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Use of a mobile water delivery system in wildfire operations

A case study in Alberta

PROJECT NUMBER: 301014839

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FPInnovations

The Trident mobile high-volume water delivery system is self-contained. The main components of the system are two UTVs, a 200 hp high-volume pump, and 7000 feet (2134 m) of 4-inch hose. It can deliver 500 gpm of water at 190 psi in a wildfire operational situation. Alberta Wildfire asked FPInnovations to document three deployments in 2021 to identify opportunities for using the system and to reduce the knowledge gaps around best practices for deployment.

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BACKGROUND

Trident Pump Inc. (hereafter referred to as “Trident” or “vendor”) demonstrated its innovative mobile water delivery system for Alberta Agriculture and Forestry staff and FPInnovations researchers in August 2017. This demonstration was documented in an FPInnovations Info Note (Ault, Campbell, & Gough, 2017) and the authors had suggested that “the system fills a gap between much larger agriculture pumps and the common small pressure pumps used today on wildfires” (p. 3). However, the deployment of the system in wildfire operations has not been well documented and some knowledge gaps exist.

To address these knowledge gaps, Alberta Wildfire asked FPInnovations to document the deployment of Trident’s mobile water delivery system in wildfire operations. The goal was to examine the system in action and gain additional knowledge that would help wildfire incident teams identify opportunities for its use and understand the best practices for its deployment.

Trident was contracted by Alberta Wildfire to support wildfire operations for the 2021 fire season. The vendor was called to provide its services three times:

- Wildfire EWF-075
- Wildfire LWF-184
- Beaver Lake helipad fire control exercise

About the system

The Trident mobile water delivery system is self-contained. It consists of two main components: a high-volume pump mounted on a six-wheel utility vehicle (UTV) and a hose deployment spool mounted on a second UTV (Figure 1). The system has 7000 feet (2134 metres) of 4-inch hose and 28 feet of 6-inch suction hose. High-volume Rain Bird sprinklers and multiple 1½-inch water thieves with a quarter-turn cam lock and valve are included in the service package. The system can be transported, deployed, and operated by three people.

The components and specifications of the system changed slightly during the 2021 fire season. Equipment details for each deployment are provided in the sections that follow.

The system uses a 200 hp high-volume Gorman-Rupp 06D1-GA pump (Gorman-Rupp, n.d.). According to Trident’s self-test, this pump is capable of pushing water through 4-inch hose at 500 gpm and 190 psi consistently on a flat ground. Because the system uses UTVs, it can be deployed, maneuvered, and demobilized quickly. As soon as the system is set up, it can move large volumes of water to designated areas to support fire operations.

Figure 1. The two main components of the Trident mobile water delivery system: a high-volume pump (left) and a hose deployment spool (right) each mounted on a six-wheel UTV.

According to Trident, the main uses for this system include but are not limited to:

- accessing water sources that are difficult for water tenders and fire engines to access
- delivering large volumes of water to fill relay tanks, water tenders, and fire engines
- providing a water source for sprinklers for both the wildland urban interface and fire control lines
- allowing fire crews to connect their 1½-inch hoses to the system's 4-inch hose line for fire suppression

WILDFIRE EWF-075

Wildfire EWF-075 was detected on June 22, 2021, in Yellowhead County, Alberta. The fire was 9 km northwest of Evansburg (Figure 2). Edson Wildfire Management Area (Alberta Wildfire) deployed wildfire crews, tankers, and heavy equipment to supress the wildfire. By the evening of June 22, the wildfire was estimated to be 143 hectares and residents in the area had been evacuated.

The wildfire did not grow significantly after June 22. Figure 3 shows the fire perimeter on June 23. On the evening of June 23, the wildfire status was classified as under control. Fire operations moved into the mop-up phase to extinguish hotspots and residents who had been evacuated returned to their homes. The cause of fire is currently under investigation.

C2[1] was the dominant fuel type on the south side of fire with patches of M2 (50% conifer / 50% hardwood). On the ground was a thick layer of peat moss. The focus of the operations at the time was the south side because of available standing fuels.

[1] C2 is a fuel type that represents Boreal Spruce in the Canadian Wildland Fire Behaviour Prediction System (https://cwfis.cfs.nrcan.gc.ca/background/fueltypes/c2).

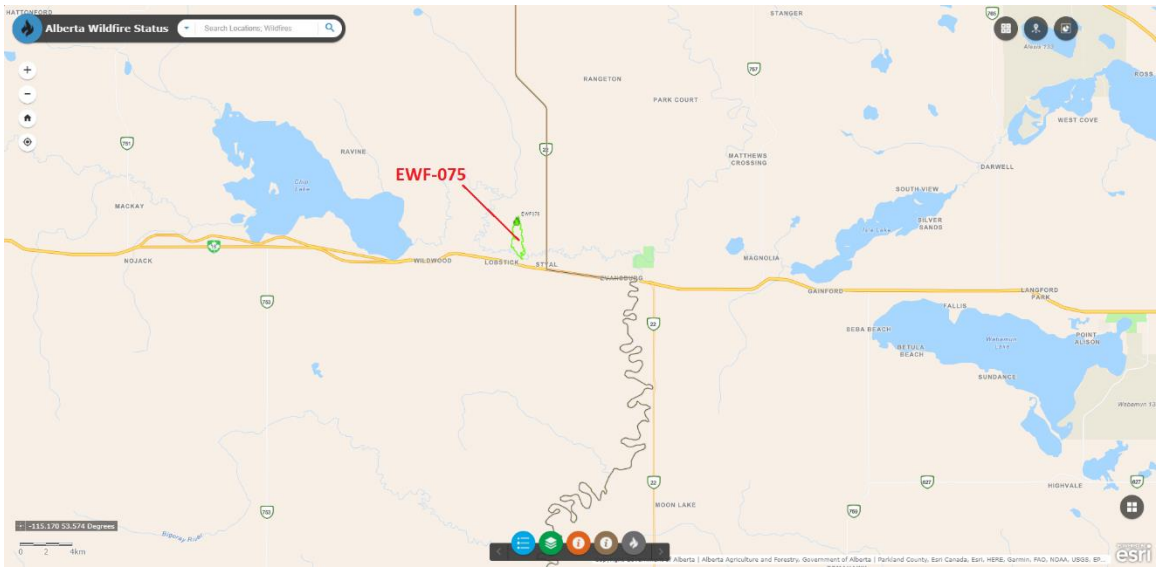

Figure 2. The location of EWF-075. Source: esrd.maps.arcgis.com

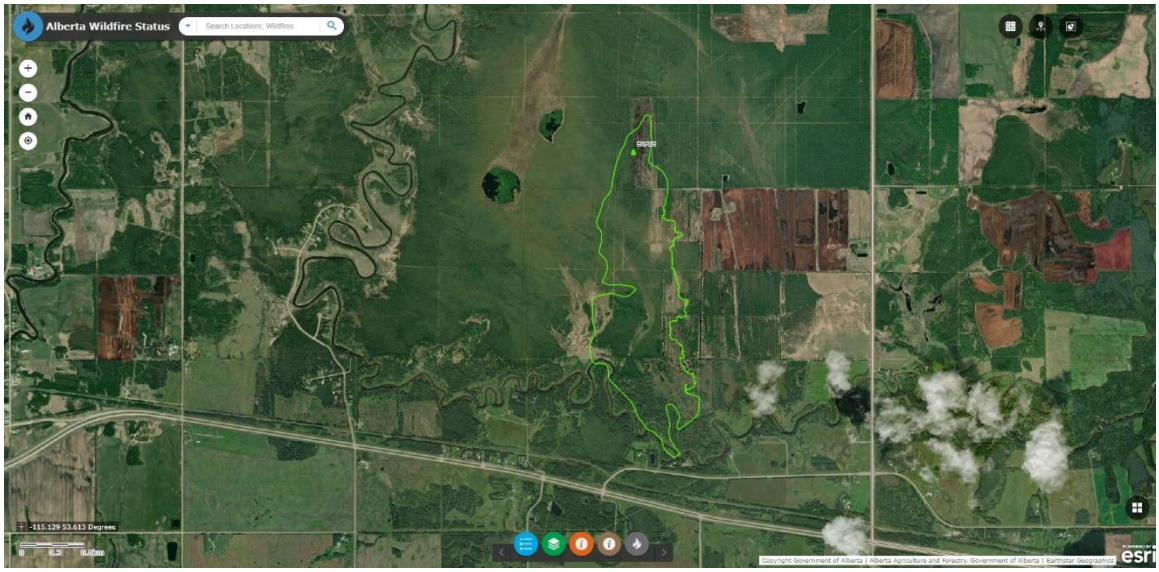

Figure 3. EWF-075 perimeter (green polygon) on June 23, 2021. Source: esrd.maps.arcgis.com

Trident was notified on June 26, 2021, and was requested to be on site on June 28, 2021, for the morning briefing. The FPInnovations researcher arrived on site by the afternoon of June 28, 2021, and gathered information from Trident, the incident commander, and the fire crews.

Assignment

The mobile water delivery system was assigned to support a unit crew of firefighters on the south side of the wildfire that was mopping up hotspots along the north side of Township Road 534C. The fuel type in the area was C2 (now burned) with a thick layer of smouldering peat

moss. The firefighters needed large amounts of water to soak the smouldering peat moss. The nearest water source was the Lobstick River to the south.

Execution

Equipment list

Table 1 lists the equipment that comprised the system used on wildfire EWF-075. All the equipment arrived on a 37-foot flat deck trailer.

Table 1. Equipment that comprised the system used on wildfire EWF-075.

Equipment	Quantity	Figure No.
Pump (modified Gorman-Rupp 06D1-GA pump, 200 HP) mounted with 8 feet (2.4 metres) of 6-inch suction hose	1	Figure 7
Extended suction hose, 6-inch, 20 feet (6.1 metres)	1	Figure 7
Hose, 4-inch – spooled, 200 feet (61 metres)	30	Figure 5
Master spool	1	Figure 5
Deployment spool	1	Figure 1
Sprinkler head (Rain Bird 80EHD)	10	N/A
Water thief, 1½-inch outlet and quarter-turn cam lock and valve	40	Figure 8
Half-ton pickup truck	1	N/A
One-ton pickup truck	1	Figure 5
37-foot (11 metre) trailer	1	Figure 5
UTV	2	Figure 1

Equipment setup

The vendor was instructed to use the Lobstick River as the water source and to lay out the 4-inch hose along Township Road 534C (Figure 4). The vendor unloaded the UTVs and conducted a reconnaissance of the area to identify a suitable access point to the water source (i.e., a stable riverbank). The pump was set up with 28 feet of suction hose: 8 feet mounted on the pump plus a 20-foot extension. The deployment spool loaded 4-inch hose from the master spool and then deployed the hose along Township Road 534C toward the location of the fire crews. A total of 2400 feet (732 m) of 4-inch hose was deployed.

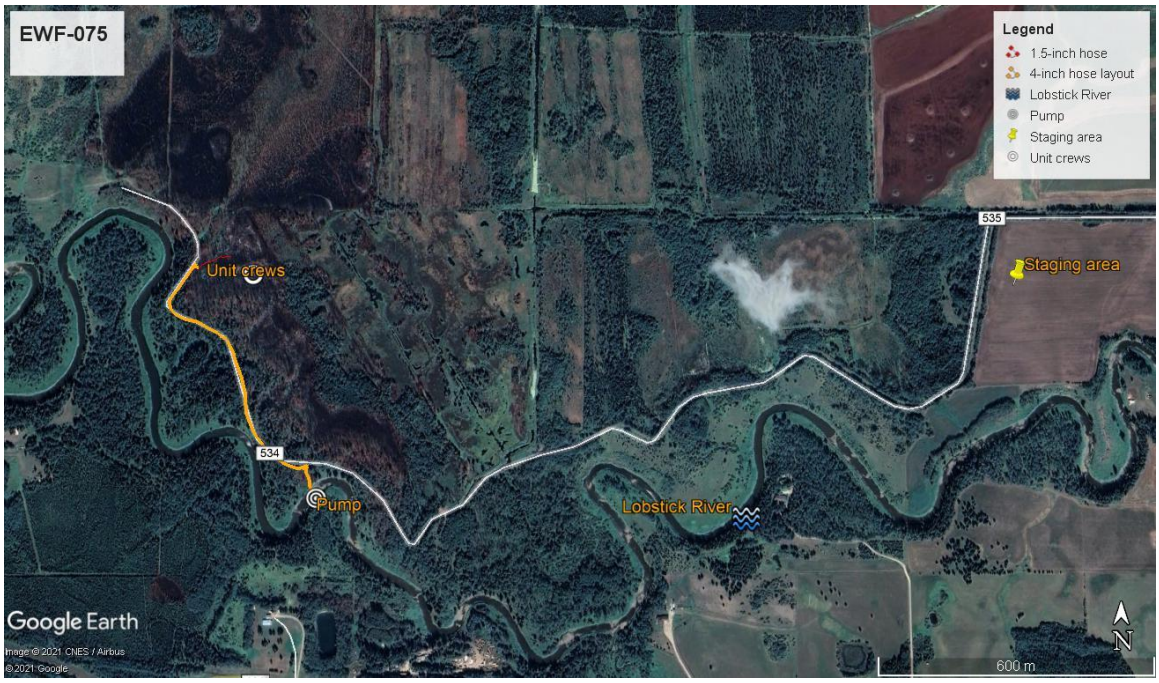

Figure 4. Map of the mobile water delivery system setup at EWF-075.

Figure 5. The 37-foot trailer with the two UTVs and the master spool. Provided by Sietse Vandermeulen of Alberta Wildfire.

There was no existing path or trail to the Lobstick River from Township Road 534C. Without cutting any vegetation, the vendor created a path that allowed the UTV with the pump to maneuver through the trees and descend to the riverbank (Figure 6), showcasing the mobility of the system.

Figure 6. The vendor's UTVs were able to maneuver between trees to access the water source.

The incident commander estimated the setup time to be approximately two hours. Setup activities included:

- unloading the two UTVs
- conducting a reconnaissance of the area with a UTV
- setting up the pump at the water source (Figure 7)
- loading the 4-inch hose onto the deployment spool from the master spool
- laying out the 4-inch hose
- attaching the water thieves

Figure 7. Pump setup on the Lobstick River.

System operation

Before the arrival of the Trident system, two unit crews were conducting mop-up operations using Mark-3® pumps set up at the Lobstick River. They were using 1½-inch hose with straight-stream nozzles to cast high-pressure, long distance water streams into the deep peat moss.

The vendor set up their system with 1½-inch water thieves (with quarter-turn cam lock and valve) at every section of 4-inch hose (Figure 8). The fire crews connected three 1½-inch hose lines to the water thieves (Figure 9 and Figure 10).

Figure 8. A 1½-inch water thief between two 4-inch hose lengths.

Figure 9. Fire crews connected their 1½-inch hoses to water thieves on the 4-inch line.

Figure 10. A fire crew member using water from the Trident system for mop-up operations.

Weather conditions

Weather data was retrieved from the Evansburg AGCM weather station, which was 1.5 km away from the fire.

Table 2. Weather conditions during the operation of the system on June 28, 2021. Source: acis.alberta.ca

Time	Temperature	RH	Wind Speed	Gust	Wind Direction
11:00	28.8°C	48%	6.2 km/h	N/A	N/A
18:00	33.4°C	32%	9.6 km/h	N/A	N/A

n/a = not available

The weather conditions did not impact the setup or operation of the system.

System performance

Crew leaders and crew members found the pressure of the vendor's system to be lower than that of the Mark-3® pumps. This lower pressure resulted in significantly shorter casting distances of the water streams and impacted the productivity of the crews. By the time the researcher arrived at 14:30, only one line of 1½-inch hose was still connected to the system and being used for mop-up. Reducing the number of hose lines did not improve the casting distance because the pump gear ratio adjusted automatically to maintain pressure and flow rate based on the volume output. The vendor commented that it would be possible to achieve longer

casting distances by increasing the number of hose lines to ten because of the higher flow rate, but this was not verified due to time constraints.

The pump ran from 11:00 to 18:30; no downtime was recorded. The system operated at 120 psi consistently during operation.

System demobilization

There were no fire operations on June 29, 2021, and the incident commander released the vendor from the fire at 17:30.

Demobilization took 3.3 hours and included the following activities:

- shutting down the pump
- disassembling the 4-inch hose
- moving the pump UTV to the trailer
- picking up 4-inch hose with the deployment UTV
- loading the UTVs on the trailer
- tying down equipment

WILDFIRE LWF-184

Wildfire LWF-187 was located 1 km west of Hwy 63, approximately 80 km north of Lac La Biche (Figure 11). On August 12, 2021, the fire was 150 ha and classified as out of control. By September 10, 2021, it had reached 500 ha, but had been classified as under control. (Figure 12). Lighting was determined to be the cause of the fire.

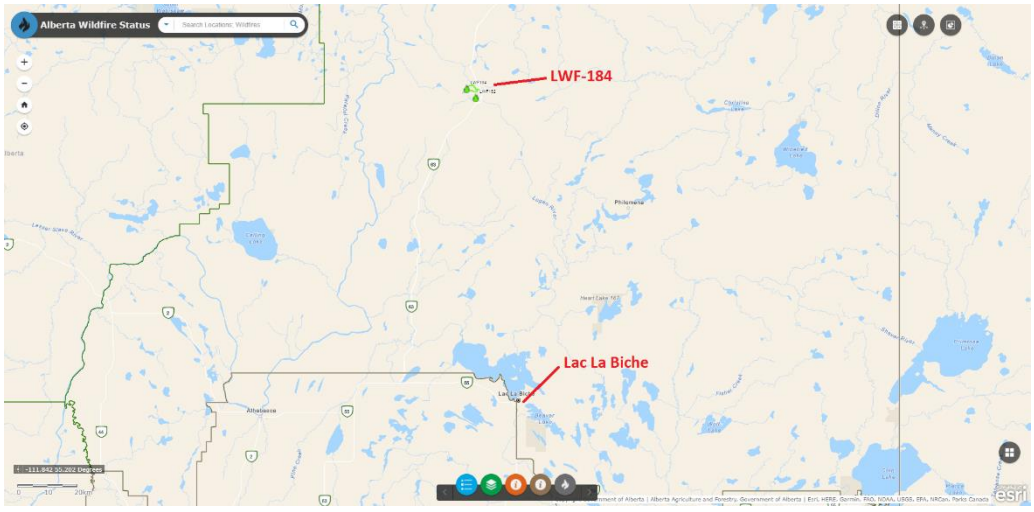

Figure 11. The location of LWF-184. Source: esrd.maps.arcgis.com.

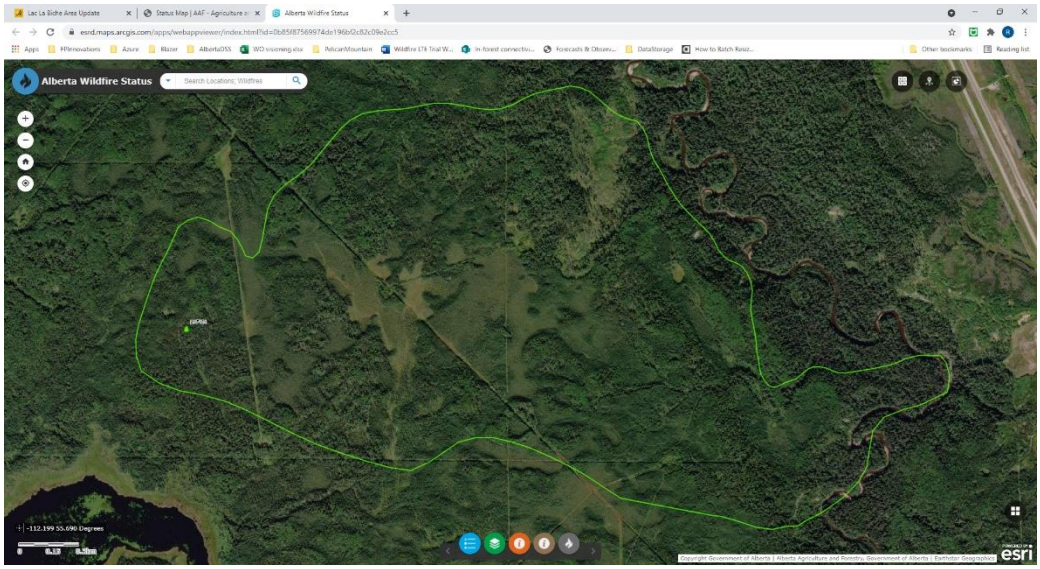

Figure 12. Perimeter of LWF-184 on September 10, 2021. Source: esrd.maps.arcgis.com.

The vendor was contacted the morning of August 14, 2021, to report to fire LWF-184. The vendor arrived on site the same day and discussed with the incident commander options for how the system could be used. However, after a reconnaissance flight the morning of August 15, 2021, it was determined that overall access was not possible because of soft muskeg throughout the area. The vendor was released the same day.

BEAVER LAKE HELIPAD EXERCISE

The Lac La Biche Wildfire Management Area wanted to gather more information on using the Trident mobile water delivery system to create a fire control line. The area west of Beaver Lake helipad was identified as a suitable test location. The Beaver Lake helipad is approximately 4 km from Lac La Biche (Figure 13). The water source and deployment path were scouted two days before the deployment by a wildfire officer to ensure accessibility.

The area was dominated by an M2[2] fuel type. A pipeline right-of-way provided firm ground and a clear path for hose deployment. An existing trail provided a connection between the staging area and the pipeline right-of-way (Figure 18).

[2] M2 is a fuel type that represents Boreal Mixedwood - Green in the Canadian Wildland Fire Behaviour Prediction System (https://cwfis.cfs.nrcan.gc.ca/background/fueltypes/m2).

Figure 13. The location of the Beaver Lake helipad, pipeline right-of-way, and water source. Aerial imagery source: Google Earth.

Assignment

The assignment was to deploy sprinklers in a designated area identified by the researcher and then pump water from the water source to the sprinklers for one hour. Rain gauges were set up in a grid pattern in three plots, each in a different fuel type (open, M1, and a fuel treatment), to measure water reaching the ground. The rain gauge data was used to determine the rainfall equivalent, and the casting distance of the sprinklers was measured. The objective was to collect quantitative data that would help evaluate the system's performance as a fire control line.

The first plot was set up along the pipeline right-of-way (open area) (Figure 14), the second plot was set up in an M1 fuel type beside the pipeline right-of-way (Figure 15), and the third plot was set up in a fuel treatment demonstration area that was a conifer stand with 3 m crown spacing and 2 m high pruning (Figure 16).

Figure 14. The rain gauge plot in the open area.

Figure 15. The rain gauge plot in the M1 fuel type.

Figure 16. The rain gauge plot in the fuel treatment demonstration area.

Execution

Equipment list

The equipment that comprised the system for this assignment is listed in Table 3. Two one-ton trucks each pulling a trailer carried all the equipment. One trailer carried two UTVs: one UTV carried a pump and the other carried the hose deployment spool. The second trailer carried the master hose spool (Figure 17). The second trailer was an upgrade that allowed the 4-inch hose to be deployed from the master spool; however, this feature was not used during this assignment.

Table 3. Equipment that comprised the system for the Beaver Lake control line assignment.

Equipment	Quantity	Figure No.
Pump (modified Gorman-Rupp 06D1-GA pump, 200 HP) mounted with 8 feet (2.4 metres) of 6-inch suction hose	1	Figure 16
Extended suction hose, 6-inch, 20 feet (6.1 metres)	1	N/A
Hose, 4-inch – spooled, 200 feet (61 metres)	20	Figure 15
Hose, 4-inch – spooled, 300 feet (91 metres)	10	Figure 15
Master spool	1	Figure 15
Deployment spool	1	Figure 17
Sprinkler head (Rain Bird 80EHD)	12	Figure 18

Equipment	Quantity	Figure No.
Water thief, 1½-inch outlet with quarter-turn cam lock and valve	40	Figure 18
One-ton pickup truck	2	Figure 15
37-foot trailer	1	N/A
20-foot trailer	1	Figure 15
UTV	2	Figure 16, 17

Figure 17. An upgraded trailer that allows a pick-up truck to deploy the 4-inch hose from the master spool.

Equipment setup

The vendor arrived at the staging area on September 10, 2021, at 09:30 after meeting with the forestry officer at the Lac La Biche Wildfire Centre. After an onsite briefing, the forestry officer toured the area with the vendor. The vendor confirmed the deployment plan and did not identify any access limitations.

The vendor unloaded the UTVs from the trailer and proceeded to set up the pump at the water source first (Figure 19). The second UTV then loaded the 4-inch hose onto the deployment spool from the master spool (Figure 20). Once the hose was loaded, the UTV with the deployment spool laid out the hose starting from the pump and worked toward the staging area. Four trips were required for the deployment UTV to lay out all the hose. The entire 7000 feet (2134 meters) of 4-inch hose were used.

Once the hose was laid out, the researcher identified the locations for the sprinkler deployment. The vendor installed six sprinklers but turned on only four.

For this assignment, 200-foot and 300-foot lengths of 4-inch hose were deployed. Between each length, a water thief was installed. The sprinklers were installed on the water thieves. The vendor had modified its large-volume Rain Bird sprinklers to fit on the water thieves (Figure 21).

Figure 18. Location of the pump, 4-inch hose, and sprinklers. Aerial imagery source: Google Earth.

Figure 19. Pump setup at the water source during the Beaver Lake helipad exercise.

Figure 20. The deployment spool loading 4-inch hose from the master spool.

The forest officer had scouted the water source and the path ahead of time, had considered the surface conditions for the UTVs, and had confirmed everything with the vendor, this resulted in no challenges being encountered during equipment setup.

Set up of the equipment took approximately 2.6 hours and included the following activities:

- unloading the UTVs
- conducting a reconnaissance of the water source and deployment path with a UTV
- setting up the pump at the water source
- loading the 4-inch hose onto the deployment spool from the master spool
- laying out the 4-inch hose
- attaching the water thieves and sprinklers

Figure 21. A large Rain Bird sprinkler attached to a water thief on the 4-inch hose line.

System operation

It took eight minutes to fully charge the entire 7000 feet of 4-inch hose line. The vendor estimated the water pressure to be 100 psi consistently during the operation. The system operated for an hour; no downtime was observed.

Weather conditions

A Kestrel 5500 weather logger was used to record the weather conditions at the staging area (Table 4).

Table 4. Weather conditions between 14:00 and 15:00 on September 10, 2021.

Average Temperature	Average RH	Average Wind Speed	Gust	Wind Direction
19.1°C	52%	3.04 km/h	7.6 km/h	126 to 270 degrees

The weather conditions during the operation were mild and consistent. There was significant variability in the wind direction, but this did not appear to affect sprinkler performance or the researcher's measurements.

System performance

The average casting distance of the sprinklers was 24 m in the open plot and 22 m in both the M1 plot and the fuel treatment plot. There was no coverage overlap. The average gap in coverage between the sprinklers was 13 m.

The rain gauge results in the open plot represented the baseline for sprinkler coverage. The rain gauge results from the M1 fuel plot showed some shadow effects in a mixed-wood environment. The rain gauge results from the fuel treatment plot had the largest variation. The higher conifer crown density blocked the sprinkler streams and water dripped from the canopy in proximity to the sprinklers (Figure 22).

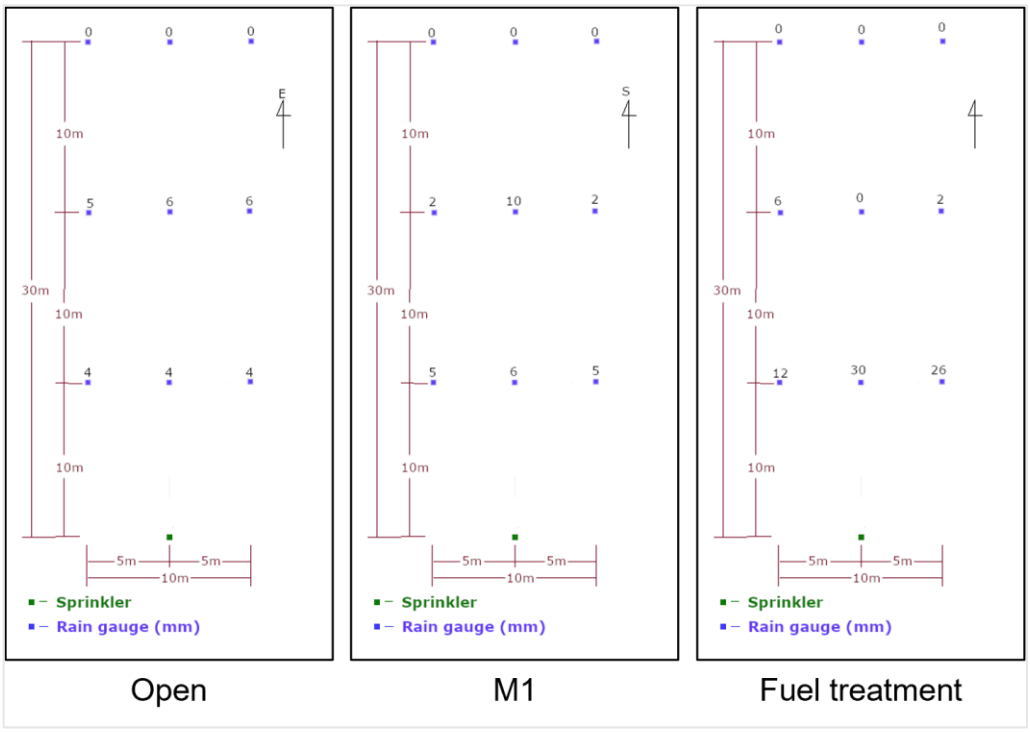

Figure 22. Rain gauge measurements in the three different fuel type plots after one hour of sprinkler operation.

System demobilization

After one hour of operation, the system was turned off and the vendor demobilized the system. Demobilization took approximately 2.5 hours and consisted of the following activities:

- shutting down the pump
- disassembling the sprinklers and 4-inch hose
- move the pump to the trailer
- picking up the 4-inch hose with the UTV
- loading the UTVs on the trailer
- tying down the equipment

DISCUSSION

Effectiveness

The Trident system was found to efficiently move water. Using UTVs to set up and deploy 4-inch hose is an innovative design, and the speed of deployment and maneuverability was impressive compared to other industrial water delivery systems. As a self-contained system, no additional support, resources, or heavy equipment was required to deliver a large volume of water. By using UTVs to transport the pump and the hose with smaller footprints, the system can access water sources that other industrial water delivery systems or fire engines cannot.

Supporting mop-up operations

During the operation of the system on EWF-075, the fire crews found the pressure at the nozzle end of their 1½-inch hose was reduced compared to the Mark-3® pump. Because of the fuel type in the area, the fire crews felt the lower pressure reduced their productivity. The fire crews, therefore, switched back to the Mark-3® pumps to gain the extra pressure for better casting distances and deeper penetration into the burning fuels.

The operational pressure of the vendor's pump was 120 psi; the Mark-3® pump in comparison is 300 psi. However, the vendor's pump was capable of delivering 500 gpm whereas the Mark-3® pump could deliver only 90 gpm. The incident commander on wildfire EWF-075 had commented that the system would be more useful if it were used to transfer water to bladders or pumpkin tanks which multiple Mark-3® pumps could then draw water.

Although the system has water thieves to allow the connection of 1½-inch hose, it should be seen as a value-added feature and not used as a primary water source for direct attack or mop-up operations if fire crews have better options.

Because the system has a valve every 200 or 300 feet, depending on the length of 4-inch hose sections deployed, it can be used for flooding operations. However, the 4-inch hose is susceptible to damage from heat, so care must be taken to protect the hose from direct heat sources. The 4-inch hose is also heavy and the deployment UTV is needed to move it. In addition, when the hose needs to be moved, the pump needs to be shut down and the hose discharged. Although the system has the capability to be used for flooding operations, it should be limited to fire perimeters and open areas and not used within densely forested areas.

Creating a fire control line

During the exercise at the Beaver Lake helipad, the vendor demonstrated the capability of its large Rain Bird sprinklers to create a wet line. The vendor had customized the sprinklers to fit on the water thieves that were attached to the 4-inch hose. This is an innovative design and was a convenient feature when deploying the sprinklers.

The vendor includes 12 sprinklers with its standard service package. This allows for a 2400 foot (732 meters) sprinkler line (12 sections of 200-foot length of 4-inch hose each connected by a

water thief onto which a sprinkler is installed). However, with the sprinklers set at 200 feet apart and a 24 m cast distance, the sprinkler streams did not overlap and gaps were observed along each section. A fire could breach these gaps, escape the containment, and damage the hose. The solution would be to install more sprinklers. Additional forestry fire fittings can be attached to the vendors' water thieves so that additional hose sections and sprinklers can be attached (Figure 23). The requesting agency would be responsible for supplying these additional sprinklers and fittings. We estimate that 11 additional sprinklers and parts would be needed to close the coverage gaps. For Alberta Wildfire, this would equate to two standard sprinkler kits (each kit contains eight sprinkler heads).

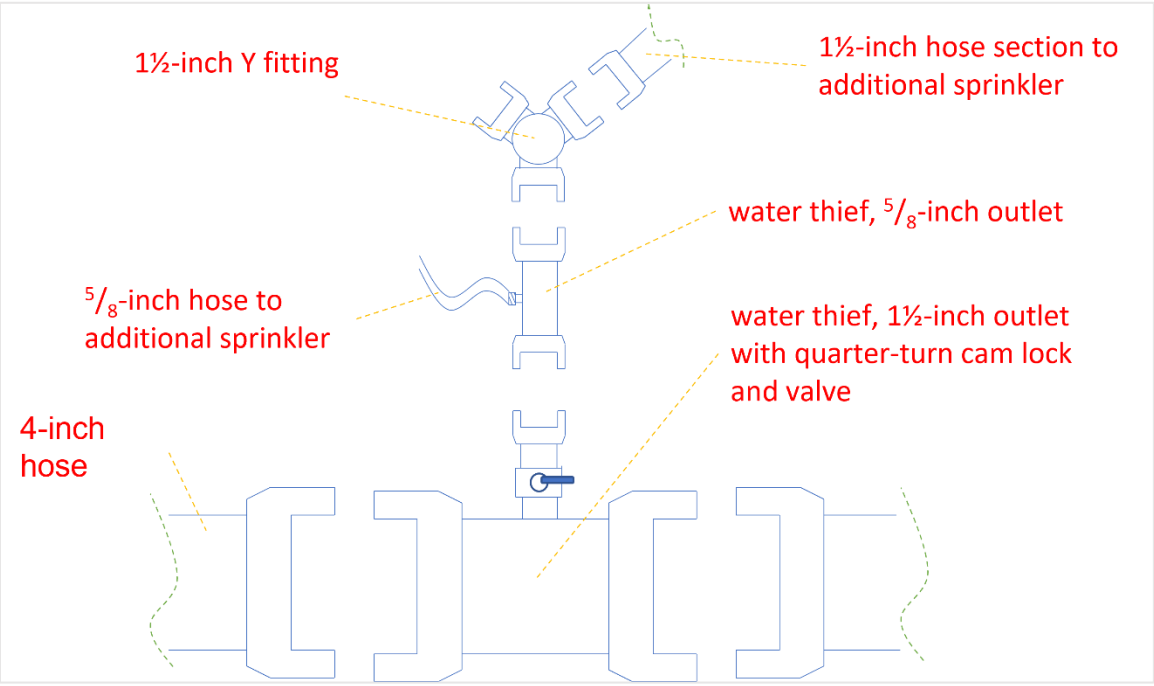

Figure 23. An example of adding multiple connections to a water thief in the Trident system to accommodate more sprinklers.

During the Beaver Lake helipad exercise, the pump was operating at the operational flow rate (500 gpm) with friction loss through 4-inch hose line. Although six sprinklers were installed, only four were turned on to demonstrate the maximum casting distance. The maximum output of the sprinklers is 120 gpm each and more than four sprinklers operating at the same time would exceed the operational flow rate and the maximum casting distance would not be achieved. The total wet line created during this exercise was 800 feet (244 meters) but with gaps.

According to the vendor, the total length of the wet line is limited to 2400 feet and 12 sprinklers (one sprinkler for every 200 feet of hose). This limitation is due to the maximum flow rate through 4-inch hose and the maximum output of the sprinklers. This assumes the pump is operating at its maximum flow rate (1200 gpm) and it does not account for additional sprinklers. It is reasonable to assume, therefore, that if additional sprinklers are used, the length of wet line would be less than 2400 feet. Future testing would be required to verify the maximum length of wet line the system could create and the maximum number of sprinklers it could support.

The results from the three rain gauge plots after one hour of operation were:

- open plot – average 5 mm
- M1 plot – average 5 mm
- fuel treatment plot – average 13 mm

According to Barnes, Baxter, and Miller (2017), it is recommended that feather moss (0−5 cm) and upper duff (5−13 cm) in lowland boreal forests receive between 10 and 20 mm of sprinkler operation to raise moisture content to near saturation levels for a 24-hour period (i.e., FFMC = 0). Based on the rain gauge data obtained from the Beaver Lake helipad exercise, it is estimated that Trident's sprinklers would effectively lower the FFMC to zero for a 24-hour period after four hours of operation.

In the M1 fuel type plot and the fuel treatment plot, the rain gauge results were variable, and the casting distances were shorter (trees and other vegetation blocked the sprinkler streams). This was most evident in the fuel treatment plot with its thick conifer crowns. The higher rain gauge values at close range in this plot were the result of water dripping from tree crowns and the high average value in the rain gauge was not representative. We could assume, therefore, that without fuel treatment thick conifer fuel types such as C2 and C3 would limit the sprinklers' effectiveness further.

Considerations

Road access

This mobile water delivery system uses pickup trucks and trailers to transport equipment to the staging area. Road access, therefore, plays a key role in determining setup times. Longer distances between the staging area (where the master spool is located) and the assignment area (where the hose is deployed) means longer trips for the deployment UTV. According to the vendor, the system could be modified to be flown in by a helicopter, but this option is not currently available.

Water access

By mounting the pump on a UTV, this system has the capability to access water sources that water tenders and fire engines cannot. The pump is equipped with 28 feet of 6-inch suction hose and can be operated from 21 feet above the water source. The UTV can be parked on sloped and uneven surfaces, but the pump system still requires solid stable ground to operate.

Best practice is to identify a suitable water access before sending out a service request. Also, the vendor needs to conduct a reconnaissance to confirm water access before initiating deployment. Water sources with an extensive steep bank or located in muskeg should be avoided. Wildfire LWF-184 was an example of where a water source located in muskeg had no possible access.

Terrain

Because this system uses UTVs to deploy its equipment, it can take advantage of quad trails and relatively narrow paths. However, caution is warranted when taking the system across soft ground. The UTV and the pump together weigh nearly 2500 lbs (1134 kg) and is at risk of getting stuck in soft ground and damaged. This was the reason the incident commander and the vendor agreed to cancel the assignment on LWF-184.

Currently, there is no guideline available that defines the terrain that should be avoided. In the interim, a good rule of thumb is if the ground could support the weight of an empty 4x4 half-ton pickup truck, then the system can be deployed. If not, extreme caution should be exercised, or the area should be avoided. Future research would be required to verify this assumption.

Other considerations

In addition to road access, water access, and terrain, the requesting agency should consider the following:

1. **Hose damage.** The 4-inch hose is made of a rubber material that can be easily damaged by heat. If the hose is damaged, the system cannot supply water to designated areas.
2. **Wildfire size.** This system is good for a large complex wildfire campaign, but it is not suitable for initial attack, small, or fast-moving fires. Although the system can be deployed relatively quickly, it still needs several hours to mobilize, deploy, and maneuver. Large complex wildfire campaigns may also have multiple opportunities to use the system in the event the original assignment does not work out.
3. **Multiple uses.** If multiple uses for the system are identified, the incident commander should consider prioritizing them. Based on the findings in this report and feedback from the incident commanders involved in this study, the following prioritization of uses is recommended:
    a. Moving water to portable water bladders and pumpkin tanks.
    b. Filling water tenders by accessing water sources that are difficult to get to.
    c. Protecting structures by supplementing agency's sprinkler systems.
    d. Creating a wet line for backburns (using its sprinklers).
    e. Creating a wet line (i.e., fire control lines) in wildland environment (using its sprinklers).
    f. Providing a primary water source for direct attack or mop-up operations.

    If the system is used to create a wet line (d and e), additional sprinklers will need to be supplied by the requesting agency. If the system is used as the primary water source for direct attack or mop-up operations (f), there will be less pressure at the nozzle end compared to Mark3® pumps.
4. **Backup plan.** The researcher did not observe any downtime of the system during the deployments described in this report. However, the incident commander from wildfire EWF-075 had suggested that a backup plan would be good practice in case the system failed.

Other deployments

During the 2021 fire season, the vendor deployed its system on multiple assignments in British Columbia, Canada. The vendor's system was assigned to BC Wildfire structure protection service units and had two primary uses: (1) sprinkler deployment for structure protection; and (2) fill water tenders and portable water tanks. According to the vendor, these assignments were a great success.

CONCLUSION

This project aimed to understand the efficacy of using a mobile water delivery system in wildfire operations and to help close the knowledge gaps of where and when the system could be used.

The Trident system is a mobile water delivery system with many innovative features. It uses UTVs to deploy its equipment, thus it can access water sources that are difficult for traditional water tenders and fire engines. One UTV carries a high-volume pump and another carries and deploys 4-inch hose. The primary function of this system is to move a large volume of water. The system includes 12 large Rain Bird sprinklers and several water thieves to allow the connection of 1½-inch hose fittings.

Alberta Wildfire contracted Trident for the 2021 fire season and requested the system for three assignments:

- Wildfire EWF-075 – assignment was to support fire crews during mop-up operations
- Wildfire LWF-184 – assignment was cancelled because access to the water source was determined to be not possible (soft muskeg)
- Beaver Lake helipad – assignment was a fire control line exercise using sprinklers

The researcher found the system to be highly agile and mobile. The vendor deployed and demobilized its system efficiently with its two UTVs. The setup time for both deployments was approximately 2 to 3.3 hours. Demobilization took approximately 2.5 to 2.6 hours.

Although the system has multiple features that allow it to be used for different applications, we feel it should be used primarily to move water, taking advantage of its high-volume pump and its ability to quickly deploy 4-inch hose. Its other features are less capable compared to current wildfire operation practices. One example is the lower pressure experienced by fire crews on EWF-075 during mop-up operations. Another example is the gaps in coverage observed along the sprinkler line in the Beaver Lake helipad exercise.

Despite the maneuverability and accessibility offered by the UTVs, the system is still heavy and has its limitations when the ground is soft (e.g., muskeg). This was the reason for cancelling the assignment on LWF-184. Until more research is conducted to better understand the limitations of the system in this regard, we suggest that wildfire operation personnel use their extensive experience with half-ton 4x4 pickup trucks to gauge whether the terrain would support the

weight of the system. Extreme caution is warranted when using the system in environments with soft muskeg.

Planning is an important part of a successful deployment. The following points are important to consider before calling the vendor:

- Identify and prioritize potential uses.
- Identify potential water sources and bank conditions.
- Identify potential deployment paths with firm ground to accommodate a maximum of 7000 feet of hose.

Once the vendor arrives on site, a reconnaissance should be conducted to confirm the deployment plan.

For a quick reference, Appendix 1 compiles the major items that should be considered for a deployment.

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APPENDIX 1: TRIDENT PUMP INFO NOTE

October 2021

Features

The Trident mobile water delivery system is self-contained. The main components of the system are two UTVs, a 200 hp high-volume pump and 7000 feet (2134 m) of 4-inch hose. The system can deliver 500 gpm of water at 190 psi. The system also includes 12 large Rain Bird sprinklers that are capable of casting water to 80 feet (24 m). The system has 40 1½-inch water thieves with a quarter-turn cam lock and valve to quickly connect 1½-inch fire hoses. The system can be set up within 3.5 hours and demobilized within 3 hours. The system is highly mobile but still requires trails with firm ground.

Usage priority

Of the uses listed below, A and B are primary.

A. Move water to portable water bladders and pumpkin tanks.
B. Fill water tenders by accessing water sources that are difficult to get to.
C. Support structure protection by supplementing agency's sprinkler systems.
D. Create a wet line for backburns with its sprinkler system. *
E. Create a wet line as a fire control with its sprinkler system in wildland environment. *
F. Provide a primary water source for direct attack or mop-up. **

* *For Alberta Wildfire, two additional standard sprinkler kits will be needed to close coverage gaps. Have a plan in place to protect the 4-inch hose.*

** *Expect only half the water pressure at nozzle ends compared to Mark-3® pumps.*

Considerations and recommendations

Access: Need firm ground for pump setup and hose layout. To gauge whether the ground conditions are suitable, use your judgement to determine if the ground could support an empty 4x4 half-ton truck. Soft muskeg requires extreme caution or should be avoided.

Planning: Before requesting the service, identify and prioritize the potential uses, water sources, and access paths. Conduct a reconnaissance with the vendor.

Hose protection: Any heat source can damage the 4-inch hose. Have a protection plan in place to protect the hose from heat sources.

Fire type: The system is best used for large campaign fires or in urban-interface areas. The system is not suitable for small and fast-moving, initial attack fires.

Backup plan: Always have a backup system set up, when possible, in case the system fails.

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