

Innovation Title/Name: Airlume,

Problem/Objective Statement: Vancouver has 45,000 catch basins, of which under 15% receive regular maintenance. In other words, a clogged drain must be reported by citizens before cleared manually by government workers, or themselves [1]. As a result, clogs are addressed after pooling becomes visible. Each unattended obstruction disrupts traffic through road closure. Clogged drains also cause street overflows that carry dangerous chemicals eroding from the road, such as 6PPD, one of “the most toxic chemicals known for aquatic organisms”, into local waterstreams, such as the Fraser River, negatively affecting biodiversity, notably the coho salmon [7][9]. Furthermore, clogged drains increase water velocity, which erodes pipes and surrounding river walls, causing need for replacement, overflow and landslides [3].

How it works: Airlume is a minimalistic, low-maintenance Internet of Things (IoT) device that collects data from multiple sensors, including water depth and conductivity, to determine whether a drain grate is obstructed. It does so by making comparisons across nearby units; high conductivity signals leaf accumulation, and the water depth indicates changes in flow patterns. Airlume is powered by a solid-liquid triboelectric nanogenerator (SL-TENG), an innovative method that converts the mechanical energy of rain into electricity for the device’s circuitry (power output $\sim 45\text{mW/m}^2$) [5]. Consequently, Airlume removes the need for battery replacement, which often occurs 2-3 times across an IoT device’s lifetime [4].

Finally, Airlume transmits data using a LoRa module to the cloud, which would connect to the government’s ArcGIS system, enabling real-time monitoring of catch basins across the city.

Impact/Mission: We developed our third prototype from scratch and are conducting local field testing in real drain grates this October for three units [6][10]. Through our research and testing, the SL-TENG sustains the device’s ability to take data at 15-20 minute intervals. At \$150 per unit (including installation), it would just cost the government \$6.75 million to cover all 45,000 drain grates in Vancouver, barely a fraction of what is lost annually to this natural disaster [2].

Conclusion: Airlume is an innovative device with significant local and global potential, offering the government systemized access to smart drain grates. It can also be integrated into existing government programs, like the Adopt-A-Basin program in Vancouver, to optimize when volunteers should clean basins. The main challenges with this device are product lifetime and detection accuracy under real-world conditions. The former can be easily alleviated with improved engineering, while the latter would require testing/data collection to mitigate the issue.

References

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3D Model (#1) | Physical Prototype (#2) | ArcGIS Integration (#3)

