GUIDANCE MEMO

SUBJECT: Fargo-Moorhead Metro Flood Risk Management Project - Oxbow, Hickson, Bakke (OHB) Ring Levee - GM-004 Snow Fence

1. **Purpose :**
This Guidance Memo documents discussions and decisions related to the recommended use of snow fence for the OHB Ring Levee.

2. **References**:
Analysis of Snow Climatology., *climate.umn.edu*, [online], http://climate.umn.edu/snow_fencE/index.html (Accessed: 26 February 2014).

N. Godon and V Godon, "Fargo, North Dakota Climate," National Weather Service Eastern North Dakota, Grand Forks, ND, April 2002.

3. **Background**:
The OHB ring levee project includes parallel local drainage ditches along the inside and outside of the Levee. In general, the parallel drainage ditches are being designed to include a 20' bench between the ring levee toe and the edge of the ditch. Along the N and NW portion of the OHB ring levee along WP-43B, snow drifting is a major concern for the local residents of Bakke. Historically, snow drifts have caused internal drainage issues during spring snow melt as well as heavy blowing and drifting snow on roads and driveways within the community. During the OHB VE design charrette, the local sponsor expressed interest in having the U.S. Army Corps of Engineers (COE) analyze the affect the ring levee will have on drifting snow in this area of concern.

4. **Design Parameters**:
The prevailing wind direction for this area that has the greatest potential for snow transport is 340 degrees (NNW). Along the north and west of Bakke the snow wind fetch, or length of an area that is contributing to blowing snow, can reach up to 9,800 feet from approximately Sta. B 61+00 to B 105+80 and 4,775 feet from approximately Sta. B 109+00 to B 122+00. Using the Winter Climate Database (climate.umn.edu), the most recent 30-year (1971 to 2000) average seasonal snowfall amount for the Fargo area is 3.0 feet. This average was used as a baseline for the OHB ring levee snow drift analysis. The average snowfall water equivalent, or snowfall density ratio (0.102), was determined by taking the ratio of liquid precipitation to snowfall. The relocation coefficient (0.34) represents the fraction of snow that is relocated by the wind.

A sensitivity analysis was conducted on the parameters from the Winter Climate Database using the 10 most extreme seasonal snowfalls for the area. The average depth of snow for the 10 most extreme seasonal snowfalls on record is approximately 6.5 feet, which includes the record breaking 1997 seasonal snowfall of 117 inches.

Other parameters used to evaluate the design included:
The ring levee project should not make the snow drift and drainage issues worse than existing conditions,
The inside drainage ditch should be kept clear of drifts during the design events. Drifting in the outside ditch is acceptable.

5. **Project without Snow Fence**:
The OHB Ring Levee is designed with 4:1 side slopes. For snow fence purposes, slopes flatter than 3:1 act as a ramp and carry the snow further downwind. Using the aforementioned design parameters, an average snow fall of 3.0 feet, and using the levee as the only means to capture the drifting snow, the inside drainage ditch would need to be at least 163 feet from the centerline of the levee to keep snow from drifting into the ditch. Since ROW is limited and moving the ditch that far away from the levee would encroach on neighboring properties, this approach was determined unfeasible.

6. **Project with Snow Fence**:
Because of the potential for snow to drift up and over the levee and completely fill the inside drainage ditch adjacent Bakke, the best approach is to capture the snow upwind of the levee with a snow fence. While the levee by itself without a snow fence will not cause the existing snow drifting conditions to worsen, to meet our criteria of keeping the inside ditch clear of snow drifts, the concept of an exterior snow fence was evaluated. This approach was modeled with 2 different scenarios.

The first scenario was to examine placing a snow fence far enough upwind of the levee so that the outside drainage ditch was clear of the drifting snow and therefore the inside ditch would also be clear of the drifting snow. Using the design parameters and the average snow fall (3.0 feet), it was determined that a minimum 6.7 feet tall fence would need to be placed 224 feet upwind of the outside ditch. Using the extreme snowfall amount of 6.5 feet, it was determined that the snow fence would need to be a minimum of 9.5 feet tall and 320 feet upwind of the outside ditch. After internal discussions with the MVP PDT, it was concluded that the outside drainage ditch did not need to be kept clear of snow drifts and that minimizing ROW impacts was more valuable and therefore this approach was ruled out.

The second scenario was to examine placing a snow fence just inside the ROW (as of the 35% submittal), upwind from the levee. In this case, the snow fence would capture most of the snow within the ROW between the fence and the exterior levee toe. Some drifting would occur over the levee, but the levee would act as a second snow fence and buffer drifting snow and store additional snow just at the downwind (interior) toe of the levee. Using the design parameters and the average snow depth of 3.0 feet, a snow fence of 6.7 feet tall would be needed between Sta. B 61+00 to B 105+80. When the extreme snowfall amount of 6.5 feet was used, it was determined that the fence would need to be 9.5 feet tall. From Sta. B 109+00 to B 122+00 it was determined that the snow fence would need to be 5.7 feet tall and 8.2 feet tall respectively.

7. **Recommendation**:
Because of the possibility for extreme snow events in the area, it is recommended that a 9 foot tall snow fence be used from Sta. B 61+00 to B 105+80 and an 8 foot tall snow fence used from Sta. B 109+00 to B 122+00. The snow fence should be placed 5-10 feet inside the ROW, upwind from the levee. It is also recommended that the bench between the inside toe of the levee and the inside drainage ditch be increased to at least 30 feet wide where snow fence is to be installed. This will allow for more snow storage adjacent the interior toe of the levee while keeping the inside ditch clear of drifts. While trees and shrubs could be used as a living snow fence, to ensure snow storage immediately after construction, a structural snow fence is recommended. However, with the structural snow fence 10 feet from the ROW, there is sufficient room to plant vegetation for screening if desired. Vegetation on either side of the snow fence will only increase its effectiveness.

For the portion of WP-43B that is south of B 61+00, snow fencing has not been recommended due to the prevailing seasonal winds and the approach angle to the levee. The levee itself will be sufficient to buffer drifting snow and allow snow storage adjacent the interior toe of the levee while keeping the inside ditch clear of drift. Drifting snow is not as prevalent in the communities of Oxbow, Hickson and Bakke from winds coming from the S, SE due to the existing vegetation and proximity to the Red River, therefore snow fencing was not evaluated for the south and eastern portions of the ring levee.

Additional snow fence may be required adjacent the proposed pump station and CR 81 road raises. However, this cannot be determined until further information regarding the design and location is developed and finalized.

8. **Document Author:**
For questions regarding this Guidance Memo, please contact Renee McGarvey at renee.c.mcgarvey@usace.army.mil or 651-290-5640.

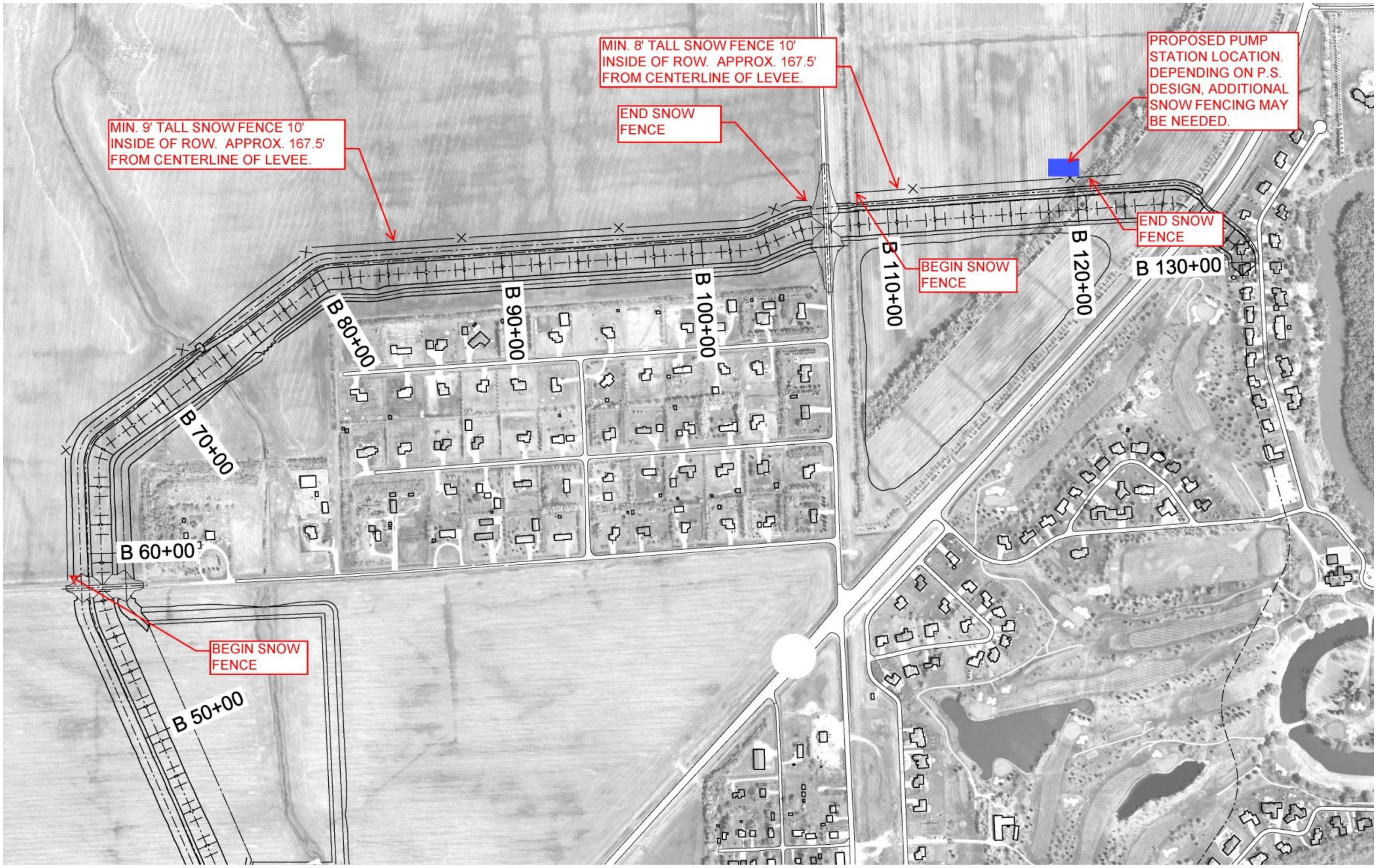

Figure 1 – GENERAL SNOW FENCE PLAN

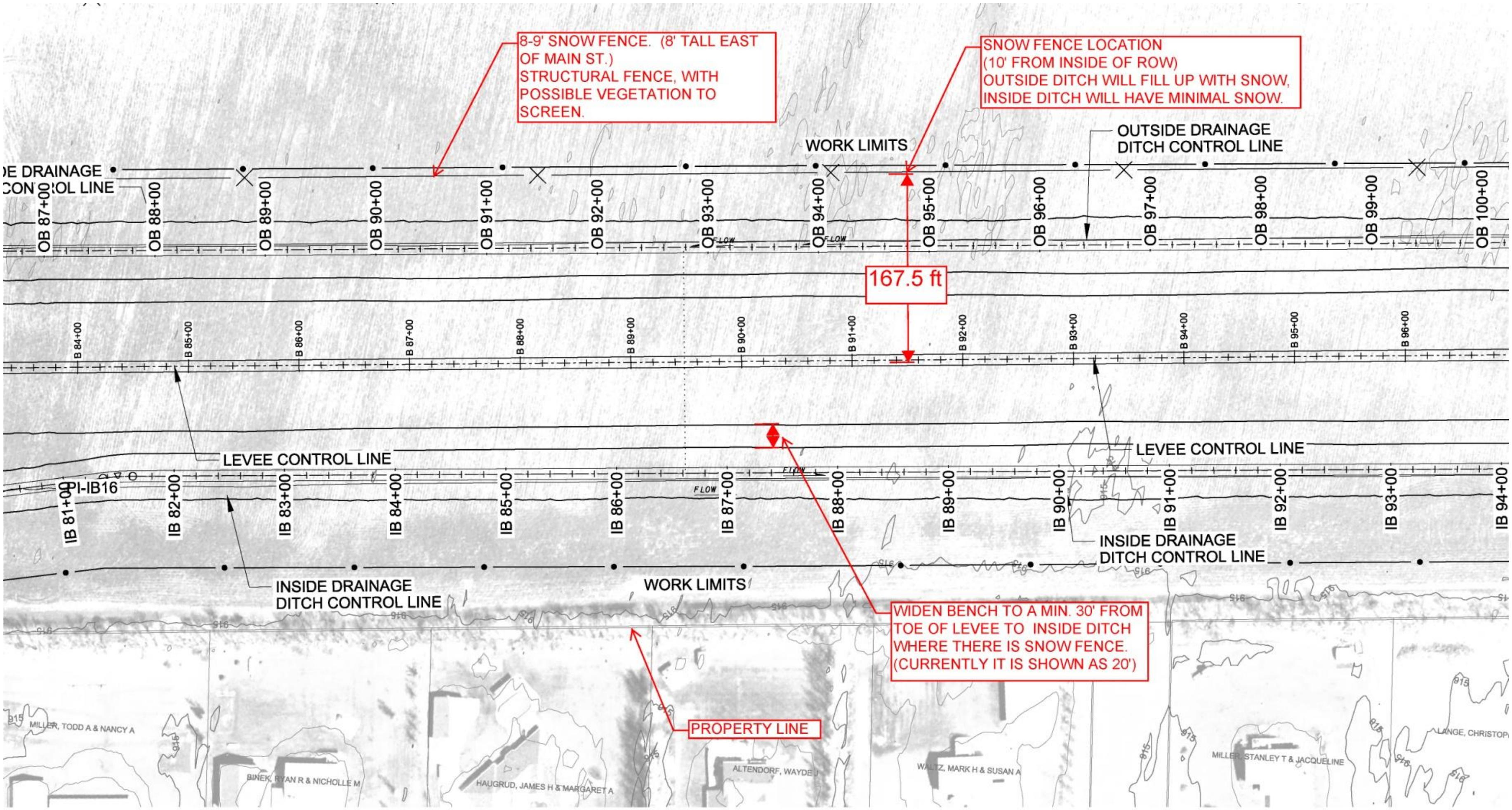

Figure 2 – DETAILED PLAN VIEW OF SNOW FENCE

Figure 3 – STRUCTURAL FENCE

Designing A Snow Fence

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Snowfall

Snow Water Equiv.

Relocation Coefficient

Wind Direction

Fetch Distance

Snow Transport

Porosity

Height

Attack Angle

Setback

Fence Extension

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Snow Fence Design Summary From User Specified Variables

Snowfall over Snow Accumulation Season*: 2.96 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 9800 ft

Mean seasonal snow transport*: 13.53 Tons/foot

Fence Porosity*: .1

Fence Height*: 9.63 ft

Attack Angle*: 90°

Fence Setback*: 163.1 ft

*Your fence must extend **94.2 ft** from the acute angle side of the problem area and **94.2 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 2:16:47 PM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee without sno

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Snowfall over Snow Accumulation Season*: 2.96 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 9800 ft

Mean seasonal snow transport*: 13.53 Tons/foot

Fence Porosity*: .5

Fence Height*: 6.66 ft

Attack Angle*: 90°

Fence Setback*: 224 ft

*Your fence must extend **129.3 ft** from the acute angle side of the problem area and **129.3 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:53:18 AM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee West of Ma

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Snowfall over Snow Accumulation Season*: 6.5 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 9800 ft

Mean seasonal snow transport*: 29.71 Tons/foot

Fence Porosity*: .5

Fence Height*: 9.53 ft

Attack Angle*: 90°

Fence Setback*: 320.4 ft

*Your fence must extend **185 ft** from the acute angle side of the problem area and **185 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:44:48 AM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee _fence at R

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Snowfall over Snow Accumulation Season*: 2.96 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 4775 ft

Mean seasonal snow transport*: 9.69 Tons/foot

Fence Porosity*: .5

Fence Height*: 5.72 ft

Attack Angle*: 90°

Fence Setback*: 192.4 ft

*Your fence must extend **111.1 ft** from the acute angle side of the problem area and **111.1 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:52:28 AM

Run by*: Renee McGarvey

Project Number*: OHB RIng Levee East of Mai

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Snowfall over Snow Accumulation Season*: 6.5 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 4775 ft

Mean seasonal snow transport*: 21.27 Tons/foot

Fence Porosity*: .5

Fence Height*: 8.18 ft

Attack Angle*: 90°

Fence Setback*: 275.2 ft

*Your fence must extend **158.9 ft** from the acute angle side of the problem area and **158.9 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:47:14 AM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee East of Mai

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Snow Fence Design Summary From User Specified Variables

Snowfall over Snow Accumulation Season*: 2.96 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 170 ft

Mean seasonal snow transport*: 0.53 Tons/foot

Fence Porosity*: .1

Fence Height*: 2.2 ft

Attack Angle*: 90°

Fence Setback*: 37.2 ft

*Your fence must extend **21.5 ft** from the acute angle side of the problem area and **21.5 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:50:44 AM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee Fence and

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Snow Fence Design Summary From User Specified Variables

Snowfall over Snow Accumulation Season*: 6.5 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 170 ft

Mean seasonal snow transport*: 1.16 Tons/foot

Fence Porosity*: .1

Fence Height*: 3.14 ft

Attack Angle*: 90°

Fence Setback*: 53.2 ft

*Your fence must extend **30.7 ft** from the acute angle side of the problem area and **30.7 ft** from the obtuse angle side to prevent drifting.

Date/Time Run: 3/5/2014 11:48:21 AM

Run by*: Renee McGarvey

Project Number*: OHB Ring Levee _Fence anc

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Snow Fence Design Summary From User Specified Variables

Snowfall over Snow Accumulation Season*: 6.5 ft

Snow Water Equivalent Ratio*: 0.102

Relocation Coefficient*: 0.34

Direction of greatest snow transport*: 340°

Fetch Distance*: 9800 ft

Mean seasonal snow transport*: 29.71 Tons/foot

Fence Porosity*: .1

Fence Height*: 13.78 ft

Attack Angle*: 10°

Fence Setback*: 40.5 ft

Your attack angle is 35° or less, a situation where the average wind direction is nearly parallel with the road. Blowing snow conditions can be improved by placing fences on both sides of the road in a swept-back herringbone pattern (**see illustration**). This orientation helps to deflect the blowing snow away from the road. (Tabler 1994)

Date/Time Run: 3/6/2014 12:24:09 PM

Run by*:	Renee McGarvey
Project Number*:	OHB Levee 43b south of B61

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