Fate and Transport of Metals in Wetland Soils

DR Patrick Baker DR Michael Butkus

- Metals, such as cadmium, arsenic, and lead, are present in varying concentrations in wetlands on the West Point reservation.

- Sources of metals in wetlands include natural deposition and man-made sources, including atmospheric deposition, runoff from agricultural fields, and wastewater discharge, landfills, and shooting ranges.

- Understanding the movement of metals through the food chain is important in managing natural areas.

- Cadets collecting soil and plant samples from wetlands in the West Point Reservation.

- They will then analyze the soil samples for lead using microwave digestion and inductively coupled plasma mass spectrometry.

- In collaboration with faculty and cadets in CLS, the movement of metals from soil to plant to animals will be assessed.

- Work in this project could result in peer-reviewed publication or presentation at regional conferences.
Phytoremediation of Ammunition Waste
DR Patrick Baker DR Michael Butkus

- Algae naturally takes up excess nutrients (Nitrogen, Phosphorous) from water
- Immobilized algae have great potential for remediation of ammunition waste because they convert harmful nitrogen into a less toxic form
- The resulting algae biomass can be converted into a biodiesel or biogas

• Cadets involved in this project will compare filamentous and colonial algae species in wastewater treatment
• Nutrient concentrations (N, P, NH₄) will be measured through biochemical assays
• Biomass will be quantified gravimetrically or through calorimetry
• Work in this project could result in peer-reviewed publication or presentation at regional conferences

Comparing adjacent urban and rural watersheds allows us to assign differences in water quality to land use or management practices (e.g., road salt).

Impervious surfaces (roads, parking lots) have impacts on the morphology and chemistry of urban streams.

Agricultural practices in rural watersheds can also degrade water quality through inputs of Nitrogen and Phosphorous.

Cadets will collect water samples from established locations in two streams.

Field data (turbidity, TDS, DO) will be collected with a hand-held multi-meter.

In the laboratory, cadets prepare and analyze water samples for ion concentrations.

Work in this project could result in peer-reviewed publication or presentation at regional conferences.
Indoor Air Quality Investigation & Modeling

COL Phil Dacunto, COL Mike Benson, CPT Andy Ng, Mr. Anand Shetty, CDT Dylan Moser

**Background**: Aerosol droplets (i.e., those that remain suspended for extended periods) may represent a significant transmission risk of COVID-19

**Research questions**: What is the impact of 3-sided desk dividers on airflow within a typical classroom? Would such dividers enable us to increase classroom capacity?

**Method**: release CO$_2$ as a tracer gas from various locations in a classroom with varying spacing and divider conditions; model results using CONTAM

**Funding**: USMA Dean

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**Preliminary results**

\[
\Delta C_{DIV} = C_{DIV} - C_{NODIV}
\]

- $\Delta C_{DIV}$ = Difference in normalized concentration with the addition of dividers
  - Negative value (green) represents the desired result
- Decreased concentrations without adverse effects

*Figure 8: $\Delta C_{DIV}$ for all releases and configurations*
USMA Storm Water System Improvements  COL Phil Dacunto

- USMA’s storm water infrastructure is aging and not environmentally-friendly
- Much of the cadet area is impermeable, creating large amounts of storm water runoff
- Pollutants collected in the storm water system run directly into the Hudson

- Design “low-impact development” storm water systems to treat and retain storm water on site, as well as to enhance aesthetics
- Systems include bioswales, rain gardens, cisterns, etc.
- Possibilities exist for storm water reuse (irrigation)
- This project involves field investigation and design using EPA software and other tools
- Designs can possibly be integrated into the Cadet Barracks and Academic Building Upgrade programs

Source: EPA
West Point Soil Lead Analysis (GIS & EV Focus)

LTC Ben Wallen, LTC Will Wright & COL Mindy Kimball (Support by Mr. Anand Shetty)
CDT Michael Roberts ’22 (ESC)


- West Point residential areas emerged during six distinct periods from 1819-2010
- In the US, it is common for urban soils to have elevated lead levels due to prevalent lead use in previous years
- Lead is a neuro toxin that is especially harmful to young children
- Understanding the spatial and temporal distribution of soil lead in developed areas will help to better prevent toxin exposure

- Cadets involved in this project will spend the early portion of their semester collecting soil samples around West Point.
- They will analyze the soil samples for lead using an XRF (X-Ray Fluorescence) hand-held device both on-site and after sample preparation in the laboratory.
- Coupling with the GIS program, Cadets will then create maps that help to explain the spatial distribution of soil lead as it relates to time.
- Work in this project is geared toward a peer-reviewed publication or presentation at a conference
• Partnership with the Tank Automotive Research, Development and Engineering Center (TARDEC) – Force Projection Technology
• Conduct simultaneous research with TARDEC
• This research has implication to help Soldiers in a combat environment through reducing the frequency of resupply required for RO units.

• Cadets integrate modeling with design to evaluate pressure drop and flow regimes
• Design and evaluate different spacer geometries using Solid Works
• Cadets conduct experiments to validate model results, improve flow, and reduce scaling
• Work in this project is geared toward a peer-reviewed publication or presentation at regional conferences
Geoarcheology at Revolutionary War Fortifications

LTC Mindy Kimball

- As the 250 year anniversary of the Revolutionary War approaches, interest is high in preserving West Point sites.
- 30+ sites located on West Point, many with structures buried/unknown, none investigated with geophysics.
- Ground Penetrating Radar is a geophysics instrument that can investigate archeological sites without disturbing them.
- West Point has agreed to preserve the 30+ fortifications, and any new information will be extremely useful in 2025.
- Redoubts, Cemeteries, Batteries, Forts, Supe’s front lawn.

Constitution Island “Parade Ground” — rectangular structure discovered at 6 ft depth.

- Learn geophysics data collection, processing, interpretation.
- Investigate archeological and historic information to ground-truth geophysics data.
- Characterize bedrock geomorphology shaped by the last ice age (find kettle lakes, define kame terrace).

At a depth of 6.6 ft, the area continues to show an outline of two circular figures.
Every major university in the U.S. has a published Sustainability Strategy.

West Point has some initiatives, but no comprehensive starting point to build on.

The West Point Energy Council (WPEC) started some initiatives, and has almost 10 years of historic data, but no collective strategy moving forward.

Executive Orders and DoD Regulations require many “green” options, but tracking compliance is a constant issue.

• Conduct Life Cycle Assessment (LCA) of systems or programs to inform future goals

• Research sustainability strategies from our peer institutions, what should USMA track?

• Establish a construct for a proposed West Point Sustainability Strategy

• Gather data to report baseline status on Sustainability Performance Indicators
Town of Highlands Environmental Conservation

- Build on previous Cadet work
- 2019 project conducted a baseline “Carbon Footprint” of Town operations, but the Town would like to expand the work
- Potential to work on food waste projects
- Potential to work on facilitating local business abilities to comply with new laws
  - No food scraps in waste by ‘22
  - No plastic bags by ‘20
  - Reducing plastic & styrofoam packaging from “to go” containers
Historically, printed maps required hand-engraved copper plates (one for each ink color)

The US Geological Survey (USGS) gifted USMA with 27 copper plates from a 1918 publication on “Camp Knox” (300+ pounds of copper)

No copies of the publication/maps exist, and the complete version is unknown

The survey work to create the maps was completed by Corps of Engineers officers in 1917 (surely West Point grads)

- Establish a procedure for digitizing each copper plate, georeferencing, and layering into GIS database
- Follow USGS-provided best practices on cleaning/restoring the plates
- Deliverable is a recreation of the original publication (or a reasonable portion)
- High potential for group work and interdisciplinary project (D/History, AOG, Fort Knox, US Army Center for Military History)

AY21, 4 Cadets on project already (2 GIS, 2 EVSci)
Characterization of a combined waste stream for lunar base applications

LTC Pfluger, Dr. Butkus, LTC James (CLS); Research Partner: ITility LLC

- Humans produce wet wastes with high organic content: food, fecal matter, WW sludge, laundry
- Anaerobic co-digestion can produce methane for energy for useful purposes (heat, energy, etc.)
- Can anaerobic waste degradation be useful for a future NASA-led lunar base?

We have four Cadets on-board for AT21: CDT Tom Rafferty (ChemE), CDT Emma Begin (Ev Eng), CDT MacKenzie Burns (Ev Eng), CDT Lauran Carag (Ev Eng)

Phase 1: bench-scale characterization of probable organic waste streams
Phase 2: modeled production of methane, downstream products
Phase 3: follow-on bioreactor studies (TBD)

Methane produced by the anaerobic treatment of domestic wastewater
Objective of this study is to improve knowledge concerning public service (water, energy, wastewater) on military installations.

Project is in the early stages, so looking for underclass Cadets interested in multi-year projects.

Goal is to develop a generalizable approach for all DoD installations.

• Cadets on this project will:
  • Study resilience at West Point using resilience theory published by Linkov et al. (2013)
  • Begin building base models for analysis

• Project team will collaborate with the ERDC Risk & Decision Team in Boston

Resilience Framework Proposed by Linkov et al. (2013):

- Prepare
- Absorb
- Recover
- Adapt

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The “Resilience Matrix”
Co-digestion of Food Waste & Sludge at Target Hill WWTP
LTC Andrew Pfluger, Dr. Mike Butkus, COL Phil Dacunto; Partners: American Water, Mr. Bill Meinert

- West Point must divert food waste from landfills by Jan 2022
- One viable solution is co-digestion of food waste and wastewater sludge at Target Hill WWTP in anaerobic digesters
- American Water has funds for upgrade – this is a real-world problem!
- This research builds upon preliminary work by cadets, faculty, and engineering firms

- Cadets on this project will:
  - Help categorize food waste from major generators at West Point
  - Help re-design the Target Hill WWTP to include modifications to the anaerobic digesters
  - Conduct methane generation calculations and model results
  - Explore lifecycle environmental impacts

- Long-term project with lots of publication potential!