SUPPLY RELIABILITY RISK

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1. INTRODUCTION

The Dominion Energy Utah (DEU, Dominion Energy, or the Company) created this risk analysis in order to identify and discuss probable scenarios that could result in a significant supply shortfall and impact natural gas service to the Company's customers. The Company reviewed recent events, known risks, and industry concerns to determine events that could result in supply disruption. The Company identified the following scenarios: high demand coinciding with cold temperatures in the production area resulting in freeze-offs, flooding and landslides, earthquakes, human error, upstream facility design inadequacies and maintenance, cyber-attacks, and third-party damage. Each of these scenarios has caused issues for Dominion Energy Utah or other companies.

2. PROBABILITY OF OCCURRENCE

A. Probability of High Demand

Generally, the risk to the DEU gas supply increases with decreasing temperatures. This is true because, as temperatures decrease, natural gas demand increases. For this reason, the Design-Peak Day is directly related to temperature. As temperatures decrease, demand on DEU's system approaches capacity of the system. In addition to the strain on the system imposed by increases in demand, cold temperatures can result in mechanical issues in processing plants or freeze-offs at wellheads. At normal winter temperatures (around 30°F mean), the Company's gas supply portfolio has sufficient storage and transportation capacity to manage supply disruptions. Similarly, at normal temperatures, additional gas supply is generally available for purchase. However, at colder winter temperatures, DEU utilizes all its gas supply options and has no surplus storage or transportation, gas to purchase is more difficult to find, if it can be found at all, and it likely comes at a higher cost.

The Company has a threshold beyond which it cannot make up supply shortfalls with storage, purchases, and upstream transportation. In the Company's current gas supply plan, the aquifer storage volumes (Coalville, Leroy and Chalk Creek) are held in reserve

until demand is high enough that other options (i.e. available supply and transportation capacity or remaining Clay Basin storage capacity) have been utilized. The Company has modeled the mean temperature at which it could meet demand without using aquifer capacity. The resulting temperature is a 3°F mean. However, temperature is but one factor in the analysis. Adverse conditions or upstream supply disruption could create situations that, even at warmer temperatures, would be difficult to address with reserve aquifer storage alone.

Examination of the distribution of historical winter temperatures at the Salt Lake International Airport from 1980 through February of 2017 demonstrates that there will likely be daily temperatures at or below a 3°F mean about once every 14 years. Figure 1 shows the distribution of temperatures along with the normal distribution of the same data and a smoothed curve of historical data. The historical data has an average of 29°F and a standard deviation of 10°F, which results in one occurrence every 14 years of experiencing a 3°F mean day. What is notable about this information is that it is based on cold temperatures that have been experienced in just over the past 30 years. In other words, the Company can expect similar temperatures, but it could also encounter the unexpected – mean daily temperatures below 3°F.

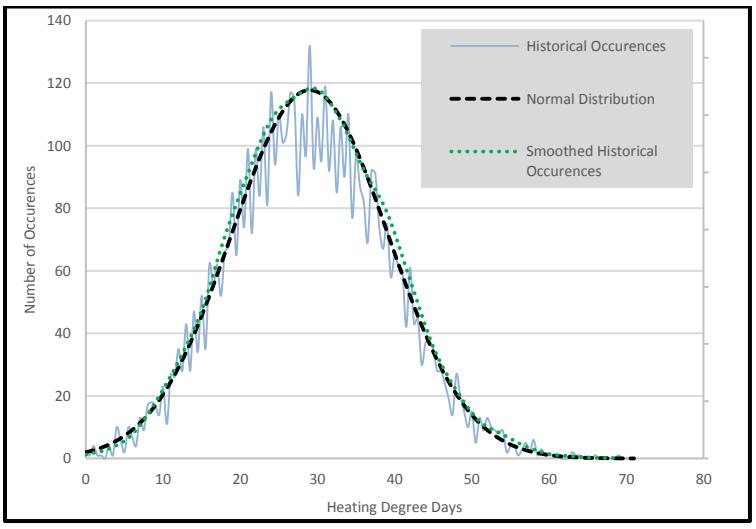

Figure 1: Winter Temperature Probability

B. Probability of Supply Shortfalls

Based on historical evidence, there is a high probability of a supply shortfall. There are many causes of supply shortfalls, including production freeze-offs of wells or processing plants, third-party tear outs, equipment failures, landslides, earthquakes, fires, and flooding. In recent history, the Company has experienced supply shortfalls and production freeze-offs even when the Company's service territory has not experienced very cold temperatures. In fact, in recent years, such shortfalls on cold (but warmer than Design-Peak Day temperatures) have reached shortfall volumes in excess of 100,000Dth/day. Therefore, the Company believes it is prudent to plan its gas supply and design its system to function reliability on a Design-Peak Day that coincides with a supply shortfall of at least that magnitude.

3. CAUSES OF SUPPLY SHORTFALLS

A. Cold-Weather Events

Dominion Energy has historically experienced supply shortfalls during cold weather events. These shortfalls have been the result of a number of different issues, such as well freeze-offs, plant shut-downs, and equipment failures. Well freeze-offs occur when condensates in the gas freeze causing problems with equipment at the wellhead. Plant shut downs have been caused by a number of issues, including reductions in supply being delivered to plants, power failures at plants, and equipment failures. Compressor failures have also resulted in supply reductions. These issues are generally the result of the extreme cold weather in the producing regions, but may also occur on other days as well. The Company has experienced minor shortfalls many times during recent heating seasons and significant supply shortfalls on December 5, 2013 and January 6, 2017. Most recently, DEU experienced shortfalls during Presidents' Day weekend 2018, when the Blacks Fork processing plant in Wyoming experienced compressor problems due to cold weather. When the Blacks Fork plant shut down, the Company experienced supply reductions of about 25,000 Dth. When the shortfall occurred, the Company had very limited options for replacing the missing supply. The shortfall occurred on a Tuesday

following a holiday weekend, meaning that gas purchases for that day were completed on the previous Friday. This left the Company, and many other parties, competing to purchase supplies intra-day when temperatures dropped on that Tuesday. In order to manage the fluctuating demand over the four-day period, storage was already being fully utilized. Fortunately, the shortfalls were limited in duration, and the Company was able to manage its system using existing tools, including purchasing as much high-priced gas as was available. Had the event lasted longer, or if the Company had experienced colder temperatures, it may not have been able to make up the shortfall, and its customers might have lost service.

In 2011, cold weather caused supply disruptions to utilities in New Mexico and Arizona, resulting in loss of service to firm customers, including residential customers. When these utilities lost service, the temperatures were lower than those service territories had seen in decades, but were significantly warmer than temperatures experienced in DEU's service territory regularly every heating season. Nonetheless, approximately 40,000 customers suffered loss of service and some suffered dramatic consequences— many were at risk of serious injury or even death. Moreover, because the service outage was so widespread, many of these customers were without service for several days. Had a similar event occurred in DEU's service territory, the Company expects that the risk to health and safety would be greater because temperatures are typically much colder. The Company would also expect higher levels of property damage due to frozen and burst pipes.

When the Company inquired about such events with other natural gas distribution companies, it learned that three other natural gas utilities have also suffered weather-related supply disruptions that resulted in loss of service to customers.

B. Landslides/Flooding

DEU is also at risk of supply shortfalls due to landslides. The Dominion Energy Questar Pipeline (DEQP) system that delivers gas to the Wasatch Front passes through a number of landslide areas. One such area is the Chalk Creek slide east of Coalville through

which DEQP has 2 of its 3 main lines. These main lines are the primary feed to the DEUWI system serving Salt Lake, Davis, Weber, Morgan, Summit, and Wasatch counties. The landslide is still active and the lines are being monitored by strain gauges. A significant landslide in this area could disrupt supply to the Wasatch Front.

Landslide risks also exist in Morgan County, Utah, near the mouth of Weber Canyon. In fact, in 2017 DEQP shut down its main line for several months due to land movement in that area. A significant landslide there could disrupt supply to DEU's demand center.

The Kern River Natural Gas Transmission Company (Kern River) pipeline also passes through areas with known land movement. In 2014, Kern River shut down its line in North Salt Lake due to a landslide.

 [1]

[1] Grimmett, Brian (2014 August 20) *Victims of North Salt Lake Landslide Waiting For Someone to Take Responsibility.* Retrieved from http://kuer.org/post/victims-north-salt-lake-landslide-waiting-someone-take-responsibility#stream/0

 [2]

 [3]

[2] AP Photo/Rick Bowmer (2014, August 5) Retrieved from https://www.vosizneias.com/174609/2014/08/07/north-salt-lake-utah-family-escapes-minutes-before-slide-pummeled-home/

[3] Grimmett, Brian (2014, August 5) *North Salt Lake Landslide Destroys Home, Threatens More.* Retrieved from http://kuer.org/post/north-salt-lake-landslide-destroys-home-threatens-more#stream/0

[4]

DEU is not immune to landslide risks. Its 20-inch diameter feeder line in North Salt Lake was shut down in 2014 by the same landslide that impacted Kern River.

As another example, in 2011, the Green and White rivers outside Ouray, Colorado overflowed their banks forcing the closure of at least three roads. The closed roads provide access to hundreds of oil and natural gas well sites in southern Uintah County. Thirteen of those sites and the pipelines that connect them were shut in to try to prevent possible water contamination.[5]

DEU and its upstream suppliers are at risk of landslides or flooding disrupting supply to DEU's demand center along the Wasatch Front. Landslides in any of these areas could have a significant impact on gas supplies to the Wasatch Front.

[4] Neugebauer, Cimaron (2014, August 5) *North Salt Lake Landslide.* Retrieved from http://www.standard.net/gallery/North-Salt-Lake-Landslide

[5] Lieskik, Geoff (2011, June 11) *Flooding Forces Closure of Roads Near Ouray.* Retrieved from ***http://www.ubmedia.biz/ubstandard/news/article_7110922e-8488-528a-8d9f-8584a807d403.html***

C. Earthquakes

All of the natural gas supply that serves DEU customers along the Wasatch Front crosses a fault line to reach customers. "The probability that at least one magnitude 6.75 earthquake will rattle the Wasatch Front in the next 50 years is 43%."[6] An earthquake like those predicted could substantially disrupt supply in DEU's service territory.

D. Human Error

Human error also can and does cause supply disruption. For example, on October 31, 2013, human error caused disruption to DEU's system in Monticello and the entire town lost service as a result. On that day, upstream transportation pipeline (Williams Northwest Pipeline or Williams) closed a block valve for maintenance and did not re-open it when the maintenance was completed. Williams' Operations Department did not know the valve remained shut until DEU Gas Control informed them that the town had lost service. Similar errors could occur along the path the natural gas travels from wellhead to DEU's demand center. For this reason, supply reliability options focused close to DEU's demand center would minimize the likelihood that human error could impact supply reliability.

E. Upstream Facility Design Inadequacies and Maintenance

DEU is dependent upon upstream pipelines (third parties) to design and maintain their own systems such that supply disruptions do not occur. However, disruptions related to design do occur. For example, on the morning of January 6, 2017, DEU began receiving calls from residents in Coalville indicating that appliances were not functioning. DEU discovered that a DEQP-owned meter had "seized up," preventing gas from being delivered to downstream customers. Alternate design could have prevented the event.

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[6] McKellar, Katie (2016, April 16) *New report reveals 'disconcerting' earthquake risk along Wasatch Front.* Retrieved from https://www.deseretnews.com/article/865652493/New-report-reveals-disconcerting-earthquake-risk-along-Wasatch-Front.html

As a result of the failure, the town of Coalville (approximately 600 customers) lost service.

F. Cyber-Attacks

DEU's upstream supply is also vulnerable to cyber-attacks. In April of 2018, Bloomberg reported that at least seven pipeline operators stated their third-party electronic communication systems had shut down, with five confirming that the service disruption was caused by hacking.[7] If such a cyber-attack were to occur on a system upstream of DEU's system, a supply disruption could occur.

This risk is not merely hypothetical or a problem for other utilities. On Saturday, April 7, 2018, DEU representatives were attempting to nominate gas out of the Ryckman Creek storage facility and were experiencing difficulty doing so. Company representatives soon learned that Ryckman Creek had experienced a cyber-attack. Because of the attack, Company representatives spoke with a Ryckman representative over the phone that morning to facilitate the Company's weekend needs because the nomination system was not functioning. The Company was unable to make nomination changes on the electronic system until the following Monday. Though this did not result in a supply disruption, a targeted or more severe attack could have resulted in a supply disruption.

G. Third-Party Damage

Pipelines are vulnerable to third-party damage, which can and do result in supply shortfalls. On November 11, 2006, a bulldozer hit a natural gas pipeline south of Cheyenne, Wyoming, damaging the pipeline and killing the bulldozer driver.[8]

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[7] Malik, Naureen S. (2018, April 6) *cyberattack 'Wake-Up Call' Puts Pipeline Industry in Hot Seat.* Retrieved from https://www.bloomberg.com/news/articles/2018-04-06/cyberattack-wake-up-call-puts-pipeline-industry-in-hot-seat

[8] Denver ABC Channel 7 News (2006, November 11) *Worker Killed in Gas Pipeline Explosion, Fire.* Retrieved from ***https://www.thedenverchannel.com/news/worker-killed-in-gas-pipeline-explosion-fire***

When the Company inquired about such events with other natural gas distribution companies, another natural gas utility reported that its customers had lost service due to third-party line damage.

Pipeline tear-outs occur every year and could cause a disruption of supply. Figure 2 shows national data from the Pipeline Hazardous Materials Safety Administration (PHMSA) and details the number of pipeline incidents caused by excavation damage. Should such an event occur upstream of DEU's demand center, it could result in a supply shortfall.

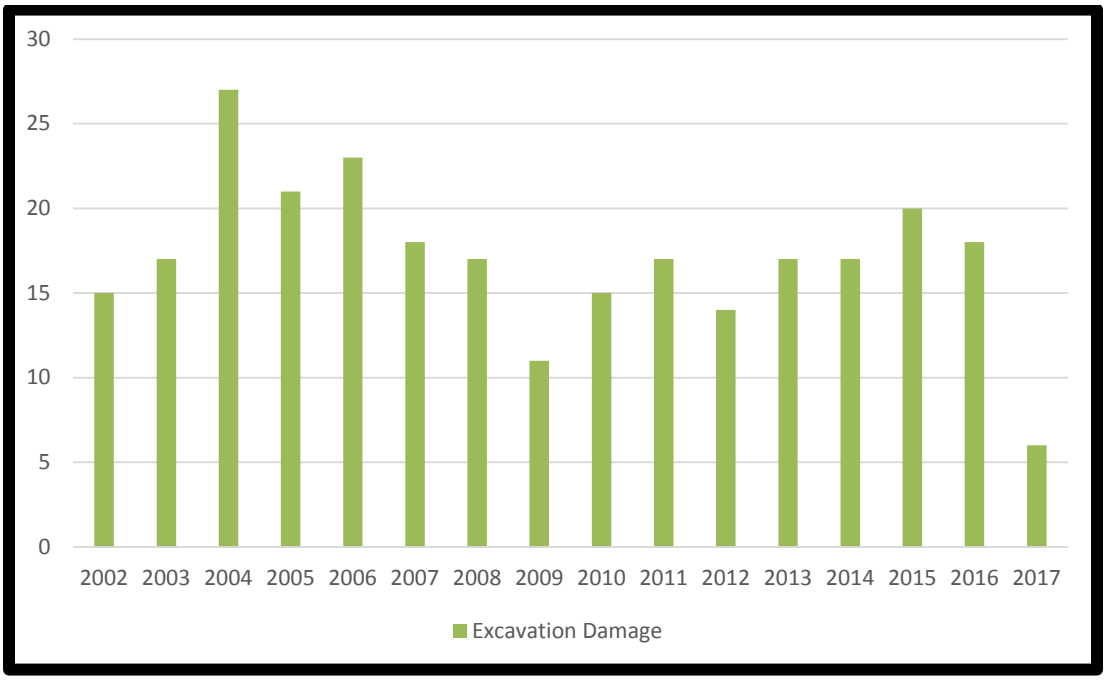

Figure 2: PHMSA Statistics on Transmission Line Damages (2002 – 2017)

H. Force Majeure Events

All pipelines face integrity threats that cause failures on occasion. These threats include: stress corrosion cracking, internal and external corrosion, fatigue, AC corrosion, and other forms of material degradation. A high profile pipeline incident resulted from internal corrosion on an El Paso pipeline in August of 2000

(https://www.nace.org/CORROSION-FAILURES-El-Paso-Natural-Gas-Pipeline-Explosion.aspx). Recently, a failure on Enbridge Pipeline resulted from Stress Corrosion Cracking (https://www.eenews.net/stories/1060077949). As another example, on December 13, 2003 a 26-inch line owned by Williams Companies ruptured near Toledo, Washington. Federal Regulators ordered Williams (the pipeline company that supplies most of Washington's natural gas) to shut down certain pipes because safety inspectors determined frailties in the 268-mile pipeline would "likely result in serious harm to life, property and the environment." The pipeline ruptured twice in six months and the federal Office of Pipeline Safety required Williams Northwest Pipeline to replace every section of line it hopes to use, or prove it is resistant to stress corrosion cracking.[9] Pipelines that transport gas long distances are subject to all these risks, each mile increases the probability of failure.

4. Risk Factors Associated with Scheduling Gas Based on the North American Energy Standards Board (NAESB) Schedule

Interstate pipelines and off-system storage facilities utilize the NAESB schedule for nominating deliveries of natural gas. This schedule restricts the ability to bring the gas on quickly since there is a lag between the time the gas is purchased, nominated and flows on the interstate pipeline.

[9] Corrosion Doctors (2003, December) *Gas Pipeline SCC – Catastrophic* Ruptures. Retrieved from http://www.corrosion-doctors.org/Pipeline/Williams-explosion.htm.

The current NAESB schedule is as follows:

	TIMELINE	NEW 809 MCT
	START OF GAS DAY	8:00AM
TIMELY	**Nominations Due**	**12:00 PM**
	Confirmations Due	3:30 PM
	Scheduled Quantities	4:00 PM
	Gas Flow Time	**8:00 AM**
	Bumpable?/EPSQ[10]?	No/No
	Hours of Gas Flow Avail	24
EVENING	**Nominations Due**	**5:00 PM**
	Confirmations Due	7:30 PM
	Scheduled Quantities	8:00 PM
	Gas Flow Time	**8:00 AM**
	Bumpable?/EPSQ?	Yes/No
	Hours of Gas Flow Avail	24
INTRADAY 1	**Nominations Due**	**9:00 AM**
	Confirmations Due	11:30 AM
	Scheduled Quantities	12:00 PM
	Gas Flow Time	**1:00 PM**
	Bumpable?/EPSQ?	Yes/Yes
	EPSQ Qty Remaining	5/24 (20.8333%)
	Hours of Gas Flow Avail	19
	START OF GAS DAY	8:00AM
INTRADAY 2	**Nominations Due**	**1:30 PM**
	Confirmations Due	4:00 PM
	Scheduled Quantities	4:30 PM
	Gas Flow Time	**5:00 PM**
	Bumpable?/EPSQ?	Yes/Yes
	EPSQ Qty Remaining	9/24 (37.5%)
	Hours of Gas Flow Avail	15

[10] Elapsed Pro-rated Scheduled Quantity

	TIMELINE	NEW 809 MCT
INTRADAY 3	**Nominations Due**	**6:00 PM**
	Confirmations Due	8:30 PM
	Scheduled Quantities	9:00 PM
	Gas Flow Time	**9:00 PM**
	Bumpable?/EPSQ?	No/Yes
	EPSQ Qty Remaining	13/24 (54.1667%)
	Hours of Gas Flow Avail	11

Most supply reductions result from issues that occur during the night. Often such reductions are not known until the Intraday 1 scheduling notices are sent out, as late as 12:00 PM. Once this notice is received, any replacement gas cannot be nominated until the Intraday 2 deadline of 1:30 PM. Gas nominated by the Intraday 2 deadline does not flow until 5:00 PM. Even if the supply shortfall occurs early in the morning prior to the scheduling notice, and nominations were in by the Intraday 1 deadline, the gas would not flow until 1:00 PM. The Company should consider options to mitigate the supply reliability risk that are not subject to the NAESB nominating schedule, and that can be called upon on very short notice.

CONCLUSION

Events often occur during a heating season that can cause significant supply disruptions. Freeze-offs at wellheads or processing plants occur during periods of cold weather. Upstream pipelines traverse areas, including remote areas, prone to landslides and flooding. Pipelines serving the Wasatch Front cross a variety of fault lines and could be

damaged during an earthquake. All of these facilities are vulnerable to human error-caused outages and third-party damage. Faulty facility design, poor maintenance and cyber-attacks pose additional risks to upstream facilities. These events are too common, and it is fortunate that DEU has not experienced a related supply disruption when mean temperatures are at or below 3 degrees Fahrenheit. If such a disruption occurred at or near Design-Peak Day temperatures, it is likely that a significant number of DEU's customers, including residential customers, would lose service altogether. Such a loss of service on a mean 3 degree Fahrenheit or colder day would threaten life, health, safety and property.

DEU should identify and seek a solution that mitigates as many of these risks as possible. It should seek a supply resource that is near its demand center to minimize the risks associated with landslides, earthquakes, third-party tear outs, and other events that occur along the path from production field to the DEU load center. DEU should also seek solutions that provide a ready supply on a moment's notice. Those subject to the NAESB nominating schedule may not be available in a timeframe sufficient to address an unanticipated supply shortfall. Therefore, solutions that are not subject to such restrictions should be preferred.