

Analysis of Worst-Case Spills From the Proposed Keystone XL Pipeline

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Summary of Key Findings

A major spill from the proposed Keystone XL tar sands pipeline on the Platte River in Nebraska could spill 5.9 million gallons of toxic, corrosive tar sands oil and spread pollutants such as carcinogenic benzene in excess of federal health standards hundreds of miles downstream, contaminating drinking water for hundreds of thousands of people as far south as Kansas City, Mo. Even a small, undetected leak from an underground rupture of the pipeline in the Nebraska Sandhills could pollute almost 5 billion gallons of groundwater with benzene at concentrations exceeding safe drinking water levels – enough water to form a plume 15 miles long, posing serious health threats to anyone using the underlying Ogallala Aquifer for drinking water or agriculture. And a worst-case spill at the pipeline's crossing of the Missouri or Yellowstone Rivers in Montana could spill well over 5 million gallons of tar sands oil, contaminating drinking and recreational water in North Dakota with harmful levels of benzene and other chemicals.

An independent analysis of worst-case spill scenarios for four locations along the proposed Keystone XL pipeline route through Montana, South Dakota, Nebraska, Kansas, Oklahoma and Texas found that the pipeline's operator, TransCanada Corp., made significant flawed and inappropriate assumptions about the frequency and severity of expected spills from its pipelines.

Although the federal Clean Water Act requires pipeline builders to analyze and make public worst-case spill scenarios and resulting environmental impacts for their projects before beginning operation, TransCanada has yet to adequately do so for the Keystone XL, and the pipeline could be approved before regulators see the conclusions. However, in comparison to the methods the company used to calculate worst-case scenarios for the existing Keystone I pipeline, to which the XL would connect, this independent analysis found:

- While TransCanada estimates that the Keystone XL will have 11 significant spills (more than 50 barrels of crude oil) over 50 years, a more realistic assessment is 91 significant spills over the pipeline's operational lifetime.
- TransCanada arbitrarily and improperly adjusted spill factors to produce an estimate of one major spill on the 1,673 miles of pipeline about every five years, but federal data on the actual incidence of spills on comparable pipelines indicate a more likely average of almost two major spills per year. (The existing Keystone I pipeline has had one major spill and 11 smaller spills in its first year of operation.)
- Analysis of the time needed to shut down the pipeline shows that response to a leak at a river crossing could conservatively take more than ten times longer than the 11 minutes and 30 seconds that TransCanada assumes. (After the June 2010 spill of more than 800,000 gallons of crude oil into a tributary of the Kalamazoo River, an Enbridge tar

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sands pipeline – a 30 inch pipe compared to the 36-inch Keystone XL – was not completely shut down for 12 hours.)

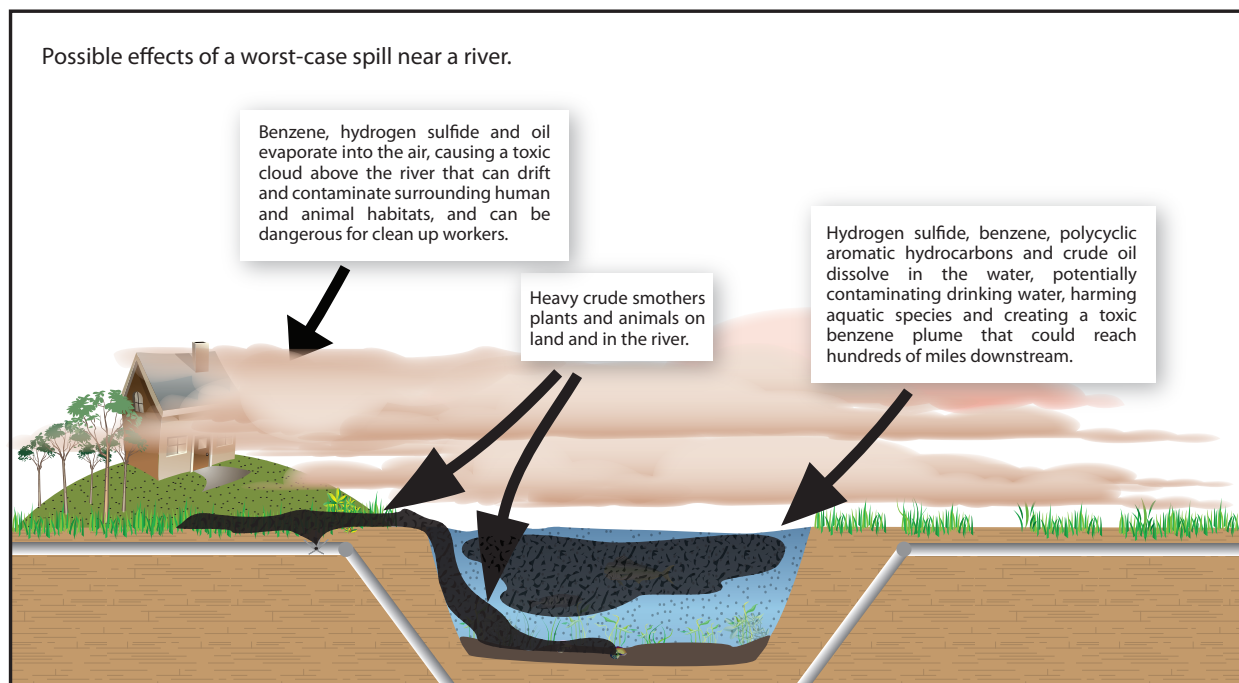
- Realistic calculations yield worst-case spill estimates of more than 180,000 barrels (about 7.9 million gallons) in the Nebraska Sandhills above the Ogallala Aquifer, more than 160,000 barrels (about 6.9 million gallons) of crude oil at the Yellowstone River crossings, more than 140,000 barrels (about 5.9 million gallons) at the Platte River crossing and more than 120,000 barrels (about 5.2 million gallons) at the Missouri River crossing.

Key Chemicals in a Keystone XL Pipeline Spill

| Chemical | Impacts |
|--|--|
| Benzene | Benzene poses threats as an airborne and water-borne pollutant. It can form gaseous clouds around a spill site and dissolve into a toxic plume that extends downstream. Health impacts (according to the EPA): Anemia; decrease in blood platelets; increased risk of cancer. |
| Polycyclic Aromatic Hydrocarbons (e.g., benz(a)pyrene) | Most PAHs will remain close to the site of a spill, forming a toxic plume. PAHs are a particular threat to aquatic life. Health impacts (according to the EPA): Reproductive difficulties; increased risk of cancer. |
| Hydrogen Sulfide | Hydrogen sulfide is very volatile, meaning that it will vaporize quickly. Most impacts, which include acute toxicity via inhalation and toxic effects to aquatic life, will be close to the spill site. |
| Bitumen (raw tar sands oil) | Bitumen is denser than water and will sink to the riverbed, smothering aquatic animals and plants close to the spill site and making clean up difficult. These impacts are of particular concern in the habitats of endangered species. |

Worst-case Scenarios

Although a major spill could occur on any part of the pipeline, the most likely failure points are welds, valve connections and pumping stations. River crossings are especially vulnerable because the pipeline, which must include valves on either side of the river, is underground but relatively shallow. At river crossings the pipeline is more susceptible to corrosion because it is below ground and pressures are relatively high. Small initial leaks from corroded pipe, according to estimates made by TransCanada, could go undetected for up to 90 days, a prescription for catastrophic failure during a pressure spike. Areas with shallow groundwater overlain by permeable soils (such as the Ogallala Aquifer in the Sandhills), where, according to estimates made by TransCanada, slow leaks could go undetected for up to 90 days, also pose risks of special concern.



Missouri River, Mont.

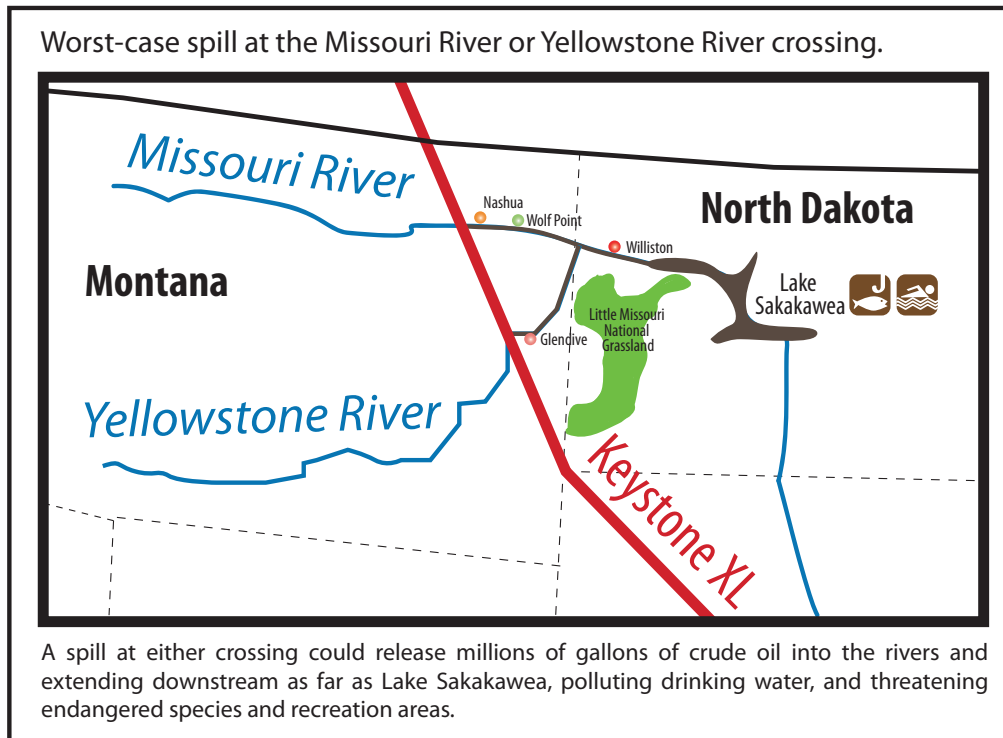
The Keystone XL would cross the Missouri River just downstream of Fort Peck Dam in northern Montana. The worst-case scenario would be for the upstream pipeline valve, closest to the river, to fail. An estimated 75,000 barrels of crude oil would be released from the leak in the two hours assumed for the response time. In addition, 47,867 barrels would drain from the pipeline from elevations above the rupture resulting in a total worst-case release of 122,867 barrels (5.2 million gallons).

Benzene and other contaminants from a worst-case spill at the Missouri River crossing would enter Lake Sakakawea in North Dakota where they would adversely affect drinking water, aquatic wildlife, and recreation. A spill would pose a significant threat to a number of threatened or endangered species in the river and lake. Concentrations of benzene and hydrogen sulfide in the air near the spill site could also be a serious health threat to emergency workers, remediation workers and local residents.

Yellowstone River, Mont.

The pipeline would cross the Yellowstone River approximately 20 miles upstream of Glendive in eastern Montana. This crossing is between two high points 17 miles apart. The worst-case scenario would be failure of the valve two miles upstream from the crossing, which could release 90,416 barrels of crude oil in the pipe between the elevations. Adding 75,000 barrels for the two-hour response time, the worst-case spill would be 165,416 barrels, or almost 6.9 million gallons.

Benzene and other contaminants from a worst-case spill at the Yellowstone River crossing, as at the Missouri river crossing, would enter Lake Sakakawea in North Dakota where they would

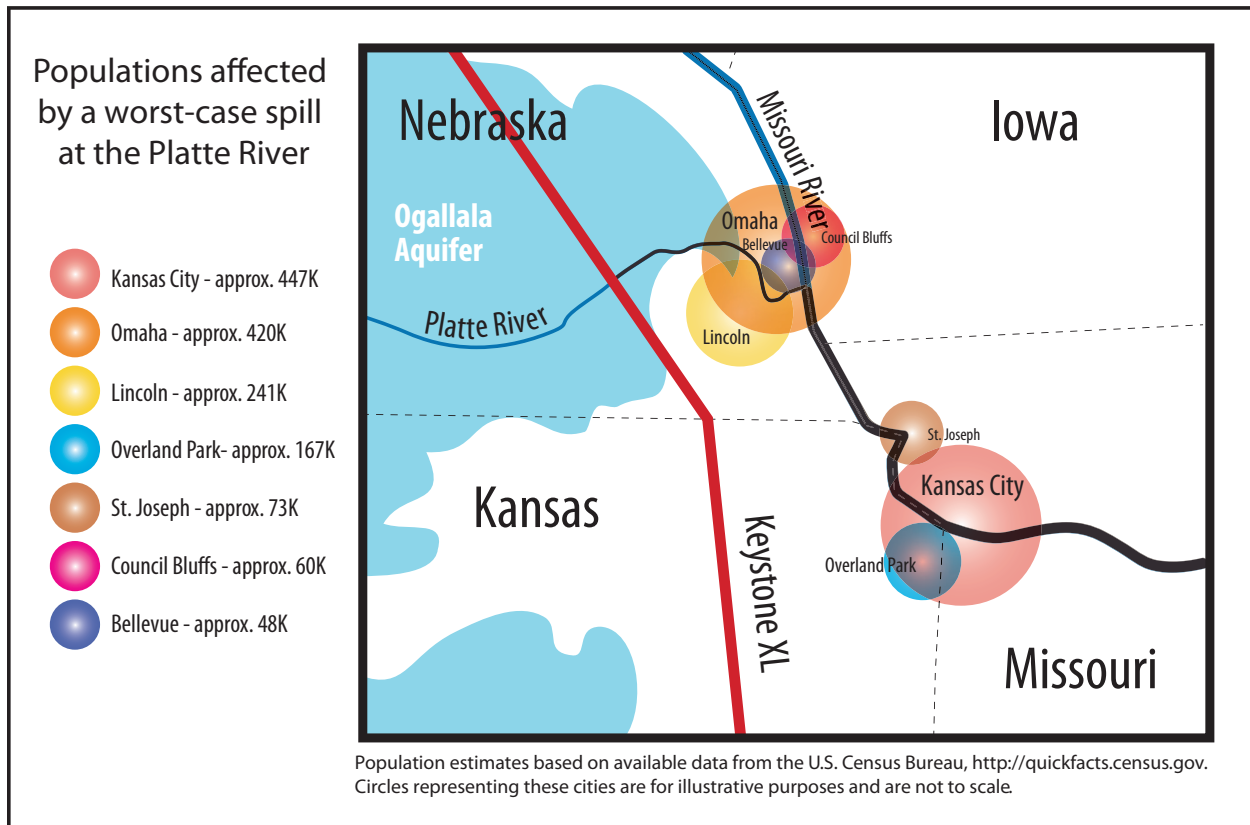


adversely affect drinking water, aquatic wildlife, and recreation. A spill would pose a significant threat to a number of threatened or endangered species in the river and lake. Airborne concentrations of benzene and hydrogen sulfide at the spill site could also be a serious health threat to emergency workers, remediation workers and local residents.

Platte River, Neb.

The pipeline would cross the Platte River approximately three miles downstream of Central City, Nebraska. If the valve 8.5 miles downstream failed, 65,950 barrels of crude oil could be released between the nearest high point and the closest upstream valve. With the additional oil pumped during the response time, the worst-case spill could total 140,950 barrels, or more than 5.9 million gallons.

A spill of this magnitude at this location could create a plume of water contaminated with benzene at a level over 10 times higher than the EPA's Maximum Contamination Level (MCL) for drinking water. The benzene concentration would decrease as the plume spread, but it would have to travel hundreds of miles downstream before the level dropped below the MCL and became safe to drink. The plume could flow down the Platte River into the Missouri River, threatening drinking water intakes for hundreds of thousands of people in cities including Lincoln, Omaha and Nebraska City, Neb., and St. Joseph and Kansas City, Mo. Other constituents from the spill would pose serious health risks to aquatic species in the river.

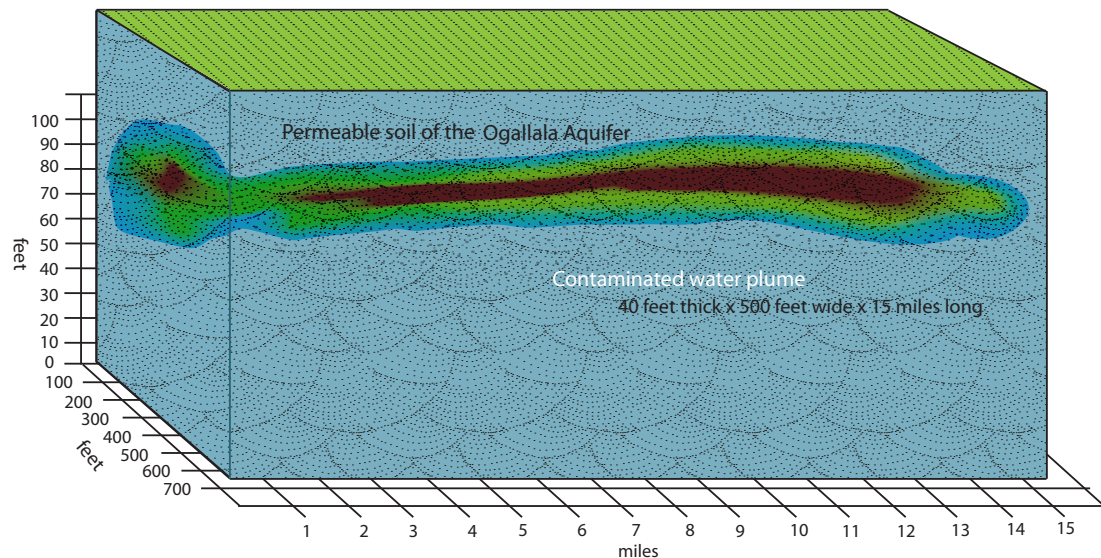


Sandhills, Neb.

The worst-case spill from a small leak, as opposed to a valve failure, would be a remote location where the pipeline is buried above a source of groundwater and where direct observation is infrequent, such as the Sandhills. TransCanada acknowledges that a slow leak could go undetected for up to 90 days, but a reasonable assumption is that a leak would be detected within 14 days, the interval between aircraft inspections. Such a spill across 14 days would result in a release of 189,000 barrels of crude oil, or 7.9 million gallons.

The benzene released by the worst-case spill to groundwater in the Sandhills would be enough to contaminate 4.9 billion gallons of water at concentrations exceeding the MCL. This water could form a plume 40 feet thick by 500 feet wide by 15 miles long. This plume would pose serious health risks to people using that groundwater for drinking water and irrigation.

Worst-case spill above the Nebraska Sandhills.



A spill over 14 days, releasing 7.9 million gallons of crude oil could contaminate 4.9 billion gallons of water and form a plume 40 feet thick by 500 feet wide by 15 miles long. By comparison:

The length of the plume is equal to 264 football fields.
Manhattan is 13.4 miles long.
The volume of the plume (1,584,000,000 feet³) is equal to that of 19,631 Olympic sized pools.

TransCanada's Flawed Assumptions

According to TransCanada, significant spills (more than 50 barrels) are expected to be very rare (0.00013 spills/year/mile, or 11 major spills over a 50-year design life). However, TransCanada made several highly questionable assumptions, including:

- TransCanada ignored historical data on almost one-fourth of pipeline spills by excluding all spills for which the cause is not known.
- TransCanada assumed, without supporting data, that Keystone XL will be constructed so well that it will have only half as many spills as existing pipelines, even though the tar sands crude to be transported through the pipeline is more likely to leak than the conventional crude in other pipelines.

Therefore, a more realistic assessment of expected frequency of significant spills, based on historical data, is 0.00109 spills per year per mile, resulting in 91 significant spills over a 50-year design life of the pipeline (including more than 12 spills from holes greater than 10 inches).

TransCanada consistently states the frequency of spills in terms of spills per year per mile. This is misleading; a more appropriate way to state the frequency would be the frequency of a spill somewhere along the length of the pipeline. Stating the spill frequency in terms of spills per mile is comparable to acknowledging that, although some 33,000 deaths from automobile accidents

occur annually in the U.S., the average annual fatality rate across 350 million people is only 0.000094; therefore, fatalities from automobile accidents are so rare as to be unimportant.

TransCanada's other major flawed assumption – again, unsupported by any data – is that in case of an accident, the Keystone XL can be shut down in 11.5 minutes. This is wildly optimistic. In the June 2010 spill on the very similar Enbridge pipeline in Michigan, the time to finally shut down the pipeline was approximately 12 hours, and during that time the pumps operated for at least two hours. Therefore, a more realistic estimate of shutdown time is two hours. When applied to a hypothetical spill at the Keystone's pumping station in Hardisty, Alberta, the difference between TransCanada's assumptions and the appropriate values is a spill of 41,504 barrels vs. one of 87,964 barrels.