



Aerial Surveys of flow control structures within the Avalon Wilderness Reserve: A UAV Pilot Project

August 25 – 26, 2016



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Background

Unmanned aerial vehicles (UAVs, or drones) are increasingly displacing helicopters as a primary tool for surveillance and aerial photography. Key aspects include a greater degree of safety, increased responsiveness – through in-house expertise, as opposed to outside contractors – and relative low-cost.

Potential applications include inspections, investigations, environmental monitoring, and assessment, when relying on high-resolution cameras. In the future, additional sensors such as infrared cameras could allow for in-depth investigation of pollution sources.

While the applications and benefits are manifold, the use of UAVs does come with a certain degree of responsibility – namely in the form of additional training, regulatory approval from Transport Canada, and increased liability.

Using affordable, DJI Phantom 3 Professional off-the-shelf drones, an attempt was made to perform visual inspection of flow control structures within the Avalon Wilderness Reserve related to hydroelectric power generation on the Southern Shore of Newfoundland. The purpose of this surveillance was to determine if such a surveillance program could be useful in pursuing the mandate of the Water Resources Management Division (WRMD) in an efficient and cost-effective fashion.

Method and Discussion

According to Canadian Aviation Regulations, all non-recreational operation of UAVs must be approved via a Special Flight Operations Certificate (SFOC) issued by Transport Canada. The application process for this SFOC is loosely defined and requirements depend on a case-by-case basis. Critical factors in the issuance of an SFOC are proximity to roadways, buildings, residential areas, and structures not involved in the operation. Additionally, some indication of training and the possession of > \$100 000 liability insurance is required. Application for an SFOC is time consuming, but regulations may become more streamlined in the future, especially as UAVs become more commonplace.

An SFOC application for this initial pilot project was made on January 29, 2016. The SFOC was granted on February 5, 2016 and was valid from February 5 to October 31, 2016. Additionally, the SFOC was only valid for flights within the area predefined in the application (the Avalon Wilderness Reserve).

On August 25th, two WRMD staff (Ryan Pugh and Tara Clinton) entered the Avalon Wilderness Reserve via Horsechops Road to perform initial test flights. Some photos of this field work are included in the Appendix.

A total of two flights were flown on the afternoon of August 25th (locations are depicted in Figure 1). Unfortunately, heavy winds and rain beginning overnight prevented additional flights that had been planned for August 26th.



Figure 1: Satellite photo of Stage Pond depicting the locations of two UAV flights

Videos produced during the two flights can be viewed on the shared drive at the following locations:

- <https://youtu.be/njk4zN0phj8>
 - This video starts with nadir imagery captured during a flyover of south-western Stage Pond while proceeding in a north-northeast heading at 270' above ground level (agl). The drone then reverses course and transitions to oblique imagery before circling about to land.
- <https://youtu.be/Rw7-Fqw0Ouo>
 - This video starts with high-oblique imagery captured during a rotation at 270' agl along the mid southeastern shore of Stage Pond. Imagery then transitions to nadir imagery as the drone proceeds west-southwest before landing.

The imagery captures show two earthen dykes intended to prevent southerly flow from Stage Pond, instead directing water in an easterly fashion towards a series of hydropower generating facilities on the Southern Shore of the Avalon Peninsula. Imagery does not show any obvious deterioration, however, there does appear to be seepage emerging from the dyke in the first video, as seen in Photo 1.



Photo 1: Potential seepage from the foot of Northwest Blackwoods Pond Spillway on Stage Pond

Conclusions and Path Forward

In viewing these videos, it is apparent that off-the-shelf UAVs can be useful tools in performing visual inspection of flow control structures and shallow water (near-shore) areas.

Rules and regulations surrounding UAV use are complicated. In late 2016, Transport Canada released a document outlining the exemption from SFOC application for the class of UAVs used by WRMD. While the rules are restrictive in terms of distance from built-up areas, much of WRMD's interest will exist beyond the outlined distance. For planned missions outside the exemption, an official SFOC will be required.

During the 2017 field season, additional projects will be undertaken as spelled out in the 2016 – 2017 WRMD Work Plan. These projects may include monitoring of siltation events and blue-green algae blooms as they occur, creation of technical video footage, and developing digital surface models for select areas.

As additional experience is gained with the UAV program, the Department may be able to avail of a more permissive SFOC with a broader geographic range of operation. With a broader range of regions in which to fly, the possibility of potential mission objectives is also increased leading to opportunities to experiment with sensors beyond the visual spectrum. Such sensors could include infra-red spectrometry for vegetative studies, LiDAR for mapping and modelling studies, or potentially water sampling devices for remote surface water sampling.

Appendix

As a condition of the Research Permit needed for entry into the Avalon Wilderness Reserve, a series of photos were requested by the Parks and Natural Areas Division.



Photo 2: 47° 4' 52.89" N, 53° 9' 33.38" W, looking east

Dry streambed within the Avalon Wilderness Reserve, depicting interesting scenery on the ground.



Photo 3: Setting camp at outlet of Blackwood Ponds (47° 2'33.83" N, 53°12'16.20" W)



Photo 4: Ryan Pugh prepping for UAV flight at Stage Pond (46°58'10.10" N, 53°17'18.60" W)



Photo 5: Ryan Pugh flying UAV at Stage Pond (46°58'10.10" N, 53°17'18.60" W)



Photo 6: Landing UAV at Stage Pond (46°58'10.10" N, 53°17'18.60" W)



Photo 7: View from UAV, ~ 100' agl looking west (46°58'10.10" N, 53°17'18.60" W)



Photo 8: View from UAV, 300' agl looking south-west (46°58'29.65" N, 53°16'2.93" W)