Investigation and Treatment of PFAS at a Rurally-Located Naval Airfield

Laura Cook (CH2M)
Angela Jones (NAVFAC), Bill Diguiseppi (CH2M), Juliana Dean (CH2M)
Site History

- Site is an outlying landing field used primarily for touch-and-go’s
- Staffed by 40 military personnel, primarily fire-fighters
- Groundwater from two supply wells is used as the only source of water (potable and non-potable) on-base
- Former drinking water treatment involves green sand filters, permanganate oxidation, water softening, and chlorination
- Wastewater is treated with settling in a series of lagoons and subsequently used for spray irrigation on-site
- Residences near the landing field use private wells for potable and non-potable purposes
Hydrogeologic Setting

- Surficial aquifer – heterogeneous silty sand to 20-30 feet bgs
- Shallow water table at 2-8 ft bgs
- Yorktown confining unit - ~8-15 feet thick
- Yorktown aquifer - silty-sand >100 ft thick (drinking water aquifer)
Site Layout

Current Fire Fighter Training Area
Abandoned World War II Aircraft Landing Area
Site 17, Former Fire Fighting Training Area
Building 106 - AFFF Storage and Transfer Area
Approximate Location of Abandoned Aircraft
Current Crash Truck Equipment Test Site

Current Liquid Wastewater Irrigation Field
Building 20
Current Training, H₂O Only
Site 14, Former Base Landfill
Former Liquid Wastewater Irrigation Field
Approximate Location of Abandoned Aircraft
Crash Truck Waiting Area When Operations Ongoing
Aircraft Crash Site
Initial PFAS Investigation

• Six UCMR3 PFAS initially evaluated in on-base groundwater and drinking water in December 2015

• Monitoring wells sampled in locations of reported or probable aqueous film forming foam (AFFF) releases and at base boundary:
  – Crash truck test area
  – Former fire-fighting training area
  – Former Base Landfill
  – Crash sites
  – Irrigation spray fields

• Raw groundwater from on-base drinking water supply wells and treated drinking water was tested at various points within the drinking water treatment process
Initial (2015) Investigation Findings - Groundwater

• Detections of PFAS in both aquifers, focus is on PFOS/PFOA

• Exceedances of the 2009 USEPA Provisional Health Advisory (PHA) of PFOA (0.4 µg/L) and PFOS (0.2 µg/L) in Surficial Aquifer monitoring wells:
  – Crash Truck Test Area
    • PFOS – 11 µg/L
    • PFOA – 0.32 µg/L
  – Fire-fighting Training Area
    • PFOS – 3.0 µg/L
    • PFOA – 0.320 µg/L
  – Facility boundary wells

• Yorktown Aquifer Monitoring Wells – detections but no exceedances

• Base water supply (raw water and finished drinking water) samples exceeded PHAs
Follow-on Investigations – Groundwater and Drinking Water

- Conceptual Site Model (CSM) developed to assess need to test off-site drinking water
- Off-base private wells within 0.5 mile of wells with concentrations exceeding 25% of the PHA were sampled
  - Two downgradient properties exceeded the PHA
  - Based on step outs and establishment of the lifetime health advisory (L-HA), 6 properties exceeded the L-HA
  - 52 wells on 49 properties ultimately sampled
- Installation and sampling of new wells and sampling of existing on-base wells for better delineation
  - Monitoring wells sampled to date: 47
  - Concentrations of up to 49 µg/L (PFOS) and 6 µg/L (PFOA) at old tank site
- Deep double-cased environmental well concentrations were in most cases less than the health advisory level
- Straight-drilled deep water supply wells exceeded the health advisory in many cases
Plume Extents – 6 UCMR3 PFAS

1273 acres
954 acres
915 acres
855 acres
741 acres
576 acres
Primary and Secondary Source Evaluation

• Soil sampling completed to assess primary and secondary source areas:
  – Areas where fire-fighting training activities were conducted
  – Irrigation sprayfields

• Sludge evaluation to determine if liner replacement would be necessary once the upgraded drinking water treatment system was functional
  – From wastewater storage lagoon
Site 17 – Former Fire Fighting Training Area

Groundwater

Surface/Subsurface Soil

units: µg/L and µg/kg
Sludge Testing Results

- Highest PFAS concentrations found within sludge of storage lagoon
- Liner replaced ~1 year prior to collection of sludge sample
- PFOS dominates, with lower levels of PFOA observed
Follow-on Investigations and Rapid Response Actions, On-base and Off-base Drinking Water

- Base personnel supplied with bottled water
- Water filling station established by local municipality for concerned residents during off-base groundwater sampling
- Residences with exceedances of the PHA and subsequently the L-HA (PFOA + PFOS > 0.070 μg/L) were immediately supplied with bottled water when results were received (6 properties)
Evaluation of Drinking Water and Wastewater Systems

Drinking water system

- Used Total Oxidizable Precursor (TOP) assay to assess precursor mass
- TOP assay PFOA values higher than non-TOP assay PFOA in raw water
- PFOA was greater after permanganate/greensand filter treatment, indicating oxidative transformation of precursors
- PFOS levels remained fairly consistent throughout treatment system and were relatively consistent between non-TOP and TOP samples

Wastewater system

- PFOS levels remained fairly consistent throughout treatment system
- PFOA levels declined slightly through treatment process
- TOP assay suggested some precursor mass remains throughout
Water and Wastewater Treatment Approach

GAC selected to treat potable water and wastewater because:

- Removes the target compounds very well
- In routine use for PFAS, readily available
- PFAS destroyed by incineration during GAC regeneration

Drinking Water

- Multiple GACs isotherm tested with Rapid Small Scale Column Testing
- For finished drinking water, breakthrough occurred at >16,000 bed volumes

Wastewater

- Tested alum and ferric sulfate pretreatment at multiple doses, 50 mg/L alum selected
- Alum pretreatment reduced concentrations of PFOA (22%) and PFOS (56%)
- Breakthrough for wastewater considerably sooner than for drinking water due to total organic carbon (TOC)
Treatment Systems/System Retrofits

Drinking water systems

• Designed GAC systems on- and off-base using Filtrasorb 600

• System installations in progress

Wastewater system

• Designed GAC system using Filtrasorb 400

• Operating successfully, removing PFOS and PFOA to non-detect levels
General Conclusions and Take-aways - Characterization

• Releases came from a number of different aviation fire fighting sources with significant migration in groundwater, particularly for PFHxS

• Concentrations in groundwater well above L-HAs

• Significant redistribution occurred as a result of irrigation spraying of contaminated wastewater

• Deeper aquifer was impacted by straight drilling wells through the confining unit and pumping

• PFOS was the dominant compound in surface and subsurface soil and in wastewater sludge

• Dominant compounds varied in groundwater depending on source area
General Conclusions and Take-aways - Remediation

- Oxidizable precursors resulted in increases in PFOA concentrations following permanganate/greensand filter treatment in drinking water
- Bench-testing confirmed Filtrasorb 600 bituminous GAC as most effective treatment for drinking water
- Bench-testing confirmed alum was an adequate flocculant for high TOC wastewater effluent
- Bench-testing confirmed Filtrasorb 400 bituminous GAC as most effective treatment for pre-treated wastewater
- Continuing releases from the spray irrigation system were mitigated through GAC treatment of wastewater
- Impacts to current drinking water receptors were successfully mitigated through bottled water supply and subsequent GAC treatment
Thank you!

Laura Cook
Laura.Cook@ch2m.com