supplies can be diverted to the West Roxbury Lateral on the "I" system. Upon completion of the Algonquin AIM project, the Company will install additional distribution pipeline downstream of the West Roxbury delivery point to increase takeaway capacity and enable full utilization of the capacity of the lateral. This work

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needs to commence after the AIM project is completed to allow for proper coordination of the gas transmission and distribution work.

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COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITIES
PF 13-16-000

PUBLIC HEARING, held at the Holiday Inn,
55 Ariadne Road, Dedham, Massachusetts, on Tuesday,
December 3, 2013, commencing at 7:09 p.m.,
concerning

ALGONQUIN GAS TRANSMISSION, LLC

SITTING:

Robert Shea, Hearing Officer

Barbara Shapiro, Environmental Director

Enid Kumin, Economist

Maggie Suter, FERC

-----Reporter: David A. Arsenault, RPR-----

Farmer Arsenault Brock LLC

50 Congress Street, Boston, MA 02109

617.728.4404

PF 13-16-000 - Algonquin Gas Transmission LLC - Vol. A - 12/3/2013

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<p>1 PROCEEDINGS -- 7:09 p.m.</p> <p>2 MR. SHEA: Good evening. This is a</p> <p>3 public hearing held by the Massachusetts Energy</p> <p>4 Facilities Siting Board relating to a pre-filing</p> <p>5 proceeding at the Federal Energy Regulatory</p> <p>6 Commission, which is better known as FERC. The FERC</p> <p>7 docket number in this case is P, as in Peter, F as</p> <p>8 in Frank, 13-16. This pre-filing process was begun</p> <p>9 by Algonquin Gas Transmission, LLC and it relates to</p> <p>10 the Algonquin Incremental Market Project, also</p> <p>11 called the AIM project. The AIM project involves an</p> <p>12 expansion of Algonquin's existing pipeline system in</p> <p>13 New York, Connecticut, Rhode Island and</p> <p>14 Massachusetts. The portion of the AIM project to be</p> <p>15 constructed in Massachusetts consists of 4.9 miles</p> <p>16 of new pipeline that will be located in West</p> <p>17 Roxbury, Dedham and Westwood, as well as new meter</p> <p>18 stations in West Roxbury and Assonet.</p> <p>19 My name is Robert Shea. I have been</p> <p>20 designated as the hearing officer from the</p> <p>21 Massachusetts Energy Facilities Siting Board for</p> <p>22 this matter. With me this evening are -- to my</p> <p>23 immediate left is Barbara Shapiro, the environmental</p> <p>24 director of the Siting Board; to Barbara's left is</p>	<p>1 Siting Board is to review proposals for the</p> <p>2 construction of new energy facilities in</p> <p>3 Massachusetts, including large power plants,</p> <p>4 electric transmission lines, natural gas pipelines</p> <p>5 and natural gas storage tanks. The Siting Board</p> <p>6 does not, however, have the authority to approve or</p> <p>7 disapprove interstate natural gas pipelines such as</p> <p>8 the one proposed by Algonquin in this case.</p> <p>9 Instead, such authority rests with FERC, which is</p> <p>10 located in Washington, D.C. The Siting Board is not</p> <p>11 a part of FERC. FERC is an agency of the federal</p> <p>12 government, and the Siting Board is a state agency.</p> <p>13 When an interstate natural gas pipeline</p> <p>14 company such as Algonquin applies to FERC to</p> <p>15 construct or modify facilities within Massachusetts,</p> <p>16 the Siting Board is required by its regulations to</p> <p>17 preserve the rights of interested citizens and</p> <p>18 residents of the Commonwealth by intervening in the</p> <p>19 FERC proceedings in any such application. The</p> <p>20 Siting Board is also required to hold a public</p> <p>21 informational hearing in the area where the proposed</p> <p>22 facility will be located. The interstate pipeline</p> <p>23 company must attend the hearing to address the</p> <p>24 questions and concerns of the public.</p>	
<p>1 Enid Kumin, who is an economist with the Siting</p> <p>2 Board. And then to my far left is Maggie Suter, a</p> <p>3 representative of FERC who has been kind enough to</p> <p>4 come up from Washington today. Representatives from</p> <p>5 Algonquin and Algonquin's attorneys are also here</p> <p>6 and many of them are seated in the front row to my</p> <p>7 left.</p> <p>8 My opening remarks tonight are designed</p> <p>9 to provide a brief description of the Siting Board</p> <p>10 and its role in this particular case, to explain how</p> <p>11 individuals can be involved in the Board's process,</p> <p>12 and to establish some guidelines for tonight's</p> <p>13 public hearing. The Siting Board is an</p> <p>14 administrative agency of the Commonwealth of</p> <p>15 Massachusetts. The Siting Board consists of nine</p> <p>16 members. The board members include the Secretary of</p> <p>17 Energy and Environmental Affairs, who serves as a</p> <p>18 chairman; the Secretary of Housing and Economic</p> <p>19 Development; the Commissioner of the Department of</p> <p>20 Environmental Protection; the Commissioner of the</p> <p>21 Division of Energy Resources; two Commissioners from</p> <p>22 the Department of Public Utilities; and three public</p> <p>23 members who are appointed by the Governor.</p> <p>24 One of the principal functions of the</p>	<p>3</p> <p>1 After the conclusion of the public</p> <p>2 hearing and an additional public comment period, the</p> <p>3 Siting Board will file written comments regarding</p> <p>4 the proposed project with FERC. The Siting Board's</p> <p>5 comments are intended to identify difficulties and</p> <p>6 problems with the project associated with</p> <p>7 environmental issues as required by the Siting</p> <p>8 Board's regulations.</p> <p>9 The Siting Board's comments to FERC will</p> <p>10 be based in part upon a review of the documents that</p> <p>11 Algonquin has filed with FERC in connection with</p> <p>12 this pre-filing proceeding, a site visit by the</p> <p>13 Siting Board staff along the proposed pipeline</p> <p>14 route, and also upon public comments and questions</p> <p>15 received by the Siting Board. The Siting Board</p> <p>16 encourages those attending the hearing tonight to</p> <p>17 comment on the potential environmental impacts of</p> <p>18 Algonquin's proposal, especially any specific</p> <p>19 concerns that you may have and any possible</p> <p>20 solutions or mitigation measures.</p> <p>21 In addition to comments received at</p> <p>22 tonight's hearing, the Siting Board will also accept</p> <p>23 written comments following this hearing. All</p> <p>24 comments regarding the AIM project must be received</p>	5

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1 by me no later than Monday, December 9, 2013 in 2 order to be included in the comments that the Siting 3 Board will file with FERC. 4 At the back table there are several 5 sheets of paper copies that contain my contact 6 information. The same sheet also contains the 7 regulations that dictate how the Siting Board 8 proceeds in cases such as this one. So please feel 9 free to go to the back table and take a copy of this 10 document. It has my contact information and you 11 will be able to send me written comments, if you 12 want, or just if you have questions later on or you 13 just want to keep in contact you will be able to 14 contact me. 15 I have a few more words about this 16 evening's procedure. In a minute I will turn the 17 microphone over to Maggie Suter from FERC who will 18 explain the FERC process in more detail. Then 19 Algonquin will present a description of the proposed 20 project. That will be followed by questions and 21 comments from the public. I will first call on 22 state or local officials or their representatives 23 who may be present. Then I will call on people in 24 the order that they have signed the speakers list	1 environmental impact statement for this project. 2 Many of you may have spoken to me before 3 or attended our scoping meeting a few months ago. 4 I'm going to reiterate a bit of information about 5 FERC and our process for you. 6 FERC is an independent agency that 7 regulates the interstate transmission of 8 electricity, natural gas and oil. As a federal 9 licensing agency the FERC has the responsibility 10 under the National Environmental Policy Act, or 11 NEPA, to consider the potential environmental 12 impacts associated with the project which is under 13 its consideration. 14 With regard to Algonquin's AIM project, 15 the FERC is the lead federal agency for the NEPA 16 review and the preparation of the EIS. We are 17 currently meeting with other federal, state and 18 local agencies to determine their NEPA 19 responsibilities and their potential levels of 20 involvement in the project and whether any agencies 21 may wish to become cooperating agencies in 22 preparation of the EIS. 23 These issues generally focus on the 24 potential for environmental effects but may also
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<p>10</p> <p>1 pre-filing so that FERC can be involved earlier to 2 meet with the stakeholders and other agencies to 3 begin identifying the issues and work on the 4 resolution of those issues. To do that we have 5 attended open houses and we have hosted our scoping 6 meetings earlier on in the pre-filing process so 7 that we can get out earlier. So those are all held, 8 in this red box here, early on in this first public 9 input opportunity.</p> <p>10 As I mentioned, the pre-filing process 11 allows for extra public input opportunities earlier 12 on in Algonquin's development of an application. On 13 September 13th FERC issued a notice of intent, or 14 NOI, to prepare an EIS for this project and 15 initiated a scoping period. The scoping or comment 16 period ended on October 15, 2013.</p> <p>17 I'm going to note here that NEPA 18 requires FERC to have a comment period. However, 19 the Commission's pre-filing process allows FERC to 20 continue to accept comments beyond the end of that 21 NEPA comment period. Our docket continues to remain 22 open and comments and can continue to be filed with 23 the FERC for further valuation.</p> <p>24 During our review of the project, we</p>	<p>12</p> <p>1 project is quite large and undergoing constant 2 revision. You can be added to our mailing list by 3 finding me or Jennifer after this evening and 4 providing us with your address and we will ensure 5 that you are on our mailing list. If you have 6 received a notice from us in the past, you are on 7 our mailing list.</p> <p>8 It is very important that any comments 9 you send, either electronically or by traditional 10 mail, include our internal docket number for the 11 project. As Robert mentioned earlier, that docket 12 number is PF 13-16.</p> <p>13 I would like to finish by explaining the 14 roles of the FERC Commission and the FERC 15 environmental staff. Up to five member 16 Commissioners are responsible for making a 17 determination on whether to issue a certificate of 18 public convenience and necessity to the applicant 19 for a specific project. In this case that is 20 Algonquin for the AIM project. The EIS prepared by 21 the FERC environmental staff, which I am a part of, 22 describes the project facilities and associated 23 environmental impacts, alternatives to the project, 24 mitigation to avoid or reduce impacts, and</p>
<p>11</p> <p>1 will assemble information from a variety of sources, 2 including Algonquin, the public, other state, 3 federal and local agencies, and our own independent 4 analysis and field work. This will include an 5 examination of the proposed facility locations as 6 well as alternative sites. We will assess the 7 project's effects on water bodies and wetlands, 8 vegetation and wildlife, endangered species, 9 cultural resources, soil, land use, air quality, and 10 safety. We will analyze this information. And 11 after an application is filed with FERC, we will 12 prepare and issue a draft environmental impact 13 statement or EIS. This draft EIS will be mailed to 14 our entire mailing list for the project for public 15 comment. During the 45-day comment period on the 16 draft EIS, we will hold more public meetings to 17 gather feedback on our analysis and findings. 18 That's this second red box on this flow chart, which 19 is your next public input opportunity that FERC will 20 hold.</p> <p>21 After making any necessary changes or 22 additions to the draft EIS, a final EIS will again 23 be mailed to the entire mailing list. I'm going to 24 note here quickly that the mailing list for this</p>	<p>13</p> <p>1 conclusions and/or recommendations.</p> <p>2 The EIS is not a decision document. I'm 3 going to say that one again. The EIS is not a 4 decision document. It is being prepared to disclose 5 to the public and to the Commission the 6 environmental impact of constructing and operating 7 the proposed project. When it is completed, the 8 Commissioners will consider the environmental 9 information in the EIS along with nonenvironmental 10 issues, such as engineering, market and rates, in 11 making its decision whether to approve or deny 12 Algonquin's request for a certificate. There is no 13 review of FERC's decision by the President or 14 Congress, which maintains FERC independence as a 15 regulatory agency and provides for fair and unbiased 16 decisions. Thank you.</p> <p>17 MR. SHEA: Thank you very much, 18 Ms. Suter. I note that Algonquin has placed a very 19 detailed series of maps and diagrams out there. 20 I'll call on Algonquin to make a presentation at 21 this time.</p> <p>22 MR. LUSKAY: Thank you, Robert. Good 23 evening. My name is James Luskay. I'm the regional 24 project director for Algonquin Gas, Spectra Energy.</p>

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<p style="text-align: center;">14</p> <p>1 I'm very pleased to be here. Thank you for the 2 opportunity to address you this evening.</p> <p>3 Spectra Energy, Algonquin Gas has served 4 customers and communities in North America for more 5 than a century. The company develops and operates 6 natural gas, liquid and crude oil pipelines. 7 Additionally, the company gathers and processes 8 natural gas, stores it and distributes it.</p> <p>9 Spectra Energy's assets include 10 Algonquin Gas Transmission, LLC or Algonquin, which 11 is an interstate pipeline system which has been 12 operating safely for 60 years in this area 13 transporting up to 2.44 billion cubic feet per day 14 of natural gas from major supply basins into New 15 Jersey, New York and New England.</p> <p>16 The Algonquin system includes 1,120 17 miles of various size pipelines extending from 18 Lambertville, New Jersey to New York, Connecticut, 19 Rhode Island and Massachusetts. The system includes 20 main lines, laterals and 35 miles of offshore 21 pipeline from Weymouth to Beverly, Massachusetts, 22 referred to as hub line.</p> <p>23 The Algonquin system interconnects with 24 Spectra Energy's Texas Eastern Transmission System</p>	<p style="text-align: center;">16</p> <p>1 future growth for clean-burning natural gas. 2 Investment in new natural gas pipeline 3 infrastructure, such as the AIM project, will lead 4 to savings in energy costs. A report by the 5 Concentric Energy Advisors concludes that the direct 6 benefit of the New England infrastructure is 7 estimated to range from approximately 243 to \$313 8 million in annual cost savings.</p> <p>9 Open seasons were held in September 10 through November of 2012 and in June of this year. 11 An open season is a process where potential 12 customers express interest in participating in 13 pipeline expansion projects that will provide them 14 with access to pipeline capacity. How much they 15 request is based on their projected needs. The 16 accumulation of all of the participating customer 17 requirements is what determines the scope of the 18 project and what facilities need to be built to 19 serve their demand.</p> <p>20 As the development of the project 21 evolves, the volumes committed to by the customer 22 and the resulting scope does change. Currently our 23 scope, as previously mentioned, is 343,000 24 decatherms per day. We have executed precedent</p>
<p style="text-align: center;">15</p> <p>1 in Lambertville, New Jersey, and with the Maritimes 2 and Northeast pipeline, a majority owned by Spectra 3 Energy Corporation in Beverly, Massachusetts. We 4 also connect with the interstate pipeline 5 infrastructure that allows us access to all major 6 North American natural gas supply sources. By 7 regulation, Algonquin is an open-access pipeline 8 that must transport natural gas on a 9 nondiscriminatory basis.</p> <p>10 A little about the purpose and need for 11 this project. As Robert has mentioned, currently 12 Algonquin is participating in the Federal Energy 13 Regulatory Commission or FERC's pre-filing process 14 for a proposed expansion called the Algonquin 15 Incremental Market Project or AIM project. The AIM 16 project will expand Algonquin's existing pipeline 17 system in order to transport an additional 342,000 18 decatherms per day of natural gas from an 19 interconnect at Ramapo, New York into the Northeast. 20 The increased capacity offered by the AIM project 21 will allow abundant domestically produced natural 22 gas supplies to flow reliably into Northeast 23 markets. These secure, cost-effective supplies will 24 help meet the region's current demand as well as</p>	<p style="text-align: center;">17</p> <p>1 agreements with the following Massachusetts local 2 distribution companies: Northeast Utilities, which 3 includes Yankee Gas Service in Connecticut as well 4 as NSTAR Gas Company in New York; National Grid, 5 which includes Narragansett, Colonial and Boston Gas; 6 NiSource, which includes Bay State Gas Company and 7 Middleborough Gas.</p> <p>8 About our project schedule. In February 9 and March of this year, we began contacting 10 landowners and federal and state and local officials 11 to begin to introduce the project and to start to 12 gather feedback on proposed facilities and 13 locations. With FERC's approval, we began the 14 pre-filing process in June. As part of the FERC 15 process, agencies such as the Massachusetts Siting 16 Board are involved in the review of the project as a 17 participating agency. As part of the Massachusetts 18 Energy Facilities Siting Board's due diligence, they 19 have requested this meeting this evening.</p> <p>20 From April to October there have been 21 approximately 30 landowner informational meetings, 22 open houses and FERC scoping meetings in New York, 23 Connecticut, Rhode Island and Massachusetts. This 24 is the fourth such meeting held in this area. These</p>

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<p>1 meetings provide opportunities for people to learn 2 more about the AIM project, let us know how the 3 proposed facilities may impact them, and discuss how 4 the impacts may be mitigated. We expect to complete 5 the pre-filing process and submit a certificate 6 application to FERC in February of 2014. We hope 7 that FERC will issue a draft environmental impact 8 statement, as has been mentioned, in July 2014 which 9 will include comments received at this public 10 meeting and throughout the scoping period.</p> <p>11 We will ask that FERC approve the AIM 12 project by January of 2015. This will allow us to 13 begin construction in the second quarter of 2015. 14 Construction will be scheduled over a two-year 15 period to manage outages and minimize local impacts. 16 We anticipate placing the AIM project fully into 17 service in November of 2016.</p> <p>18 A little bit about the project scope. 19 As the AIM projects move forward, we have revised 20 facilities to align them with the needs of our 21 customers. At this time the overall project we are 22 proposing is to construct approximately 21.7 miles 23 of various segments of main line primarily by 24 removal and replacement or looping of existing</p>	<p>1 route is beginning, including opportunities to 2 minimize impacts to the area.</p> <p>3 One area of attention is proposed in- 4 street construction and subsequent traffic control. 5 Measures will be taken to develop sequence of 6 construction activities and traffic management plans 7 to minimize traffic and business interference to the 8 extent feasible. This work is similar to recent 9 successful projects such as the 2009 expansion of 10 Algonquin's J system in Somerville and Medford, 11 Massachusetts as well as a recently completed 12 project in New Jersey and New York. Preliminary 13 planning discussions have already begun with Mass. 14 DOT and the public works departments of Westwood, 15 Dedham and Boston.</p> <p>16 Blasting is another area of special 17 attention, both for the construction of the new line 18 and the meter station as well as ensuring the design 19 accommodates the ongoing quarry blasting. Should 20 blasting be necessary to install the proposed 21 facilities, shots will be designed to minimize 22 vibrations beyond the work area. Pre- and 23 post-survey structure surveys will also be conducted 24 as part of the blasting plan. A blasting specialty</p>
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<p>1 lines; also, to construct approximately 15.3 miles 2 of lateral pipeline either by removal, replacement 3 or looping existing lines and expansion that also 4 includes 4.8 miles of new 16-inch and 24-inch 5 pipeline lateral.</p> <p>6 We propose to add six new compressor 7 units for a total of 72,240 additional horsepower at 8 five existing Algonquin compressor stations, 9 construct three new meter stations, and modify 10 existing meter stations.</p> <p>11 More specifically here in Massachusetts, 12 we propose to construct 4.8 miles of new 16- and 13 24-inch-diameter lateral pipeline from Westwood to 14 West Roxbury, Massachusetts; construct a new meter 15 station in West Roxbury, Massachusetts; construct a 16 new meter station in Assonet, Massachusetts; and 17 make modifications to existing meter stations.</p> <p>18 For the design and construction for the 19 West Roxbury lateral, there are a few areas that 20 have been recognized as requiring specific attention 21 which have been raised at previous meetings through 22 the FERC scoping comments and during our evaluation 23 of the proposed route. The preliminary survey work 24 is complete, and a more detailed evaluation of the</p>	<p>1 consultant will be engaged to evaluate the blasting 2 activities at the quarry, and the information will 3 be incorporated into the safe design of the pipeline 4 and the meter station.</p> <p>5 Should contaminated soil or water be 6 encountered during construction, it will be analyzed 7 and characterized in order to be properly handled. 8 Again, the procedures employed will be similar to 9 those utilized in the recent J lateral work in 10 Massachusetts as well as a recent project in New 11 Jersey and New York.</p> <p>12 In closing, we wish to thank landowners, 13 public officials, regulatory agencies, including the 14 Massachusetts Energy Facilities Siting Board, and 15 FERC and other interested parties who have offered 16 their guidance and input as we develop the AIM 17 project. We are certain that the information we 18 receive throughout the pre-filing process will help 19 us design, construct and operate a safe, efficient 20 and environmentally responsible expansion of the 21 Algonquin system.</p> <p>22 Thank you again for your time. 23 MR. SHEA: Thank you. 24 Let me first ask, are there any public</p>

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<p>1 officials who are here tonight who would like to 2 speak? No. Then let me take a look at the sign-up 3 sheet. The first person who signed up is Sanford 4 Matathia.</p> <p>5 MR. MATATHIA: Thank you, Robert. My 6 name is Sanford, S a n f o r d, Matathia, M a t a t 7 h i a. I'm counsel at Rackemann Sawyer and Brewster 8 in Boston and representing National Amusements in 9 connection with their Legacy Place Showcase Cinema 10 and lifestyle retail center just on the other side 11 of Route 1 from here.</p> <p>12 I would like to offer a handful of 13 comments tonight. I do not have prepared remarks, 14 so excuse me for that. However, I do have an 15 outline of bullet points which I can pass out to the 16 head table here and whoever else might care to have 17 one.</p> <p>18 MR. SHEA: Thank you very much.</p> <p>19 MR. MATATHIA: My first comment is 20 procedural. And I'll follow it with a couple of 21 substantive remarks or remarks on substantive 22 issues. The procedural issue is the observation 23 that this project is subject to environmental review 24 both at the federal level under NEPA, which has</p>	<p>1 As for substance, the observation on 2 behalf of National Amusements and Legacy Place is 3 that a key impact of this project, however temporary 4 it may be, is with respect to traffic and roadway 5 congestion. The identity of issues of concern by 6 FERC to date in the NEPA environmental review 7 process does not yet include traffic, per se. There 8 was a list that was ticked off earlier this evening. 9 It did not include traffic. I do note that the 10 proponent's representative did identify that issue 11 or that concern as being voiced previously, and duly 12 noted. However, it is customary for NEPA as well as 13 MEPA to include traffic impact analysis in the 14 environmental review as a major area of impact and 15 concern. And I have outlined in the bullet-style 16 presentation handout a number of datapoints that we 17 believe must be brought to bear in order to see that 18 issue clearly and to deal with it effectively. 19 Those include getting average annual 20 daily traffic on Route 1 and connecting roadways; 21 getting monthly variations off of the average 22 annual; getting hourly variations, which fluctuate 23 wildly on Route 1 commensurate with commuter traffic 24 and retail traffic, consumer traffic and other</p>
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<p>1 already been described to you, as well as at the 2 state level, under MEPA, which has not yet been 3 mentioned. The thought here is that these two 4 processes at the federal and the state level come 5 together and be dovetailed and coordinated.</p> <p>6 The suggestion is that the Facilities 7 Siting Board's comments which are being elicited 8 here tonight and which will be delivered to FERC 9 await and incorporate the comments which will be 10 given by the public, including state agencies, to 11 the MEPA unit in the environmental affairs office of 12 the Commonwealth and that those all get folded in 13 and passed through. The mechanism, if you will, to 14 enable that coordinated process to happen would be 15 to extend the deadline for comment here to the 16 Siting Board so that those comments are open until 17 the conclusion of the MEPA process on the ENF.</p> <p>18 The further observation is that in 19 documents filed with FERC that the proponent has 20 indicated that they are filing the project with MEPA 21 in November. I don't believe that has happened as 22 yet. Assuming they do so in December, the comment 23 period would run through 20 days thereafter. We can 24 leave the procedural point there.</p>	<p>1 traffic, as well as looking at major intersecting 2 roads and turning movements on and off those roads, 3 all of which will be affected by construction in the 4 roadway. 5 The basic idea of collecting this 6 information is to analyze it and to identify the 7 severity and duration of traffic effects owing to 8 the construction of the project at different times 9 of the year and different times of the day, and to 10 identify those periods, those time periods both 11 seasonally and daily where construction will cause 12 the least possible traffic impact. That data and 13 that study and that analysis will enable the project 14 proponent to be well informed in the agency's 15 reviewing and guiding the project to effectively 16 point up the types of mitigation that would be 17 appropriate in order to minimize or avoid these type 18 of effects. 19 Examples of what I'm talking about would 20 include the avoidance of construction during heavy 21 traffic congestion periods such as summer holiday 22 weekends, early school startup period and the 23 Thanksgiving period as well; to limit construction 24 to predominantly nighttime hours and to avoid lane</p>

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<p>1 closures during daytime hours, and to selectively 2 use horizontal drilling across major driveways in 3 order to avoid impeding traffic flow as well as 4 detailed -- traffic detail officers and other 5 customary traffic management measures.</p> <p>6 One other point here is that traffic 7 impacts can easily become exacerbated and multiplied 8 in the event that construction in these roadways 9 proceeds with interruption or impediment or 10 encumbrance. One of the primary examples of this 11 which showed itself in connection with the Central 12 Artery project and also with the Legacy Place 13 project is due to hazardous materials that 14 unfortunately dot the landscape in this vicinity due 15 to historic activities.</p> <p>16 The resource reports that were filed by 17 the project proponent indicate a whole cluster of 18 contaminated sites along Elm Street and Route 1 as 19 well as elsewhere. The potential for that 20 contamination to bleed into the public right-of-way 21 is present. Some detail evaluation of that issue 22 needs to be made. It is not unusual to have that 23 evaluation be actual testing of sites along the 24 right-of-way; and with the benefit of the data</p>	<p>1 address the comments especially about extending the 2 comment period? You don't have to address it. 3 MS. SUTER: I can address what I can, 4 but this is your comment period he was taking about. 5 MR. SHEA: But our comment period is set 6 on FERC's comment period. We require all comments 7 to be in by the 9th of December in order that we can 8 get them to FERC, so that we can summarize them and 9 get them to FERC by the 13th, and that's a FERC 10 deadline. We are working within the FERC framework. 11 Mr. Luskay, do you want to address any 12 of the issues that Mr. Matathia raised? 13 MR. LUSKAY: I'll not address but I 14 appreciate the comments. I think that they are very 15 important. Some of them we have heard before, 16 certainly on traffic mitigation. That is a major 17 item that we need to focus on. We look forward to 18 working with your client and addressing what is 19 going to be least disruptive to business in that 20 area and also on contaminated materials. That is 21 something we do have extensive experience with, as I 22 mentioned in our J system expansion as well as our 23 work recently done in New Jersey and New York. It 24 is something that unfortunately we do encounter</p>
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<p>1 coming from that testing, to characterize the 2 right-of-way and actually to preclear it in advance 3 of construction for the pipeline itself so that when 4 you're laying the pipeline it can go smoothly and 5 not be hung up, if you will, or bogged down by the 6 presence of contamination, which itself is a 7 juggernaut sometimes to deal with. And obviously 8 when, as and when hazardous waste cleanup proceeds 9 along the right-of-way that that in and of itself is 10 a construction activity and it too needs traffic 11 mitigation along the lines that I previously 12 outlined.</p> <p>13 One last comment is that we think it is 14 still appropriate, particularly at the early stage 15 of project planning, to look at alternative 16 alignments and to the extent there are routes that 17 avoid these issues and perhaps are not in 18 rights-of-way but instead are cross-country that 19 that should be considered.</p> <p>20 I appreciate your time and attention. I 21 hope these comments are helpful and will be happy to 22 follow up as you might wish. Thank you.</p> <p>23 MR. SHEA: Let me ask in response to 24 Mr. Matathia's comment, Ms. Suter, do you want to</p>	<p>1 quite often and do have to mitigate. Those are 2 going to be on the forefront as we move forward in 3 planning the project. Thank you for your comment. 4 MS. SUTER: Just in response, although I 5 didn't mention it the environmental impact statement 6 or EIS will include a traffic analysis. We include 7 it as part of a socioeconomic analysis, that section 8 of the document. So there are a lot of areas, 9 resource areas that will be addressed. That list 10 that I mentioned was not an exhaustive list of 11 everything. We address all comments that are 12 brought up as part of our scoping analysis. So we 13 will address traffic.</p> <p>14 MR. SHEA: Thank you, Ms. Suter. 15 Mr. Matathia, do you have anything else 16 to add?</p> <p>17 MR. MATATHIA: The resource report filed 18 by the proponent indicates that they do not expect 19 significant traffic impacts in connection with the 20 project. I was wondering whether or not you would 21 take that at face value or whether or not you would 22 proceed with an analysis.</p> <p>23 MS. SUTER: So right now, as we 24 mentioned with the pre-filing process, what the</p>

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<p style="text-align: center;">30</p> <p>1 applicant has filed are draft resource reports. You 2 probably saw that they were labeled that way. Right 3 now we are evaluating those. We are going to be 4 providing comments. That's probably what you saw 5 relating to -- Robert was talking about trying to 6 give us feedback related to those. Because we are 7 going to be making comments on those resource 8 reports.</p> <p>9 We work with our local field knowledge. 10 We work with federal, state and local agencies, 11 along with our own consultants and experts, to 12 question the information that the applicant has 13 provided along with any comments that we have 14 received from the local public as well. We use that 15 to question whether or not the information that the 16 applicant has provided is good enough, whether we 17 need more information, whether we agree or disagree. 18 And we use that to gather more information or do 19 some analysis on our own or use other agency 20 information. So we may say no, that's not enough, 21 we need more; or what you've given us is fine; we 22 are going to supplement it with our own information. 23 So we don't take what they give us at face value. 24 Sometimes we ask for more or sometimes use some of</p>	<p style="text-align: center;">32</p> <p>1 pavement and the streets seem to almost be like a 2 step, it comes along at street level and goes down 3 deep at 90 degrees. When traffic comes they smash 4 into this thing. I don't know if this is a cost- 5 savings thing or nobody wants to go back and make it 6 more reasonable so that maybe it is a little bit of 7 a bump but certainly not a crash. With this project 8 I noted they are going to be opening up the streets 9 in West Roxbury and going down some of the side 10 streets. I didn't know if there was a code somebody 11 was going to follow or leave it up to the contractor 12 or we are going to have a lot more of that. It is 13 very inconvenient and dangerous to a certain extent. 14 It certainly doesn't help your automobile at all. I 15 noticed that.</p> <p>16 I don't know if anybody else driving 17 around the neighborhood experiences that, but it 18 would be good for somebody to make a note and say 19 when we make a temporary patch -- because there's 20 no -- I have no idea if it is a temporary patch 21 that's made or it is going to stay like that forever 22 until it wears down. It is very inconvenient. 23 Somebody in authority should address it with the 24 contractors to say leave the streets so that people</p>
<p style="text-align: center;">31</p> <p>1 our own knowledge and information.</p> <p>2 MR. SHEA: Thank you, Ms. Suter.</p> <p>3 The next person who signed up to speak 4 is Joe Goode.</p> <p>5 MR. GOODE: Joseph Goode. I went to the 6 last meeting. I noticed that some of the issues 7 that I brought up were mentioned tonight. So 8 hopefully folks are looking at that. I belong to 9 the West Roxbury Civic Improvement Association. I 10 understand some members of this project will be 11 attending that meeting next Wednesday night. We 12 probably have maybe 30, 35 people that show up. And 13 they have lots and lots of questions. You're 14 showing up?</p> <p>15 MR. LUSKAY: Yes, I am.</p> <p>16 MR. GOODE: You will enjoy that. It is 17 a little more lively than this group.</p> <p>18 A couple of things. Driving around West 19 Roxbury, which I do every day, and through Dedham, 20 in West Roxbury there's a lot of projects going on 21 and they are busting up the sidewalks and they do 22 temporary repairs. I've noticed just recently, I 23 don't know if anybody has noticed these temporary 24 repairs -- I've made a sketch of it here -- in the</p>	<p style="text-align: center;">33</p> <p>1 can navigate back and forth. That was one comment 2 that I had. At the last meeting I had a few other 3 things to say.</p> <p>4 I didn't know about the metering station 5 that I think is going to be somewhere near West 6 Roxbury Crushed Stone. I made a note last time that 7 it does make a noise. I tried to inquire as to what 8 the decibel reading of that noise would be. I think 9 it is important. It is a neighborhood area. I 10 don't know if it is going to be far away and nobody 11 hears it or it is going 24/7 or it is a hissing 12 sound. It is going to be permanent, obviously. It 13 is going to be 16- or 24- or 26-inch pipes. That 14 sounds imposing. I was curious if anybody knew from 15 an engineering standpoint or project standpoint how 16 noisy that station would be. I'm concerned about 17 that.</p> <p>18 MS. SHAPIRO: I believe in the resource 19 report there is an indication that you are going to 20 do a noise analysis; is that correct?</p> <p>21 MR. LUSKAY: That is correct. We do a 22 preconstruction and post-construction noise survey, 23 and we are required to meet noise requirements at 24 the property line.</p>

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<p style="text-align: center;">34</p> <p>1 MS. SHAPIRO: Could you explain a little 2 more to Mr. Goode what a meter station is in that 3 area, what decibels are associated with the size, if 4 you know, or give some approximation?</p> <p>5 MR. LUSKAY: Our requirement is 55 6 decibels at the property line we are required to 7 meet. That would be the maximum noise at the edge 8 of the property.</p> <p>9 MS. SUTER: I'm going to jump in just 10 quick. It is not the property line but at the noise 11 sensitive area, at the home. But the regulation 12 that FERC has, this is a FERC regulation that he's 13 talking about, that applies to compressor stations 14 unless Algonquin chooses or elects to have it apply 15 to meter stations as well. However, we evaluate 16 what the noise impact is at meter stations as well 17 and we evaluate whether or not that noise level 18 would be significant at the meter station. We've 19 seen varying levels. We've seen locations where it 20 is not audible at all. We have seen ones where it 21 is audible and we have asked for recommended 22 mitigation measures based on the projected noise 23 levels.</p> <p>24 So you guys will do the noise analysis,</p>	<p style="text-align: center;">36</p> <p>1 the top of your head, the meter station that they 2 are going to construct around West Roxbury Crushed 3 Stone, is it on their property, on the street, is it 4 way back?</p> <p>5 MR. LUSKAY: It is set back and in a 6 parcel is opposite the quarry in a vacant parcel.</p> <p>7 MR. GOODE: I think that's about it. I 8 look forward to seeing you at the meeting.</p> <p>9 MR. LUSKAY: I look forward to it as 10 well.</p> <p>11 MR. SHEA: Thank you, Mr. Goode.</p> <p>12 No one else has signed the speaker 13 sign-up sheet as of the time I grabbed it. Anybody 14 else that wants to speak? Please come up and take 15 the podium.</p> <p>16 MR. PROVIDAKES: George Providakes, P r 17 o v i d a k e s, West Roxbury, 9 Mallkuar Road.</p> <p>18 Several questions or observations as 19 well. First, thanks for your comments regarding the 20 Legacy Place issues and concerns. I would observe 21 that commercial needs and residential needs are 22 different. So in the commercial space, if you want 23 to do the work at night, that's cool with me. In 24 the residential space, I would rather you didn't</p>
<p style="text-align: center;">35</p> <p>1 which they have identified they are going to do a 2 noise analysis. We'll take a look at that to see 3 whether or not we believe mitigation is necessary, 4 recognizing the residential nature of the location. 5 In some cases it is the middle of cornfields and it 6 is not necessary to add extra.</p> <p>7 MR. GOODE: That's good to know it can 8 be mitigated somehow. That's good. We talked about 9 traffic.</p> <p>10 The last thing. I know at the last 11 meeting it was mentioned that there's a lot of rock 12 in West Roxbury and they are going to be doing 13 blasting. West Roxbury Crushed Stone is also doing 14 blasting. Does any of that get coordinated?</p> <p>15 MR. LUSKAY: As far as coordinating with 16 the quarry?</p> <p>17 MR. GOODE: You are blasting down the 18 street on Grove Street. Are you going to blast 19 together?</p> <p>20 MR. LUSKAY: We wouldn't want shots 21 occurring at the same time. It seems to me we could 22 coordinate so that we don't have shots going off at 23 the same time.</p> <p>24 MR. GOODE: Do you happen to know off</p>	<p style="text-align: center;">37</p> <p>1 because I want to sleep at night. So a heads-up on 2 that and how you balance that.</p> <p>3 The issue of traffic. I know that when 4 I first came to West Roxbury, Center Street was not 5 a very good street. And every time that darn gravel 6 truck would go down Center Street it was so noisy 7 that when I worked around my house I had to have ear 8 protectors on. It was deafening. When they redid 9 the street, that problem went away or they got 10 better shock absorbers on the trucks. If you again 11 come in and dig up the road and it is like that for 12 how many months, it can be deafening as well. I 13 would like attention paid to that.</p> <p>14 The other thing is that Algonquin or 15 whoever is going to provide information to FERC. 16 FERC is going to look at it. If they have 17 questions, they may ask questions. In turn they are 18 going to get -- if they notice something they will 19 bring it up. It strikes me that it would be prudent 20 to check with other people who have gone through 21 this in the area, like Legacy Place, and get their 22 experience during the construction recently so that 23 you actually have data to compare against what is 24 being proposed or you may have sitting in a file</p>

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<p>1 somewhere.</p> <p>2 Additionally, it was mentioned that some</p> <p>3 smaller-scale work had been done in Medford and</p> <p>4 Somerville. It would be investing to know how did</p> <p>5 that go? Were there any problems, noise, et cetera,</p> <p>6 to calibrate the quality of the analysis and the</p> <p>7 uncertainty built into trying to do this in these</p> <p>8 areas.</p> <p>9 It was mentioned that this was sized</p> <p>10 based on the demand. Life changes. It would be</p> <p>11 nice to get a sense of how much spare capacity is</p> <p>12 being put into this so that somebody doesn't come in</p> <p>13 five years from now and put in a 24-inch pipe where</p> <p>14 a 16-inch is.</p> <p>15 I asked last time to get some detailed</p> <p>16 schedules about what's going to be happening when.</p> <p>17 I'm looking forward to that. I saw the maps were</p> <p>18 updated substantially. I saw the surveyors running</p> <p>19 around the neighborhood. I would like to get a copy</p> <p>20 of those maps. PDFs are fine. Hopefully those will</p> <p>21 be available.</p> <p>22 It was mentioned that testing, that</p> <p>23 analysis would be done in the environmental</p> <p>24 protection saying that the noise level is X and Y.</p>	<p>1 only location where we will have buffer zone</p> <p>2 impacts. I believe at the end of the day they will</p> <p>3 likely have a crossing over a water body.</p> <p>4 The rest is we also have some buffer</p> <p>5 zone on impacts in Boston with respect to the meter</p> <p>6 station location. Beyond that, this is a pretty</p> <p>7 clean route. We only have I think three</p> <p>8 jurisdictional areas that we cross on the entire</p> <p>9 project here on the West Roxbury lateral. So we</p> <p>10 will, in fact, be filing with the con-com for that</p> <p>11 buffer zone impact, resource impact.</p> <p>12 MR. PREVITERA: Your name again?</p> <p>13 MR. TYRRELL: Mike Tyrrell, T y r r e l l</p> <p>14 I. I'm with TRC Environmental for Spectra Energy.</p> <p>15 MR. PREVITERA: The other thing I had</p> <p>16 was, Mr. Matathia mentioned some contaminated areas.</p> <p>17 In reviewing the plans with my agent and with the</p> <p>18 plans that were shown out front, I did not see</p> <p>19 those. Are we talking about 21E contamination?</p> <p>20 MR. TYRRELL: I can address that.</p> <p>21 MR. PREVITERA: Are there any</p> <p>22 contaminated areas in Westwood?</p> <p>23 MR. TYRRELL: No.</p> <p>24 MR. PREVITERA: One quick thing. One</p>
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<p style="text-align: center;">42</p> <p>1 and they are more detailed than anything I've seen 2 before.</p> <p>3 MR. TYRRELL: Those are part of the FERC 4 filing that was made. They are part of the public 5 record today. They are part of that package. We 6 can extract those and make them easier to get to. 7 We can create a list if you would like. We would be 8 happy to provide copies.</p> <p>9 MS. SUTER: They are available on our 10 website. They are large files and may not be the 11 easiest to access. Any landowner should be able to 12 contact the right-of-way agent. There should have 13 been a phone number to contact Algonquin. You 14 should be able to get the individual map for your 15 location. If not, you also should put the filing 16 and the maps in the public libraries. So there are 17 multiple ways to access all the maps.</p> <p>18 MR. PROVIDAKES: How many documents?</p> <p>19 MS. SUTER: Quite a few maps.</p> <p>20 MR. PROVIDAKES: How do I find it? Is 21 there a search function that I can use?</p> <p>22 MS. SUTER: The best way to get your 23 individual one, we put out repeatedly Algonquin's 24 hot line or phone number, an 800 number. You might</p>	<p style="text-align: center;">44</p> <p>1 should see eLibrary. You want to go to that tab and 2 use -- there's a number of preferences. You can do 3 a more advanced search or an entire docket search. 4 There are a couple of options for how you want to 5 search. Within that you will want to use the docket 6 number PF 13-16. You want to identify an 7 appropriate date range. That's important to get 8 right. I think it may set automatically to the past 9 one or two months. If you want to see something 10 from further back, you may want to set that 11 appropriately. You can see and find anything that 12 has been filed or is available.</p> <p>13 There's other options also. There's 14 something -- using that Documents and Filings tab, 15 there is something called eSubscription. Using that 16 you can create an account on FERC's website. You 17 put in PF 13-16, and that means any time anybody 18 files something on this docket, Algonquin, FERC, any 19 agency or landowner will get an email that says so 20 and so just filed something. You can click on a 21 link to go to that. You will get an email any time 22 something has been filed. It is a way to keep up 23 with the information.</p> <p>24 MR. PROVIDAKES: I get that email thing.</p>
<p style="text-align: center;">43</p> <p>1 have a local number for this area. One of you guys 2 might identify what that phone number is. We might 3 have it listed somewhere. You can call that phone 4 number. Someone from Algonquin will contact you 5 back and get you the individual map that you need.</p> <p>6 MR. LUSKAY: We will get one printed out 7 for you.</p> <p>8 MR. PROVIDAKES: I can handle a big 9 electronic file.</p> <p>10 MR. SHEA: Ms. Suter, you did mention 11 that certain things are available in the public 12 domain. Could you talk for a second about how an 13 individual can access the documents on FERC, the 14 online system? I think it is very good but it is 15 not necessarily very simple. There's a little bit 16 of a wrinkle.</p> <p>17 MS. SUTER: I understand. So anybody 18 who wants to access information electronically 19 through FERC's website, and anything that FERC 20 issues, any comments that go on, anything that 21 Algonquin files with us, everything goes on our 22 website and is available for you to access. The way 23 to do that is that you go to www.ferc.gov. In there 24 is a tab, Documents and Filings. From there you</p>	<p style="text-align: center;">45</p> <p>1 In there there's one that came from Algonquin or 2 Spectra that said we put the maps up here. Or it 3 says we posted our CD of our thing, which is about 4 three-terabyte size. Is there any specificity in 5 that?</p> <p>6 MS. SUTER: Our system will only allow 7 you to upload up to a certain file size. Don't ask 8 me what it is. I'm not a tech expert. They will 9 have to break down a large file into components. 10 When you click on the link, it will say there are 11 multiple files on there and you can click a button 12 on there to see all of the files under that 13 particular filing. You have to start going through 14 them. The maps are probably multiple files. You 15 probably have to go through to get to the 16 appropriate one.</p> <p>17 It is not the easiest website to 18 navigate. I have no control over that. This is 19 just some of the options that are available to you. 20 It is all on there and it is all publicly available 21 to you. As we mentioned, it is out there at your 22 local public library. You do have that option for 23 anybody who wants to go there and access it.</p> <p>24 MR. SHEA: Thank you very much. I</p>

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<p>1 appreciate that. Let me ask now, is there anyone 2 else who would like to speak? Mr. Goode?</p> <p>3 MR. GOODE: I was curious if there was 4 anybody from the local press here tonight? I don't 5 know if they are invited. They always like to make 6 sure that they are here.</p> <p>7 MR. SHEA: Someone from the local press 8 was here when FERC had its meeting on October 3rd. 9 But I don't know if anyone is here.</p> <p>10 MR. PREVITERA: Are they invited?</p> <p>11 MR. SHEA: The notifications go out to 12 abutters and to town and city officials, not 13 specifically to members of the press unless they 14 request to be invited.</p> <p>15 MR. MATATHIA: One final question. In 16 order to inform the first procedural point that I 17 had made in my remarks, I was wondering if the 18 proponent can identify when they plan to file with 19 MEPA so that you would know what the extension of 20 your comment period through that proceeding would 21 be.</p> <p>22 MR. TYRRELL: We are actively working on 23 the ENF now. We are trying to marry up the ENF with 24 our formal application being filed with FERC in</p>	<p>1 EIS. We will marry those two documents together so 2 that we don't have one document covering federal and 3 one for state. The will run closely in parallel in 4 the event we are required to submit an EIR with 5 MEPA. That has already been discussed as well.</p> <p>6 MR. MATATHIA: So the idea is to 7 formally propose with FERC at the same time you are 8 formally proposing with MEPA.</p> <p>9 MR. TYRRELL: Correct. By the time we 10 formally file with FERC at the end of February, we 11 will have been through the ENF stage with MEPA, and 12 the determination of whether an EIR is required will 13 be completed at that time, if an EIR is required. 14 We don't expect the EIS from NEPA to be issued until 15 July, as Jim had mentioned in his statements.</p> <p>16 MR. MATATHIA: What I'm wondering about 17 is whether the scopes will issue at the same time, 18 assuming both processes are invoked.</p> <p>19 MR. TYRRELL: I think there is plenty of 20 time there in order for the Secretary to issue the 21 scope on the EIR at the end of the ENF period once 22 we file. The FERC has got until the end of June or 23 July before the EIS ever hits the street, so that's 24 five months. The period in between in which any of</p>
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FARMER ARSENAULT BROCK LLC	

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<p>50</p> <p>1 triggered it catches up.</p> <p>2 MR. TYRRELL: My response is that they</p> <p>3 will be in parallel. That's the simplest answer.</p> <p>4 We have navigated that before. If we have to</p> <p>5 navigate it, we will keep it in parallel for</p> <p>6 simplicity's sake.</p> <p>7 MR. SHEA: Anyone else?</p> <p>8 MR. DOYLE: My name is Ed Doyle, a</p> <p>9 resident of Dedham, D o y l e. My concern is safety</p> <p>10 after this is constructed. I've worked with gas</p> <p>11 over a long period of time, natural gas. I see</p> <p>12 these explosions in gas lines in Texas and other</p> <p>13 parts of the country. I looked at one a couple of</p> <p>14 months ago. They evacuated people to a mile and a</p> <p>15 half back from the site of the explosion.</p> <p>16 I hope there's going to be an extensive</p> <p>17 evaluation after the pipeline is in. How soon can</p> <p>18 you shut that line down? Are we going to have</p> <p>19 evacuation routes? That road at times is completely</p> <p>20 covered with traffic for miles. How would you move</p> <p>21 those cars out of there if you had a leak? How soon</p> <p>22 could you move people out? How would you get people</p> <p>23 out of the area?</p> <p>24 There is no possibility that you can</p>	<p>52</p> <p>1 to stay to our schedule, and we can't alter it, is</p> <p>2 that we'll get the comments on Monday, April (sic)</p> <p>3 9th. The comments have to be filed with the</p> <p>4 company, Algonquin, and FERC at the same time at the</p> <p>5 end of that week on the 13th. That's a FERC</p> <p>6 deadline. As people pointed out, we are still in</p> <p>7 the pre-filing process. No petition for approval of</p> <p>8 the project has been filed with FERC. At this point</p> <p>9 for the comments we are going to be submitting to</p> <p>10 FERC, we will summarize the comments that are made</p> <p>11 tonight, certainly. But if anyone wants to add some</p> <p>12 written comments, we will be happy to read them and</p> <p>13 see how we can incorporate them into our written</p> <p>14 comments to FERC. They have to be received by me by</p> <p>15 Monday, December 9th.</p> <p>16 Since there are no other members of the</p> <p>17 public that wish to speak, I'll conclude. First I</p> <p>18 would like to thank everyone for coming. I know it</p> <p>19 is a weekday night. I appreciate your interest in</p> <p>20 what is going on. I would like to thank the company</p> <p>21 for making people available for answering questions.</p> <p>22 I especially thank Ms. Suter for coming up here from</p> <p>23 Washington, D.C. and my colleagues for coming in</p> <p>24 from Boston.</p>
<p>51</p> <p>1 guarantee a hundred percent that you won't have a</p> <p>2 leak. You are know that. Is there going to be a</p> <p>3 probability analysis of the leak? What's the</p> <p>4 possibilities of a leak? What's your history? A</p> <p>5 lot of the lines aren't in as heavily a populated</p> <p>6 area as this is going through in Dedham. The impact</p> <p>7 on Dedham from a safety point of view is going to be</p> <p>8 enormous. We have heavy trucks going over that road</p> <p>9 you are going to put the pipe down in. The road</p> <p>10 goes up and down. I heard your pipe is only 3 feet</p> <p>11 down. Are we going to fatigue those pipes? What's</p> <p>12 going to happen in 10 or 20 years? I'm not worried</p> <p>13 about 20 years from now but younger people are. I</p> <p>14 think this is a very unsafe thing you are doing in a</p> <p>15 very populated area. I hope when FERC does a safety</p> <p>16 analysis and they take that into account.</p> <p>17 MR. SHEA: Thank you, Mr. Doyle.</p> <p>18 Does anyone else want to speak? Let me</p> <p>19 just address one issue. As I said before, any</p> <p>20 comments, any written comments that you would like</p> <p>21 the Siting Board to consider must be filed with me</p> <p>22 no later than Monday, December 9th. And my contact</p> <p>23 information is on a sheet at the back of the room.</p> <p>24 We don't have -- the reason that we need</p>	<p>53</p> <p>1 If you have any further questions, we'll</p> <p>2 be around for a few minutes after tonight's hearing.</p> <p>3 Thank you for attending. The meeting is now</p> <p>4 adjourned.</p> <p>5 (8:24 p.m.)</p> <p>6</p> <p>7</p> <p>8</p> <p>9</p> <p>10</p> <p>11</p> <p>12</p> <p>13</p> <p>14</p> <p>15</p> <p>16</p> <p>17</p> <p>18</p> <p>19</p> <p>20</p> <p>21</p> <p>22</p> <p>23</p> <p>24</p>

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1	CERTIFICATE	
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3		
4	I, David A. Arsenault, Registered	
5	Professional Reporter, and Certified Reporter in the	
6	Commonwealth of Massachusetts, #100693, do hereby	
7	certify that the foregoing record is a true and	
8	accurate transcript of my stenographic notes taken	
9	on December 3, 2013 in the above-captioned matter.	
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23	_____ David A. Arsenault, RPR	
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**Exhibit 4 to West Roxbury Motion for
Rehearing: Senator Markey Study**

America Pays for Gas Leaks



Natural Gas Pipeline Leaks Cost Consumers Billions

A report prepared for Sen. Edward J. Markey

Released: July X, 2013

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America Pays for Gas Leaks

Natural Gas Pipeline Leaks Cost Consumers Billions

American consumers are paying billions of dollars for natural gas that never reaches their homes, but instead leaks from aging distribution pipelines, contributing to climate change, threatening public health, and sometimes causing explosions. This report, which was prepared at the request of Sen. Edward J. Markey (D-MA),¹ draws on data from a variety of sources to assess the impact of leaks and other “lost and unaccounted for” natural gas, using Massachusetts as a case study.

Gas distribution companies in 2011 reported releasing 69 billion cubic feet of natural gas to the atmosphere, almost enough to meet the state of Maine’s gas needs for a year and equal to the annual carbon dioxide emissions of about six million automobiles.² Nonetheless, last year these companies replaced just 3 percent of their distribution mains made of cast iron or bare steel,³ which leak 18 times more gas than plastic pipes and 57 times more gas than protected steel.⁴ Gas companies have little incentive to replace these leaky pipes, which span about 91,000 miles across 46 states, because they are able to pass along the cost of lost gas to consumers. Nationally, consumers paid at least \$20 billion from 2000-2011 for gas that was unaccounted for and never used, according to analysis performed for this report.⁵

Natural gas has been touted as a cleaner alternative to coal for producing electricity, but its environmental benefits cannot be fully realized so long as distribution pipelines are leaking such enormous quantities of gas, which is primarily comprised of methane, a greenhouse gas that is at least 21 times more potent than carbon dioxide.⁶ Americans also remain at risk from gas explosions and other safety hazards caused by leaky natural gas pipelines. From 2002 to 2012, almost 800 significant incidents on gas distribution pipelines, including several hundred explosions,⁷ killed 116 people, injured 465 others, and caused more than \$800 million in property damage.

¹ The House Natural Resources Committee Democratic staff prepared the report at the request of Sen. Markey when he was serving as the senior ranking Democrat on the committee.

² U.S. Environmental Protection Agency, “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011,” April 12, 2013, available at <http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf>. Maine gas consumption levels are based on data reported to the Energy Information Administration (EIA), available at <http://www.eia.gov/naturalgas/annual/pdf/nga11.pdf>.

³ Distribution mains are a common gas source for multiple customers. Individual customers receive gas via service lines. In 2012, gas companies replaced 12 percent of their leak-prone service lines, according to PHMSA data.

⁴ This calculation is based on an average of the emissions factors for cast iron and bare steel pipelines assigned by the U.S. Environmental Protection Agency in 40 CFR Part 98, Subpart W, available at <http://www.gpo.gov/fdsys/pkg/FR-2011-12-23/pdf/2011-31532.pdf>.

⁵ Based on unaccounted for gas reported to EIA, multiplied by the average city gate price, and adjusted for inflation. An EIA official recommended we use the average city gate price because it reflects the price the distribution company paid for the gas from the transmission company.

⁶ Conservation Law Foundation, “Into Thin Air: How Leaking Natural Gas Infrastructure is Harming our Environment and Wasting a Valuable Resource,” available at: http://www.clf.org/static/natural-gas-leaks/WhitePaper_Final_lowres.pdf.

⁷ There were 257 explosions from Mar. 2004 - Dec. 2012, according to data from PHMSA. PHMSA data before Feb. 2004 does not indicate whether significant incidents involved explosions. There were 191 significant incidents from Jan 2002- Feb. 2004.

Table 1: U.S. Unaccounted for Gas, Emissions, and Significant Incidents on Natural Gas Systems

Total U.S. Unaccounted for Gas from Natural Gas Systems from 2000-2011^a	2.6 trillion cubic feet of natural gas
Total U.S. Reported Emissions from Natural Gas Distribution Systems from 2010 - 2011^b	Equivalent to releasing 56.2 million metric tons of CO ₂
Significant Incidents on U.S. Natural Gas Distribution Systems from 2002-2012^c	796 incidents / 116 fatalities / 465 injuries / \$810,677,757 in property damage

^aSource: EIA, Form 176. Includes unaccounted for gas from transmission companies and distribution companies.

^bSource: EPA, U.S. Greenhouse Gas Inventory of Sources and Sinks, 1990-2011, available at: <http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf>

^cSource: PHMSA, available at: <http://primis.phmsa.dot.gov/comm/reports/safety/SigPSI.htm?nocache=1229>

Gov. Deval Patrick's administration has started to address this problem in Massachusetts, which is a nationally recognized leader among states in energy efficiency⁸ and reducing greenhouse gas emissions.⁹ In particular, the commonwealth's Department of Public Utilities (DPU) recently launched incentive programs to encourage gas companies to replace leak-prone pipelines and operate more efficiently. The incentive programs are needed because gas companies in Massachusetts own and operate one of America's oldest natural gas pipeline distribution systems, ranking sixth among state systems in the number of miles of main distribution pipelines made of cast iron or bare steel.¹⁰ These companies have replaced less than 4 percent of their leak-prone pipes per year while billing Massachusetts ratepayers an estimated \$640 million to \$1.5 billion from 2000-2011 for unaccounted for gas (see Table 3 on page 7).

The problem of leaky gas pipelines may be even worse than the data presented in this report suggests. Indeed, companies frequently report negative volumes of unaccounted for gas to various agencies—even though it's physically impossible to dispose of more gas than enters a closed system.¹¹ Federal and state regulators explained in interviews for this report that there isn't a consistent methodology for calculating lost and unaccounted for gas, and data quality problems are common. The Massachusetts DPU has responded by requesting additional funds in its 2014 budget to hire a third-party consultant to review companies' procedures for classifying leaks and calculating lost and unaccounted for gas.¹²

Last year, 24.5 trillion cubic feet of natural gas was produced in the United States, up 4 trillion cubic feet since 2007.¹³ Sales of natural gas from federal lands were about 18 percent (4.3 tcf) of total U.S. sales in fiscal year 2012, including 3 trillion cubic feet produced onshore and 1.3

⁸ Massachusetts was the top-ranked state according to The American Council for an Energy Efficient Economy's 2012 State Energy Efficiency Scorecard, available at <http://aceee.org/research-report/e12c>.

⁹ For example, Massachusetts is part of the Regional Greenhouse Gas Initiative—the first mandatory cap and trade emissions program in the United States.

¹⁰ In 2012, Massachusetts had 5,482 miles of leak-prone mains and 194,326 leak-prone service lines, according to PHMSA data.

¹¹ Commonwealth of Pennsylvania Bureau of Investigation and Bureau of Audits, 2012 "Unaccounted-for-Gas in the Commonwealth of Pennsylvania," February 2012, available at http://www.puc.state.pa.us/transport/gassafe/pdf/UFG_Report_Feb2012.pdf.

¹² Statement of Richard K. Sullivan, Massachusetts Secretary of Energy and Environmental Affairs, before the Joint Committee on Telecommunications, Utilities and Energy, June 11, 2013.

¹³ Congressional Research Service, "U.S. Crude Oil and Natural Gas Production in Federal and Non-Federal Areas," March 7, 2013, available at <http://www.fas.org/sgp/crs/misc/R42432.pdf>.

trillion cubic feet produced offshore.¹⁴ Additionally, about 28 percent (85 tcf of 305 tcf) of U.S. proved reserves of dry natural gas are located on federal lands.¹⁵ Fixing leaky pipelines is important in making sure these newly abundant natural gas resources are put to responsible use and fully benefit the American people.

To address the problems identified in this report, Sen. Markey is drafting legislation that will push states and non-regulated utilities to accelerate replacement of high-risk, leaky pipelines and curtail the practice of passing along the costs of lost gas to consumers. The following section of the report uses Massachusetts as a case study to show why this legislation is necessary.



Crews work to extinguish a fire following a gas explosion in Allentown, Penn., in February 2011.

¹⁴ U.S. EIA, “Sales of Fossil Fuels Produced from Federal and Indian Lands, FY 2003 through FY 2012”, May 2013, available at <http://www.eia.gov/analysis/requests/federallands/pdf/eia-federallandsales.pdf>.

¹⁵ *Ibid*, 13.

The price of leaked gas

By not replacing leaking pipelines, gas companies nationwide are charging ratepayers for gas that never reaches homes and is contributing to climate change, endangering public health,¹⁶ and risking explosions and other safety hazards. The problem is particularly acute in Massachusetts because of the advanced age of the commonwealth's distribution system. Specifically, the data show:

- **Massachusetts ratepayers paid between \$640 million to \$1.5 billion from 2000-2011 for gas that never reached their homes and businesses.** At least 99 billion cubic feet of natural gas was "lost and unaccounted for" in Massachusetts from 2000-2011, according to data reported by utilities to the Massachusetts Department of Public Utilities (DPU). The cost of this unaccounted for gas—\$640 million to \$1.5 billion, according to calculations performed for this report¹⁷—was passed on to the commonwealth's approximately 1.5 million residential, commercial and other customers (see Table 3 on page 7).¹⁸

Three companies, Boston Gas, Colonial Gas, and Nstar Gas, accounted for 80 percent of these passed-on costs from 2000-2011. As a group, Boston Gas customers paid the most, covering an estimated \$352 to \$781 million in unaccounted for gas costs, followed by Nstar Gas customers at \$109 to \$229 million, and Colonial Gas customers at \$92 to \$221 million. On a per customer basis, Westfield Gas & Electric customers paid the most (about \$304 to \$2,426 per customer) because of the company's small customer base relative to its unaccounted for gas levels. Boston Gas, New England Gas, Nstar Gas and Essex Gas customers each paid over \$370 to \$875 on average in lost and unaccounted for gas costs from 2000-2011.

Table 2: Massachusetts Unaccounted for Gas, Emissions, and Significant Incidents on Natural Gas Systems

Total Unaccounted for Gas from Massachusetts Natural Gas Distribution Systems from 2000-2011^a	99 - 227 billion cubic feet of natural gas
Total Reported Emissions from Massachusetts Natural Gas Distribution Systems from 2010 - 2011^b	Equivalent to releasing between about 1 million and 1.3 million metric tons of CO ₂
Significant Incidents on Massachusetts Natural Gas Distribution Systems from 2002-2012^c	23 incidents / 24 injuries / \$9,492,677 in property damage

^aSource: Staff analysis of DPU Annual Reports. See notes under Table 3 on page 7 for our methodology. This value may not align with the national value provided in Table 1, because how companies calculate and report unaccounted for gas varies across states and agencies (see Table 7 on page 17).

^bSource: Staff analysis of EIA data, Massachusetts Department of Environmental Protection (DEP) data, and U.S. Environmental Protection Agency emissions data, summarized in Table 4 on page 13. Unit conversions were performed using EPA's methane conversion tool at:

<http://www.epa.gov/cmip/resource/converter.html>.

^cSource: PHMSA data, summarized in Table 5 on page 14.

¹⁶ West, J.J. et al., 2006. "Global Health Benefits of Mitigating Ozone Pollution with Methane Emissions Controls," *Proceedings of the National Academy of Sciences*, vol. 103, no. 11, available at <http://www.pnas.org/content/103/11/3988.full>.

¹⁷ See the notes under Table 3 on page 7 for information on our methodology.

¹⁸ The average number of customers as reported to the U.S. Energy Information Administration (EIA) for 2000-2011. The number of customers reported to EIA in 2011 was about 1.4 million.

- **Lost natural gas accounts for at least 45 percent of Massachusetts' methane emissions for large, stationary facilities.**¹⁹ Utilities serving Massachusetts reported releasing between 1.1 and 1.4 billion cubic feet of gas into the atmosphere in 2011, accounting for between 45 and 58 percent of the commonwealth's methane emissions for large, stationary facilities, as reported to the Massachusetts Greenhouse Gas Registry (see Table 4 on page 13).²⁰

The three companies reporting the greatest emissions (Boston Gas, Nstar Gas, and Columbia Gas) were also the three companies that had the most leak-prone pipes in their distribution systems, as of 2012 (see Table 4 on page 13). In addition, researchers from Boston University and Duke University recently measured methane levels over 785 miles of Boston roads and found 3,356 leaks likely due to natural gas distribution pipelines.²¹

State law requires Massachusetts to reduce greenhouse gas emissions to 25 percent below 1990 levels by 2020.²² Addressing gas leaks is especially important in meeting this goal because methane is such a potent heat-trapping gas, with at least 21 times the warming potential of carbon dioxide over a 100-year time horizon and as much as 72 times the warming potential over a 20-year horizon.²³ By 2010, Massachusetts had already succeeded in reducing methane emissions from the natural gas distribution system by 14 percent below 1990 levels.²⁴

However, greater reductions are still possible by accelerating replacement of leaky pipes. Natural gas companies could reduce their emissions in Massachusetts to 25 percent below 1990 levels by replacing about 777 miles of cast iron mains (the most leak-prone pipe material), according to staff calculations.²⁵

¹⁹ Calculation is based on data reported for large, stationary facilities during 2011 as part of the Greenhouse Gas Registry, and is available at <http://www.mass.gov/eea/docs/dep/air/climate/11faculg.pdf>. These facilities represent one quarter of Massachusetts' total emissions inventory. The most recent year for data from Massachusetts' total emissions inventory is 2010. In 2010, distribution systems accounted for about 33 percent of total methane emissions, available at <http://www.mass.gov/eea/docs/dep/air/climate/ghginv9012.xls>.

²⁰ Companies reported different amounts of methane lost or emitted per year to different agencies—largely due to differences in reporting methodologies. EIA does not require companies to follow a specific methodology for calculating natural gas losses, and in some cases, there is a substantial difference between the numbers reported to EIA and those reported to DEP and EPA.

²¹ Nathan G. Phillips et al., 2013, "Mapping urban pipeline leaks: Methane leaks across Boston," *Environmental Pollution*, vol. 173, available at <http://www.sciencedirect.com/science/article/pii/S0269749112004800>.

²² The Global Warming Solutions Act of 2008.

²³ According to the EPA, methane has a global warming potential of 21 for a hundred-year time horizon, compared to carbon dioxide's global warming potential of 1. The International Panel on Climate Change (IPCC) and individual studies have assigned a higher global warming potential of 25 and 33 for hundred-year time horizons, respectively. For more information, see http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html.

²⁴ Calculation is based on 2010 emissions levels reported in the Greenhouse Gas Inventory, <http://www.mass.gov/eea/docs/dep/air/climate/ghginv9012.xls>.

²⁵ Calculation is based on the 1990 emissions levels for the natural gas distribution system in the Massachusetts Greenhouse Gas Inventory, the emissions reductions reported as of 2010 in the Greenhouse Gas Inventory in 2010 and EPA's emission rate for cast iron pipelines in 40 CFR Part 98, Subpart W.

Nationwide, the natural gas distribution system is the largest source of methane emissions, accounting for 19 percent of total emissions in 2011, according to the U.S. Environmental Protection Agency (EPA). EPA also found that recent reductions in U.S. methane emissions have been driven in part by replacing leak-prone pipelines in distribution systems.²⁶

- **More significant pipeline incidents in Massachusetts involved cast iron or other high-risk pipes.** Incidents are four times more likely to occur on cast iron mains than mains made of other materials, according to an analysis of national pipeline incidents by the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA).²⁷

In Massachusetts, 57 percent of the significant incidents²⁸ from 2002-2012—attributable to human error, leaks, natural forces, excavation damage, and a variety of other causes—occurred around segments of the distribution system utilizing cast iron or steel pipe (see Table 5 on page 14). One of these incidents, a gas explosion in July 2002 involving a corroded fitting on a steel pipe, leveled a home and killed two children in Hopkinton, Mass. Another powerful explosion occurred in Springfield, Mass., last November, as a result of human error after a worker from Columbia Gas of Massachusetts accidentally punctured a steel service line, which had been retrofitted with plastic, while responding to a call about a gas leak. The incident resulted in injuries to 17 people and \$1.3 million in property damage, according PHMSA data.

Nationally, a number of recent killer pipeline explosions have been traced to aging, cast iron pipelines,²⁹ including explosions in Austin, Texas, Philadelphia, and Allentown, Penn., where a gas main explosion in February 2011 resulted in five fatalities, three hospitalizations, and eight destroyed homes (see photo on page 3). Some of these accidents might have been prevented had gas companies performed timelier repair, rehabilitation and replacement of high-risk pipeline, such as cast iron and unprotected bare steel pipes, according to PHMSA.³⁰ PHMSA warns that “public safety requires prompt action [by gas companies] to repair, remediate, and replace high-risk gas pipeline infrastructure.”

²⁶ EPA, 2013 “Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011”, available at <http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf>. The EPA Inspector General is currently reviewing what actions can be taken to reduce methane leaks from pipelines, according to the *Wall Street Journal*, available at

<http://online.wsj.com/article/AP68bfefc2d9ce4d2c95fba5214c33dc19.html>.

²⁷ PHMSA’s analysis is based on incidents reported from 2005 – 2011, available at

http://opsweb.phmsa.dot.gov/pipeline_replacement/cast_iron_inventory.asp#recent_incidents.

²⁸ Significant Incidents are those incidents reported by pipeline operators to PHMSA when any of the following conditions are met: 1) Fatality or injury requiring in-patient hospitalization. 2) \$50,000 or more in total costs, measured in 1984 dollars. 3) Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more. 4) Liquid releases resulting in an unintentional fire or explosion.

²⁹ See http://opsweb.phmsa.dot.gov/pipeline_replacement/cast_iron_inventory.asp#recent_incidents.

³⁰ United States Department of Transportation, Pipeline and Hazardous Materials Safety Administration, 2011, “White Paper on State Pipeline Infrastructure Replacement Programs,” December, 2011, available at: <http://opsweb.phmsa.dot.gov/pipelineforum/docs/PHMSA%20111011-002%20NARUC.pdf>.

Table 3: Unaccounted for Gas Volumes and Estimated Cost by Company, 2000-2011, in 2012 dollars

Company	Lower Bound ^a			Upper Bound ^b		
	Unaccounted for Gas Volume (mcf)	Estimated Cost of Gas, 2000-2011	Average Cost of Gas per Customer, 2000-2011	Unaccounted for Gas Volume (mcf)	Estimated Cost of Gas, 2000-2011	Average Cost of Gas per Customer, 2000-2011
Berkshire Gas	521,363	\$3,327,089	\$96	4,985,339	\$34,508,094	\$998
Blackstone Gas	19,013	\$82,400	\$63	72,138	\$462,469	\$352
Boston Gas ^c	54,938,203	\$352,164,446	\$604	117,674,912	\$780,832,567	\$1,340
Columbia Gas ^e	6,098,769	\$39,557,300	\$143	17,175,142	\$113,874,947	\$412
Colonial Gas ^c	14,668,152	\$91,740,162	\$377	31,055,129	\$220,658,386	\$907
Essex Gas ^c	1,861,260	\$12,801,477	\$380	5,780,463	\$43,893,343	\$1,302
Fitchburg Gas & Electric ^d	908,172	\$5,905,935	\$211	3,592,072	\$24,765,349	\$886
City of Holyoke ^d	498,363	\$2,914,285	\$291	818,892	\$4,402,208	\$440
Middleborough Gas & Electric ^d	159,915	\$757,985	\$188	313,768	\$1,663,604	\$412
New England Gas	2,998,250	\$19,585,719	\$371	9,353,842	\$64,893,441	\$1,230
Nstar Gas	16,118,577	\$109,076,406	\$427	33,654,316	\$228,538,748	\$895
Wakefield Municipal Gas & Light ^d	75,498	\$523,290	\$88	547,872	\$3,304,418	\$553
Westfield Gas & Electric ^d	429,284	\$1,816,422	\$304	2,130,869	\$14,501,210	\$2,426
Total	99,294,819	\$640,252,916	\$273	227,154,754	\$1,536,298,783	\$935

Source: Staff Analysis of Massachusetts Department of Public Utilities (DPU) Annual Reports.

Notes: The transfer of gas costs onto rate payers is based on 220 CMR 6, <http://opsweb.phmsa.dot.gov/pipelineforum/docs/PHMSA%20111011-002%20NARUC.pdf> and <http://www.agc.org/SiteCollectionDocuments/KnowledgeCenter/PGAS%20Mechanisms.doc>. We calculated the cost of unaccounted for gas by multiplying the reported gas volumes by the NYMEX average futures price for that month, which are commonly used in cost of gas adjustments. We adjusted costs to 2012 dollars according to PHMSA's methods for adjusting costs associated with pipeline incidents.

^a Based on the yearly unaccounted for gas volumes reported to DPU, which include negative unaccounted for gas volumes on a monthly basis.

^b Based on the positive monthly unaccounted for gas volumes reported to DPU, and excludes negative unaccounted for gas volumes.

^c Owned by National Grid. Of these, Essex Gas was merged into Boston Gas in 2010.

^d Data were not available for all the years of our analysis. For the City of Holyoke, data were missing for 2006, 2005, 2004, 2003, 2002, and 2000. For Middleborough Gas & Electric, data were missing for 2006, 2005, and 2001. For Westfield Gas & Electric, data were missing for 2006. For the City of Wakefield, data were missing for 2005, 2004, 2002, and 2001.

^e Columbia Gas is a subsidiary of NiSource.

The slow pace of fixing leaks

There are some federal and state incentives in place to accelerate the pace of infrastructure replacement. Massachusetts is one of several forward-looking states that have either established or are considering policies that create financial incentives for gas companies to repair or replace leaky infrastructure. Despite these incentives, gas distribution companies' progress at replacing leak-prone pipeline remains slow. Specifically, the data show:

- **U.S. gas companies are replacing less than 5 percent of their leakiest pipes per year.** Cast iron and bare steel are the most leak-prone pipe materials, releasing 27.25 and 12.58 cubic feet of methane per hour, per mile, respectively, according to the EPA.³¹ PHMSA also lists these materials as high-risk pipeline infrastructure that is prone to failure.³² Nonetheless, last year gas companies nationwide replaced just 3 percent of their cast iron and bare steel distribution mains—pipes that connect transmission lines to service lines—with less leak-prone plastic pipes.³³

The Massachusetts gas distribution system—which is owned and operated by gas companies—ranks third among state distribution systems in the total number of miles of cast iron mains and second in the number of cast iron service lines (or “services”), which connect mains to customers. The distribution system ranks ninth and fourth in the number of miles of bare steel mains and services, respectively.³⁴ Gas companies operating in Massachusetts, however, replaced just 4 percent of cast iron and bare steel pipes in 2012 (see Table 6 on page 16). Of these companies, Boston Gas replaced the most miles (99) and service lines (3,277) made of cast iron and bare steel in 2012. Since 2004, New England Gas has reduced its inventory of cast iron and bare steel pipeline the most, replacing 1,408 miles of leak-prone mains and 51,496 leak-prone services (Table 6).³⁵

- **Nationwide, there are few federal or state incentives to repair or replace leaky pipes or minimize lost gas.** Federal pipeline safety regulations require only “hazardous leaks” posing imminent threat to be repaired promptly, allowing non-hazardous leaks to go unrepaired.³⁶ Gas companies are required to identify and classify leaks according to risk as part of their federally mandated Distribution Integrity Management Plans,³⁷ but only five states require all non-hazardous leaks to be repaired within a certain timeframe.³⁸

³¹ 40 CFR Part 98, Subpart W, available at <http://www.gpo.gov/fdsys/pkg/FR-2011-12-23/pdf/2011-31532.pdf>.

³² *Ibid.* 30.

³³ Companies may also retrofit bare steel pipelines with protective linings, which also have a lower emissions rate.

³⁴ The ranking is based on PHMSA’s cast and wrought iron and bare steel pipeline inventory, available at:

http://opsweb.phmsa.dot.gov/pipeline_replacement/cast_iron_inventory.asp and

http://opsweb.phmsa.dot.gov/pipeline_replacement/bare_steel_inventory.asp.

³⁵ Both of these companies participate in Massachusetts’ targeted infrastructure replacement program.

³⁶ 49 CFR 192 Part 192.703(c). A hazardous leak represents an existing or probable hazard to people or property and requires immediate action until the conditions are no longer hazardous, according to PHMSA guidance.

³⁷ 49 CFR Part 192 §§1005-1007.

³⁸ *Ibid.* 30; and National Association of Pipeline Safety Representatives, “Compendium of State Pipeline Safety Requirements & Initiatives Providing Increased Public Safety Levels compared to Code of Federal Regulations,” September 30, 2011, available at:

<http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Pipeline/Compendium.pdf>.

The Massachusetts legislature is currently considering repair timeframes for all non-hazardous leaks.³⁹

Thirty-three states, including Massachusetts,⁴⁰ have infrastructure replacement programs targeting cast iron and bare steel pipelines that allow companies to recover costs for replacing their leak-prone pipelines.⁴¹ However, companies may have little incentive to use these programs to accelerate pipeline replacement so long as they can still pass costs on to customers for lost gas.

Only two states with infrastructure replacement programs, Pennsylvania and Texas, have established limits on the amount companies can charge customers for lost gas.⁴² Pennsylvania just took these actions, so the results are not in yet, but in Texas the results are dramatic. From 2010 to 2012, with four gas companies participating in infrastructure replacement programs, Texas gas companies reduced their inventory of leak-prone service lines by 55 percent (101,790 lines). In this same time period, gas companies in Massachusetts reduced their leak-prone service lines by just 4 percent (8,278 lines). Notably, the Massachusetts legislature is also considering a cap on allowable unaccounted for gas, which could provide an additional financial incentive for gas companies to repair or replace leak-prone pipes.⁴³

- **It's hard to monitor company performance because data on unaccounted for gas is of such poor quality.** Companies regularly report negative volumes of unaccounted for gas, and there can be substantial variance in the numbers reported across agencies (see Table 7 on page 18). Negative unaccounted for gas volumes indicate calculating or reporting errors because it's physically impossible to dispose of more gas than enters a closed distribution system, according to a 2012 report prepared for the Pennsylvania Utility Commission.⁴⁴ This report also noted that inconsistencies in methodologies across companies can inhibit regulators' ability to monitor company performance over time.

According to federal and state officials, companies do not use a consistent methodology to calculate unaccounted for gas. Officials from PHMSA's Office of Pipeline Safety explained in an interview for this report that the agency provides companies with a formula for calculating unaccounted for gas, as well as guidance about the types of adjustments that are appropriate to make; however, each company decides which adjustments to make and less sophisticated operators may not make basic adjustments,

³⁹ H. 2933, "An Act enhancing natural gas pipeline safety;" H.2950, "An Act relative to natural gas leaks;" and S. 1580, "An Act relative to natural gas leaks," available at <https://malegislation.gov/Committees/Joint/J37>.

⁴⁰ New England Gas, Columbia Gas, and National Grid (MA)—which includes Boston Gas, Colonial Gas, and Essex Gas—all participate in Massachusetts' targeted infrastructure replacement program. As noted above, New England Gas and Boston Gas replaced the most leak-prone pipeline.

⁴¹ Based on the states listed in *Ibid*, 30 and *Ibid*, 6.

⁴² Pennsylvania capped unaccounted for gas at 3 percent, to be phased in over time, and finalized its rule in 2013, (52 PA Code §59.111). Texas capped unaccounted for gas for distribution systems at 5 percent in 2002. 16 TX Admin. Code §7.5525.

⁴³ See S. 1580, "An Act relative to natural gas leaks," available at <https://malegislation.gov/Committees/Joint/J37>.

⁴⁴ *Ibid*, 11.

such as adjusting volumes based on standard temperature pressure.⁴⁵ In Massachusetts, the Department of Public Utilities requested additional funds in its 2014 budget to hire a third-party consultant to review companies' procedures for classifying leaks and calculating lost and unaccounted for gas.⁴⁶

Actions needed to accelerate pipeline replacement

Despite slow progress to date, some state initiatives—like those established or proposed in Massachusetts—show promise and should be expanded to accelerate the repair or replacement of leak-prone pipelines. In particular:

- **States and non-regulated utilities such as municipal gas companies should adopt cost recovery programs for accelerated replacement of high-risk, leak-prone pipelines.** Companies typically cannot recover the costs of their infrastructure investments until the utility files for and receives such approval, which can be many months—and sometimes more than a year—after costs have been incurred.⁴⁷ Cost recovery programs allow gas companies to recover the costs of infrastructure improvements on a timelier basis, which could provide more incentive for companies to replace their leaky pipelines.⁴⁸ Ratepayers and the public may also benefit from these programs through increased safety, reductions in rates from decreased operations and maintenance and unaccounted for gas costs,⁴⁹ and reduced greenhouse gas emissions, according to a recent analysis of such programs in New England.

Taking into account widely accepted assumptions from the EPA regarding the rate of gas leaks, global warming potential and the social cost of carbon, and including costs associated with replacing pipelines, Massachusetts residents stand to realize \$156 million in net benefits over 10 years from the companies participating in the commonwealth's infrastructure replacement program.⁵⁰ One of these companies, Colonial Gas, increased their annual replacement rate of leak-prone pipeline by an average of 7 percent for

⁴⁵ Examples of appropriate adjustments are temperature, pressure, heat content, meter reading cycles, calculable losses from leaks or maintenance. PHMSA's guidance is available at [http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Forms/Gas%20Distr%20Annual%20Report%20Instructions%20-%20PHMSA%20F%207100.1-1%20\(01-2011\).pdf](http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Forms/Gas%20Distr%20Annual%20Report%20Instructions%20-%20PHMSA%20F%207100.1-1%20(01-2011).pdf).

⁴⁶ *Ibid.* 12.

⁴⁷ American Gas Association, "Infrastructure Cost Recovery Mechanisms," December, 2007, available at [http://www.agaj.org/SiteCollectionDocuments/RatesReg/0712INFRA\\$REPLAC.pdf](http://www.agaj.org/SiteCollectionDocuments/RatesReg/0712INFRA$REPLAC.pdf).

⁴⁸ While timelier cost recovery increases companies' incentives to replace infrastructure, it may also reduce companies' incentive to control costs, as noted in a National Regulatory Research Institute analysis, "How Regulators Should View Cost Trackers" Sept. 2009, available at http://nrri.org/pubs/gas/NRRI_cost_trackers_sept09-13.pdf.

⁴⁹ These reductions would help offset some, but not all, of the rate increase associated with replacing leak-prone infrastructure. For an example of how such a program might impact Massachusetts ratepayers, see the Attorney General's comments in the National Grid petition for targeted infrastructure cost recovery, available at <http://www.env.state.ma.us/dpu/docs/gas/10-55/11310dpuard.pdf>.

⁵⁰ The companies were National Grid (Boston Gas and Colonial Gas), New England Gas, and Columbia Gas. The Analysis Group, Inc. "Summary of Quantifiable Benefits and Costs Related to Select Targeted Infrastructure Replacement Programs," January, 2013, available at http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Benefits_Costs_TIRF_Jan2013.pdf.

service lines and 13 percent for main lines during its two years in the program. The other companies participating in the cost recovery program—Boston Gas, New England Gas, and Colombia Gas—have not appreciably improved their replacement rates of leak-prone pipes. This suggests that additional financial incentives, such as those currently under consideration by the Massachusetts legislature, may be needed.⁵¹

In 2009, Secretary of Transportation Ray LaHood called on states to adopt and expand infrastructure replacement programs. Forty-six states have leak-prone pipelines and could benefit from such programs, but so far only 33 states, including Massachusetts,⁵² have answered LaHood's call to action.

- **States and non-regulated utilities should establish timeframes for repairing non-hazardous gas leaks.** Gas companies are already required by federal regulation to identify, classify, and manage safety risks posed by leaks.⁵³ Nonetheless, leaks that do not pose a safety risk may continue unabated. Just five states—Florida, Georgia, Kansas, Maine and Texas—have established firm timeframes for repairing all non-hazardous leaks, with timeframes ranging from 3 months to 36 months for the least hazardous leaks.⁵⁴ As noted by the Conservation Law Foundation, this program may be having an effect, as Maine had one of the lowest lost gas rates in the country, according to data from the Energy Information Administration.⁵⁵ The Massachusetts legislature is considering repair timeframes for all non-hazardous leaks.⁵⁶
- **States and non-regulated utilities should adopt a standard definition and methodology for calculating unaccounted for gas.** Inconsistent data reported by companies inhibits regulators' ability to perform oversight, according to the Pennsylvania Public Utility Commission and others.⁵⁷ Furthermore, negative unaccounted for gas levels are indicative of calculating or reporting discrepancies, not actual gas volumes—and PHMSA does not allow companies to report negative values. To address this issue, the Pennsylvania Commission adopted a standard definition and methodology for unaccounted for gas, based in part on PHMSA's definition.⁵⁸ Other states with similar reporting issues should follow Pennsylvania's lead. Massachusetts state regulators plan to study the issue.⁵⁹

⁵¹ In the current legislative session, Massachusetts has at least two other innovative financing proposals for infrastructure replacement under consideration, including one—H. 2990 “An Act establishing natural gas infrastructure improvement financing”—specific to financing the repair of non-hazardous leaks.

⁵² *Ibid*, 51.

⁵³ 49 CFR Part 192 §1007.

⁵⁴ *Ibid*, 6.

⁵⁵ *Ibid*, 6.

⁵⁶ H. 2933, “An Act enhancing natural gas pipeline safety;” H.2950, “An Act relative to natural gas leaks;” and S. 1580, “An Act relative to natural gas leaks,” available at <https://malegislature.gov/Committees/Joint/J37>.

⁵⁷ Pennsylvania Public Utility Commission Public Meeting held June 7, 2012 Re: Proposed Rulemaking Order, Docket No. L-2012-2294746 and *Ibid*, 6.

⁵⁸ *Ibid*, 57.

⁵⁹ *Ibid*, 12.

- **States and non-regulated utilities should limit the ability of gas companies to recover costs for unaccounted for gas.** Limiting the amount of unaccounted for gas for which companies can charge would create a powerful financial incentive for gas companies to minimize emissions. As noted earlier, Pennsylvania and Texas are the only states that have set statewide caps on the percentages of gas for which companies can recover costs.⁶⁰ In both states, companies can recover costs for no more than 5 percent of the unaccounted for gas, and Pennsylvania plans to lower that to 3 percent in coming years.⁶¹ In finalizing its plan earlier this year, the Pennsylvania Public Utility Commission stated that eliminating cost recovery for gas lost above the cap shifts the financial burden of lost gas from the ratepayer to the gas company. That approach appears to have worked in Texas, which reduced its inventory of leak-prone service lines by an impressive 55 percent over the last two years. As noted earlier, the Massachusetts legislature is considering a cap on allowable unaccounted for gas.⁶²

To encourage action on these measures and build on Massachusetts' efforts, Sen. Markey is currently drafting legislation amending the Public Utilities Regulatory Policy Act of 1978.

American consumers, businesses and communities now pay for gas they don't receive and bear the risks of gas leaks they cannot repair. Gas distribution companies, on the other hand, have little reason to treat leaky pipelines as an urgent problem. They may even make money off of lost gas because they're reimbursed whether it reaches the home or not. The Markey legislation will help make sure gas companies take responsibility and fix their leaks.

⁶⁰ Pennsylvania and Texas are the only states with permanent, statewide caps in place. Other states may have temporary caps or company-specific caps in place.

⁶¹ *Ibid*, 28.

⁶² See S. 1580, "An Act relative to natural gas leaks," available at <https://malegislature.gov/Committees/Joint/J37>.

Appendix

Table 4: Natural Gas Losses or Emissions as reported to the U.S. Energy Information Administration (EIA), the Massachusetts Department of Environmental Protection (DEP), and the U.S. Environmental Protection Agency (EPA), 2010-2011, in thousands of cubic feet (mcf)

Company Name	2010 EIA (gas losses)	2010 DEP (emissions)	2011 EIA (gas losses)	2011 DEP (emissions)	2011 EPA (emissions)
Berkshire Gas	68,702	40,954	45,434	40,706	-
Blackstone Gas	1,016	52	4,171	-	-
Boston Gas	911,944	967,390	499,814	918,066	915,842
Colonial Gas	-	121,778	-	109,876	109,546
Columbia Gas	388,391	377,102	249,454	345,050	-
Essex Gas	40,680	-	-	-	-
Fitchburg Gas & Electric	20,049	-	13,372	-	-
City of Holyoke	-	-	-	-	-
Middleborough Gas & Electric	5,116	19,387	3,358	8,086	3,934
New England Gas	43,310	-	27,857	-	202
Nstar Gas	416,273	-	259,721	-	205,491
Wakefield Municipal Gas & Light	3,273	-	2,346	-	-
Westfield Gas & Electric	224	-	123	-	-
Total	1,898,978	1,526,663	1,105,650	1,421,784	1,235,015

Source: Staff analysis of EIA data as reported by gas companies on Form EIA-176, "Annual Report of Natural and Supplemental Gas Supply and Disposition", DEP data, downloaded from the Climate Registry at <https://www.crisreport.org/web/questionnaire-and-reports>, and EPA emissions data, downloaded from <http://ghgdata.epa.gov/ghg/main.do>.

Notes: Natural gas companies began reporting GHG emissions to the Massachusetts DEP in 2010 and to EPA in 2011. According to an EPA official, differences in the emission amounts reported for individual companies are due to methodological differences between the General Reporting Protocol used as part of the Climate Registry and EPA's reporting requirements. For example, the EPA official said that the General Reporting Protocol in place for 2010 did not include different emissions factors specific to the type of pipe material used in the distribution system. In 2012, DEP amended its regulations so that companies which are also required to report GHG emissions to the U.S. EPA must use the same reporting methodology when they report to DEP.

The reporting thresholds for each agency are different. According to an EIA official, all companies are required to report natural gas losses. At the state level, companies are required to report emissions to DEP if they are (a) regulated under Title V of the U.S. Clean Air Act and 310 CMR 700 Appendix C, or (b) emit more than 5,000 short tons of CO₂ equivalent. For federal GHG emissions reporting to EPA, companies are required to report if they emit more than 25,000 metric tons of GHGs annually.

Metric ton CH₄ and CO₂ equivalent values were converted to cubic feet using EPA's online methane conversion tool, available at: <http://www.epa.gov/cmop/resources/converter.html>.

Table 5: Significant Incidents on Massachusetts Gas Distribution Pipelines, as Reported to PHMSA, 2002-2012^a

Date	City	Operator	Cause	Injuries	Property Damage	Type of Pipe
05/24/2002	Framingham	Nstar Gas	Excavation Damage	0	\$186,437	Steel
02/13/2003	Turners Falls	Berkshire Gas	Other Cause	0	\$550,330	Steel
11/21/2003	New Bedford	Nstar Gas	Other Cause	0	\$391,346	No data reported
04/13/2004	Walpole	Columbia Gas	Other Cause	0	\$182,281	Steel
04/06/2005	Boston	Boston Gas	Other Cause	1	\$0	No data reported
11/09/2005	Lexington	Boston Gas	Other Cause	0	\$1,661,938	No data reported
04/28/2006	Needham	Nstar Gas	Unknown Cause	1	\$22,285	Plastic
03/08/2007	Peabody	Boston Gas	Unknown Cause	0	\$110,386	No data reported
05/17/2007	Wapole	Columbia Gas	Unknown Cause	1	\$27,399	Plastic
09/10/2007	Easton	Columbia Gas	Unknown Cause	2	\$2,208,346	Other
01/03/2008	Maynard	Nstar Gas	Unknown Cause	0	\$161,597	Steel
01/25/2009	Gloucester	Boston Gas	Unknown Cause	1	\$416,505	Cast iron (likely) ^c
03/09/2009	West Barnstable	Colonial Gas	Unknown Cause	0	\$364,442	Plastic
01/15/2010	Waltham	Boston Gas	Incorrect Operation	0	\$510,449	Steel
01/25/2010	Reading	Boston Gas	Natural Force Damage	1	\$255,224	Cast iron
01/23/2011	West Springfield	Columbia Gas	Other Cause	0	\$104,409	Steel

06/24/2012	Seekonk	Columbia Gas	Other Outside Force Damage	0	\$315,400	Steel
11/09/2012	Fitchburg	Fitchburg Gas & Electric Light	Excavation Damage	0	\$110,000	Steel
11/23/2012	Springfield	Columbia Gas	Other Cause	17	\$1,310,300	Plastic ^e
Total	23 incidents			24	\$9,492,677	
Berkshire Gas Subtotal	1 incident			0	\$550,330	
Boston Gas Subtotal	8 incidents			3	\$3,060,938	
Colonial Gas Subtotal	1 incident			0	\$364,442	
Columbia Gas Subtotal	6 incidents			20	\$4,148,135	
Fitchburg Gas & Electric Subtotal	1 incident			0	\$110,000	
New England Gas Subtotal	1 incident			0	\$0	
Nstar Gas Subtotal	5 incidents			1	\$1,258,832	

Source: PHMSA incident and accident data for gas distribution pipelines in Massachusetts. The data were accessed on June 6, 2013 at: http://primis.phmsa.dot.gov/comm/reports/safety/IncDelStat_MA_ft_sig.html. Data on the pipeline materials were collected from PHMSA's Flagged Incident files for May 31, 2013, accessed at <http://primis.phmsa.dot.gov/comm/reports/safety/SIDA.html?nocache=1646>.

^a Significant Incidents are those incidents reported by pipeline operators to PHMSA when any of the following conditions are met: 1) Fatality or injury requiring in-patient hospitalization. 2) \$50,000 or more in total costs, measured in 1984 dollars. 3) Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more. 4) Liquid releases resulting in an unintentional fire or explosion.

^b Property damage is estimated as the sum of all public and private costs reported in the 30-day incident report. The costs for incidents prior to 2012 are presented in 2012 dollars. Cost of Gas lost is indexed via the Energy Information Administration, Natural Gas City Gate Prices. All other costs are adjusted via the Bureau of Economic Analysis, Government Printing Office inflation values.

^c The company did not officially report the type of pipeline material involved, however the wrongful death lawsuit filed by the parents of the victims implicated a corroded metal fitting as the source of the gas leak that led to the fatal explosion.

^d The company did not officially report the type of pipeline material involved, however the incident report indicated that a piece of cast iron pipeline was identified at the incident scene.

^e The company reported that the pipeline material was plastic. DPU officials clarified that the plastic pipeline had been inserted into an existing steel pipeline.

Table 6: Replacement rates for leak-prone pipeline in Massachusetts, by company, 2004-2012

Company Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	Replacement rate	Leak-prone Pipeline Remaining in 2012
										Leak-prone Pipeline Replaced Since	
Berkshire Gas - Main Miles	23	-2%	-73%	251%	-2%	-2%	-2%	-3%	-4%	115	
Berkshire Gas - Service Lines	1,088	-3%	-3%	-3%	-2%	-2%	-4%	-2%	-5%	3,864	
Blackstone Gas - Main Miles	2	0%	0%	0%	0%	0%	0%	100%	0%	0	
Blackstone Gas - Service Lines	0	0%	0%	0%	0%	0%	0%	0%	0%	0	
Boston Gas - Main Miles ^{a,b}	496	-1%	-2%	-1%	-1%	-2%	-3%	-2%	-3%	2,997	
Boston Gas - Service Lines ^{a,b}	6,609	-2%	13%	-1%	-2%	-3%	-5%	-3%	-3%	90,523	
Colonial Gas - Main Miles ^{a,b}	189	-1%	-2%	-2%	-3%	-3%	-5%	-19%	-17%	253	
Colonial Gas - Service Lines ^{a,b}	1,078	26%	1%	-6%	-8%	-6%	-3%	-10%	-10%	4,466	
Columbia Gas - Main Miles ^{b,c}	344	-5%	-5%	-4%	-4%	-3%	-2%	-4%	-4%	979	
Columbia Gas - Service Lines ^{b,c}	13,907	-3%	-4%	-3%	-3%	-3%	-3%	-3%	-4%	46,622	
Essex Gas - Main Miles ^{a,b}	23	-2%	-4%	-1%	-1%	-3%	-6%	1%	-3%	111	
Essex Gas - Service Lines ^{a,b}	533	-1%	4%	-2%	-2%	-3%	-2%	-3%	-3%	4,433	
Fitchburg Gas & Electric - Main Miles ^b	21	-83%	433%	-3%	-3%	-3%	-3%	-3%	-4%	66	
Fitchburg Gas & Electric - Service Lines ^b	-490	-6%	-14%	-8%	-9%	-8%	119%	-6%	-8%	3,379	
City of Holyoke Main Miles	6	0%	-2%	0%	-3%	-3%	0%	-2%	0%	58	
City of Holyoke Service Lines	1,127	-2%	-4%	-2%	-2%	-5%	-3%	-7%	-10%	2,557	

Middleborough Gas & Electric Main Miles	5	-1%	-90%	795%	0%	0%	0%	-17%	-7%	11
Middleborough Gas & Electric Service Lines	86	-7%	-3%	-9%	-5%	-3%	-3%	-3%	-10%	149
New England Gas Main Miles ^b	1,408	-1%	-87%	-1%	-2%	-3%	-3%	8%	-4%	185
New England Gas Service Lines ^b	51,496	-2%	-95%	-2%	-11%	-13%	-19%	448%	-5%	8,813
Nstar Gas Main Miles	145	-3%	-2%	-2%	-2%	-3%	-2%	-3%	-3%	716
Nstar Gas Service Lines	9,303	-2%	-4%	-2%	-3%	-4%	-4%	-4%	-5%	26,514
Wakefield Municipal Gas & Light Main Miles	11	-1%	-3%	-4%	-1%	-1%	-9%	-4%	-3%	37
Wakefield Municipal Gas & Light Service Lines	529	0%	-4%	-4%	-1%	-4%	-7%	-8%	-2%	1,463
Westfield Gas & Electric Main Miles	15	-4%	-2%	-2%	-2%	-5%	-4%	-1%	-10%	42
Westfield Gas & Electric Service Lines	493	14%	-7%	-6%	-8%	-6%	-4%	-4%	-5%	1,543
Massachusetts - Main Miles	2,684	-3%	-20%	-0%	-2%	-2%	-3%	-3%	-4%	5,571
Massachusetts - Service Lines	85,759	-2%	-18%	-2%	-3%	-4%	-3%	0%	-4%	194,326
National- Main Miles	20,944	-5%	-3%	-3%	-2%	-4%	3%	-4%	-3%	93,705
National- Services	2,036,032	-10%	4%	-2%	-2%	-4%	-35%	-4%	-12%	2,568,279

Source: Staff analysis of PHMSA's Cast and Wrought Iron and Bare Steel Pipeline Inventory, available at: http://opsweb.phmsa.dot.gov/pipeline_replacement/cast_iron_inventory.asp and http://opsweb.phmsa.dot.gov/pipeline_replacement/bare_steel_inventory.asp respectively.

Notes: According to PHMSA officials, changes in replacement rates are generally due to three factors: (1) pipeline replacement, (2) acquisition of or selling off part of a distribution pipeline, or (3) changes in pipeline classification due to updated information or recordkeeping.

^a Owned by National Grid. Essex Gas was merged into Boston Gas in 2010.

^b Participating in Massachusetts' Targeted Infrastructure Replacement Program. Fitchburg Gas & Electric applied in 2011.

^cColumbia Gas is a subsidiary of NiSource.

Table 7: Unaccounted For Gas as reported to the U.S. Energy Information Administration (EIA), the Massachusetts Department of Public Utilities (DPU), and the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA), 2000-2011, in thousands of cubic feet (mcf).

Year	Berkshire Gas			Blackstone Gas			Boston Gas		
	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU
2000 ^b	120,978	63,692 ^b	168,984	(15,162)	1,272 ^b	(15,162)	426,214	1,195,670 ^b	11,075,967
2001	(154,150)	109,702	(77,929)	2,663	3,172	3,198	(484,330)	2,298,696 ^e	(4,122,104)
2002	(30,005)	72,381	38,868	- ^c	0	1,353	3,914,559	1,825,298 ^e	3,430,856
2003	102,524	15,179	59,821	(9,910)	0	(10,257)	(7,548,200)	1,899,037 ^e	2,348,739
2004	130,896	23,282	84,457	- ^c	0	3,126	349,109	1,085,110	7,530,492
2005	(55,099)	6,702	(19,904)	(1,048)	1,359	(1,048)	(7,309,864)	1,506,820 ^e	2,854,048
2006	(4,341)	14,205	(54,000)	1,502	1,508	1,502	(33,818)	1,582,028	3,466,829
2007	4,608	80	73,152	258	245 ^d	258	1,745,671	1,925,199	5,621,285
2008	(4,600)	0	39,820	424	42	1,117	4,753,488	1,148,131	4,398,551
2009	93,290	0	56,261	3,666	3,674	3,666	4,389,219	1,361,536	4,301,979
2010	(124,956)	0	(34,102)	(395)	612 ^e	621	4,853,998	1,628,005	6,006,689
2011	(204,783)	0	(122,974)	- ^c	4,408 ^d	4,172	1,209,084	3,056,038 ^e	3,902,768

Year	Colonial Gas			Columbia Gas			Essex Gas		
	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU
2000	4,156,770	428,180 ^b	3,345,846	560,631	0	383,435	448,976	78,232 ^b	299,459
2001	1,547,492	818,573	1,617,123	748,841	0	(299,313)	531,639	150,556	506,173
2002	1,017,066	646,801	1,056,732	(1,828,316)	171,874	(95,467)	138,544	210,175	145,516
2003	(2,012,982)	224,138	167,355	846,681	526,380	967,263	397,023	29,213	(7,006)
2004	3,661,867	196,647	339,082	432,808	500,806	435,819	— ^c	82,640	224,803
2005	(1,665,602)	460,716	1,378,995	141,385	350,591	168,940	— ^c	193,763	288,613
2006	444,983	455,120	847,750	495,274	472,090	505,677	61,068	134,072	102,530
2007	(2,810,835)	962,352 ^e	1,160,167	422,819	239,207	431,702	(873,400)	15,633	178,873
2008	1,757,733	505,349	1,105,796	897,251	889,654	906,609	589,382	0	105,165
2009	3,803,689	509,276	2,109,285	914,520	775,345	951,102	(65,256)	0	10,128
2010	2,660,178	459,805	1,268,962	(366,512)	889,321	803,978	(70,192)	0	(37,516)
2011	(116,205)	630,792	271,059	273,855	730,366	544,244	— ^c	— ^c	— ^c

Year	Fitchburg Gas & Electric			New England Gas			Nstar Gas		
	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU
2000	64,340	17,284 ^b	252,875	602,683	1,385,336 ^b	539,117	(156,442)	588,377 ^b	729,716
2001	(5,504)	26,660	(117,568)	31,703	1,005,596	51,776	800,345	983,195	2,404,231
2002	40,314	86,104	162,540	349,369	287,360	430,622	991,910	559,799 ^e	817,956
2003	3,790	2,970	(184,846)	(1,646,155)	286,070	285,346	1,074,279	412,850	1,287,457
2004	4,690	2,572	(8,587)	(1,995,970)	242,633	365,839	1,604,333	1,044,258	1,733,842
2005	779	18,131	136,487	(455,114)	305,275	204,480	2,597,673	919,919	1,734,586
2006	2,334	40,719	190,397	(1,061,367)	228,572	183,237	3,875,109	723,353	1,244,381
2007	(4,014)	(16,227)	42,842	(641,455)	284,468	448,312	3,161,389	971,746 ^e	1,734,530
2008	75,480	32,584	4,254	(1,010,077)	210,260	133,218	5,480,650	868,733 ^e	1,392,017
2009	(302,429)	20,325	118,777	(874,917)	198,355	329,704	4,880,295	821,512 ^e	1,130,819
2010	63,964	15,283	(68,348)	(1,355,813)	140,535	26,599	5,467,124	591,043 ^e	1,057,108
2011	(20,415)	4,581	(42,142)	(1,477,340)	116,679	(4,163)	1,971,460	584,880 ^e	851,934

Year	City of Holyoke			Middleborough Gas and Electric			Wakefield Municipal Gas & Light Department		
	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU	EIA	PHMSA ^a	MA DPU
2000	26,252	11,076 ^b	- ^c	9,604	2,426 ^b	9,604	372	6,412 ^b	(1,547)
2001	404	- ^c	403	5,368	1,615 ^b	- ^c	12,604	4,683 ^b	- ^c
2002	65,469	26,759 ^b	- ^c	33,798	18,404 ^b	29,723	12,284	- ^c	- ^c
2003	88,471	- ^c	- ^c	26,219	27,329	22,617	14,615	7,837 ^{b, d}	12,494
2004	100,409	- ^c	- ^c	22,558	21,316 ^d	23,289	18,345	6,345 ^b	- ^c
2005	- ^c	- ^c	- ^c	7,846	3,256 ^b	- ^c	28,796	- ^c	- ^c
2006	39,185	- ^c	- ^c	(1,663)	- ^c	- ^c	10,968	10,761 ^b	9,386
2007	92,669	6,076 ^b	90,666	52,692	4,053 ^b	(9,606)	14,711	8,536 ^d	9,904
2008	92,041	63,800	84,155	(2,070)	8,871	10,232	50,687	14,413 ^e	21,041
2009	(49,658)	161,684	163,870	28,763	36,704 ^d	36,653	18,270	9,905	19,877
2010	46,100	74,063	103,923	22,072	20,813 ^d	20,256	15,752	17,709	1,398
2011	51,876	103,358	55,346	4,381	8,515	7,541	16,857	17,697	1,398

Westfield Municipal Gas & Light Department			
Year	EIA	PHMSA ^a	MA DPU
2000	34,191	31,397 ^b	98,687
2001	7,404	54,448	24,890
2002	35,730	47,617	63,304
2003	(46,922)	52,823	37,398
2004	26,659	43,856	82,085
2005	(31,237)	28,761	10,465
2006	53,718	16,603 ^b	- ^c
2007	50,401	37,696 ^b	112,455
2008	(97,848)	33,429	(53,350)
2009	(79,530)	49,255	(55,449)
2010	(8,176)	12,682	(7,412)
2011	(44,794)	7,455	(45,652)

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Sources: Energy Information Administration, EIA Form 176, "Annual Report of Natural and Supplemental Gas Supply and Disposition", Unaccounted for Gas item, PHMSA, "Annual Gas Distribution Reports", Form 7100.1.1. Unaccounted for Gas Percent, and Annual Reports filed with the Massachusetts DPU. The reporting timeframes are different for PHMSA versus EIA and DPU. Specifically, PHMSA requests data for the previous year through June 30 of the reporting year, while EIA and DPU request data for the previous calendar year.

^a Unaccounted for Gas is reported annually to PHMSA as a percentage. Based on discussions with PHMSA officials, we calculated a volume of gas by multiplying that percentage by the amount of reported gas made and purchased for one year through June 30 of the reporting year, per the instructions in PHMSA's Annual Gas Distribution Report Form 7100.1.1.

^b Only partial year data were available, since annual reports from the Massachusetts DPU were not available for both of the years necessary to calculate the gas volume from the unaccounted for gas percentage reported to PHMSA.

^c No data were available for this year, either because annual reports from the Massachusetts DPU were not available, or companies did not report data for this field to EIA.

^d The percentage of unaccounted for gas reported to PHMSA and DPU were the same, however the volumes are different. Some of this variation may be due to differences in reporting timeframes (e.g. July 1 of the previous year-June 30 of the reporting year for PHMSA and calendar year for DPU).

^e The percentage of unaccounted for gas reported to PHMSA was greater than that reported to DPU, however the PHMSA volume listed here is less than that listed for DPU. Some of this variation may be due to differences in reporting timeframes (e.g. July 1 of the previous year-June 30 of the reporting year for PHMSA and calendar year for DPU).

Notes: Boston Gas, Colonial Gas, and Essex Gas are subsidiaries of National Grid. Essex Gas was merged into Boston Gas in 2010.

Columbia Gas is a subsidiary of NiSource.

**Exhibit 5 to West Roxbury Motion for
Rehearing: Harvard Emissions Study**

Methane emissions from natural gas infrastructure and use in the urban region of Boston, Massachusetts

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Methane emissions from natural gas delivery and end use must be quantified to evaluate the environmental impacts of natural gas and to develop and assess the efficacy of emission reduction strategies. We report natural gas emission rates for 1 y in the urban region of Boston, using a comprehensive atmospheric measurement and modeling framework. Continuous methane observations from four stations are combined with a high-resolution transport model to quantify the regional average emission flux, 18.5 ± 3.7 (95% confidence interval) $\text{g CH}_4 \cdot \text{m}^{-2} \cdot \text{y}^{-1}$. Simultaneous observations of atmospheric ethane, compared with the ethane-to-methane ratio in the pipeline gas delivered to the region, demonstrate that natural gas accounted for $\sim 60\text{--}100\%$ of methane emissions, depending on season. Using government statistics and geospatial data on natural gas use, we find the average fractional loss rate to the atmosphere from all downstream components of the natural gas system, including transmission, distribution, and end use, was $2.7 \pm 0.6\%$ in the Boston urban region, with little seasonal variability. This fraction is notably higher than the 1.1% implied by the most closely comparable emission inventory.

natural gas distribution | greenhouse gas emissions | cities | methane

Atmospheric methane (CH_4) is an important greenhouse gas (1) and major contributor to elevated surface ozone concentrations worldwide (2). Current atmospheric CH_4 concentrations are 2.5 times greater than preindustrial levels due to anthropogenic emissions from both biological and fossil fuel sources. The growth rate of CH_4 in the atmosphere slowed beginning in the mid-1980s and plateaued in the mid-2000s, but growth has resumed since 2007. The factors responsible for the observed global increase and interannual trends, and the spatiotemporal distribution of sources, remain uncertain (3).

Losses of natural gas (NG) to the atmosphere are a significant component of anthropogenic CH_4 emissions (3), with important implications for resource use efficiency, worker and public safety, air pollution, and human health (4), and for the climate impact of NG as a large and growing source of energy. A major focus area of the US Climate Action Plan is reduction of CH_4 emissions (5), but implementation requires identification of dominant source types, locations, and magnitudes. A recent review and synthesis of CH_4 emission measurements in North America, spanning scales of individual components to the continent, found that inventory methods consistently underestimate CH_4 emissions, that fossil fuels are likely responsible for a large portion of the underestimate, and that significant fugitive emissions may be occurring from all segments of the NG system (6).

The present study quantifies CH_4 fluxes from NG in the urbanized region centered on Boston. Elevated CH_4 concentrations in urban environments have been documented around the world for decades (7) (*SI Appendix, Table S1*) and attributed to a variety of anthropogenic source types. Recent studies of urbanized regions in California, using diverse atmospheric observing and modeling

approaches, consistently found that CH_4 emission rates were larger than those estimated by regional bottom-up inventories (8–12). In Boston, elevated CH_4 concentrations have been observed at street level and attributed to $>3,000$ NG pipeline leaks from antiquated infrastructure (13), but associated CH_4 emission rates were not quantitatively assessed.

In this study, we combine four key quantities in an atmosphere-based analytical framework: (i) atmospheric CH_4 enhancements above background (ΔCH_4) were determined from measurements at a network of continuous monitoring stations, inside and upwind of the urban core (Fig. 1), for 12 mo in 2012–2013; (ii) the NG fraction of the observed ΔCH_4 was quantified for cool and warm seasons by measuring atmospheric ethane (C_2H_6), a tracer of thermogenic CH_4 , and comparing ratios of C_2H_6 and CH_4 in the atmosphere and in the pipeline gas flowing through the region; (iii) total CH_4 emissions were derived from an atmospheric transport model, which quantitatively links surface fluxes with observed ΔCH_4 using assimilated meteorology; and (iv) the fraction of delivered NG lost to the atmosphere was estimated by comparing CH_4 emissions to spatially explicit data on NG consumption. The result encompasses NG losses from the entire urbanized region, including emissions from NG transmission, storage, distribution, end use, and liquefied NG importation.

Significance

Most recent analyses of the environmental impact of natural gas have focused on production, with very sparse information on emissions from distribution and end use. This study quantifies the full seasonal cycle of methane emissions and the fractional contribution of natural gas for the urbanized region centered on Boston. Emissions from natural gas are found to be two to three times larger than predicted by existing inventory methodologies and industry reports. Our findings suggest that natural-gas-consuming regions may be larger sources of methane to the atmosphere than is currently estimated and represent areas of significant resource loss.

Author contributions: K.M., S.M.R., J.B., L.R.H., T.N., R.B.J., N.P., and S.C.W. designed research; K.M., S.M.R., and L.R.H. designed and constructed the prior emission model; K.M. and J.B. designed and maintained the measurement network; K.M., L.R.H., and S.C.W. conducted a pilot study of the measurement network; K.M., A.D., S.M.R., C.F., S.C.H., T.N., and M.S.Z. performed research; T.N. adapted, ran, and evaluated the WRF-STILT model; K.M. collected and analyzed the methane data; A.D. collected pipeline data; A.D., C.F., S.C.H., and M.S.Z. collected and analyzed the atmospheric ethane data; and K.M. and S.C.W. wrote the paper.

The authors declare no conflict of interest.

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Data deposition: Archival datasets are available through the Boston Regional Atmospheric Measurement Network Dataverse at dx.doi.org/10.7910/DVN/28530.

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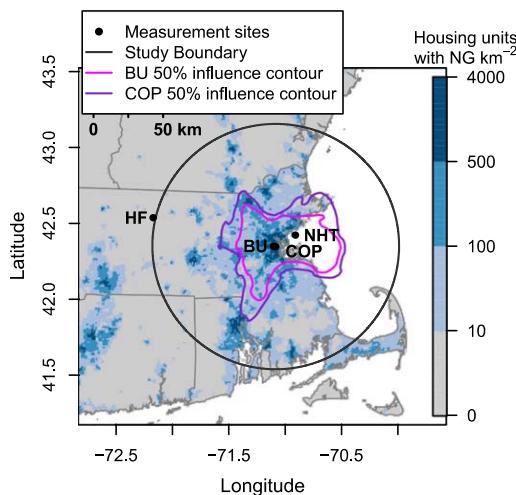


Fig. 1. Location of two city [Boston University (BU), 29-m height; Copley Square (COP), 215-m height] and two peripheral [Harvard Forest (HF); Nahant (NHT)] measurement stations (black points) in Boston, and the surrounding area, overlaid on a map of the number of housing units with NG per square kilometer (14). The 90-km radius circle delineates the ~18,000-km² land area for which CH₄ emissions and the NG loss rate were calculated. The magenta and purple contours enclose 50% of the average footprint (sensitivity area) of the BU and COP afternoon measurements, respectively. The two city sites are difficult to distinguish at this scale because the horizontal distance between them is ~2 km. The influence area is ~80% larger for COP than BU because the former station is higher. See *SI Appendix*, Table S2, for additional measurement site location information.

Methane Concentrations in the Boston Atmosphere

Atmospheric CH₄ concentrations were measured continuously from September 2012 through August 2013 at two locations near the urban center [Boston University (BU) and Copley Square (COP)] and two locations outside of Boston [Harvard Forest (HF) and Nahant (NHT)] (Fig. 1 and *SI Appendix*, Table S2 and section S1). Background concentrations in air flowing into the city were estimated by randomly sampling from a range (5th to 35th) of lower percentiles of CH₄ measurements from two upwind stations (HF or NHT, depending on the direction of simulated air trajectories; *SI Appendix*, section S3.1), averaged over a 48-h moving window, to capture synoptic-scale variability and remove possible influences of small nearby sources (*SI Appendix*, section S3.3). Values of ΔCH_4 were calculated by subtracting background from urban concentrations. Hourly average ΔCH_4 data were aggregated into daily afternoon (11–16 h EST, 16–21 h UTC) means to remove autocovariance and focus the analysis on periods of well-mixed atmospheric conditions.

Methane concentrations in Boston were consistently elevated over background (Fig. 2 and *SI Appendix*, Figs. S1 and S2) and followed a distinct daily pattern (Fig. 3 A and C, and *SI Appendix*, Fig. S16), associated with growth and decay of the planetary boundary layer. Concentrations fluctuated over short timescales (*SI Appendix*, Fig. S1) due to small-scale atmospheric circulations and heterogeneous sources in the urban environment. Methane concentrations were higher in winter than the other seasons at both sites, but ΔCH_4 varied less with season (Fig. 2). The average annual afternoon values of ΔCH_4 at BU and COP were 45.9 (37.3, 58.5) ppb and 30.5 (23.6, 39.3) ppb, respectively (Fig. 2), reflecting different sampling altitudes (30 and 215 m, respectively; *SI Appendix*, Table S2). All errors reported throughout the paper are 95% confidence intervals. Uncertainties in ΔCH_4 (Fig. 2) were calculated through a bootstrap analysis that included background concentrations and afternoon hourly, daily, and seasonally averaged CH₄ measurements (*SI Appendix*, section S3.3).

Contribution of NG to Elevated CH₄ Concentrations

To quantify the fraction of the observed ΔCH_4 that was due to NG emissions, we compared ratios of C₂H₆ and CH₄ measured in the atmosphere and NG pipelines serving the region. Ethane is a significant component of NG, whereas microbial CH₄ sources, such as landfills, sewage, and wetlands, produce little or no C₂H₆ (15). Because Boston has no geologic CH₄ seeps, no oil and gas production or refining, and low rates of biomass burning, there are no known significant sources of C₂H₆ in the region other than NG.

Ethane concentrations were measured with a laser spectrometer (15) at BU for 3 mo in the fall and winter of 2012–13 and 1 mo in the late spring of 2014 (*SI Appendix*, Fig. S6). Covariances between atmospheric C₂H₆ and CH₄ observations were determined from the daily slopes of a linear model that minimizes χ^2 (16) of 5-min median afternoon data (Fig. 4 and *SI Appendix*, section S2.1). The median of the daily slopes of atmospheric C₂H₆ versus CH₄ was 2.6 (2.5, 2.8) % during the cool season and 1.6 (1.4, 1.7) % during the warm season, obtained from days with a coefficient of determination (R^2) > 0.75 (~50% of the days).

The average C₂H₆ and CH₄ ratio in the NG flowing into the region during the two atmospheric measurement periods was $2.7 \pm 0.0\%$ in the fall and winter of 2012–2013 and $2.4 \pm 0.1\%$ in the spring of 2014, determined from hourly gas quality data from the three main pipelines that serve the region (17, 18) (*SI Appendix*, Figs. S7 and S8, and section S2.2). The quotient of the C₂H₆ and CH₄ ratios in the atmosphere and pipeline demonstrates that NG contributed 98 (92, 105) and 67 (59, 72) % of the ΔCH_4 in Boston in the cool and warm seasons, respectively. This result is insensitive to assumptions about the relative contribution of the three pipelines that supply the region and

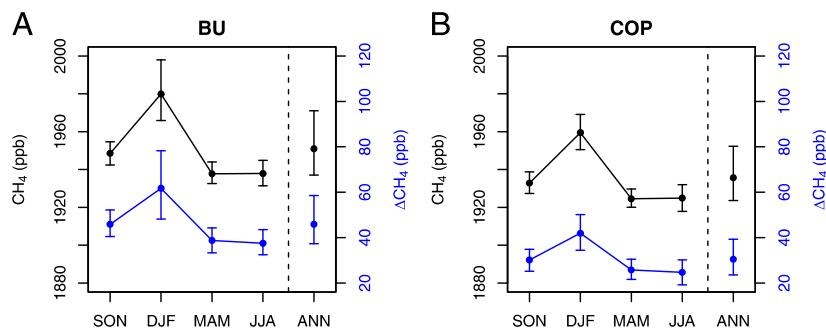


Fig. 2. Average (±95% confidence intervals) afternoon (11–16 h EST) CH₄ (black; left y axis) and ΔCH_4 (blue; right y axis) by season and for the whole year at (A) BU and (B) COP.

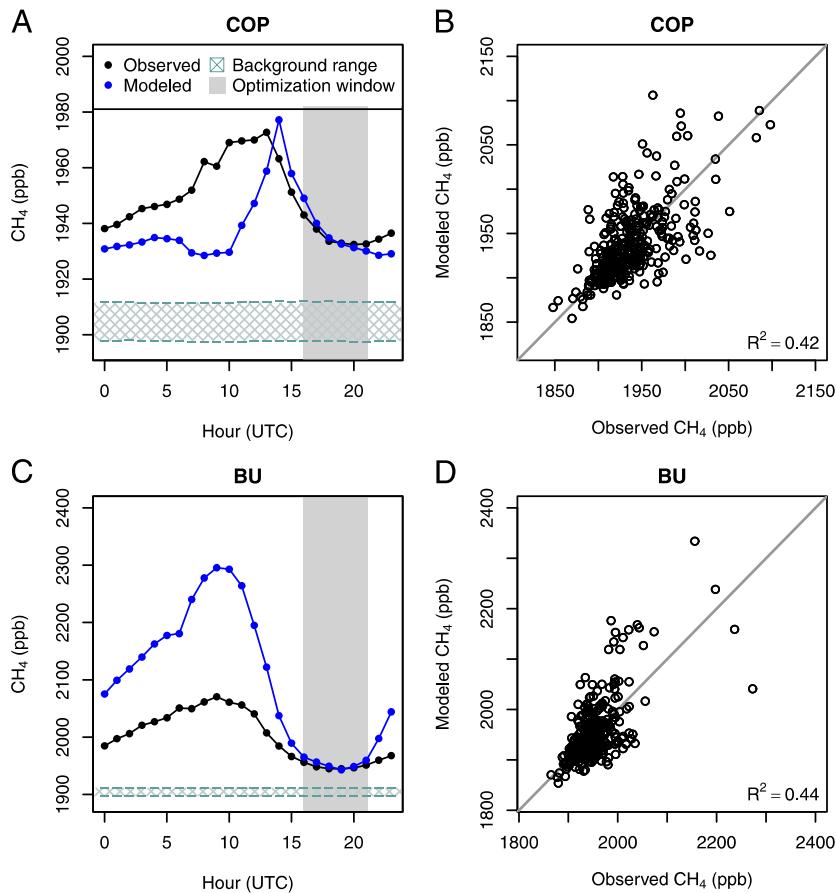


Fig. 3. Observed and optimized modeled CH_4 at (A and B) COP and (C and D) BU for 1 y. (A and C) Observed, modeled, and background CH_4 concentrations averaged by hour of the day. The horizontal hatched area shows the average range of possible background concentrations, derived from 5th to 35th percentiles of the background station data. The gray vertical shaded area indicates the afternoon model optimization period, 11–16 h EST (16–21 h UTC). (B and D) Modeled versus observed daily average afternoon CH_4 concentrations. The gray line is the one-to-one line.

to the filtering criteria for the atmospheric data (*SI Appendix*, section S2.3).

Methane and Natural Gas Emissions in Greater Boston

Methane enhancements were modeled at BU and COP with the Stochastic Time-Inverted Lagrangian Transport (STILT) model (19), coupled to the Weather Research and Forecasting (WRF) meso-scale meteorological model run at 1-km² grid resolution (WRF-STILT; ref. 20; *SI Appendix*, section S3.1). WRF-STILT generates footprints (with units ΔCH_4 per unit surface flux), which represent the sensitivity of each measurement point in space and time to upwind surface fluxes. Both urban measurement sites were sensitive to emissions from the greater Boston region, with COP sensitive to a larger area than BU due to its higher altitude (Fig. 1 and *SI Appendix*, Table S2).

A spatially resolved prior model of CH_4 emissions was constructed for the study region (*SI Appendix*, section S3.2.2, Fig. S12, and Table S4) and combined with WRF-STILT footprints to generate a set of simulated ΔCH_4 values for each hour at each measurement station. The emission inventory was scaled for each season to equalize mean afternoon (11–16 h EST) modeled and observed ΔCH_4 , providing optimized CH_4 emission rates for the region. Detailed methods and results for the model framework, including details on the emissions error quantification and results from alternative methodological approaches, are given in *SI Appendix*, sections S3 and S4. Observation-model comparisons are shown in Fig. 3 and *SI Appendix*, Figs. S13 and S14.

The mean annual optimized emission rate for the study area was $18.5 \pm 3.7 \text{ g CH}_4 \cdot \text{m}^{-2} \cdot \text{y}^{-1}$ from all sources (Fig. 5A). Seasonal variations of total CH_4 emissions were modest, with fluxes in spring and summer marginally higher than in fall at the 95% confidence level (Fig. 5A). The weak seasonality of observed ΔCH_4 (Fig. 2) and the CH_4 flux rate is consistent with the finding that most of the emissions are from thermogenic gas, rather than biological processes, which would likely depend more strongly on season (21, 22). When data from each urban site are analyzed independently, CH_4 emission results are not significantly different (*SI Appendix*, Fig. S4), despite the large differences in ΔCH_4 (Fig. 2) and modeled footprints (Fig. 1) between the two sites. This result provides strong support for the observation-model framework, which is further strengthened by the robustness of the emission result to adoption of different model frameworks (*SI Appendix*, sections S4.2–S4.3).

To assess the fraction of delivered NG emitted to the atmosphere, we constructed a spatially explicit estimate of NG consumption in the region (Fig. 6 and *SI Appendix*, section S3.2.1). Fractional loss rates for the region were obtained by multiplying optimized emissions by the fractional contribution of NG to the atmospheric signal, as indicated by the ethane tracer data, and dividing by the mean NG consumption in the region (Fig. 5A and B). The inferred mean annual NG loss rate in the study area was $2.7 \pm 0.6\%$ of the total delivered gas in 2012–2013, with little seasonal dependence (Fig. 5C). Uncertainties in the average loss rates were calculated by summing in quadrature the relative

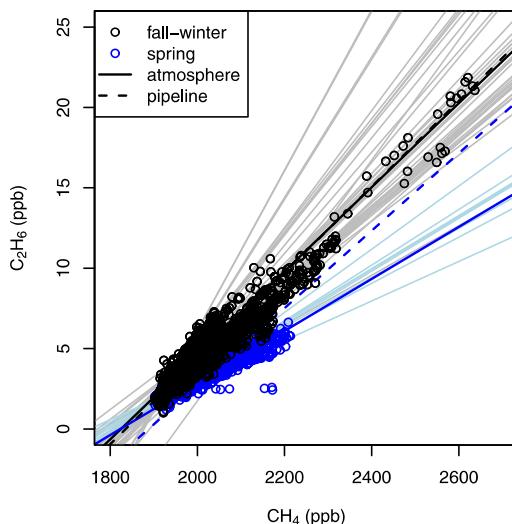


Fig. 4. Five-minute median atmospheric C_2H_6 and CH_4 measurement points at BU in fall and winter of 2012–2013 (black) and spring of 2014 (blue), χ^2 optimization lines fit to each day (light lines), average fit lines for both seasons from all days with $R^2 > 0.75$ (bold solid lines), and lines with slopes of pipeline $\text{C}_2\text{H}_6/\text{CH}_4$ (dashed lines).

errors for the average emissions, atmospheric NG fraction, and NG consumption terms (*SI Appendix*, section S3.2.1).

The modest seasonality of the inferred NG loss rate (Fig. 5C) is driven by the small seasonal variability in total NG consumption (Fig. 5B). Our analysis makes no assumptions about the relative contribution to emissions of specific NG-consuming sectors or emission processes (*SI Appendix*, section S3.2.1), which could individually have very different loss rates than the aggregate

estimate generated by this study. Our finding that the regional average NG emission rate was seasonally invariant may indicate that it does not strongly depend on the seasonally varying components of the NG system, or could result from multiple compensating processes.

Comparison with Atmospheric Studies and Inventories

Two recent studies in Los Angeles covering ~2 mo provide the only previous atmosphere-based (“top-down”) estimates of emissions from NG in an urban area, 1–2% (0.7–3% when accounting for the error ranges) of total NG consumed in the basin (10, 11). However, attribution of CH_4 emissions to pipeline gas in Los Angeles is complicated by the presence of current and abandoned oil and gas wells, refinery operations, and natural CH_4 seeps, in addition to NG consumption. Other studies have estimated total CH_4 emission fluxes from a number of urban areas around the world (*SI Appendix*, Table S1), using atmospheric data-model frameworks of varying sophistication, but have not quantitatively attributed fluxes to NG. Our value for total CH_4 emissions in Boston is at the low end of the overall range of fluxes reported for other urban areas (*SI Appendix*, Table S1), suggesting that total CH_4 emission rates in Boston are not anomalous.

The US greenhouse gas (GHG) inventory (23) attributes 3,302 Gg of CH_4 emissions to NG transmission, storage, and distribution in 2012, equal to ~0.7% of the NG delivered to consumers (24). The key input data for NG distribution systems in the national inventory are emissions factors developed from industry measurements (25) and activity data on miles of pipeline by material and counts of metering and regulating stations, customer meters, and pipeline maintenance events and mishaps (23). Emissions of NG in our study area are equal to ~8% of US emissions attributed to distribution, transport, and storage, and ~23% of national emissions from distribution alone, a notably higher fraction than the ~3% of US residential and commercial

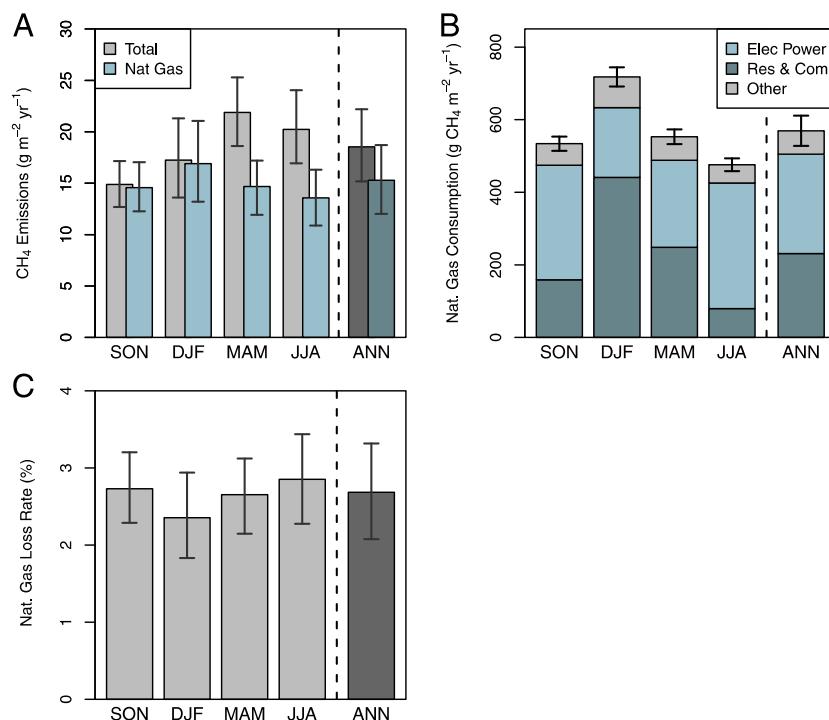


Fig. 5. Seasonal and annual average (±95% confidence intervals) (A) optimized CH_4 emissions in total and from NG, (B) NG consumption by sector, and (C) NG loss rates, derived from CH_4 concentration observations from the BU and COP sites together. (B) Consumption categories are electric power, residential and commercial, and other, which is comprised of industrial, vehicle fuel, and pipeline and distribution use (*SI Appendix*, section 3.2.1).

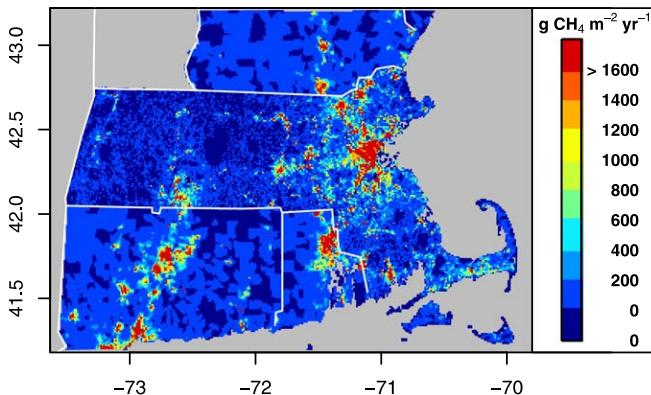


Fig. 6. Reconstructed geographical distribution of NG consumption, in units of CH_4 mass flux, during September 2012 through August 2013 for the four states included in the study region (*SI Appendix*, section S3.2.1).

gas consumed in the study region. More detailed comparison of our results for the Boston urban region to the US GHG inventory is not possible because the inventory is not spatially disaggregated.

Massachusetts has compiled a state GHG inventory (26) (*SI Appendix*, Table S4) using the same methods as the national inventory with state-level data, where available, and reports CH_4 emissions from NG systems equal to ~1.1% of NG consumed in the state. The larger loss fraction implied by the Massachusetts (~1.1%) versus the national (~0.7%) inventory is likely due to larger proportions of cast iron and bare steel pipelines (27), which have higher emission factors (23). Because most (68%) of our study region lies in Massachusetts, and most (88%) of the NG delivered in Massachusetts is consumed in the region, this value approximates the result that would be obtained by downscaling the national inventory to the study region. Our result for the NG loss fraction is approximately two to three times larger than that implied by the state inventory (although no uncertainty range is reported for the latter).

NG companies also report their GHG emissions and NG losses to public agencies. Methane emission and NG delivery data reported to both the US Environmental Protection Agency (28) and Massachusetts GHG Reporting Programs (29) show NG loss rates of 0.4–1.6% among individual NG distribution companies in Massachusetts in 2012 and 2013, with an average of 0.6%, weighted by delivered NG volumes. Data reported to the US Energy Information Administration (30) for “losses from leaks, damage, accidents, migration and/or blow down” indicate loss rates of 0–1.1%, with a weighted average of 0.4%, among Massachusetts NG distribution companies in 2012 and 2013.

Policy analyses of NG distribution emissions (31, 32) sometimes use reported quantities of “lost and unaccounted-for” (LAUF) gas, an accounting term and cost-recovery mechanism reported by utilities to public utility commissions. LAUF fractions reported by individual distribution companies in Massachusetts in 2012 and 2013 were 0–4.6%, with a weighted average of 2.7% (33). However, LAUF encompasses leaks, metering and accounting inaccuracies, and theft (34), and hence the relationship between LAUF and NG emissions is unknown.

Deficiencies in Existing Estimates

Several possible reasons may explain why existing methodologies predict lower CH_4 emissions from NG than we observe in the Boston urban region.

i) Not all emission sources are inventoried. The US and Massachusetts inventories (23, 26) do not include NG losses occurring

downstream of customer meters, neither at large industrial facilities, nor in residential and commercial settings.

ii) Leak surveys are not comprehensive. Leak surveys (e.g., refs. 13 and 35) are based on detection of discrete, highly elevated atmospheric signals, expressed at accessible locations. Numerous small leaks can occur without posing a safety hazard while still contributing significantly to the total CH_4 source, and would require sensitive and accurate measurements for detection and quantification. Some NG leaks may be emerging in locations that are difficult to access (e.g., indoors, on private property, through sewers or subway tunnels) with conventional surveys.

iii) Sampling protocols used to calculate emission factors have significant limitations. Due to practical constraints, NG emission factors are calculated from very small samples relative to the population they are intended to represent, and measurements are obtained from short-duration, non-repeated campaigns in a limited number of locations (25). These limitations can lead to undersampling of infrequent, high-emission events (6). Measurement of emissions from individual components requires access to restricted, privately owned facilities, which could lead to sample bias (6), whether intentional or not. Inaccurate device and activity counts (6), and incomplete understanding of controlling variables, may lead to inappropriate extrapolation of emission factors in space and time. Data collected through new reporting requirements (36) may help address some of these limitations for particular devices and processes.

These issues arise from our fundamental lack of knowledge about the specific sources and processes responsible for the discrepancies found in this and other studies (6), and about the requirements for designing and testing a statistically rigorous accounting of emissions from the NG supply chain. Both high-emission events and diffuse low-emission sources need to be sampled continuously or repeatedly to gain understanding of the true distribution of NG emissions. In addition to emission data, improved quantification of the fractional NG loss rate requires the compilation and availability of more rigorous, standardized, and detailed data on NG flows. Datasets should be spatially explicit to facilitate collation of disparate datasets and analysis of specific areas. Closer cooperation in data sharing and synthesis and wide data dissemination are needed to better constrain CH_4 emissions from NG and to provide the information needed to reduce those emissions.

Significance of Natural Gas Emissions

This study used 1 y of atmospheric CH_4 measurements from a network of observing stations, a high-resolution modeling framework, atmospheric measurements of C_2H_6 , a tracer for NG emissions, and statistics on NG composition and consumption to quantify the NG emission rate for the Boston urban area as $2.7 \pm 0.6\%$ (95% confidence interval) of consumed NG, approximately two to three times higher than that given by the most applicable (state) GHG inventory. The total volume of emitted gas in the study area over 1 y was ~15 billion standard cubic feet (scf), valued conservatively at ~\$90 million [using 2012 and 2013 Massachusetts city gate prices (37)], equal to ~6 scf·person⁻¹·d⁻¹ [using the study area population of ~7.2 million (38)].

The US President’s Methane Strategy (5) for reducing downstream NG emissions describes state and utility programs to accelerate infrastructure replacement, but offers no new federal initiatives for the distribution sector (39). A new Massachusetts law (40) is intended to improve the classification, reporting, and repair of NG leaks. The current study provides an example of a measurement-model framework that can be used to evaluate the effectiveness of programs aimed at reducing NG distribution emissions. More detailed measurements and accounting,

following a more rigorous statistical design, are needed to fully characterize and prioritize the components, geographic areas, and supply chain sectors that are contributing the most emissions. The full environmental benefits of using NG in place of other fossil fuels will only be realized through active measures to decrease direct losses to the atmosphere, including in receiving areas such as the Boston urbanized region.

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1. Myhre G, et al. (2013) Anthropogenic and natural radiative forcing. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds Stocker TF, et al. (Cambridge Univ Press, Cambridge, UK), pp 659–740.
2. Fiore AM, Jacob DJ, Field BD, Streets DG, Fernandes SD (2002) Linking ozone pollution and climate change: The case for controlling methane. *Geophys Res Lett* 29(19): 25-1–25-4.
3. Ciais P, et al. (2013) Carbon and other biogeochemical cycles. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, eds Stocker TF, et al. (Cambridge Univ Press, Cambridge, UK), pp 465–570.
4. West JJ, Fiore AM, Horowitz LW, Mauzerall DL (2006) Global health benefits of mitigating ozone pollution with methane emission controls. *Proc Natl Acad Sci USA* 103(11):3988–3993.
5. The White House (2014) *Climate Action Plan: Strategy to Reduce Methane Emissions*. Available at www.whitehouse.gov/sites/default/files/strategy_to_reduce_methane_emissions_2014-03-28_final.pdf. Accessed March 28, 2014.
6. Brandt AR, et al. (2014) Energy and environment. Methane leaks from North American natural gas systems. *Science* 343(6172):733–735.
7. Blake DR, Woo VH, Tyler SC, Rowland FS (1984) Methane concentrations and source strengths in urban locations. *Geophys Res Lett* 11(12):1211–1214.
8. Wunch D, Wennberg PO, Toon GC, Keppel-Aleks G, Yavin YG (2009) Emissions of greenhouse gases from a North American megacity. *Geophys Res Lett* 36:L15810.
9. Hsu YK, et al. (2010) Methane emissions inventory verification in southern California. *Atmos Environ* 44:1–7.
10. Wennberg PO, et al. (2012) On the sources of methane to the Los Angeles atmosphere. *Environ Sci Technol* 46(17):9282–9289.
11. Peischl J, et al. (2013) Quantifying sources of methane using light alkanes in the Los Angeles basin, California. *J Geophys Res Atmos* 118:1–17.
12. Santoni GW (2013) Fluxes of atmospheric methane using novel instruments, field measurements, and inverse modeling. PhD thesis (Harvard University, Cambridge, MA).
13. Phillips NG, et al. (2013) Mapping urban pipeline leaks: Methane leaks across Boston. *Environ Pollut* 173:1–4.
14. US Census Bureau (2012) *2010 American Community Survey 5-Year Estimates*. Available at www.census.gov. Accessed September 30, 2013.
15. Yacovitch TI, et al. (2014) Demonstration of an ethane spectrometer for methane source identification. *Environ Sci Technol* 48(14):8028–8034.
16. Press WH, Teukolsky SA, Vetterling WT, Flannery BP (2002) Modeling of data. *Numerical Recipes in FORTRAN: The Art of Scientific Computing* (Cambridge Univ Press, New York), 2nd Ed, Chap 15.
17. Algonquin Gas Transmission, LLC (2014) *Link System Informational Postings, Gas Quality, Hourly Chromatograph Postings* (Spectra Energy, Houston TX). Available at infopost.spectraenergy.com/infopost. Accessed July 9, 2014.
18. Tennessee Gas Pipeline Company, LLC (2014) *Informational Postings, Gas Quality, Hourly Gas Quality Data* (Kinder Morgan, Houston, TX). Available at webapps.elpaso.com/PortalUI/DefaultKM.aspx?TSP=TGPD. Accessed November 28, 2012 through July 9, 2014.
19. Lin JC, et al. (2003) A near-field tool or simulating the upstream influence of atmospheric observations: The Stochastic Time-Inverted Lagrangian Transport (STILT) model. *J Geophys Res* 108:4493–4510.
20. Nehrkorn T, et al. (2010) Coupled weather research and forecasting-stochastic time-inverted Lagrangian transport (WRF-STILT) model. *Meteorol Atmos Phys* 107:51–64.
21. Van Hulzen JB, Segers R, van Bodegom PM, Leffelaar PA (1999) Temperature effects on soil methane production: An explanation for observed variability. *Soil Biol Biochem* 31(14):1919–1926.
22. Spokas K, Bogner J, Chanton J (2011) A process-based inventory model for landfill CH₄ emissions inclusive of seasonal soil microclimate and CH₄ oxidation. *J Geophys Res Biogeosci* 116:G04017.
23. US Environmental Protection Agency (2014) *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2012*, EPA-430-R-14-003. Available at www.epa.gov/climatechange/ghgemissions/usinventorystatus.html. Accessed June 1, 2014.
24. US Energy Information Administration (2014) *Natural Gas Consumption by End Use*. Available at www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm. Accessed December 26, 2014.
25. US Environmental Protection Agency/Gas Research Institute (1996) *Methane Emissions from the Natural Gas Industry*, eds Harrison M, Shires T, Wessels J, Cowgill R (Radian International LLC for National Risk Management Research Laboratory, Research Triangle Park, NC).
26. Massachusetts Department of Environmental Protection (2014) *Massachusetts Annual Greenhouse Gas Emissions Inventory: 1990 through 2011, with Partial 2012 Data*. Available at www.mass.gov/eea/docs/dep/air/climate/maghginv.xls. Accessed December 27, 2014.
27. US Department of Transportation, *Pipeline Hazardous Materials Safety Administration, Pipeline Replacement Updates*. Available at opsweb.phmsa.dot.gov/pipeline_replacement. Accessed December 27, 2014.
28. US Environmental Protection Agency (2014) *2012 and 2013 Greenhouse Gas Emissions from Large Facilities*. Available at ghgdata.epa.gov/ghgp. Accessed December 26, 2014.
29. Massachusetts Department of Environmental Protection (2014) *MassDEP GHG Reporting Program Summary Report and Facility List, Emissions Year 2012 and 2013*. Available at www.mass.gov/eea/agencies/massdep/climate-energy/climate/approvals/ma-greenhouse-gas-emissions-reporting-program.html. Accessed December 26, 2014.
30. US Energy Information Administration (2014) *Natural Gas Annual Respondent Query System, Annual Report on Natural and Supplemental Gas Supply and Disposition*. Available at www.eia.gov/cfapps/ngqs/mqqs.cfm?f_report=RP1. Accessed December 26, 2014.
31. Markey EJ (2013) *America Pays for Gas Leaks. A Report Prepared for Senator Markey by the House Natural Resources Committee Democratic Staff and Senator Markey's Staff*. Available at www.markey.senate.gov/documents/markey_lost_gas_report.pdf. Accessed August 7, 2013.
32. Cleveland S (2012) *Into Thin Air* (Conservation Law Foundation). Available at www.clf.org/static/natural-gas-leaks/WhitePaper_Final_lowres.pdf. Accessed February 28, 2013.
33. Pipeline and Hazardous Materials Safety Administration (2013) *Distribution Annual Data*. Available at www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Pipeline2data/annual_gas_distribution_2013.zip. Accessed December 27, 2014.
34. Costello K (2013) *Lost and Unaccounted-for Gas: Practices of State Utility Commissions* (National Regulatory Research Institute, Silver Spring, MD) Report No. 13-16.
35. US Code of Federal Regulations, Title 49, Subtitle B, Chapter 1, Subchapter D, Part 192, Section 192.723, Distribution systems: Leakage surveys. Available at www.gpo.gov/fdsys/pkg/CFR-2013-title49-vol3/xml/CFR-2013-title49-vol3-sec192-723.xml.
36. US Environmental Protection Agency (2014) *Greenhouse Gas Reporting Program, Subpart W, Petroleum and Natural Gas Systems Subpart W Rulemaking Resources*. Available at www.epa.gov/ghgreporting/reporters/subpartw-regdocs.html. Accessed December 27, 2014.
37. US Energy Information Administration (2014) *Natural Gas Prices*. Available at www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm. Accessed December 27, 2014.
38. US Census Bureau (2012) *2010 Decennial Census*. Available at www.census.gov. Accessed June 25, 2014.
39. US Environmental Protection Agency, Office of Inspector General (2014) *Improvements Needed in EPA Efforts to Address Methane Emissions From Natural Gas Distribution Pipelines*, Report No. 14-P-0324. Available at www.epa.gov/oig/reports/2014/20140729-14-P-0325.pdf. Accessed July 28, 2014.
40. Massachusetts Laws (2014) *An Act Relative to Natural Gas Leaks*. Available at malegislature.gov/Laws/SessionLaws/Acts/2014/Chapter149. Accessed June 27, 2014.

**Exhibit 6 to West Roxbury Motion for
Rehearing: B.U. Gas Leak Study**



Rapid communication

Mapping urban pipeline leaks: Methane leaks across Boston

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ABSTRACT

Natural gas is the largest source of anthropogenic emissions of methane (CH_4) in the United States. To assess pipeline emissions across a major city, we mapped CH_4 leaks across all 785 road miles in the city of Boston using a cavity-ring-down mobile CH_4 analyzer. We identified 3356 CH_4 leaks with concentrations exceeding up to 15 times the global background level. Separately, we measured $\delta^{13}\text{CH}_4$ isotopic signatures from a subset of these leaks. The $\delta^{13}\text{CH}_4$ signatures (mean = $-42.8\text{‰} \pm 1.3\text{‰}$ s.e.; $n = 32$) strongly indicate a fossil fuel source rather than a biogenic source for most of the leaks; natural gas sampled across the city had average $\delta^{13}\text{CH}_4$ values of -36.8‰ ($\pm 0.7\text{‰}$ s.e., $n = 10$), whereas CH_4 collected from landfill sites, wetlands, and sewer systems had $\delta^{13}\text{CH}_4$ signatures $\sim 20\text{‰}$ lighter ($\mu = -57.8\text{‰} \pm 1.6\text{‰}$ s.e., $n = 8$). Repairing leaky natural gas distribution systems will reduce greenhouse gas emissions, increase consumer health and safety, and save money.

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1. Introduction

Methane (CH_4) is a greenhouse gas more potent molecule for molecule than carbon dioxide (Shindell et al., 2012). In the United States, leaks of CH_4 from natural gas extraction and pipeline transmission are the largest human-derived source of emissions (EPA, 2012). However, CH_4 is not just a potent greenhouse gas; it also influences air quality and consumer health. CH_4 reacts with NO_x to catalyze ozone formation in urban areas (West et al., 2006). Incidents involving transmission and distribution pipelines for natural gas in the U. S. cause an average of 17 fatalities, 68 injuries, and \$133 M in property damage each year (PHMSA, 2012). A natural gas pipeline explosion in San Bruno, CA, for instance, killed eight people and destroyed 38 homes in 2010. Detecting and reducing pipeline leaks of CH_4 and other hydrocarbons in natural gas are critical for reducing greenhouse gas emissions, improving air quality and consumer safety, and saving consumers money (West et al., 2006; Han and Weng, 2011; Shindell et al., 2012; Alvarez et al., 2012).

To assess CH_4 emissions in a major urban metropolis, we mapped CH_4 emissions over the entire 785 centerline miles of Boston's

streets. To evaluate the likely source of the street-level CH_4 emissions, we also measured the $\delta^{13}\text{C}-\text{CH}_4$ carbon isotope composition, which can differentiate between biogenic (e.g., landfill, wetland, sewer) and thermogenic (e.g., natural gas) sources (Schoell, 1980).

2. Materials and methods

We conducted 31 mobile surveys during the period 18 August, 2011–1 October, 2011, covering all 785 road miles within Boston's city limits. We measured CH_4 concentration ($[\text{CH}_4]$, ppm) using a mobile Picarro G2301 Cavity Ring-Down Spectrometer equipped with an A0491 Mobile Plume Mapping Kit (Picarro, Inc, Santa Clara, CA). This instrument was factory-calibrated on 15 August 2011, immediately prior to use in this study, and follow-up tests of the analyzer were made during 11–21 August, 2012, comparing analyzer output to a National Oceanic and Atmospheric Administration (NOAA) primary standard tank. In both pre- and post-checks, the analyzer output was found to be within 2.7 parts per billion of known $[\text{CH}_4]$ in standard tanks, three orders of magnitude below typical atmospheric concentrations. Spectrometer and mobile GPS data were recorded every 1.1 s. To correct for a short time lag between instantaneous GPS location and a delay in $[\text{CH}_4]$ measurement due to inlet tube length (~ 3 m), we used an auxiliary pump to increase tubing flow throughput to within 5 cm of the analyzer inlet; we also adjusted the time stamp on the $[\text{CH}_4]$ readings based on a 1-s delay observed between analyzer response to a standard CH_4 source that we injected into the instrument while driving, and the apparent GPS location. We also checked the GPS-based locations of leaks with dozens of street-level sampling to confirm specific leak locations and the estimated sampling delay. Air was sampled through a 3.0 μm Zefluor filter and Teflon tubing placed ~ 30 cm above road surfaces.

For our mobile survey data, we defined a "leak" as a unique, spatially contiguous group of $[\text{CH}_4]$ observations, all values of which exceed a concentration threshold of 2.50 ppm. This was used as a threshold because it corresponded to the 90th

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percentile of the distribution of data from all road miles driven, and, relative to global background, is ~37% above 2011 mean mixing ratios observed at Mauna Loa (NOAA, 2012).

Independently of mobile street sampling of CH₄, we measured $\delta^{13}\text{CH}_4$ from a subset of the leaks with a Picarro G2112i Cavity Ring-Down Spectrometer (Crosson, 2008). This instrument is calibrated monthly using isotopic standards from Isometric Instruments (Victoria, BC, Canada). The instrument was checked at least once daily to ensure analyzer output was within 1‰ of a tank of CH₄ with $\delta^{13}\text{CH}_4$ measured by a private lab (Isotech Labs, IL). Samples were collected in 1-L Tedlar sampling bags with valve and septa fittings, manufactured by Environmental Supply Company (Durham, NC). A Gas Sentry CGO-321 handheld gas detector (Bascom-Turner, MA) was used to identify the area of highest ambient [CH₄] at each site sampled for $\delta^{13}\text{CH}_4$. Sampling bags were pre-evacuated and filled at the area of highest ambient concentration at the sampling site using a hand pump. $\delta^{13}\text{CH}_4$ was analyzed using a Picarro G2112i with a sample hold time typically of a few days and always less than two weeks.

At a subset of sampling sites ($n = 12$), we collected duplicate samples in glass vials to assess potential leaking or fractionation by the Tedlar sampling bags. We also sent duplicate samples from a different subset of sampling sites ($n = 5$) to a private lab (Isotech Labs, IL) for independent $\delta^{13}\text{CH}_4$ analysis. These analyses suggest no significant fractionation or bias either from the sampling bags or the Picarro G2112i analyzer. Most samples were analyzed at less than the maximum hold time of two weeks, at which bag diffusion could account for a 1.2‰ drift in our measurements of $\delta^{13}\text{CH}_4$.

We compared $\delta^{13}\text{CH}_4$ of these locations with samples taken from area landfills, wetlands, and the Deer Island Water Treatment Facility. Sampling equipment and procedures, as well as laboratory analyses, for landfill and wetland sites were similar to those for $\delta^{13}\text{CH}_4$ sampling locations described above. Samples were collected from three capped, inactive landfills (there are currently no active landfills in the Boston area). At one former landfill site, samples were collected at approximately three-month intervals between September, 2011 and April, 2012. The $\delta^{13}\text{CH}_4$ signature of the landfill was consistent over this period ($\pm 3.4\text{‰}$ s.e.). At all wetland sampling sites, a plastic chamber (10 cm × 25 cm × 5 cm) connected to a sampling tube was placed over the surface of exposed moist sediment or shallow (>5 cm) water. Sediment below the chamber was disturbed gently before drawing air samples from the headspace within the chamber. The sample from the Deer Island Treatment Facility was drawn from the headspace of a sample bottle of anaerobic sludge, collected onsite by Deer Island staff for daily monitoring of the facility's anaerobic sludge digesters.

3. Results and discussion

We identified 3356 CH₄ leaks (Figs. 1 and 2) exceeding 2.50 parts per million. Surface concentrations corresponding to these leaks ranged up to 28.6 ppm, 14-times above a surface background concentration of 2.07 ppm (the statistical mode of the entire concentration distribution). Across the city, 435 and 97 independent leaks exceeded 5 and 10 ppm, respectively.

Based on their $\delta^{13}\text{CH}_4$ signatures, the CH₄ leaks strongly resembled thermogenic rather than biogenic sources (Fig. 3). Samples of natural gas from the gateway pipelines to Boston and from other consumer outlets in the city were statistically indistinguishable, with an average $\delta^{13}\text{CH}_4$ signature of -36.8‰ ($\pm 0.7\text{‰}$ s.e., $n = 10$; ‰ vs. Vienna Pee Dee Belemnite). In contrast, CH₄ collected from landfill sites, wetlands, and sewer systems reflected a greater fractionation from microbial activity and $\delta^{13}\text{CH}_4$ signatures $\sim 20\text{‰}$ lighter. Biogenic values ranged from -53.1‰ to -64.5‰ ($\mu = -57.8\text{‰}$, $\pm 1.6\text{‰}$ s.e., $n = 8$) for samples collected in four wetlands, three capped landfills, and the primary sewage facility for the city, Deer Island Sewage Treatment Plant, which had the heaviest sample observed for non-natural-gas sources (-53.1‰). Our results for biogenic CH₄ carbon isotope signatures are consistent with other studies of the $\delta^{13}\text{CH}_4$ signature of CH₄ from landfills (Bergamaschi et al., 1998; Björansson et al., 2001) and wetlands (Hornibrook et al., 2000).

Peaks of [CH₄] detected in the road surveys strongly reflected the signature of natural gas rather than biogenic sources (Table 1). The average $\delta^{13}\text{CH}_4$ value for peaks was $-42.8\text{‰} \pm 1.3\text{‰}$ ($n = 32$), reflecting a dominant signal from natural gas, likely altered in some cases by minor fractionation of natural gas traveling through soils and by mixing with background air ($\delta^{13}\text{CH}_4 = -47\text{‰}$; Drlugokencky et al., 2011). A minority of samples had $\delta^{13}\text{CH}_4$ more negative than

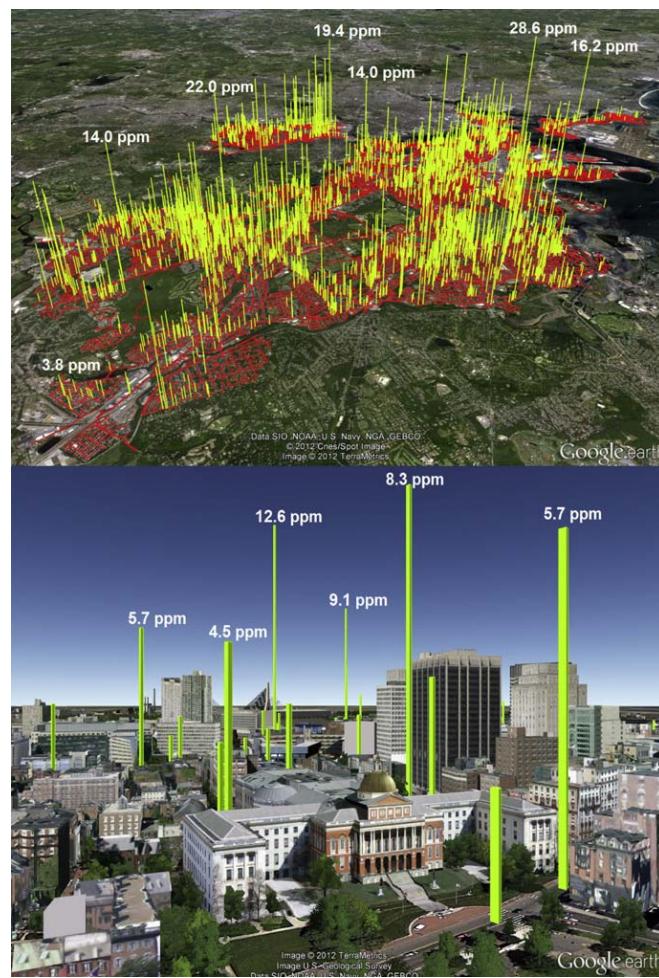


Fig. 1. Upper Panel: Methane leaks (3356 yellow spikes > 2.5 ppm) mapped on Boston's 785 road miles (red) surveyed in this study. Lower Panel: Leaks around Beacon Hill and the Massachusetts State House. Sample values of methane concentrations (ppm) are shown for each panel. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

that of background air, reflecting apparent influence of biogenic CH₄. Most samples emitted a distinct odor of the mercaptan additive associated with natural gas, including those with a larger apparent biogenic influence on $\delta^{13}\text{CH}_4$.

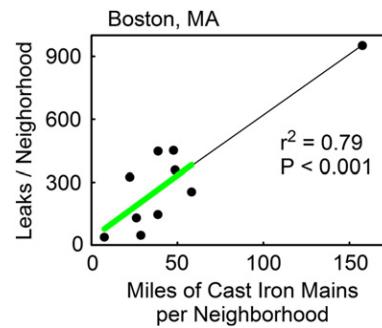


Fig. 2. Leak prevalence is associated with old cast iron pipes across ten Boston neighborhoods. (The combined line is the regression across all ten neighborhoods ($P < 0.001$); the green regression line [$r^2 = 0.34$; $P = 0.08$], which eliminates the influence of the leverage point [Dorchester neighborhood], has a slope and intercept indistinguishable ($P > 0.10$) from the combined regression.). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

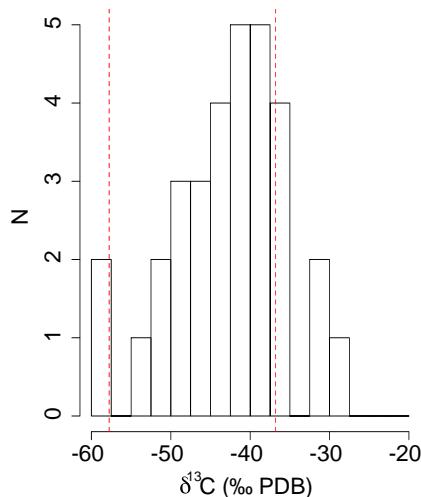


Fig. 3. $\delta^{13}\text{CH}_4$ of $[\text{CH}_4]$ peaks detected in road surveys ($n = 32$). Red lines represent means of thermogenic ($-36.8\text{‰, } \pm 0.7\text{‰ s.e., } n = 10$) and biogenic ($-57.8\text{‰, } \pm 1.6\text{‰ s.e., } n = 8$) sources, respectively. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Leaks across Boston (Fig. 1), were associated primarily with cast iron mains that were sometimes over a century old (Fig. 2). Across ten Boston neighborhoods, leak frequency was linearly related to number of miles of cast iron mains ($r^2 = 0.79, P < 0.001$; Fig. 2), but only marginally to miles of non-cast-iron piping ($r^2 = 0.27, P = 0.12$, data not shown). Leak counts did not differ statistically by neighborhood or by socio-economic indicators for the neighborhoods obtained from the 2010 US Census ($P > 0.1$ for number of housing

Table 1
Locations and isotopic values from discrete street leak samples.

Latitude	Longitude	$\delta^{13}\text{CH}_4$ (‰ PDB)
42.3654	-71.0612	-53.959
42.3439	-71.2628	-47.898
42.3493	-71.2265	-57.590
42.3583	-71.1749	-40.818
42.3411	-71.2440	-37.323
42.3543	-71.2441	-38.241
42.3559	-71.1898	-39.412
42.3513	-71.2092	-41.978
42.3515	-71.2081	-39.531
42.3614	-71.2314	-41.796
42.3426	-71.1012	-44.100
42.3443	-71.0949	-41.848
42.3328	-71.0761	-37.516
42.3360	-71.0738	-46.414
42.3441	-71.0673	-45.490
42.3303	-71.0569	-37.476
42.3409	-71.0542	-40.029
42.3524	-71.0445	-43.127
42.3799	-71.0272	-48.182
42.3722	-71.0361	-57.693
42.3785	-71.0681	-48.429
42.3730	-71.0632	-37.471
42.3593	-71.0629	-42.689
42.3584	-71.0644	-52.033
42.3546	-71.1271	-47.241
42.2943	-71.1891	-52.028
42.2793	-71.1514	-37.648
42.2887	-71.1428	-32.467
42.3285	-71.0792	-28.251
42.3215	-71.0692	-36.214
42.3269	-71.0796	-30.662
42.3553	-71.0573	-43.836
Mean		-42.793
Standard error		1.259

units and ethnicity) or the 2000 US Census ($P > 0.1$ for median income and poverty rate).

Reducing CH_4 leaks will promote safety and help save money. Although our study was not intended to assess explosion risks, we observed six locations where gas concentrations in manholes exceeded an explosion threshold of 4% $[\text{CH}_4]$ at 20 °C (concentrations measured using a Gas Sentry CGO-321 handheld gas detector; Bascom-Turner, MA). Moreover, because CH_4 , ethane (C_2H_6), and propane (C_3H_8) interact with NO_x to catalyze ozone formation, reducing these hydrocarbon concentrations should help reduce urban ozone concentrations and respiratory and cardiopulmonary disease (West et al., 2006; Shindell et al., 2012). CH_4 is also a potent greenhouse gas, with an estimated 20-year global warming potential 72 times greater than CO_2 (Alvarez et al., 2012; Townsend-Small et al., 2012). Replacing failing natural gas mains will reduce greenhouse gas emissions, thereby providing an additional benefit to the fewer mercury, SO_2 and particulate emissions that natural-gas burning emits compared to coal (Shindell et al., 2012). Finally, leaks contribute to \$3.1 B of lost and unaccounted natural gas annually in the United States (EIA, 2012; 2005–2010 average).

Our ongoing and future research evaluates how surface $[\text{CH}_4]$ values correspond to individual, and city-wide, urban leak rates and greenhouse-gas emissions. Two approaches to this question are useful: “bottom-up” chamber measurements taken on representative samples of individual leaks, and “top-down” atmospheric mass-balance estimates from rooftops of the collective urban leak rate that exploit the known isotopic signature of natural gas versus that of biogenic sources and other fossil fuel sources. The instrumentation used in this study is well-suited for both approaches.

We propose that a coordinated campaign to map urban pipeline leaks around the world would benefit diverse stakeholders, including companies, municipalities, and consumers. Repairing the leaks will bring economic, environmental, and health benefits to all.

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References

- Alvarez, R.A., Pacala, S.W., Winebrake, J.J., Chameides, W.L., Hamburg, S.P., 2012. Greater focus needed on methane leakage from natural gas infrastructure. *Proceedings of the National Academy of Sciences U.S.A.* 109, 6435–6440.
- Bergamaschi, P., Lubina, C., Knigstedt, R., Fischer, H., Veltkamp, A.C., Zwaagstra, O., 1998. Stable isotopic signatures ($\delta^{13}\text{C}$, δD) of methane from European landfill sites. *Journal of Geophysical Research* 103, 8251–8265.
- Borjesson, G., Chanton, J., Svensson, B.H., 2001. Methane oxidation in two Swedish landfill covers measured with carbon-13 to carbon-12 isotope ratios. *Journal of Environmental Quality* 30, 369–376.
- Crosson, E.R., 2008. A cavity ring-down analyzer for measuring atmospheric levels of methane, carbon dioxide, and water vapor. *Applied Physics B: Lasers and Optics* 3, 403–408.
- Dlugokencky, E.J., Nisbet, E.G., Fisher, R., Lowry, D., 2011. Global atmospheric methane: budget, changes and dangers. *Philosophical Transactions of the Royal Society A* 369, 2058–2072.
- Energy Information Administration (EIA), 2012. http://205.254.135.7/dnav/ng/ng_sum_lsum_dcus_nus_a.htm, http://205.254.135.7/naturalgas/annual/pdf/table_a01.pdf, http://205.254.135.7/naturalgas/annual/archive/2009/pdf/table_a01.pdf.
- Environmental Protection Agency (EPA), 2012. <http://epa.gov/methane/sources.html>.

Han, Z.Y., Weng, W.G., 2011. Comparison study on qualitative and quantitative risk assessment methods for urban natural gas pipeline network. *Journal of Hazardous Materials* 189, 509–518.

Hornbrook, E.R.C., Longstaffe, F.J., Fyfe, W.F., 2000. Evolution of stable carbon isotope compositions for methane and carbon dioxide in freshwater wetlands and other anaerobic environments. *Geochimica Cosmochimica Acta* 64, 1013–1027.

National Oceanic and Atmospheric Administration, Annual Greenhouse Gas Index (AGGI), 2012. Earth System Research Laboratory, Global Monitoring Division. <http://www.esrl.noaa.gov/gmd/aggi/> (accessed 10.09.12.).

Pipeline and Hazardous Materials Safety Administration (PHMSA), 2012. www.phmsa.dot.gov/pipeline/library/data-stats.

Schoell, M., 1980. The hydrogen and carbon isotopic composition of methane from natural gases of various origins. *Geochimica Cosmochimica Acta* 44, 649–661.

Shindell, D., Kuylenstierna, J.C.I., Vignati, E., van Dingenen, R., Amann, M., Klimont, Z., Anenberg, S.C., Muller, N., Janssens-Maenhout, G., Raes, F., Schwartz, J., Faluvegi, G., Pozzoli, L., Kupiainen, K., Höglund-Isaksson, L., Emberson, L., Streets, D., Ramanathan, V., Hicks, K., Oanh, N.T.K., Milly, G., Williams, M., Demkine, V., Fowler, D., 2012. Simultaneously mitigating near-term climate change and improving human health and food security. *Science* 335, 183–189.

Townsend-Small, A., Tyler, S.C., Pataki, D.E., Xu, X., Christensen, L.E., 2012. Isotopic measurements of atmospheric methane in Los Angeles, California, USA: influence of “fugitive” fossil fuel emissions. *Journal of Geophysical Research* 117, D07308.

West, J.J., Fiore, A.M., Horowitz, L.W., Mauzerall, D.L., 2006. Global health benefits of mitigating ozone pollution with methane emission controls. *Proceedings of the National Academy of Sciences U.S.A.* 103, 3988–3993.

**Exhibit 7 to West Roxbury Motion for
Rehearing: Opinion of Attorney General**

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Opinion of the Attorney General Regarding the Disposition of Public Lands Under the “Clean Environment” Amendment to the Constitution of Massachusetts

Robert H. Quinn

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OPINION OF THE ATTORNEY GENERAL REGARDING
THE DISPOSITION OF PUBLIC LANDS UNDER THE
"CLEAN ENVIRONMENT" AMENDMENT TO THE
CONSTITUTION OF MASSACHUSETTS

*By Robert H. Quinn**

In November, 1972, the voters of Massachusetts approved an amendment to the state constitution which established the right to a clean environment for every citizen.¹ Subsequently, the Massachusetts House of Representatives addressed several questions to me, as Attorney General, regarding those provisions in the amendment (Article 97) requiring that acts concerning the disposition of, or certain changes in, the use of public lands be approved by a two-thirds roll call vote of each branch of the Legislature.²

The questions were as follows.

1. Do the provisions of the last paragraph of Article XCVII of the Articles of the Amendments to the Constitution requiring a two-thirds vote by each branch of the general court, before a change can be made in the use or disposition of land and easements acquired for a purpose described in said Article, apply to all land and easements held for such a purpose regardless of the date of acquisition or, in the alternative, do they apply only to land and easements acquired for such purposes after the effective date of said Article of Amendments?

2. Does the disposition or change of use of land held for park purposes require a two thirds vote, to be taken by the yeas and nays of each branch of the general court, as provided in Article XCVII of the Articles of the Amendments to the Constitution, or would a majority vote of each branch be sufficient for approval?

3. Do the words "natural resources" as used in the first paragraph of Article XCVII of the Articles of the Amendments to the Constitution include ocean, shellfish and inland fisheries; wild birds, including song and insectivorous birds; wild mammals and game; sea and fresh water fish of every description; forests and all uncultivated flora, together with public shade and ornamental trees and shrubs; land, soil and soil resources, lakes, ponds, streams, coastal, underground and surface waters; minerals and natural deposits, as formerly set out in the definition of

the words "natural resources" in paragraph two of section one of chapter twenty-one of the General Laws (of Massachusetts)?

4. Do the provisions of the fourth paragraph of Article XCVII of the Articles of the Amendments to the Constitution apply to any or all of the following means of disposition or change in use of land held for a public purpose: conveyance of land; long-term lease for inconsistent use; short-term lease, two years or less, for an inconsistent use; the granting or giving of an easement for an inconsistent use; or any agency action with regard to land under its control if an inconsistent use?

The proposed amendment to the Constitution was agreed to by the majority of the members of the Senate and the House of Representatives, in joint session, on August 5, 1969 and again on May 12, 1971, and became part of the Constitution by approval by the voters at the state election next following, on November 7, 1972. The full text of Article 97 is as follows:

ART. XCVII. Article XLIX of the Amendments to the Constitution is hereby annulled and the following is adopted in place thereof:—The people shall have the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose.

The general court shall have the power to enact legislation necessary or expedient to protect such rights.

In the furtherance of the foregoing powers, the general court shall have the power to provide for the taking, upon payment of just compensation therefor, or for the acquisition by purchase or otherwise, of lands and easements or such other interests therein as may be deemed necessary to accomplish these purposes.

Lands and easements taken or acquired for such purposes shall not be used for other purposes or otherwise disposed of except by laws enacted by a two thirds vote, taken by yeas and nays, of each branch of the general court.

I. QUESTION ONE

The first question of the House of Representatives asks, in effect, whether the two-thirds roll-call vote requirement is retroactive, to be applied to lands and easements acquired prior to the effective date of Article 97, November 7, 1972. For the reasons below, I answer in the affirmative.

The Legislature did not propose this Amendment nor was it approved by the voting public without a sense of history nor void of a

purpose worthy of a constitutional amendment. Examination of our constitutional history firmly establishes that the two-thirds roll-call vote requirement applies to public lands wherever taken or acquired.

Specifically, Article 97 annuls Article 49, in effect since November 5, 1918. Under that Article the Legislature was empowered to provide for the taking or acquisition of lands, easements and interests therein "for the purpose of securing and promoting the proper conservation, development, utilization and control" [of] "agricultural, mineral, forest, water and other natural resources of the commonwealth." Although inclusion of the word "air" in this catalogue as it appears in Article 97 may make this new article slightly broader than the supplanted Article 49 as to purposes for which the Legislature may provide for the taking or acquisition of land, it is clear that land taken or acquired under the earlier Article over nearly fifty years is now to be subjected to the two-thirds vote requirement for changes in use or other dispositions. Indeed all land whenever taken or acquired is now subject to the new voting requirement. The original draftsmen of the Massachusetts Constitution prudently included in Article 10 of the Declaration of Rights a broad constitutional basis for the taking of private land to be applied to public uses, without limitation on what are "public uses." By way of acts of the Legislature as well as through generous gifts of many citizens, the Commonwealth and Massachusetts cities and towns have acquired parkland and reservations. To claim that new Article 97 does not give the same care and protection for all these existing public lands as for lands acquired by the foresight of future legislators or the generosity of future citizens would ignore public purposes deemed important in Massachusetts laws since the beginning of the Commonwealth.

Moreover, if this amendment were only prospective in effect, it would be virtually meaningless. In Massachusetts, with a life commencing in the early 1600s and already cramped for land, it is most unlikely that the Legislature and the voters would choose to protect only those acres hereafter added to the many thousands already held for public purposes. The comment of the Massachusetts Supreme Judicial Court concerning the earlier Article 49 is applicable here: "It must be presumed that the convention proposed and the people approved and ratified the Forty-ninth Amendment with reference to the practical affairs of mankind and not as a mere theoretical announcement."³

II. QUESTION TWO

In its second question the House asks, in effect, whether the two-thirds roll-call vote requirement applies to land held for park purposes, as the term "park" is generally understood. My answer is in the affirmative, for the reasons below.

One major purpose of Article 97 is to ensure that the people shall have "the right to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment." The fulfillment of these rights is uniquely carried out by parkland acquisition. As the Supreme Judicial Court has declared:

The healthful and civilizing influence of parks in or near congested areas of population is of more than local interest and becomes a concern of the State under modern conditions. It relates not only to the public health in its narrow sense, but to broader considerations of exercise, refreshment, and enjoyment.⁴

A second major purpose of Article 97 is "the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources." Parkland protection can afford not only the conservation of forests, water and air but also a means of utilizing these resources in harmony with their conservation. Parkland can undeniably be said to be acquired for the purposes in Article 97 and is thus subject to the two-thirds roll-call requirement.

This question as to parks raises a further practical matter in regard to implementing Article 97 which warrants further discussion. The reasons the Legislature employs to explain its actions can be of countless levels of specificity or generality and land might conceivably be acquired for general recreation purposes or for very explicit uses such as the playing of baseball, the flying of kites, for evening strolls or for Sunday afternoon concerts. Undoubtedly, to the average man, such land would serve as a park but at even a more legalistic level it clearly can also be observed that such land was acquired, in the language of Article 97, because it was a "resource" which could best be "utilized" and "developed" by being "conserved" within a park. But it is not surprising that most land taken or acquired for public use is acquired under the specific terms of statutes which may not match verbatim the more general terms found in Article 10 of the Declaration of Rights of the Constitution or in Articles 39, 43, 49, 51 and 97 of the Amendments. Land originally acquired for limited or specific public purposes is thus not to

be excluded from the operation of the two-thirds roll-call vote requirement for lack of express invocation of the more general purposes of Article 97. Rather the scope of the Amendment is to be very broadly construed, not only because of the greater broadness in "public purpose", changed from "public uses" appearing in Article 49, but also because Article 97 establishes that the protection to be afforded by the Amendment is not only of public uses but of certain express rights of the people.

Thus, all land, easements and interests therein are covered by Article 97 if taken or acquired for "the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources" as these terms are broadly construed. While small greens remaining as the result of constructing public highways may be excluded, it is suggested that parks, monuments, reservations, athletic fields, concert areas and playgrounds clearly qualify. Given the spirit of the Amendment and the duty of the Legislature, it would seem prudent to classify lands and easements taken or acquired for specific purposes not found verbatim in Article 97 as nevertheless subject to Article 97 if reasonable doubt exists concerning their actual status.

III. QUESTION THREE

The third question of the House asks, in effect, how the words "natural resources", as appearing in Article 97, are to be defined.

Several statutes offer assistance to the Legislature, all without limiting what are "natural resources". Massachusetts General Laws (M.G.L.) ch. 21, §1 defines "natural resources", for the purposes of Department of Natural Resources jurisdiction, as including:

ocean, shellfish and inland fisheries; wild birds, including song and insectivorous birds, wild mammals and game; sea and fresh water fish of every description; forests and all uncultivated flora, together with public shade and ornamental trees and shrubs; land, soil and soil resources, lakes, ponds, streams, coastal, underground and surface waters; minerals and natural deposits.

In addition, M.G.L. ch. 12, §11D, establishing a Division of Environmental Protection under the Attorney General, uses the words "natural resources" in such a way as to include air, water, "rivers, streams, flood plains, lakes, ponds or other surface or subsurface water resources" and "seashores, dunes, marine resources, wetlands, open spaces, natural areas, parks or historic districts or sites." M.G.L. ch. 214, §10A, the so-called citizen-suit statute, con-

tains a recitation substantially identical. To these lists Article 97 would add only "agricultural" resources.

It is safe to say, as a consequence, that the term "natural resources" should be taken to signify *at least* these catalogued items. Public lands taken or acquired to conserve, develop or utilize any of these resources are thus subject to Article 97.

It is apparent that the Legislature has never sought to apply any limitation to the term "natural resources" but instead has viewed the term as an evolving one which should be expanded according to the needs of the time and the term was originally inserted in our Constitution for just that reason.⁵ The resources enumerated above should, therefore, be regarded as examples of and not delimiting what are "natural resources."

IV. QUESTION FOUR

The fourth question of the House requires a determination of the scope of activities which is intended by the words: "shall not be used for other purposes or otherwise disposed of."

The term "disposed" has never developed a precise legal meaning. As the Supreme Court has noted, "The word is *nomen generalissimum*, and standing by itself, without qualification, has no technical signification."⁶ The Supreme Court has indicated however, that "disposition" may include a lease.⁷ Other cases on unrelated subjects suggest that in Massachusetts the word "dispose" can include all forms of transfer no matter how complete or incomplete.⁸

In this absence of precise legal meaning, *Webster's Third New International Dictionary* is helpful. "Dispose of" is defined as "to transfer into new hands or to the control of someone else." A change in physical or legal control would thus prove to be determinative.

I therefore conclude that the "dispositions" for which a two-thirds roll-call vote of each branch of the General Court is required include: transfers of legal or physical control between agencies of government, between political subdivisions, and between levels of government, of lands, easements and interests therein originally taken or acquired for the purposes stated in Article 97, and transfers from public ownership to private. Outright conveyance, takings by eminent domain, long-term and short-term leases of whatever length, the granting or taking of easements and all means of transfer or change of legal or physical control are thereby covered, without limitation and without regard to whether the transfer be for the same or different uses or consistent or inconsistent purposes.

This interpretation affords a more objective test, and is more

easily applied, than "used for other purposes." Under Article 97 that standard must be applied by the Legislature, however, in circumstances which cannot be characterized as a disposition—that is, when a transfer or change in physical or legal control does not occur. A change of use within a governmental agency or within a political subdivision would serve as an apt example. Within any agency or political subdivision any land, easement or interest therein, if originally taken or acquired for the purposes stated in Article 97, may not be "used for other purposes" without the requisite two-thirds roll-call vote of each branch of the Legislature.

It may be helpful to note how Article 97 is to be read with the so-called doctrine of "prior public use," application of which also turns on changes in use. That doctrine holds that

public lands devoted to one public use cannot be diverted to another inconsistent public use without plain and explicit legislation authorizing the diversion.⁹

The doctrine of "prior public use" is derived from many early cases which establish its applicability to transfers between corporations granted limited powers of the Commonwealth, such as eminent domain, and authority over water and railroad easements.¹⁰ The doctrine was also applied at an early date to transfers between such corporations and municipalities.¹¹

The doctrine of "prior public use" has in more modern times been applied to the following transfers between governmental agencies or political subdivisions: (1) a transfer between state agencies;¹² (2) transfers between a state agency and a special state authority;¹³ (3) a transfer between a special state commission and special state authority;¹⁴ (4) transfers between municipalities;¹⁵ (5) transfers between state agencies and municipalities;¹⁶ (6) a transfer between a special state authority and a municipality;¹⁷ (7) a transfer between a state agency and a county;¹⁸ and (8) transfers between counties and municipalities.¹⁹

The doctrine has also been applied to the following changes of use of public lands within governmental agencies or within political subdivisions: (1) intra-agency uses;²⁰ (2) intramunicipality uses;²¹ and (3) intracounty uses.²² The doctrine may also possibly reach *de facto* changes in use,²³ and may be available to protect reservation land held by charitable corporations.²⁴ In addition to these extensions of the doctrine, special statutory protections, codifying the doctrine of "prior public use", are afforded local parkland and commons²⁵ and public cemeteries.²⁶

This is the background against which Article 97 was approved.

The doctrine of "prior public use" requires legislative action, by majority vote, to divert land from one public use to another inconsistent public use. As the scope of the doctrine discussed above indicates, the doctrine requires an act of the Legislature regardless of whether the land in question is held by the Commonwealth, its agencies, special authorities and commissions, political subdivisions or by certain corporations granted powers of the sovereign. And the doctrine applies regardless of whether the public use for which the land in question is held in a conservation purpose.

As to all such changes in use previously covered by the doctrine of "prior public use" the new Article 97 will only change the requisite vote of the Legislature from majority to two-thirds. Article 97 is designed to supplement, not supplant, the doctrine of "prior public use."

Article 97 will be of special significance, though, where the doctrine of "prior public use" has not yet been applied. For instance, legislation and a two-thirds roll-call vote of the Legislature will now, for the first time, be required even where a transfer of land or easement between governmental agencies, between political subdivisions, or between levels of government is made with no change in the use of the land, and even where a transfer is from public control to private.

Whether legislation pending before the General Court is subject to Article 97, or the doctrine of "prior public use," or both, it is recommended that the legislation meet the high standard of specificity set by the Supreme Judicial Court in a case involving the doctrine of "prior public use":

We think it is essential to the expression of plain and explicit authority to divert [public lands] to a new and inconsistent public use that the Legislature identify the land and that there appear in the legislation not only a statement of the new use but a statement or recital showing in some way legislative awareness of the existing public use. In short, the legislation should express not merely the public will for the new use but its willingness to surrender or forgo the existing use.²⁷

Each piece of legislation which may be subject to Article 97 should, in addition, be drawn so as to identify the parties to any planned disposition of the land.

CONCLUSIONS

Article 97 of the Amendments to the Massachusetts Constitution establishes the right of the people to clean air and water, freedom from excessive and unnecessary noise, and the natural, scenic, his-

toric and esthetic qualities of their environment. The protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is declared to be a public purpose. Lands, easements and interests therein taken or acquired for such public purposes are not to be disposed of or used for other purposes except by two-thirds roll-call vote of both the Massachusetts Senate and House of Representatives.

Answering the questions of the House of Representatives, I advise that the two-thirds roll-call vote requirement of Article 97 applies to all lands, easements and interests therein *whenever* taken or acquired for Article 97 conservation, development or utilization purposes, even prior to the effective date of Article 97, November 7, 1972. The Amendment applies to land, easements and interests therein held by the Commonwealth, or any of its agencies or political subdivisions, such as cities, towns and counties.

I advise that "natural resources" given protection under Article 97 would include at the very least, without limitation: air, water, wetlands, rivers, streams, lakes, ponds, coastal, underground and surface waters, flood plains, seashores, dunes, marine resources, ocean, shellfish and inland fisheries, wild birds including song and insectivorous birds, wild mammals and game, sea and fresh water fish of every description, forests and all uncultivated flora, together with public shade and ornamental trees and shrubs, land, soil and soil resources, minerals and natural deposits, agricultural resources, open spaces, natural areas, and parks and historic districts or sites.

I advise that Article 97 requires a two-thirds roll-call vote of the Massachusetts Senate and House of Representatives for all transfers between agencies of government and between political subdivisions of lands, easements or interests therein originally taken or acquired for Article 97 purposes, and transfers of such land, easements or interests therein from one level of government to another, or from public ownership to private. This is so without regard to whether the transfer be for the same or different uses or consistent or inconsistent purposes. I so advise because such transfers are "dispositions" under the terms of the new Amendment, and because "disposition" includes any change of legal or physical control, including but not limited to outright conveyance, eminent domain takings, long and short-term leases of whatever length and the granting or taking of easements.

I also advise that *intra-agency* changes in uses of land from Article 97 purposes, although they are not "dispositions", are similarly

subject to the two-thirds roll-call vote requirement.

Read against the background of the existing doctrine of "prior public use", Article 97 will thus for the first time require legislation and a special vote of the Legislature even where a transfer of land between governmental agencies, between political subdivisions or between levels of government results in no change in the use of land, and even where a transfer is made from public control to private. I suggest that whether legislation pending before the General Court is subject to Article 97, or the doctrine of "prior public use", or both, the very highest standard of specificity should be required of the draftsmen to assure that legislation clearly identifies the locus, the present public uses of the land, the new uses contemplated, if any, and the parties to any contemplated "disposition" of the land.

In short, Article 97 seeks to prevent government from ill-considered misuse or other disposition of public lands and interests held for conservation, development or utilization of natural resources. If land is misused a portion of the public's natural resources may be forever lost, and no less so than by outright transfer. Article 97 thus provides a new range of protection for public lands far beyond existing law and much to the benefit of our natural resources and to the credit of our citizens.

FOOTNOTES

*Attorney General, Commonwealth of Massachusetts.

¹Article 97 of the Articles of Amendment, Constitution of Massachusetts.

²Mass. H. 6085 (1973); this article is an edited version of the letter which I sent to Hon. David M. Bartley, Speaker of the House of Representatives, on June 6, 1973, in response to those questions.

³Opinion of the Justices, 237 Mass. 598, 608 (1921).

⁴Higginson v. Treasurer and School House Commissioners of Boston, 212 Mass. 583, 590 (1912); *see also*, Higginson v. Inhabitants of Nahant, 11 Allen 530, 536 (Mass. 1866).

⁵See, DEBATE OF THE CONSTITUTIONAL CONVENTION 1917-1918, at 595.

⁶Phelps v. Harris, 101 U.S. 370, 381 (1880).

⁷U.S. v. Gratiot, 39 U.S. 526 (1840).

⁸Rogers v. Goodwin, 2 Mass. 475 (1807); Woodbridge v. Jones, 183 Mass. 549 (1903); Lord v. Smith, 293 Mass. 555 (1936).

⁹Robbins v. Department of Public Works, 355 Mass. 328, 330 (1969), and cases there cited.

¹⁰See, e.g., *Old Colony Railroad Company v. Framingham Water Company*, 153 Mass. 561 (1891); *Boston Water Power Company v. Boston and Worcester Railroad Corporation*, 23 Pick. 360 (Mass. 1839); *Boston and Maine Railroad v. Lowell and Lawrence Railroad Company*, 124 Mass. 368 (1877); *Eastern Railroad Company v. Boston and Maine Railroad*, 111 Mass. 125 (1872); and *Housatonic Railroad Company v. Lee and Hudson Railroad Company*, 118 Mass. 391 (1875).

¹¹See, e.g., *Boston and Albany Railroad Company v. City Council of Cambridge*, 166 Mass. 224 (1896) (eminent domain taking of railroad land); *Eldredge v. County Commissioners of Norfolk*, 185 Mass. 186 (1904) (eminent domain taking of railroad easement); *West Boston Bridge v. County Commissioners of Middlesex*, 10 Pick. 270 (Mass. 1830) (eminent domain taking of turnpike land); and *Inhabitants of Springfield v. Connecticut River Railroad Co.*, 4 Cush. 63 (1849) (eminent domain taking of a public way).

¹²*Robbins v. Department of Public Works*, 355 Mass. 328 (1969) (eminent domain taking of Metropolitan District Commission (MDC) wetlands).

¹³*Commonwealth v. Massachusetts Turnpike Authority*, 346 Mass. 250 (1963) (eminent domain taking of MDC land); *see Loschi v. Massachusetts Port Authority*, 354 Mass. 53 (1968) (eminent domain taking of parkland).

¹⁴*Gould v. Greylock Reservation Commission*, 350 Mass. 410 (1966) (lease of portions of Mount Greylock).

¹⁵*City of Boston v. Inhabitants of Brookline*, 156 Mass. 172 (1892) (eminent domain taking of a water easement); *Inhabitants of Quincy v. City of Boston*, 148 Mass. 389 (1889) (eminent domain taking of a public way).

¹⁶*Town of Brookline v. Metropolitan District Commission*, 357 Mass. 435 (1970) (eminent domain taking of parkland); *City of Boston v. Massachusetts Port Authority*, 356 Mass. 741 (1970) (eminent domain taking of a park).

¹⁷*Appleton v. Massachusetts Parking Authority*, 340 Mass. 303 (1960) (eminent domain, Boston Common).

¹⁸*Abbott v. Commissioners of Dukes County*, 357 Mass. 784 (1970) (Department of Natural Resources grant of navigation easement).

¹⁹*Town of Needham v. County Commissioners of Norfolk*, 324 Mass. 293 (1949) (eminent domain taking of common and park lands); *Inhabitants of Easthampton v. County Commissioners of Hampshire*, 154 Mass. 424 (1891) (eminent domain taking of school lot).

²⁰Sacco v. Department of Public Works, 352 Mass. 670 (1967) (filling of a portion of a Great Pond).

²¹Higginson v. Treasurer and School House Commissioners of Boston, 212 Mass. 583 (1912) (erecting a building on a public park); *see*, Kean v. Stetson, 5 Pick. 492 (1827) (road built adjoining a river).

²²Bauer v. Mitchell, 247 Mass. 522 (1924) (discharging sewage upon school land).

²³*See, e.g.*, Pilgrim Real Estate Inc. v. Superintendent of Police of Boston, 330 Mass. 250 (1953) (parking of cars on park area).

²⁴*See, e.g.*, Trustees of Reservations v. Town of Stockbridge, 348 Mass. 511 (1965) (eminent domain).

²⁵M.G.L. ch. 45.

²⁶M.G.L. ch. 114, §§17, 41; as to changes in use of public lands held by municipalities or counties generally *see*, M.G.L. ch. 40 §15A; ch. 214, §3(11).

²⁷Robbins v. Department of Public Works, 355 Mass. 328, 331 (1969).

**Exhibit 8 to West Roxbury Motion for
Rehearing: Mahajan v. DPU**



1 of 1 DOCUMENT



Positive

As of: Mar 29, 2015

**SANJOY MAHAJAN & others¹ vs. DEPARTMENT OF ENVIRONMENTAL
PROTECTION & another.²**

1 Victor Brogna, Stephanie Hogue, David Kubiak, Mary McGee, Anne M. Pistorio, Thomas Schiavoni, Pasqua Scibelli, Robert Skole, and Patricia Thiboutot.
2 Boston Redevelopment Authority (BRA).

SJC-11134

SUPREME JUDICIAL COURT OF MASSACHUSETTS

464 Mass. 604; 984 N.E.2d 821; 2013 Mass. LEXIS 47

**November 5, 2012, Argued
March 15, 2013, Decided**

PRIOR HISTORY: [*1]**

Suffolk. Civil action commenced in the Superior Court Department on February 26, 2010. The case was heard by Elizabeth M. Fahey, J., on motions for judgment on the pleadings. The Supreme Judicial Court granted an application for direct appellate review.

Heather Maguire Hoffman for Shirley Kressel.

Thomas B. Bracken for The Sierra Club.

Peter Shelley & John A. Pike for Conservation Law Foundation, Inc., & others.

JUDGES: Present: Ireland, C.J., Spina, Cordy, Botsford, Gants, Duffly, & Lenk, JJ.

OPINION BY: CORDY

OPINION

[*605] [*823] CORDY, J. This action arises from the Department of Environmental Protection's (department's) issuance of a waterways license under G.L. c. 91 (chapter 91 license) to the Boston Redevelopment Authority (BRA) to redevelop a section of land owned by the BRA on the seaward end of Long Wharf (project site). The plaintiffs, ten residents of Boston's North End neighborhood, appealed the issuance of the chapter 91 license to the department's [***2] office of appeals and dispute resolution, and ultimately to a judge in the Superior Court, claiming the department acted unconstitutionally and beyond its statutory authority when it issued the chapter 91 license without

HEADNOTES

Department of Environmental Protection. Redevelopment of Land. Urban Renewal. Harbors. Parks and Parkways. Constitutional Law, Taking of property. Due Process of Law, Taking of property, Commonwealth's interest in tidelands.

COUNSEL: Denise A. Chicoine for Boston Redevelopment Authority.

Annapurna Balakrishna, Assistant Attorney General, for Department of Environmental Protection.

Gregor I. McGregor (Michael J. O'Neil & Luke H. Legere with him) for the plaintiffs.

The following submitted briefs for amici curiae:

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obtaining a two-thirds vote of the Legislature as required by *art. 97 of the Amendments to the Massachusetts Constitution*.³ On cross motions for judgment on the pleadings, the motion judge ordered declaratory relief and issued a writ of mandamus ordering the department to enforce *art. 97*. We granted the BRA's application for direct appellate review. We are presented with two principal questions: Whether the project site, which the BRA took by eminent domain for urban renewal purposes, is subject to *art. 97*; and if *art. 97* does apply, whether the department may issue the chapter 91 license to the BRA without triggering the requirement of a two-thirds vote of the Legislature. We conclude that the project site is not subject to *art. 97*.⁴

3 Article 97 of the Amendments to the Massachusetts Constitution, approved and ratified on November 7, 1972, superseded *art. 49* of the Amendments, but preserved the right of the people to enjoy the natural resources of the Commonwealth. [***3] We refer to the provision as *art. 97*.

4 We acknowledge the amicus briefs submitted by Shirley Kressel and the Sierra Club, as well as the brief submitted by the Conservation Law Foundation, the Massachusetts Association of Conservation Commissions, the Nature Conservancy, and the Trustees of Reservations.

1. Background. a. The BRA and the 1964 urban renewal plan. [*606] The BRA is both a "redevelopment authority" under *G. L. c. 121B*, § 4, and an "urban renewal agency" under *G. L. c. 121B*, § 9.⁵ Additionally, it serves as the planning board for the city of Boston and monitors private development under *G. L. c. 121A*. See St. 1960, c. 652, §§ 12-14.

5 A thorough comparison of the BRA's role in *G. L. c. 121A* urban redevelopment projects versus its role as an urban renewal agency in *G. L. c. 121B* urban renewal projects can be found in *Boston Edison Co. v. Boston Redev. Auth.*, 374 Mass. 37, 50-53, 371 N.E.2d 728 (1977). See *Boston Redev. Auth. v. Charles River Park "C" Co.*, 21 Mass. App. Ct. 777, 782-783, 490 N.E.2d 810 (1986).

The BRA's urban renewal powers and duties are enumerated throughout *G. L. c. 121B*, particularly in § 11 and §§ 45-57A. The legislative goals of *G. L. c. 121B* are to "eliminat[e] decadent, substandard, or blighted [***4] open" areas and to promote sound [**824] community growth. *G. L. c. 121B*, § 45. See *G. L. c. 121B*, § 1 (defining decadent, substandard, and blighted open areas). The BRA is vested with the authority to effectuate the goals of urban renewal through land assembly, title confirmation, public financial assistance, and development and design controls, all of which enable

the BRA to guide private sector development toward areas in need. See *G. L. c. 121B*, §§ 46-57A. Perhaps the most significant power granted to the BRA is the power of eminent domain, which *G. L. c. 121B* confers on the BRA as is "necessary or reasonably required to carry out the purposes of [c. 121B]," *G. L. c. 121B*, § 11 (d), such purposes being the elimination of "decadent, substandard or blighted open conditions." *G. L. c. 121B*, § 45.⁶

6 General Laws c. 121B grants the power of eminent domain to urban renewal agencies and otherwise provides for the acquisition and disposition of land pursuant to the purposes of urban renewal. A number of statutory sections discuss this power. *General Laws c. 121B*, § 11, provides: "Each operating agency shall have the powers . . . (d) To take by eminent domain . . . any property, real or personal, [***5] or any interest therein, found by it to be necessary or reasonably required to carry out the purposes of this chapter."

General Laws c. 121B, § 45, provides:

"It is hereby declared . . . that the acquisition of property for the purpose of eliminating decadent, substandard, or blighted open conditions thereon and preventing recurrence of such conditions in the area, the removal of structures and improvement of sites, the disposition of the property for redevelopment incidental to the foregoing, [and] the exercise of powers by urban renewal agencies . . . are public uses and purposes for which public money may be expended and the power of eminent domain exercised"

General Laws c. 121B, § 47, provides:

"Notwithstanding any contrary provision of this chapter, an urban renewal agency may . . . take by eminent domain, as provided in clause (d) of section eleven . . . or acquire by purchase, lease, gift, bequest or grant, and hold, clear, repair, operate and, after having taken or acquired the same, dispose of land constituting the whole or any part or parts of any area which . . . it has determined to be a decadent, substandard or

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blighted open area and for which it is preparing an urban [***6] renewal plan"

development of real property to its fullest economic potential.

Pursuant to the Downtown Waterfront-Faneuil Hall urban [*607] renewal plan, dated April 15, 1964 (1964 urban renewal plan), and an order of taking, dated June 4, 1970, which incorporated that plan, the BRA acquired the project site in 1970 as part of a larger taking by eminent domain of the Long Wharf area (1970 taking). In accordance with the legislative goals of G. L. c. 121B, the 1964 urban renewal plan provides in Section 201:

"The [***7] basic goal of urban renewal action in the Downtown Waterfront-Faneuil Hall Area is to stimulate and to facilitate development efforts in the area, by eliminating those severe conditions of blight, deterioration, obsolescence, traffic congestion and incompatible land uses which hinder private investment in new development without the aid of governmental action, in order to (1) revitalize a key portion of downtown Boston; (2) upgrade the pattern of land uses close by the North End residential community; (3) establish a functional connection between the area and its surrounding districts: the North End, the Government Center and the Financial District; and (4) provide an environment suitable to the needs of contemporary real estate development."⁷

7 Section 202 of the Downtown Waterfront-Faneuil Hall urban renewal plan, dated April 15, 1964 (1964 urban renewal plan), also outlines several planning objectives, which are as follows:

"(1) To eliminate a pattern of land uses and blighting conditions which

"(a) creates severe traffic congestion in the area;

"(b) exerts a depressing effect on adjacent areas;

"(c) inhibits the

"(2) To eliminate [***8] obsolete and substandard building conditions which are a factor in spreading blight to adjacent areas.

"(3) To prevent the further erosion of property values.

"(4) To protect and strengthen the tax base of the city.

"(5) To encourage productive and intensive use of land.

"(6) To create opportunities for development of a downtown residential community offering a range of housing types and rentals.

"(7) To provide sites suitable for the construction of efficient, economical buildings.

"(8) To promote the preservation and enhancement of buildings in the Project Area which have architectural and historical significance.

"(9) To create an environment which is conducive to the investment of funds in rehabilitation, conversion and general upgrading of property.

"(10) To create an area with a mixture of land uses compatible with living, working and recreational opportunities.

"(11) To create an area for the development of marine or marine-oriented activities designed to stimulate tourism and symbolize the importance of Boston's historic relationship to the sea.

"(12) To provide for the efficient flow of traffic within and through the area.

"(13) To improve streets and utilities and the landscaping of [***9] public areas.

"(14) To provide public ways,

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parks and plazas which encourage the pedestrian to enjoy the harbor and its activities.

"(15) To develop the area in such a way as to stimulate improvements in adjacent areas."

[*608] [**825] b. The project site. The project site is a section of land at the eastern end of Long Wharf on which sits an open-air brick structure known as Long Wharf Pavilion. The BRA continues to hold and maintain Long Wharf, including the project site, pursuant to the 1964 urban renewal plan.⁸ Long Wharf is a designated national historic landmark, and is the site of water transportation, public transportation, hotels, retail establishments, and [*609] restaurants. It is also part of the Boston Harborwalk, a pedestrian walkway that lines the waterfront.

8 Although the 1964 urban renewal plan specified a forty-year effective period, the plan was amended in 2004 to be effective through April 30, 2015.

In 1983, the department⁹ permitted the Massachusetts Bay Transportation Authority to construct an emergency egress and ventilation shaft for the Blue Line subway tunnel, to be capped off by the structure now known as Long Wharf Pavilion. At the same time, the BRA undertook renovations to the plaza [***10] area surrounding the pavilion. The plaza measures approximately 33,000 square feet, is paved with granite flagstones, and features a large inlaid compass rose to the south of the pavilion. Other features include benches, public binoculars, and a flag pole. A segment of the Harborwalk lines the perimeter of the plaza. Although not discussed in much detail in the 1964 urban renewal plan, the plaza's current use is consistent with the plan's provision for an "observation platform" on Long Wharf.

9 The Department of Environmental Protection (department) was then referred to as the Department of Environmental Quality Engineering.

In addition to the 1964 urban renewal plan, the project site is also subject to Boston's Municipal Harbor Plan, which was approved in 1991 by the Secretary of the Executive Office of Environmental Affairs pursuant to *301 Code Mass. Regs. §§ 23.00* (2000) (municipal harbor plan). Among other objectives, the municipal harbor plan calls for the activation and revitalization of Boston's underutilized shoreline "by promoting growth through private investment [**826] that is appropriately designed, and is a balanced mix of uses that bring vitality to the waterfront and public [***11] benefits and

amenities that are shared by all Boston residents." The municipal harbor plan was designed to complement waterways regulations that accompanied G. L. c. 91, already applicable to much of the waterfront area.

Considering the project site to be underutilized, the BRA proposed a plan in 2008 to redevelop it by enclosing and expanding the pavilion to accommodate a restaurant with outdoor seating, "takeout service," and a bar. Specifically, the BRA planned to expand the 3,430 square foot pavilion by 1,225 square feet. In addition to the restaurant, the proposed redevelopment includes shaded seating, restrooms, and several sets of binoculars, all available to the public independent of patronage of the restaurant. The proposed redevelopment is intended to allow year-round [*610] use of the pavilion and provide facilities and seating to the large number of pedestrians and water transit users who frequent the area.

The BRA obtained fourteen zoning variances from the Boston zoning board of appeals that allow for live entertainment, "takeout service," and food and alcohol service until 1 A.M. at the proposed restaurant. In addition, because the project site is located on filled tidelands, [***12] the BRA was required to obtain the chapter 91 license from the department. See *G. L. c. 91, § 14; 310 Code Mass. Regs. §§ 9.00-9.55* (2012). See also *Moot v. Department of Envtl. Protection*, 448 Mass. 340, 342, 861 N.E.2d 410 (2007), S.C., 456 Mass. 309, 923 N.E.2d 81 (2010) (discussing applicability of G. L. c. 91, which governs development on tidelands).

The department granted the chapter 91 license to the BRA on September 17, 2008. The plaintiffs appealed. They argued that the proposed restaurant would create unnecessary noise and would damage public open space, parkland, and scenic quality.¹⁰ On January 29, 2010, the commissioner of the department issued a final decision affirming the issuance of the chapter 91 license.¹¹ The plaintiffs appealed from that final decision to the Superior Court, seeking a declaratory judgment under *G. L. c. 231A* and a writ of mandamus under *G. L. c. 249, § 5*, ordering the department to enforce the requirements of *art. 97* by seeking a two-thirds vote of the Legislature prior to issuing the license. The motion judge concluded that because the 1964 urban renewal plan aimed to create parkland, open space, and a [*611] means of utilizing and enjoying the harbor, it served *art. 97* purposes and [***13] was therefore subject to *art. 97*. The judge further concluded that the issuance of the chapter 91 license constituted a transfer of legal control from the [**827] department to the BRA sufficient to effect a disposition, as well as a change in use of the land, both of which triggered the two-thirds vote requirement. Accordingly, the judge granted the plaintiffs' requested relief.¹²

10 The standard for granting a waterways

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license under G. L. c. 91 (chapter 91 license) for a nonwater dependent use (like the proposed restaurant) on filled tidelands is a finding by the department that the use "shall serve a proper public purpose and that said purpose shall provide a greater public benefit than public detriment to the rights of the public in said lands." *G. L. c. 91*, § 18.

11 The plaintiffs filed their appeal from the department's office of appeals and dispute resolution (OADR) on October 9, 2008, and at a prescreening conference on December 3, 2008, the parties established a list of issues for resolution. Those issues pertained only to the chapter 91 license and did not include the *art. 97* issue. In a motion for summary decision filed during the appeals process on February 24, 2009, the plaintiffs [***14] raised the *art. 97* issue for the first time. The BRA and the department countered by asserting that *art. 97* is outside the department's express statutory authority. Based on that assertion, the OADR hearing officer (and, by adoption, the commissioner of the department) declined to consider the issue, and it was litigated for the first time in the Superior Court.

12 The plaintiffs also invoked *G. L. c. 30A*, § 14, arguing that the commissioner's decision was based on an error of law, and that issuance of the chapter 91 license was in contravention of G. L. c. 91 statutory and regulatory requirements. See note 10, *supra*. Because the judge disposed of the case on *art. 97* grounds, she did not consider the plaintiffs' request for *G. L. c. 30A* review. Because the propriety of the chapter 91 license (apart from the potential *art. 97* issue) was not reviewed in the Superior Court, it is not properly before us on appeal.

On appeal, the plaintiffs contend that the project site is subject to *art. 97*, and that the department's issuance of the chapter 91 license constituted a use or disposition triggering the two-thirds vote requirement. The BRA counters that *art. 97* does not apply because the project [***15] site was not taken for *art. 97* purposes. The department argues that it lacks the authority to interpret and apply *art. 97*, and that even if *art. 97* did apply, the department's issuance of the chapter 91 license did not constitute a use or disposition triggering the vote requirement. Both defendants argue that the motion judge improperly voided the chapter 91 license through declaratory and mandamus relief.

2. Discussion. a. Applicability of *art. 97*. *Article 97* was approved and ratified on November 7, 1972, superseding *art. 49 of the Amendments*. See note 3, *supra*. It provides, in pertinent part, as follows:

"The people shall have the right to clean

air and water, freedom from excessive and unnecessary noise, and the natural, scenic, historic, and esthetic qualities of their environment; and the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources is hereby declared to be a public purpose.

"The general court shall have the power to enact legislation necessary or expedient to protect such rights.

[*612] " . . .

"Lands and easements taken or acquired for such purposes shall not be used for [***16] other purposes or otherwise disposed of except by laws enacted by a two-thirds vote, taken by yeas and nays, of each branch of the general court." (Emphases added.)

The principal issue in this case concerns whether the project site, which the BRA took by eminent domain in 1970, was "taken" for *art. 97* purposes. See *Selectmen of Hanson v. Lindsay*, 444 Mass. 502, 504-506, 829 N.E.2d 1105 (2005) (in order for *art. 97* vote requirement to apply, land must have been taken or acquired for *art. 97* purposes). *Article 97* clearly states that its purposes are "the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources." In contrast, land taken for urban renewal purposes is generally understood to be taken "for the purpose of eliminating decadent, substandard or blighted open conditions." *G. L. c. 121B*, § 45. See *Aaron v. Boston Redev. Auth.*, 66 Mass. App. Ct. 804, 807, 808, 810, 850 N.E.2d 1105 (2006) (in context of claim for prescriptive easement, land taken by BRA for urban renewal purposes held for "other public purpose," not conservation). Although as a practical matter, certain aspects of an urban renewal plan may accomplish goals similar to those outlined in [***17] *rt. 97*, the overarching purpose for which [**828] the land is taken is distinct from *art. 97* purposes.

With that distinction in mind, the issue is whether the project site can nonetheless be characterized as having been "taken or acquired for [art. 97] purposes." Reported cases interpreting *art. 97* are scarce. In concluding that the project site was taken for *art. 97* purposes, the motion judge relied heavily on the June 6, 1973, opinion of then Attorney General Robert Quinn. See *Rep. A.G., Pub. Doc. No. 12*, at 139 (1973) (Quinn Opinion). Using the Quinn Opinion for guidance, she identified certain aims or objectives referenced in the

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1964 urban renewal plan, including the creation of public ways, parks, open space, and plazas, and a means of utilizing and enjoying the harbor. Because those aims were consistent with the purposes of *art. 97*, the judge concluded that the project site, which realizes them, was taken for *art. 97* purposes and is therefore subject to the two-thirds [*613] vote requirement. Not surprisingly, the plaintiffs rely extensively on the Quinn Opinion in their arguments before this court.

The Quinn Opinion was issued in response to a general inquiry from the Speaker of the House [****18] of Representatives regarding the applicability of *art. 97*, and was rendered without reference to any particular set of facts. Although the Quinn Opinion is entitled to careful judicial consideration on the question of the scope of *art. 97* and the intent of its drafters, see *Opinions of the Justices*, 383 Mass. 895, 918, 424 N.E.2d 1092 (1981), citing Rep. A.G., Pub. Doc. No. 12, at 141 (concluding *art. 97* applies retroactively), its interpretation of *art. 97* is not binding in its particulars, and we are hesitant to afford it too much weight due to the generalized nature of the inquiry and the hypothetical nature of the response.¹³ See A.J. Cella, *Administrative Law and Practice* § 20, at 70-75 (1986) (discussing legal effect of opinions of the Attorney General).

13 It is highly unusual for an opinion of the Attorney General to be rendered on a hypothetical basis. See A.J. Cella, *Administrative Law and Practice* § 20, at 69 n.2 (1986) (Cella). Opinions of the Attorney General are rendered pursuant to *G. L. c. 12, § 3*, which provides for the rendering of legal advice by the Attorney General to State "departments, officers, and commissions" in matters relating to their official duties. Cella, *supra* at 69. [****19] "Opinions of the Attorney General are rendered solely upon factual situations which actually confront a given state department or agency, and not upon hypothetical questions or general requests for information." *Id.* at 69 n.2, citing Rep. A.G., Pub. Doc. No. 12, 114 (1967). An advisory opinion of the Attorney General "is entitled to careful judicial consideration and is generally regarded as highly persuasive." Cella, *supra* at 74 & n.37. However:

"[I]t is clear that the courts retain the power to determine for themselves on a case by case basis whether or not, and if so, to what extent, the courts agree or disagree with an advisory opinion of the Attorney General as to the proper interpretation of some issue of law."

Id. at 75.

The Quinn Opinion suggests a more expansive reading of *art. 97* than we afford it today, and it may reasonably be read to support the plaintiffs' argument that the project site is subject to *art. 97*. We disagree with the Quinn Opinion to the extent it suggests that the vast majority of land taken for any public purpose may become subject to *art. 97* if the taking or use even incidentally promotes the "conservation, development and utilization of the . . . forest, [****20] water and air," Rep. A.G., Pub. [*614] Doc. No. 12, at 142, or that the land simply displays some attributes of *art. 97* land generally.¹⁴ *Id.* at 143. We also do not [***829] agree that the relatively imprecise language of *art. 97* warrants [*615] an interpretation as broad as the Quinn Opinion would afford it, particularly in light of the practical consequences that would result from such an expansive application, as well as the ability of a narrower interpretation to serve adequately the stated goals of *art. 97*.

14 Unconstrained by a particular set of facts, the then Attorney General, in Rep. A.G., Pub. Doc. No. 12 (1973) (Quinn Opinion) paints a broad picture of the scope of *art. 97*. In response to the question, "Does the disposition or change of use of land held for park purposes require a two thirds vote . . . as provided in [art. 97], or would a majority vote of each branch be sufficient for approval?" the Quinn Opinion answered, "Yes," and then went on to suggest that the actual use, appearance, or attributes of a piece of land may be better evidence of the purpose for which it was taken or acquired than the language of the instrument effectuating the acquisition. *Id.* at 143. Its most expansive language [****21] reads:

"Th[e] question as to [the applicability of *art. 97* to] parks raises a further practical matter in regard to implementing *Article 97* which warrants further discussion. The reasons the Legislature employs to explain its actions can be of countless levels of specificity or generality and land might conceivably be acquired for general recreation purposes or for very explicit uses such as the playing of baseball, the flying of kites, for evening strolls or for Sunday afternoon concerts. Undoubtedly, to the average man, such land would serve as a park but at even a more legalistic level

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it clearly can also be observed that such land was acquired, in the language of *Article 97*, because it was a 'resource' which could best be 'utilized' and 'developed' by being 'conserved' within a park. But it is not surprising that most land taken or acquired for public use is acquired under the specific terms of statutes which may not match verbatim the more general terms found in *Article 10 of the Declaration of Rights of the Constitution* or in *Articles 39, 43, 49, 51 and 97 of the Amendments*. Land originally acquired for limited or specified public purposes is thus not to be excluded from the operation [***22] of the two-thirds roll-call vote requirement for lack of express invocation of the more general purposes of *Article 97*. Rather the scope of the Amendment is to be very broadly construed, not only because of the greater broadness in 'public purpose,' changed from 'public uses' appearing in *Article 49*, but also because *Article 97* establishes that the protection to be afforded by the Amendment is not only of public uses but of certain express rights of the people.

"Thus, all land, easements and interests therein are covered by *Article 97* if taken or acquired for 'the protection of the people in their right to the conservation, development and utilization of the agricultural, mineral, forest, water, air and other natural resources' as these terms are broadly construed. While small greens remaining as the result of constructing public highways may be excluded, it is suggested that parks, monuments, reservations, athletic fields, concert areas and playgrounds clearly qualify. Given the spirit of the Amendment and the duty of the General Court, it would seem prudent to classify lands and easements taken or acquired for specific purposes not found verbatim in *Article 97* as

nevertheless subject [***23] to Article 97 if reasonable doubt exists concerning their actual status." (Emphases added.)

Id. at 142-143.

The critical question to be answered is not whether the use of the land incidentally serves purposes consistent with *art. 97*, or whether the land displays some attributes of *art. 97* land, but whether the land was taken for those purposes, or subsequent to the taking was designated for those purposes in a manner sufficient to invoke the protection of *art. 97*. See *Selectmen of Hanson v. Lindsay*, 444 Mass. 502, 508-509, 829 N.E.2d 1105 (2005) (*art. 97* protections may arise where subsequent to taking for purposes other than *art. 97*, land is "specifically designated" for *art. 97* purpose by deed or other recorded restriction). See also *Toro v. Mayor of Revere*, 9 Mass. App. Ct. 871, 872, 401 N.E.2d 853 (1980) (applicability of *art. 97* hinged on whether land had in fact been conveyed "to the conservation commission . . . to maintain and preserve it for the use of the public for conservation purposes"). In this case, while it can be argued that the project site displays some of the attributes of [**830] a park¹⁵ and serves the purpose of the utilization of natural resources -- in that it promotes access to the waterfront and the [***24] sea -- this specific use is incidental to the overarching purpose of urban renewal for which the land including the project site was originally taken. Cf. *Benevolent & Protective Order of Elks, Lodge No. 65 v. Planning Bd. of Lawrence*, 403 Mass. 531, 551-552, 531 N.E.2d 1233 (1988), citing *Papadinis v. Somerville*, 331 Mass. 627, 632, 121 N.E.2d 714 (1954) (any benefit from disposition to private redeveloper of land taken for urban renewal purposes is "incidental to the main purpose of the plan, which is the elimination of a substandard, decadent, or blighted open area").

15 As the motion judge noted, a bronze plaque located on the plaza designates the area as "Long Wharf Park," and the BRA's owned-land database identifies the area at the end of Long Wharf as a "park."

In *Selectmen of Hanson v. Lindsay*, *supra*, we held that a [*616] town meeting vote to designate for conservation purposes land that had originally been taken for tax purposes did not subject that land to *art. 97* protections absent recordation of a restriction on the title. Without the execution or recordation of a deed containing the conservation restriction, the land "never became specifically designated for conservation purposes in the first instance" and accordingly [***25] "was not held for a specific purpose" under *art. 97*, so "compliance with the provisions of *art. 97* . . . was not

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required." *Id. at 508-509*. This was true despite the clear intent of the town meeting members to hold the property for conservation purposes. *Id. at 505*. As the plain language of *art. 97* indicates, for land to be subject to the two-thirds vote requirement on disposition or use for other purposes, it must be "taken or acquired for [the] purpose" of protecting interests covered by *art. 97*. In *Selectmen of Hanson v. Lindsay*, *supra* at 508-509, where the property had indisputably been acquired as a tax forfeiture and held as general corporate property, the town had to deed the land to itself for conservation purposes -- or record an equivalent restriction on the deed -- in order for *art. 97* to apply to subsequent dispositions or use for other purposes. Here, where the land at issue is but a small part of a much larger taking effectuated for the purposes of urban renewal, it is difficult to identify a "specific purpose" for which the project site was acquired or held that would clearly bring it within the protection of *art. 97*.¹⁶ See *id. at 509*.

16 We do not conclude that land taken [***26] pursuant to an urban renewal plan is automatically immune from *art. 97*. See note 19, infra.

Because the spirit of *art. 97* is derived from the related doctrine of "prior public use," cases applying that doctrine inform our analysis. See Rep. A.G., Pub. Doc. No. 12, at 146 (prior public use doctrine "background against which [*art. 97*] was approved"). See also Rep. A.G., Pub. Doc. No. 14, 131 (1980) ("language of Article 97 must be read in conjunction with the judicially developed doctrine of 'prior public use'"). The prior public use doctrine holds that "public lands devoted to one public use cannot be diverted to another inconsistent public use without plain and explicit legislation authorizing the diversion." *Robbins v. Department of Pub. Works*, 355 Mass. 328, 330, 244 N.E.2d 577 (1969). See [*617] *Brookline v. Metropolitan Dist. Comm'n*, 357 Mass. 435, 440, 258 N.E.2d 284 (1970), and cases cited. However, that doctrine is only applicable "to those lands which are in fact 'devoted to one public use'" (emphasis added). [**831] *Muir v. Leominster*, 2 Mass. App. Ct. 587, 591, 317 N.E.2d 212 (1974), quoting *Robbins v. Department of Pub. Works*, *supra*. In the *Muir* case, the Appeals Court held the prior public use doctrine inapplicable to the sale for commercial [***27] purposes of a parcel of land, where that parcel had been conveyed to a city as a gift with no limitation on its use but was in fact used for thirty years as a playground and for other recreational purposes. *Muir v. Leominster*, *supra* at 588-589, 591 ("[i]n this case there had been neither prior legislative authorization of a taking for a particular purpose nor a prior public or private grant restricted to a particular purpose").

Here, as the motion judge highlighted, the 1964 urban renewal plan enumerates, among its listed planning

and design objectives, certain objectives that are consistent with *art. 97* purposes. The 1964 urban renewal plan also contains vague descriptions of the project site and Long Wharf generally that are consistent with its current use as an open space.¹⁷ Most significantly, § 202 of the 1964 urban renewal plan, entitled "Planning Objectives," states as one of its fifteen objectives, the objective "[t]o provide public ways, parks and plazas which encourage the pedestrian to enjoy the harbor and its activities." In addition, in § 203, entitled "General Design Principles," the plan lists several design principles, including:

"3. To provide maximum opportunity for [***28] pedestrian access to the water's edge.

"4. To establish an orderly sequence and hierarchy of open spaces and views for both the pedestrian and the motorist.

"5. To establish a relationship between buildings, open [*618] spaces and public ways which provides maximum protection to the pedestrian during unfavorable weather conditions."

17 Section 204(1)(f) of the 1964 urban renewal plan, under the heading "Sub-Area Design Objectives," identifies a "developmental characteristic[]" of the plan as: "The preservation or redevelopment of wharves which retain the historic tradition of fingers out into the harbor and create active and intimate water inlets. Long Wharf is to retain its historic position as the farthest projection of land into the harbor, and will become an observation platform."

By definition, *G. L. c. 121B* vests in the BRA the authority to take or acquire "decadent, substandard or blighted open area[s]" for the purpose of eliminating those undesirable conditions (emphasis added). See *G. L. c. 121B* §§ 11, 45, 47. However, it does not follow that, where a comprehensive urban renewal plan calls for some areas of a taking to be left open -- without a more specific and particularized invocation [***29] of *art. 97* purposes unique to those areas that effectively designates those areas as separate and apart from the rest of the taking -- a two-thirds vote of the Legislature is required for any subsequent change in use or disposition of those open areas. Nor do we find sufficient to invoke *art. 97* protection the fact that a comprehensive urban renewal plan may identify, among other objectives, some objectives that are consistent with *art. 97* purposes, or where certain areas taken pursuant to that plan ultimately

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display some attributes of *art. 97* land. A contrary rule would be particularly nonsensical where the proposed change in use or disposition that would purportedly trigger the two-thirds vote is made in furtherance of the goals of the particular urban renewal plan and is otherwise appropriate.

Given the overarching purpose of the 1964 urban renewal plan to eliminate urban blight through the comprehensive redevelopment of the waterfront area, including its revitalization through the development [**832] of mixed uses and amenities, it cannot be said that the retention of certain open spaces, like the project site, is sufficiently indicative of an *art. 97* purpose as to trigger a two-thirds vote [***30] of the Legislature should the BRA wish to slightly revise the use of certain spaces in a manner consistent with the objectives of the original urban renewal plan.¹⁸ The fact that the 1964 Urban Renewal Plan (which covered a large [*619] section of downtown Boston) provided in general terms for open spaces and pedestrian access to the water's edge is itself insufficient to invoke *art. 97* protections for parts of the original taking that ultimately serve those general purposes. The single, fleeting reference in the 1964 urban renewal plan to an "observation platform" on Long Wharf similarly fails to adequately invoke the specific purposes of *art. 97*.

18 Section 1101 of the 1964 urban renewal plan provides for modification of the plan, stating:

"The Urban Renewal Plan may be modified at any time by the Boston Redevelopment Authority provided that, if the general requirements, controls, or restrictions applicable to any part of the Project Area shall be modified after the lease or sale of such part, the modification is consented to by the Developer or Developers of such part or their successors and assigns. Where proposed modifications will substantially or materially alter or change the Plan, the [***31] modifications must be approved by the Boston City Council and the State Division of Urban and Industrial Renewal."

Although a modification clause certainly cannot serve as a unilateral bar to the application of *art. 97*, the provision for modification demonstrates the often fluid purposes for which land is taken pursuant to an urban renewal plan.

Nevertheless, we disagree with the BRA's contention that it cannot possibly take land for *art. 97* purposes pursuant to its urban renewal powers under G. L. c. 121B. The purposes served by urban renewal and by *art. 97* are not mutually exclusive. Certainly, for the BRA to take land by eminent domain, it must exist in a "decadent, substandard, or blighted" condition. However, where an urban renewal plan accompanying a taking clearly demonstrates a specific intent to reserve particular, well-defined areas of that taking for *art. 97* purposes, the BRA conceivably may take land for such purposes while remaining within its statutory authority.¹⁹ The recording of a restriction on the use of land subsequent to a taking may also place land within the [*620] protections of *art. 97*. See *Selectmen of Hanson v. Lindsay*, 444 Mass. 502, 504-506, 829 N.E.2d 1105 (2005). Furthermore, [***32] we disagree with the BRA that the language of an order of taking is necessarily determinative of the applicability of *art. 97*. Under certain circumstances not present here, the ultimate use to which the land is put may provide the best evidence of the purposes of the taking, notwithstanding the language of the original order of taking or accompanying [**833] urban renewal plan. See Quinn Opinion, *supra* at 142-143.

19 We note, for example, that relying on the Quinn Opinion, the office of the Attorney General concluded in a December 16, 1997, letter to the BRA director that City Hall Plaza in Boston was subject to *art. 97* and a two-thirds vote of the Legislature was required to approve the construction of a hotel and parking garage on the site. The Attorney General's letter relied primarily on the language of the Government Center urban renewal plan, which specifically stated that the site of City Hall Plaza "shall be devoted to public open space," as well as the BRA's description of the Plaza at the unveiling of the plan in 1963:

"The strong focal point of the Government Center will be the new City Hall and the Government Center Plaza. Comparable as a monumental public space to the most famous squares [***33] in Europe . . . (the) City Hall and the new plaza together will be comparable in function and relationship to the town meeting house and common in an old-time New England village" (emphasis in original).

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b. Occurrence of triggering condition. Even if *art. 97* did apply to the project site, the issue would remain whether the department's issuance of the *chapter 91* license constituted a disposition or change in use of the land triggering the two-thirds vote requirement. Although not necessary to our holding, we briefly address the issue.

The answer to this question depends on whether the *chapter 91* license is in fact a mere license, or if it is more properly characterized as an easement. Although the granting of an easement over *art. 97* land constitutes a disposition triggering the two-thirds vote requirement, a disposition of any lesser property interest does not. See *Opinions of the Justices*, 383 Mass. 895, 919, 424 N.E.2d 1092 (1981) (relinquishment by Commonwealth of any vestigial property interests in tidelands other than "lands and easements" would not trigger *art. 97* voting requirement); *Miller v. Commissioner of the Dep't of Envtl. Mgt.*, 23 Mass. App. Ct. 968, 969-970, 503 N.E.2d 666 (1987) (department's issuance [***34] of revocable one-year permit to operate ski area did not trigger two-thirds vote under *art. 97*).

General Laws c. 91, § 15, states that "the grant of a license" under that chapter "shall not convey a property right."²⁰ The [*621] BRA owns the project site, and accordingly, the BRA's right to lease the Long Wharf Pavilion to a restaurant operator derives not from the *chapter 91* license, but from the fact that the BRA owns the land. The *chapter 91* license merely certifies that the planned use, including the lease, complies with G. L. c. 91 and accompanying department regulations. It does not, as the motion judge concluded, transfer from the department to the BRA "an extent of legal control over the land at issue."²¹ Any disposition triggering the [**834] *art. 97* voting requirement would need to be granted by the BRA -- as would be the case with the lease to the restaurant operator -- not to the BRA.

20 In support of their argument that the *chapter 91* license confers a property right on the BRA, the plaintiffs point out that the license is not revocable at will but only for noncompliance, lasts thirty years, runs with the land, and must be recorded to be valid. In addition, any revocation of the *chapter 91* license is considered a taking that requires just compensation for "valuable structures, fillings, enclosures, uses or other improvements built, made or continued in compliance with said authorization or license." *G. L. c. 91, § 15*.

Furthermore, *G. L. c. 91, § 15*, provides:

"A license issued pursuant to this chapter is hereby made a mortgageable interest lawful for

investment by any banking association, trust company, savings bank, cooperative bank, investment company, insurance company, executor, trustee, or other fiduciary, and any other person who is now or may hereafter be authorized to invest in any mortgage or other obligation of a similar nature."

We conclude that, while the aforementioned characteristics of the *chapter 91* license acknowledge the economic value of the license, they do not make the license "tantamount to an easement," because the department has no property interest in the project site over which to grant an easement.

21 In concluding that the department's issuance of the *chapter 91* license constituted a disposition of the land, the motion judge relied on language from the Quinn Opinion, *supra* at 144, stating that "all means of transfers or change of legal or [***36] physical control are thereby covered, without limitation." First, the notion that any change of legal or physical control no matter how small constitutes a disposition for *art. 97* purposes conflicts with our opinion in *Opinions of the Justices*, 383 Mass. 895, 918, 424 N.E.2d 1092 (1981), issued after the Quinn Opinion, and with the Appeals Court's holding in *Miller v. Commissioner of the Dep't of Envtl. Mgt.*, 23 Mass. App. Ct. 968, 969-970, 503 N.E.2d 666 (1987). Second, and perhaps more important, in issuing the *chapter 91* license, the department has not transferred legal control over the project site. As the agency charged with enforcing G. L. c. 91, the department has no affirmative legal control over the project site; it is merely vested with the authority to ensure that uses that implicate G. L. c. 91 conform with its requirements and the accompanying regulations.

The *chapter 91* license itself is "granted upon the express condition that any and all other applicable authorizations . . . shall be secured by the Licensee prior to the commencement of any activity or use authorized pursuant to this License" (emphasis in original). The license also states that it is "granted subject to all applicable Federal, State, [***37] County, and Municipal laws, ordinances and regulations." Even if, arguendo, the *chapter 91* license created a property right, the right it created is a contingent [*622] future interest and would not trigger the voting requirement until the interest vests on obtaining all necessary approvals.

Nor does the issuance of the *chapter 91* license

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constitute a "use[] for other purposes" that would trigger the legislative vote. For lands to which *art. 97* does apply, *art. 97* legislative approval is likely just one of the many approvals a project proponent will need to acquire in order to proceed with the project. These approvals are issued by various State and local regulatory agencies and are largely independent of one another, yet all are necessary to proceed with the project. It would make little practical sense to condition the application for one such approval, in this case the chapter 91 license, on the successful application for another approval. The chapter 91 license facilitates the change in use in the same way the zoning variances and other necessary approvals do. A project proponent like the BRA could conceivably obtain the necessary approvals to change the use of land and, for myriad reasons, [***38] never follow through on the planned use. *Article 97* requires a two-thirds vote of the Legislature prior to an actual change in use, not mere preparations for that change.

3. Conclusion. For the reasons discussed, we conclude that *art. 97* does not apply to the project site and, therefore, a two-thirds vote of the Legislature is not required to approve the planned redevelopment. Because the motion judge did not review the issuance of the

chapter 91 license pursuant to *G. L. c. 30A*, § 14, we remand the case to the Superior Court for proceedings consistent with this opinion.²²

22 We note, however, that with *art. 97* inapplicable and relief in the form of mandamus therefore inappropriate, we have serious doubts whether the plaintiffs can demonstrate standing to otherwise challenge the chapter 91 license. The department's hearing officer concluded that the plaintiffs did not have standing because they failed to demonstrate that the issuance of the license may cause them to "suffer an injury in fact, which is different either in kind or magnitude from that suffered by the general public which is within the scope of the public interest protected by [G. L. c. 91]." See *310 Code Mass. Regs.* § 9.02. [***39] In her final decision, the commissioner declined to adopt the hearing officer's finding of a lack of standing because of her conclusion that the plaintiffs' challenge failed on the merits.

So ordered.

**Exhibit 9 to West Roxbury Motion for
Rehearing: Eversource Map**

Access Northeast

A partnership of Spectra Energy, Eversource Energy, and National Grid involves expanding major pipelines that feed into New England.



- **Maritimes & Northeast Pipeline**
- **Algonquin Gas Transmission**

**Exhibit 10 to West Roxbury Motion for
Rehearing: LNG Article from Boston Globe**

gas imports for US

60 billion cubic feet

HIGH: Jan. 2010

50b

56.4b

50b

40b

30b

20b

10b

20b

10b

26.9b

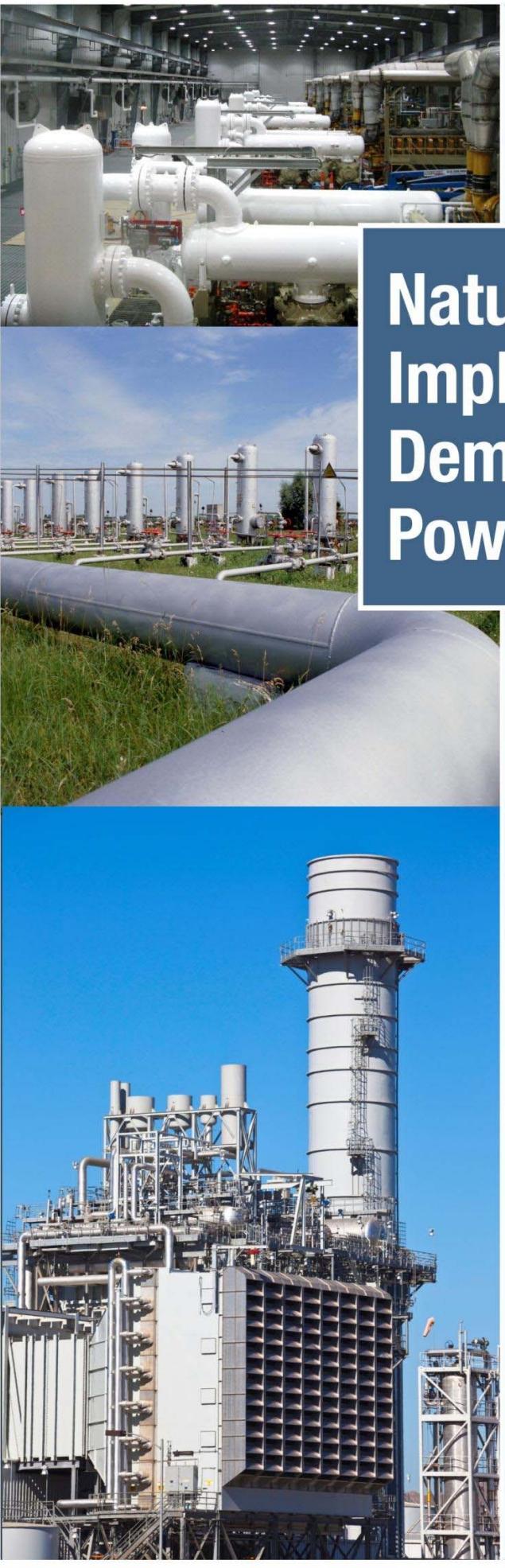
8b

Dec.
2014

Jan.
2009

'09 '10 '11 '12 '13 '14

**Exhibit 11 to West Roxbury Motion for
Rehearing: DOE Study**



U.S. DEPARTMENT OF ENERGY

Natural Gas Infrastructure Implications of Increased Demand from the Electric Power Sector

February 2015

U.S. DEPARTMENT OF
ENERGY

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Executive Summary

The natural gas sector in the United States has been fundamentally transformed by technological advancements in horizontal drilling and hydraulic fracturing that have enabled the economic extraction of natural gas from shale formations. This breakthrough has, in turn, unlocked new, geographically diverse natural gas resources that are unprecedented in size.

The availability of abundant, low-cost natural gas has increased demand for natural gas from multiple end-use sectors. In the electric power sector, which is currently the largest consumer of natural gas in the United States, the record-low natural gas prices during the month of April 2012 drove generation from natural gas to virtually match that of coal. While coal has regained some of its market share because of gradually rising natural gas prices, the combination of favorable economics and the lower conventional air pollution and greenhouse gas emissions associated with natural gas relative to other fossil fuels is likely to contribute to expanded use of natural gas in the electric power sector in the future.

However, increased use of natural gas in the electric power sector also presents some potential challenges. Unlike other fossil fuels, natural gas cannot typically be stored on-site and must be delivered as it is consumed. Because adequate natural gas infrastructure is a key component of electric system reliability in many regions, it is important to understand the implications of greater natural gas demand for the infrastructure required to deliver natural gas to end users, including electric generators.

The purpose of this study is to understand the potential infrastructure needs of the U.S. interstate natural gas pipeline transmission system under several future natural gas demand scenarios. Specifically, three scenarios were developed: a reference scenario and two scenarios with increased electric sector natural gas demand. Both increased demand scenarios—an Intermediate Demand Case and a High Demand Case—are based on a simple, illustrative national carbon policy applied to the electric power sector (not based on any real or proposed policy) that drives increased electric sector natural gas use. The Intermediate and High Demand Cases differ only in their underlying assumptions about coal-fired power plant retirements. In particular, the High Demand Case, which assumes greater coal-fired power plant retirements, is intended to be an upper-bound test case on natural gas consumption in the electric power sector.¹

To perform this analysis, the U.S. Department of Energy commissioned Deloitte MarketPoint to examine these scenarios in its North American Integrated Model (NAIM), which simultaneously models the electric power and the natural gas sectors.

¹ For a more detailed description of the scenarios considered in this analysis, see Section 2.3 Description of Scenarios.

The key findings of this analysis are the following:

Key Finding 1: Diverse sources of natural gas supply and demand will reduce the need for additional interstate natural gas pipeline infrastructure. The combination of a geographic shift in regional natural gas production—largely due to the expanded production of natural gas from shale formations—and growth in natural gas demand is projected to require expanded natural gas pipeline capacity. However, the rate of pipeline capacity expansion in the scenarios considered by this analysis is lower than the historical rate of natural gas pipeline capacity expansion. Pipeline capacity additions in the cases considered here are projected to be 38–42 billion cubic feet per day (Bcf/d) between 2015 and 2030. In comparison, between 1998 and 2013, nearly 127 Bcf/d of pipeline capacity was added in the United States. Because projected natural gas production and demand are geographically diverse, the need for additional interstate natural gas pipeline infrastructure is lower than would be expected if the increased production or demand were concentrated in a particular region. Furthermore, recent pipeline capacity additions that were placed in service between 2007 and the present in order to realign the U.S. natural gas transmission system with changing supply and demand conditions driven by increases in shale gas production are likely to reduce the need for future pipeline infrastructure.

Key Finding 2: Higher utilization of existing interstate natural gas pipeline infrastructure will reduce the need for new pipelines. The U.S. pipeline system is not fully utilized because flow patterns have evolved with changes in supply and demand. Increased demand for natural gas in the scenarios considered by this analysis does not lead to larger increases in pipeline capacity because, in some regions, available existing pipeline capacity is projected to be used before expanding existing pipelines or building new capacity. Given the cost of building new pipelines, finding alternative routes that utilize available existing pipeline capacity is often less costly than expanding pipeline capacity. While seasonality of demand requires pipelines to accommodate peak natural gas demand, the incremental demand from new base load natural gas generation in the scenarios considered in this analysis tends to be relatively uniform across the year. It is easier to accommodate this relatively uniform incremental natural gas demand on existing pipelines than it would be to accommodate demand that coincides more strongly with peak demand.

Key Finding 3: Incremental interstate natural gas pipeline infrastructure needs in a future with an illustrative national carbon policy are projected to be modest relative to the Reference Case. While a future carbon policy may significantly increase natural gas demand from the electric power sector, the projected incremental increase in natural gas pipeline capacity additions is modest relative to the Reference Case. In the Intermediate Demand Case, an incremental 1.4 Bcf/d (about 4% of total Reference Case capacity additions of 38 Bcf/d) of additional pipeline capacity above Reference Case levels is projected to be built. Similarly, in the High Demand Case, an incremental 3.9 Bcf/d (10% of total Reference Case capacity additions of 38 Bcf/d) of additional pipeline capacity above Reference Case levels is projected to be built. These relatively modest incremental additions follow from the system characteristics described previously and from the pipeline infrastructure attributes of the sources of incremental natural gas supply across the cases.

Key Finding 4: While there are constraints to siting new interstate natural gas pipeline infrastructure, the projected pipeline capacity additions in this study are lower than past additions that have accommodated such constraints. Siting energy infrastructure in the United States is a complex, multi-jurisdictional, and multidimensional process, with no two projects facing the same set of issues. While these barriers present potential challenges to expanding U.S. natural gas infrastructure, the Federal Energy Regulatory Commission (FERC) has authorities to facilitate siting of natural gas pipeline infrastructure. Similarly, while there are a number of institutional and other barriers to siting infrastructure and coordinating the natural gas and electric systems, there are multiple processes underway to address these issues. In addition, the projected pipeline capacity additions in this study (ranging from 38 to 42 Bcf/d across the cases from 2015 to 2030) are lower than past additions (127 Bcf/d of pipeline capacity was added from 1998 to 2013) that have accommodated siting constraints. However, if siting energy infrastructure becomes more or less challenging in the future, the level of effort needed to site the pipeline capacity additions projected in this analysis could increase or decrease.

1. Introduction

1.1 Purpose of This Study

Over the past decade, natural gas production in the United States has undergone a revolution. The combination of hydraulic fracturing and horizontal drilling technology has allowed economic access to enormous quantities of natural gas from shale formations. As a result, in 2013, the United States became the world's largest producer of hydrocarbons.² This development has had and will likely continue to have significant consequences for the broader economy. The impact of abundant, low-cost natural gas is particularly important in the electric power sector. During the month of April 2012, electricity generation from natural gas-fired plants virtually matched generation from coal-fired plants.³ While coal has regained some of its market share because of gradually rising natural gas prices, growth in natural gas generation is projected to continue in the future.⁴

Increased use of natural gas in electric generation presents some potential challenges. While coal can typically be stored on-site at power plants, natural gas must be delivered as it is used.⁵ Because adequate natural gas infrastructure is a key component of electric system reliability in many regions, it is important to understand the implications of greater natural gas demand for the infrastructure required to deliver natural gas to end users, including electric generators.

The United States has more than 217,000 miles of interstate natural gas pipelines to deliver natural gas from producing regions to end users.⁶ However, the continued development of natural gas from shale formations, which tend to be situated outside of traditional natural gas producing regions, will require new pipeline infrastructure and/or the repurposing of existing infrastructure.

The purpose of this study is to understand the potential infrastructure needs of the natural gas pipeline system under several future natural gas demand scenarios. Specifically, three scenarios were developed: a reference scenario and two scenarios with increased electric sector natural gas demand. Both increased demand scenarios—an Intermediate Demand Case and a High Demand Case—apply a simple, illustrative carbon policy to the U.S. electric power sector (not based on any real or proposed policy) that drives increased electric sector natural gas use. These cases differ only in their underlying

² U.S. Energy Information Administration, "Total Oil Supply (Thousand Barrels Per Day)," International Energy Statistics, <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=5&pid=53&aid=1>; U.S. Energy Information Administration, "Dry Natural Gas Production (Billion Cubic Feet)," International Energy Statistics, accessed September 24, 2014, <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=26&aid=1>.

³ U.S. Energy Information Administration, "Net generation for United States, monthly," Electricity Data Browser, accessed September 24, 2014, <http://www.eia.gov/electricity/data/browser/#/topic/0?agg=0,1,2&fuel=pe&geo=g&sec=g&freq=M&start=200701&end=201204&charted=3-5-7-9-11>.

⁴ U.S. Energy Information Administration, "Table 8. Electricity Supply, Disposition, Prices, and Emissions," *Annual Energy Outlook 2014*, May 7, 2014, accessed September 24, 2014, http://www.eia.gov/forecasts/aoe/excel/aeotab_8.xlsx.

⁵ Some natural gas power plants also have the ability to operate on alternatives to pipeline-delivered natural gas, such as fuel oil and local stores of liquefied natural gas (LNG) or liquefied petroleum gas (LPG). In addition, note that potential deliverability challenges for coal have also been documented. For example, see: U.S. Energy Information Administration, "Coal stockpiles at coal-fired power plants smaller than in recent years," Today in Energy, November 6, 2014, accessed November 12, 2014, <http://www.eia.gov/todayinenergy/detail.cfm?id=18711>.

⁶ U.S. Energy Information Administration, "Estimated Natural Gas Pipeline Mileage in the Lower 48 States, Close of 2008," accessed October 23, 2014, http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/ngpipeline/mileage.html.

assumptions about coal-fired power plant retirements. In particular, the High Demand Case, which assumes greater coal-fired power plant retirements, is intended to be an upper-bound test case on natural gas consumption in the electric power sector.

1.2 Recent Developments in the U.S. Natural Gas Sector

The United States has an extensive natural gas infrastructure that efficiently produces, stores, and transports natural gas from producing fields to end users. The United States is the largest consumer of natural gas in the world, and with the recent growth in shale gas production, the United States is also now the world's largest natural gas producer.⁷ As shown in Figure 1, pipelines originate in supply regions and transport natural gas to major market regions as well as to smaller markets throughout the country. While most pipelines are relatively short (several hundred miles or less), some major transmission pipelines stretch over a thousand miles. For example, the Transcontinental (Transco) pipeline, connecting Texas and Louisiana supplies to Mid-Atlantic markets, and the Rockies Express (REX) pipeline, connecting Colorado and Wyoming supplies to Ohio and eastern markets, are both about 1,700 miles long.

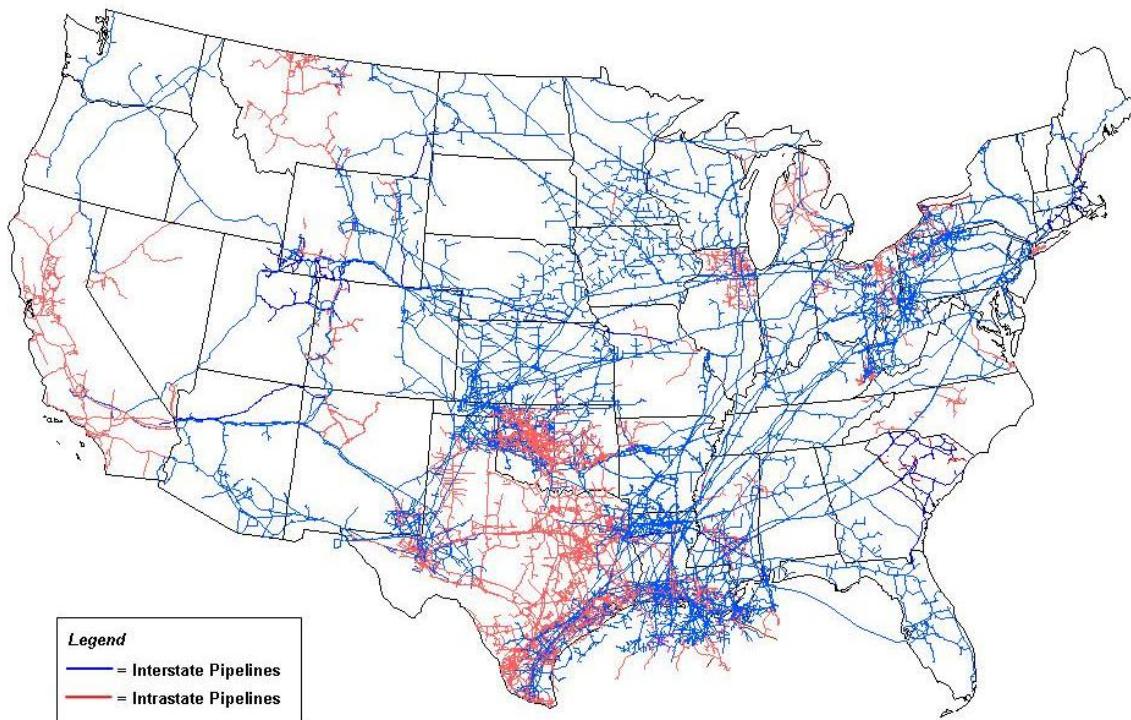


Figure 1: U.S. Natural Gas Pipeline System⁸

Because pipelines are not moved once they are built, new pipelines or modifications to existing pipelines are required when production in a supply basin grows and reaches pipeline takeaway capacity constraints out of the region, or when demand in a market area grows to exceed the pipeline system

⁷ U.S. Energy Information Administration, "Dry Natural Gas Production (Billion Cubic Feet)," International Energy Statistics, accessed September 24, 2014, <http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=3&pid=26&aid=1>.

⁸ U.S. Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System.

capacity to deliver into the region. For example, during the previous decade, rapid growth in Rockies natural gas production gave rise to the REX pipeline, which transports natural gas produced in the region to markets in the East. Similarly, rapid natural gas demand growth in Florida prompted construction of the Gulfstream pipeline and numerous expansions of the Florida Gas Transmission pipeline so that natural gas produced in the Gulf region could be delivered to consumers in Florida.

The most prolific shale gas basin in the United States is the Marcellus, with the prime fields located in Pennsylvania and West Virginia. The growth in Marcellus shale gas production has had a major impact on the flow of natural gas throughout the United States. Natural gas that was once imported from other states into eastern markets has been increasingly displaced by Marcellus production. While pipeline capacity connecting Marcellus producing fields to either natural gas markets or interconnections to existing pipelines has been added, some natural gas production has yet to be connected, because pipeline takeaway capacity is still limited.

1.3 Economics of Natural Gas Transmission

New natural gas pipeline development is driven by market supply and demand, which expresses itself in the form of basis differential, or the difference in natural gas prices between two locations or “hubs.”

Basis differentials provide an incentive for prospective pipeline shippers (the party that wants to transport natural gas) to request that a pipeline company (the party that develops and/or owns the pipeline, often referred to as the “operator”) construct new pipeline capacity and enter into long-term contracts for firm pipeline transportation service sufficient to enable the pipeline operator to proceed with the project.⁹ Effectively, such an agreement enables the operator to have confidence that a significant share of the project’s development, construction, financing, and operating costs will be recoverable from shippers. Once a new natural gas pipeline is constructed, the shipper can rely on its contract for firm transportation service to capture the resulting basis differential.¹⁰ Basis differentials, and how the captured revenues compare to the cost of constructing pipelines, largely determine how much and in which locations pipeline capacity is likely to be added.¹¹

⁹ Shippers may be gas marketers or other entities, such as local distribution companies that contract for transportation service in order to gain access to supply to serve retail customers. Also, pipeline operators typically do not own upstream natural gas assets but instead generate revenue by offering pipeline capacity to shippers. In 1992, the Federal Energy Regulatory Commission issued Order Number 636, “Restructuring of Interstate Natural Gas Pipeline Services (Final Rule).” Order Number 636 fundamentally altered the manner in which pipeline operators conducted business by requiring pipeline companies to sell natural gas transportation, storage, and other services separately (often referred to as “unbundling”), and enabled all participants in the U.S. natural gas market to buy, sell, or trade natural gas with any other market participant. For more details, see <http://www.ferc.gov/legal/maj-ord-reg/land-docs/restruct.asp>. Note also that natural gas may be contracted on a firm, or uninterrupted, basis. Firm transportation service is backed by an agreement that typically binds both parties to the agreement to either deliver or receive the quantity of natural gas specified in the agreement. Firm service has priority over interruptible service and cannot be curtailed during periods of high demand.

¹⁰ Note also that while requests for firm transportation service by shippers effectively drive new pipeline expansion, these shippers may make available transportation service to others in the secondary or resale markets once the pipeline is fully constructed and operating.

¹¹ Changes in other sectors, such as electricity, may further change the supply and demand conditions within natural gas markets. These changes may, in turn, affect basis differentials and the resulting incentives for natural gas pipeline infrastructure development.

The cost of constructing pipelines can be significant. For example, the 1,698-mile-long REX pipeline, which has a capacity of 1.8 billion cubic feet per day (Bcf/d), cost approximately \$5 billion to construct.¹² In order for the economics of the pipeline to be favorable, the natural gas flowing through the pipeline must generate sufficient revenue over its operating lifetime to justify the upfront capital investment.

Revenue and/or cost recovery for pipeline shippers depends on the demand for natural gas, which is highly seasonal, particularly in the East. Moreover, pipeline shippers sometimes capture high value for short durations, often during peak periods, when increased demand, coupled with transmission constraints, causes basis differentials to rise. For example, the “polar vortex,” which occurred during the winter of 2013–2014 and plunged the Mid-Atlantic, Northeast, and Southeast into a deep freeze, highlights how pipeline transmission constraints can cause price spikes in transmission-constrained markets. In fact, even during normal years in regions served by limited pipeline capacity, significant transmission constraints can last for weeks. However, while price spikes and temporary transmission constraints associated with extreme weather events can have significant impacts on natural gas consumers, a price spike may or may not provide sufficient revenue to justify additional infrastructure investment.

1.4 Institutional Considerations

Siting energy infrastructure in the United States is a complex, multi-jurisdictional, and multidimensional process, with no two projects facing the same set of issues. While these barriers present potential challenges to expanding U.S. natural gas infrastructure, the Federal Energy Regulatory Commission (FERC) has authorities to facilitate siting of natural gas pipeline infrastructure. Specifically, under the Natural Gas Act (NGA), FERC has authority to regulate the interstate transmission and certain sales for resale of natural gas.¹³ Central to resolving siting and cost allocation issues, FERC also possesses authority to grant the right of eminent domain for the construction of pipelines, and under Section 7 of the NGA, FERC can issue a certificate of public convenience and necessity to allow pipeline operators to recover expenses associated with pipeline construction and operation.

The combination of technical change, fundamental economic drivers, and related institutional considerations explain the history of pipeline capacity additions in the United States. Figure 2 depicts total U.S. pipeline capacity additions and construction expenditures by year in which pipelines were or are expected to be placed in service.¹⁴ There has been significant investment in new interstate pipeline capacity over the last 18 years for which data are available, with more than 133 Bcf/d of capacity additions and \$65 billion in capital expenditures. The pipeline expenditures in Figure 2 do not follow a smooth path over time; major projects, such as the REX pipeline, which placed sections of the pipeline into service in 2008 and 2009, result in total expenditures for a particular year that exceed the long-run

¹² Scott Parker, “Natural Gas Pipelines,” Kinder Morgan Energy Partners, L.P., accessed September 24, 2014, http://www.kindermorgan.com/content/docs/2008_Analysts_Conf_02_Natural_Gas_Pipelines.pdf.

¹³ U.S. Energy Information Administration, “Natural Gas Act of 1938,” accessed September 24, 2014, http://www.eia.doe.gov/oil_gas/natural_gas/publications/ngmajorleg/ngact1938.html.

¹⁴ The data in Figure 2 reflect both the capacity and cost associated with constructing new pipelines as well as adding capacity to existing pipelines. In addition, the data account for the capacity and cost associated with reversing flows in existing pipelines.

average. Recent growth in natural gas production from shale formations has spurred new growth in pipeline construction because many large shale deposits are located outside of regions with a history of natural gas production and therefore lack the associated infrastructure. As such, the majority of expenditures for pipelines placed in service from 2010 through 2013 were for projects designed to transport shale gas.

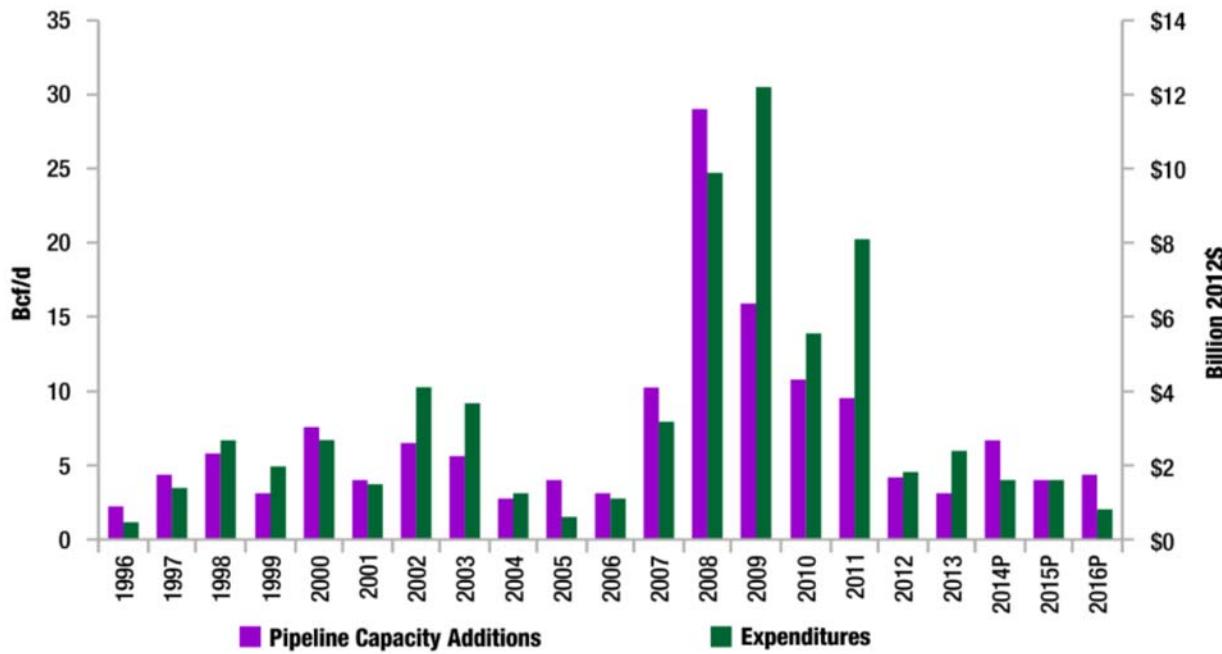


Figure 2: Interstate Pipeline Capacity Additions and Capital Expenditures by Year in Service¹⁵

¹⁵ U.S. Energy Information Administration, "U.S. natural gas pipeline projects," July 1, 2014, accessed September 24, 2014, <http://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xls>. Years 2014–2016 are additions reported as planned.

2. Model Description, Limitations, and Scenarios

2.1 Model Description

This study uses the Deloitte MarketPoint North American Integrated Model (NAIM) to analyze the interaction between electric power and natural gas markets in North America.¹⁶ NAIM includes detailed and comprehensive electricity and natural gas market models. Each sectoral model includes disaggregated representations of supply, infrastructure, and demand by geographic region within North America. These two sectoral models are then integrated both geographically and temporally to produce a comprehensive and self-consistent set of results across both markets.

NAIM applies microeconomic theory to solve for market-clearing prices and quantities simultaneously across multiple markets, multiple commodities, and multiple time steps. It performs fundamental market analysis of supply and demand within each region and their dynamic interactions. The model uses monthly time steps over a 30-year time horizon, but the electricity model further disaggregates the monthly time steps to more accurately represent load duration curves in each region.

On the natural gas side of NAIM, the model represents natural gas producer decisions regarding the timing and quantity of reserves to add, given producers' resource endowments, the cost to bring production online, and anticipated forward prices. Within the model, there are about 40 natural gas supply regions in the United States. The model uses depletable resource economics to compute a resource production schedule that maximizes profit, given endogenously projected wellhead prices. Under this approach, today's drilling affects tomorrow's natural gas prices and, conversely, expectations about tomorrow's natural gas prices affect today's drilling.

NAIM also represents the existing interstate pipeline system by pipeline segment. The model builds additional pipeline capacity when it is economic, given the computed supply-demand dynamics as well as infrastructure constraints and costs. Specifically, the model builds pipeline capacity if the basis differential across a new pipeline would be large enough to cover pipeline variable costs and recovery of upfront capital costs for expansion, while providing a sufficient rate of return. That is, the volume of natural gas flows over time must deliver sufficient after-tax margins to justify the cost of expansion.

The model input that determines the cost of expansion is the overnight capital cost.¹⁷ Estimates of capital cost are derived from the cost of actual pipeline projects. For example, a 1 Bcf/d pipeline expansion that costs \$500 million would have a capital cost of \$1.37 per million cubic feet (Mcf) of

¹⁶ For more details on the Deloitte MarketPoint North American Integrated Model, see: Deloitte MarketPoint, *Deloitte MarketPoint*, 2011, http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/us_er_marketpoint_marketbuilder011411.PDF. The results are solely for informational purposes and are not intended to be predictions of events or future outcomes. Deloitte MarketPoint is not, by means of this publication, rendering accounting, business, financial, investment, legal, tax, or other professional advice or services to any person. Deloitte MarketPoint shall not be responsible for any loss sustained by any person who uses or relies on this publication.

¹⁷ The overnight capital cost is the cost at which a unit could be constructed, assuming that the entire process from planning through completion could be accomplished in a single day. It does not include related financing costs (cost of capital) and does not reflect potential changes in cost over the actual period during which the capacity would be constructed.

annual transmission capacity. The cost of each additional Mcf of expansion for a specific pipeline segment is assumed to be constant in the model.¹⁸

To represent natural gas demand for the residential, commercial and industrial sectors, the model applies growth rates by sector and region derived from the U.S. Energy Information Administration's (EIA's) *Annual Energy Outlook 2014* (AEO 2014) Reference Case to historical state-level demand data. Demand for natural gas from these sectors is assumed to be responsive to changes in natural gas prices over time. Demand for natural gas from the electric power sector is determined endogenously by NAIM, which computes fuel use based on competition between different types of power generation.

More specifically, on the electricity side of NAIM, the model contains a representation of the North American electricity system, including electric generation assets, bulk transmission between regions, and load patterns. NAIM projects prices, generation mix, associated fuel use, and environmental emissions for North American power markets. The geographic scope encompasses all areas under the jurisdiction of the North American Electric Reliability Corporation (NERC), which includes portions of Canada and Northern Baja Mexico, as well as all of the lower 48 United States.¹⁹ Within NAIM there are a total of 76 electricity balancing regions.

Electric generating capacity additions are largely endogenous, with some planned and other capacity additions specified exogenously, while all capacity retirements are specified exogenously. NAIM uses technology cost and performance assumptions similar to those assumed in EIA's AEO 2014 Reference Case. Electric transmission capacity additions are specified exogenously, and NAIM's total electric load projection is based on the AEO 2014 Reference Case.²⁰

Finally, the representation of inter-commodity linkages allows the model to project how an illustrative national carbon policy might affect each regional electricity market, which in turn affects the natural gas market. Integrating the markets for natural gas and electricity within the model is important because future U.S. natural gas demand growth is projected to be largely driven by the electric power sector.

2.2 Modeling Limitations

This analysis assumes rational economic behavior with perfect foresight, but a variety of barriers may lead to outcomes that differ from those projected by this analysis. Real-world markets may overbuild or underbuild infrastructure in anticipation of future demand and prices. For example, by 2006, FERC had received 43 applications to construct new U.S. liquefied natural gas (LNG) import terminals, and a total of 11 facilities were ultimately built in anticipation of a large increase in LNG imports that never

¹⁸ The model also accounts for the costs associated with adding capacity to existing pipelines through expansions and looping (adding a new pipeline running parallel to an existing pipeline). In addition, the model accounts for the costs associated with reversing flows in existing pipelines. For example, in June 2014, a portion of the Rockies Express Pipeline, which was originally constructed to bring natural gas from the Rocky Mountain region to eastern markets, was reconfigured to allow natural gas produced in the Marcellus and Utica shale basins to be transported to midwestern markets. See U.S. Energy Information Administration, "First westbound natural gas flows begin on Rockies Express Pipeline," Today in Energy, June 18, 2014, accessed October 22, 2014, <http://www.eia.gov/todayinenergy/detail.cfm?id=16751>.

¹⁹ For details, see Appendix A.1 Map of Electric Power Sector Natural Gas Demand Regions.

²⁰ U.S. Energy Information Administration, "Market Trends: Electricity demand," *Annual Energy Outlook 2014*, May 7, 2014, accessed October 1, 2014, http://www.eia.gov/forecasts/aeo/MT_electric.cfm. Total electric generation in NAIM is, on average, approximately 0.8% lower than AEO 2014 Reference Case levels over the projection period.

materialized.²¹ The approach taken in this study does not try to anticipate suboptimal actions. While real-world markets do not always perfectly align supply and demand, it is difficult to determine a credible way to anticipate potential future market disequilibrium.

In addition, interstate pipeline capacity additions in the model are presumed to use the most efficient routing, regardless of ownership. Full access to pipeline segments is assumed for both the utilization of existing capacity and future capacity additions. As such, the model is limited in its ability to account for the potential cost of barriers facing many interstate natural gas pipeline projects, including siting and permitting challenges as well as cost allocation and cost recovery issues.²²

As discussed later in this report, the amount of new interstate natural gas pipeline capacity projected in the scenarios considered in this analysis between 2015 and 2030 (38–42 Bcf/d) is considerably lower than the amount of new capacity added for the historical period between 1998 and 2013 (127 Bcf/d). Because this historical capacity was constructed in a market and regulatory environment prone to the siting, permitting, and cost recovery issues described previously, it is reasonable to conclude that a smaller amount of total capacity (such as that projected in the Reference Case, Intermediate Demand Case, and High Demand Case) could be constructed in the future in a similar market and regulatory environment. However, if siting energy infrastructure becomes more or less challenging in the future, the level of effort needed to site the pipeline capacity additions projected in this analysis could increase or decrease.

Moreover, in the near term, all three scenarios in this analysis project relatively modest interstate pipeline capacity additions (2.2–2.7 Bcf/d annually between 2015 and 2020). Increased production from shale and other geographically diverse sources of natural gas as well as geographic diversity in the sources of natural gas demand have significantly reduced the need for additional construction of interstate natural gas pipeline infrastructure. Projected near-term pipeline capacity additions are smaller than the annual average additions over the last five years for which data are available (8.8 Bcf/d annually between 2009 and 2013) and also smaller than the average annual capacity additions reported

²¹ Bipartisan Policy Center, National Commission on Energy Policy, *Siting Critical Energy Infrastructure: An Overview of Needs and Challenges*, June 2006, 33, http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/Siting%20Critical%20Energy%20Infrastructure_448851db5fa7d.pdf; Federal Energy Regulatory Commission, “Existing FERC Jurisdictional LNG Import/Export Terminals,” April 19, 2012, accessed October 23, 2014, <http://www.ferc.gov/industries/gas/indus-act/lng/exist-term.asp>.

²² Independent system operators (ISOs), state governments, and FERC are actively working to improve natural gas system deliverability and reliability in organized electricity markets. Policy changes underway include modifications to ISO forward capacity market incentives to better align resource performance and flexibility, FERC’s proposed reforms to improve the coordination and scheduling of natural gas pipeline capacity with electricity markets, and a New England States Committee on Electricity (NESCOE, an organization comprising representatives appointed by six New England governors) proposal to expand natural gas pipeline capacity and electric transmission capacity in New England. Selected examples include: FERC, “Coordination of the Scheduling Processes of Interstate Natural Gas Pipelines and Public Utilities,” Notice of Proposed Rulemaking, March 20, 2014, <http://www.ferc.gov/whats-new/comm-meet/2014/032014/M-1.pdf>; NESCOE, “New England Governors’ Commitment to Regional Cooperation on Energy Infrastructure Issues,” December 6, 2013, http://nescoe.com/uploads/New_England_Governors_Statement-Energy_12-5-13_final.pdf; PJM Interconnection, “PJM Capacity Performance Updated Proposal,” October 7, 2014, <http://pjm.com/~media/documents/reports/20141007-pjm-capacity-performance-proposal.ashx>; and ISO New England, “Potential Changes in the Forward Capacity Market (FCM) in New England,” October 20, 2014, http://www.iso-ne.com/static-assets/documents/2014/11/03_fcm101_oct_2014_potential_fcm_changes.pdf.

as planned for the years 2014–2016 by EIA (5.1 Bcf/d annually).²³ Taken together, these comparisons suggest that the rate of near-term and medium-term pipeline capacity expansion projected by this analysis is consistent with the rate of both historical and planned capacity expansion.

Projections in this study are also limited by the spatial and temporal resolution of the model. The monthly time resolution in the model may not identify interstate pipeline constraints that reflect peak demand days or shorter time intervals. Moreover, these projections will not capture most future *intrastate* pipeline capacity additions (as opposed to *interstate* pipeline capacity additions). Increased natural gas demand will likely also require new, smaller pipelines (known as laterals) to connect new electric power sector generation. Laterals are difficult to represent because they depend on the precise locations of any new electric generating capacity that is built. Similarly, the model represents the pipeline gathering system as part of an integrated natural gas gathering and processing system within each basin, so natural gas gathering pipeline additions are not explicitly modeled. However, these limitations are not likely to affect the conclusions about interstate natural gas pipeline infrastructure.

Finally, the model computes optimal natural gas storage dispatch based on projected monthly prices and storage operating parameters. The model does not endogenously determine future storage capacity, and storage capacity is held constant in the model.²⁴ This study also does not address how greater natural gas demand may affect the need for high-deliverability storage, which becomes important at time scales shorter than the monthly time resolution of the model, and is often used by natural gas electric power generators. However, none of these assumptions is likely to affect the conclusions about interstate natural gas pipeline infrastructure. In fact, the lack of natural gas storage additions in this study could place more pressure on the natural gas transmission system than would be the case if storage expansion were explicitly represented, consistent with the intention to create an upper-bound test case.

2.3 Description of Scenarios

In order to analyze the potential impact of increased demand from the electric power sector, this report examines three scenarios: a “Reference Case” with no national carbon policy, an “Intermediate Demand Case” with an illustrative national carbon policy applied to the electric power sector, and a “High Demand Case” with an illustrative national carbon policy applied to the electric power sector and accelerated coal-fired power plant retirements. The cases are described in Figure 3.

²³ Planned projects include projects that have been publicly announced, projects that have applied for or have received FERC approval, and projects that are under construction.

²⁴ Total U.S. natural gas underground storage capacity grew at an average annual rate of 1.2% from 2008 to 2013. See: U.S. Energy Information Administration, “U.S. Total Underground Natural Gas Storage Capacity,” September 30, 2014, accessed October 9, 2014, <http://www.eia.gov/dnav/ng/hist/n5290us2a.htm>.

Case Name	Case Description
1. Reference Case	Reference Case with no national carbon policy
2. Intermediate Demand Case	Nationally uniform carbon policy (illustrative) applied to the Reference Case
3. High Demand Case	Nationally uniform carbon policy (illustrative) applied to the Reference Case, with accelerated coal-fired power plant retirements

Figure 3: Cases Analyzed

The Reference Case does not include an illustrative national carbon policy, but it does include existing state renewable energy portfolio standards as well as regional greenhouse gas emissions policies, such as the Regional Greenhouse Gas Initiative (RGGI) in the Northeast and Mid-Atlantic and the California Global Warming Solutions Act (AB32).²⁵ In the Reference Case, approximately 25 gigawatts (GW) of coal capacity are retired after 2014. These retirements have been publicly announced and are imposed exogenously in the model.

In the increased demand cases, an illustrative carbon policy was applied nationally beginning in the year 2020 at a price of about \$32 (2012\$) per metric ton of CO₂, increasing at a rate of 5% per year in real terms. This pathway matches EIA's AEO 2014 \$25 Carbon Price side case from 2020 onwards. This illustrative national carbon policy is not intended to represent any actual or proposed policy, but instead is used as a means to drive growth in electric power sector natural gas demand, and consequently in natural gas infrastructure.

In the Intermediate Demand Case, coal-fired power plant retirements are assumed to follow the trajectory in the Reference Case. In other words, no additional retirements beyond those already announced occur. However, in such a policy scenario, coal-fired power plants for which no announcements have been made to date could in fact retire prior to 2030, which in turn would require additional generation from other sources, including natural gas.

To analyze this, a High Demand Case was also modeled. In this case, all coal-fired power plants that lacked scrubber-type emissions controls as of the first quarter of 2014 are assumed to retire in 2017. This assumption results in an incremental reduction of 104 GW of coal-fired capacity beyond the 25 GW of capacity that retires in the Reference and Intermediate Demand Cases. Just as some units that have not yet publicly announced a decision to retire may in fact eventually retire, it is likely that some uncontrolled units will be economic to retrofit and will continue to operate after 2017.

This analysis focuses specifically on the sensitivity of the interstate natural gas pipeline infrastructure to varying levels of electric power sector natural gas demand. Additional scenarios would be needed to characterize a broader range of possible natural gas futures. For example, future work might consider alternative natural gas supply assumptions (such as the size of the natural gas resource base or the rate of technology advances that affect drilling cost and/or drilling productivity) that could result in natural

²⁵ Existing federal production tax credits and investment tax credits for renewable energy sources are assumed to be expired in all of the cases considered in this analysis.

gas supply that is higher or lower than Reference Case levels. Similarly, future work might consider scenarios in which energy efficiency or conservation is significantly deployed to meet end-user demand, or scenarios with alternative assumptions about future industrial or transportation natural gas demand.

3. Model Results

3.1 Natural Gas Demand

In the Reference Case, total U.S. natural gas demand is projected to grow steadily and reach about 76 Bcf/d by 2030, an 18% increase from 2015 levels.²⁶ Reference Case demand in 2030 is close to EIA's AEO 2014 Reference Case level of approximately 80 Bcf/d.²⁷ Figure 4 shows natural gas demand by sector in the Reference Case.

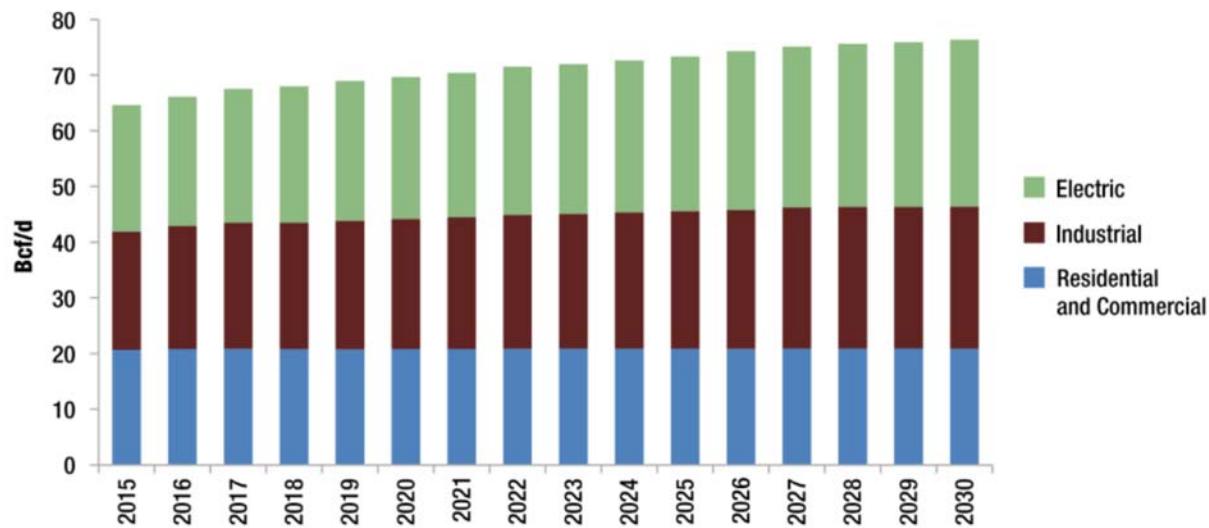


Figure 4: Reference Case Total U.S. Natural Gas Demand by Sector, 2015 to 2030

One of the implications of increased natural gas production from shale formations is that the United States is now an attractive source of LNG for global buyers. The Reference Case projects about 5.1 Bcf/d of U.S. LNG exports by 2020.²⁸ The volume of U.S. LNG exports in the model is determined by Deloitte MarketPoint's World Gas Model, which computes the competitiveness of U.S. LNG exports in global markets based on projections of the domestic price of natural gas, the cost of building LNG liquefaction terminals, the cost of transportation and liquefaction, and the price and demand for natural gas in foreign markets.²⁹ Given these conditions, the model determines whether the capital investment would be recovered. The model's estimate of LNG export volumes is based purely on underlying economics

²⁶ The model output presented in Figure 4 does not include natural gas used at the production site, volumes used in processing, pipeline use and losses, or natural gas exports.

²⁷ U.S. Energy Information Administration, "Table 13. Natural Gas Supply, Disposition, and Prices," *Annual Energy Outlook 2014*, May 7, 2014, accessed September 24, 2014, http://www.eia.gov/forecasts/aoe/excel/aeotab_13.xlsx.

²⁸ For comparison, the U.S. Energy Information Administration's *Annual Energy Outlook 2014* projects 5.7 Bcf/d of LNG exports by 2020. See: U.S. Energy Information Administration, "Table 134. Natural Gas Imports and Exports," *Annual Energy Outlook 2014*, May 7, 2014, accessed September 29, 2014, http://www.eia.gov/forecasts/aoe/suptab_134.xlsx.

²⁹ For more details on the Deloitte MarketPoint World Gas Model, see: Deloitte MarketPoint, *Deloitte MarketPoint*, http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/us_er_marketpoint_marketbuilder011411.PDF.

and does not capture purchase decisions of LNG consumers who are willing to pay above market prices in order to diversify their LNG acquisition portfolios.³⁰

In general, under an illustrative national carbon policy, a shift away from more carbon-intensive generation such as coal to lower-carbon generation such as natural gas and to zero-carbon options such as nuclear, renewables, and energy efficiency would be expected. Because this study examines the impacts of an illustrative national carbon policy on the natural gas pipeline system, this section will focus on the impact of these two scenarios on electric power sector natural gas demand. See Appendix B. Electric Power Sector Results for additional electric power sector results.

Figure 5 compares electric power sector natural gas demand across the cases. In the Intermediate Demand Case, electric power sector natural gas demand increases by about 7.5 Bcf/d (about 25%) in 2030 relative to the Reference Case. In the High Demand Case, electric power sector natural gas demand increases by about 14 Bcf/d (about 46%) in 2030 relative to the Reference Case.³¹

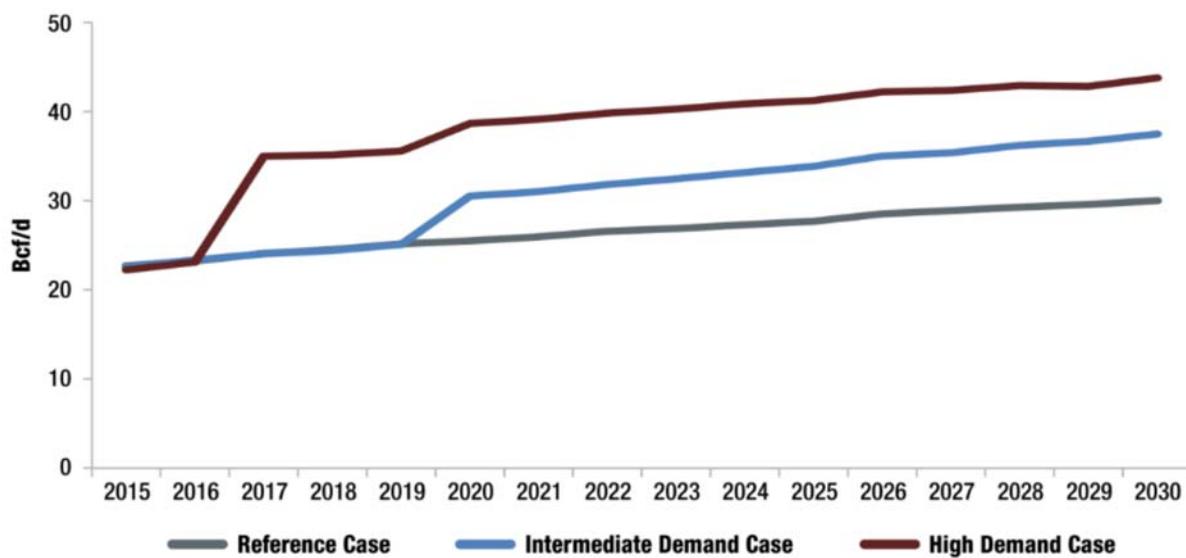


Figure 5: Electric Power Sector Natural Gas Demand across the Cases, 2015 to 2030

Figure 6 shows electric power sector natural gas demand by region in the Reference Case (for a description of regions, see Appendix A.1 Map of Electric Power Sector Natural Gas Demand Regions).

³⁰ In order to test the sensitivity to alternative assumptions about U.S. LNG export volumes, an additional case was run with approximately 10 Bcf/d of LNG exports by 2022. The pipeline capacity additions projected in this case are not significantly different from those projected in the Reference Case.

³¹ These increases are equivalent to 10% and 18%, respectively, of total natural gas demand in 2030 in the Reference Case.

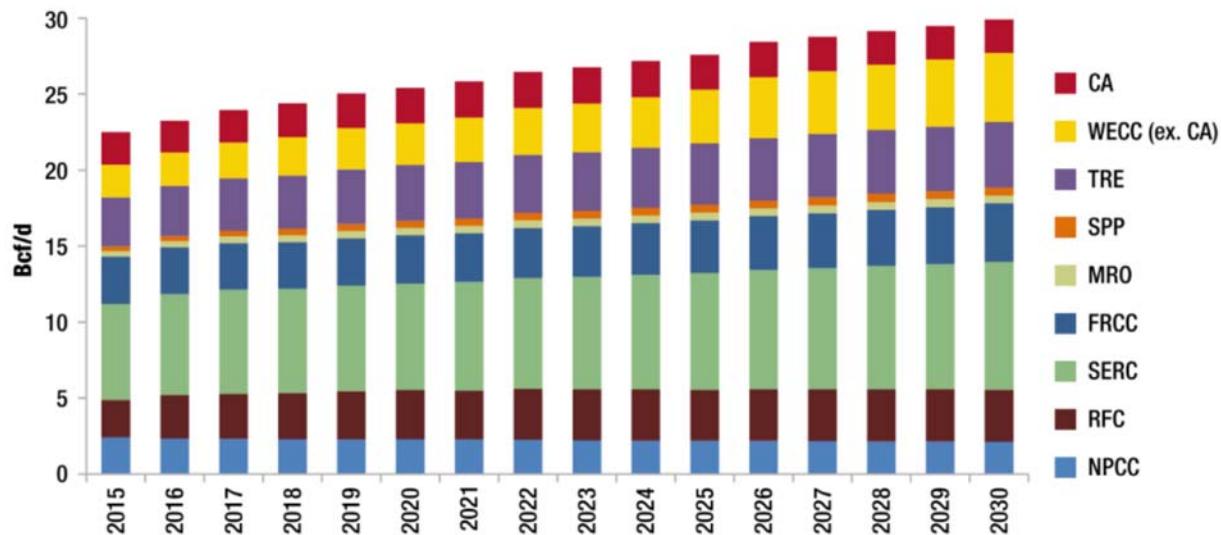


Figure 6: Reference Case Electric Power Sector Natural Gas Demand by Region, 2015 to 2030

The incremental change in electric power sector natural gas demand between the Intermediate Demand Case and the Reference Case is shown in Figure 7. Positive values are increases relative to the Reference Case, while negative values are decreases. The electric power sector natural gas demand results are consistent with the electric power sector generation results presented in Appendix B. Electric Power Sector Results. Nearly all regions see an increase in electric power sector natural gas demand once the illustrative national carbon policy is applied in 2020, as natural gas-fired generation replaces generation from coal-fired units. However, regions in which coal-fired generation is replaced with a greater amount of renewable power, such as MRO and SPP, do not demand as much incremental natural gas as other regions.

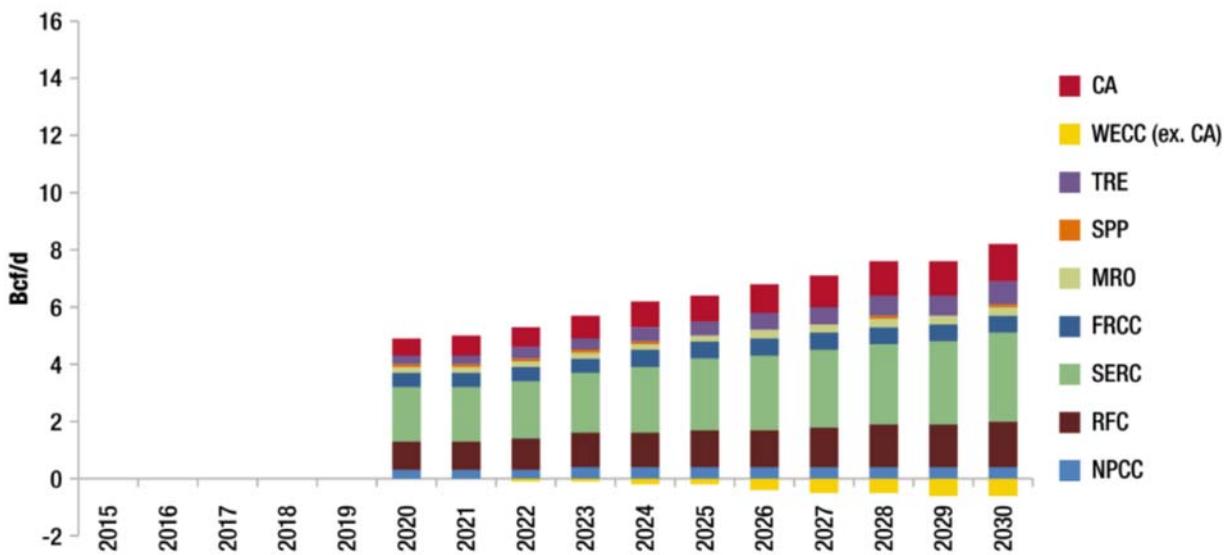


Figure 7: Intermediate Demand Case Electric Power Sector Natural Gas Demand Relative to the Reference Case, 2015 to 2030

Figure 8 shows the change in electric power sector natural gas demand in the High Demand Case relative to the Reference Case. In this modeling framework, the greater number of coal plant retirements assumed in this scenario results in greater natural gas-fired generation and, in turn, greater natural gas demand in the electric power sector. This increase in natural gas demand also begins earlier, reflecting the assumption about the timing of coal-fired power plant retirements.

In the WECC (excluding CA) region, power sector natural gas demand declines in the Intermediate Demand Case (Figure 7) but increases in the High Demand Case (Figure 8) relative to the Reference Case. In the Reference Case, WECC (excluding CA) exports electricity to California. However, the application of the illustrative national carbon policy in the Intermediate Demand Case increases the costs to operate fossil generation in the WECC (excluding CA) region. In light of these higher costs, the WECC (excluding CA) region exports less electricity to California, and fossil generation—and, in turn, power sector natural gas demand—in the WECC (excluding CA) region declines relative to the Reference Case (Figure 7). Natural gas power generation increases in California to replace decreasing imports of power from the WECC (excluding CA) region. The greater number of coal-fired power plant retirements assumed in the High Demand Case requires replacement energy to be made up by natural gas-fired generation in the WECC (excluding CA) region. This effect works in the opposite direction as the prior one, resulting in greater WECC (excluding CA) power sector natural gas demand in the High Demand Case relative to the Reference Case (Figure 8).

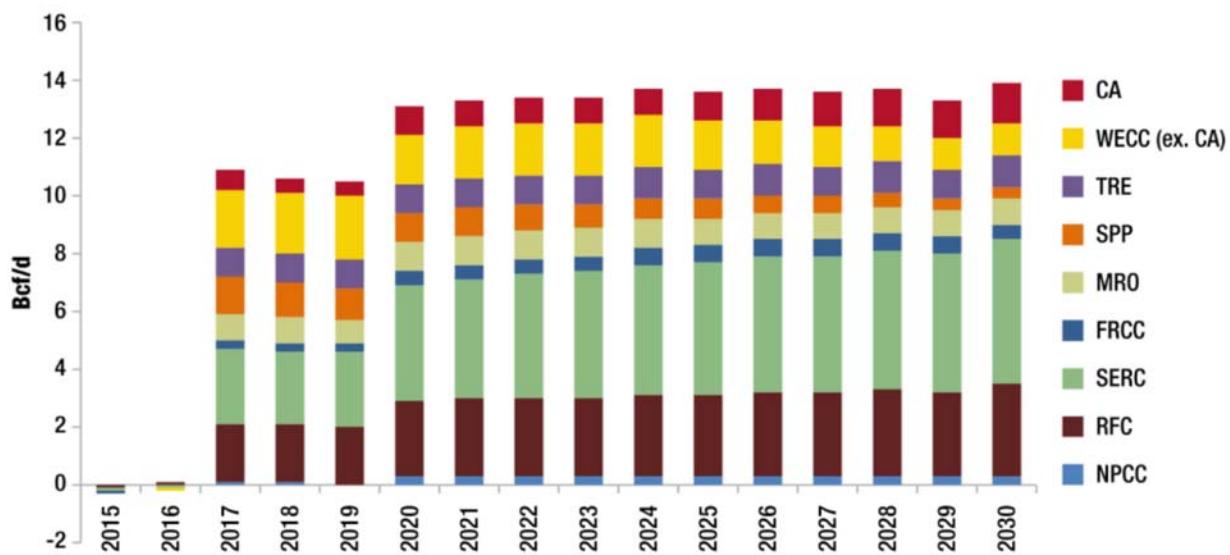


Figure 8: High Demand Case Electric Power Sector Natural Gas Demand Relative to the Reference Case, 2015 to 2030

3.2 Natural Gas Supply

Growing demand for natural gas leads to a significant increase in the supply of natural gas. In the Reference Case, total natural gas production is projected to grow by 37% from 2015 to 2030, increasing from approximately 71 Bcf/d in 2015 to nearly 98 Bcf/d in 2030 (Figure 9).³² Reference Case natural gas supply in 2030 is comparable to EIA's AEO 2014 Reference Case level of approximately 94 Bcf/d.³³ The Reference Case projection also shows a continued increase in shale gas production over the projection period. With the most significant contribution coming from the Marcellus basin, total U.S. shale gas production is projected to reach about 70 Bcf/d by 2030 and to become the dominant source of U.S. natural gas supply (for a description of the production regions, see Appendix A.2 Map of Lower 48 States Shale Plays).

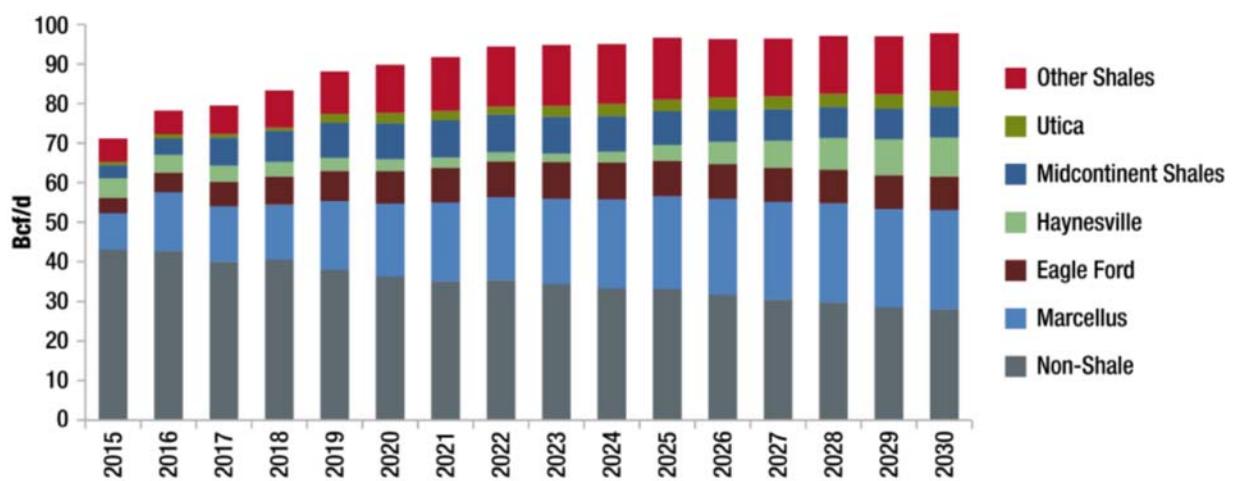


Figure 9: Reference Case Natural Gas Production by Production Region, 2015 to 2030

In response to the increased use of natural gas for power generation in the Intermediate and High Demand Cases, U.S. natural gas production is projected to increase by 6%–10% over Reference Case levels in 2030. The majority of production is projected to come from shale gas basins, as shown in Figure 10. The remainder, totaling 38% of total natural gas supply in both the Intermediate Demand Case and the High Demand Case, includes conventional natural gas, offshore natural gas, associated gas, coalbed methane, and tight gas.³⁴ Just as in the Reference Case, shale gas production in the Intermediate Demand Case is spread across multiple regions. While the volumes of natural gas supplied are larger in the High Demand Case, the geographic distribution of that supply is similar.

³² In any given year, natural gas production is greater than natural gas demand plus net exports because of fuel used or lost in all stages of natural gas production, transmission, distribution, and storage.

³³ U.S. Energy Information Administration, "Table 13. Natural Gas Supply, Disposition, and Prices," *Annual Energy Outlook 2014*, May 7, 2014, accessed September 24, 2014, http://www.eia.gov/forecasts/aeo/excel/aeotab_13.xlsx.

³⁴ "Tight gas" is natural gas found in low-permeability sandstones and carbonate reservoirs. The rock layers that hold the natural gas are very dense, preventing easy flow of natural gas.

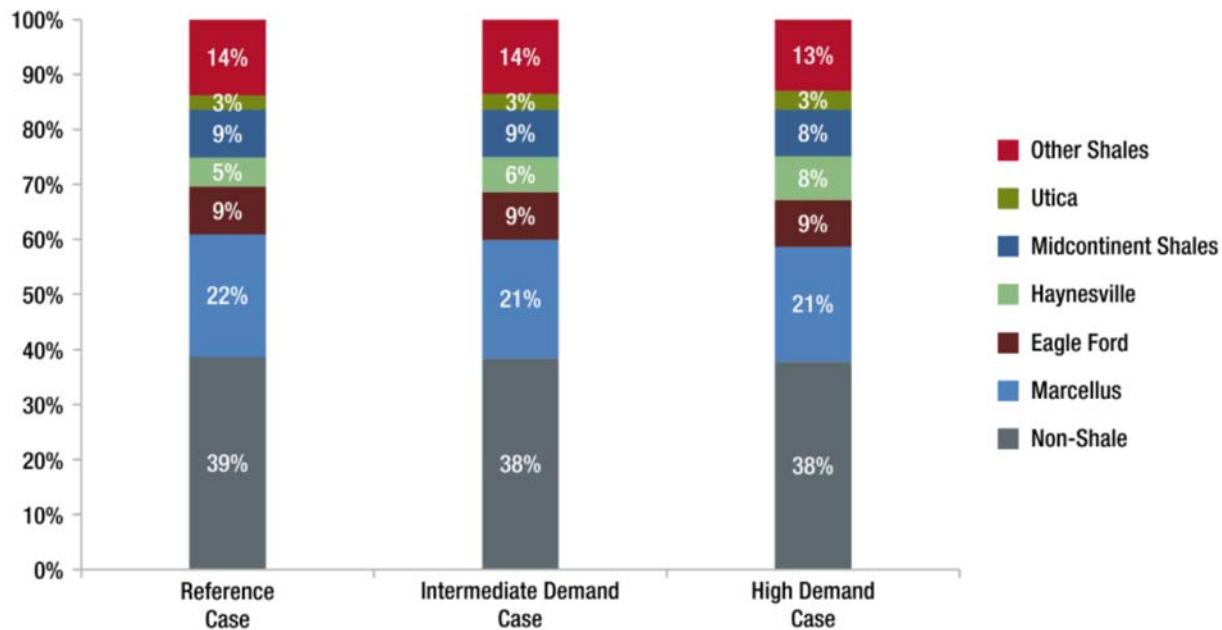


Figure 10: Share of Total Natural Gas Production from Different Production Basins across the Cases, 2015 to 2030

Interestingly, while the Marcellus region is the largest source of shale gas production in the Reference Case, it is not the largest incremental source, relative to the Reference Case, of projected future natural gas production in the Intermediate and High Demand Cases. Instead, the largest source of incremental shale gas production in these cases is the Haynesville basin, which is situated in East Texas and Northwest Louisiana. This result follows from the underlying resource economics of the shale plays represented in the model. As the lowest-cost Marcellus resources are depleted over the course of the Reference Case projection, only higher-cost Marcellus supplies remain available for incremental production in the increased demand cases. Incremental Marcellus production is also likely to require additional infrastructure to bring production to market, diminishing the attractiveness of Marcellus production relative to other basins. In addition, the Haynesville is well positioned to supply natural gas to southern electricity markets, which account for a significant share of the increase in demand from the U.S. electric power sector in the Intermediate and High Demand Cases (Figure 7 and Figure 8).

3.3 Natural Gas Prices

The United States is estimated to hold about 2,400 trillion cubic feet (Tcf) of technically recoverable natural gas in shale formations, equivalent to approximately 100 years of supply at present levels of demand.³⁵ The large shale gas resource potential has effectively made the long-run natural gas supply curve more elastic, and as a result, long-run natural gas demand changes are less likely to result in major price impacts.

³⁵ U.S. Energy Information Administration, "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States," June 13, 2013, accessed September 24, 2014, <http://www.eia.gov/analysis/studies/worldshalegas/>.

In the Reference Case, U.S. natural gas prices are among the lowest compared to other industrialized countries throughout the forecast period. Figure 11 shows historical prices through 2010 as well as the projected price at Henry Hub in the Reference Case.³⁶ Advancements in the technology used to produce natural gas from shale formations, coupled with the global recession, caused natural gas prices to fall sharply from 2009 to 2012. In the Reference Case, natural gas prices slowly rebound and rise throughout the projection period at levels that are sufficient to incentivize production from marginal sources of natural gas supply. Henry Hub natural gas prices in the Reference Case are similar to prices in EIA's AEO 2014 Reference Case. In 2030, Reference Case Henry Hub prices are projected to be \$6.16/million British thermal units (MMBtu), while EIA's AEO 2014 Reference Case prices are projected to be \$6.03/MMBtu.³⁷

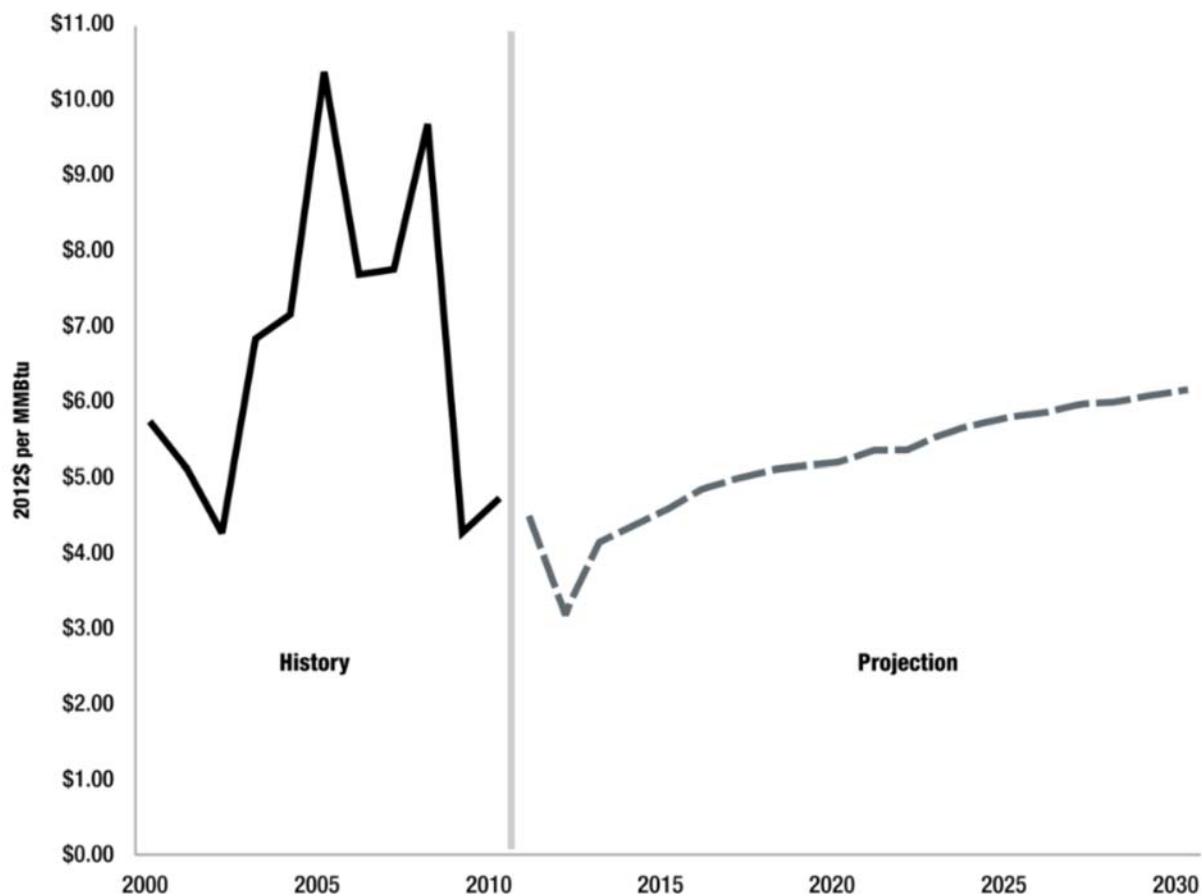


Figure 11: Historical and Projected Henry Hub Natural Gas Prices in the Reference Case, 2000 to 2030³⁸

³⁶ The projection begins in 2011 in order to calibrate the model.

³⁷ U.S. Energy Information Administration, "Figure MT-40: Annual average Henry Hub spot natural gas prices in the Reference case, 1990–2040," *Annual Energy Outlook 2014*, May 7, 2014, accessed September 25, 2014, http://www.eia.gov/forecasts/aeo/excel/figmt40_data.xls.

³⁸ Source for historical Henry Hub prices: U.S. Energy Information Administration, "Henry Hub Natural Gas Spot Price," September 17, 2014, accessed September 24, 2014, <http://www.eia.gov/dnav/ng/hist/rngwhhdA.htm>.

Figure 12 shows average prices from 2015 to 2030 across the cases for selected major regional natural gas markets and hubs. In the Intermediate Demand Case, growing demand for natural gas results in an average increase in Henry Hub prices of \$0.19/MMBtu (or about 4%) from 2015 to 2030 relative to the Reference Case. In the High Demand Case, the average increase in Henry Hub prices is about \$0.53/MMBtu (or about 10%) from 2015 to 2030 relative to the Reference Case. The largest price impact in these cases is in Massachusetts, which is far downstream in regional pipeline flows.

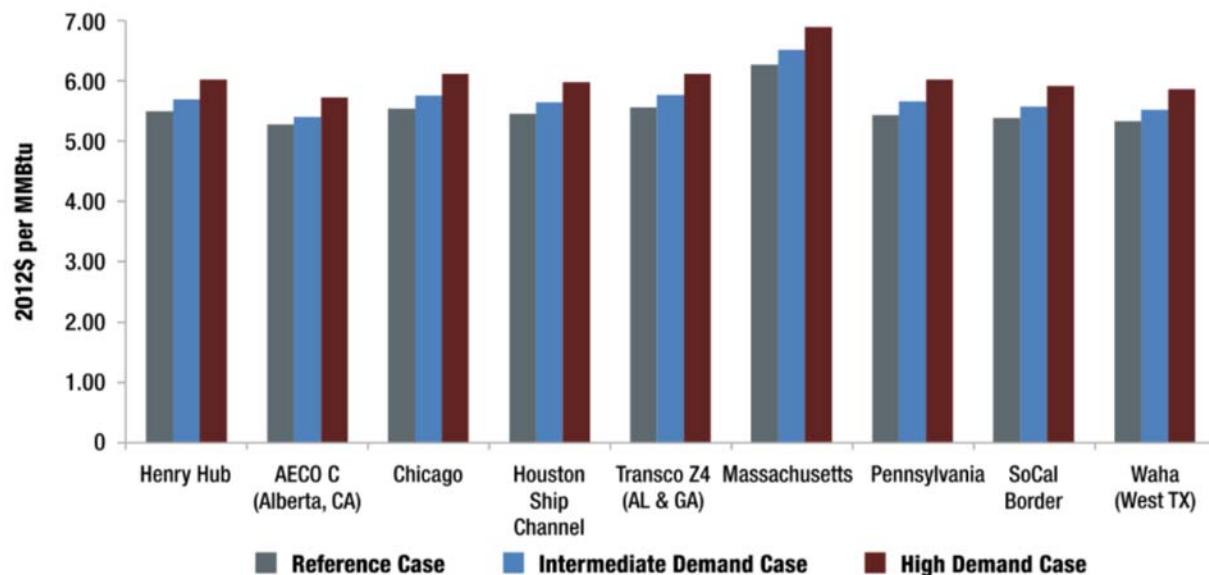


Figure 12: Average Natural Gas Prices by Location across the Cases, 2015 to 2030

3.4 Natural Gas Transmission

Reference Case

In the Reference Case, the combination of a geographic shift in regional natural gas production—largely due to the expanded development of natural gas from shale formations—and growth in natural gas demand is projected to require more interstate natural gas pipeline capacity.

Figure 13 shows the historical and planned capacity additions from 1996 to 2016, along with the projected pipeline capacity additions between 2015 and 2030 in the Reference Case. Pipeline capacity additions in the Reference Case are projected to be 38 Bcf/d between 2015 and 2030. In comparison, between 1998 and 2013, nearly 127 Bcf/d of pipeline capacity was added in the United States.

Continued integration of shale gas production from the Marcellus basin, which is the largest producing basin in the Reference Case projection, is a key driver of future pipeline capacity additions in the Reference Case. Shale gas produced from the Marcellus is both lower in cost and situated geographically closer to end-user demand in the eastern United States. As a result, more than half of the 38 Bcf/d of interstate pipeline capacity additions in the Reference Case are associated with further integrating Marcellus natural gas production into U.S. natural gas markets.

Even with the significance of the Marcellus, projected natural gas production and demand are geographically diverse, so the need for additional interstate natural gas pipeline infrastructure is lower than would be

expected if the increased production or demand were concentrated in a particular region. Furthermore, pipeline capacity additions that were placed in service between 2007 and the present in order to realign the U.S. natural gas transmission system with changing supply and demand conditions driven by increases in shale gas production are projected to reduce the need for future pipeline infrastructure.

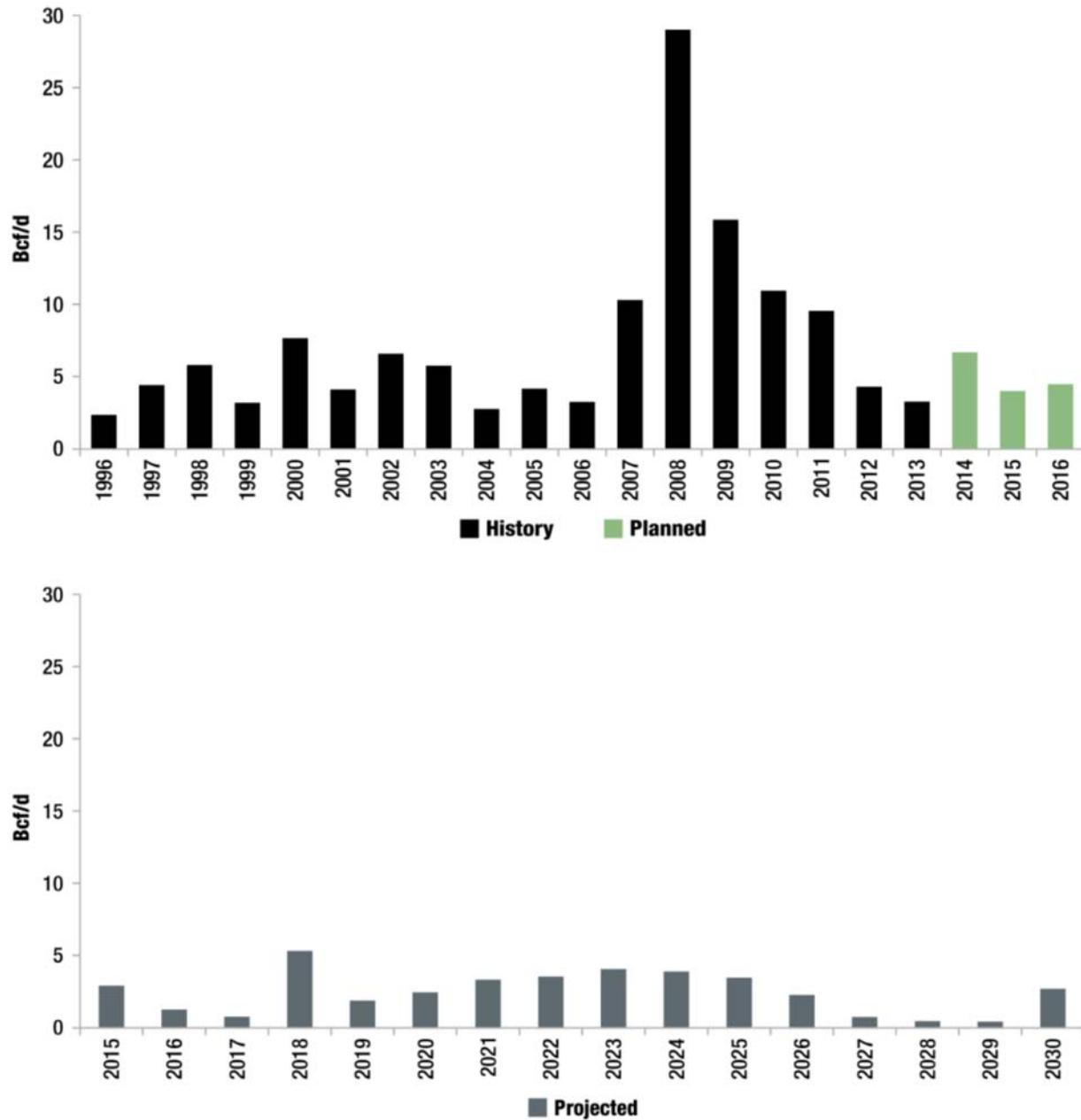


Figure 13: Historical, Planned, and Projected U.S. Interstate Pipeline Capacity Additions, 1996 to 2030³⁹

³⁹ Source for historical and planned additions: U.S. Energy Information Administration, "Natural Gas Pipeline Projects from 1996 to Present," July 7, 2014, accessed September 24, 2014, <http://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xls>. The Deloitte MarketPoint projection for years 2015 through 2018 includes both planned and economic expansion.

Another reason that pipeline capacity additions in the Reference Case are not greater is that, in many regions, existing pipeline capacity is not fully utilized during many parts of the year. Average capacity utilization between 1998 and 2013 was 54%.⁴⁰ For comparison, projected pipeline utilization for the top 200 pipeline segments by projected flow volume in the Reference Case in 2030 is 57%.⁴¹ Given the cost of building new pipelines, finding alternative routes utilizing available capacity on existing pipelines is often less costly than expanding pipeline capacity.⁴² This response is more likely when incremental natural gas demand does not strongly coincide with peak natural gas demand, which is true in the Reference Case, because the incremental demand is largely driven by increases in base load natural gas generation in the electric power sector.

Figure 14 shows the regional distribution of projected pipeline capacity additions between 2015 and 2030 (for more detail on the regions, see Appendix A.3 Map of Natural Gas Pipeline Expansion Regions). In the Marcellus, growth in natural gas production is projected to require additional expansion of pipeline takeaway capacity from the region. In total, an estimated 8.4 Bcf/d of additional pipeline capacity will be needed to integrate Marcellus production with regional markets and interstate pipelines (shown as “Within Marcellus” in Figure 14). Growing Marcellus natural gas production is projected to dominate the Mid-Atlantic natural gas market. Not only will natural gas from the Marcellus displace flows from other regions, but it will also be exported to other parts of the country. A portion of the growth in Marcellus natural gas production is projected to serve northeastern markets and will require 3.2 Bcf/d of incremental pipeline capacity (shown as “Mid-Atlantic to North” in Figure 14).⁴³

⁴⁰ Calculation based on data from the following sources: U.S. Energy Information Administration, “U.S. State-to-State capacity,” January 16, 2014, accessed November 13, 2014, <http://www.eia.gov/naturalgas/pipelines/EIA-StatetoStateCapacity.xls>; U.S. Energy Information Administration, “International & Interstate Movements of Natural Gas by State,” October 31, 2014, accessed November 13, 2014, http://www.eia.gov/dnav/ng/ng_move_ist_a2dcu_nus_a.htm.

⁴¹ This value represents annual average utilization for the top 200 segments in the model. Projected pipeline utilization in any given region or at any given time may be higher or lower than the average values reported here, depending on seasonal patterns of natural gas demand and regional natural gas system characteristics. In addition, annual pipeline utilization will be well below 100% for most pipelines because of the seasonality of natural gas flows. A pipeline might operate near full capacity during peak seasons but will operate at much lower levels during off-peak seasons.

⁴² As discussed in Section 1.3 Economics of Natural Gas Transmission, pipeline expansions are driven by basis differential, which means that new pipelines may be constructed even when existing capacity is available to perform the same transportation service, provided that the anticipated revenue can justify the investment and operating costs.

⁴³ The construction of a planned 1.7 Bcf/d expansion to the Transco Pipeline, which will serve markets in the Northeast, is exogenously specified to be in service in 2018 in the model.

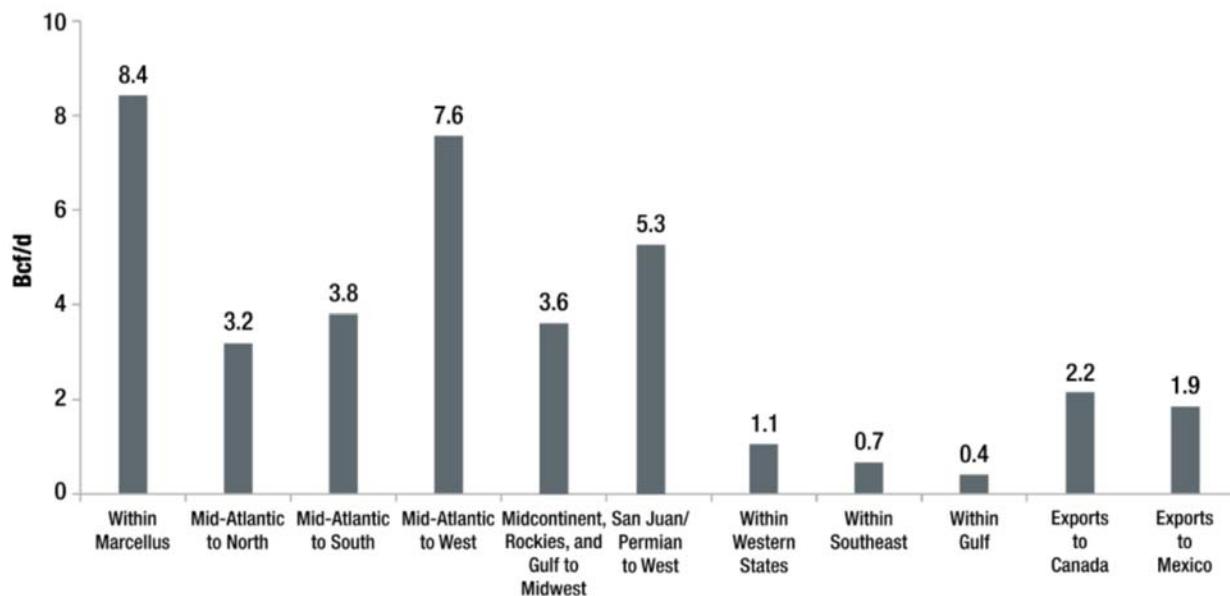


Figure 14: Projected Interstate Pipeline Capacity Additions in the Reference Case, 2015 to 2030

Growth in the Marcellus and in the Utica is also projected to reverse flows that historically have come from west and south of the region. In the Reference Case, the model projects 4.4 Bcf/d will reverse flow from Ohio to Indiana (included within the total for “Mid-Atlantic to West” in Figure 14). Other expansions are projected to increase flows from Pennsylvania and West Virginia to Ohio, bringing total Mid-Atlantic to West expansion to 7.6 Bcf/d. Flow reversal is also projected southward out of the Marcellus to serve markets in the Southeast. Pipelines that currently bring natural gas from the Gulf region to the north are projected to reverse flow so that Marcellus production can serve the Virginia and Carolinas markets (included within the total for “Mid-Atlantic to South” in Figure 14). As a result of the projected expansions, Virginia is almost completely served by Marcellus production. However, pipeline reversals do not go any farther south beyond the Carolinas because Gulf production is able to maintain hold of southern markets.

In addition, Midcontinent, Rockies, and Gulf production, which is largely displaced from eastern markets, is increasingly transported to the Midwest and is projected to require 3.6 Bcf/d of capacity (shown as “Midcontinent, Rockies, and Gulf to Midwest” in Figure 14). The greater quantity of natural gas from the Midcontinent, Rockies, and Gulf region, as well as from the Marcellus and Utica, that serves midwestern markets, in turn, leads to a greater amount of natural gas that is available for export to Canada. As a result, export pipelines from the Midwest to Canada are projected to expand by 2.2 Bcf/d (shown as “Exports to Canada” in Figure 14).⁴⁴ Finally, as production increases in the San Juan and Permian basins,

⁴⁴ The model assumes Canadian natural gas demand will grow to 5.5 Tcf (approximately 15 Bcf/d) by 2030, compared to 4.3 Tcf (about 12 Bcf/d) as estimated in the U.S. Energy Information Administration’s *International Energy Outlook 2013* for the same period. Deloitte MarketPoint’s Canadian demand projections are in line with estimates from the Canadian National Energy Board. See: U.S. Energy Information Administration, “Table A6. World natural gas consumption by region, Reference case, 2009-2040,” *International Energy Outlook 2013*, July 25, 2013, accessed September 24, 2014, http://www.eia.gov/forecasts/archive/ieo13/excel/ieotab_6.xls; Canadian National Energy Board, “Energy Demand: Reference

more pipeline capacity is projected to be added to allow natural gas produced in the Rockies and in the Permian basin to increase its share of California and western markets (shown as “San Juan/Permian to West” in Figure 14).

Intermediate and High Demand Cases

In the Intermediate Demand Case, electric power sector natural gas demand increases by 7.5 Bcf/d in 2030 compared to the Reference Case. This is a 25% increase relative to Reference Case electric power sector natural gas demand and a 10% increase relative to total Reference Case natural gas demand. The impact on natural gas production is lower, at 6.1 Bcf/d (6%) over Reference Case levels in 2030. Higher U.S. natural gas demand results in lower U.S. pipeline exports to Canada, which in turn reduces the need for additional U.S. natural gas production.⁴⁵ Moreover, only a relatively modest 1.4 Bcf/d (about 4% of the total Reference Case capacity additions of 38 Bcf/d) of additional pipeline capacity beyond Reference Case levels is projected to be built by 2030. As in the Reference Case, because incremental natural gas production and demand are broadly distributed, and because utilization of some existing pipelines can be increased, the need for additional natural gas infrastructure is reduced.⁴⁶

In the High Demand Case, electric power sector natural gas demand is projected to increase by about 14 Bcf/d over Reference Case levels in 2030. This is a 46% increase relative to Reference Case electric power sector natural gas demand and an 18% increase relative to total Reference Case natural gas demand. This increase in demand results in a 10 Bcf/d (10%) increase in U.S. natural gas production relative to the Reference Case in 2030. Just as in the Intermediate Demand Case, reductions in natural gas pipeline exports account for the difference between natural gas production and demand. With the increase in natural gas demand in the High Demand Case, an incremental 3.9 Bcf/d (approximately 10% of the total Reference Case capacity additions of 38 Bcf/d) of additional pipeline capacity above Reference Case levels is projected to be built by 2030. Just as in the Reference and Intermediate Demand Cases, the wide geographic distribution of both natural gas production and demand and the ability to increase utilization of some existing pipelines reduce the need for additional interstate natural gas pipeline infrastructure. Projected pipeline utilization for the top 200 pipeline segments by projected flow volume in the model in 2030 rises to 60% in the Intermediate Demand Case and 61% in the High Demand Case, compared to 57% in the Reference Case.

Finally, to further understand the reasons for the modest incremental infrastructure needs in the Intermediate and High Demand Cases, it is necessary to consider the incremental sources of supply in

Case – Canada,” *Canada’s Energy Future 2013: Supply and Demand Projections to 2035*, November 11, 2013, accessed September 24, 2014, <http://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2013/ppndcs/pxndsdmdn-eng.html>.

⁴⁵ In the Intermediate and High Demand Cases, U.S. LNG export levels are unchanged from the Reference Case level of 5.1 Bcf/d. In order to test the sensitivity to alternative assumptions about U.S. LNG export volumes, an additional case was run that coupled the High Demand Case assumptions with approximately 10 Bcf/d of LNG exports by 2022. The total pipeline capacity additions projected in this case are not significantly different from those projected in the High Demand Case.

⁴⁶ Just as in the Reference Case, incremental demand in the increased demand cases largely follows from increases in natural gas-fired electric power generation primarily designed to serve base load electricity demand. As a result, incremental natural gas demand in these cases is relatively uniform over the course of a year, compared to total natural gas demand in the Reference Case, which exhibits a stronger seasonal pattern. It is easier to accommodate this relatively uniform incremental natural gas demand on existing pipelines than it would be to accommodate demand that coincided more strongly with peak demand.

these cases relative to the Reference Case. As discussed previously, while the Marcellus is the largest source of shale gas production in the Reference Case, driving more than half of the total pipeline capacity additions in the Reference Case, the Haynesville basin is the largest source of incremental shale gas supply in the Intermediate and High Demand Cases, relative to the Reference Case. Compared to the Marcellus, increased production of shale gas in the Haynesville basin requires little or no additional interstate pipeline capacity in order to access markets, because the region has a history of natural gas production and is already well served by interstate natural gas pipelines. However, even if the incremental natural gas supply in the Intermediate or High Demand Cases were to come from another basin with a history of natural gas production, the additional infrastructure requirements would be unlikely to affect the conclusions about infrastructure needs relative to historical experience.

Figure 15, which compares the incremental regional pipeline capacity additions in the Intermediate and High Demand Cases to those in the Reference Case, demonstrates that the regional incremental capacity additions (and subtractions) are comparatively small, relative to the level of capacity additions in the Reference Case (shown in gray). However, there are some modest changes in regional capacity additions between the cases.

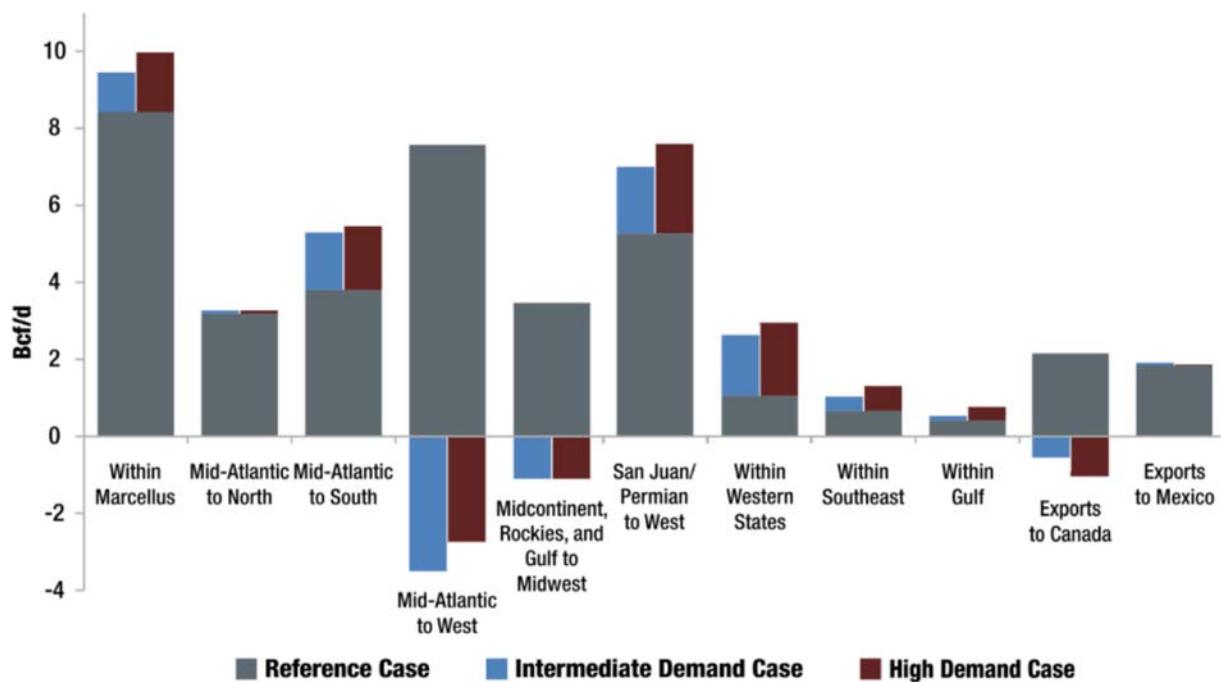


Figure 15: Incremental Interstate Pipeline Capacity Additions in the Intermediate Demand (blue) and High Demand (red) Cases Compared to the Reference Case (gray), 2015 to 2030⁴⁷

In both increased demand cases, greater natural gas demand within the Mid-Atlantic and southeastern regions results in regionally produced natural gas remaining within the region or being sent to

⁴⁷ The gray bars are identical to Figure 14, which shows Reference Case pipeline capacity additions between 2015 and 2030. The blue and red bars show the incremental changes in additions relative to the Reference Case over the same period in the Intermediate Demand and High Demand Cases, respectively. Total additions in these cases over the period can therefore be found by summing the gray and blue and gray and red bars, respectively.

southeastern markets (shown as “Within Marcellus” and “Mid-Atlantic to South” in Figure 15). Furthermore, in both increased demand cases, the demand for natural gas in midwestern markets (and the resulting tendency to send natural gas westward) is lower than the demand in the Mid-Atlantic (and the resulting tendency to use such supplies within the region), so the 7.6 Bcf/d of projected capacity expansions in the Reference Case (shown as “Mid-Atlantic to West” in Figure 15) is reduced by 3.5 Bcf/d in the Intermediate Demand Case and by 2.9 Bcf/d in the High Demand Case. Given the increased demand for natural gas in the Southeast, the tendency to send natural gas northward to midwestern markets is lower than the tendency to use Gulf production in the Southeast, so fewer pipeline capacity expansions are projected into the Midwest from the Gulf in the Intermediate and High Demand Cases than in the Reference Case (shown as “Midcontinent, Rockies, and Gulf to Midwest” in Figure 15).

In both increased demand cases, more pipeline capacity additions are projected relative to Reference Case levels within the West as well as westward from the San Juan and Permian basins to meet growing demand for natural gas in California and western markets (shown as “Within Western States” and “San Juan/Permian to West” in Figure 15). While there are not any coal-fired power plants to displace in California, natural gas demand increases because of reduced imports of electricity and the resulting higher utilization of in-state natural gas-fired power plants.

Finally, compared to the Reference Case, which projects 2.2 Bcf/d of pipeline capacity additions to support U.S. exports to Canada, the Intermediate Demand Case projects 0.5 Bcf/d fewer capacity additions, while the High Demand Case projects 1.0 Bcf/d fewer capacity additions (shown as “Exports to Canada” in Figure 15). These reductions in export volumes follow from the increasing demand for natural gas in the United States relative to Canada, driven by the growing demand from the U.S. electric power sector.

3.5 Expenditures on Natural Gas Transmission Infrastructure

The projected capital expenditures required to construct, expand, and modify interstate pipeline infrastructure described in the previous section are shown in Figure 16. Total capital expenditures on pipeline capacity expansion in the Reference Case are projected to be about \$42 billion between 2015 and 2030. In comparison, between 1998 and 2013, pipeline capacity expenditures totaled more than \$63 billion.⁴⁸ In the Intermediate Demand Case, the incremental capital expenditures are projected to be about \$0.6 billion, 1.3% higher than the Reference Case, and in the High Demand Case, the incremental capital expenditures are projected to be about \$2.8 billion, 6.5% higher than the Reference Case.⁴⁹

⁴⁸ While projected costs are lower than historical costs (over a similar time period), the difference in expenditures is not as large as the difference in pipeline capacity additions between history and the model projection. The distance associated with the pipeline capacity additions in the model projection is comparable to (but lower than) the distance associated with historical pipeline capacity additions. Because project costs reflect, in part, the distance associated with new pipelines, the projected expenditures are closer to (but still lower than) historical expenditures.

⁴⁹ As noted previously, the model does not include the cost of expanding natural gas gathering and processing systems. As such, the projected capacity expansions are limited to the granularity of the pipeline system representation in the model. Because demand is mostly represented at the state level, intrastate pipeline capacity is only partially represented in the model.

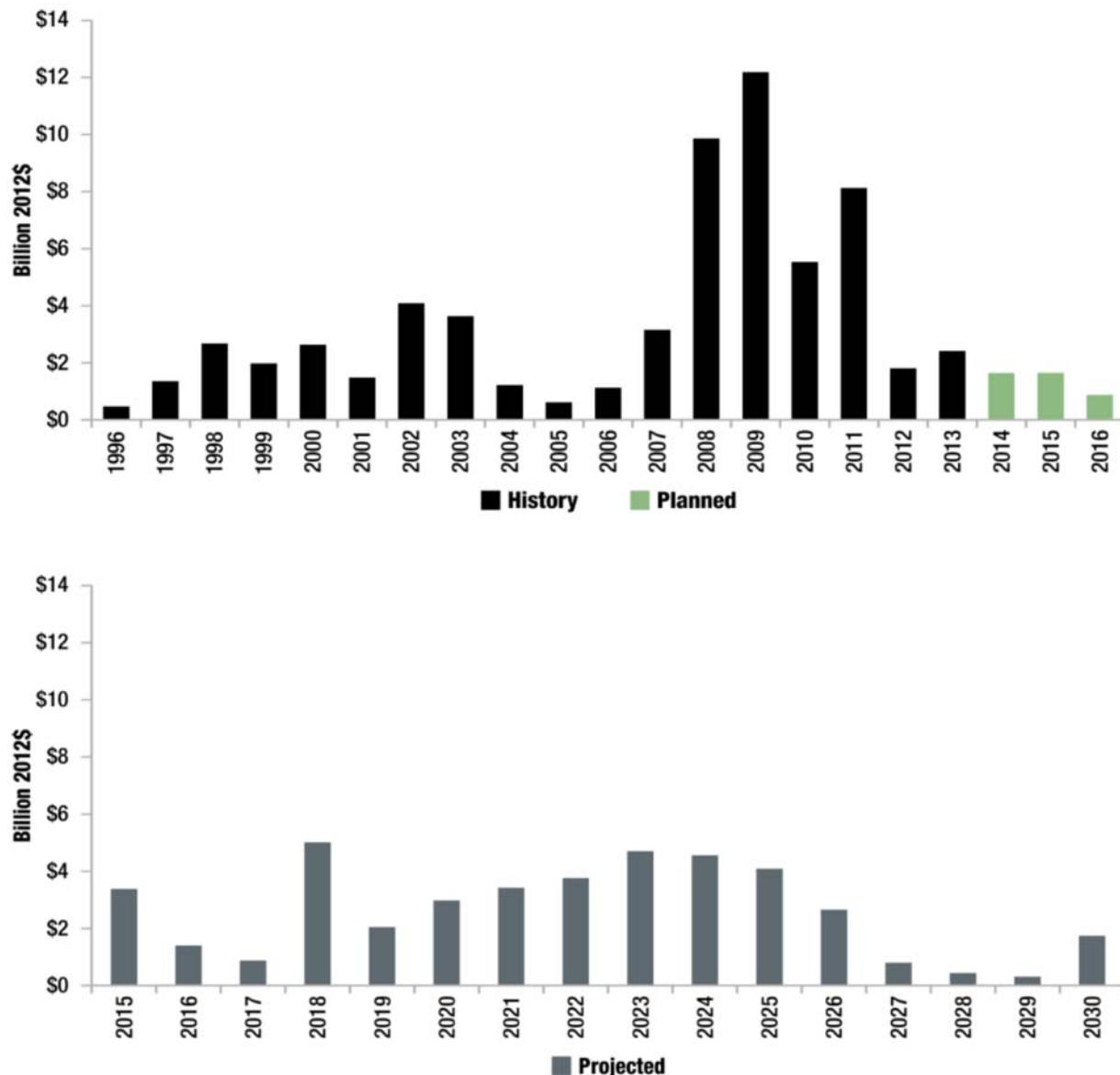


Figure 16: Historical, Planned, and Projected Capital Expenditures on U.S. Interstate Pipeline Capacity, 1996 to 2030⁵⁰

⁵⁰ Source for historical and planned additions: U.S. Energy Information Administration, "Natural Gas Pipeline Projects from 1996 to Present," July 7, 2014, accessed September 24, 2014, <http://www.eia.gov/naturalgas/pipelines/EIA-NaturalGasPipelineProjects.xls>. The Deloitte MarketPoint projection for years 2015 through 2018 includes both planned and economic expansion.

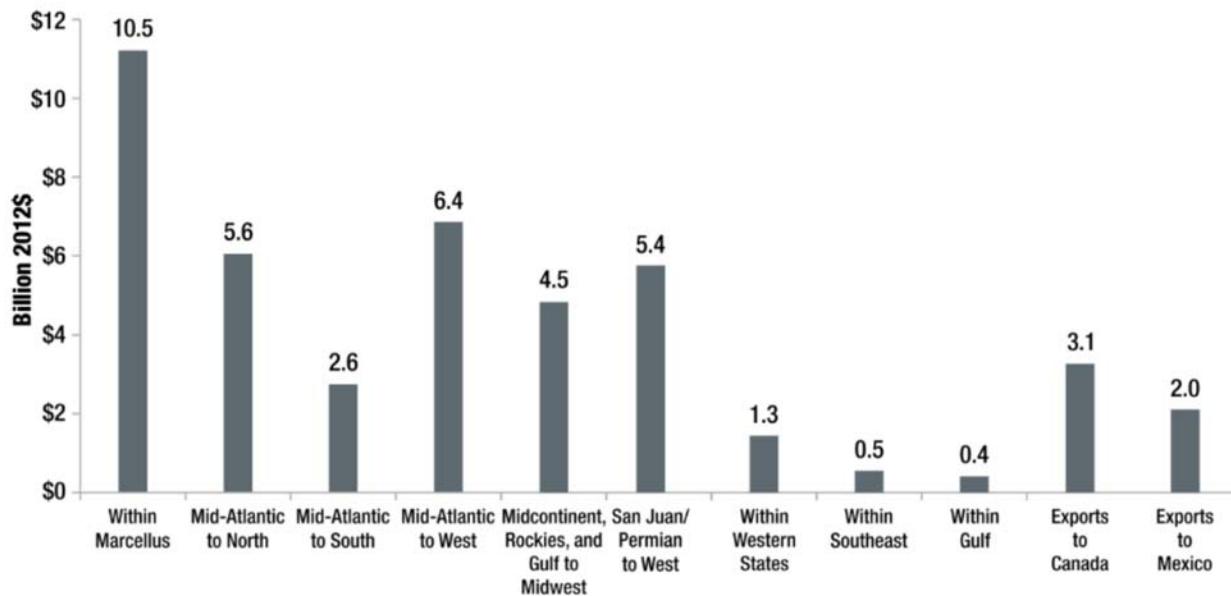


Figure 17: Projected Capital Expenditures on U.S. Interstate Pipeline Capacity in the Reference Case, 2015 to 2030

Projected regional pipeline capital expenditures are displayed in Figure 17. The largest interstate pipeline capital expenditures in the Reference Case are projected to be in the Marcellus to construct pipeline takeaway capacity. In the Intermediate and High Demand Cases (Figure 18), expenditures to expand Marcellus takeaway capacity and to transport natural gas southward increase relative to the Reference Case. Furthermore, in these cases, expenditures to transport Marcellus production westward and Midcontinent, Rockies, and Gulf production northward decline relative to the Reference Case, consistent with the changes in pipeline capacity additions between the cases (Figure 15). Finally, in both cases, expenditures to bring Rockies and southwestern natural gas into and around California increase compared to Reference Case levels (shown as “Within Western States” and “San Juan/Permian to West” in Figure 18), also consistent with the changes in pipeline capacity additions between the cases.

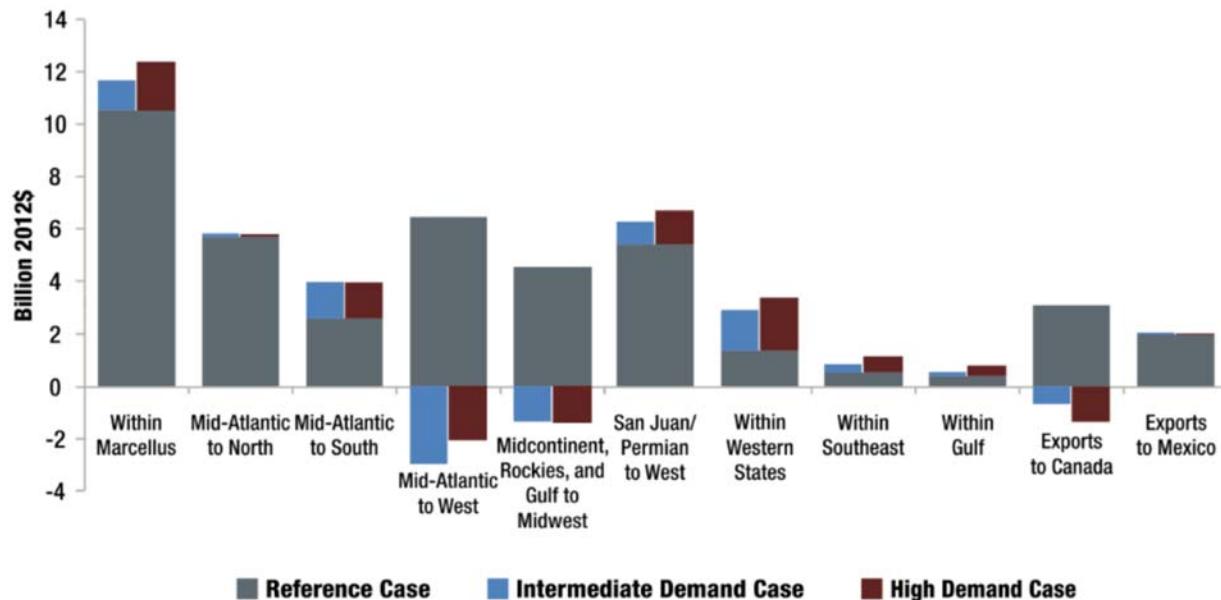


Figure 18: Incremental Projected Pipeline Capital Expenditures in the Intermediate Demand (blue) and High Demand (red) Cases Compared to the Reference Case (gray), 2015 to 2030⁵¹

⁵¹ The gray bars are identical to Figure 17, which shows Reference Case pipeline capital expenditures between 2015 and 2030. The blue and red bars show the incremental changes in expenditures relative to the Reference Case over the same period in the Intermediate Demand and High Demand Cases, respectively. Total expenditures in these cases over the period can therefore be found by summing the gray and blue and gray and red bars, respectively.

4. Conclusion

This study concludes that, under scenarios in which natural gas demand from the electric power sector increases, the incremental increase in interstate natural gas pipeline expansion and associated investment is modest, relative to historical capacity additions. The projected rate of interstate pipeline capacity expansion in the scenarios considered in this analysis is lower than the rate of historical capacity additions over the past 15 years and is consistent with information currently available on planned capacity additions over the next 3 years. In the scenarios considered here, 38–42 Bcf/d of new and expanded interstate pipeline capacity is projected to be constructed between 2015 and 2030, compared to nearly 127 Bcf/d of pipeline capacity added in the United States between 1998 and 2013.

Similarly, capital expenditures on new interstate pipelines in the scenarios considered here are projected to be significantly less than the capital expenditures associated with infrastructure expansion over the last 15 years. The scenarios in this analysis project \$42 billion to \$45 billion in capital expenditures on new, expanded, and modified interstate pipeline capacity between 2015 and 2030, while pipeline capacity expenditures totaled more than \$63 billion between 1998 and 2013.

The results of this study are consistent with a recent report prepared by ICF International for the Interstate Natural Gas Association of America (INGAA) Foundation.⁵² Average annual expenditures on interstate natural gas pipeline infrastructure range from \$2.6 billion to \$2.8 billion across the cases considered in this analysis between 2015 and 2030. The INGAA study, which utilizes a different set of input assumptions and projection methodologies, projects annual expenditures that range between \$2.7 billion and \$4.0 billion across the cases considered in its analysis.⁵³

Two primary factors mitigate the need for additional interstate natural gas pipeline infrastructure and related capital expenditures in these scenarios. First, the growth in both natural gas demand from electricity generation and natural gas production is broadly distributed rather than geographically concentrated, reducing potential interstate pipeline capacity constraints as well as the need for new interstate pipelines. Second, increasing utilization of capacity that is not fully utilized in existing interstate natural gas pipelines, re-routing natural gas flows, and expanding existing pipeline capacity are potentially lower-cost alternatives to building new infrastructure and can accommodate a significant increase in natural gas flows.⁵⁴

While the conclusions about interstate pipeline additions and capital expenditures are likely to be robust to a range of alternative assumptions, additional research could further inform discussions about natural gas infrastructure needs and related natural gas system issues. Such research might consider representation of shorter time intervals (such as peak days or peak hours), the role of seasonal and high-

⁵² Interstate Natural Gas Association of America Foundation, Inc., “North American Midstream Infrastructure through 2035: Capitalizing on Our Energy Abundance,” March 17, 2014, accessed November 4, 2014, <http://www.ingaa.org/Foundation/Foundation-Reports/2035Report.aspx>.

⁵³ Ibid., p. 26.

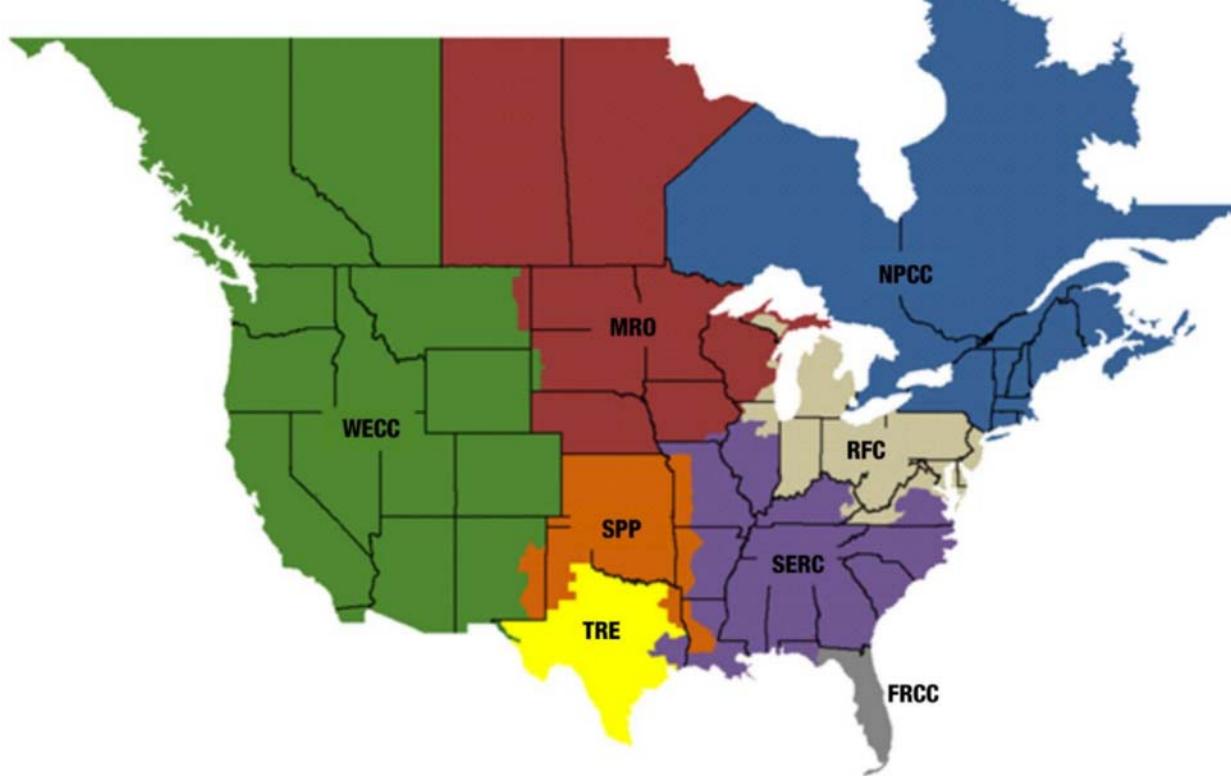
⁵⁴ As discussed in Section 1.3 Economics of Natural Gas Transmission, pipeline expansions are driven by basis differential, which means that new pipelines may be constructed even when existing capacity is available to perform the same transportation service, provided that the anticipated revenue can justify the investment and operating costs.

deliverability natural gas storage, and more granular regional and local segmentation of natural gas markets to pinpoint areas where future investment may be needed. In addition, a variety of other supply and demand cases might be considered, including cases that represent alternative industrial demand, transportation demand, or export futures, as well as alternative natural gas supply assumptions.

Appendix A. Additional Figures

Appendix A.1 Map of Electric Power Sector Natural Gas Demand Regions

NERC REGIONS

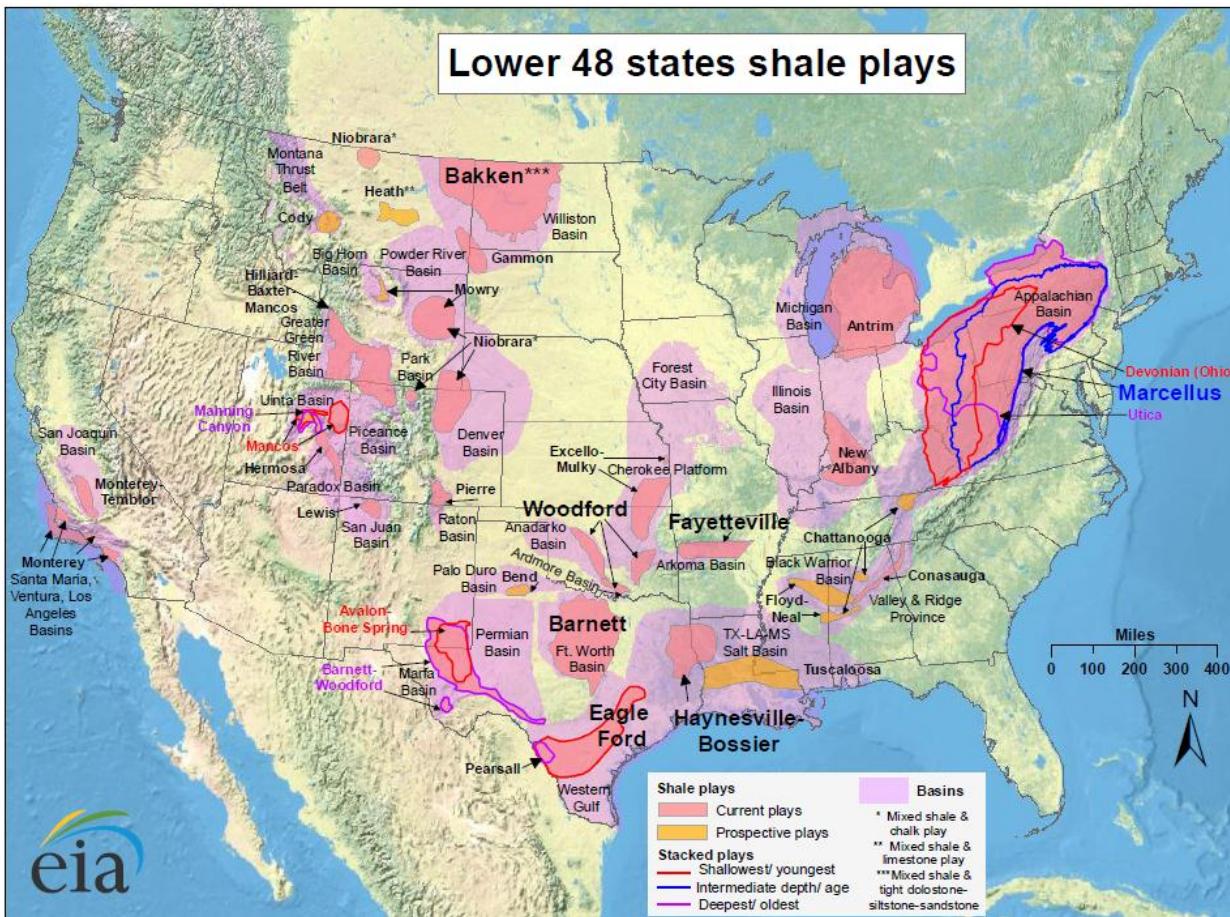


Region Abbreviation	Definition
FRCC	Florida Reliability Coordinating Council
MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RFC	ReliabilityFirst Corporation
SERC	SERC Reliability Corporation
SPP	Southwest Power Pool
TRE	Texas Reliability Entity
WECC	Western Electricity Coordinating Council

Figure 19: Map of North American Electric Reliability Corporation (NERC) Regions⁵⁵

⁵⁵ North American Electric Reliability Corporation, “NERC Regions Map,” accessed October 22, 2014, http://www.nerc.com/AboutNERC/keyplayers/Documents/NERC_Interconnections_Color_072512.jpg.

Appendix A.2 Map of Lower 48 States Shale Plays



Model Region	Producing Region
Non-Shale	All conventional, associated, offshore, tight, and coalbed methane production
Eagle Ford	Eagle Ford shale basin
Haynesville	Haynesville shale basin
Marcellus	Marcellus shale basin
Midcontinent Shales	Fayetteville, Woodford, and Arkoma shale basins
Utica	Utica shale basin
Other Shales	Barnett, Permian, Niobrara, and all other shale basins

Figure 20: Map of Lower 48 States Shale Plays⁵⁶

⁵⁶ U.S. Energy Information Administration, "Lower 48 states shale plays," May 9, 2011, accessed October 22, 2014, http://www.eia.gov/oil_gas/rpd/shale_gas.pdf.

Appendix A.3 Map of Natural Gas Pipeline Expansion Regions



Figure 21: Map of Natural Gas Pipeline Expansion Regions⁵⁷

⁵⁷ Regions that are not included in this figure are not projected to have pipeline capacity additions. Pipeline capacity additions from the Bakken region are not reported with the regional pipeline expansion results, because Bakken region wet natural gas production is represented in the model as natural gas liquids processing that is delivered to the Chicago market via the Alliance Pipeline. LNG exports are also not reported with the regional pipeline expansion results.

Appendix B. Electric Power Sector Results

Figure 22 shows the projected generation by fuel in the Reference Case. In this case, the majority of electricity generation is supplied by coal- and natural gas-fired generation, along with generation from nuclear and renewable energy sources. Coal-fired generation decreases by 2% from 2015 to 2030, while natural gas-fired generation increases substantially, by approximately 33% over the same period. Non-hydro renewable generation grows by approximately 76% between 2015 and 2030, but the absolute increase is slightly less than half of the increase from natural gas-fired sources.

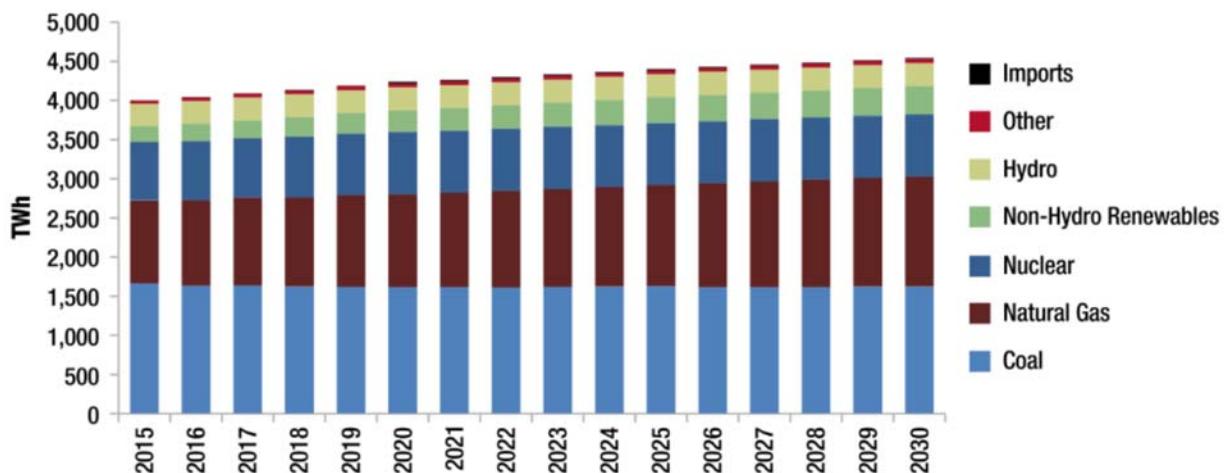


Figure 22: Electric Sector Generation by Fuel in the Reference Case, 2015 to 2030⁵⁸

Regional natural gas-fired generation is shown in Figure 23. While the WECC (excluding CA) region is expected to experience the largest relative increase in natural gas-fired generation during the forecast period (a 106% increase and absolute growth of 112 terawatt-hours [TWh]), the Southeast (SERC and FRCC) is expected to see the largest absolute increase in natural gas-fired generation (a 31% increase and absolute growth of 137 TWh).⁵⁹ Part of the increase in natural gas-fired generation in these regions stems from a decrease in coal-fired capacity; both WECC (excluding CA) and the Southeast (i.e., SERC and FRCC) have large coal-fired fleets with a significant number of announced retirements.

⁵⁸ The label “Imports” represents U.S. imports of electricity generated in Canada.

⁵⁹ For a map of the regions mentioned here, see Appendix A.1 Map of Electric Power Sector Natural Gas Demand Regions.

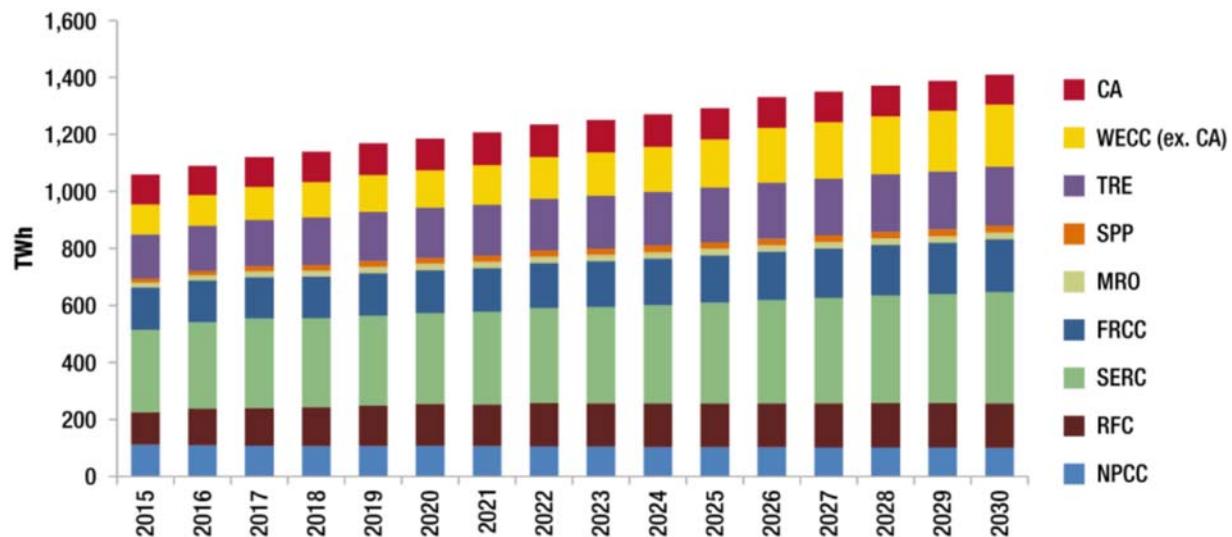


Figure 23: Natural Gas-Fired Generation by Region in the Reference Case, 2015 to 2030

Figure 24 shows the shift in generation in the Intermediate and High Demand Cases relative to the Reference Case. The dominant source of replacement generation for coal in both cases is natural gas-fired generation. Non-hydro renewables make up the balance, with a small contribution from cross-border imports from Canada (shown as “Imports”).

In the High Demand Case, all coal-fired power plants that lacked scrubber-type emissions controls as of the first quarter of 2014 (the most recent data that were available prior to publication of this report) are assumed to retire in 2017. Consequently, the electric power sector responds in two steps: first, in 2017, when the coal-fired capacity is retired, and then again in 2020, when the illustrative national carbon policy begins to affect dispatch. The reduction in coal-fired capacity assumed in the High Demand Case drives a larger shift from coal to natural gas, renewables, and imports.

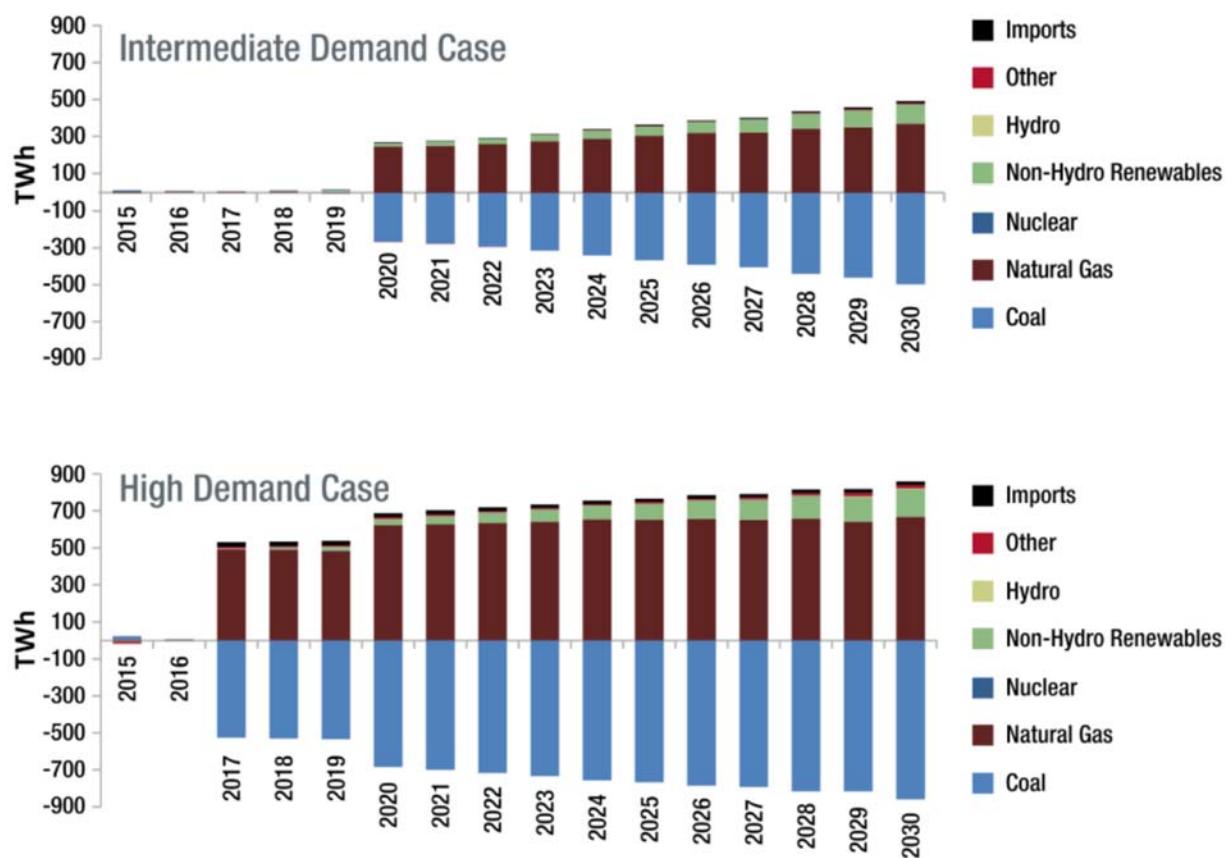


Figure 24: Change in Generation in the Intermediate Demand and High Demand Cases
Relative to the Reference Case, 2015 to 2030⁶⁰

⁶⁰ The label "Imports" represents U.S. imports of electricity generated in Canada.

U.S. DEPARTMENT OF
ENERGY

February 2015



**Exhibit 12 to West Roxbury Motion for
Rehearing: Harvey letter**

Docket #CP14-96-000

January 21, 2015

Letter from the Steering Committee of West Roxbury Saves Energy to the Federal Energy Regulatory Commission and to Senator Elizabeth Warren, Senator Ed Markey, Congressman Stephen Lynch, State Rep. Ed Coppinger, State Sen. Mike Rush, Mayor Martin Walsh, and the Boston City Council

Dear Commissioners of FERC and Elected Officials:

We are writing in regard to Spectra's Algonquin Incremental Market (AIM) expansion project, docket #CP14-96-000, and in particular in regard to the portion of the AIM project designated as the West Roxbury Lateral.

As the deadline for the Final Environmental Impact Statement approaches, we feel compelled to go on record with our objections to a process that has not been transparent and that has not considered adverse impacts to an existing residential neighborhood in locating a high-pressure transmission lateral as part of AIM. It also has not truly considered alternatives to the local supply requests. And, further, it has not taken into account the cumulative impacts of related projects.

In addition, our requests for health and safety information and/or reviews in regard to placing a high-pressure line and M&R station in a densely populated neighborhood and adjacent to an active, blasting quarry have gone unaddressed.

In conclusion, we believe that the AIM project requires further study and information prior to approval. However, if FERC feels it must approve the AIM project, then we request that you sever the West Roxbury Lateral, as it is not integral to the project and its sole purpose is to provide gas to one local distribution company without identifying reasonable alternatives.

Thank you for addressing our concerns and for your assistance.

Respectfully,

Rickie Harvey
Chair of the Steering Committee of West Roxbury Saves Energy

**Exhibit 13 to West Roxbury Motion for
Rehearing: EPA Post EIS Concens**



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
5 POST OFFICE SQUARE, SUITE 100
BOSTON, MA 02109-3912

March 2, 2015

OFFICE OF THE
REGIONAL ADMINISTRATOR

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE, Room 1A
Washington, DC 20426

RE: Algonquin Incremental Market Project (AIM Project), FERC Docket No. CP14-96-000,
CEQ # 20150025

Dear Secretary Bose:

In accordance with our responsibilities under the National Environmental Policy Act (NEPA), and Section 309 of the Clean Air Act, we have reviewed the Final Environmental Impact Statement (FEIS) for Algonquin's Incremental Market gas pipeline and related facilities in New York, Connecticut, Rhode Island and Massachusetts.

The proposed Algonquin project includes construction and operation of 37.6 miles of natural gas pipeline and associated infrastructure in New York, Connecticut, Rhode Island and Massachusetts. Seventy percent of the work entails replacement of existing pipelines with larger capacity pipe, and the balance of the work is associated with the installation of new pipeline including a new mainline, a loop and a lateral. The project also includes upgrades to existing compressor stations in New York, Connecticut, and Rhode Island.

As described in both the DEIS and FEIS, the majority of the proposed project entails replacement of an existing pipeline with larger pipe to increase capacity. EPA has actively participated as a cooperating agency throughout the FERC review process by offering detailed scoping comments on the project, comments on the interagency review draft of FERC's Administrative Draft Environmental Impact Statement (ADEIS), comments on the DEIS and observations on the Administrative Draft of the Final Environmental Impact Statement (AFEIS). EPA appreciated the brief opportunity to coordinate with FERC in advance of the publication of the FEIS as it provided an opportunity to more fully explain our comments on the DEIS. In addition to the comments on the FEIS provided here, EPA remains willing to work with FERC on this project in the future with a focus on the efficacy of project mitigation measures to address impacts.

Our previous comments on the DEIS focused on impacts to wetlands, drinking water, groundwater supply, greenhouse gas emissions, environmental justice communities, and air quality (during construction and operation of the pipeline). Generally, the responses provided to the majority of our DEIS comments are informative and helpful. The attachment to this letter

highlights several areas where more could be done to characterize and address project impacts. EPA also notes that on December 18, 2014, The Council on Environmental Quality (CEQ) published a draft guidance for public comment directing how Federal agencies should consider the effects of GHG emissions and climate change in NEPA reviews. EPA looks forward to working with FERC on other upcoming actions with the guidance in mind.

Please feel free to contact me or Timothy Timmermann of the Office of Environmental Review at 617/918-1025 if you wish to discuss these comments further.

Sincerely,

A handwritten signature in black ink, appearing to read "H. Curtis Spalding".

H. Curtis Spalding
Regional Administrator

Enclosure

Detailed Comments – Algonquin Incremental Market Project FEIS

Wetland Issues

EPA appreciates the responses provided to address wetland characterization, impact and mitigation issues we raised in response to the DEIS. We believe the information advances the discussion on these issues and will help support the ongoing review of the project under Section 404 of the Clean Water Act. Nevertheless, we note several outstanding concerns based on our review of the FEIS.

- EPA continues to believe that placing fill in wetlands is a direct impact. For example, backfilling trenches within new right of way (ROW) is considered a direct impact, which may result in either permanent or temporary impacts depending upon whether the resource is fully restored to its previous condition. We note that the FEIS was updated to itemize new ROW impacts. Also, we consider any permanent conversion of wetland type within the existing alignment as a permanent impact; for example, if project activities were to require expansion of permanently maintained areas into previously restored forested wetland areas. We intend to continue to participate in discussions regarding restoration and mitigation as part of the Corps Section 404 permit process for the project.
- EPA continues to recognize the placement of temporary construction mats, timber rip rap, etc. in wetlands, even though deployed as mitigative measures, as temporary wetland impacts that should be considered in the calculation of the total wetland impacts for the project. We are confident that this impact will be addressed in the Corps' Section 404 permitting for the project.
- EPA's comments on the FEIS requested additional analysis to determine if horizontal directional drilling (HDD) could be implemented to help reduce project impacts at stream crossing locations. We note that Algonquin has revised the project design to incorporate HDD at the Susquetonscut Brook (B13-ELR-S5B) crossing. EPA supports this approach, which will avoid and minimize impacts to the stream and adjacent wetlands.
- EPA believes that additional information is needed to understand the potential for impacts to streams from blasting and to determine the most appropriate mitigation measures for those impacts. It remains unclear whether the recommendation for providing blasting schedules for only designated coldwater fisheries and streams greater than 10 feet wide, along with the other measures described in the FEIS, is sufficiently protective of stream resources. The FEIS identified two streams - Susquetonscut Brook and the Unnamed Tributary to Stony Brook - as streams requiring time of year restrictions on blasting, and noted that additional restrictions may be required on a site-specific basis. EPA intends to work with the Corps and Connecticut Department of Energy & Environmental Protection (DEEP) to determine whether additional mitigation measures for blasting impacts are necessary for other streams in the project corridor.

We encourage FERC to be mindful of these issues as it works to develop final conditions and mitigation measures for the project certificate. Close interagency coordination will remain important to help successfully address these issues as the project continues through the FERC and Corps' Section 404 permitting processes.

Air Quality

EPA's comments during scoping, in response to the ADEIS and the DEIS, strongly recommended a commitment from Algonquin and a corresponding certificate condition by FERC to require specific measures during construction to help reduce and minimize air quality impacts. Our comments noted that these measures are not complicated to implement and they benefit residents in the project corridor during construction. The FEIS reports that, "Algonquin has committed to using ultra low sulfur diesel and best available technology on non-road engines where feasible." As of 2014 ultra-low sulfur diesel fuel is required for non-road applications. Despite the applicant's pledge, the lack of a FERC condition requiring the use of this technology provides little incentive and gives no certainty that these measures will be utilized for the project. We continue to encourage FERC to do more to reduce diesel emissions from the construction portion of the project, especially in populated areas, through the addition of a specific condition requiring these mitigation measures in the project certificate.

Enhanced Community Coordination

The FEIS response to comments section regarding Environmental Justice issues notes the commitment by Algonquin to prepare additional "fact sheets in Spanish to be posted on the Project website and to prepare notices regarding public meetings and, in the future, notices regarding construction information in Spanish for the identified Environmental Justice communities." Algonquin's willingness to enhance their community coordination for the balance of the project should be applauded. The commitment is the result of successful coordination between EPA and Algonquin during the EIS review process. EPA values the proponent's pledge to improve and enhance the communication with Spanish speaking populations in the project area. Better communication, regardless of whether the project will result in significant impacts to any particular community, and regardless of the language spoken in that community, is an important component of a successful project.

While we do not question the applicant's willingness to do more to communicate with the communities affected by the proposed project, EPA encourages FERC to make the requirement for community specific, language appropriate outreach a condition of project approval for this and other future projects. We disagree with the statement in the FEIS that "there is no need or requirement for additional measures, beyond those already proposed, to mitigate an impact that is not significant." The need for effective, targeted communication with the host communities exists regardless of the potential for impact, or the need for mitigation (in EJ and non-EJ communities alike). Language barriers can and should be overcome so that the public understands the potential for project impacts during construction and operation of the project and can effectively communicate with both FERC and the project applicant as appropriate. EPA looks forward to learning how FERC will incorporate the applicant's willingness to enhance project communication into the project authorization.

Greenhouse Gas Emissions

EPA notes and agrees with FERC staff acknowledgment that “disparate sources of greenhouse gas (GHG) emissions individually contribute to the global climate change issue.” As noted in our comments on the DEIS, we continue to believe that FERC should avoid the comparison of project related GHG emissions to those associated with an entire region. The goal of the analysis should not be to make emissions seemingly more or less significant; rather, it should be to disclose the emissions from the project in a manner that allows for an informed discussion of the emissions and measures that can be taken to address them.

EPA appreciates the information provided in the FEIS regarding Algonquin’s best management practices to minimize fugitive methane emissions and we encourage FERC to adopt those (applicant supported) measures as a condition of the project approval.

Cumulative/Indirect Effects

EPA continues to believe that the EIS should have more fully considered the potential for increased gas production associated with the development of project related pipeline capacity. In addition, we note that the FEIS discussion continues to make reference to gas extraction occurring more than 10 miles from the proposed project location as a rationale for limiting the discussion of cumulative impacts. Geographic proximity is not in and of itself the standard for NEPA’s requirement to consider impacts that have a reasonably close causal relationship to the proposed federal action.

We also continue to recommend that FERC consider relevant studies regarding methane leaks and emissions. With regard to EPA regulations concerning methane emissions from natural gas processing and transmission sources, please note that EPA is planning to issue a proposed rule later this year that will set standards for emissions from these sources (see “FACT SHEET: Administration Takes Steps Forward on Climate Action Plan by Announcing Actions to Cut Methane Emissions,” 1/14/2015, <http://yosemite.epa.gov/opa/admpress.nsf/6424ac1caa800aab85257359003f5337/8af2a9bcb2fd9d4f85257dcd0052a8fb!OpenDocument>). The link above provides information regarding EPA white papers that address various technical issues in the construction of gas pipelines. These papers may be helpful in developing estimated methane emissions from the entire project, as well as providing a basis for developing mitigation measures.

Document Content(s)

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