Prepared for:

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Risk Assessment of Alternative Gas Supply Options

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Appendix C

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1. Background

1.1. The STL Pipeline

The STL pipeline is a 65-mile long, 24-inch-diameter interstate natural gas pipeline system connecting the St. Louis metropolitan area to the 1,700-mile Rockies Express Pipeline LLC ("REX") pipeline. The STL pipeline is designed to provide up to 400,000 dekatherms ("Dth") per day of firm transportation services. Spire Missouri has entered a 20-year contract with the STL pipeline for 350,000 Dth per day of firm transportation service. Beyond the interconnection with REX in Scott County, Illinois, the STL pipeline also interconnects with the MoGas Pipeline LLC ("MoGas") and Enable Mississippi River Transmission, LLC ("MRT") downstream pipelines.

1.2. Scope of Work

CRA has been retained by Spire Missouri to provide an independent assessment of the risks associated with certain specified gas supply options to support winter heating demand, should the STL pipeline not be available for or beyond the 2021-2022 winter. Throughout this report, Spire and Spire Missouri are used interchangeably.

The work was performed during the period between October 11th and November 29th, 2021. The risk analysis covers operational risk, public safety impact, property impact, environmental impact, system integrity impact, supply security risk and permitting challenges. The analysis compares the STL pipeline to three alternative supply options identified by Spire Missouri. In addition, CRA considered the use of CNG. Given that CNG provides less than half of the energy content of LNG for a similar size vessel, this option was removed from consideration as impractical given the considerable supply gap created if the STL Pipeline were unavailable. The three alternative supply options considered in the following risk analysis include:

- **Continued operation of Line 880**: Line 880 is a section of Spire Missouri transmission pipeline that historically allowed Spire Missouri to receive gas from Enable MRT and transport it to its underground storage facility. This option requires a reestablishment of an interconnection between Spire Missouri's distribution system and the Enable Mississippi River Transmission, LLC's ("MRT") East Line via Line 880. Line 880 was installed in 1961 with a portion of the pipeline consist of electric resistance weld ("ERW") long-seam pipe; and
- **Propane vaporization:** This option involves the use of propane-peaking facilities at Catalan to vaporize liquid propane. The propane is stored at the Lange storage facility and transported to Catalan via a third-party open access products pipeline, for injection into Spire Missouri's distribution network to cover its peak-day capacity requirements; and
- **Micro-LNG:** This option involves Spire Missouri entering into an LNG supply agreement with a third-party to provide incremental supply and localized pressure support for Spire Missouri's distribution network. The envisioned service would provide 10,000 Dth/day of supply for up to 151 days for future winter seasons.

1.3. Assumptions and Limitations

In preparing this report, CRA primarily relied on data and documents provided by Spire to CRA, as well as public documents in the Spire certificate proceeding CP-17-40. The list of data and documents relied upon for the preparation of this report can be found in Appendix C.

2. Risk assessment of certain supply alternatives

2.1. Risk Assessment Approach

In this section, we present our assessment of the risks associated with gas supply options to replace the STL pipeline, should that not be available for or beyond the 2021-22 winter. The framework for risk assessment comprises seven risk factors as described below:

- **Operational risk:** This is an assessment of the likelihood, but not the magnitude, of an operational error and/or an incident outside of Spire's operational control that could lead to a detriment to public safety, property impact, environmental impact, and a compromise to the integrity of the local gas distribution system;
- **Public safety impact**: This is an assessment of the potential magnitude of direct harm to the public, operators or contractors should there be an abnormal operating condition and/or an incident outside of Spire's operational control;
- **Property impact**: This is an assessment of the potential magnitude of property damage should there be an abnormal operating condition and/or an incident outside of Spire's operational control. Property in this context include pipeline assets, third-party equipment, and other structures locating within the vicinity of the gas supply infrastructure;
- **Environmental impact**: This is an assessment of emissions, leakage, and spills or releases during transport and consumption;
- **System integrity impact**: This is an assessment of the scope of changes to the fuel delivery, increasing the likelihood of service disruptions;
- **Supply security risk**: This is an assessment of the risk to the ability of securing and delivering sufficient fuel supply when needed; and
- **Permitting challenges**: This is an assessment of the risk of securing the necessary permits on a timely basis.

We assess each risk factor in four levels of increasing severity, namely:

- **Low risk**: Operation is unlikely to lead to hazardous situations that may cause accidents or adverse impact, and even if it does, results in only negligible harm;
- **Moderate risk**: Operation will seldom result in hazardous situations that lead to accidents or adverse conditions that results in incidents and/or minor accident damage;
- **Elevated risk**: Operation may create hazardous situations that results in occasional accidents or adverse impact which may lead to accident level injury and equipment damage; and
- **Unacceptable risk**: Operation may create hazardous situations with a higher potential for accidents or materially adverse impacts leading to catastrophic equipment losses, injury, or death.

Figure 1 provides a summary of the risk assessment of the supply options, based on CRA analysis.

Figure 1 Summary of Risk Assessment of Supply Options Based on CRA Analysis

Risk Factor	STL Pipeline	Line 880	Propane Injection	Micro-LNG
Operational risk	Highly automated and monitored operations posing low risks	Aged infrastructure and manufacturing methods contribute to risks	Manual blending using old systems, requiring experienced operators	Require constant monitoring of pressure but state-of-art equipment mitigates risks
Public safety impact	Highly automated and monitored operations posing low risks	Antiquated infrastructure poses risks (ERW pipe). Large portion of pipe located in HCA	Above ground facilities located at low security site	Trucking in bad weather creates risk of road accidents
Property Impact	New materials and state of the art systems / requiring no new construction works	Adjacent properties could be impacted in the event of a release	Risk to appliances and vehicle damages due to exceeding propane interchangeability limit	Limited risks due to limited scale of operations and state-of-art equipment
Environmental impact	Gas transported through pipeline designed and constructed to meet and exceed current industry standards, posing low risk of leakage	Higher risk of gas release resulting from pipeline failure (SMYS > 30%) due to asset age and manufacturing method. Repair and testing work contribute to emissions. Infrastructure in EJ areas of concern	Potential for in-house emissions due to improper blending. Potential for increased emissions at fuel substation. Infrastructure in EJ areas of concern	Trucking of LNG and on-site generators release local emissions, and emissions related to liquefaction process
System integrity impact	Status quo	Asset previously scheduled for retirement due to age, materials and construction	Hydrotest required to check for integrity issues	Requires system change. Third-party interface (REV LNG)
Supply security risk	Extremely high reliability history for pipelines, especially those constructed to meet current industry standards	Risk of inability to re-certify Line 880 for maximum allowable operating pressure	Requires planning lead time for scheduling from third party open access "batched" pipeline supply	Dependence on up to 151 days of consecutive operation, risk of driver shortages and trucking in winter weather
Permitting challenges	Infrastructure in place and operational	Require permits for hydrostatic test	Requires air permits, and hydrotest could uncover issues	Require permits for tap and siting the peaker

Legend: **Low Risk** | **Moderate Risk** | **Elevated Risk** | **Unacceptable Risk**

Appendix C

2.2. STL Pipeline

2.2.1. Risk Assessment

Figure 2 below provides a summary of our risk assessment for the STL pipeline.

Figure 2 A Summary of Risk Assessment Associated with the STL Pipeline

Risk Factor	STL Pipeline
Operational Risk	●
Public Safety	●
Property Impact	●
Environmental Impact	●
System Integrity	●
Supply Security Risk	●
Permitting Challenges	●

Operational Risk

The STL pipeline was placed into service in 2019, making it one of the newest pipelines in the U.S. It was certificated by FERC after an exhaustive review of environmental impacts and construction practices. The operational record for pipelines in general is excellent. With a new pipeline, such as STL, constructed with state-of-the-art materials and construction procedures, the risk of any unintended release of natural gas is extremely low. The pipeline is also monitored 24/7 from a secure gas control center with automated operations including automated shutdown devices in the unlikely event of a gas release.

Public Safety Impact

Given the extremely low likelihood of natural gas releases since the pipeline is designed and constructed to meet or exceed current industry standards, as discussed above, the likelihood of any impact on public safety is also very remote.

Property Impact

As with public safety, absent any release of gas, the likelihood of property damage is extremely low.

Environmental Impact

As part of the original certificate review and certificate conditions, all possible steps were taken to mitigate construction and operating environmental impacts. Given the pipe is in service, well maintained and operating safely and the likelihood of any release is extremely low, the likelihood of future environmental impact should also be extremely low. Further, the STL pipeline was ranked superior to other supply options reviewed in this report.

System Integrity

The state-of-the-art STL pipeline has been integrated into the operation of the Spire Missouri distribution system with modern metering and regulating equipment, which like the pipeline is continually monitored with real time Supervisory Control and Data Acquisition ("SCADA") systems. The likelihood of any system integrity issues with this new system is extremely low.

Unlike Line 880, the STL Pipeline has also been designed to accommodate internal inspection tools.

Supply Security

Pipelines have the highest level of supply security of all of the supply resources available to natural gas utilities. STL receives its gas primarily from the Rockies Express Pipeline ("REX"). REX went into service in 2009 delivering gas from the Rockies Basin to markets in central and eastern U.S. In 2015, the REX pipeline was made bi-directional allowing gas to flow from both the Rockies and Appalachian basins, vastly improving its supply security from both a pricing and availability standpoint. STL also has interconnections with MoGas and MRT on the southern end of its system to add an added layer of supply security. For all the reasons stated above, and demonstrated during winter storm Uri, the likelihood of any supply disruption is extremely low.

Permitting Challenges

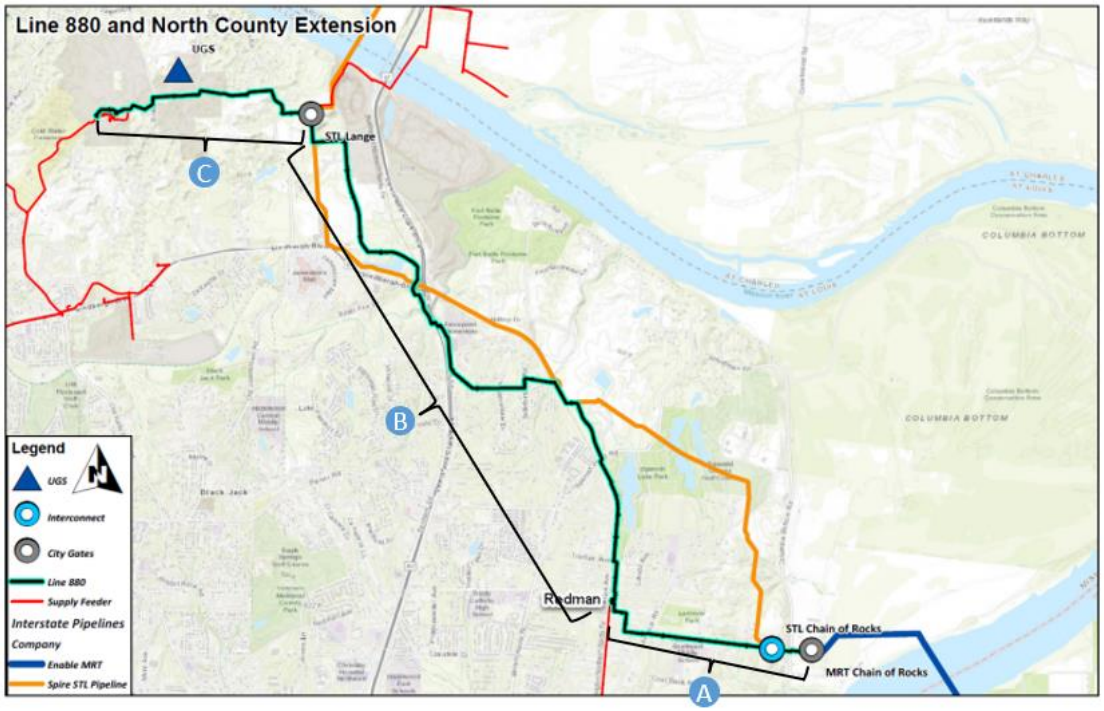
While STL is in the process of obtaining a permanent certificate from FERC, all other permits are in place. The pipeline is currently operating safely and reliably.

2.3. Continued Operation of Line 880

2.3.1. Overview and History of Asset

This option is in relation to the reconnection of Spire Missouri's system to the MRT system via a section of pipe known as Line 880 which consists of approximately seven miles of existing 20" pipeline.[1] Line 880 can be broken down into three distinct operating segments. The first segment (segment A) begins at the retired MRT Chain of Rocks meter station and continues west to Spire's Redmond station. While this pipeline segment will remain in service, with STL pipeline in service, it can operate at lower pressures as it will only be required to support local distribution load. Absent the STL pipeline, it will need to operate at transmission pressures as a feeder line. The second and longest segment (segment B) extends north from the Redmond station to the new STL Lange meter station. With the new supply from STL pipeline, this segment of Line 880 can either be derated or retired. The final segment of Line 880 (segment C) extends east from the STL Lange station west to Lange underground storage. This section will remain in service to move natural gas to the Lange storage facility.

Figure 3 Line 880 and Associated Facilities



While the use of Line 880 was included as part of several supply alternatives in the STL pipeline certificate process[2], these alternatives were deemed environmentally inferior, and FERC ultimately approved the STL pipeline in the Certificate Order[3] over the use of Line 880 in the final supply configuration. As a result, Line 880's supply from the Chain of Rock

1 *See* STL Pipeline LLC, *Resource Report 10*, pg 10-7

2 STL Pipeline Resource Report 10 Alternatives – CP17-40

3 *See* Docket No. CP17-40-007, Certificate Order

metering and regulation station was disconnected. In addition, MRT abandoned its East Line delivery infrastructure at Chain of Rocks and Spire Missouri's direct connection with MRT's East Line at Chain of Rocks was severed and replaced with a connection to the STL pipeline.[4] Thus, the receipt of gas supply from the MRT East Line will require a new interconnect at the Chain of Rocks station. The ultimate volume which could be flowed on this pipeline segment would be limited to the unsubscribed capacity available on MRT's East Line as well as the inlet pressure from MRT feeding Line 880.

History of the asset

The pipeline was installed in the 1960s and is comprised of electric resistance welded ("ERW") pipe and some spiral welded pipe.

The pipeline was constructed prior to the current pipeline safety regulations found in 49CFR192, which were instituted in the 1970s and govern the installation, operations and maintenance of natural gas pipelines across the United States. While the pipeline was constructed using best practices and industry standards prevalent during this time of construction, it was grandfathered from meeting the more stringent regulations when the regulations went into effect in the 1970s. One example is the current specified minimum yield strength ("SMYS") of the pipe is 49.19% at 880 psig, which puts it well above 350 psig which is required to keep it under 20% SMYS.[5] Pipelines with SMYS above 30%, due to higher pressure, have a greater tendency of leaking and/or failure, increasing risk. Since the pipeline SMYS is over 20%, it is considered a transmission pipe, which puts it under more stringent federal pipeline safety integrity management regulations.

In regard to Line 880, while there have not been any reportable incidents like the ones mentioned below, there is concern that the potential for such incidents exists if the line remains in transmission service. It should be noted that there was a rupture in segment C on Line 880 along a longitudinal weld whilst the pipe was being purged of air using Nitrogen during the commissioning stage. The ruptured pipe was replaced, eliminating any localized integrity issues found in commissioning. This would have been a reportable incident and a catastrophic failure if natural gas were in the pipe. Also, to address any similar issues, Spire replaced all main related to the commissioning rupture (0.312" wall thickness) with new stronger pipe with increased wall thickness (0.344" wall thickness) of approximately 2 miles.

Also, there is a section of the pipe that the Missouri PSC has required a pressure test on, in order to maintain current maximum allowable operating pressure ("MAOP"). The pipe has to be pressure tested to 1.5x MAOP. [6] The PSC Staff is focused on the seam on a section of pipe manufactured in 1961 being potential low frequency electric resistance weld ("LFERW") pipe, which is more susceptible to integrity issues and wants that to be pressure tested to confirm integrity. Spire cannot confirm whether it is or not, through paper records, so a sample would need to be extracted and sent to a lab for testing. The section of pipe also was not tested to 1.5x MAOP at the time of installation. The section identified is between New Jamestown & Bellefontaine to the Lange interconnect. Staff's position to pressure test has been a follow-up response to Spire from an audit in 2016. The pipeline issues referenced above occurred in Segment B of Line 880 between the Redmond Station and STL Lange Station. As discussed above, this segment can be derated below transmission pressure or retired with the STL pipeline in service.

4 *See* Docket No. CP17-40-007, Certificate Order, pg. 8

5 As per the definition for a transmission line in United States Code of Federal Regulations 49 § 192.3

6 Based on United States Code of Federal Regulations 49 § 192.619

Electric Resistance Weld ("ERW") Pipe

ERW is made from steel coil and the weld seam runs parallel to the pipe. ERW line-pipe materials and a similar material called electric-flash-welded ("EFW") pipe first appeared in the 1920s. Both processes involved making line pipe by cold forming previously hot-rolled plates or strips into round "cans" and joining the longitudinal edges of the cans by a combination of localized electrical resistance heating and mechanical pressure. The heat-softened edges were forced together extruding excess material to the outside and inside of the newly formed pipe. The excess material was immediately trimmed away leaving smooth surfaces or at most a small protrusion along the bondline. Both types of processes resulted in a narrow bondline and an associated local heat-affected zone. In many instances in the past and in all cases with modern ERW materials, the bondline/heat-affected-zone region was also subjected to a post-weld heat treatment, the purpose of which is to eliminate zones of excessive hardness from the initial welding process as such zones could be susceptible to various forms of environmental cracking.[7]

Spiral weld pipe, like ERW pipe, is also manufactured from steel coil but the difference is the coil is wound at an angle, so the weld runs around the outside of the pipe in the shape of a helix. Both of these types of steel pipe vary from the modern steel pipe used primarily in the natural gas industry today, which is welded circumferentially at the joint ends of pipe vs longitudinally or spiral welds.

This type of longitudinally and spiral welded pipe has historically proven to be a potential source for rupture and the issues with and incidents associated with ERW pipe have been well documented by various government agencies as cited below.

The Office of Pipeline Safety ("OPS")

The Office of Pipeline Safety and its successor the Research and Special Programs Administration ("RSPA") have issued two "Alert Notices" to operators of ERW pipelines on January 28, 1988, and March 8, 1989.[8] From the March 8, 1989, alert notice it cited, "In January 28, 1988, the Office of Pipeline Safety ("OPS") issued an Alert Notice advising pipeline operators who have pipe manufactured by the Electric Resistance Weld ("ERW") process of the occurrence of twelve hazardous liquid pipeline failures and of actions which operators may take to reduce the risks of similar failures. The continuing failure of ERW seams remains a matter of concern to the Research and Special Programs Administration ("RSPA"). Since the issuance of the Alert Notice, the RSPA has data on eight additional hazardous liquid pipeline failures and one on a gas transmission pipeline involving pipe seams manufactured prior to 1970 by the ERW process."[9]

The National Transportation Safety Board ("NTSB")

On 1 November 2007 a 12-inch diameter liquid propane pipeline operated by Dixie Pipeline Company ruptured in a rural area near Carmichael, Mississippi, resulting in two deaths, with seven others suffering minor injuries. The National Transportation Safety Board ("NTSB") determined that the significant length of the rupture that contributed to the large volume of

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7 Kiefner (Feb 2002), *Dealing with Low-Frequency-Welded ERW Pipe and Flash-Welded Pipe with respect to HCA related Integrity Assessments*

8 OPS and RSPA are the predecessors of PHMSA, the current federal agency tasked with oversight of the US pipeline system

9 RSPA (March 1989), *RSPA Alert Notice*

product released was due to running axial fracture in the longitudinal electric resistance weld ("ERW") seam used to make the pipe.[10]

Following their analysis, the NTSB issued Recommendation P-09-1 on the safety and performance of ERW pipe, which called on the PHMSA to conduct a comprehensive study to identify actions that can be implemented by pipeline operators to eliminate catastrophic longitudinal seam failures in ERW pipe. In the PHMSA study, conducted by Battelle, a leading research institution based in Columbus, Ohio, one conclusion was that "the data showed is the older the vintage of the ERW or flash-welded pipe prior to 1970, the more prone it is to seam defect problems." [11]

Representative of systemic issues with ERW pipe is the Rancho Pipeline, operated by the Kinder Morgan Company near Austin, Texas, which had ten incidents reported to the OPS from 1968 to 2002.[12]

Pipeline and Hazardous Materials Safety Board ("PHMSA")

In a report to PHMSA on Pipeline Corrosion, energy industry consultant Michael Baker stated that "Certain vintages of pipe, including pre-1971 manufactured low frequency electric weld resistance ("ERW") pipe, have exhibited seam-related problems that might be particularly susceptible to selective seam corrosion."[13]

Among the worst recent examples of ERW weld seam failures is the 2010 Kalamazoo River spill in Michigan. This largest, costliest inland spill in US history occurred along a 40-year-old reversed pipeline that was carrying diluted bitumen from the Alberta, Canada, tar sands. From an article written about the incident, ERW pipelines were discussed for their risk in the pipeline incident cited above and others stating, "Exacerbating the risks associated with old pipe is a lethal welding flaw that occurs in US pipelines built between 1930 and 1970. Although considered state-of-the-art when it was introduced, low-frequency electric resistance welded pipe ("ERW") was identified as prone to seam failures as early as the 1960s and phased out a decade later when it was replaced by stronger welding techniques. ERW failure has been blamed for a 1976 pipeline blast in Whitharral, Texas, that killed a young mother and her child. In the years since, at least 200 accidents have occurred along the same kind of welded pipe, resulting in at least 14 deaths, according to PHMSA."[14]

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10 Battelle (October 2013), *Final Summary Report and Recommendations for the Comprehensive Study to Understand Longitudinal ERW Seam Failures – Phase One*, pg 4.

11 Ibid., pg 41-42

12 Duckworth-Elder Consultants (June 2004), *Assessment of Pipeline Integrity of Kinder-Morgan Conversion Of the Rancho Pipeline*

13 Baker M. (June 2008), *Pipeline Corrosion Final Report to PHMSA*, pg 13

14 *See* Eberhart (Feb 2014), *The Trouble with Aging Pipelines: Too Many Candles on the Cake Can Spark Disaster*, available at https://canaryusa.com/aging-us-pipelines/; accessed on November 4th, 2021

Figure 4 ERW Longitudinal Failure[15]

2.3.2. Continued operation of Line 880

Continued dependence of the Chain of Rocks to Redmond (Segment A) and Redmond to Lange (Segment B) pipeline segments of Line 880 at transmission pressures raises a number of concerns due to the age of the pipeline, potential for leaks and its operating history, especially given the broader concerns around ERW type pipe. The pipeline is nearly at its end of life and issues discussed will continue and prohibit it from becoming an appropriate option as a Department of Transmission defined transmission pipeline. ERW pipe has been proven to be susceptible to corrosion and subsequent failure along the longitudinal weld and while Spire did a good job keeping the pipeline functioning without incident, there is significant risk in utilizing this pipeline segment in transmission service, to provide a portion of the gas supply needs, vs. using a modern pipeline like the STL pipeline, which is essentially risk free comparatively.

Required New Interconnection with MRT

Spire Missouri has already begun evaluating rebuilding the interconnect but estimates a new interconnection at this site would take 9 to 12 months to construct.[16]

2.3.3. Risk Assessment

Figure 5 below provides a summary of our risk assessment for the continued operation of Line 880. While individual risk elements by themselves are a concern, the cumulative impact

15 *Ibid.*

16 *See* Docket No. CP17-40-007, STL Responses to FERC data requests, Question 2, b

of the broad risk elements renders the operation of Line 880 as a transmission feeder as an unacceptable outcome of the current events.

Figure 5 A Summary of Risk Assessment Associated with Line 880

Risk Factor	Transmission pressures in Line 880	STL Pipeline
Operational Risk		
Public Safety		
Property Impact		
Environmental Impact		
System Integrity		
Supply Security Risk		
Permitting Challenges		

As shown in Figure 5 above, most risk factors for the Line 880 option, indicate elevated risk with one moderate risks and no low-risk items involved. Specifically, operational risk, public safety impact, property impact, supply security risk, permitting challenges are elevated because Line 880 is an aged infrastructure and expedited testing and repairs and continued operation in general of such an asset will contribute to elevated risks, as the line is antiquated infrastructure (ERW pipe), spiral welded pipe adjacent to properties that could be impacted in the event of a release.

Operational Risk

This option would add additional complexity to the system and require more hands-on work. Overreliance on Line 880, especially as a transmission feeder line will be very challenging and inappropriate due to the risk, safety and reliability factors involved.

There is higher risk of gas leakage due to asset age / repair and testing work which contributes to emissions of an asset previously scheduled for retirement or derating due to age, materials and construction.

As the use of the STL is simpler and involves fewer separate elements, it would by definition incur less risk to operational safety than the use of Line 880.

Insomuch as each added element of the system increases risk, attempting to acquire multiple assets to perform the same function as the STL will likely increase operational risk – and with reduced peak supply.

Overall, the risks delineated above make this option inappropriate.

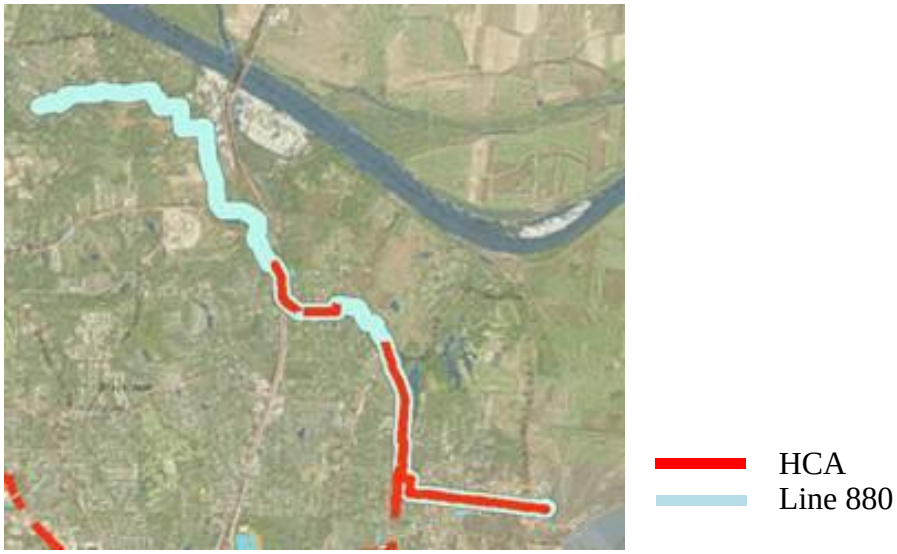
Public Safety Impact

The STL pipeline is very new and is constructed using modern best practices, modern materials, and corrosion prevention. Attempting to utilize any other infrastructure such as Line 880, especially as a transmission feeder, will result in a system with a greater chance of leaks, failures or other issues – particularly since it was installed in 1961 and is nearly 60 years old.

With this option comes an increase in chance of leaks or failures and related increased risk to human health over the use of the STL. One important and accepted measure of public safety

is the identification of High Consequence Areas ("HCA") along a pipeline route.[17] A review of Line 880's path indicates that over 48% of the line's route is contained in HCAs. This is shown in Figure 6 below where Line 880 is shown in light blue, and HCAs are shown in red. As described above, the segments of Line 880 in the HCA areas are the very segments which may be derated or retired with STL pipeline in service. Given the previously discussed elevated risks associated with this pipeline segment, it would create an unacceptable risk in populated areas.

Figure 6 Overlap between Line 880 and HCA



Further, in the event of any failure on the line, it will take time to safely restore service since this must be done on a customer-by-customer basis in person rather than remotely as with electrical outages. This could leave customers without gas for a dangerous amount of time – as seen in the 2020-2021 winter season in the South-Central parts of the country.

As such, it appears that this option incurs a higher risk to human health than the use of the STL pipeline.

17 HCA is defined as the area within a potential impact circle containing: (i) 20 or more buildings intended for human occupancy, unless the exception in paragraph (4) applies; or (ii) An identified site. An identified site being: (a) An outside area or open structure that is occupied by twenty (20) or more persons on at least 50 days in any twelve (12)-month period. (The days need not be consecutive.) Examples include but are not limited to, beaches, playgrounds, recreational facilities, camping grounds, outdoor theaters, stadiums, recreational areas near a body of water, or areas outside a rural building such as a religious facility; or (b) A building that is occupied by twenty (20) or more persons on at least five (5) days a week for ten (10) weeks in any twelve (12)-month period. (The days and weeks need not be consecutive.) Examples include, but are not limited to, religious facilities, office buildings, community centers, general stores, 4-H facilities, or roller skating rinks; or (c) A facility occupied by persons who are confined, are of impaired mobility, or would be difficult to evacuate. Examples include but are not limited to hospitals, prisons, schools, day-care facilities, retirement facilities or assisted-living facilities.

Property Impact

As discussed above, the STL pipeline is very new and is constructed using modern best practices, modern materials, and corrosion prevention. The utilization of any other older infrastructure, such as the 60-year-old Line 880, will result in a system with a measurably greater chance of leaks, failures, or other issues.

The STL pipeline has been installed and is operational. There does not appear to be any additional work required to continue the use of STL pipeline that would impact the risk to property.

Therefore, this option of using Line 880 as a transmission feeder main appears to have greater risk to property than continuing to utilize the STL pipeline.

Environment Impact

As a 60-year-old pipe, Line 880 will inherently experience more leaks than new pipe with modern materials and corrosion mitigation. Line 880 has been in the ground for 60 years and it is clear that the use of this line will result in greater emissions than the use of STL. Any hydro testing, repairs and other work required to get Line 880 back to its pre-STL operation will also have more environmental impact than using the STL which is already installed and in service.

We have also considered the environmental justice indicators ("EJ indexes") of the areas within which the infrastructure associated with the STL pipeline and Line 880 are located, based on the Environmental Justice Screening and Mapping Tool ("EJSCREEN") created by the United States Environmental Protection Agency ("EPA"). The EJ index is defined as:

> *"a combination of environmental and demographic information. The EJ index highlights block groups with the highest intersection of low-income populations, people of color, and a given environmental indicator."*[18]

The formula for the EJ index is:

$$\text{EJ Index} = (\text{Environmental Indicator}) \times$$

$$(\text{Demographic Index for Block Group - Demographic Index for US}) \times$$

$$(\text{Population Count for Block Group})$$ [19]

The EJSCREEN tool reports the EJ indices as percentiles, i.e. how is the EJ index for the area ranked against other areas across the United States. The higher the percentile is, the higher the worse the environmental *in*justice is. The EPA considers an area with a percentile value above 80 to be an area of concern for which to consider additional information.[20]

It is important to note that the EJ indices provide a snapshot of the *current* environmental and demographic condition in the area. It does not consider future potential risks. It is not an indication of the environmental impact or the condition of the asset of the alternative supply options being considered for this report. It is simply the environmental justice condition of the site as it is today.

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18 Environmental Protection Agency, *EJSCREEN Map Descriptions*, available at https://www.epa.gov/ejscreen/ejscreen-map-descriptions; accessed on November 4th, 2021

19 Ibid.

20 Ibid.

In addition, we noted that Spire STL Pipeline has filed a preliminary environmental justice impact assessment prepared by AECOM to support its request for expedited reissuance of certificates.[21] The AECOM report assessed the environmental justice conditions along the route of the Spire STL pipeline, and identifies the environmental justice communities of concern that would be impact by potential service outages due to the removal of the STL pipeline from service.

The environmental justice analysis in this report complements the AECOM analysis. This report focuses on identifying the environmental justice communities of concern along the routes of the alternative supply options that would be impacted should the risk issues we identified for each alternative supply option occur.

Table 1 below compares the EJ indices of Line 880 against the STL pipeline. The Table shows that the EJ indices for Line 880 are generally at a higher percentile relative to the STL pipeline. In particular, there are five environmental aspects for which the EJ index exceeds 80 for Line 880, including Ozone, Diesel Particulate Matter, Lead Paint Indicator, and Superfund Site Proximity and Wastewater Discharge Indicator. There is one environmental aspect for which the EJ index exceeds 80 for the STL pipeline. Therefore, any incident on Line 880 would further exacerbate the environmental injustice in areas that already have relatively worse environmental outcomes relative to the areas where the STL pipeline is located. Therefore, the use of Line 880 appears to result in greater environmental risk than the continued use of the STL pipeline.

21 See Docket No. CP17-40-000, Request of Spire STL Pipeline LLC for Expedited Reissuance of Certificates under CP17-40, Attachment E

Table 1 Comparison of EJ Indicators between Line 880 and the STL Pipeline

EJ Index	STL Pipeline Right of Way	Line 880 Right of Way
Particulate Matter	74	79
Ozone	74	81
NATA Diesel Particulate Matter	78	81
NATA Air Toxics Cancer Risk	74	79
NATA Respiratory Hazard Index	73	77
Traffic Proximity and Volume	66	66
Lead Paint Indicator	76	86
Superfund Proximity	79	82
Proximity to Risk Management Plan Facilities	70	73
Hazardous Waste Proximity	69	70
Wastewater Discharge Indicator	99	98

System Integrity

The system changes that would need to be made for this option to be implemented would inherently increase the complexity of the system. Adding additional system elements, each with their own maintenance and operational needs would increase the effort required by Spire Missouri to maintain system integrity.

If Line 880 were to flow transmission pressure gas from the recommissioned Chain of Rocks station, we understand that the Missouri PSC Staff has recommended, in its correspondence with Spire, that the Line in an HCA have to be pressured tested.

There are no system changes that would need to be made for the STL pipeline to continue to operate. As such, it appears from our analysis that this option would result in increased risk to system integrity.

Supply Security

Maintaining Line 880 in transmission service would necessitate a great deal of ongoing monitoring of the condition of the pipeline segment. Spire has indicated that segments are in disrepair and likely in need of work or replacement before it can be used. In addition, the Missouri PSC staff has required the pipe to be pressure tested as a result of an audit in 2016, which may reveal additional issues.

There are no similar issues with using the STL pipeline.

Permitting Challenges

As noted earlier, Line 880 would need to be hydrostatic tested if it were to flow transmission pressure gas from the recommissioned Chain of Rocks station. Conducting a hydrostatic test would require permits, which represent a challenge for this option.

2.4. Propane

2.4.1. Overview of Supply Option

In order to address the loss of supply deliverability from the removal of the STL pipeline from Spire Missouri's portfolio, the Company has looked at multiple alternate supply options.

This option involves injecting vaporized liquid propane into Spire's local distribution system in order to maintain pressure and provide additional peak capacity to meet the requirements. The propane supply will come from the propane underground storage cavern at Lange. The cavern has a storage capacity of 750,000 barrels. Historically, the propane could be vaporized and injected into the Spire distribution system near the storage cavern (Lange) or transported from the propane underground storage at Lange to Spire's southern propane vaporization point at Catalan through a system of pipelines as shown in Figure 7 below.

These facilities include two propane vaporization installations that, when operational, provided approximately 160,000 Dth/day.[22] The STL pipeline eliminated Spire Missouri's need to rely on these liquid propane peak-shaving facilities, and so these have been retired. The industry has been moving towards less reliance on propane facilities when pipeline capacity becomes available that can meet full supply needs.[23] Note however that unlike other propane facilities in the industry that are usually propane-air, Spire's facilities use pure liquid propane.

This option would require the replacement of some portions of the facilities, as well as integrity work involving the propane pipeline supply system.[24] Furthermore, this option relies on historical supply capabilities for mixing pure propane with flowing natural gas. When these facilities were functional, they were designed to provide up to 160,000 Dth/day of propane.[25] If reestablished, Spire estimates that the design capacity of each facility is 80,000 Dth/day of propane supply. However, interchangeability limits and the volumes of gas flow at the interconnects nearest to the Catalan facility reduces actual capacity to between 53,718 Dth/day and 59,267 Dth/day, as discussed later in Section 2.4.2. This capacity is based on unrestricted downstream take-away capacity from the Catalan facility interconnect with the Spire distribution network. If downstream capacity constraints exist, Catalan's propane injection capacity could be reduced.

This particular situation, of take-away constraints, exists at the Lange site. Through discussions with Spire's operating personnel we have learned that take-away capacity from the Lange site is approximately 360,000 Dth/day. This take-away capacity is shared with withdrawals from the Lange natural gas storage facility. Given the storage withdrawal capacity is 357,000 Dth/day, virtually all propane injections would physically back off storage volumes which could be withdrawn. While this would severely limit the ability to use both

22 Spire Temp Certificate Application, Pg. 4 Paragraph 9. The potential effective capability of the facility is discussed further below in this report.

23 See for example Duke Energy Ohio's decision to retire its propane-air peaking facilities, available at https://www.duke-energy.com/home/natural-gas-projects/central-corridor-pipeline-ext. Also see Docket DG 12-001, Direct Testimony of George R. McCluskey in the Matter of EnergyNorth Natural Gas, Inc. Investigation into Excess Capacity, Pg. 12

24 Spire Missouri is currently pursuing efforts to reestablish the facilities and ability to vaporize liquid propane at the Catalan location for this upcoming winter.

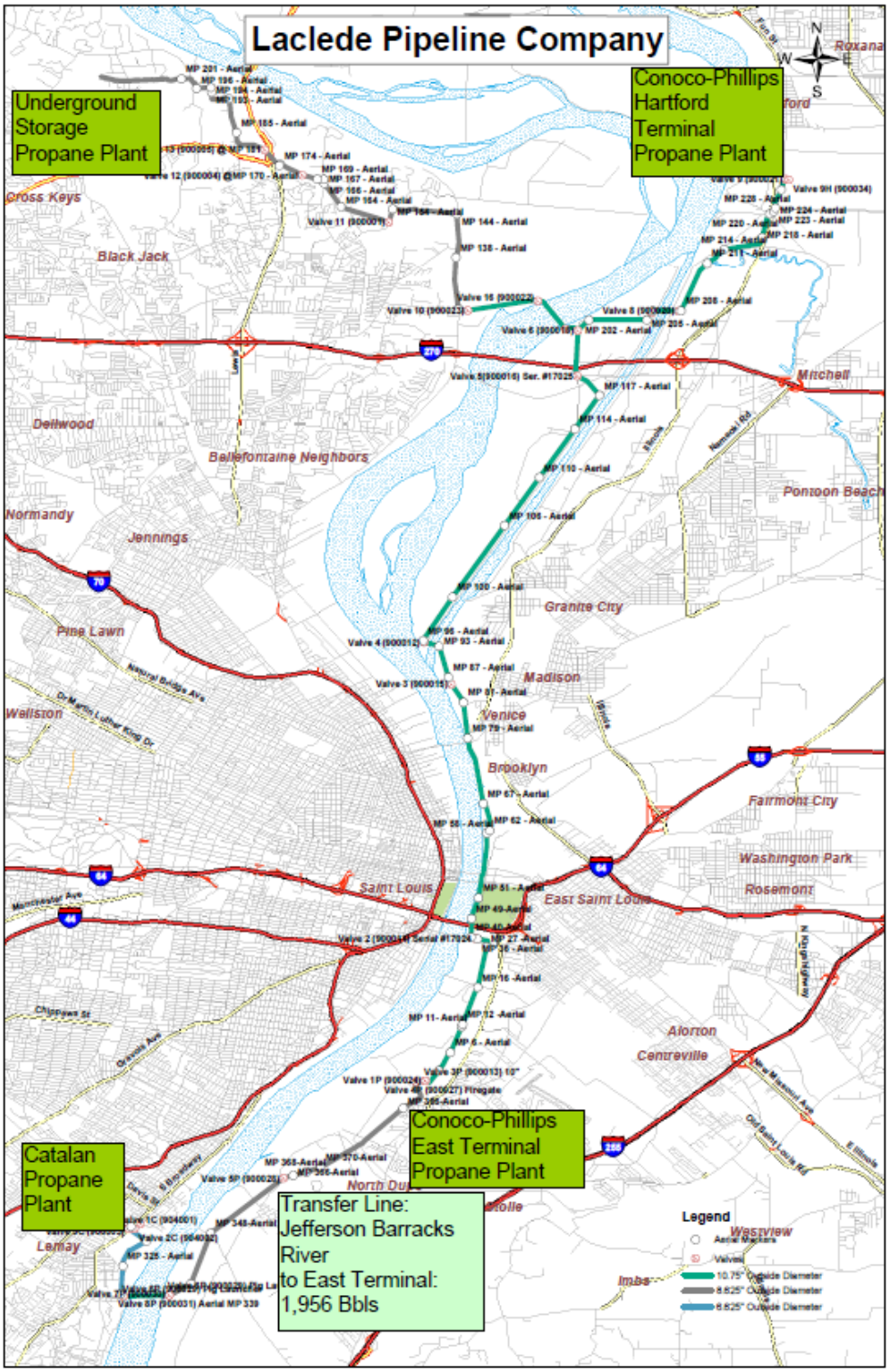
25 Spire Temp Certificate Application, Pg.17 Paragraph 44. The potential effective capability of the facility is discussed further below in this report.

propane injection and storage withdrawals at Lange to provide incremental support for peak day requirements (above the 360,000 Dth/d downstream capacity limitation), reactivation of the Lange propane injection facility would allow Spire to better manage their limited winter inventories of LNG, propane and onsite natural gas storage. In the event that Spire chose to dispatch propane from the Lange site rather than storage withdrawals, the maximum propane injection at the Lange site would be limited to approximately 67,000 Dth/d. This is based on the downstream limitation of 360,000 Dth/d, and the 8% volumetric interchangeability limit calculated below.

A section of the pipeline to be used to ship propane to Catalan is shared with Conoco-Phillips refineries (identified in Figure 7 below). The local refineries are currently using the pipe to ship butane for processing as well. As such, the line would have to be cleared of butane before propane can be transported from Lange to Catalan. This will require coordination with the local refineries in terms of scheduling.

In order for Spire to activate this option, several prerequisite actions must be taken.

Figure 7 Map of Spire's Propane System



Refurbishment and Testing of Propane Vaporization Facilities

The propane vaporization facilities at Lange and Catalan must be replaced and/or refurbished and tested before resuming operations. With respect to the Lange vaporization facility, Spire Missouri indicates that at this facility, propane heaters/vaporizers have been modified, physically moved, and re-purposed as natural gas heaters for withdrawal of gas.[26] In order to resume operation at Lange, Spire would be required to:

- purchase a new pre-heater and another pre-heater/vaporizer, replace the 12" valve (P-45) and the 12" vapor piping that connects to the supply feeder system, replace the 6" regulator system (P-2), and replace the Bingham pump system (three pumps) to pump the liquid propane to the vaporizer system;
- modernize controls and train operators; and
- obtain/modify its St. Louis County air permits to include the pre-heater and vaporization equipment in order to install the equipment.

With respect to the Catalan vaporization facility, Spire indicates that the source of propane on the propane supply pipeline has been physically disconnected from the propane vaporization equipment.[27] In addition to having to reconnect the propane pipeline to the vaporization equipment, there are additional challenges associated with shipping propane from the Lange storage cavern to the vaporization facility as discussed below. Finally, if the propane facility is deemed to be required for an extended period of time, the equipment and controls should be modernized.

Refurbishment and Testing of the Propane Supply Line

As noted above, a section of the pipeline ("the Transfer Line") that connects the propane storage cavern at Lange to the Catalan vaporization facility, constructed in the 1930s, was in the process of being abandoned. Even if the Transfer Line is not abandoned, Spire would be required to do a hydrostatic test to keep it in compliance.[28] Pipe of this vintage has been exposed to corrosive elements for many years. After 80-90 years of exposure to the elements, there is risk that the hydrostatic test may uncover additional integrity issues which would need to be resolved prior to placing the line back into service.

Acquisition of Fuel

Spire indicated that the Company has access to 185,000 barrels in the propane storage cavern at Lange. This would be enough for a normal or typical winter season if it could be delivered and vaporized.

The pipeline that is used to transport propane to Catalan is also now generally used to move butane for refineries in the area and would have to be cleared of butane to transport propane requiring lead times well in excess of the times required to schedule pipeline gas. Changes in weather forecasts and or demand forecasts would present challenges to timely receipt of propane.

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26 *See* STL Responses to FERC DRs, Question 14

27 *See* STL Responses to FERC DRs, Question 14

28 Spire Missouri is working with Spire NGL to have these necessary tests performed.

There is also limitation on the amount of vaporized propane that can be injected to the distribution system at a particular time, which further limits the capacity of the propane option during peak. This is discussed further in Section 2.4.2.

Training of Staff

Spire Missouri has indicated that the dispatching of propane from its vaporization facilities was historically done manually. If this option were to be put back into service, then the dispatching of propane would still need to be done manually in severe weather conditions. Spire has indicated that some staff who have performed this work in the past are still employed by the Company, but that refreshing training would need to be done.

Figure 8 Example of unprotected operating environment[29]

29 Spire Missouri Propane Operating Procedures documentation

Figure 9 Manual operations subject to severe weather conditions

Re-training on how to safely operate and maintain the facilities must also be done. This is particularly important given the aging infrastructure that would need to be relied on in order to activate this option. Further, Spire staff indicated that the mixing of propane into natural gas is done manually, so there is room for error if staff are not fully trained and competent. Inaccuracies in blending can lead to issues ranging from the failure of all CNG vehicles using the blend all the way to incidents at the point of use in residential, commercial, and industrial customers.

As such, it is imperative that staff be fully trained in propane dispatch, facility operations, and facility maintenance. It may be possible that Spire could supply and train the staff necessary but the impact on current operations could be an issue and should be evaluated.

2.4.2. Interchangeability

Interchangeability is defined as:

> *"The ability to substitute one gaseous fuel for another in a combustion application without materially changing operational safety, efficiency, performance or materially increasing air pollutant emissions."*[30]

In order to assure safe and reliable service at consumer end use equipment, when introducing mixed gases into a pipeline network, specific concentrations of supplemental gases must be monitored and maintained. The most recent published analysis of gas interchangeability recommendations, to the authors' best knowledge, was filed as part of the

30 Natural Gas Supply Association (Feb 2005), *Natural Gas Interchangeability and Non-Combustion End Use*

Federal Energy Regulatory Commission ("FERC") Docket PL04-3-000[31]. While the proceeding was specifically focused on understanding the impacts of new LNG deliveries, the formulas governing gas quality requirements remain the same.

As part of this proceeding, the Natural Gas Supply Association ("NGSA") filed a technical white paper entitled *Natural Gas Interchangeability and Non-Combustion End Use* on February 28, 2005. In that paper, the following guidelines were presented.[32]

> *A range of plus and minus 4% Wobbe[33] Number Variation from Local Historical Average Gas or, alternatively, Established Adjustment or Target Gas for the service territory.*
>
> *Subject to:*
>
> *Maximum Wobbe Number Limit: 1,400*
>
> *Maximum Heating Value Limit: 1,110 Btu/scf*

The report presented interim guidelines for gas interchangeability limits stating that

> *"The interim guideline limits proposed in this document have been developed for new gas supplies to those market areas without extended experience with gas supplies characterized by Wobbe Numbers higher than 1,400 or gross heating values higher than 1,110 Btu/scf."*[34]

This guideline applies to Spire given the pipelines serving this market all operate well below the upper limit of 1,110 Btu/scf. The actual heating value of natural gas delivered to Missouri consumers over the last 14 years (2007 through 2020) has averaged 1,015 Btu/scf.[35]

Determination of Interchangeability limits at Spire Missouri's Catalan Propane Plant

The first step in arriving at interchangeability limits is to determine the gas quality of the flowing natural gas at the point of injection. For these values we are using the gas sample analysis provided by Enable Mississippi River Transmission at their Ameren Meramec Missouri station (Loc. 808368)[36] for the period of October 20, 2021, through October 26, 2021. For this period the average specific gravity observed was 0.5818 and the average heating value of the gas stream was 1,017 btu/scf.[37] Applying the maximum Wobbe Index guideline of 1,400 would limit the pure propane to 8% of the total flowing gas volume. The calculation is shown in Box 1 below.

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31 Federal Energy Regulatory Commission (Jun 2007), *Policy Statement on Provisions Governing Natural Gas Quality and Interchangeability in Interstate Natural Gas Pipeline Company Tariffs, Docket Pl04-3-000, pg 7*

32 Natural Gas Supply Association (Feb 2005), *Natural Gas Interchangeability and Non-Combustion End Use*, pg 27

33 The Wobbe Index and Natural Gas Interchangeability, *Wobbe Index = (Btu/scf)/√specific gravity; Application Data Document 1660AD-5a, 7/30/2007, Emerson Process Management*

34 Natural Gas Supply Association (Feb 2005), *Natural Gas Interchangeability and Non-Combustion End Use*, pg 26

35 Energy Information Administration, *Natural Gas – Heat Content of Natural Gas Consumed*

36 Mississippi River Transmission EBB, *Gas Quality – Daily Average Samples Report*

37 See Appendix D

Box 1: Calculation of Interchangeability Limits at Catalan Propane Vaporization Facility

The Wobbe Index is defined as:

$$\text{Wobbe Index} = \frac{V_C}{\sqrt{G_s}}$$

Where V_C is the higher heating value in British thermal units ("BTU") per standard cubic foot ("SCF"), and G_s is the specific gravity of the gas.

The Wobbe Index of the flowing natural gas at the point of injection, based on the gas sample at the Ameren Meramec Missouri station, is

$$\text{Wobbe Index of Flowing Gas} = \frac{V_C}{\sqrt{G_s}} = \frac{1{,}017}{\sqrt{0.5818}} = 1{,}334$$

The Wobbe Index of vaporized propane gas is[38]

$$\text{Wobbe Index of Propane} = \frac{V_C}{\sqrt{G_s}} = \frac{2{,}522}{\sqrt{1.52}} = 2{,}045$$

Applying the maximum Wobbe Index guideline of 1,400 would limit the pure propane to 8% of the total flowing gas volume as shown below

$$\text{Wobbe Index of Mixed Gas at 8\% Propane} = (1{,}333 \times 0.92) + (2{,}045 \times 0.08) = 1{,}390$$

Applying the 4% +/- rule, we can see that the Wobbe index of the mixed gas with 8% propane is just slightly above the 4% guideline

$$\text{Maximum Wobbe Index} = \text{Wobbe Index of Flowing Gas x } 1.04 = 1{,}333\ x\ 1.04 = 1{,}387$$

In addition, calculating the mixed gas heating value results in a value just slightly above the maximum heating value presented in the guideline of 1,110 Btu/scf result. The resulting heating value is, however, within the range of acceptable heating values of 950 and 1,150 btu/scf established in the STL pipeline tariff[39]

$$\text{Heating Value of Mixed Gas} = (1{,}017 \text{ x } 0.92) + (2{,}522 \text{ x } 0.08) = 1{,}137 \text{ btu/scf}$$

Utilizing the measured heating value (Btu/scf) and specific gravity of flowing gas into the Spire Missouri system[40], an 8% mixture of pure propane and 92% flowing (pipeline) natural

38 See *Application Data Document 1660AD-5a, 7/30/2007, Emerson Process Management*

39 See STL Pipeline FERC Tariff General Terms and Conditions, Section 4.2(j)

40 Mississippi River Transmission EBB, *Gas Quality – Daily Average Samples Report*

gas would represent the upper limit of propane as a supplemental gas while reasonably satisfying the generally accepted criteria for safe and reliable service.

Maximum propane injection for Spire's peak day operations

Based on the analysis presented above, the maximum propane gas which could be supplemented into the Spire Missouri system on a peak day would be between 21,300 Mcf/d and 23,500 Mcf/d. This maximum volume is based on experienced winter day gas flow of 245,000 Mcf/d and 270,000 Mcf/d from the Ivory interconnect which feeds gas past the Catalan Propane Plant.

$$Propane\ Volume_{Catalan} = \frac{Flowing\ Gas\ Volume_{Catalan} \times 0.08}{0.92} = \frac{245{,}000 \times 0.08}{0.92} = 21{,}300\ \text{Mcf/d}$$

Given that flows past the Catalan plant will vary considerably between peak morning deliveries and overnight minimum deliveries, hourly (or more frequent) monitoring and adjustment of the equipment will be required on a 24/7 basis.

In order to properly assess the incremental energy delivery to Spire's customers, an additional calculation to adjust for heating value needs to be conducted. The heating value of the propane injected into the Spire distribution system is 2,522 Btu/scf. Applying this heating value to the volume of flowing gas would result in gas supply available from the Catalan facility of between 53,718 Dth/day and 59,267 Dth/day This is lower than the design capacity of the Catalan facility of 80,000 Dth/day due to the interchangeability limit and the projected gas flow at the Ivory interconnect.

Implications of exceeding interchangeability limits on end use equipment

Varying natural gas composition beyond acceptable limits can have the following effects in combustion equipment.[41] This is of particular concern given that Spire Missouri's propane operation involves the direct injection of pure propane into their distribution system rather than the industry practice of injecting a mixture of propane and air (generally a 50/50 mix).

- In appliances, it can result in soot formation, elevated levels of carbon monoxide and pollutant emissions, and yellow tipping. It can also shorten heat exchanger life, and cause nuisance shutdowns from extinguished pilots or tripping of safety switches.
- In reciprocating engines, it can result in engine knock, negatively affect engine performance and decreased parts life.
- In combustion turbines, it can result in an increase in emissions, reduced reliability/availability, and decreased part's life.
- In appliances, flame stability issues including lifting are also a concern.
- In industrial boilers, furnaces, and heaters, it can result in degraded performance, damage to heat transfer equipment and noncompliance with emission requirements.

Given the operational complexity and risks associated with Spire Missouri's propane facility, and the fact that the Catalan facility would be limited to replacing just 15-17% of the STL pipeline's firm flowing gas energy content, CRA does not view propane injection as a prudent alternative to the STL pipeline for reliably serving Missouri's winter heating requirements.

41 Natural Gas Supply Association (Feb 2005), *Natural Gas Interchangeability and Non-Combustion End Use*

2.4.3. Risk Assessment

Figure 10 below provides a summary of our risk assessment for the propane supply option.

Figure 10 A Summary of Risk Assessment Associated with Propane Vaporization

Risk Factor	Propane Vaporization	STL Pipeline
Operational Risk	🟠	🟢
Public Safety	🟠	🟢
Property Impact	🟠	🟢
Environmental Impact	🟠	🟢
System Integrity	🟡	🟢
Supply Security Risk	🟠	🟢
Permitting Challenges	🟠	🟢

Operational Risk

The use of propane-air as a blended fuel is uncommon but does exist across the country as an emergency peak shaving method. Spire's use of liquid propane is very unusual, and to our knowledge, does not exist elsewhere in the country. Therefore, the operation of propane blending facilities is significantly different than any natural gas facilities, and as such – employees must be trained on these operations.

New England, despite its well documented pipeline constraints, has experienced material reductions in propane-air capacity. In 1989, just prior to the construction of the Iroquois Pipeline, 20 natural gas utilities vaporized propane to meet winter peak demand with a total capacity of 593,901 MMBtu/d. Today only 5 natural gas utilities operate propane-air plants with a combined capacity of 99,908 MMBtu/d. This represents an 83% reduction in capacity over the past 32 years.[42] We note that these New England facilities are all propane-air, which further emphasize the uniqueness of Spire's facilities which rely on liquid propane.

Given these operational differences, the use of the propane vaporization option would result in an elevated risk level over the use of the STL pipeline.

Public Safety Impact

The propane vaporization facilities are above ground, subject to winter weather and not in fully secured site. This by itself raises the risk the public safety of this supply option relative to the STL pipeline, which is below ground. In addition, propane is heavier than air and can 'pool' in structures if a leak is present, which exacerbates the potential for an accident.

Regardless, the use of unblended propane is always going to result in greater risk to public safety than the use of pipeline gas. As such, this option is rated as having an elevated risk level relative to the STL pipeline.

Property Impact

Propane has a higher energy content and is more dense than natural gas. As such, it is typically necessary to blend the propane with air in order to reduce the resulting blend's energy content and density to values that match natural gas. A system, like Spire Missouri's,

42 Northeast Gas Association

that contains unblended propane may have impacts to end users such as industrial clients that rely on carefully moderated fuel.

Additionally, blended propane fuels at the percentages Spire used historically could cause issues with CNG vehicles – including those that the Company uses. Spire has discussed dropping the percentage blended to mitigate this, but there is still a potential impact on this equipment.

As such, the use of propane in the Company's system would increase the risk to property over using the STL.

Environment Impact

A blend of too high concentration or one that is not dispatched correctly can result in additional emissions at end use. In addition, this option is a peak shaving option and, as such, would likely be activated after customer curtailment. To the extent that the curtailed customers substitute gas with a higher carbon intensity fuel, emissions at end use will also increase relative to supplying gas through the STL pipeline.

Table 2 below compares the EJ indices of the propane option against the STL pipeline. Again, it is important to note that the EJ indices provide a snapshot of the *current* environmental and demographic condition in the area. It does not consider future potential risks. It simply indicates the environmental justice condition of the site as it is today.

Table 2 shows that the EJ indices for the propane option are generally at the same or higher percentiles relative to the STL pipeline. In particular, there are four environmental aspects for which the EJ index exceeds 80 for this option, including Lead Paint Indicator, Superfund Site Proximity, Proximity to Risk Management Plan Facilities and Wastewater Discharge Indicator. This is in contrast to the STL pipeline where there is only one environmental aspect for which the EJ index exceeds 80. Therefore, any incident on the propane line would further exacerbate the environmental injustice in areas that already have worse environmental outcomes relative to the areas where the STL pipeline is located. As such, this option is rated as having elevated risk of environmental impact.

Table 2 Comparison of EJ Indicators between Propane and the STL Pipeline

EJ Index	STL Pipeline Right of Way	Propane Right of Way
Particulate Matter	74	74
Ozone	74	75
NATA Diesel Particulate Matter	78	78
NATA Air Toxics Cancer Risk	74	74
NATA Respiratory Hazard Index	73	74
Traffic Proximity and Volume	66	69
Lead Paint Indicator	76	80
Superfund Proximity	79	87
Proximity to Risk Management Plan Facilities	70	81
Hazardous Waste Proximity	69	76
Wastewater Discharge Indicator	99	98

System Integrity

All natural gas pipeline operators are required to identify the characteristics of the pipeline's design and operations with the goal of minimizing threats and risks to its gas distribution pipeline. The addition of this propane vaporization facility would meaningfully impact Spire's risk profile. Therefore, it can only be a single injection point at one end of the system away from the propane storage.

Furthermore, the Transfer Line will require a hydrostatic test to assess the integrity of the pipeline. This could unearth additional issues and delay the recommissioning of the Transfer Line. Spire would also need to coordinate with a third-party, i.e., the local refineries, in scheduling fuel delivery.

Given the additional operational complexity, this option is rated as having moderate risk to system integrity.

Supply Security

Propane facilities are typically used for peak-shaving. This type of facility is not intended to be relied on for primary supply to the system. Blending propane-air, and even more so pure propane like Spire Missouri, will always be less reliable than using pipeline natural gas since it is only supporting a part of the distribution system vs a reliable gas supply source from the STL pipeline. There are many more unique parts of the system and procedures than need to be manually and carefully performed to ensure proper blending occurs.

We also understand that there could be up to 36 hours of lead time in order to schedule the pipeline for transporting propane. This is a result of having to rely on a third-party open access "batched" pipeline supply which has to be cleared of butane before propane can be transported.

In its proceedings, New York State ("NYS") has recognized the reliability concerns associated with reliance on peaking services to meet peak day load. In response to that concern, the NYS utilities jointly analyzed this matter and determined that the probability of non-performance could range from 0% to 25% when there are on-system storage facilities, depending on the number of days that can be served by the facilities or the condition of aging facilities.[43] Given the age and condition of Spire's propane facilities, this supply option would be placed at the high end of the proposed derating formula proposed. For more detailed discussion of the findings from NYS utilities, please see Appendix B.

As such, the use of this system for supply will result in decreased reliability over using the STL pipeline.

Permitting Challenges

Installing these facilities would require Spire Missouri to obtain/modify its St. Louis County air permits to include the pre-heater and vaporization equipment. In addition, the required hydrostatic test for the Transfer Line could uncover pipeline issues, necessitating repairs. This may result in delays or an extension of the timeline for Spire Missouri to achieve the supply needed to service its customers this coming winter season.

As such, this option is rated as having an elevated risk of permitting challenges.

2.5. Micro-LNG

2.5.1. Overview of Supply Option

In order to address the loss of supply deliverability from the removal of the STL pipeline from Spire Missouri's portfolio, the Company evaluated utilizing a micro-LNG peak-shaving service. To utilize this service, Spire Missouri would be required to obtain a permit and construct a new supply tap into its existing distribution grid. The arrangements made for this contingency are being extrapolated for future winter seasons.

The envisioned service would provide 10,000 Dth/d of daily base load supply for up to 151 days over the winter between November - March if necessary. The base load operation, while highly inappropriate to serve winter heating demand, would be required to preserve natural gas inventories at Spire's Lange storage facility which could not be replenished during the winter heating season without the pressure and supply provided by the STL pipeline. The service would provide both incremental supply as well as localized pressure support for Spire Missouri's distribution network. The LNG would be sourced from Indiana and require a 250-mile trip taking approximately 4 hours each way to service Spire Missouri's requirements, excluding loading and offloading. To provide the service, the best case is 12 LNG trucks utilizing 18 drivers would be required per day to make deliveries.

While the addition of the envisioned LNG delivery point would help narrow the supply and deliverability gap, it would be significantly less reliable than the supply from the STL pipeline. In addition, the manner in which the LNG deliveries would be made is inconsistent with how these services have been and should be utilized. The LNG service would only supply peaking service to one portion of the Spire distribution system and not replace the gas supply needed and currently supplied by the STL pipeline. To accomplish the replacement of the STL gas supply, the LNG service provider indicated Spire initially considered 40 such LNG peaking units providing 300,000-400,000 Dt/day which could not be met practically nor economically

43 Central Hudson Gas & Electric Corporation et al. (July 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg 16*

due to the lack of such equipment, drivers and the logistics and cost of providing such if available. In general, the micro-LNG peaking services are typically used only to provide 3-10 days of peaking service to one part of the gas distribution system not total pipeline gas supply replacement for a pipeline. In addition, the LNG service provider has indicated that service requirements exceeding 6-7 consecutive days would be at risk of insufficient qualified driver availability. This is obviously far short of the duration of the winter.

In addition to the risk elements stated above, there will be a heightened issue related to public perception and concern. While the STL Pipeline is buried and out of public view, the public will be aware of and concerned with ongoing LNG truck traffic through their neighborhoods.

2.5.2. Risk Assessment

Figure 11 below provides a summary of our risk assessment for the micro-LNG option.

Figure 11 A Summary of Risk Assessment Associated with Micro-LNG

Risk Factor	Micro-LNG	STL Pipeline
Operational Risk	🟡	🟢
Public Safety	🔴	🟢
Property Impact	🟢	🟢
Environmental Impact	🟠	🟢
System Integrity	🟡	🟢
Supply Security Risk	🔴	🟢
Permitting Challenges	🟡	🟢

Operational Risk

The operation of the new LNG interconnect would require to be manned 24/7 and an operator would be required to perform manual operating procedures during the transfer and connection/disconnection process. The pressure would also have to be monitored, and manually adjusted based on instructions from Spire, adding to operational risk. The risk is partially mitigated as we understand that the equipment is state-of-the-art, and would be operated by skilled technicians from the LNG service provider.

Accordingly, the micro-LNG option is considered to have moderate operational risk.

Public Safety Impact

The public safety impact of this option stems from two sources, the on-site LNG storage and LNG trucking.

Firstly, LNG would be stored in the LNG storage tanker onsite, which could pose a risk to public safety. However, we understand that there would be two security staff as well as four technicians on the site full time. These measures mitigate risks to public safety.

Secondly, LNG would be delivered via truck from Indiana to St. Louis. These deliveries would be made during winter conditions which could pose a higher risk of traffic incidents. While LNG burns slower than gasoline, traffic accidents involving LNG trucks could still present a public issue if the LNG is released.

Given the potential number of trucks containing combustible fuel having to travel long distance during winter conditions, the micro-LNG option is considered to have unacceptable public safety impact.

Property Impact

The footprint of the micro-LNG facility is relatively limited. The equipment, which we understand is state-of-art, would include the vaporizer unit, the LNG storage tanker, and the on-site generators. In addition, the scale of operation would be relatively marginal at 10,000 Dth/day. As such, there is limited risk to property damage comparable to the STL pipeline.

Environment Impact

On a best case basis, the option requires 12 LNG trucks delivering every day. Each truck would be traveling approximately 250 miles from the LNG facility in Indianapolis to St. Louis and back. Over the duration of winter, these trucks would be travelling nearly one million miles. The trucking of LNG would contribute to additional carbon dioxide emissions along the route relative to transporting the equivalent amount of natural gas through the STL pipeline.

In addition, the LNG vaporization site would require two on-site 400 kV generators to provide power to the vaporizer and the reciprocal pump. According to the LNG service provider, these generators would be running on diesel contributing to additional emissions on the site. These emissions are on top of those associated with the natural gas liquefaction process to produce LNG.

Given the small footprint of the LNG facility, the EJ index is less meaningful and as such is not presented for this option.

Given the requirements for fuel trucking and on-site generators, the micro-LNG option has a higher environmental impact relative to the STL pipeline.

System Integrity

With a proposed 151-day winter service, the micro-LNG option should be categorized as a seasonal baseload service. That is not the manner in which this type of service should be relied upon. Per the LNG service providers website[44], the services and solutions they typically provide are listed below. The level of deliverability (duration) required to support Spire Missouri's needs are well in excess of any of these services provided by the LNG service provider or any similar service provider.

- Peak Shaving
- Emergency Services
- Planned Maintenance Services
- Temporary or longer term "gas island" customer services (specific to individual customers with much smaller volumes)[45]

In addition, activating this option would require a new interconnection, which represents a change to Spire's operations. Spire would also have to interface with a third-party operator in coordinating the operations of the LNG facility.

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44 See RevLNG, *Services and Solutions*, available at https://www.revlng.com/services-solutions/; accessed on November 4th, 2021

45 *Ibid.*

Given the additional operational complexity, the micro-LNG option is rated as having a moderate system integrity risk. This is higher than the STL pipeline, which is the status quo.

Supply Security

As proposed, Spire Missouri would require 12 LNG trucks delivering every day in a best case scenario to support its contracted volumes. Traditionally these services are only used a few days each winter, mitigating risk somewhat. Requiring 151 days of service during the winter significantly increases the risk associated with LNG trucking. As noted by NYS Commission Staff[46] and the utilities within NY[47] the transportation logistics related to LNG or CNG deliveries represent an ongoing concern related to reliability (see Appendix B for more information). This is particularly acute in the winter months when driving conditions are likely to impact deliveries.

During extended periods of cold weather, which are highly probable in St. Louis, there would be the additional risk of certified driver availability. Per the DOT regulations after 60 hours of service within a 7-day period or 70 hours of service within an 8-day period, each driver must be off duty for 36 consecutive hours before they can return to service.[48] Accordingly, REV LNG believes it will be required to seek additional qualified drivers if Spire Missouri requires service beyond 6-7 consecutive days. Given the 151-day service request, the need for additional drivers is likely. Also, finding qualified drivers during an extended cold weather event is not a given.

In its proceedings NYS has recognized the reliability concerns associated with overreliance on off system trucked supplies. In response to that concern, the NYS utilities jointly analyzed this matter and determined that the probability of non-performance could range from 0% to as high as 50%. Given the manner in which Spire Missouri is using this service, it is reasonable to expect risk of non-performance would be on the high end of the range proposed by the NYS utilities.

Given the accumulated impacts of the reliability issues raised, it is understandable that the service provided is not a firm service, as would be provided by the STL pipeline. As such, the micro-LNG option has a higher supply security risk relative to the STL pipeline.

Permitting Challenges

This option will require a new connection between the LNG facility and Spire's local distribution system. As a result, a new tap permit would be required. In addition, a noise waiver would also be required due to the elevated noise level associated with the on-site generators.

Due to the additional permits required, the micro-LNG option is rated as having a moderate permitting challenge compared to the STL pipeline which does not need a new permit.

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46 State of New York Public Service Commission (Mar 2020), *CASE 20-G-0131 - Proceeding on Motion of the Commission in Regard to Gas Planning Procedures. ORDER INSTITUTING PROCEEDING*, pg 7

47 Central Hudson Gas & Electric Corporation et al. (Jul 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg 17*

48 Federal Motor Carrier Safety Administration (March 2015), *Interstate Truck Driver's Guide to Hours of Service*, pg 5

3. Summary of Findings

In the event that natural gas supply and deliverability provided by the STL pipeline becomes unavailable to Spire and consumers in Missouri, Spire has identified alternative solutions to bridge the considerable supply gap that would be created. It is clear from the analysis that these solutions cannot bridge the supply gap created by the loss of STL from both deliverability and operational perspectives. In addition, the people of Missouri would be subjected to elevated risks related to fuel availability, safety and environmental matters. The analysis has identified a large number of independent findings where each present elevated risks to Missouri and its residents. When the individual risks are considered as a whole, it becomes clear that the alternative solutions represent an unacceptable alternative to the continued operation of the STL pipeline.

Appendix A: List of Acronyms

BTU	British Thermal Units
CNG	Compressed Natural Gas
Dth	Dekatherms
ERW	Electric Resistance Weld
EJSCREEN	Environmental Justice Screening and Mapping Tool
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
HCA	High Consequence Areas
LFERW	Low Frequency Electric Resistance Weld
MAOP	Maximum Allowable Operating Pressure
MRT	Mississippi River Transmission
MoGas	MoGas Pipeline LLC
NTSB	National Transportation Safety Board
NGPL	Natural Gas Pipeline Company of America
NGSA	Natural Gas Supply Association
NESI	Northeast Supply Enhancement Project
OPS	Office of Pipeline Safety
PHMSA	Pipeline and Hazardous Materials Safety Board
PSC	Public Service Commission
PNM	Public Service Company of New Mexico
RSPA	Research and Special Programs Administration
REX	Rockies Express Pipeline
SSC	Southern Star Central
SMYS	Specified Minimum Yield Strength
The Company	Spire Missouri
STL	Spire STL Pipeline
SCF	Standard Cubic Foot
SCADA	Supervisory Control and Data Acquisition
Trunkline	Trunkline Gas Company

Appendix B: NYS Review of Risks of Non-Pipeline Options

As part of CRA's review of Spire Missouri's current supply shortfall, we have identified parallel events in New York related to the inability to add pipeline capacity and the resulting overreliance on non-pipeline and peaking services.

As background, in order to support peak day requirements in their market areas, the utilities serving the New York metropolitan area, have attempted to add additional pipeline capacity to reliably serve their markets. Most notable of the recent pipeline proposals to serve New York City is Transco's Northeast Supply Enhancement Project ("NESI"). The NESI Project (CP17-101) filed for a FERC Certificate on 3/27/17 and after over two years of review received its FERC Certificate on 5/03/19. After considerable and prolonged opposition by New York State and various environmental groups the project was placed on hold by its developer, Transcontinental Pipeline, who ultimately filed with FERC for a two-year extension to complete the project on 3/19/21.

The delays in acquiring incremental firm deliveries to New York City, required both Con Edison and National Grid to institute moratoriums on new gas connects. The National Grid moratorium resulted in an investigation into the moratorium (19-G-0678) which required National Grid to investigate other non-pipeline solutions to serve its market. The broader implications of serving New York States markets without new pipelines required the initiation of a new docket entitled the *Proceeding on Motion of the Commission in Regard to Gas Planning Procedures* (20-G-0131).

In the order establishing this proceeding, NYS recognized the significant risk associated with the use of delivered services to meet firm market needs and stated the following:[49]

> *Criteria for reliance on peaking services: Gas utilities are increasingly reliant on peaking services in the form of compressed natural gas (CNG) and delivered services. Delivered services, as opposed to firm capacity procured directly by utilities, are provided by third parties and combine pipeline capacity held by those parties with the commodity they have purchased. These contracts typically: include a term of not more than one year; cannot be relied on for year-over-year renewal; and are priced at market prices, which can be very expensive.* ***Reliance on delivered services for a high percentage of a utility's peak load presents significant risks****. Gas utilities currently rely on peaking services to varying degrees and would need to increase that reliance to serve new load in the near term in the absence of other solutions. Gas utilities have asserted that their moratoria decisions have been based, in part, on the need to avoid over-reliance on delivered services, and Con Edison's and National Grid's near-term winter supply plans rely on increased usage of CNG. At present, though, there are no clear or commonly accepted standards for acceptable levels of reliance on these peaking services. Given the pivotal role of peaking services in moratorium decisions, clear criteria must be developed.*

At New York State's direction, the utilities operating within the state were directed to develop clear criteria related to the reliance on these peaking services. On 7/17/20 the NYS utilities jointly filed their findings in a report titled Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management.[50] In this report, the utilities proposed a few alternatives to address the risk associated with greater use of peaking

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49 State of New York Public Service Commission (Mar 2020), *CASE 20-G-0131 - Proceeding on Motion of the Commission in Regard to Gas Planning Procedures. ORDER INSTITUTING PROCEEDING*, pg 7

50 Central Hudson Gas & Electric Corporation et al. (Jul 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management*

services. The utilities' first approach utilized standard limits on the use of peaking services within their portfolio.

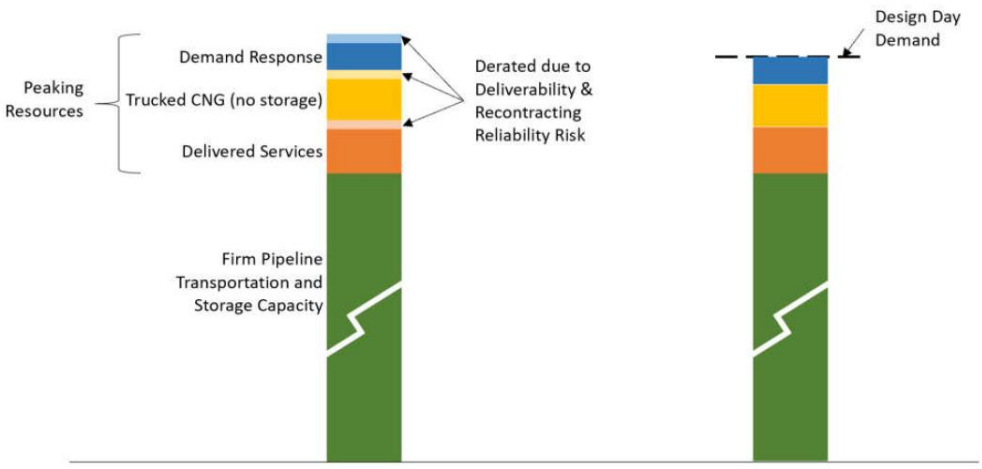
> *"One approach to addressing the concern about the increasing reliance on peaking services is to develop a simple standard that limits peaking services to a particular percentage of an LDC's portfolio, or limits peaking services to a particular volume level."*

Given the broad circumstances facing individual utilities. The joint filing alternatively suggested a framework which derates different types of peaking services based upon their perceived level of risk.

> *"The Joint LDCs' proposed framework and standards for reliance on peaking services distinguishes between deliverability and recontracting/renewal reliability. The framework effectively "derates" the capacity contribution of resources for planning purposes based on historical data (and other relevant information in the absence of historical data). For example, if a particular resource is assumed to be 95% reliable — or, stated another way, if a particular resource is expected to have a 5% chance of a forced interruption — then the capacity of that resource would be derated by 5% when included in demand/supply balance evaluations."*[51]

This approach is presented graphically below.

Figure 12 Illustration of Resource Capacity Derating



Source: Central Hudson Gas & Electric Corporation et al. (Jul 2020), Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg. 13

In their analysis, the joint utilities developed a common derating range for each category of resources, taking into account deliverability and recontracting/renewal reliability. The joint utilities also proposed a common set of guidelines for determining a specific derating value for each resource that lies within the range for the respective category. The joint utilities supported this approach by stating that,

51 Central Hudson Gas & Electric Corporation et al. (Jul 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg 12*

> *"This approach provides a common framework and range but preserves the ability to reflect LDC-specific and resource-specific circumstances when identifying a specific assumption to be used in planning analyses. LDC-specific circumstances include local market conditions, the composition of the overall portfolio, and their customer and demand profile."*[52]

The analysis established the following derating ranges for each category of supply resources.

Table 3 NYS Joint Utilities Proposed Portfolio Derating of Peaking Services

Resource	Derating Range	Comment
Firm Pipeline Capacity	0%	
Firm Pipeline Capacity	0-15%	Interruptions/Contracting Issues
On-system CNG/LNG Storage	0-25%	Influenced by days of service
Delivered Services	0-15%	During Term of Contract
Delivered Services	0-35%	Beyond Term of Contract
On-system CNG/LNG Reliant on Trucked Supplies	0-50%	Ongoing trucking results in more risk/ higher derating

With respect to reliance on trucked supplies, the joint utilities went on to explain that,

> *"However, sites with little or no storage — and that therefore rely on constant turnover of trucks to deliver the necessary supplies on an ongoing basis — have lower deliverability reliability. The use of trucks to deliver natural gas supplies introduces a number of reliability concerns. First, there are many issues that could prevent one or more trucks from making on-time deliveries including traffic, bridge/road closures, delays caused by adverse weather conditions, truck breakdowns, and truck loading issues. Second, delayed CNG/LNG trucks cannot be substituted for easily. CNG/LNG needs are local; injecting additional supplies at a location remote from a constrained zone on the distribution system when trucks are unable to reach a specific location may not resolve the issue. Third, there may be little time to implement an alternative plan because there may be little advance warning that a truck may not make its delivery on time."*[53]

After reviewing the filed data and testimony, NYS DPS Staff issued its planning process proposal on 2/12/21. While Staff found that the utilities' derating proposal lacked detail and was subjective in its application, it believed the reliability of delivered services and other peaking assets remained a concern through the following statements.

> *"Reliance on peaking services (also called delivered services) to meet peak day load can have certain risks."*
>
> *"Given this information, Staff is uncertain that reliance on peaking services is a reliable strategy."*
>
> *"Staff will gather data on this subject and make recommendations to the Commission in the future. Unless and until the Commission sets generic standards for reliance on delivered*

52 Central Hudson Gas & Electric Corporation et al. (Jul 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg 14*

53 Central Hudson Gas & Electric Corporation et al. (Jul 2020), *Modernized Gas Planning Process: Standards for Reliance on Peaking Services and Moratorium Management, pg 17*

> *services, each LDC should state how much it will rely on delivered services and other peaking assets to meet peak day load and how it justifies that reliance."*

From the facts presented above, it is clear that the absence of firm pipeline capacity is requiring NYS to assess the heightened risk associated with overreliance on peaking services to serve either winter peaking or seasonal firm requirements.

These facts are a direct parallel to the issues now facing Spire Missouri, and due to its specific circumstances (high degree of reliance and off-system resources) places Spire Missouri at the highest level of risk based on the criteria established by the analysis conducted by the New York utilities.

Appendix C: Data Relied Upon

File Name	Date Received	Description
Spire Missouri Propane Vaporization Procedure	10/18/2021	Vaporization operating procedures and calculation tables
Propane Operation	10/18/2021	Spire's answers to questions from data request
590a Propane Initial Start Up	10/18/2021	Procedures for initial startup for propane
590b Circulating Propane	10/18/2021	Procedure for circulating propane through inlet separator
590c Shipping Propane	10/18/2021	Procedure for shipping propane
590d Receiving Propane	10/18/2021	Procedure for receiving propane product
500 Propane Operation	10/18/2021	Lange Plant propane geographic location, safety, and tables with descriptions on pump areas, cavern areas, and pig launcher
503 Characteristics of Propane	10/18/2021	Vapor and liquid characteristics of Propane
505 Emergency Shutdown Procedure for Lange Propane Plant & Cavern	10/18/2021	Procedure for shutting down Lange power plant
506 Propane Power Failure or Surge Procedure	10/18/2021	Procedure if power surge knocks out vaporizers (Johnston Cavern)
510 Schematic of Propane Piping - Lange Propane Facilities	10/18/2021	Schematic of propane flows through the Lange Propane facility
511 Propane Turbine Meters	10/18/2021	Description and calculations behind Daniel turbine meters at Laclede pipeline
520 Operation of the Lange Propane Plant	10/18/2021	Procedures to run Lange plant and taking plant off-line - includes safety
521 Ely Propane Vaporizer Operation	10/18/2021	Startup and shutoff procedure for Ely Vaporizer
560 Propane Meter Proving	10/18/2021	Procedure for proving of propane meters
580 Propane Strainer Cleaning Procedures rev 1-31-14	10/18/2021	Procedure on cleaning strainers
590e Vaporizing Propane	10/18/2021	Procedure for vaporizing propane
Old Propane Piping Drawing #4898	10/18/2021	Old schematic for propane piping
Propane Piping Schematic	10/18/2021	New schematic for propane piping
PROPANE RELIEF VALVE INSPECTION	10/18/2021	Procedure to inspect relief valves
880Line	10/22/2021	Shapefile for 880 line
2731VeteransMemorial_Buffer	10/22/2021	Shapefile for Veterans Memorial
Catalan_Station	10/22/2021	Shapefile for Catalan station
PropaneLine	10/22/2021	Shapefile for Propane line
StLPipeline	10/22/2021	Shapefile for STL Pipeline

Between Laclede Gas and Laclede Pipeline Company	10/26/2021	Amendment for LPG supply contract from 1990
New Big Propane Map	10/26/2021	Propane map with terminals
1990 liquefied petroleum gas supply contract	10/26/2021	LPG supply contract with plant details from Laclede pipeline company
SpireMissouriHCA-Draft20211014 (1)	10/28/2021	ArcMap for Spire stations and pipelines
Temperature thresholds and peak shaving	10/28/2021	Peak shaving operation flow and weather thresholds
Pigging facilities and valves	10/28/2021	Location of pigging facilities and valve numbers
880 Line Map	11/11/2021	880 Map detailed

Appendix C

Appendix D: Historical Gas Data for Interchangeability Calculation

Station	Date	Specific Gravity	BTU
Ameren Meramec Missouri station (Loc. 808368)	10/20/2021	0.5796	1.01657
Ameren Meramec Missouri station (Loc. 808368)	10/21/2021	0.5793	1.01716
Ameren Meramec Missouri station (Loc. 808368)	10/22/2021	0.5793	1.01635
Ameren Meramec Missouri station (Loc. 808368)	10/23/2021	0.5975	1.01779
Ameren Meramec Missouri station (Loc. 808368)	10/24/2021	0.5789	1.01751
Ameren Meramec Missouri station (Loc. 808368)	10/25/2021	0.5789	1.01698
Ameren Meramec Missouri station (Loc. 808368)	10/26/2021	0.5789	1.01748
Averages		**0.5818**	**1.017**