BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF SOUTH DAKOTA

IN THE MATTER O FTHE APPLICATION OF MONTANA-DAKOTA UTILITIES CO. AND OTTER TAIL POWER COMPANY FOR A PERMIT TO CONSTRUCT THE BIG STONE TO SOUTH ELLENDALE 345KV TRANMISSION LINE	DIRECT TESTIMONY OF GREGORY TYLKA EL13-028

1. **State your name and address.**

Gregory L. Tylka, 922 New Hampshire Circle, Ames, IA 50014

2. **Describe your occupation and educational background.**

I am a professor in the Department of Plant Pathology and Microbiology at Iowa State University. My responsibilities are to conduct research and extension educational programs on the biology and management of plant-parasitic nematodes, with a heavy emphasis on the soybean cyst nematode (SCN), *Heterodera glycines*.

3. **Is a complete copy of your resume or C.V. attached to this testimony?**

Yes.

4. **Are you familiar with the proposed B.S.S.E. transmission line?**

Yes.

5. **Could the construction and maintenance of the proposed line impact the spread of soil-born pests like the Soybean Cyst Nematode or "SCN"?**

Yes, construction and maintenance of the proposed line could accelerate the spread of SCN into previously uninfested townships, farms, and fields.

6. **Please explain what the SCN is.**

Nematodes are microscopic worms, many of which live in terrestrial ecosystems such as row-crop farm fields. A majority of soil-dwelling nematodes are not harmful to plants. They consume bacteria, fungi, and other nematodes and contribute to cycling of nutrients in the soil. But agricultural soils also contain nematodes called plant-parasitic nematodes that feed on plants. Many plant-parasitic nematodes are believed to be native to midwestern soils, feeding off of naturally occurring plants in the landscape. These native, plant-parasitic nematodes must reach high population densities (numbers) in order to be damaging to crops. The soybean cyst nematode, SCN, is very different than native plant-parasitic nematodes that reside in typical midwestern soils. SCN is an introduced pest, which means it

does not naturally occur in the United States. Introduced pests like SCN have few or no natural enemies when they are first introduced into a new environment, and the lack of natural enemies allows for very high reproduction in the first few years following introduction into an area. SCN is believed to have been introduced into North America from Asia (Riggs, 2004). The nematode feeds from the soybean root's vascular tissue, stunting the roots and making the roots less able to use atmospheric nitrogen, making it highly damaging to the soybean crop. Also, soybean plants infected with SCN are more vulnerable and suffer greater yield loss from soil-borne soybean diseases caused by fungi that are commonly found in soybean fields in the Midwest (Niblack et al., 2006). The nematode has a relatively short generation time (24 to 40 days), allowing it to complete three to six generations on a single soybean crop, and the nematode females each produce 250 or more eggs, allowing SCN population densities to increase very quickly. Finally, eggs of SCN can survive in a dormant condition in the soil without soybeans or another host crop being grown for a decade or more (Riggs, 2004).

7. **Please describe the research you've done, or of which you are aware, regarding the impact and spread of SCN.**

The soybean cyst nematode, scientific name *Heterodera glycines*, is considered the most damaging pathogen of soybean in the United States and Canada. Annual yield losses in the United States alone are estimated to exceed $1 billion (Wrather et al., 2010). Soybean cyst nematode can reduce soybean yields without causing aboveground symptoms (Wang et al., 2003), which allows the nematode to build up in fields to more damaging levels before farmers notice a problem. In a single growing season, SCN population densities can increase from less than 1,500 eggs per 100 cm^3 of soil (a little less than a half cup) in the spring to more than 19,000 eggs per 100 cm^3 of soil on susceptible soybean varieties and nearly 6,000 eggs per 100 cm^3 of soil on SCN-resistant soybean varieties at the time of harvest (Tylka et al., 2013). The map of the known distribution of SCN in North America was recently updated, and South Dakota was identified as a state that was particularly vulnerable to having SCN spread considerably in the future (Tylka and Marett, 2014).

8. **Please describe the impact SCN can have on crop production.**

It is difficult to scientifically quantify the exact impact of SCN on soybean yields in infested fields because yield loss is dependent on the nematode population density (with greater yield loss occurring at higher SCN numbers), the soybean variety grown (SCN-susceptible varieties suffer greater damage than SCN-resistant varieties), and weather (there is much greater SCN reproduction and greater yield loss in hot dry years than in years of moderate temperatures and adequate to excess moisture). However, one can gain some insight into the yield-reducing effects of SCN by comparing the yields of SCN-resistant and SCN-susceptible soybean varieties in experiments conducted in SCN-infested fields. SCN-resistant soybean varieties allow some nematode reproduction and, consequently the varieties suffer some yield loss. But SCN-resistant soybean varieties suppress reproduction of the nematode compared to susceptible soybeans, which allow unchecked nematode reproduction. My research program at Iowa State University compares the yields of >60 SCN-resistant soybean varieties to yields of several widely grown SCN-susceptible soybean varieties each year at nine locations throughout Iowa (see www.isuscntrials.info). In 2013, the average yield of SCN-resistant soybeans ranged from 3.7 bushels per acre (5.6%) to 18.4 bushels per acre (56%) greater than the susceptible soybean varieties among the nine experiments (Tylka, 2014). Those yield differences equate to $54 to $268 per acre at current soybean prices ($14.60 per bushel). At very high SCN population densities and under very stressful weather conditions (severe drought), yield loss can approach or exceed 50%.

9. **Please describe the ways that SCN can spread from field-to-field.**

The life stage of SCN that best survives dormant in the soil and poses the greatest threat for spread is the cyst, which is the egg-filled body of a dead SCN female. SCN females and cysts are about the size of a period at the end of a printed sentence in a newspaper, and each female and cyst can contain 200 or more eggs. Anything that moves soil particles of this size is capable of moving SCN. Common avenues of spreading the nematode include moving soil on farming equipment, wind-blown soil, and soil moved with surface erosion due to rainfall. Equipment that digs into and disrupts the soil to a depth of a foot or more would likely be more effective at spreading SCN than surface soil adhering to the wheels of vehicles simply because of the volume of soil being moved.

10. **Could both construction equipment and ordinary farm equipment cause SCN to spread?**

Yes. Movement of any equipment (example: tractors, sprayers, combines, cranes, cement trucks) could directly move SCN by transporting clumps of soil containing SCN cysts, which are the size of a period on a printed page and can be full of hundreds of eggs each.

11. **Has SCN been identified in the areas of South Dakota where the proposed B.S.S.E. Line would be constructed?**

Yes. SCN has been found in northeastern South Dakota as well as in southeastern North Dakota (Tylka and Marett, 2014). Also, because fields infested with SCN may not exhibit obvious symptoms of damage for years (Wang et al., 2003), it is likely that more fields and counties are infested with SCN than officially reported.

When SCN becomes first established in a new field, it tends to be aggregated or clustered in discrete areas in the field because the nematode is relatively immobile. The SCN second-stage juveniles that hatch from the egg are the only mobile and infective stage of the nematode, and these juveniles can move no more than an inch or so under their own power. So SCN usually takes years to spread throughout a field. But SCN reproduction rates (increases in numbers over time) on soybeans usually are greatest in the first few years after the nematode is introduced into a field because there are no natural enemies present in the soil (since SCN has never occurred in that field before) and the nematode will have good nutrition because the soybean crop will be relatively healthy.

12. **Can construction equipment used in a project like the proposed B.S.S.E. Line cause SCN to spread farther or more rapidly than ordinary farming practices? If so, how?**

Yes. Soil disturbed by construction equipment would likely result in greater spread of the nematode than soil disturbed by most other common occurrences by making the soil more friable (easily crumbled) and prone to erosion compared to soil that is left undisturbed or disturbed just minimally.

Also, soil moved by construction equipment could be from properties owned by various farmers. And SCN-infested soil from a less-than-diligent farmer's field could be moved into a field farmed by someone who has diligently worked to avoid introduction of SCN into their fields by careful management of the movement of soil.

13. **Could ongoing maintenance of the proposed B.S.S.E. line also impact the spread of SCN in the region? If so, how?**

Ongoing maintenance of the proposed line would not likely have much greater impact on spreading SCN than other activities involving vehicles traveling through the SCN-infested fields, but it depends somewhat on the condition of the soil at the time that vehicles or crews are present in the field. The least chance of movement, in my opinion, would be when the soil is frozen because frozen soil would not adhere well to vehicles or on people's boots. And the greatest chance would be when the soil is moist enough to allow for mud to easily adhere to vehicles and on people's boots.

14. **Are there ways to remove SCN from a field once it has been introduced? If so, please describe these.**

Once SCN is introduced into a field, there is nothing that can be done to eradicate the nematode other than to not grow soybeans for an extended period of time. Many of the eggs that are present within cysts (dead females) of SCN are in a dormant state and capable of surviving in the absence of a host crop for a decade or more. There are anecdotal reports of SCN surviving in soil without a host for thirty years (Riggs, 2004). So a field that is infested with SCN would have to remain fallow or be planted with a nonhost crop from 10 to 30 years or more to eliminate the nematode from the field.

15. **Are there ways to mitigate the damage caused by SCN in a field once it has been introduced? If so, please describe these.**

Soil applied chemicals to kill SCN directly are no longer available for use in fields in the Midwest. Current management options are 1) minimize field-to-field movement of SCN-infested soil, 2) grow SCN-resistant soybean varieties, 3) grow nonhost crops, and 4) use seed-applied nematode protectants when planting soybeans.

The most effective option to maximize soybean production is delaying introduction of the nematode into a field or an area. States like South Dakota and North Dakota are in a unique position to be able to significantly delay the spread of SCN into the soybean-producing areas of their states by managing the movement of SCN-infested soil from field to field and farm to farm.

Growing nonhost crops, such as corn, in an SCN-infested field will reduce SCN numbers, but the reduction can vary from 5 or 10% to about 50% within a single growing season. Unfortunately, the reduction in egg numbers as a consequence of growing a nonhost crop does not occur in multiple years in a row. That is, the greatest reduction of SCN egg numbers occurs in the first year that a nonhost crop is grown, with a slight reduction in numbers occurring the second year, and very little reduction occurring in years thereafter because dormant eggs will primarily remain in the soil after two years of growing a nonhost crop.

SCN-resistant soybean varieties can be effective at producing acceptable soybean yields in SCN-infested fields and slowing the build-up of the nematode, but as described above, even SCN-resistant soybean varieties suffer some yield loss. Also, there will be considerably fewer SCN-resistant soybean varieties adapted for growing in South Dakota than in more southern areas of the Midwest, including Iowa. Another significant shortcoming of SCN-resistant soybean varieties is that almost all (>95%)

contain the same set of resistance genes (Tylka and Mullaney, 2013). This lack of genetic diversity has lead to SCN populations in the Midwest developing an increased ability to reproduce on the SCN-resistant soybean varieties.

There are at least four nematode-protectant seed treatments that are being advertised as providing protection against early season infection by SCN. But the seed treatments infrequently increased yields or reduced SCN population densities in university field experiments conducted throughout the Midwest in 2012 and 2013. So the utility of these nematode-protectant seed treatments has yet to be proven.

16. **Are there ways to prevent SCN from being spread from field-to-field by construction or farm equipment? If so, please describe these.**

Fields could be tested for SCN in advance of moving equipment in by collecting soil samples from the fields and having the samples tested for presence of the nematode. But when we did follow-up testing of soil samples that tested negative for SCN that were submitted to the Iowa State University Plant and Insect Diagnostic Clinic, we discovered a 14% rate of false negative results (Tylka and Flynn, 2000). That is, 14% of the time, we observed SCN females growing on soybean roots after 30 days growing in leftover soil from samples that had tested negative for SCN with our standard extraction procedure. This rate of false negative results would likely occur with any laboratory processing the samples and is the result of soil clods containing SCN cysts remaining clumped during the soil processing procedure and not releasing the SCN cysts to be trapped on the sieves used in the process.

Another possible way to reduce likelihood of spread of SCN on equipment is to clean the equipment before it moves from field to field. Soil adhering to all parts of all machines must be washed off (although disinfecting probably isn't warranted). But this washing effort, no matter how thorough, can be inefficient because all of the soil on a vehicle must be removed and then the run-off water and soil from the rinsing must be directed away from the next area or field that will be worked in.

17. **Is there anything else you feel the Commission should know about SCN as it relates to the construction of the proposed B.S.S.E. transmission line?**

Following are references to scientific articles and extension publications that support specific statements made above:

Niblack, T.L., K.N. Lambert, and G.L. Tylka. 2006. A model plant pathogen from the kingdom Animalia: *Heterodera glycines*, the soybean cyst nematode. Annual Review of Phytopathology 44:283-303.

Riggs, R.D. 2004. History and distribution. Pages 9-39 in: Biology and Management of Soybean Cyst Nematode: Second Edition. Walsworth Publishing Company, Marceline, MO.

Tylka, G.L. and P.H. Flynn. 2000. Effectiveness of soil analysis for presence of the soybean cyst nematode, *Heterodera glycines*. Journal of Nematology 32: 467-468.

Tylka, G.L. and M.P. Mullaney. 2013. Soybean cyst nematode-resistant soybeans for Iowa. Iowa State University Extension Publication PM 1649, 22 pp.

Tylka, G.L., G.D. Gebhart, C.C. Marett, and M.P. Mullaney. 2013. Evaluation of soybean varieties resistant to soybean cyst nematode in Iowa – 2012. Iowa State University Extension, publication IPM-52, 32 pp.

Tylka, G.L. and C.C. Marett. 2014. Distribution of the soybean cyst nematode (*Heterodera glycines*) in the United States and Canada: 1954 to 2014. Plant Health Progress (accepted for publication).

Tylka, G. 2014. Trial results show dual benefits of SCN resistance. Iowa State University Integrated Crop Management News, January 17, 2014 (http://www.extension.iastate.edu/CropNews/2014/00117tylka.htm).

Wang, J., T.L. Niblack, J.N. Tremaine, W.J. Wiebold, G.L. Tylka, C.C. Marett, G.R. Noel, O. Myers, and M.E. Schmidt. 2003. The soybean cyst nematode reduces soybean yield without causing obvious symptoms. Plant Dis. 87:623-628.

Wrather, A., G. Shannon, R. Balardin, L. Carregal, R. Escobar, G.K. Gupta, Z. Ma, W. Morel, D. Ploper, and A. Tenuta. 2010. Effect of diseases on soybean yield in the top eight producing countries in 2006. Online. Plant Health Progress doi:10.1094/PHP-2010-0102-01-RS.

18. **Does this conclude your testimony?**

Yes.

Dated this 23rd day of April, 2014

Gregory L. Tylka

Gregory Tylka

STATE OF Iowa)
:SS
COUNTY OF Story)

On this 23 day of April, 2014, before me personally appeared Gregory Tylka, known to me to be the person who is described in, and who executed the foregoing instrument and acknowledged to me that he or she executed the same.

(seal) NOTARIAL SEAL IOWA RITA M BRUELAND Commission Number 775715 My Commission Expires November 14, 2015 RMB

Rita M Brueland
Rita Brueland, Notary Public
My Commission Expires: Nov. 14, 2015

CERTIFICATE OF SERVICE

The undersigned attorney hereby certifies that at true and correct copy of the foregoing **DIRECT TESTIMONY OF GERALD PESALL** was served upon the following parties of record,

electronically or in paper form, this 24th day of April, 2014:

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