

















#### 









## Air Deposition of PFAS to Remote Lakes - Grenoble, France

- Air deposition is sole source of PFAS to mountainous lakes outside of Grenoble
- Concentrations of PFOS and PFOS precursors in fish were similar between reference lake and lakes near Grenoble
- Concentrations of PFCAs and PFCA precursors in fish were dependent on proximity to local industrial sources











































































## Case Study 3: Ellsworth AFB Fire Training Area (FTA)

- Active FTA from 1942 to 1990
- Site received treatment for VOCs, SVOCs until 2011:
  - Soil vapor extraction
  - Pump and treat (watch discharged back to on-site pond): oil water separation, air sparging, GAC
  - Dual phase extraction trench
  - · Several wells received bioventing and oxygen infusion
- Surface soil, aquifer solids, and groundwater collected in 2011 for PFAS analysis
- Data summarized in two studies: Houtz et al. ES&T 2013, McGuire et al. ES&T 2014

© Arcadis 2016



Figure 1. Aerial schematic of the former fire training area at Ellsworth Air Force Ross. Specifically identified are the locatine; of the former bum pit, the cretents of the histoch berence plunes,"<sup>10</sup> the former site of discharge for the pump and treat system, and the two in atu reductive trainment (IRT) wild. Oxygen infusion into groundwater flow groundwater flow is also indicated.

33

### Case Study: Ellsworth AFB Fire Training Area

 Surface Soil PFAS profile resembled original benzene plume 10+ years after active remediation







## Case Study: Ellsworth AFB Fire Training Area



© Arcadis 2016

- Historical benzene plume
  received significant treatment
- PFHxA signal (and other PFCAs) likely the result of precursor transformation
- In Eastern source area, no treatment
  - Precursor signal is more dominant, suggesting significant transformation to terminal products has not occurred





## Case Study: Ellsworth AFB Fire Training Area

- Ratio of PFHxS to PFOS measured in some AFFF formulations is 1:10 (Houtz et al. 2013)
- Significant presence of PFHxS precursors documented in some AFFF formulations (Houtz et al. 2013)
- Ratio of PFHxS to PFOS is up to 50:1 in the historical benzene plume
- Significant formation of PFHxS
  from precursors is apparent

Ratio of PFHxS to PFOS in GW

17 May 2017 37





39

# Arcadis PFAS Management



Remediation is not always necessary:

- Site A: Site-specific characterization of PFOS aquifer retardation factors justified an MNA management approach to protect a drinking water supply well
- Site B: Site-specific modelling of soil leaching, groundwater flow, and reservoir hydraulics determined acceptable residual PFOS concentrations in impacted soils

Arcadis is developing new technologies for sites where remediation or treatment of PFAS may be required:

- Water treatment reactor systems which destroy PFAS via sonolysis •
- Regenerable, cost effective sorbent materials which remove both short and long chain PFAS
- PFAS stabilization solutions using multiple reagents for source areas
- Oxidative and reductive technologies showing promise for PFAS treatment May 17, 2017







