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TransCanada's Keystone XL Southern Segment:

Construction Problems Raise Questions About the Integrity of the Pipeline

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This report presents evidence documenting numerous construction problems and apparent code violations that raise questions not only about the chances of a spill on the southern segment of the Keystone XL pipeline, but also about the quality of TransCanada's construction and in-house inspection system, as well as the ability of the federal government to oversee the process.

About this Report

This report encapsulates the accounts of landowners and citizens along the Texas portion of the southern segment of the Keystone XL pipeline route. The information was compiled by Public Citizen, in cooperation with landowners and observers, who traveled the area from May through late June. Observers flew over the pipeline and examined hundreds of photos and video of damaged pipe and work sites for the preparation of this document.

Landowners were interviewed and visited by Public Citizen and Evan Vokes for this report.

The anomalies described in the report were identified in context of the code and industry practices by Evan Vokes, a former TransCanada engineer who did so as an unpaid volunteer. Vokes worked for TransCanada from 2007-2012 in the engineering department that was responsible for construction standards.[1] He came to Texas to talk with landowners, verify landowners' concerns and review provided documents.

*It should be noted that this report is based on observations or evidence provided by landowners, reviewers and other observers. At no time in the compilation of this report was access given to TransCanada or PHMSA records, documentation or specification data.

Risks of Tar Sands Spills

A tar sands spill not only could harm people but also could contaminate rivers, streams and aquifers that the pipeline crosses in Texas. This is particularly worrisome because of the toxic tar sands crude that will move through the pipeline. Tar sands are mined and then diluted with natural gas condensate and a host of hazardous chemicals.[2] Canadian tar sands crude is thick, transported at very high pressure and is problematic to clean up, as exemplified by the ongoing three-year cleanup on the Kalamazoo River in Michigan and the recent spill in Mayflower, Arkansas.[3] In Mayflower, a lab report showed that more than 30 toxic chemicals were found, exposure to which may cause many in the community to experience serious health problems.[4]

TransCanada has claimed in recent news accounts that the excavation and replacement of the new pipe for Keystone XL's southern segment demonstrates its concern for quality and its commitment to the U.S. State Department to implement 57 special conditions of quality assurance, and go above and beyond engineering standards to build a "state-of-the-art" pipeline.[5] However, landowners and observers documented dozens of anomalies and problems apparently caused by TransCanada contractors not following the mandated engineering code.

Introduction

As the fate of the Keystone XL pipeline's northern segment is being decided by the Obama administration, this report shows that TransCanada continues to face major construction and pipeline integrity issues on the southern segment – issues that should alarm all citizens and elected officials enough to hit the pause button and start an immediate investigation into TransCanada's quality control.

To sell this risky pipeline, TransCanada has proclaimed that Keystone XL will be the one of the "safest pipelines ever built."[6] The reality is, however, that anomalies such as dents and sags, along with other new construction problems, were identified on the southern segment of TransCanada's Keystone XL pipeline.

What appears to be problematic construction and corner-cutting raise questions not only about the chances of a spill, but also about the quality of TransCanada's in-house inspection system, as well as the ability of the federal government to oversee the process.

While construction is nearing completion of the Keystone XL pipeline's southern leg, which runs from Cushing, Oklahoma, to the Gulf Coast of Texas,[7] Public Citizen believes that landowners' concerns and pictures of serious pipeline construction problems will be seen as business as usual rather than as a red flag. The pipeline will traverse 631 streams and rivers in Texas alone.[8] The families and communities that live in the path of this pipeline face a big risk to their land and livelihoods should this pipeline leak or rupture.

The pipeline is slated to carry tar sands crude – a unique form of crude containing a host of hazardous chemicals[9] – so quality and control and potential for toxic spills are at the forefront of families' minds.

In 250 miles, observers identified that the southern segment of the Keystone XL pipeline had at least 125 excavations of possible anomalies – and possibly many more than that. One of TransCanada's contractors represented to a landowner that there were as many as 70 anomalies in a 60-mile stretch between the Sabine and Sulphur rivers in Texas.[10]

Problems with the construction are alarming both Texas landowners and pipeline experts, whose concerns about the safety and integrity of the pipeline made to the Pipeline and Hazardous Material Safety Administration (PHMSA), the federal agency that has oversight over pipeline construction, and to TransCanada, have only been ignored. TransCanada dug up sections of brand new pipe that had been buried on landowners' properties for months. There have been numerous "anomalies" identified along the route, including dents, welds and other problems in East Texas.[11] Observers documented initial construction that used new pipe riddled with patching about to be placed into the ground. The photos in this report and landowners' firsthand accounts provide the evidence needed to prompt an investigation and testing of Keystone XL's southern segment before it goes online.

Numerous "anomalies" have been identified along the route including dents, welds and other problems in East Texas.

Based on these observations, interviews and photographs, it appears that an unusually high number of sections of the brand new pipeline have been excavated due to damage in the field during pipeline construction, forcing replacement of brand new pipe. However, the safety of these replaced sections is not assured because the new welds are not required to be hydrostaticly tested – a testing process that sends water through a pipe at a specified level of pressure higher than the maximum operating pressure to test the integrity and strength of a pipe.[12]

Due to the numerous anomalies and the question of the quality of the repairs that will not be hydrostatically retested, the federal government needs to investigate possible violations of the code and require an entire retesting of the pipeline to ensure its safety and integrity.

TransCanada's Pattern of Failed Quality

Work on the Keystone XL southern segment could foretell of history repeating itself

This is not the first time TransCanada has made claims of quality regarding its pipelines. In fact, the course of work on the southern leg of the Keystone XL could foretell history repeating itself:

- While the Keystone I pipeline was being built, TransCanada initially pledged that it would meet 50 special conditions to ensure a safe pipeline.[13] After operations began on Keystone I, more than 47 anomalies in four states had to be retested,[14] yet this first leg of the Keystone line spilled 12 times in its first year of operation.[15] In North Dakota, a rupture came less than a year after the pipeline began operating, creating a geyser and spilling almost 21,000 gallons.[16]

- In July 2011, TransCanada's natural gas pipeline in Wyoming, called Bison, exploded within the first six months of operation, blowing out an approximate 40-foot section of pipe and shaking buildings more than a half-mile away.[17] The explosion occurred after the federal government and engineers within TransCanada warned of potential quality problems with construction and inspection while the pipeline was being built.[18]

- A TransCanada subsidiary pleaded guilty to violations of federal environmental laws in connection with shoddy workmanship in 1996 on the Iroquois gas pipeline, which stretches from Canada through the Northeast United States.[19] Concerns by landowners who saw the pipeline being built prompted the federal investigation and convictions of four executives.[20]

In June 2013, Evan Vokes, a TransCanada whistleblower, testified before the Canadian Senate's Committee on Energy, the Environment and Natural Resources, identifying "a culture of noncompliance" within the company.[21] During Vokes' tenure at TransCanada, he warned upper management about problems with pipeline construction.[22] Continuing disagreements with upper management over the company's lack of code compliance eventually led to Vokes being dismissed without cause from the company.[23]

Workers in a trench are finishing the new replacement of pipe on a landowner's property.

Landowners and Citizens Demand an Investigation

As a result of its investigation, Public Citizen, together with landowners along the pipeline, are calling for the Pipeline and Hazardous Material Safety Administration (PHMSA), the federal agency that has oversight over pipeline construction, to:

- Conduct a detailed review of TransCanada's construction quality assurance records;
- Determine whether state and federal laws have been violated;
- Require TransCanada to repeat a hydrotest of the entire Keystone XL southern segment in light of all the excavations and repairs, to ensure that all the anomalies are corrected and no additional construction problems exist;
- Require a rerun of the caliper inline inspection tool (a robotic device that can check the internal integrity of the pipe) to make sure that the significant amount of rework has repaired the problems and not introduced more anomalies; and
- Not permit operations on the southern segment of the Keystone XL to start until the entire line has been hydrotested and a thorough review of TransCanada's construction quality assurance records is done.

Public Citizen also calls on Congress to hold oversight hearings to ensure that PHMSA investigates the anomalies, conducts a quality assurance review, and monitors a caliper inline inspection and hydrotest of the southern segment.

In addition, Public Citizen calls on President Barack Obama and Secretary of State John Kerry, when deciding on the northern leg of Keystone XL, to take into consideration TransCanada's record of non-compliance and its potential impact on the sensitive areas of the Ogallala aquifer and Sand Hills region of Nebraska that the pipeline route crosses.

Identified Construction Problems and Anomalies

A TransCanada representative has remarked that there were as many as 70 anomalies in a 60-mile stretch.

An anomaly in a pipeline is any imperfection in the wall of the pipe.[24] All pipelines have them; some result from the manufacturing process, some are introduced during construction, and others occur when the pipe is laid in the ground. But not all anomalies affect the performance of the pipeline.[25] Inline inspection cannot identify all the anomalies, including some of the most serious types of anomalies that, if not repaired or if repaired improperly, can jeopardize the integrity of the pipe and later lead to breaks and spills.[26]

We have observed that TransCanada had marked some of the areas to be excavated with stakes marked with the word "anomalies," coupled with companion stakes marked "dent" and "welds," or other descriptive markers in the ground where the potential problems have been detected.[27]

A TransCanada representative has remarked that there were as many as 70 anomalies in a 60-mile stretch.[28] Based on ground observations of this area in East Texas and more miles of construction work observed from a plane, Public Citizen believes there were many more.

These anomalies and construction problems (explained in subsequent sections of this report) include:

- Dents
- Welds
- Field coating problems
- Improper backfilling
- Unintentional sags
- Insufficient pipe support
- Poor soil management

Landowners' Observations

David Whitley lives on 88 acres east of Winnsboro, Texas.[29] TransCanada contractors worked for more than four months on his property during the initial construction of the pipeline and returned in the spring to dig a 30- to 40-foot long trench to excavate the new pipe from the ground.

One day in mid-May, Whitley saw a section of excavated pipe marked with the words "Dent cut out" on the ground next to a trench where pipe was being replaced.[30] Whitley observed the pipe replacement process, including the partial removal of a large rock that had been left in the original ditch. As Whitley and witnesses observed the new replacement pipe being welded into place, an inspector remarked that there were dozens of anomalies.[31]

Whitley complained to TransCanada that a worker had trespassed onto his property and installed a sump pump hose that was sending silty water from the flooded trench into his creek.[32] He also noted the amount of erosion and the lack of topsoil replacement on his pasture, where an empty patch of dirt grew stubble instead of grass for his cattle.

Whitley remarked, "I was one of those go-along, get-along landowners who signed with TransCanada thinking if I was cooperative, they would be the same. But that's far from the experience I've had. Now I have a huge mess on my property and I'm concerned about what all this digging up of new pipe means for my future. You'd think they'd build this pipeline right the first time, but now what's happening makes me worry about how safe this pipeline will really be."

David Holland, his brother and his children own 3,850 acres near Beaumont. The property has been a working rice farm and cattle ranch since it was acquired by James and David's great-grandfather in 1878. The Hollands have more than 60 pipeline easements on their property, which is less than 5 miles from Port Arthur's large refining infrastructure.

David Whitley stands near his fence with a short piece of removed pipe marked "Dent" and "Cut Out."

"From the time I started dealing with TransCanada several years ago until now, they have been impossible to deal with," Holland commented. "TransCanada has steadfastly refused to provide us the protections that all other pipeline companies routinely provide, preferring to keep us in court instead. Their reason to refuse customary protections is evidenced by the shoddy way the company has treated our land and the shoddy way our land looks today now that this pipeline has been buried here."

Eleanor Fairchild, 78, owns a 350-acre farm south of Winnsboro, Texas. She has complained of severe erosion resulting from the construction of the pipeline and is pictured below near a hillside that is adjacent to her property's wetland. With Fairchild's property, it is not clear whether the appropriate construction mechanisms have been implemented, because a deep crater had formed where none existed before. Despite more than eight months of asking TransCanada to remedy the situation, the erosion has not been successfully addressed, and the agency that oversees the construction has been unwilling to help her.[33]

Eleanor Fairchild stands in an erosion area adjacent to a wetland after pipeline construction on her property.

Dark green areas show extensive applications of field coating, or patching, over damaged areas on the pipe before it is lowered into the trench during pipeline construction. The code required reasonable care in handling of the pipe to avoid damage to this very tough coating.

Our Findings

Outlined in the following pages are problems and anomalies observed during the construction of the southern segment of the Keystone XL.

Inspection Process

In mid-May, a Public Citizen representative traveled to East Texas to view excavation sites, and to take and review photos where new pipe was being replaced. Initially, about one half of the 60-mile stretch between the Sabine and Sulphur rivers was driven, with observations made from public roads as well as from landowners' property. After this initial review, and after hearing comments directly from one of TransCanada's inspectors, Public Citizen contacted Vokes, and furthered its investigation by driving and flying more of the pipeline south of the area initially explored to as far south as the Beaumont area, not far from the end of the pipeline route near the Gulf Coast refineries.

The Keystone XL is a high-pressure pipeline. As outlined in TransCanada's application to the State Department for its permit, the Keystone XL is to be designed and built to federal engineering standards. The standards for the design, construction, operations and maintenance for high-pressure, hazardous liquid pipelines are outlined in the Code of Federal Regulations (49 CFR 195) and the legally adopted American Society of Mechanical Engineers (ASME) code named "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids" (ASME B31.4).[34] TransCanada has also agreed to 57 special conditions with PHMSA in building the pipeline. Within the scope of this report, we will often refer to the federal code of construction that applies to the pipeline as simply "code." Based on observations, Public Citizen believes the evidence presented below shows the code was not adhered to.

Patches have been applied to cover "holidays," or holes and pipeline damage. Some of the patches are peeling before the pipeline is to be buried in the ground.

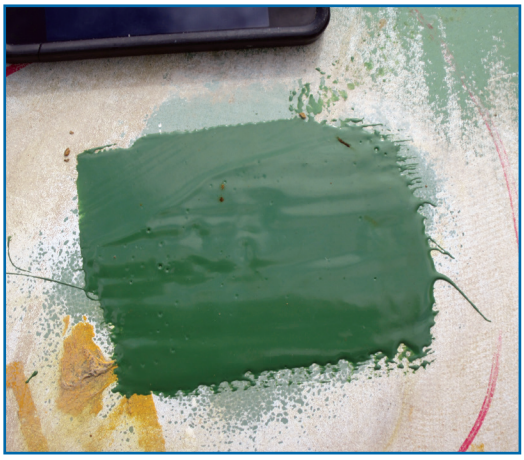
Exterior Damage and Coating Repair

The code requires in mandatory terms that care be taken in handling the pipe for construction.[35] The pipeline's external coating is vital to the protection of the pipe for the life of its operational use.[36]

The dark green patches, as illustrated in several of the photos in this report, are repair patches covering exterior damage that occurred during handling of the pipe in construction. This patching, or field coating, has been applied over a white paint used as a kind of sunscreen protection during the long pipe storage period. The light green area is the original powder coating bonded on the pipe during the manufacturing process.

Holes or damage to the original coating to the extent shown above indicates rough handling of the pipe. The damage, called "holidays" by the industry, can be points of discontinuity (such as holes and scrapes) where the pipeline surface is exposed to the environment, which can promote corrosion of the pipeline. [37]

Close-up pictures of the repair patches, showing that the apparent lack of surface preparation before application of patching material has resulted in repair patches not adhering to the pipe. Pictured above some of the patches in this photo is the word "Jeep." A jeep is an electric tool used to detect pipeline abnormalities or holes.



Tiny holes in the patching indicate uneven application of field coating, which can partially expose the area that had been repaired.

Peeling Patching Material

Coatings applied in the field require special procedures to ensure their bonding lasts for the long service life of a pipeline. As observed above, field coatings applied to cover damage to the exterior of the pipeline can peel when misapplied or not allowed to cure properly.

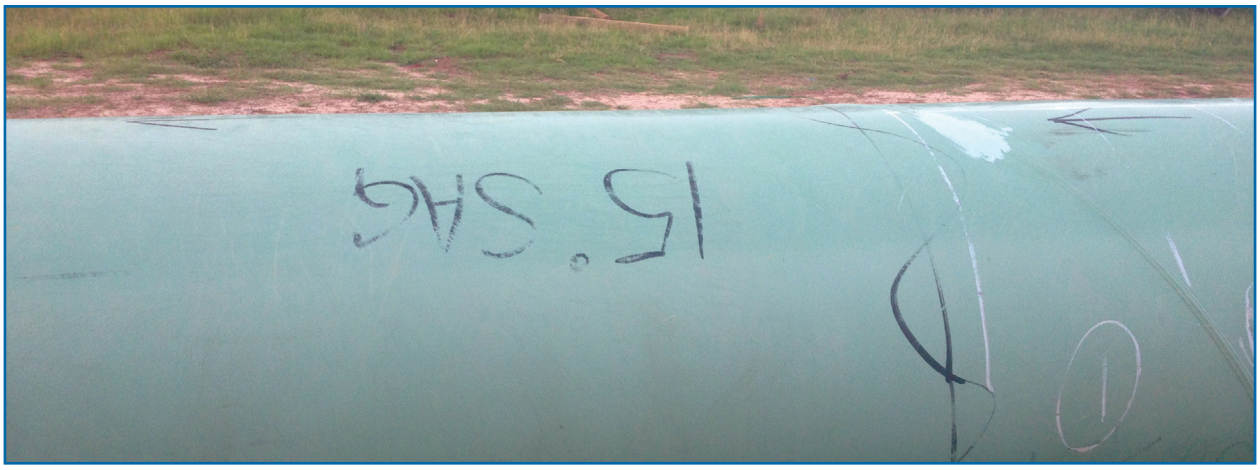
In the picture above, the dark green field coating appears to be misapplied. It appears that workers didn't follow the required application procedure to ensure adequate curing and bonding to the pipeline surface. This is evidenced by the peeling of the patch in the center of the photograph. Additionally, the patching was applied over the white sunscreen paint instead of being applied directly to the pipe's original light-green surface. Proper coating procedure calls for the surface to be properly prepared for effective bonding of the coating.[38]

Though a qualified inspector is required to review the contractor's onsite field coating work,[39] the landowners and observers noted that the coating or patch material was peeling before the pipeline was placed into the ground, indicating a lack of quality control onsite.

The peeling of the dark green field coating, due to apparent lack of proper application and adhesion, exposes the underlying construction damage to the pipe, providing the opportunity for accelerated corrosion and potential leakage.

Other observations reveal that the patches did not completely cover the pipe damage or that the patch coatings were not evenly applied. In fact, some of the dark green patches had numerous pinholes that can be seen within the poorly applied coating overlaying the pipe damage beneath it. Based on visual evidence, observers believe that the pipeline repairs may be as problematic as that of the damage inflicted upon the pipe during construction.

On one landowner's property, some East Texas residents viewed pipeline construction workers using propane torches to accelerate the curing of the coating for patching instead of allotting the proper amount of time required to do so as recommended by the product's manufacturer. This shortcut can lead to adhesion problems. It also calls into question the future performance of the coating. A site construction picture printed in the Oct. 24, 2012, edition of Fuel Fix includes photos from the Houston Chronicle showing workers accelerating the curing of coating with propane torch.[40]



A pipeline section that is cut out evidently due to the excessive sag or bending of the pipe.

Sags or Bends in the Pipeline

To build the Keystone XL's southern segment, TransCanada is using approximately 80-foot long sections of steel pipe weighing several thousand pounds. Due to the pipe's length and weight, bending and/or stress can occur when long pipe sections are lowered into a trench. Intentional bending is used to have the pipeline follow the contour of the ditch.[41] Bends or bowing can result when pipe is unsupported within the ditch.[42] Concerns arise when the unintentional bending or bowing of the pipe occurs, imposing unintentional stress on the pipeline.[43] This excessive bowing of the pipe is called a "sag."[43]

East Texas residents discovered sags in various locations where pipe had been excavated.[44] Unintentional sags due to pipe unsupported during lowering into a trench, or while pipe sections are welded together, can result in permanent bends and can allow buckling to occur. This ultimately can lead to cracks and ruptures. The degree of sag was indicated on the excavated sections. In this case, the sag of the pictured section above was 15 degrees, and the section was removed from the trench.

The two shots are of the exterior and interior of a massive dent from the inside of a pipe section near Jacksonville, Texas.

Dents

Dents were among the anomalies identified in new pipe excavated along the pipeline route. The code currently allows only for nominal mechanical deformation.[45] Some dents that were observed were as deep as that of a brick. Dents most often occur when pipe is placed in a trench where rocks or debris are present.[46] The code of construction requires pipe to be laid flat on the bottom of the trench and firmly supported. Once the trench is ready to be backfilled with soil to close the ditch, any remaining debris underlying the pipe can dent the pipe due to the downward weight and pressure of the compacted soil and backfilling equipment.[47]

Dents can provide major areas of stress concentration on a pipeline, since cracks will often develop over time where the creases of dents occur, fostering the probability of a leak or rupture where those stress points are located on the pipe, especially if dents occur on welds.[48] It is a qualified inspector's responsibility to ensure that the construction contractor does not lay or cover pipe in a ditch until the ditch can provide smooth, firm underlying support for the pipeline, as mandated by the quality assurance requirements of the construction code.[49] Fuel Fix photos published in late October, along with photos from the Houston Chronicle, indicate that the ditching inspector did not ensure that rocks were removed from the trench before lowering the pipe into the ditch.[50] Aerial pictures of an active excavation site showed that rocks were removed from under a portion of the pipeline that was excavated.

Inline Inspections

Inline inspection is a procedure in which a robotic sensor, sent into the pipe, checks for pipeline abnormalities. In the code, when the initial construction ends along the pipeline route, hydrostatic testing is done to check the pipeline and is verified by experts. Inline inspection tools are designed to view only the general condition of the pipeline, and cannot always detect smaller points of contact, cracking or the loss of metal.[51]

Once anomalies are repaired, the entire pipeline is not required to be retested hydrostatically to ensure its integrity and reliability. Yet with all the excavations and subsequent repairs, hydrostatic testing of the entire line would be a prudent measure to help ensure the integrity and safety of the pipeline.[52]

The pipe is not level in the ditch. The trench has collapsed around it on a construction site near Beaumont.

Insufficient Support of Pipe in Trench

The photo above shows pipe coming up from the bottom of the ditch, rising close to the level of the water's surface, when it should be under many feet of water.

The code mandates that, "Where the ditch is flooded, care shall be exercised so that the pipe is not floated from the bottom of the ditch prior to backfill completion."[53] The pipe needs to be anchored or secured within the trench to ensure that this situation does not occur.

The code also requires that pipe be firmly supported and secured in a smooth ditch, free of debris.[54] In this case, the pipe appears to not be secured, as it has been allowed to float up to surface on one end.

The photo illustrates a second problem, related to the fact that the soil surrounding the ditch has collapsed and filled in under the pipe. This collapse would make it extremely difficult for the pipe to be pushed down and back into place to ensure the required four-foot depth of space is maintained when the completed construction area is covered with soil. Excavating this trench to put the pipe down will result in a pipe sitting on uncompacted soil.

Improperly Handled Soil

The code of construction requires good right-of-way reclamation practices for ground disturbed during construction.[55] Good construction practice requires that excavated topsoil be kept separate from the subsurface materials, so that when the pipe is finally covered up, the arable topsoil can be once again placed atop the ground's surface to ensure plant and crop growth.[56] On David Holland's property, and on other properties, the darker topsoil appears to have been comingled with the lighter sterile subsurface clays. If the arable and substrate soil shown in this picture is used in this mixed form to cover the trench, the farmer or landowner will have difficulties growing crops, pasture or other plant life in the same way as before the ground was disturbed. David Whitley has complained that the soil where the pipeline had been constructed will not grow grass as expected for grazing purposes. Instead, only plants of no agricultural value can grow there. Many other landowners have reported a similar problem.

The good black topsoil and the underlying yellow substrate are comingled on this landowner's property near Beaumont. When replaced over the trench, this mix will not support valued agricultural plant life.

In filling the trench on this construction site near Lufkin, the trackhoe's bucket is pulling soil near the pipe, affording the possibility for the bucket to hit the line.

Improper Backfilling

The code of construction has identified improper backfilling as a source of serious pipe damage. Proper filling and compaction of the soil protects the pipeline. Ground disturbance loosens the soil, which must then be recompacted below and around the pipe to re-establish the pipeline's load-bearing capacity. [57]

Improper filling and compaction coupled with subsequent agriculture work, can strain welded areas and can cause pipe damage, especially when there is no internal pressure in the pipe during construction activities, which exacerbates the problem.[58]

In the first improper backfilling method witnessed by landowners, trackhoe operators dumped loose dirt on top of the pipe, which meant that the gap below the pipe could be unsupported without fill dirt across the length of the pipe exposed in the ditch.

As surveyed from aerial observation, the second backfilling method that could be problematic involved the trackhoe operator forcing fill dirt under the pipe, allowing some degree of compaction to occur. This is technically better than the first method, but filling in this way increases the chances of mechanical damage to the pipe as demonstrated by previous ruptures on other pipelines. Any pipe that requires remediation effort on a slope can have compaction problems, as it is very difficult to effectively pack soil under pipe on a slope.

Welding Inspection

Welds are used to "tie" or fuse sections of the pipe together during pipeline construction.[59] Welding is arguably the most important step of the field construction process, as this step is crucial to both schedule and pipeline integrity.

Quality welds are critical to a pipeline's safe operation and longevity. PHMSA sometimes grants waivers on standard construction permits based on the stress level of operation requested for high-pressure pipelines such as that on Keystone XL.[60] In exchange for the waivers for pipelines to work at a higher stress capacity, PHMSA will then require that 100 percent of the welds be inspected.[61] When problems are identified, the pipe is excavated and replaced with short segments of pipe, or pups, resulting in two new welds for each replacement.

Multiple examples of pipe replaced on the southern segment of the Keystone XL were observed to be marked with "RT," indicating that Radiography Testing had been used to inspect the welds on the new segments of replaced pipe instead of utilizing the more precise Automated Ultrasonic Testing (AUT).[62] AUT uses sound waves at high frequency.[63] With AUT, an array of probes are mounted outside the pipe. The probes move around the pipe to the side of the weld and can pinpoint the exact position of a weld problem as they travel around the circumference of the pipe. Every weld inspected with AUT is inspected to the same level of quality. It is extremely rare to miss fine cracks with AUT technology.

The markings in the picture, and observed frequently in the field, indicate that RT was used to inspect the two new welds per each replaced pipeline section. RT is a less accurate technology. It is a process similar to taking a medical X-ray.[64] Once the welded pipe is in the ground, external examination is required so an X-ray is then taken from outside the pipe. With this process, the source used for the X-ray will expose both the top and bottom layers of pipe, and thus the weld can be twice the distance from the film, which significantly reduces radiographic quality. The radiography examiner will try to make a judgment on the safety of the welds based on this X-ray, which loses some clarity since it is taken through multiple layers of steel. Radiographic technicians prefer to avoid taking these exposures because the results can be quite hard to interpret and cracks are missed.

Proof that radiography testing (RT) was used during construction. This notation was seen on pipe on multiple East Texas properties.

The difference in quality between RT and AUT is significant. AUT is comparable to viewing a picture on the wall with your glasses on. RT is similar to viewing the same picture with your glasses off – the picture is there, but the clarity of detail is diminished, and cracks missed by RT may not show up in the film.

As evidenced by the pipe's markings, some of the initial field welds during construction and many of the pipe replacements were inspected only by radiography. Despite TransCanada remarking on its website about utilizing best practices and being the "only company in North America that regularly uses automated ultrasonic testing,"[65] apparently it has chosen to use the less accurate method, radiography, in the inspection of many of its welds during construction or on replaced sections of new pipe in Texas.

Thus, if 100 sections of pipe were excavated and replaced, this would translate into 200 new welds inspected by the less accurate radiography, meaning that cracks or other possible problems from the new pipe being put in may not be discovered. Because federal regulations do not require these new sections' replacement welds to be hydrostatically retested or to be subjected to a new inline inspection, Public Citizen has concerns about the integrity of those new welds for the pipeline's start-up and lifetime of operations.

Questions Regarding Quality Assurance

When observers flew over pipeline construction sites, they noticed a disturbing trend regarding the excavation of recently buried pipe. Many of the areas where crews were digging up recently buried – and presumably damaged – pipe were in swamps, water channels and road crossings – sensitive areas that require special care and different construction techniques to mitigate risk.[66]

For instance, a pipeline buried beneath a road or railroad crossing must be built and laid to withstand the force of heavy truck or train traffic running over it and typically will require special design considerations such as a casing or uncased carrier pipe to be installed.[67]

Streams and wetlands need to be protected. In Texas, the pipeline runs underneath 631 streams and rivers, many which lead to water supply lakes or feed municipal water wells that nearby communities depend on.[68] The code requires that in sensitive areas such as water crossings and marshlands, special consideration be given, including the use of heavier wall pipe, to prevent damage or keep the pipe from floating up to the surface.[69] Many excavations were observed in the vicinity of roadways and water bodies. Vokes believes that the many excavations and pipe replacements with their associated welds near water, railroad crossings and roadways indicate problems in the initial construction.

Previous PHMSA advisories have warned companies like TransCanada about welding or tying in the connections between heavy wall and light wall pipe when transitioning construction in areas such as slopes, railroad crossings and sensitive areas where excessive downward pressure can cause the pipe to buckle, collapse, burst or affect the ovality or roundness of the pipe.[70] Special welding techniques are required to weld two different thicknesses of pipe successfully.[71]

Top: Typical view of a remediation showing extensive pipe exposed near the city of Corrigan. Above: Area near Jacksonville showing a transition area at the bottom of a hill near a watercourse, where typically two thicknesses of pipe are tied, requiring technical welding skills.

Pipe replacements during excavation can easily be identified from the air where open trenches have two new bands of coating with a short pipe in the middle. Even when the site is buried, cut-out sections of the pipe are left on the property before they are collected. It is evident from the air that TransCanada has replaced many pipe sections in these sensitive transition areas, with resulting welds that are not required to be hydrostatically tested to ensure the pipeline's integrity.

A History of Pipeline Construction Problems

TransCanada has claimed that the construction of the Keystone XL pipeline will be a "state-of-the-art" pipeline meeting many "special conditions" in its design and construction.[72]

However, TransCanada has a history of making such claims on many of the new pipelines it has constructed, dating back to the 1990s. But what occurred instead have been serious operational problems, legal trouble and fines.

Over the past two decades, construction problems on TransCanada pipelines such as the Keystone I, Bison and Iroquois have resulted in environmental spills, indictments of TransCanada executives and even the explosion of a line within six months of a pipeline's start-up operations.

The sections that follow highlight some of TransCanada's claims of superlative construction and what actually happened.

KEYSTONE I

New TransCanada Pipeline Had 12 Spills Within One Year of Operations

Crude began flowing through the $5.2 billion, 2,148-mile Keystone I pipeline in June 2010, carrying it from Canada to Patoka, Illinois, and then to Cushing, Oklahoma, going through North Dakota, South Dakota, Nebraska, Kansas and Missouri.[73] Approximately 450,000 barrels of crude travels daily through the pipe, which is 30 inches in diameter.[74]

On May 7, 2011, the pipeline spilled almost 21,000 gallons of tar sands crude in rural North Dakota.[75] A landowner who lived about a half of a mile away discovered and called in the spill to TransCanada's hotline after seeing a 60-foot geyser of oil spraying into the air.[76] The spill was not the first spill on the line – it marked the eleventh and most significant spill within the first year of Keystone I's startup operations.[77]

A subsequent analysis of the spill determined that the release occurred because of a failed three-quarter-inch fitting located on a nearby pumping station.[78]

TransCanada's response to the North Dakota incident was that the failure at the pump station did not count as a spill or a leak.[79] Though pump stations are covered by the pipeline construction code, comments from a spokesman indicated that the company counted only a leak from the pipeline itself as a spill,[80] discounting the integral role

pump stations played in making the pipeline operational and allowing crude to flow. A few weeks after the North Dakota spill, another failure occurred at a pump station in Kansas.[81] This prompted PHMSA to issue a corrective order to shut down the pipeline until TransCanada finished remedial measures before operations could resume. [82] The agency required a thorough review with measures to be taken to remedy the problem. [83] In a later report submitted to federal and state agencies, TransCanada stated that it had replaced fittings on 47 pump stations with heavier valves.[84]

The Kansas spill marked the twelfth spill within a year. An earlier risk analysis given to PHMSA stated that the company anticipated only one 50-barrel leak in a seven-year period.[85]

It is noteworthy that on its Keystone I pipeline, TransCanada received the first federal waiver ever granted by PHMSA, allowing the company to construct and design parts of the line to operate at a stress level higher than current U.S. standards.[86] The waiver allows for slightly thinner steel to reduce construction costs while providing some relief from federal pipeline safety regulations.[87]

Upon the grant of the special waiver application at a reduced operating stress, PHMSA stated that Keystone I would meet more than 50 special conditions of design, construction and inspection to help "provide a level of safety equal to, or greater than, that which would be produced if the pipelines were operated under standard existing regulations."[88]

BISON I

New TransCanada Pipeline Explodes Within the First Six Months of Service

In July 2011, near Gillette, Wyoming, TransCanada's 300-mile, 30-inch-diameter Bison natural gas pipeline exploded within six months of its January start-up.[89] The explosion blew out a 60-foot section of pipeline and shook nearby buildings.[90]

The pipeline moves natural gas from Wyoming to markets in the Midwest. Though heralded by Bison Pipeline LLC, a TransCanada subsidiary, as a pipeline exemplifying new, more stringent standards,[91] documents obtained by the Canadian Broadcasting Company (CBC) News detailed a pipeline project with problems relating to welding and inspection.

The construction manager commented, "We are in trouble on the Bison project," in a September 2010 internal email that outlined problems related to the inspection and welding on the pipeline, though construction had started only the month before.[92]

However, while PHMSA was conducting construction inspections during the same month of September, officials were also taking issue with the quality assurance of inspections, the qualifications of pipeline workers and the procedures used to test the coating on the pipe. [93]

PHMSA later issued a formal warning letter reiterating concerns about the same problems previously identified in 2010, stating that "it was apparent that an improved quality management system, if properly implemented, would reduce the need for remedial work and improve overall quality during construction." Once again, the agency identified issues with personnel, inspections and coating.[94]

Months later, Bison exploded. When PHMSA issued its final assessment for the Bison pipeline failure, it noted that the root cause was a "gouged dent containing cracks" that occurred during the final phases of construction.[95]

The Bison pipeline was carrying approximately 365 million cubic feet of natural gas per day when the rupture occurred.[96]

IROQUOIS PIPELINE

Executives Plead Guilty to Construction Noncompliance

The Iroquois gas transmission pipeline, built in 1991, stretches 375 miles from the Canadian border through the Northeast United States, passing through the heart of New York and into Connecticut and central Long Island.[97]

In May 1996, a subsidiary of TransCanada Pipelines Ltd. and four senior executives pleaded guilty to federal and state environmental and safety violations after an extensive four-year investigation for "knowingly violating a number of environmental and safety provisions of the pipeline construction permit."[98]

At the time of this prosecution, the Iroquois case represented the largest environmental prosecution and the largest fine ever levied in the U.S. other than the penalty assessed against the Exxon Valdez.[99]

TransCanada's subsidiary, Iroquois Pipeline Operations, was found guilty of felony violations for failing to restore and clean up 188 streams and failing to install proper pipeline supports on hills near wetlands, called trench breakers.[100] These breakers prevent groundwater from washing away the pipe's supporting earth on a hillside and exposing pipe to migrating rocks and other corrosion sources.[101]

But before the pipeline was built, Iroquois executives "promised 'a pipeline of exceptional safety' and pledged to take dozens of expensive measures to avert a calamity."[102]

According to The New York Times, one contractor who worked the Iroquois project stated that he was told to forego using 40 percent of the planned breakers because installing them would have slowed the project and increased its costs. Other contractors also stated they were asked to do the same.[103]

Landowners complained that Iroquois workers had filled trenches with boulders in violation of the state permit barring rocks larger than 18 inches.[104] According to the U.S. Department of Justice, "Placement of rocks in such a manner can damage the pipeline, posing a serious threat to its structural integrity."[105]

In subsequent plea agreements , Iroquois agreed to ensure that no safety issues arose from the failure to install the breakers and the improper placement of rocks, but that it also would correct problems affiliated with cleanup and the remediation of 30 wetlands and stream sites.[106]

The U.S. Attorney's office conducted its criminal investigation based on concerns raised by more than three dozen landowners, officials and some of the very contractors who built the line.[107] The investigation questioned whether Iroquois had cut corners in its rush to complete the pipeline to take advantage of the lucrative winter heating season and to avoid penalties for being late in meeting its contractual deadlines.[108]

According to federal documents, if deadlines were missed in finishing the pipeline's construction, Iroquois and its utility partners would have owed $170,000 per day in fines to the Canadian gas companies storing gas for pipeline use. Most likely, the pipeline operator also would have had to renegotiate its purchase contracts, probably at a higher cost.[109]

Conclusion

In May 2012, as the controversy over the presidential permit of the Keystone XL pipeline persisted, TransCanada's Russ Girling wrote to The New York Times claiming that TransCanada had "safely and reliably operated pipelines and other energy infrastructure across North America for more than 60 years."[110]

But history has proven that TransCanada pipelines have not been that safe or reliable.

History has proven that TransCanada pipelines have not been that safe or reliable.

TransCanada has now excavated numerous sites along the new pipeline route on the Keystone XL southern segment in Texas, claiming it is doing so out of an abundance of caution and that it is building a "state-of-the-art" pipeline.[111] But there is substantial evidence that there were problems with construction management and inspectors adhering to the requirements of the code of construction, even while the company has publicly said the many anomalies are not indicative of a more worrisome problem.

However, observers and Texas landowners are sounding the alarm. Photos and videos show that they have a lot to be alarmed about. Many excavations indicate problems with dents, sags, damage to coating and other construction problems along the southern segment of TransCanada's Keystone XL pipeline.

A significant number of sections of newly laid pipe appear to have been damaged in the field, and even some of the repairs appear to have been done poorly. This raises the specter of history repeating itself, with toxic crude leaking or even gushing from damaged pipe.

Given the stakes – the looming potential for a catastrophic spill of a hazardous crude along a pipeline that traverses hundreds of streams and rivers, and that comes within just one or two miles of some towns and cities – it would be irresponsible for the federal government to allow tar sands crude to start flowing through the southern leg without ordering a complete hydrostatic retesting of the line and a thorough quality assurance review. The two tar sands spills currently being remediated in Michigan and Arkansas have shown that this crude is extremely difficult

to clean up. Before any crude starts moving through the pipe, the government must investigate the problems with this pipeline and TransCanada's internal processes, to ensure that the pipeline is built to code and will not break.

It would be equally irresponsible for President Barack Obama to approve the northern leg of the Keystone XL if the safety of this southern segment of the pipeline is uncertain.

Further, PHMSA should:

- Review TransCanada's construction quality assurance records.
- Determine whether state and federal laws have been violated.
- Require TransCanada to completely hydrotest the entire southern leg of the Keystone XL to ensure all the anomalies are corrected and no additional construction problems exist.
- Require TransCanada to rerun the caliper inline inspection tools to ensure the massive construction rework has not further damaged the line.
- Mandate a detailed cathodic protection survey program (a process that impresses electrical current into a pipe to prevent corrosion) be put into place to ensure coating quality throughout the service life of the pipeline.
- Not permit operations on the southern segment of the Keystone XL to start until a hydrotest of the entire line has been repeated, and a thorough review of TransCanada's construction quality assurance records is done.

Also, Congress should hold oversight hearings to ensure that PHMSA indeed conducts the quality assurance review and monitors the hydrotest and caliper inline inspection for the southern segment.

Many landowners are asking, "Why not build it right the first time?" and "What does the future hold due to the questions raised over the construction of the southern segment of the Keystone XL?" They are asking the government to do something about the quality assurance of this pipeline before it's too late.

Vokes, speaking to the Canadian Parliament about the Keystone I and Bison pipelines, testified that, toward the end of his five-year employment with TransCanada, "Incidents related to business strategies (at TransCanada) were getting more serious, with major engineering scandals within the Keystone I and Bison projects that resulted in substandard materials being used in the Keystone project and a brand new pipeline that blew up in the United States."[112] The National Energy Board in Canada launched an audit in October 2012, in the wake of Vokes' concerns about the company's lack of code compliance. But PHMSA has not responded to Vokes' further inquiries concerning quality and inspection practices surrounding TransCanada.[113]

Some of the problems documented in this report are consistent with other construction problems identified in both Keystone I and the Bison pipelines before both of these lines experienced service failures.

The answer is clear. Our government agencies and our leaders must step up to ensure the Keystone XL southern segment is safe.

EndNotes

1 *Vokes, Evan. Testimony of Evan Vokes before the Standing Committee on Energy, the Environment and Natural Resources, p. 1, Calgary, Canada, June 6, 2013. http://www.parl.gc.ca/Content/SEN/Committee/411/enev/50221-e.htm*

2 *Swift, Casey-Lefkowitz, Shope, and others. Natural Resource Defense Council. "Tar Sands Pipelines Safety Risks." 2011, p. 4-7. www.nrdc.org/energy/files/tarsandssafetyrisks.pdf*

3 *Swift, Casey-Lefkowitz, Shope, and others. Natural Resource Defense Council. "Tar Sands Pipelines Safety Risks." 2011, p. 7. www.nrdc.org/energy/files/tarsandssafetyrisks.pdf See also Mosqueda, Priscilla. "Whistleblower, Landowners: TransCanada is Botching the Job on Keystone XL Pipeline."Texas Tribune, August 9, 2013. http://www.texasobserver.org/whistleblower-landowners-transcanada-is- botching-the-job-on-keystone-xl-pipeline/*

4 *Horn, Steve. DeSmogBlog.com. "Study Reveals 30 Toxic Chemicals at High Levels at Exxon Arkansas Tar Sands Pipeline Spill Site." April, 29, 2013. http://www.desmogblog.com/2013/04/29/study-reveals-30-toxic-chemicals-high-levels-exxon-arkansas-tar-sands-pipeline-spill-site*

5 *Matthew, John. TransCanada Corporation Blog. "New independent report and prominent climate scientists agree: Keystone XL meets President Obama's climate standard." August 9, 2013. https://blog.transcanada.com/new-independent-report-and-prominent-climate-scientists-agree-keystone-xl-meets-president-obamas-climate-standard/*

6 *Dobson, David. TransCanada Corporation Blog; "Digging Into Pipeline Integrity." June 17, 2013. http://blog.transcanada.com/digging-into-pipeline-integrity/*

7 *Mosqueda, Priscilla. "Whistleblower, Landowners: TransCanada is Botching the Job on Keystone XL Pipeline." Texas Tribune, August 9, 2013. http://www.texasobserver.org/whistleblower-landowners-transcanada-is- botching-the-job-on-keystone-xl-pipeline/ See also Dawson, Chester. "Canada Looks to Sell Its Oil Beyond U.S." Wall Street Journal, Updated August 22, 2013. http://online.wsj.com/article/SB10001424127887323997004578644390357748314.html*

8 *U.S. State Department. Final Environmental Impact Statement (FEIS) - Water Resources, Section 3.3-21, August 26, 2011. http://keystonepipeline-xl.state.gov/documents/organization/182017.pdf*

9 *Swift, Casey-Lefkowitz, Shope, and others. Natural Resource Defense Council. "Tar Sands Pipelines Safety Risks." 2011, p. 7. www.nrdc.org/energy/files/tarsandssafetyrisks.pdf*

10 *Song, Lisa. "TransCanada Digging Up Defective Segments of New Pipeline, Angering Landowners in Texas." Inside Climate News, June 5, 2013. http://insideclimatenews.org/print/26140*

11 *Id.*

12 *Interstate Natural Gas Association of America (INGAA). Definition of Hydrostatic Testing. http://www.ingaa.org/cms/82.aspx*

13 *Woster, Terry. "Pipeline Builder Can Waive U.S. rule." Argus Leader, September 8, 2007. p. A1. http://pqasb.pqarchiver.com/argusleader/asess1724296541.html (last accessed 7/26/2013)*

14 *Fisher, Maria Sudekum. "Oil pipeline to be retested after anomalies found." Businessweek, December 9, 2010. http://www.businessweek.com/ap/financialnews/D9K0M2GO1.htm*

15 *Kohn, Sally. Opinion "Six reasons Keystone XL was a bad deal all along." Fox News, p. A1. January 18, 2012. http://www.foxnews.com/opinion/2012/01/18/six-reasons-keystone-xl-was-bad-deal-all-along/*

16 *Winchester, Cody. Valve failure at pump station along Keystone pipeline causes spill," Argus Leader, May 10, 2011. http://pqasb.pqarchiver.com/argusleader/access/2341703801.html (last accessed 7/26/2013).*

17 *Rusnell, Charles and others. "Quality Concerns Arose Before TransCanada Pipeline Blast." CBS News, October 24, 2012. http://www.cbc.ca/news/canada/story/2012/10/24/transcanada-pipelines-bison-explosion.html*

18 *Id.*

19 *Glaberson, William. "Pipeline Concerns Draws $22 Million Fine." New York Times, May 24, 1966. http://www.nytimes.com/1996/05/24/nyregion/pipeline-concern-draws-22-million-fine.html*

20 *Berger, Joseph. "Hazard Underground: A special report.; 375 Miles of Suspected Short Cuts Fuel Fears of Northeast Pipeline." New York Times. March 27, 1995. http://www.nytimes.com/1995/03/27/nyregion/hazard-underground-special-report-375-miles-suspected-short-cuts-fuel-fears.html?pagewanted=print&src=pm*

21 *Vokes, Evan. Testimony of Evan Vokes before the Standing Committee on Energy, the Environment and Natural Resources, p. 1, Calgary, Canada, June 6, 2013. http://www.parl.gc.ca/Content/SEN/Committee/411/enev/50221-e.htm*

22 *Id.*

23 *Mosqueda, Priscilla. "Whistleblower, Landowners: TransCanada is Botching the Job on Keystone XL Pipeline." Texas Tribune, August 9, 2013. http://www.texasobserver.org/whistleblower-landowners-transcanada-is- botching-the-job-on-keystone-xl-pipeline/*

24 *Pipeline Association for Public Awareness. Glossary of Terms. Definition of Anomaly. http://www.pipelineawareness.org/residents-businesses/glossary/*

25 *Id.*

26 *Id.*

27 *Mosqueda, Priscilla. "Whistleblower, Landowners: TransCanada is Botching the Job on Keystone XL Pipeline." Texas Tribune, August 9, 2013. http://www.texasobserver.org/whistleblower-landowners-transcanada-is- botching-the-job-on-keystone-xl-pipeline/*

28 *Song, Lisa. "TransCanada Digging Up Defective Segments of New Pipeline, Angering Landowners in Texas." Inside Climate News, June 5, 2013. http://insideclimatenews.org/print/26140*

29 *Mosqueda, Priscilla. "Whistleblower, Landowners: TransCanada is Botching the Job on Keystone XL Pipeline." Texas Tribune, August 9, 2013. http://www.texasobserver.org/whistleblower-landowners- transcanada-is- botching-the-job-on-keystone-xl-pipeline/*

30 *Song, Lisa. "TransCanada Digging Up Defective Segments of New Pipeline, Angering Landowners in Texas." Inside Climate News, June 5, 2013. http://insideclimatenews.org/print/26140*

31 *Id.*

32 *Id.*

33 *Dermansky, Julie. "TransCanada's Keystone XL, the Safest Pipeline Ever, Says Who?." June, 18, 2013. http://www.truth-out.org/news/item/17067-transcanadas-kxl-the-safest-pipeline-ever-says-who*

34 *The American Society of Mechanical Engineers. ASME B31.4-2006. "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," ASME Code for Pressure Piping, Forward and Chapter V, Construction, Welding and Assembly. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

35 *Pipeline and Hazardous Materials Safety Administration, DOT, Code of Federal Regulations 49 CFR Part 195, "Transportation of Hazardous Liquids by Pipeline, Subpart A- General, p. 171.*

36 *Kletchka, Ernest W. "Liquid Coatings for Pipeline Repairs and Rehabilitation." Corrmet Engineering Services presentation to NACE International. CORROSION 2000 Conference, Orlando, Florida. Document Id #00760. http://www.onepetro.org/mslib/servlet/onepetropreview?id=NACE-00760*

37 *Pipeline Association for Public Awareness. Glossary of Terms. "Holiday" definition. http://www.pipelineawareness.org/residents-businesses/glossary/*

38 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, Chapter VI, Inspection and Testing. Sections 436.6.3-Repair of Defects and A461.1.2.-Protective Coating. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

39 *Pipeline and Hazardous Materials Safety Administration (PHSMA). DOT. Agency website: "Pipeline construction: Coatings." http://primis.phsma.dot.gov/construction/IssueCoatings.htm*

40 *Shauk, Zain. "Aerial photos show Keystone XL behind schedule, research firm says." Fuel Fix, August 30, 2013. http://fuelfix.com/blog/2013/08/30/keystone-xls-southern-leg-behind-schedule-research-firm-says-photos/*

41 *Pipeline and Hazardous Materials Safety Administration (PHMSA). Website. "Pipeline Construction: Lowering." http://primis.phmsa.dot.gov/construction/issuelowering.htm*

42 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." Chapter V, Construction, Welding and Assembly. Section 434.10- Installation of Pipe in the Ditch. P. 46, http://www.scribd.com/doc/70254674/ASME-B31-4-2006. See also*
International Pipe Line & Offshore Contractors Association (IPLOCA), "Onshore Pipelines- the Road to Success." Volume I, Appendix 6.2 – Pipeline Trench Design, Sections 6.2.5.4- Trench Bottom Preparation and 6.2.8.6-Trench Foundation. Sept. 2011. http://issuu.com/pms72/docs/onshore_pipelines_the_road_to_success_Vol_1/1. See also iploca.org site

43 *Id.*

44 *Dermansky, Julie. "TransCanada's Keystone XL, the Safest Pipeline Ever, Says who?" June, 18, 2013. http://www.truth-out.org/news/item/17067-transcanadas-kxl-the-safest-pipeline-ever-says-who*

45 *The American Society of Mechanical Engineers, ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," ASME Code for Pressure Piping, B31, Section 451.6.2.4-Dents. http://www.scribd.com/doc/70254674/ASME-B31-4-2006. See U.S. State Department-Final Environmental Impact Statement (FEIS), Appendix U-PHMSA Special Conditions. August 26, 2011. http://keystonepipeline-xl.state.gov/documents/organization/182017.pdf*

46 *Pipeline Hazardous Materials and Safety Administration Safety (PHSMA) "FactSheet: Pipe Defects and Anomalies," Dent and Gouges Section, par. 1. http://primis.phmsa.dot.gov/comm/FactSheets/FSPipeDefects.htm See also International Pipe Line & Offshore Contractors Association (IPLOCA). "Onshore Pipelines- the Road to Success, Volume I, Appendix 6.2 –Pipeline Trench Design, Section 6.2.5.4 –Trench Bottom Preparation, Sept. 2011. http://issuu.com/pms72/docs/onshore_pipelines_the_road_to_success_Vol_1/1. See also iploca.org site*

47 *International Pipe Line & Offshore Contractors Association (IPLOCA). "Onshore Pipelines- the Road to Success." Volume I, Appendix 6.2–Pipeline Trench Design, Sept. 2011. http://issuu.com/pms72/docs/onshore_pipelines_the_road_to_success_Vol_1/1. See also iploca.org site*

48 *Baker, Jr., Michael, in association with others. "Mechanical Damage-Final Report." Section 4.2.2-Stress/Strain Fields [Hopkins & Leis (2003)]. p. 15 and Section 4.4.4 Leak Versus Rupture, p. 21.primis.phmsa.dot.gov/gasimp/docs/Mechanical_Damage_Final_Report.pdf*

49 *The American Society of Mechanical Engineers. ASME B31.4-2006. "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, B31, Section 436.2 - Qualification of Inspectors. http://www.scribd.com/doc/70254674/ASME-B31-4-2006.*

50 *Zain, Shauk. "Aerial photos show Keystone XL behind schedule, research firm says." Fuel Fix. See Photo Gallery from Houston Chronicle, October 24, 2012. http://fuelfix.com/blog/2013/08/30/keystone-xls-southern-leg-behind-schedule-research-firm-says-photos/*

51 *Government Accounting Office (GAO). Report to Congressional Committees. "Natural Gas Pipelines: Greater Use of Inspection Technology Can Improve Safety." p. 4, 8. Sept. 1992. http://www.gao.gov/assets/160/152387.pdf See also Baker Jr., Michael in association with others. PHMSA report. "Mechanical Damage Final Report." p. 144 April 2009. Department of Energy. Pacific Northwest National Laboratory. "Mechanical Damage Characterization in Pipelines."Introduction p. 1-2. October 2001. http://www.netl.doe.gov/technologies/oil-gas/publications/Status_Assessments/MechanicalDamageCharacterization_1.pdf*

52 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, B31.4-2006. Chapter V - Construction, Welding, and Assembly, p. 53 Section 437-Testing. http://www.scribd.com/doc/70254674/ASME-B31-4-2006. See U.S. State Department- Final Environmental Impact Statement (FEIS) – Appendix U – PHMSA Special Conditions. August 26, 2011. http://keystonepipeline-xl.state.gov/documents/organization/182017.pdf*

53 *The American Society of Mechanical Engineers. ASME B31.4-2006. "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, B31.4-2006. Chapter V - Construction, Welding, and Assembly, p. 37, Section 434.11-Backfilling. http://www.scribd.com/doc/70254674/ASME-B31-4-2006.*

54 *Pipeline and Hazardous Materials Safety Administration, DOT. Code of Federal Regulations, 49 CFR Part 195, "Transportation of Hazardous Liquids by Pipeline, Subpart D- Construction, 195.252. http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=4897cec090a374b49748f270834020b7&tpl=/ecfrbrowse/Title49/49cfr195_main_02.tpl*

55 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, B31.4 2006, p. 37. Chapter V - Construction, Welding, and Assembly, Section 434.3-Right-of-Way See 434.3.2-Construction Requirements. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

55 *Id.*

56 *International Right of Way Association. Ramsey, J.F. and Burgess, S.A. "Pipeline construction: prevention of impacts to agricultural lands." p. 8, Col. 3, par. 4. August 1985. http://www.irwaonline.org/eweb/upload/web_0885_Pipeline_Construction.pdf. See U.S. State Department, FEIS, Section 2.3.2.2-Cleaning & Grading and Section 2.3.2.3-Trenching, p. 2-31. August 26, 2011. http://keystonepipeline-xl.state.gov/documents/organization/182012.pdf*

57 *International Pipe Line & Offshore Contractors Association (IPLOCA). "Onshore Pipelines- the Road to Success- Volume I." Appendix 6.2 – Pipeline Trench Design, Sections 6.2.4.3- External Load, Section 6.2.8.10- Compaction, Sept. 2011. http://issuu.com/pms72/docs/onshore_pipelines_the_road_to_success_Vol_1/1. See also iploca.org site*

58 *International Pipe Line & Offshore Contractors Association (IPLOCA). "Onshore Pipelines- the Road to Success-Volume I." Appendix 6.2 – Pipeline Trench Design, Sections 6.2.4 – General, p. 31. Sept. 2011. http://issuu.com/pms72/docs/onshore_pipelines_the_road_to_success_Vol_1/1. See also iploca.org site*

59 *English Dictionary. Definition of "weld." http://www.collinsdictionary.com/dictionary/english/weld*

60 *McGowan, Elizabeth. "Keystone XL Pipeline Safety Standards Not as Rigorous as They Seem." Inside Climate News. September 19, 2011. http://insideclimatenews.org/news/20110919/keystone-xl-pipeline-safety-regulations-phmsa-transcanada-oil-sands-bitumen?page=show. See Associated Press. "Waiver granted for oil pipeline," The Bismarck Tribune, September 8, 2007. http://bismarcktribune.com/news/state-and-regional/waiver-granted-for-oil-pipeline/article_e754020d-bee0-5855-8811-9e61423d0092.html*

61 *U.S. State Department, Final Environmental Impact Statement, Keystone XL, Appendix U, PHMSA Conditions for Keystone XL and Keystone 1. June 13, 2011, p. 4 of 16. http://keystonepipeline- xl.state.gov/documents/organization/182257.pdf*

62 *OSG Materials Consultants. "Automated Ultrasonic Testing." http://osgmaterialsconsultants.com/automatic_ultrasonic_testing.html*

63 *Anderson, Tony. The Fabricator.com. "Radiographic and ultrasonic weld inspection: Establishing weld integrity without destroying the component." http://www.thefabricator.com/article/weldinginspection/radiographic-and-ultrasonic-weld-inspection*

64 *Id.*

65 *TransCanada. "Pipeline Integrity: Pipeline safety and integrity – Inline inspection." http://keystone-xl.com/safety/pipeline-integrity/*

66 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," ASME Code for Pressure Piping, B31.4-2006. Chapter IV, Sections 434.13- Special Crossings, 434.13.1-Water Crossings, Section 434.13.4-Railroad and Highway Crossings. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

67 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," ASME Code for Pressure Piping, B31.4-2006. Chapter IV, Section 434.13- Special Crossings, Section 434.13.4-Railroad and Highway Crossings. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

68 *U.S. State Department, Final Environmental Impact Statement (FEIS) - Water Resources, Section 3.3-21. and Appendix E – Water Crossing Tables, p. 106-150. August 26, 2011. http://keystonepipeline-xl.state.gov/documents/organization/182017.pdf*

69 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids," ASME Code for Pressure Piping, B31.4-2006. Chapter IV, Sections 434.13- Special Crossings, 434.13.1-Water Crossings, Section 434.13.4- Railroad and Highway Crossings, p. 46. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

70 *Pipeline and Hazardous Materials Administration (PHMSA). Advisory ADB-10-03, Mar 24, 2010. PHMSA-2010-0078. "Pipeline Safety: Girth Weld Quality Issues Due to Improper Transitioning, Misalignment, and Welding Practices of Large Diameter Line Pipe." http://www.phmsa.dot.gov/portal/site/PHMSA/menuitem.ebdc7a8a7e39f2e55cf2031050248a0c/?vgnextoid=b19e7511292f7210VgnVCM1000001ecb7898RCRD&vgnextchannel=8590d95c4d037110VgnVCM1000009ed07898RCRD&vgnextfmt=print*

71 *The American Society of Mechanical Engineers. ASME B31.4-2006, "Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids." ASME Code for Pressure Piping, B31.4-2006. Chapter IV, Sections 434.8.6-Types of Welds, Joint Designs, and Transition Nipples and Fig. 434.8.6 (a)-(2) Acceptable Butt Welded Joint Design for Unequal Wall Thicknesses. http://www.scribd.com/doc/70254674/ASME-B31-4-2006*

72 *Matthew, John. TransCanada corporate blog. "New independent report and prominent climate scientists agree: Keystone XL meets President Obama's climate standard." August 9, 2013. https://blog.transcanada.com/new-independent-report-and-prominent-climate-scientists-agree-keystone-xl-meets-president-obamas-climate-standard/*

73 *Associated Press. "Route Change considered for Nebraska Section of Keystone Pipeline." Billings Gazette, November 9, 2011. http://billingsgazette.com/news/state-and-regional/route-change-considered-for-nebraska-section-of-keystone-xl-pipeline/article_e096fe8d-88a1-5435-b267-cc039195f564.html*

74 *Davidson, Osha Gray. "Keystone Pipeline Spill Raises Concerns About TransCanada's Super-Sizing." Forbes, May 11, 2011. http://www.forbes.com/sites/oshadavidson/2011/05/11/keystone-pipeline-spill-raises-concerns-about-transcanadas-super-sizing/*

75 *Pipeline Hazardous Material Safety Administration (PHMSA). Jeffrey D. Wiese, Associate Administrator for Pipeline Safety. Corrective Action Order sent to TransCanada, June 2, 2011. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Keystone%20CAO%20and%20Restart%20Approval.pdf*

76 *Hovey, Art. "North Dakotans describe Keystone Spill." Lincoln Star Journal, August 4, 2011. http://journalstar.com/news/state-and-regional/nebraska/north-dakotans-describe-keystone-spill/article_a47b0250-b942-519d-a100-566d33c77f7f.html*

77 *Winchester, Cody. "Oil Spill prompts probe in N.D." Argus Leader, May 14, 2011. http://pqasb.pqarhiver.com/arugsleadr/access/2346695351.html (Last accessed 7/26/2013)*

78 *North Dakota Public Service Commission. "Summary of Keystone Release Incident." as provided by Argus Leader, May 16, 2011. www.argusleader.com/assets/pdf/DF174518518.PDF*

79 *Davidson, Osha Gray ."Keystone Pipeline Spill Raises Concerns About TransCanada's Super-Sizing." Forbes, May 11, 2011. http://www.forbes.com/sites/oshadavidson/2011/05/11/keystone-pipeline-spill-raises-concerns-about-transcanadas-super-sizing/*

80 *Id.*

81 *Pipeline Hazardous Material Safety Administration. Jeffrey D. Wiese, Associate Administrator for Pipeline Safety, Corrective Action Order sent to TransCanada, June 2, 2011. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Keystone%20CAO%20and%20Restart%20Approval.pdf*

82 *Id.*
83 *Id.*
84 *Winchester, Cody. "Report blames vibration for oil spill." Argus Leader, May 19, 2011, http://pqasb.pqarhiver.com/arugsleadr/access/2351579141.html. (Last accessed 7/26/2013)*
85 *Davidson, Osha Gray. "Keystone Pipeline Spill Raises Concerns About TransCanada's Super-Sizing." Forbes, May 11, 2011. http://www.forbes.com/sites/oshadavidson/2011/05/11/keystone-pipeline-spill-raises-concerns-about-transcanadas-super-sizing/*
86 *Associated Press. "Waiver Granted for Oil Pipeline." Aberdeen News, September 9, 2007. http://articles.aberdeennews.com/2007-09-09/news/26393278_1_oil-pipeline-hazardous-liquid-pipelines-hazardous-materials-safety-administration*
87 *Id.*
88 *Woster, Terry. "Pipeline builder can waive U.S. Rule."Argus Leader, Sept. 8, 2007. http://pqasb.pqarchiver/argusleader/doc/282937016.html (last accessed July 26, 2013)*
88 *Id.*
89 *Business report staff. "Explosions Shuts Natural Gas Pipeline in Wyoming." Wyoming Business Report, July 22, 2011. http://www.wyomingbusinessreport.com/article.asp?id=58848*
90 *Fugleberg, Jeremy. "Natural gas pipeline explodes near Gillette." Casper Star Tribune, July 22, 2011. http://trib.com/news/state-and-regional/natural-gas-pipeline-explodes-near-gillette/article_2e99d7e2-0b53-57e0-b3f4-005a025ededf.html*
91 *Rusnell, Charles and others. "Quality Concerns Arose before TransCanada Pipeline Blast." CBS News, October 24, 2012. http://www.cbc.ca/news/canada/story/2012/10/24/transcanada-pipelines-bison-explosion.html*
92 *Id.*
93 *Id.*
94 *Pipeline and Hazardous Material Safety Administration (PHMSA). Warning Letter to Vern Meier, TransCanada Vice President of US Pipeline Operations from Peter Katchmar, Regional Director of PHMSA. March 21, 2011. https://primis.phmsa.dot.gov/comm/reports/enforce/documents/320111002W/320111002W_Warning%20Letter_03212011_text.pdf*
95 *Pipeline and Hazardous Material Safety Administration (PHMSA). Hoidal, Chris. Regional Director, Western Division. "Failure Report on Bison pipeline explosion." Issued November 7, 2012. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Pipeline/Failure%20Reports/GT_WY072011_red.pdf*
96 *Business report staff. "Explosions Shuts Natural Gas Pipeline in Wyoming." Wyoming Business Report, July 22, 2011. http://www.wyomingbusinessreport.com/article.asp?id=58848*
97 *Berger, Joseph. "Hazard Underground: A special report.; 375 Miles of Suspected Short Cuts Fuel Fears of Northeast Pipeline." New York Times, March 27, 1995. http://www.nytimes.com/1995/03/27/nyregion/hazard-underground-special-report-375-miles-suspected-short-cuts-fuel-fears.html?pagewanted=print&src=pm*
98 *Environmental Protection Agency (EPA). Press Release. "PA Iroquois Pipeline Co. To Pay Second Largest Env. Pen. Ever." May 24, 1996. http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/dda8ede4015b99318525646c00509072!OpenDocument*
99 *Department of Justice (DOJ). Press Release."Builder of Northeastern Gas Pipeline Pleads Guilty: Will Pay $22 Million in Criminal and Civil Fines." May 23, 1996. Washington, DC. http://www.justice.gov/opa/pr/1996/May96/233.enr.htm*
100 *Environmental Protection Agency (EPA). Press Release. "PA Iroquois Pipeline Co. To Pay Second Largest Env. Pen. Ever." May 24, 1996. http://yosemite.epa.gov/opa/admpress.nsf/6427a6b7538955c585257359003f0230/dda8ede4015b99318525646c00509072!OpenDocument*
101 *Id.*
102 *Berger, Joseph. "Hazard Underground: A special report.; 375 Miles of Suspected Short Cuts Fuel Fears of Northeast Pipeline." New York Times, March 27, 1995. http://www.nytimes.com/1995/03/27/nyregion/hazard-underground-special-report-375-miles-suspected-short-cuts-fuel-fears.html?pagewanted=print&src=pm*
103 *Id.*
104 *Id.*
105 *Department of Justice (DOJ). Press Release."Builder of Northeastern Gas Pipeline Pleads Guilty: Will Pay $22 Million in Criminal and Civil Fines." May 23, 1996. Washington, DC. http://www.justice.gov/opa/pr/1996/May96/233.enr.htm*
106 *Id.*
107 *Berger, Joseph. "Hazard Underground: A special report.; 375 Miles of Suspected Short Cuts Fuel Fears of Northeast Pipeline." New York Times. March 27, 1995. http://www.nytimes.com/1995/03/27/nyregion/hazard-underground-special-report-375-miles-suspected-short-cuts-fuel-fears.html?pagewanted=print&src=pm*
108 *Id.*
109 *Id.*
110 *Girling, Russ. TransCanada President and CEO. Letter to the Editor "Keystone Safety Measures." New York Times, May 21, 2012. http://www.nytimes.com/2012/05/22/opinion/keystone-safety-measures.html?_r=0*
111 *Matthew, John. TransCanada Corporation Blog. "New independent report and prominent climate scientists agree: Keystone XL meets President Obama's climate standard." August 9, 2013. https://blog.transcanada.com/new-independent-report-and-prominent-climate-scientists-agree-keystone-xl-meets-president-obamas-climate-standard/*
112 *Testimony of Evan Vokes before the Standing Committee on Energy, the Environment and Natural Resources, June 6, 2013, p. 1-2. http://www.parl.gc.ca/Content/SEN/Committee/411/enev/50221-e.htm*
113 *Rusnell, Charles. "National Energy Board announces TransCanada Audit." CBS News, Oct. 31, 2012. http://www.cbc.ca/news/canada/story/2012/10/31/transcanada-national-energy-board.html*