

**NORTH DAKOTA  
DEPARTMENT OF TRANSPORTATION**

**MATERIALS AND RESEARCH  
DIVISION**



**Evaluation of  
Viking-Cives Midwest, Inc.**

**TowPLow**

December, 2011

Prepared by

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# **TowPLow Evaluation**

December, 2011

Written by

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# TABLE OF CONTENTS

Purpose and Need..... 1

Description ..... 1

Location ..... 1

Economics ..... 2

Performance ..... 3

Summary ..... 12

Appendix A    Photos ..... A1

Appendix B    Survey ..... B1



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# TowPLow Evaluation

## Purpose and Need

As a northern state, North Dakota receives a significant amount of snowfall. The North Dakota Department of Transportation (NDDOT) is tasked with maintaining the roadways during snow events to allow safe travel for the public. As lanes are added to increase the capacity of roadways; there is a need to improve the effectiveness and efficiency of snow removal operations.

## Description

The Viking-Cives Midwest, Inc. TowPLow is an option to increase the efficiency of a snow plow truck. The TowPLow is a towable trailer and operates similar to a side wing on a snow plow truck. Photos of the TowPLow can be seen in Appendix A. The mold board or snow plow is attached to the side of the trailer. The TowPLow is hydraulically controlled. When fully deployed, it can expand the clearing width of the snow plow truck to 25 feet. The snow plow truck with TowPLow can remove two lanes of snow. An optional tank for liquids or a hopper for granular material can be added to the TowPLow to allow for de-icing of roadways. The addition of a TowPLow to a snow plow truck allows it to clear more snow from the roadway than a standard snow plow truck.



## Location

One TowPLow will be used in the Fargo District on rural and urban roads near the city of Fargo. A second TowPLow will be used in the Bismarck District on rural and urban roads near the city of Bismarck.

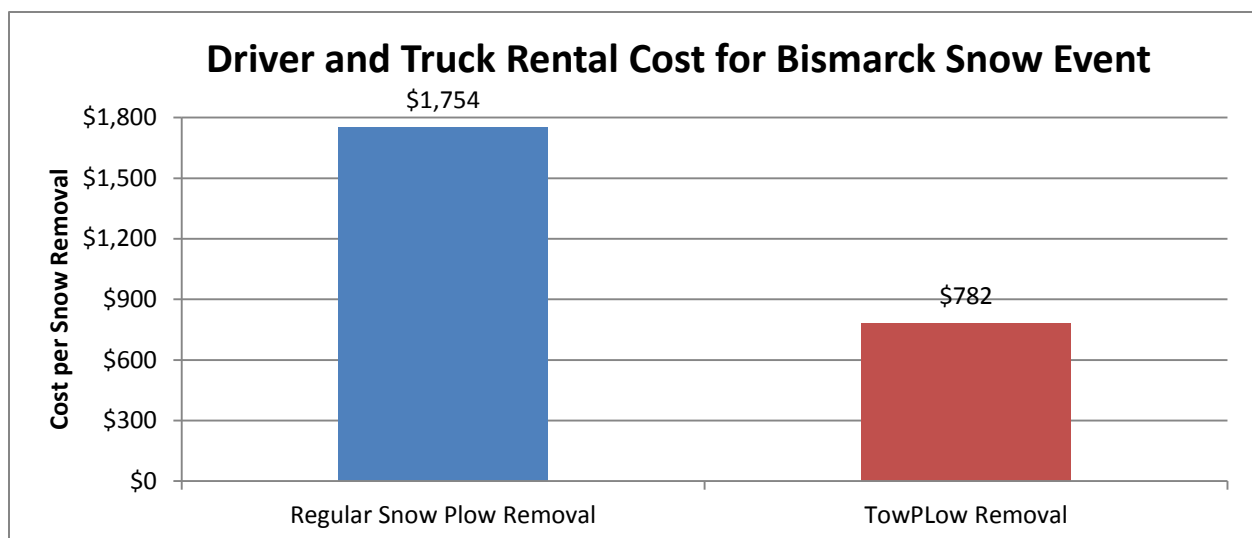
## Economics

While price is important in purchasing a TowPLow, there are some other important factors involved such as safety (NDDOT employee and Public), quality of snow removal and storage. The total cost of a TowPLow retrofitted to the NDDOT specifications is \$74,389. The estimated life of a TowPLow is 17 years.

The labor hours and time required to remove snow or de-ice the urban Bismarck/Mandan area can be seen in the chart below. Note the equipment hours also equal the labor hours.

Urban Snow Removal for Snow Event					
Operation	Mainline & Ramps			Total Hrs	Total Labor Hrs
	Drivers	Trucks	TowPLow with Truck		
Regular Snow Plow Removal	5	5	0	4	20
TowPLow Removal	2	1	1	4	8
Regular Deicing Operation	2	2	0	4	8
TowPLow Operation	1	0	1	2	2
The urban snow removal includes the Interstate 94 mainline, ramps, intersections, and bridges from approximately exit 161 to exit 153. Also included in the urban snow removal are Bismarck Expressway and Memorial Highway.					

The rental rates of the current Tandem Truck and TowPLow are \$60 per hour and \$10 per hour, respectively. The average 2010-2011 season labor rate is \$27.70 per hour. With these hourly rates the graph describes the average equipment and employee cost per snow event for the Bismarck urban sections. Note these costs do not include fuel.





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## Performance

The Bismarck Maintenance employees were asked to comment on the different performance aspects of the TowPLow. Their comments are listed below:

### Snow Removal and De-icing

- Using the TowPLow and front plow mounted truck; 25 feet of highway width can be cleared of snow.
- Less snow fog is produced because the angle of TowPLow directs snow in a downward direction as opposed to the front plow directing snow in an upward direction.
- On Interstate 94 the TowPLow is able to remove snow 1.5 feet deep across both lanes with one pass.
- The TowPLow cuts compacted snow well.
- After a drift is removed with a TowPLow, the time it takes for the drift to reform is longer. This happens because the surface area removed is larger and requires more time to reform the drift.
- The traveling public appeared to respect the TowPLow and stay behind it when in use.
- The increase in liquid carrying capacity allows for more effective direct liquid application for anti-icing and de-icing when needed.

### Operations

- The steering works very well with the TowPLow deployed. On left turns, the TowPLow wheels can be turned to assist in making the corner a wider turn.
- The time to hook-up the TowPLow trailer is 20 to 30 minutes. If the TowPLow is stored outside, it becomes more difficult to hook-up due to moving parts being iced up.
- The flashing beacon on the rear of the TowPLow was raised approximately 3 feet and a brighter beacon was used.
- The PVC pipe for the sprayer nozzles was replaced with steel pipe on the driver's side of the TowPLow.



- 
- Packed snow and ice chunks were breaking PVC pipe for the de-icing sprayers.
  - The tanks are filled to approximately 300 gallons each for a total of 600 gallons for optimal weight for snow removal. When the TowPLow is being used for direct liquid application approximately 2,000 gallons are stored in the two tanks combined. Two F550 pick-up trucks each with a 750 gallon tank are used for the regular direct liquid application operation in the Bismarck District.

### **Improvement Requests**

- Mechanical jack has difficulty lifting TowPLow with tanks filled with de-icing liquid. Hydraulic jacks are needed when tanks are full.
- Install a hydraulic switch block to reduce the amount of connections when connecting to the truck or tow vehicle.
- Add baffle balls to the tank to prevent sloshing.
- Trucks need a bigger mirror to allow full view of TowPLow.
- The TowPLow requires more skill to operate and training should be provided for new users.
- Heated storage for the TowPLow and truck will help prevent equipment from icing up.
- A gauge inside the truck to know how much liquid is left.



The Fargo Maintenance employees were asked to comment on the different performance aspects of the TowPLow. Their comments are listed below:

### **Snow Removal and De-icing**

- With TowPLow and front plow mounted truck, 25' 3" of snow can be cleared.
- De-icing system can spray 3 lanes at one time.
- Cuts compacted snow well.
- The increase in liquid carrying capacity allows for more effective direct liquid application for anti-icing and de-icing when needed.

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## Operations

- Laser guide works well in dark but difficult to see on sunny day, only Fargo District was equipped with the laser guide.
- Can adjust how fast TowPLow swings with hydraulic adjustments.
- Startup time for TowPLow takes an additional 5 minutes longer than regular truck due to the additional hydraulic hose attachments.
- Dumpbox on truck hits tongue of TowPLow when raised. A radius dumpbox would work better with granular material distribution.
- Mechanical jack has difficulty lifting TowPLow with tank filled with de-icing liquid. Hydraulic jacks are needed when tank is full.
- Controls – driver can operate only one function on TowPLow at a time. This was specific to Fargo's initial setup on a retrofit truck. New trucks will be able to operate all TowPLow functions and wing functions at the same time.



## Maintenance

- Pumps used by the de-icing system had easy access for maintenance and repairs.
- Flexible hoses near hitch on truck are located in poor location. Hoses were stressed with sharp turns, causing them to break.
- Hydraulic valves required restructuring to have the truck work with TowPLow. This is specific to Fargo's initial setup. New trucks will have the corrected hydraulic setup.

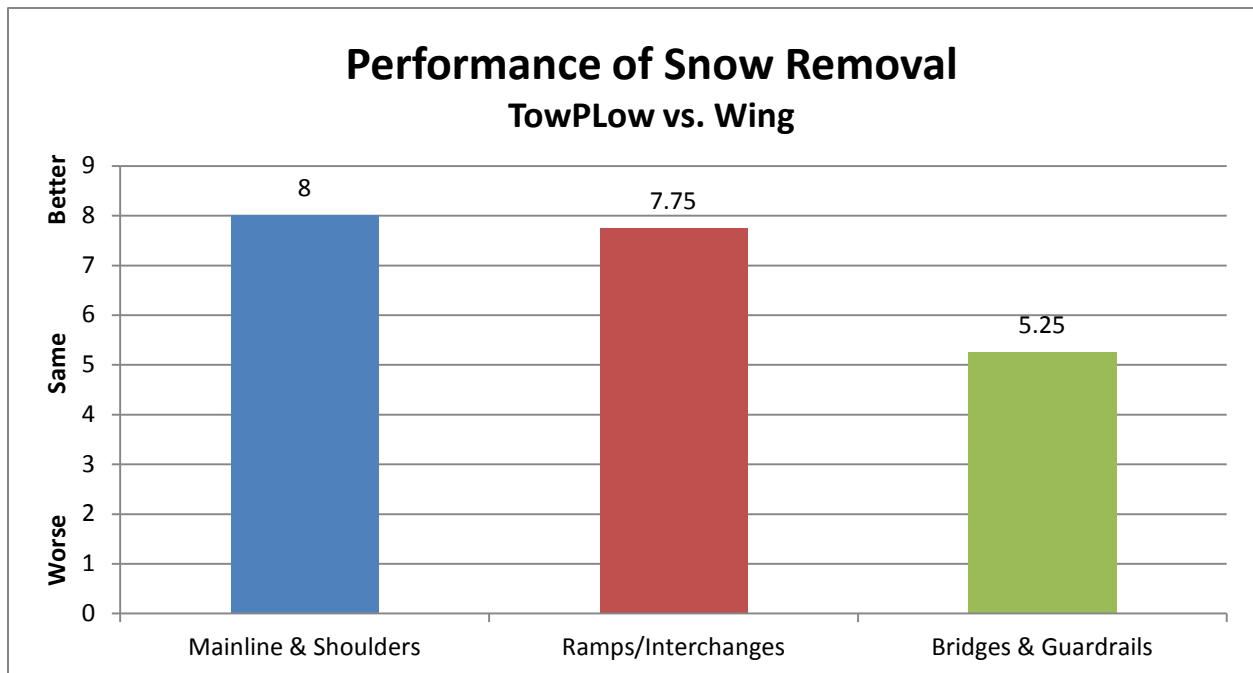


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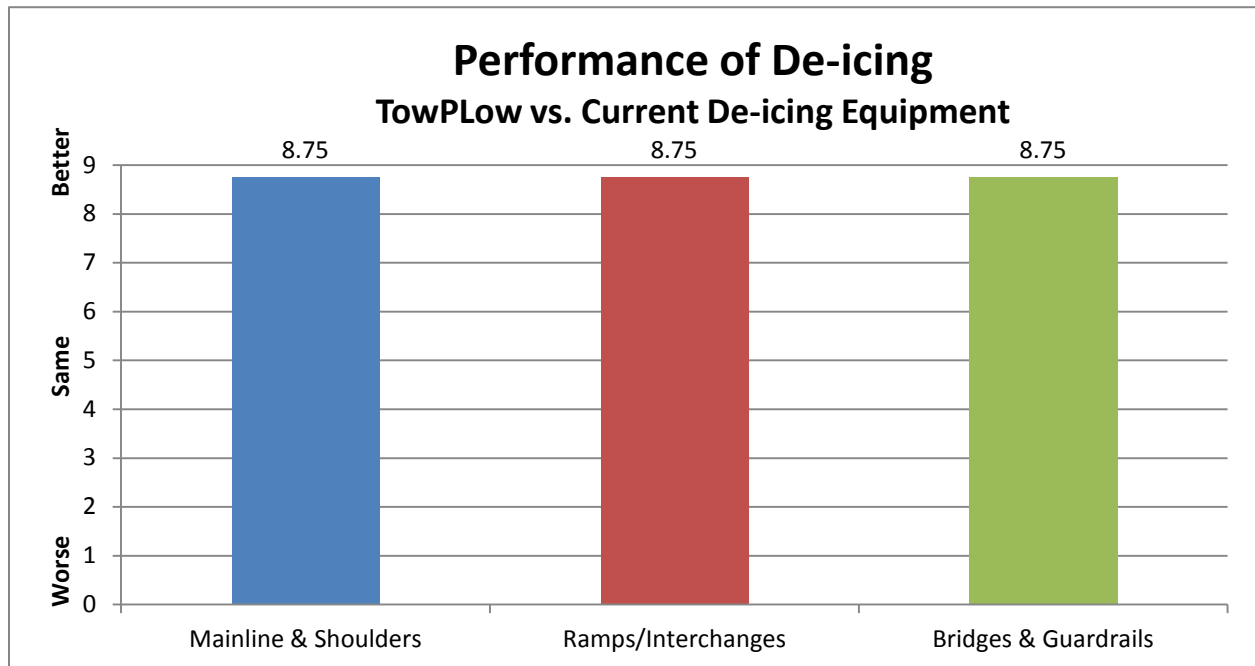
## District Maintenance Evaluation

Fargo and Bismarck District Maintenance employees used the device for snow removal and de-icing. The employees were asked to complete an evaluation of the TowPLow. The evaluation form can be found in Appendix B. The TowPLow's performance evaluation questions and rating is shown below.

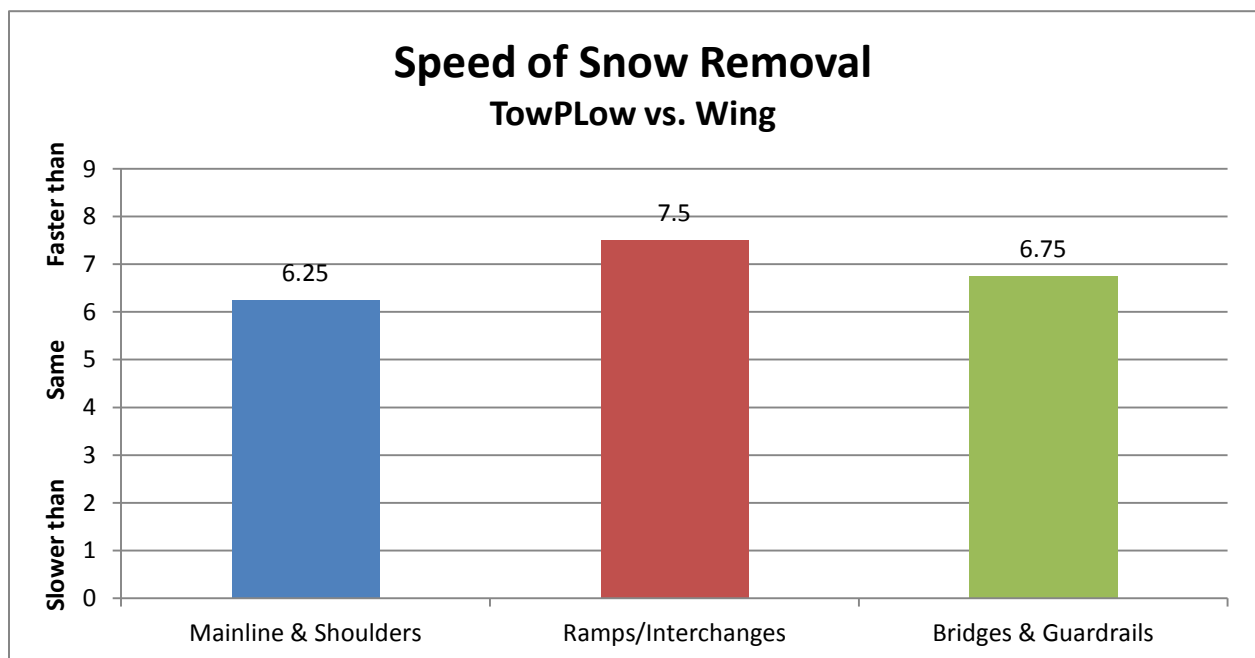
- *SNOW REMOVAL: How effective was the TowPLow in moving and clearing the snow as compared to a snow plow with wing? (How clean was the roadway, how far did it push the snow, etc.)*



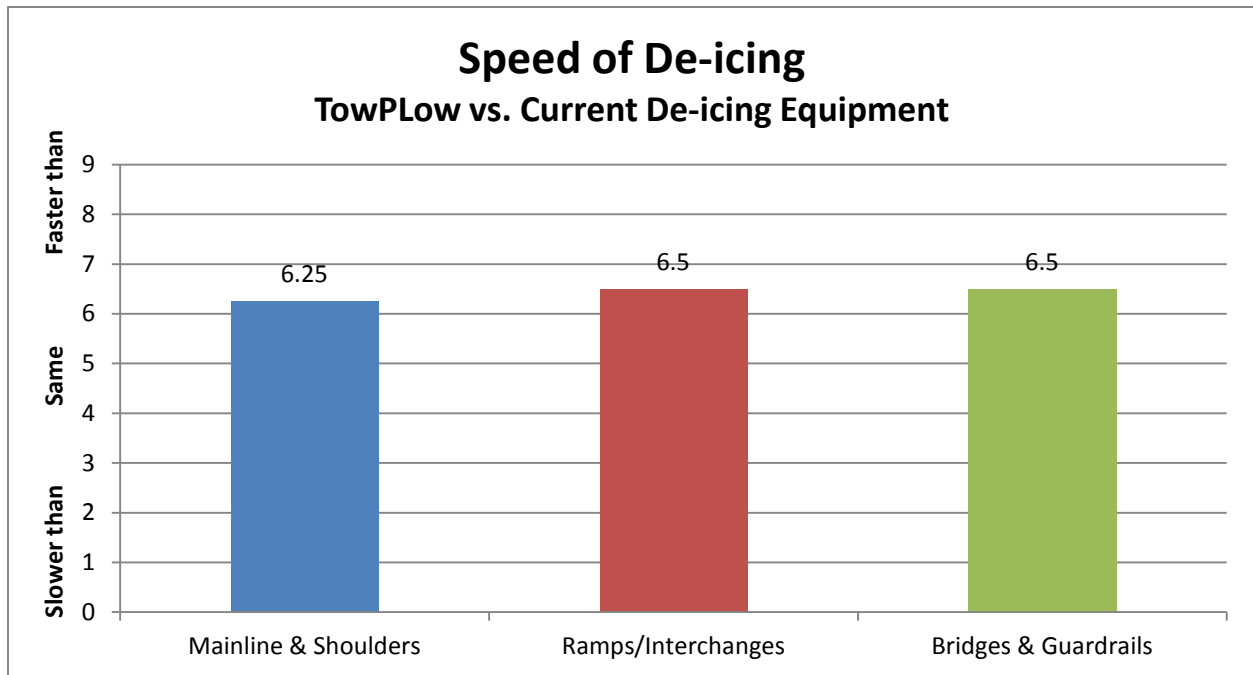
- *DE-ICING: How effective was the TowPLow in applying de-icing treatments as compared to the current de-icing equipment being used? (How evenly does it distribute, does it cover the required area, etc.)*



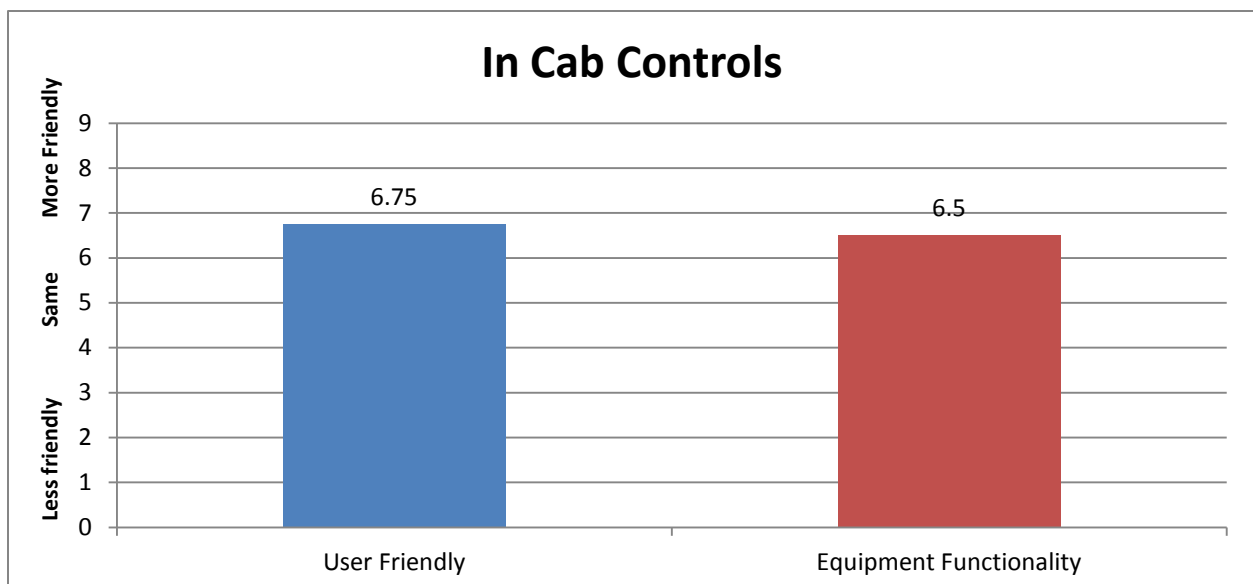
- *SPEED of OPERATION: How did the speed you traveled with the TowPLow to move and clear snow compare to a snow plow with wing?*



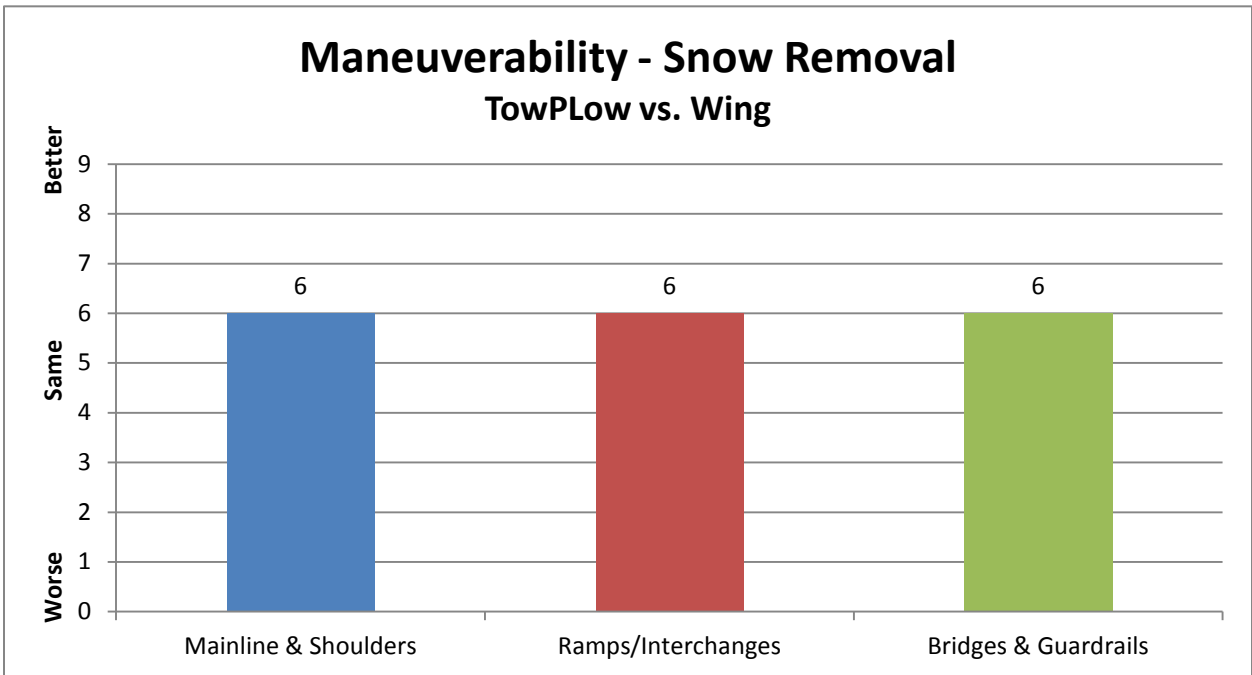
- How did the speed you traveled with the TowPLow when applying de-icing treatments compare to current de-icing equipment being used?



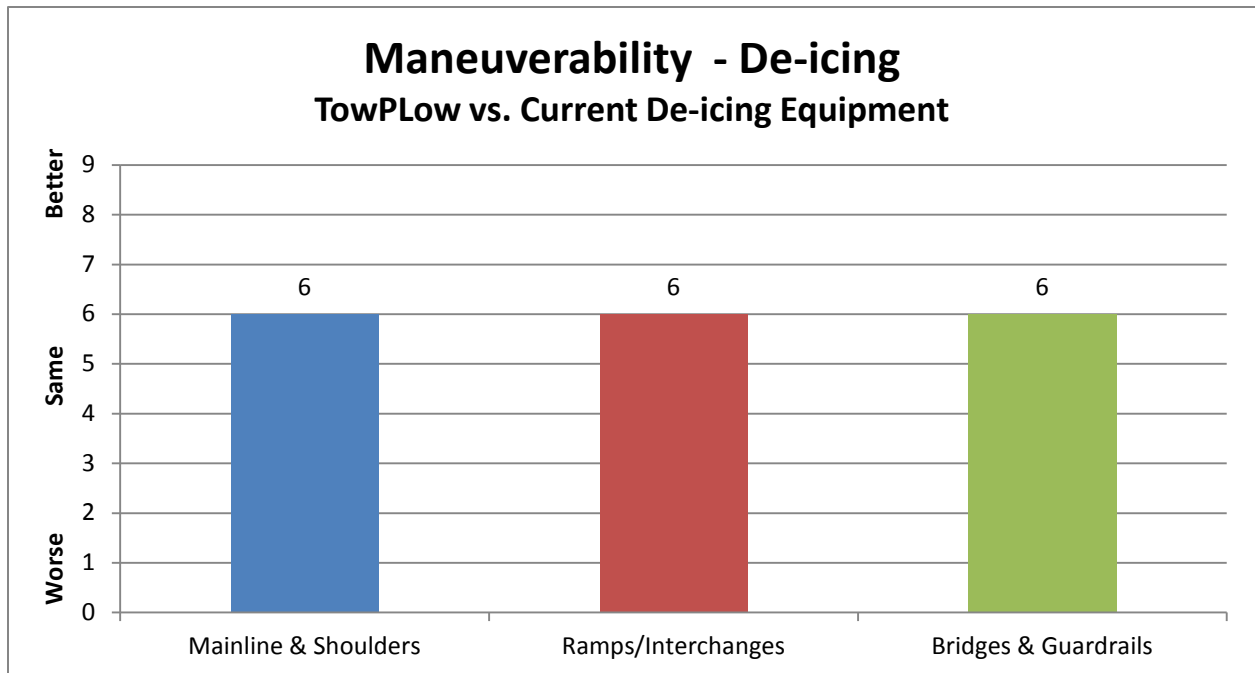
- IN CAB CONTROLS:** How “user friendly” is the TowPLow in cab controls as compared to a snow plow with wing? (location to employee, control identification, visibility and lighting, responsiveness, etc.) **EQUIPMENT FUNCTIONALITY:** How effectively do the various TowPLow systems function as compared to current snow plow/de-icing equipment?



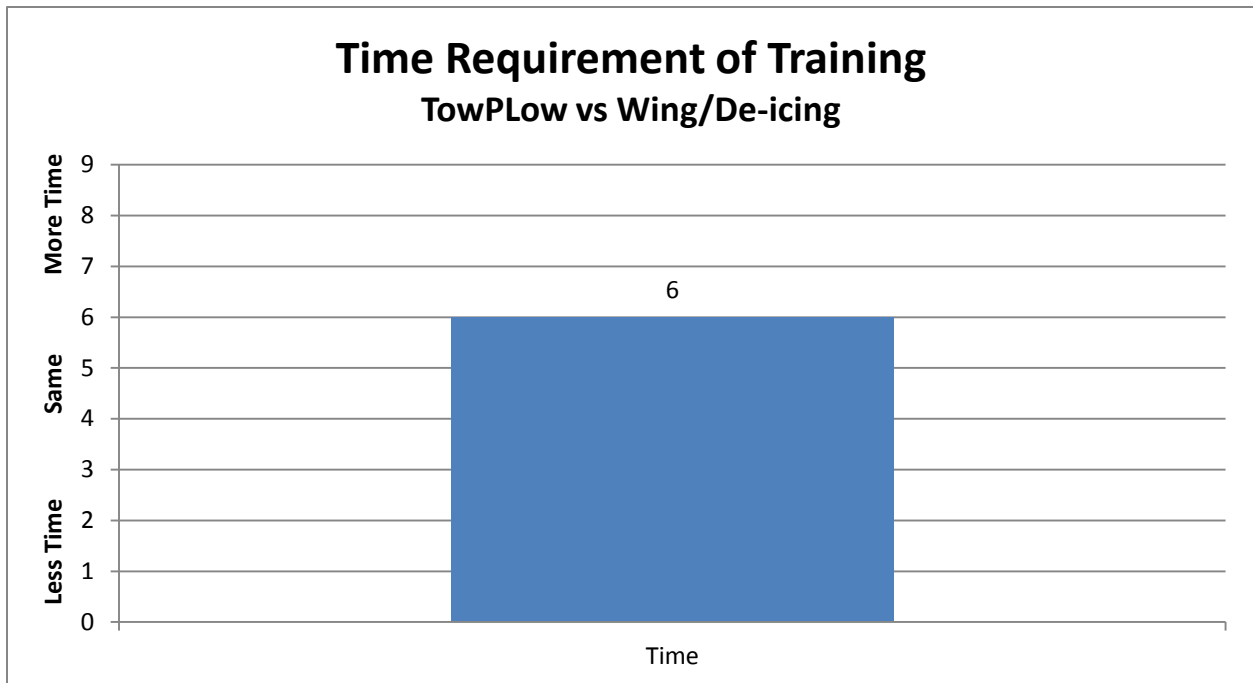
- Describe the maneuverability of the TowPLow as compared to the current snow plow with wing.



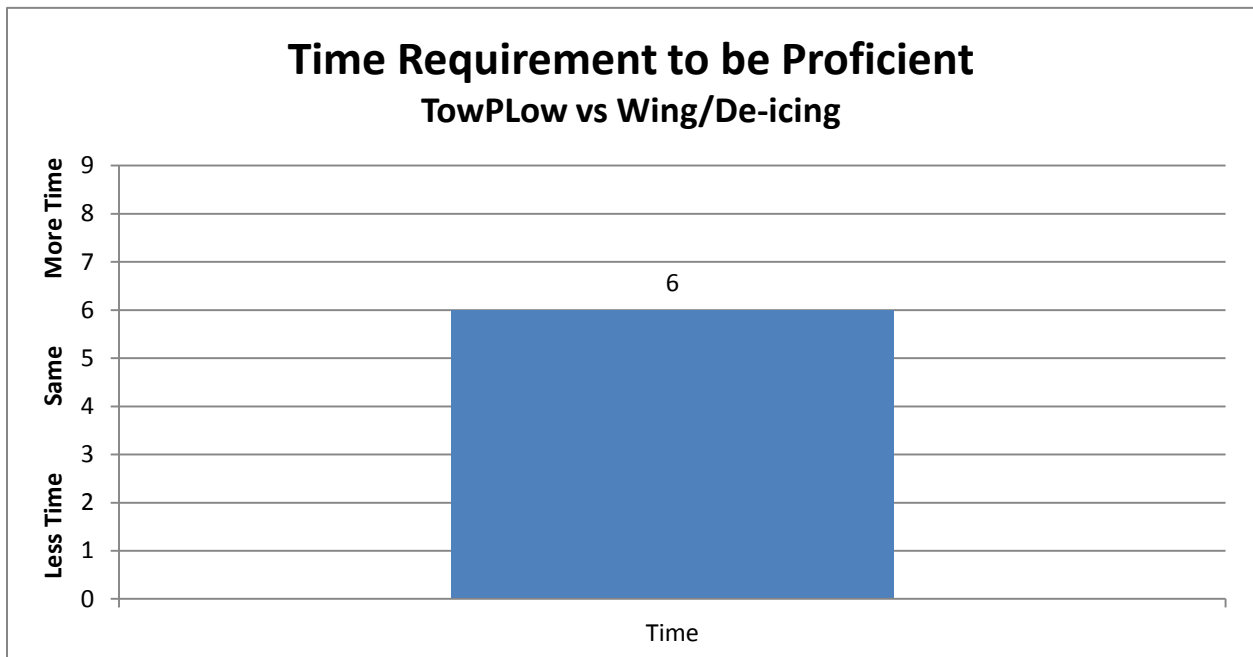
- Describe the maneuverability of the TowPLow as compared to the current de-icing equipment.



- **TRAINING REQUIREMENTS:** In terms of time, how much employee training will the TowPLow require, as compared to employee for current snow plow with wing / de-icing equipment?

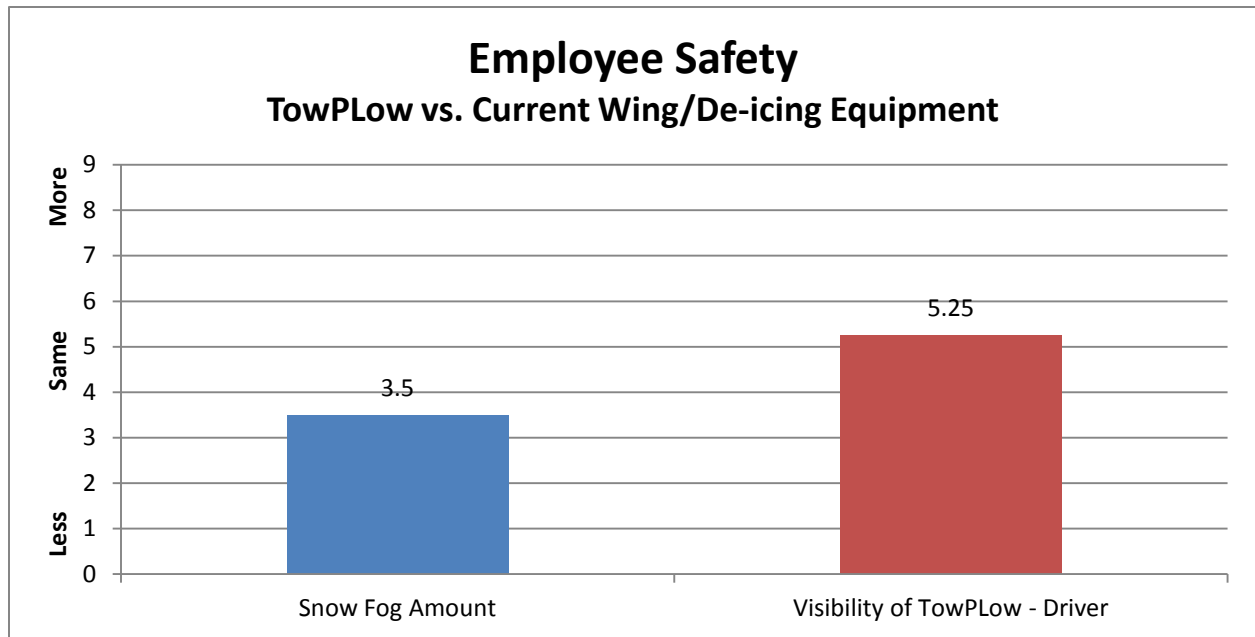


- **EMPLOYEE PROFICIENCY:** In terms of time, how much experience will the employee driving the TowPLow require to become proficient, as compared to the time to become proficient on current snow plow with wing / de-icing equipment?

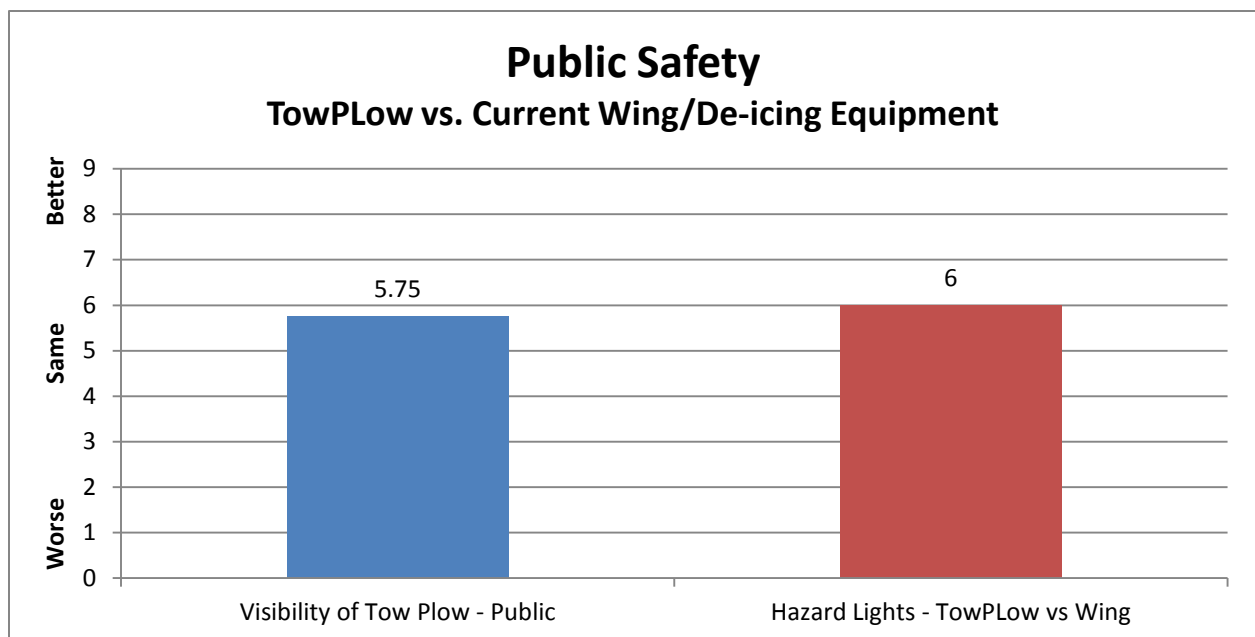




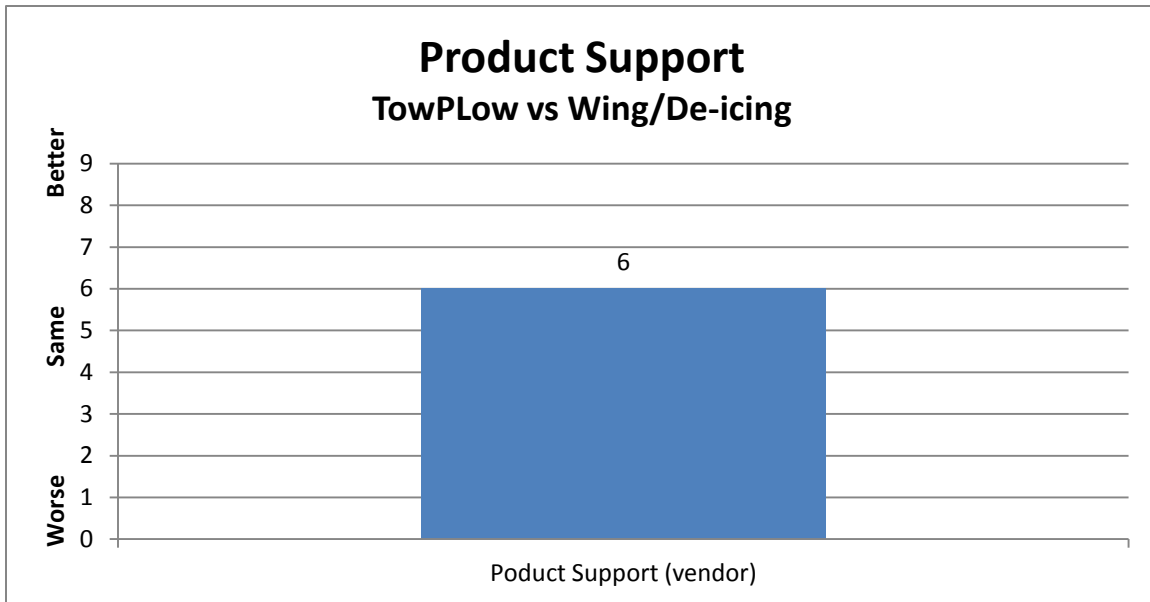
- *SNOW FOG: How does the generation of snow fog by the TowPLOW compared to a snow plow with wing? (as observed by TowPLOW driver or shadow vehicle)*



- *VISIBILITY of TOWPLOW: The employee's visibility of the TowPLOW when deployed. The Public's visibility of the TowPLOW when deployed is (vehicles following the TowPLOW). WARNING AND HAZARD LIGHTS: How effective are the warning and hazard lights as compared to a snow plow with wing/ de-icing equipment?*



- *PRODUCT SUPPORT: How does the availability and effectiveness of TowPLow product (vendor) support compare to current snow plow with wing / de-icing equipment?*



## Summary

The data and comments received from District Maintenance employees is limited data with only one season of use. It is evident from the comments that the TowPLows have performed as good or better when compared with the regular truck with wing operation. The scores from the evaluations are summarized in the chart below:

Summary (TowPLow vs. Snow Plow with wing)	
Average Snow Removal and De-icing Performance Scores	7.3 out of 9
Average Operations Scores	6.1 out of 9
Visibility (Driver and Public)	5.7 out of 9
Amount of Snow Fog Produced	3.5 out of 9
The scale is (0 = worse, 4.5 = same, and 9 = better) except for the snow fog. The snow fog scale is (0 = less snow fog, 4.5 = same snow fog, and 9 = more snow fog).	

The initial cost of the TowPLow is \$74,389 with a 17 year expected life. The Bismarck District estimated the labor and equipment cost (not including the fuel) for the regular snow removal operation is \$1,754 per snow event. They estimate the TowPLow operation labor and equipment cost was \$782 per snow event. This results in a savings of \$972 per snow event when using the TowPLow. Using the TowPLow in the snow

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removal operation frees up three snow plow trucks to address other major routes to better meet service levels for the public. These costs are unique to Bismarck. Although different urban and rural roadways may require different equipment and labor hours than the Bismarck section, it appears the TowPLow operation does offer a cost savings to the regular snow removal operation.

Generally speaking, the Bismarck and Fargo District comments indicate that the TowPLow is more efficient in clearing snow, and maybe safer for the employee and the public (in terms of reduced snow fog).



## **Appendix A**





Photo 1 - An overview of TowPLow attached to vehicle



Photo 2 - Blue and red hoses broke during turning motions,





Photo 3 – Hydraulic valves required restructuring to have truck work with TowPLow.



Photo 4 – Tongue of TowPLow attached to truck





Photo 5 – Controls used to operate the truck and TowPLOW.



Photo 6 – Photo is displaying de-icing spray bar on the rear of TowPLOW.





**Photo 7 – Photo is displaying de-icing bar for adjacent lanes of roadway.**



**Photo 8 – Mechanical jack for the TowPLow.**



**Photo 9 – Photo of the TowPLow fully deployed.**



**Photo 10 – Photo of TowPLow wheels rotated when fully deployed.**



## **Appendix B**





# NDDOT TowPLow Evaluation

Winter 2009-2010

The NDDOT is conducting an objective evaluation of the *TowPLow* to determine if benefits could in snow and ice removal could be derived from this device. **The data being collected will be used to compare the *TowPLow* to current snow and ice removal equipment.** The data you provide will be used to evaluate this equipment in the areas of:

## 1. Performance of equipment

- a) effectiveness of snow removal activities
  - i. mainline
  - ii. ramps/interchanges
  - iii. shoulders and guardrails
- b) effectiveness of de-icing activities
- c) impact of speed on performance
  - i. clearing snow
  - ii. de-icing

## 2. Operation of equipment

- a) operator controls,
- b) equipment operation
- c) maneuverability
  - i. mainline
  - ii. ramps/interchanges
  - iii. bridges
- d) training requirements
- e) experience/time required to become proficient

## 3. Safety of operator and public

- a) generation of snow fog
- b) visibility of *TowPLow*
  - i. by Operator
  - ii. by Public
- c) effectiveness of warning and hazard lights

## 4. Maintenance by operator and shop

- a) availability and effectiveness of vendor support
- b) recommended maintenance activities
  - i. frequency and types
  - ii. availability of replacement parts
  - iii. costs of parts and labor
  - iv. out-of-service or downtime
- c) non-scheduled repair activities
  - i. frequency and types
  - ii. availability of replacement parts
  - iii. costs of parts and labor
  - iv. out-of service or downtime

## 5. Cost Benefit Comparison – study of time and efficiency

- a) compare *TowPLow* to single truck and gang plow operations
  - i. hours of operation during a snow and ice event
  - ii. fuel consumption
  - iii. cost of operator labor

**Instructions:**

This form is designed to be completed at the completion of each snow removal and/or de-icing activity involving the *TowPLow*. The information you provide will be used in a report to NDDOT Executive Management on the performance and cost effectiveness of adding TowPLows to the Department's snow and ice removal equipment. It is important that you provide as much detail as possible.

The form is divided into three parts:

**PART I** – Completed by Operator and/or Supervisor and should include the environmental and equipment information as it relates to the snow removal or de-icing activity

**PART II** – Completed by the Equipment Operator and should include comments from any personnel involved with the operation or observation of the *TowPLow* during that event. Information should be recorded as close to the time of the event as possible.

**PART III** – Completed by the Maintenance Supervisor and should include comments from shop mechanics as they relate to scheduled or unscheduled equipment maintenance activities. Information should be recorded as close to the time of the event as possible.

**PART I: DESCRIPTION OF SNOW REMOVAL OR DE-ICING ACTIVITY:**

Date: \_\_\_\_\_ Location: \_\_\_\_\_  
(highway.mile, interchange, bridge)

Type of Activity: snow removal, de-icing,  
(circle all that apply)

Weather Conditions:

- Precipitation Type: frost, freezing rain, sleet, snow  
(circle all that apply)
- Rate of Snow Fall: \_\_\_\_\_
- Accumulation: \_\_\_\_\_
- Temperature: \_\_\_\_\_
- Wind Speed: \_\_\_\_\_
- Visibility: \_\_\_\_\_

Start Time of Activity \_\_\_\_\_ Stop Time of Activity \_\_\_\_\_

Gallons of Fuel Consumed: \_\_\_\_\_ Total Miles for Activity: \_\_\_\_\_



Name of Operator: \_\_\_\_\_

Name of Observer: \_\_\_\_\_

## PART II: EQUIPMENT OPERATOR PROVIDED INFORMATION

### 1. Performance of Equipment

a) *SNOW REMOVAL: How effective was the TowPLow in moving and clearing the snow as compared to a snow plow with wing? (how clean was the roadway, how far did it push the snow, etc.)*

#### **Mainline & Shoulders:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### **Ramps/Interchanges:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

#### **Bridges & Guardrails:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b) *DE-ICING: How effective was the TowPLow in applying de-icing treatments as compared to the current de-icing equipment being used? (how evenly does it distribute, does it cover the required area, etc.)*

**Mainline & Shoulders:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Ramps/Interchanges:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Bridges & Guardrails:**

Worse than				Same as		Better than		
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

c) **SPEED of OPERATION:**

- i. How did the speed you traveled with the TowPLow to move and clear snow compare to a snow plow with wing?

**Mainline & Shoulders:**

Slower than				Same as			Faster than	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Ramps/Interchanges:**

Slower than				Same as			Faster than	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Bridges & Guardrails:**

Slower than				Same as			Faster than	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- ii. How did the speed you traveled with the TowPLow when applying de-icing treatments compare to current de-icing equipment being used?

**Mainline & Shoulders:**

Slower than

☐

1

☐

2

☐

3

☐

4

Same as

☐

5

☐

6

☐

7

Faster than

☐

8

☐

9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Ramps/Interchanges:**

Slower than

☐

1

☐

2

☐

3

☐

4

Same as

☐

5

☐

6

☐

7

Faster than

☐

8

☐

9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Bridges & Guardrails:**

Slower than

☐

1

☐

2

☐

3

☐

4

Same as

☐

5

☐

6

☐

7

Faster than

☐

8

☐

9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## 2. Operation of Equipment

a) OPERATOR CONTROLS: How “user friendly” are the TowPLow operator controls as compared to a snow plow with wing? (location to operator, control identification, visibility and lighting, responsiveness, etc.)

Less friendly                      Same as                      More friendly

☐        ☐        ☐        ☐        ☒        ☐        ☐        ☐

1          2          3          4          5          6          7          8          9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

b) **EQUIPMENT FUNCTIONALITY:** How effectively do the various TowPLow systems function as compared to current snow plow/de-icing equipment? (hydraulics, blades, spray nozzles, etc. Please provide details in the comments)

Worse than                      Same as                      Better than

☐        ☐        ☐        ☐        ☐        ☐        ☐        ☐

1        2        3        4        5        6        7        8        9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

c) *MANEUVERABILITY:*

i. Describe the maneuverability of the TowPLow as compared to the current snow plow with wing.

***Mainline & Shoulders:***

Worse than                      Same as                      Better than

☐     ☐     ☐     ☐     ☐     ☐     ☐     ☐     ☐

1        2        3        4        5        6        7        8        9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Ramps/Interchanges:**

Worse than                      Same as                      Better than

☐    ☐    ☐    ☐    ☐    ☐    ☐    ☐    ☐

1       2       3       4       5       6       7       8       9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Bridges & Guardrails:**

Worse than                      Same as                      Better than

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- ii. *Describe the maneuverability of the TowPLow as compared to the current de-icing equipment.*

**Mainline & Shoulders:**

Worse than                      Same as                      Better than

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Ramps/Interchanges:**

Worse than                      Same as                      Better than

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Bridges & Guardrails:**

Worse than                      Same as                      Better than

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- d) *TRAINING REQUIREMENTS: In terms of time, how much operator training will the TowPLow require, as compared to operator for current snow plow with wing / de-icing equipment?*

Less time than				Same as			More time than	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- e) *OPERATOR PROFICIENCY: In terms of time, how much operator experience will the TowPLow operator require to become proficient, as compared to the time to become proficient on current snow plow with wing / de-icing equipment*

Less time than				Same as			More time than	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### 3. Safety of Operator and Public

a) *SNOW FOG: How does the generation of snow fog by the TowPLow compared to a snow plow with wing? (as observed by TowPLow Operator or shadow vehicle)*

Less than					Same as				More than
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9	

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b) *VISIBILITY of TOWPLOW:*

i. *The Operator's visibility of the TowPLow when deployed is :*

Poor					OK				Excellent
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9	

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

ii. *The Public's visibility of the TowPLow when deployed is (vehicles following the TowPLow):*

Poor					OK				Excellent
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9	

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

c) *WARNING AND HAZARD LIGHTS: How effective are the warning and hazard lights as compared to a snow plow with wing/ de-icing equipment?*

Less than					Same as				More than
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9	

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



Name of Maintenance Supervisor: \_\_\_\_\_

### PART III: MAINTENANCE SUPERVISOR PROVIDED INFORMATION

#### 4. Maintenance by Operator and Shop

- a) *PRODUCT SUPPORT: How does the availability and effectiveness of TowPLow product (vendor) support compare to current snow plow with wing / de-icing equipment?*

Worse than                      Same as                      Better than

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1	2	3	4	5	6	7	8	9

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- b) *SCHEDULED MAINTENANCE ACTIVITIES: How does the TowPLow compare to current snow plow with wing / de-icing equipment, in terms of:*

	<i>TowPLow</i>	<i>Snow Plow with Wing</i>	<i>De-icing Equipment</i>
<i>Maintenance Type</i>			
<i>Frequency</i>			
<i>Availability of Parts</i>			
<i>Cost in Dollars – parts &amp; labor</i>			
<i>Time to Complete – (out-of-service)</i>			

c) *NON-SCHEDULED REPAIR ACTIVITIES: How does the TowPLow compare to current snow plow with wing / de-icing equipment, in terms of:*

	<i>TowPLow</i>	<i>Snow Plow with Wing</i>	<i>De-icing Equipment</i>
<i>Maintenance Type</i>			
<i>Frequency</i>			
<i>Availability of Parts</i>			
<i>Cost in Dollars – parts &amp; labor</i>			
<i>Time to Repair – (out-of-service)</i>			

## 5. Cost Benefit Study

a) *TIME and EFFICIENCY: Compare the TowPLow to single snow plow with wing and Gang Plow?*

	<i>TowPLow</i>	<i>Single Truck with Wing</i>	<i>Gang Plow</i>
<i>Hours of Operation</i>			
<i>Fuel Consumption</i>			
<i>Cost of Operator Labor</i>			
<i>Cost of Maintenance</i>			
<i>Time to Complete – (out-of-service)</i>			

b) *TIME and EFFICIENCY: Compare the TowPLow to single snow plow with wing and Gang Plow?*

	<i>TowPLow</i>	<i>Single Truck Wing</i>	<i>Gang Plow</i>
<i>Hours of Operation</i>			
<i>Fuel Consumption</i>			
<i>Cost of Operator Labor</i>			
<i>Cost of Maintenance</i>			
<i>Time to Complete – (out-of-service)</i>			