Management of Acid-Forming Sediments at the Stafford Airport Expansion Project in Virginia

W. Lee Daniels

VIRGINIA TECH

TerraScience LLC

School of Plant & Environmental Sciences

wdaniels@vt.edu; 540-231-7175

http://www.landrehab.org

Collaborators:

Steve Petersen & Dirk Myer; Talbert & Bright Engineers

Bill Griffith, DEA, Legacy Engineering

Topics for Today

- **Review issues with identification and mitigation of acid forming materials (AFM) and resultant acid sulfate soils (ASS) in the northern Virginia Fall Zone region (Fredericksburg/Spotsylvania/Stafford)**
- **Describe the Stafford Airport Runway Extension Project and procedures employed to mitigate potential AFM/ASS impacts**
- **Summarize a new detailed field procedure developed for field ID and AFM characterization**
- **Speculate wildly about long-term mitigation probabilities**


What are the obvious surface indicators?
Red Fe-stains
Bare/dead vegetation
White and/or yellow salts
Degraded concrete & metal infrastructure

Typical young ASS weathering profile

Overlying oxidized material is typically a light yellowish brown with pH ~ 3. The yellowish salt here is *jarosite*.

Underlying reduced material is typically blue, gray or greenish, with pH > 5.5. May be pH 7-8.

What are acid sulfate soils (ASS)?

Soils formed from the weathering of sulfidic parent materials, which results in extremely low pH (commonly < 3.0), soluble metals and precipitation of sulfate salts.

- **Potential ASS*** **materials contain reduced sulfides that have been protected from near surface weathering.**
- **Active ASS are undergoing active reaction processes called *sulfuricization*. The pH is < 4.0 with high salinity (sulfates). pH 1.75 is possible and has been observed nearby at several sites.**
- **Post-Active ASS can remain strongly acidic (< pH 3.5) for years, before slowly increasing back to ~ pH 3.8 to 4.2 over time (decades) due to Al^{3+} buffering.**

*** *Thanks to Del Fanning (UMD) for sorting all this out!***

Active pyrite depositional environment in high C tidal flat along with Fe/sediment and sulfate inputs in tidal marsh.

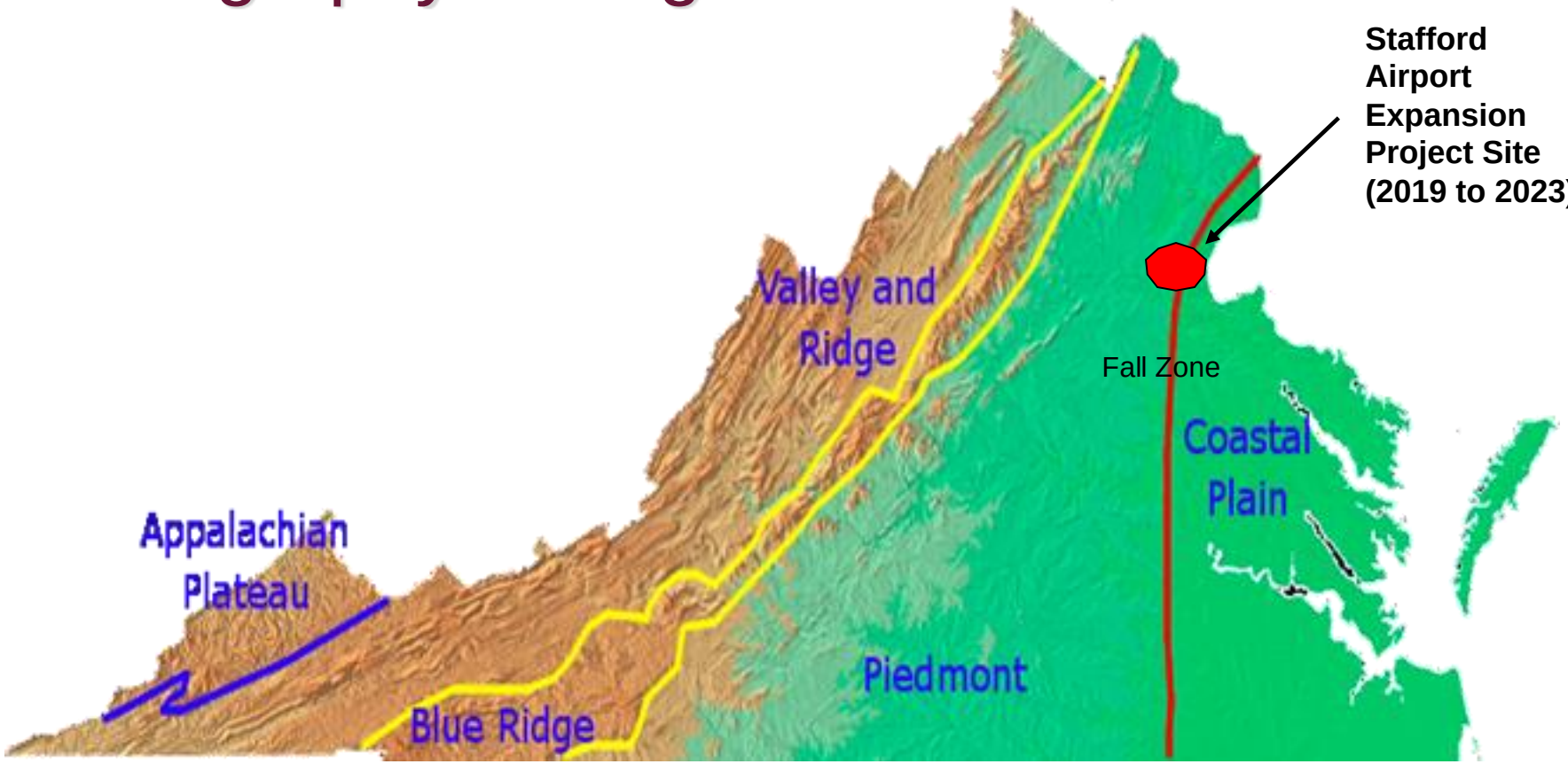
Common in reduced estuarine sediments.

Pyrite and similar sulfides are also found in a wide range of hydrothermally altered and /or volcanic igneous & metamorphic rock environments.

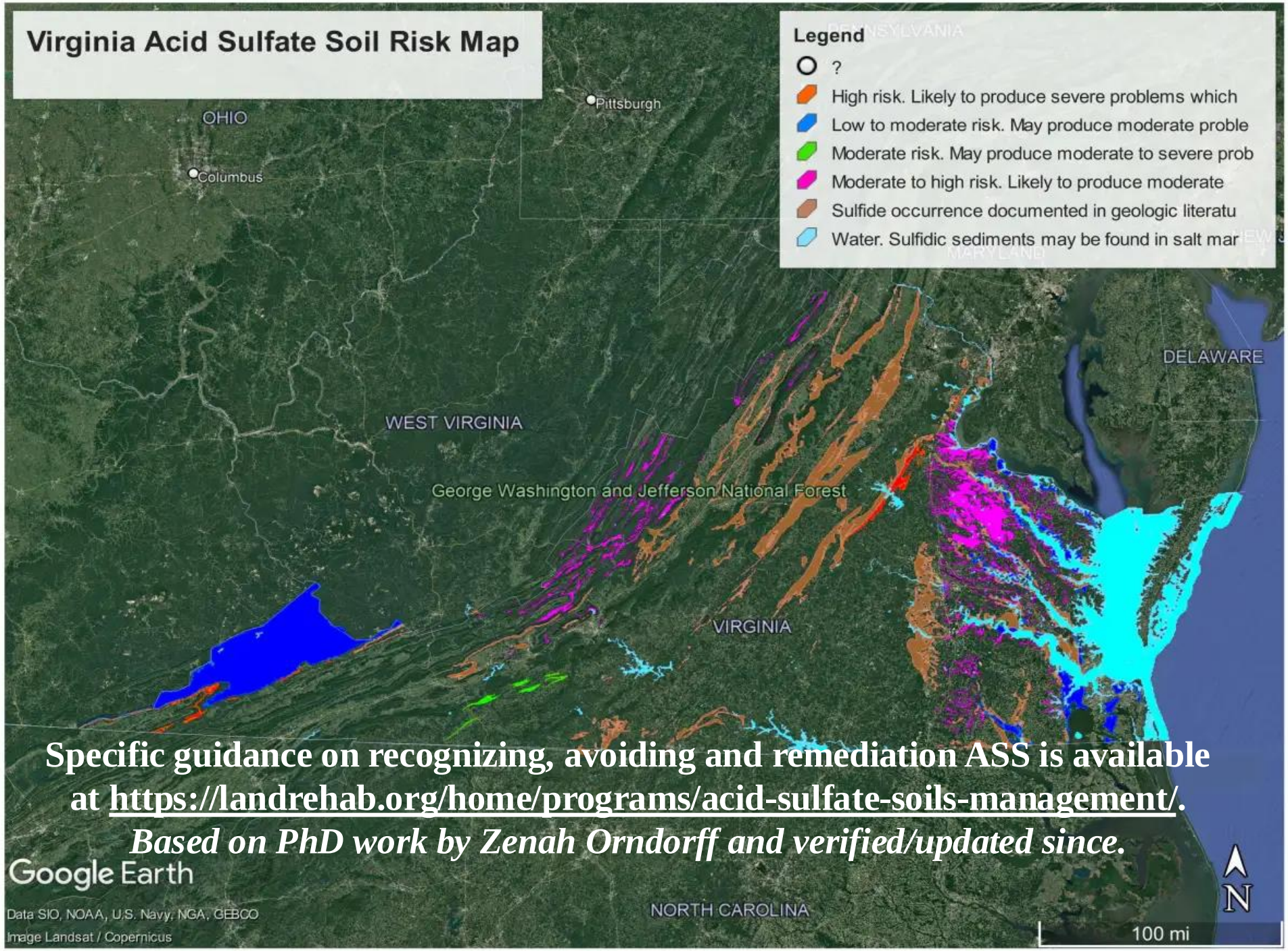
Acid sulfate materials from dredging in Queensland mangrove area.

Phragmites reeds begin to invade acid sulfate soil in sulfidic dredge materials at Hart-Miller Island (MD)

Geography of Virginia

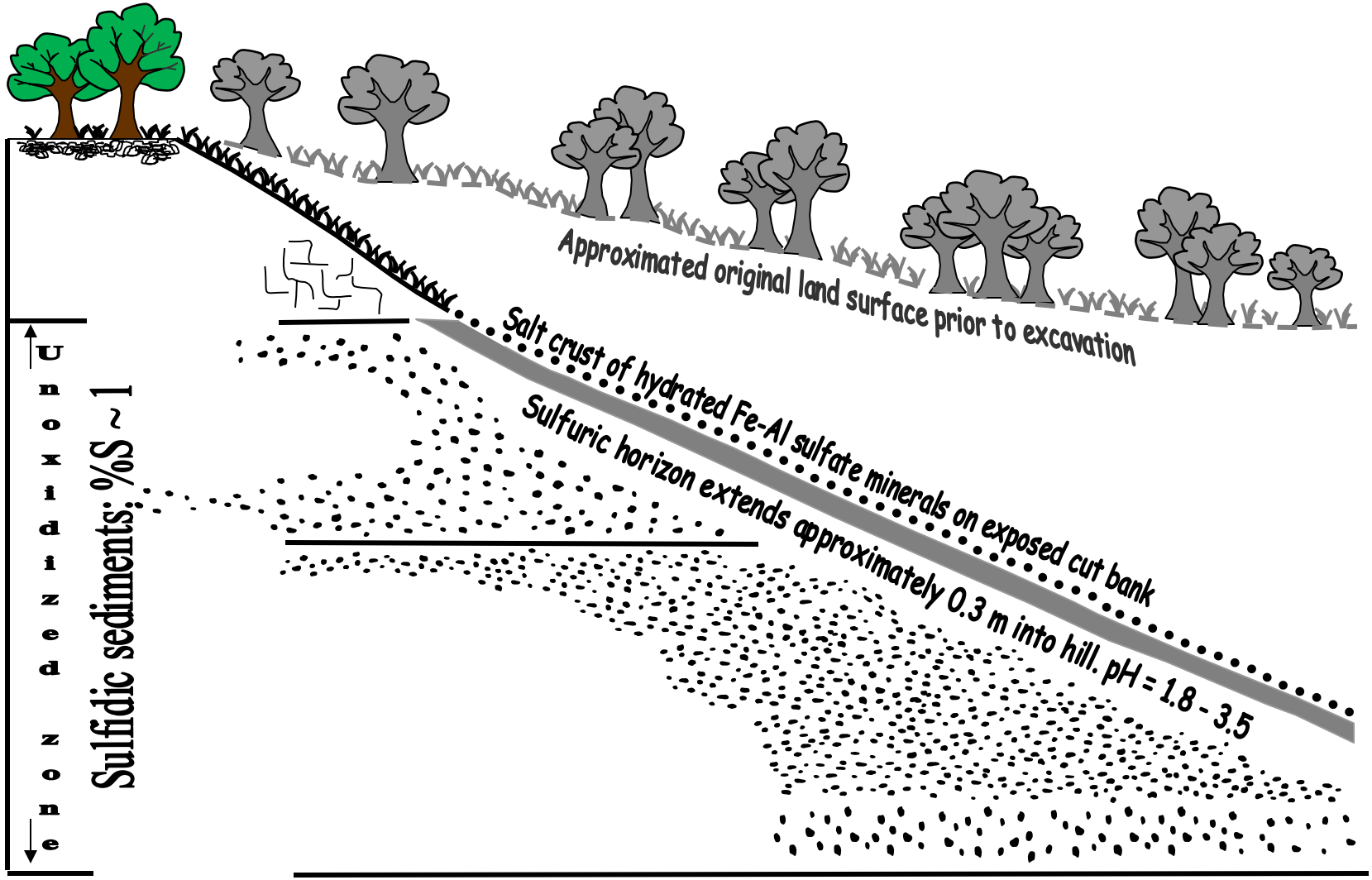


http://www.virginiaplaces.org/regions/ and
http://www.virginiaplaces.org/regions/physio.html


Virginia Acid Sulfate Soil Risk Map
Legend
?
High risk. Likely to produce severe problems which
Low to moderate risk. May produce moderate proble
Moderate risk. May produce moderate to severe prob
Moderate to high risk. Likely to produce moderate
Sulfide occurrence documented in geologic literatu
Water. Sulfidic sediments may be found in salt mar
OHIO
Pittsburgh
Columbus
WEST VIRGINIA
George Washington and Jefferson National Forest
VIRGINIA
DELAWARE
NORTH CAROLINA
Specific guidance on recognizing, avoiding and remediation ASS is available at https://landrehab.org/home/programs/acid-sulfate-soils-management/.
Based on PhD work by Zenah Orndorff and verified/updated since.
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus
N
100 mi


Stafford Airport / 2021
NRCS Flood Structure on Tributary Of Potomac Cr. Waters discharging here in February 2002 were pH 3.5 with 10 ppm Fe, 40 to 50 Al, 150 sulfate, etc.

Typical soil profile along a cut slope at Stafford Regional Airport (From Fanning et al., 2004)



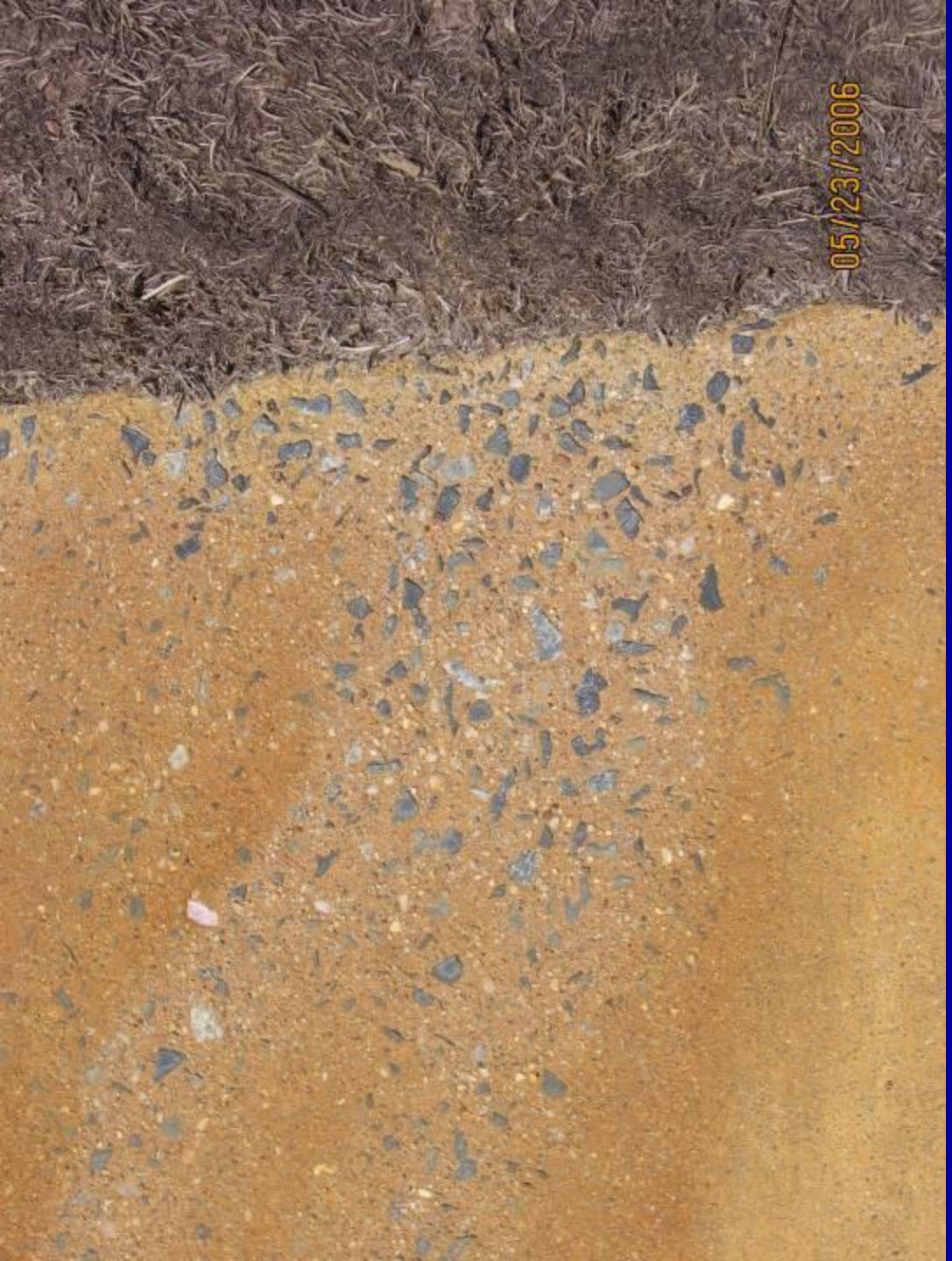
Active acid sulfate soil formed in cut Coastal Plain sediments in Stafford County (scale is in cm). This profile was originally solid gray to the surface when first exposed to weathering and this photo was taken after 15 years.

The surface was remediated via application of lime stabilized biosolids incorporated to six inches. The effective liming rate was ~50 tons per acre.

The yellow mottles in the middle of the profile are jarosite ($KFe^{3+}_3(OH)_6(SO_4)_2$), an important diagnostic mineral phase that forms when the pH drops below 3.5 with Eh > 400 mV. Jarosite is the mineral that the Mars Rover ID'd to prove that water had existed on mars.

Erosion of acid sulfate sediments and acidic leachate from an adjacent spoil fill has severely impaired this wetland.


3 6'02



Cement being stripped out of concrete; leaving aggregate exposed.

Direct corrosion attack on galvanized water control structures occurred in < 9 months.

Stafford Airport Project Remediation

- **A mixture of lime-stabilized biosolids (24 to 52% CCE) was applied in March, April and early May of 2002.**

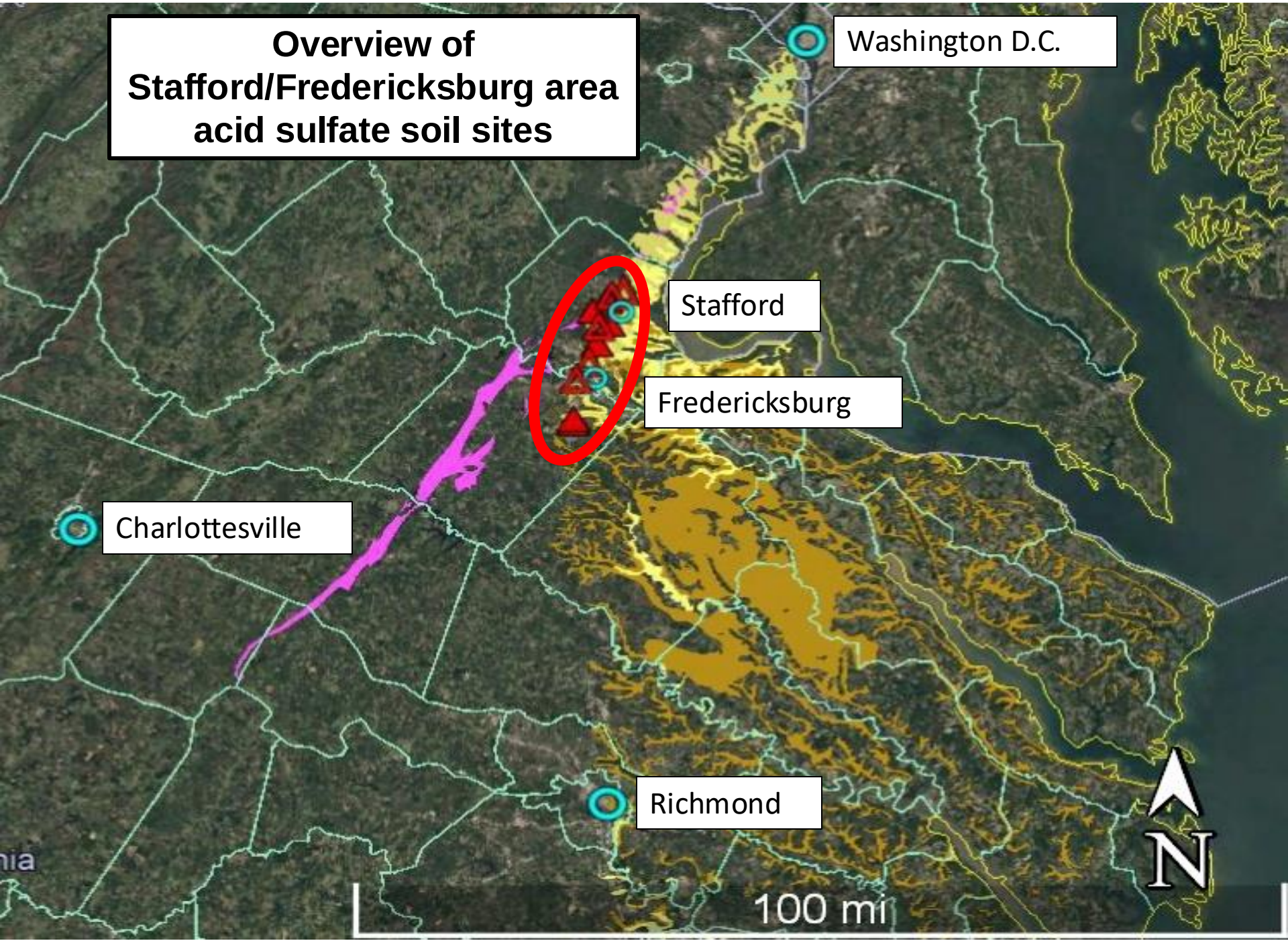
- **Over 350 acres reclaimed in 2021 and 2022. Biosolids and lime utilized 3 more times for "spot work" for new hangars & terminal.**

- **Loading rates were based on predicted lime requirements of the sulfidic soils and ranged from 20 to 100 T/Acre. Average loading rate was around 35 tons per acre or 15 tons of lime per acre.**

Area revegetated in late May as it appeared in July, 2002. Unfortunately, April through October of 2002 was the hottest/driest period on record.

Same view of Stafford Airport after a reasonable weather year. Second-order stream draining left hand side of this picture recovered from pH 3.5 to 7.2 over this period of time.

Aerial photo of Stafford Regional Airport: 2004


Overview of Stafford/Fredericksburg area acid sulfate soil sites
Washington D.C.
Stafford
Fredericksburg
Charlottesville
Richmond
N
100 mi

SRAP Runway Extension Background/Rationale

Runway expansion between 2021 and 2023 at SRAP involved cut/fill of 850,000 CY of weathered soils and non-weathered underlying sediments.

VDOT permit requirements mandated separating all handled materials into four different categories of acid formation risk with differing liming and/or placement procedures.

Most native surface soils are highly weathered from acidic sediments with a pH < 4.5 with high levels of exchangeable Al^{3+} leading to NP values < -5.0 T/1000

Original VDOT RFP Criteria

- **Category 1: All materials with S > 0.2% and NNP < -5 ppt; Isolate and/or *lime to NNP of +24 ppt*.**

- **Category 2: Materials with S < 0.2%, pH < 5.0 and NNP between -5 and +5 ppt. *Lime to NNP of +24 ppt.***

- **Category 3: NNP between +5 and +30; slight HCL fizz. No treatment needed.**

- **Category 4: NNP > +30 ppt; can be used to mix with/treat Category 2 materials.**

Field Sampling / Lab Testing

- **VDOT and USDOT funded 90% of the runway expansion project. Internal ASS policy guidance was provided by VDOT and attached to initial RFP for contractors.**

- **Used PA DOT criteria for developing liming recommendations. Based largely on Bald Eagle Mountain APM problems.**

- **We cooperated with Talbert & Bright and local geotech consultants to review detailed geologic boring logs & models and propose an alternative approach.**

- **Boring and lab testing indicated that most problematic AFM (< - 30 T/1000 NNP) were < 10 feet thick and with prominent color signature and other features.**


Stafford Reg. AP
Legend
B-18
B-19
B-16
B-17
B-20
B-15
B-7
B-21
B-14
B-13
B-8
B-3
B-6
B-12
B-9
B-11
B-10
B-4
B-2
B-1
B-5
628
Runway & Parallel Taxiway Extension
Stafford Regional Airport
Project No. 1-18-0759-EA
Figure: 1B
Google Earth
600 ft

Revised/Proposed Criteria

- **Due to the highly weathered nature of the soil mantle (Ultisols), significant portions of the upper weathered zone failed the original VDOT Category 2 criterion along with ~ 1/3 of the underlying sediments. At least 400 CY would need to be isolated and limed to +24 T/1000 NNP!**

- **Virginia Tech worked with consultants (Talbert & Bright, DEA & TerraScience) to develop a hybrid classification based on segregating potential ASS materials into three different categories with differential handling, isolation and management.**

- **Category 1: The majority of surface weathered materials (> pH 4.5)were placed with liming only required for their final revegetation.**

- **Category 2: A large portion of the underlying acid-forming materials were moved with adjacent strata such that their blended NNP was > -5 T/1000 T, were bulk limed at varying rates to achieve NNP > 0, and compacted into conventional fills.**

ACID-BASE ACCOUNTING

ABA.Rev. 0, Date 08-23-2018 (Form 1 of 1)

Pace Analytical®

DOMINION ENGINEERING ASSOCIATES

Project ID: 7721
Site ID: STAFFORD AIRPORT - B-16
PACE Job #: PENDING
Completed: 12/23/2020

Approved By: T.A. Keeney, Research Soil Scientist

˜As Referenced EPA Manual: EPA-600 / 2-78-054; Field and Laboratory Methods Applicable to Overburden and Minesoils ˜ w/ H2O2

Pace Sample Number	Client Sample Identification	Sample Collection Date	Interval (Feet) Top	Interval (Feet) Bottom	Thickness (Feet)	Munsell Soil Color	Reaction to HCl	Total % Sulfur	Calcium Carbonate Equivalent in Tons / 1000 Tons of Material: Potential Acidity	Neutralization Potential	Net Neutralizers DEFICIENCY	Net Neutralizers EXCESS	Paste pH (SU)
01	B-16	12/14/2020	0.0	2.0	2.0	10 YR 7/4	0	0.01	0.31	2.00		1.69	6.7
02	B-16	12/14/2020	2.0	4.0	2.0	10 YR 7/6	0	0.08	2.35	1.25	1.10		5.2
03	B-16	12/14/2020	4.0	6.0	2.0	10 YR 8/2	0	0.01	0.31	0.75		0.44	4.9
04	B-16	12/14/2020	6.0	8.0	2.0	10 YR 7/4	0	0.04	1.36	1.00	0.36		4.9
05	B-16	12/14/2020	8.0	10.0	2.0	10 YR 6/1	0	0.21 *	6.66	-6.25	12.91		3.9
06	B-16	12/14/2020	10.0	12.0	2.0	10 YR 5/1	0	0.34 *	10.75	-12.50	23.25		3.8

Percent Sulfur by LECO Combustion IR Detection @ 1350°

** Pyritic Sulfur*

Over two hundred ABA analyses were run on split-spoon samples from those borings and were correlated to earlier geologic work from first 2001 project.

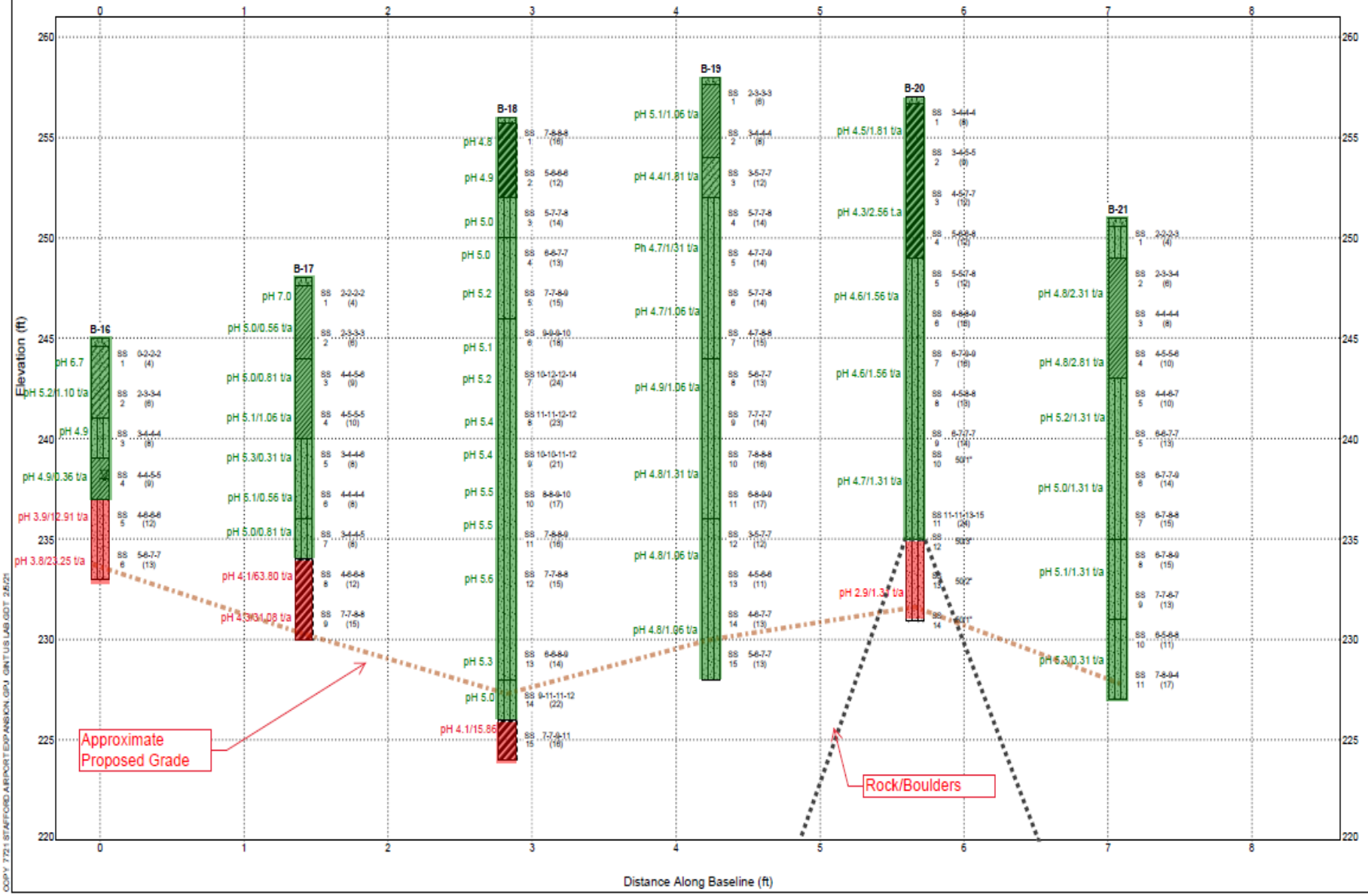
Dominion Engineering Associates
8511 Indian Hills Court Suite 202
Fredericksburg, VA 22407
Telephone: 5407109339

Cross Section F - F

SUBSURFACE DIAGRAM

Topsoil
USCS Clayey Sand
USCS Silty Sand
USCS Low Plasticity Clay
USCS High Plasticity Clay

CLIENT Stafford Airport
PROJECT NUMBER 7721
PROJECT NAME Stafford Airport Runway Extension
PROJECT LOCATION Stafford County, Virginia



Dominion Engineering Associates
8511 Indian Hills Court Suite 202
Fredericksburg, VA 22407
Telephone: 5407109339

BORING NUMBER B-05

CLIENT Stafford Airport
PROJECT NAME Stafford Airport Runway Extension
PROJECT NUMBER 7721
PROJECT LOCATION Stafford County, Virginia
DATE STARTED 12/8/20 **COMPLETED** 12/8/20
GROUND ELEVATION 241 ft **HOLE SIZE** 2.25"
DRILLING CONTRACTOR G-ES
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 8.0 ft / Elev 233.0 ft
LOGGED BY Bill Griffith **CHECKED BY** Kevin Parris
AT END OF DRILLING Dry
NOTES Cave In 9 ft
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		Topsoil 4"					
		Very Loose to Loose, Brown, Silty Fine SAND (SM), Contains Fine Roots, Moist	SS 1	58	1-1-2-2 (3)		
			SS 2	67	2-2-3-3 (5)		
5		Loose, Mottled Orangish Brown and Gray, Silty Fine SAND (SM), Very Moist	SS 3	67	3-3-3-4 (6)		
		Loose, Mottled Orangish Brown and Gray, Clayey Fine SAND (SC), Moist	SS 4	67	2-3-4-4 (7)		
		Soft, Mottled Red, Orange, Brown, and Gray, Sandy Fat CLAY (CH), Wet	SS 5	67	2-2-2-3 (4)		
10		Medium Stiff to Stiff, Gray to Dark Gray, Sandy Fat CLAY (CH), Moist	SS 6	83	4-4-4-5 (8)		
			SS 7	83	3-4-5-5 (9)		
		Bottom of hole at 14.0 feet.					

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80

Dominion Engineering Associates
8511 Indian Hills Court Suite 202
Fredericksburg, VA 22407
Telephone: 5407109339

Cross Section E - E

SUBSURFACE DIAGRAM

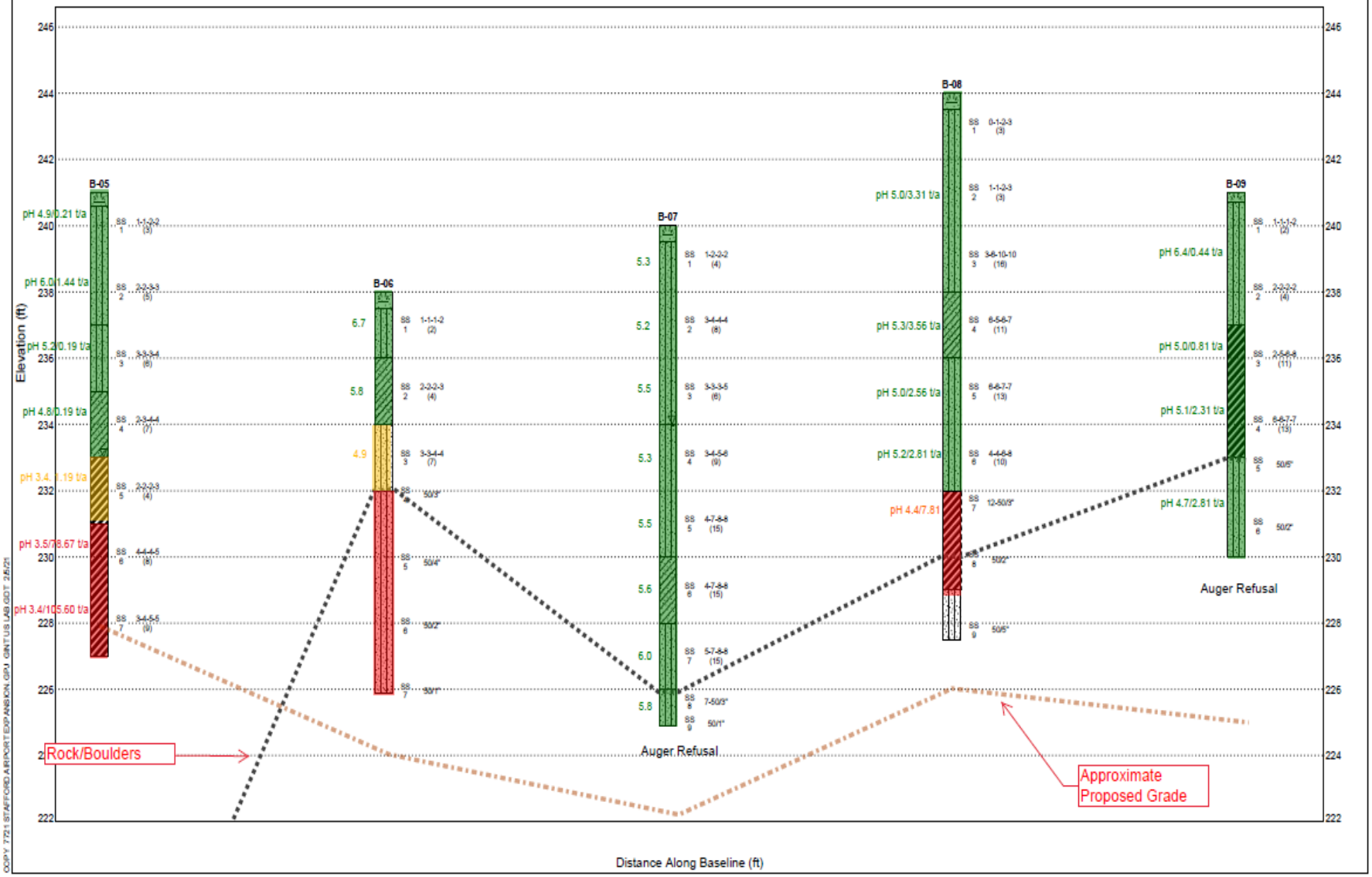
Topsoil | USCS Silty Sand | USCS Clayey Sand | USCS High Plasticity Clay

CLIENT Stafford Airport

PROJECT NAME Stafford Airport Runway Extension

PROJECT NUMBER 7721

PROJECT LOCATION Stafford County, Virginia



ACID-BASE ACCOUNTING

ABA.Rev. 0, Date 08-23-2018 (Form 1 of 1)

DOMINION ENGINEERING ASSOCIATES

Project ID: **7721**

Site ID: **STAFFORD AIRPORT - B-17**

PACE Job #: PENDING

Completed: 12/23/2020

Approved By: T.A. Keeney, Research Soil Scientist

˜ As Referenced EPA Manual: EPA-600 / 2-78-054; Field and Laboratory Methods Applicable to Overburden and Minesoils ˜ w/ H2O2

Pace Sample Number	Client Sample Identification	Sample Collection Date	Interval (Feet) Top	Interval (Feet) Bottom	Thickness (Feet)	Munsell Soil Color	Reaction to HCl	Total % Sulfur	Calcium Carbonate Equivalent in Tons / 1000 Tons of Material: Potential Acidity	Neutralization Potential	Net Neutralizers: DEFICIENCY	Net Neutralizers: EXCESS	Paste pH (SU)
01	B-17	12/14/2020	0.0	2.0	2.0	10 YR 7/4	0	0.01	0.31	0.50		0.19	7.0
02	B-17	12/14/2020	2.0	4.0	2.0	10 YR 7/6	0	0.01	0.31	-0.25	0.56		5.0
03	B-17	12/14/2020	4.0	6.0	2.0	10 YR 7/8	0	0.01	0.31	-0.50	0.81		5.0
04	B-17	12/14/2020	6.0	8.0	2.0	10 YR 7/6	0	0.01	0.31	-0.75	1.06		5.1
05	B-17	12/14/2020	8.0	10.0	2.0	2.5 YR 7/4	0	0.01	0.31	0.00	0.31		5.3
06	B-17	12/14/2020	10.0	12.0	2.0	2.5 YR 7/6	0	0.01	0.31	-0.25	0.56		5.1
07	B-17	12/14/2020	12.0	14.0	2.0	10 YR 6/1	0	0.01	0.31	-0.50	0.81		5.0
08	B-17	12/14/2020	14.0	16.0	2.0	10 YR 6/1	0	1.21 *	37.80	-26.00	63.80		4.1
09	B-17	12/14/2020	16.0	18.0	2.0	10 YR 6/1	0	0.83 *	26.08	-5.00	31.08		4.3

Percent Sulfur by LECO Combustion IR Detection @ 1350°

** Pyritic Sulfur*

Geologist checking deeper excavation at SRAP through final elevation of the runway subgrade. The lower whitish gray material is non-acid forming, but hardens irreversibly upon drying. It commonly appears in the local landscape as hard lithic sandstone outcrops.

Using a system developed originally by VDOT for the black shales project in Botetourt County, over 120 CY of the problematic ASS materials here were isolated, limed to 1.5 x their ABA and compacted into place in lined (10^{-5} cm/sec) above grade fills.

Exposure of intact ASS strata approximately 200 feet away from cut shown in last image.

Note the abrupt boundary, very bright “flame orange” colors and remnant of Cg horizon above.

This is not a typical redox feature pattern with depth!

These materials are commonly fine-textured, massive and perch local groundwater.

Revised Criteria & Field Methods

- **Category 3; Problematic subsurface materials (pH < 4.5 and/or NNP < -5; ~150 K CY) were isolated, bulk limed at 1.5 x NNP deficit, compacted in place (6 to 12" lifts) and isolated from infiltration and groundwater via a cap/liner.**

- **Separation of Category 3 in the field was based on:**
    1. **Geologic boring interpretation**
    2. **Field ID by color, ironstone, jarosite or other indicators**
    3. **In field "peroxide splash testing" by onsite supervisory engineer**
    4. **Rapid lab confirmation at VT when needed**

- **Total lime utilization was 2400 T CCE, much lower than the original VDOT criteria would have required. While not monitored rigorously, adverse water quality impacts have not been noted to date.**

- **However, exposed cut slopes with seepage continue to be "problematic"**


Active ASS will turn straw black with MnO_2 oxides in weeks.

Other Field Tests for ASS

- **30% H_2O_2 "Fizz Test"** – Can be highly predictive for reactive sulfides. Even materials with 0.2 to 0.3% sulfide can give a violent frothing reaction. Industrial reagent (not available to public) and must be handled with care (goggles/gloves, etc.).

Subject to potential "false positives" due to humus and Mn oxides which will also fizz to variable extent.

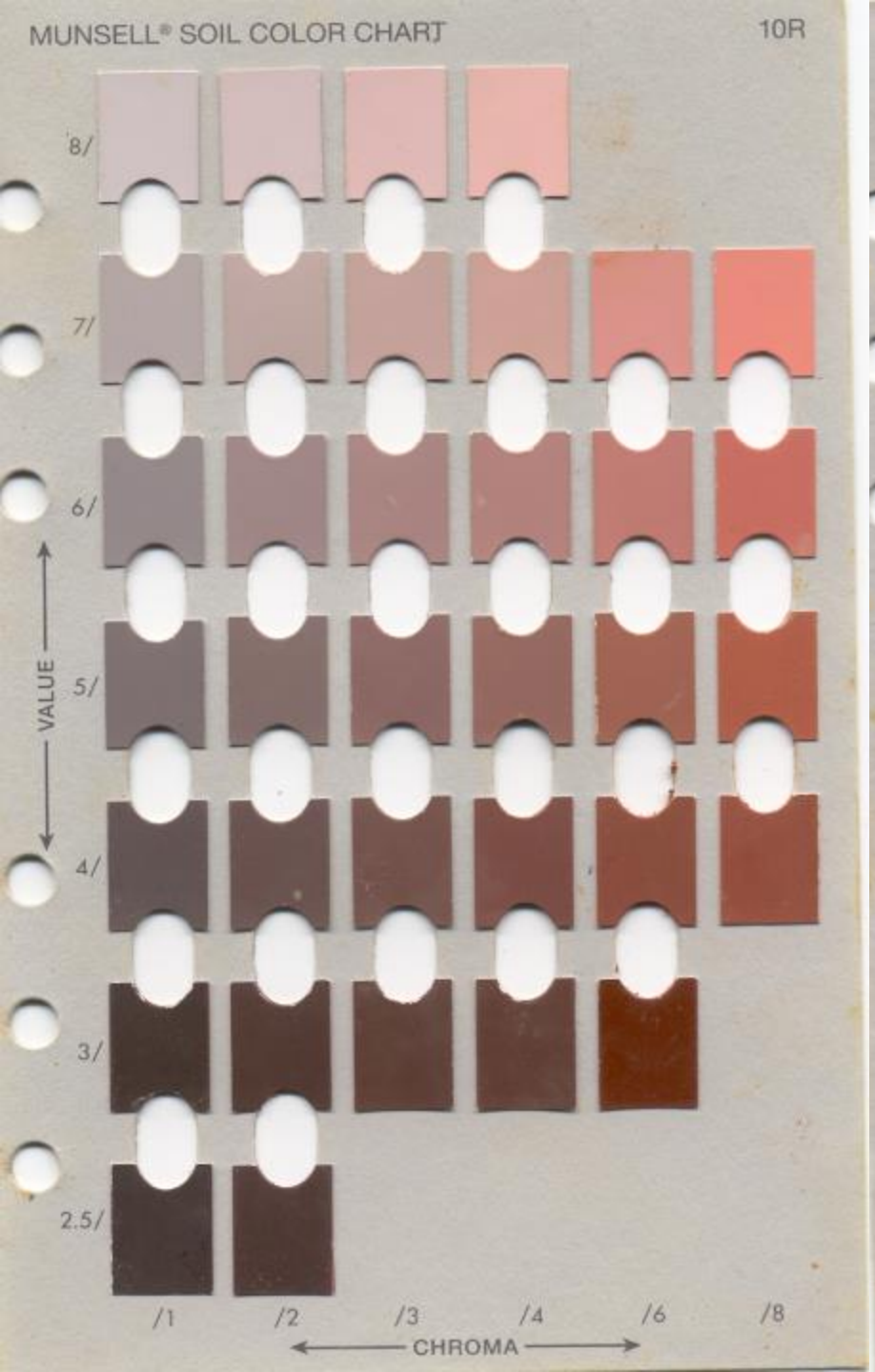
- **10% HCL "Fizz Test"** – Routinely used by geologists and soil scientists to test for reactive carbonates (neutralizers).

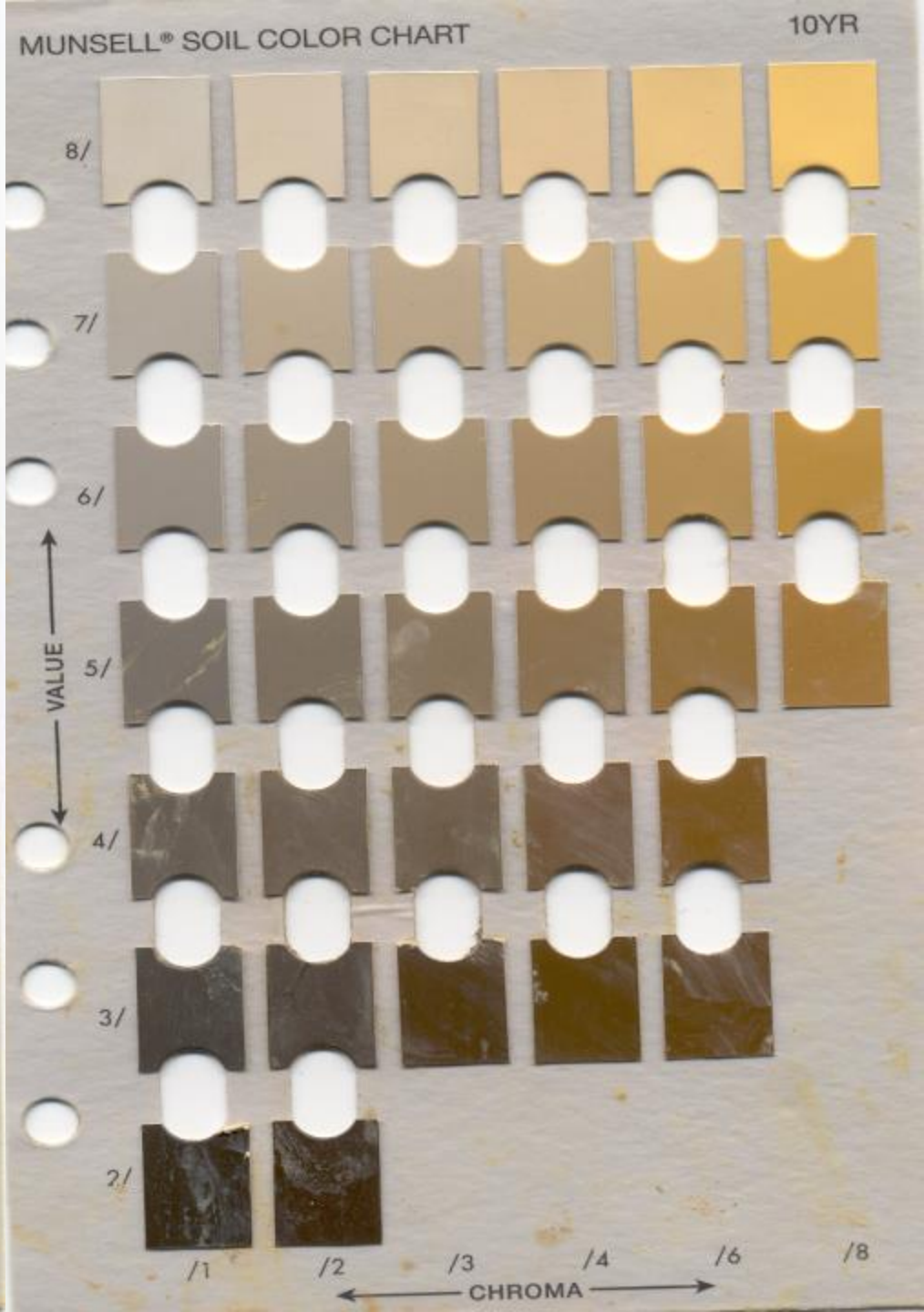
Del Fanning demonstrating the 30% peroxide fizz test at Stafford Airport for the 2013 International Acid Sulfate Soils field tour.

The “fizz test” can usually tell whether or not the material is “hot”, but cannot prescribe the necessary lime rate for remediation. You must run ABA for that.

Soil and/or Geologic Borings

- **Look at colors: Munsell color values > 3.5 with Chroma > 2.0 are unlikely to still contain significant sulfides. However, this assumes you are seeing a uniform color pattern.**
- **However, you'll need to train and cajole the boring tech to use a color book. Giving me a color description of "orangish gray" tells me little regarding the pattern/mottling etc.**
- **The contact between overlying oxidized materials and underlying reactive materials is often marked by bright red/orange "mottles", continuous bands or thin layers of "iron stone".**
- **Look for jarosite or other white salts**


MUNSELL® SOIL COLOR CHART
10R
8/
7/
6/
5/
4/
3/
2.5/
VALUE
/1
/2
/3
/4
/6
/8
CHROMA


MUNSELL® SOIL COLOR CHART
10YR
8/
7/
6/
5/
4/
3/
2/
VALUE
/1
/2
/3
/4
/6
/8
CHROMA

Typical abrupt contact between Plio/Pleistocence gravels and underlying Miocene ASS materials (Eastover fm). Fe-stone (ferricrete) often found at contact.

Cemented gravel/Fe-stone boulder in sand & gravel mine in Caroline County. Pleistocene gravel abruptly overlie dark gray ASS at this location at – 25 feet bgs.

Welcome to the Fall Zone!

Take a close look at the C.P. strata from L to R

Site-Specific Overall Results

- Total lime utilization was 2400 T CCE, much lower than the original VDOT criteria would have required. While not monitored rigorously, adverse water quality impacts have not been noted to date.

- All Category 3 material was isolated into two above grade fills with a 10-5 cm/s liner under/above and on the sides. All ASS was limed per the liming specification.

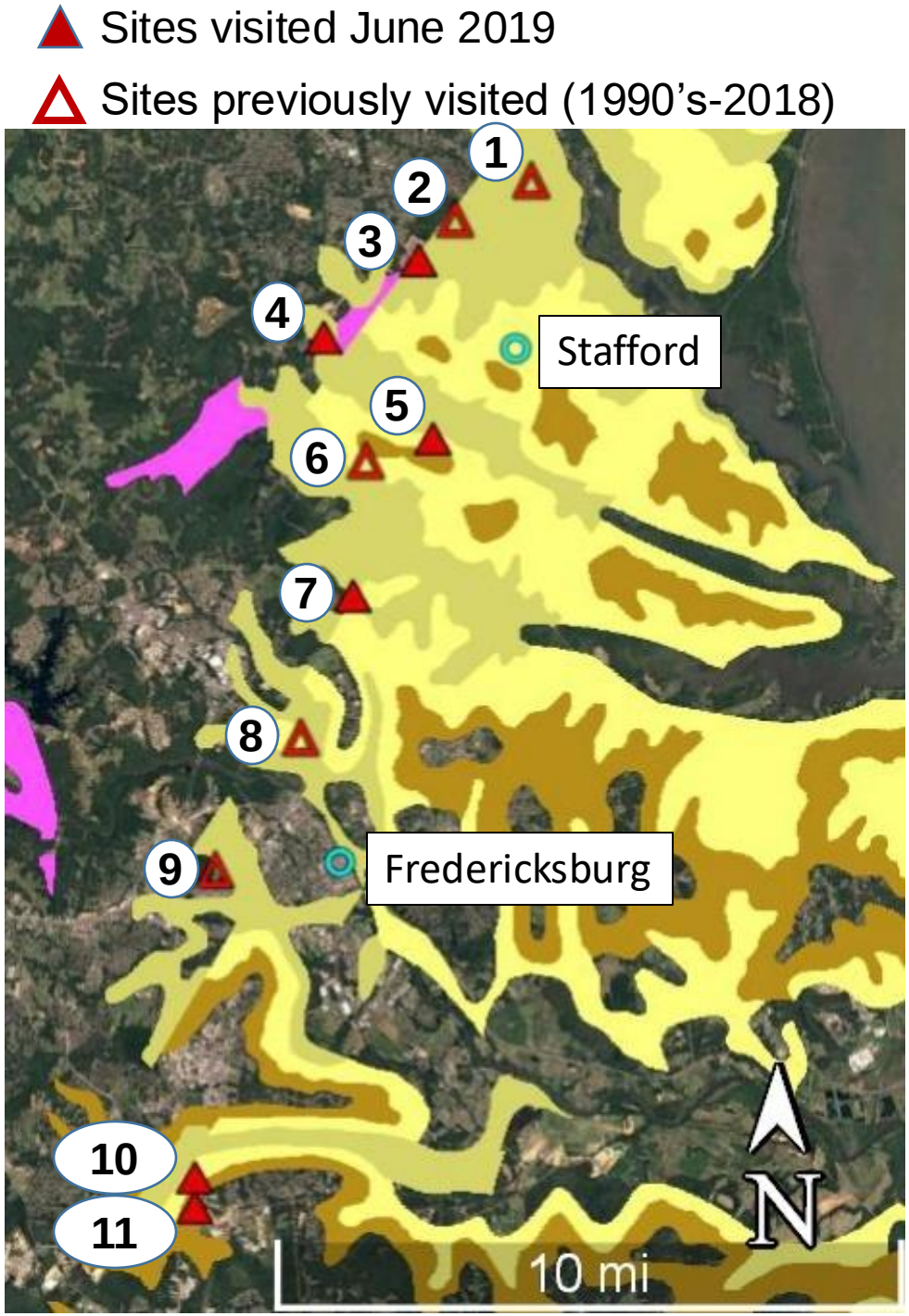
- However, exposed cut slopes with seepage continue to be "problematic".

Recent exposure of lower Chesapeake Group sediments at Stafford Airport. Note the "common symptoms".

In addition to dead plants, red water, blackened straw and white salts, if you find the following, "you're really in it":

Yellow jarosite mottles

Prominent S odor (burnt matches) on your fingers when the soil dries out.



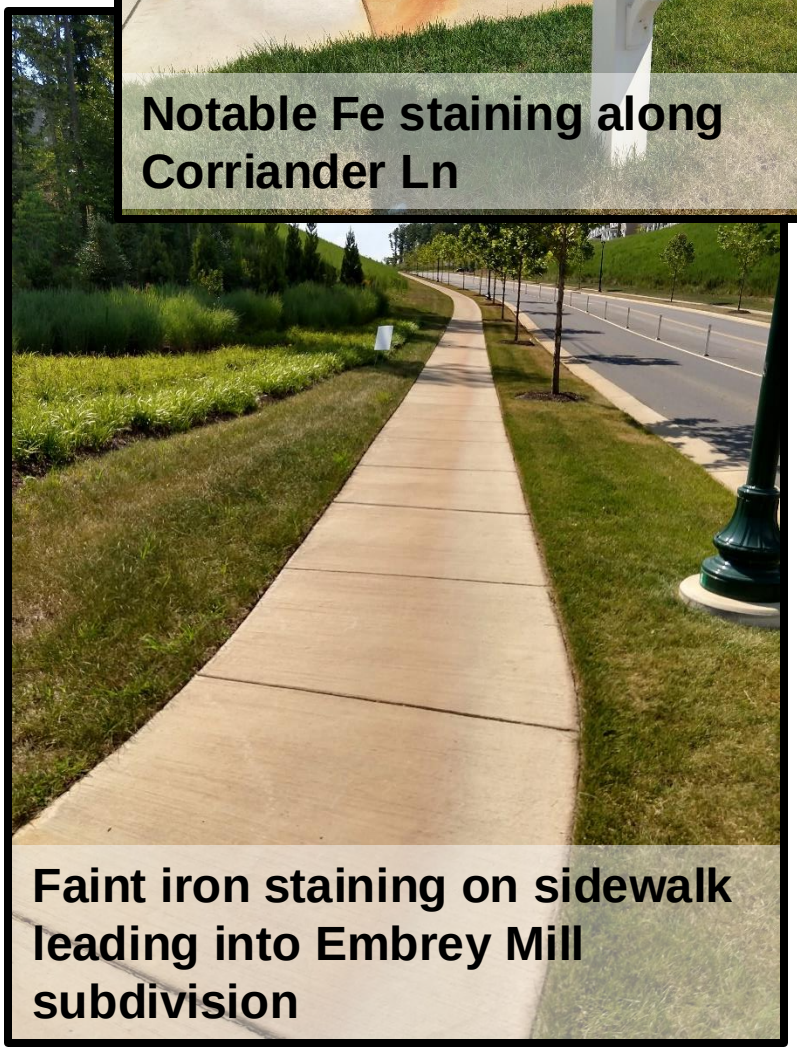
Representative Selection of acid sulfate soil sites

1. Aquia Town Center
2. Hampton Oaks
3. Embrey Mill
4. Courtyards at Colonial Forge
5. Ellison Estates (active acid sulfate soils not evident at time of visit)
6. Stafford airport
7. Spoil off Rt 1 (buried material; problems not evident at time of visit)
8. Carriage Hills (Chaps Lane)
9. Great Oaks
10. Southpoint Shopping Center
11. Cosner's Corner

Sulfide-bearing geologic formations associated with acid sulfate soil sites

- Chesapeake Group
- Lower Tertiary Deposits
- Potomac Formation
- Quantico Formation (slate)

Notable Fe staining along Corriander Ln

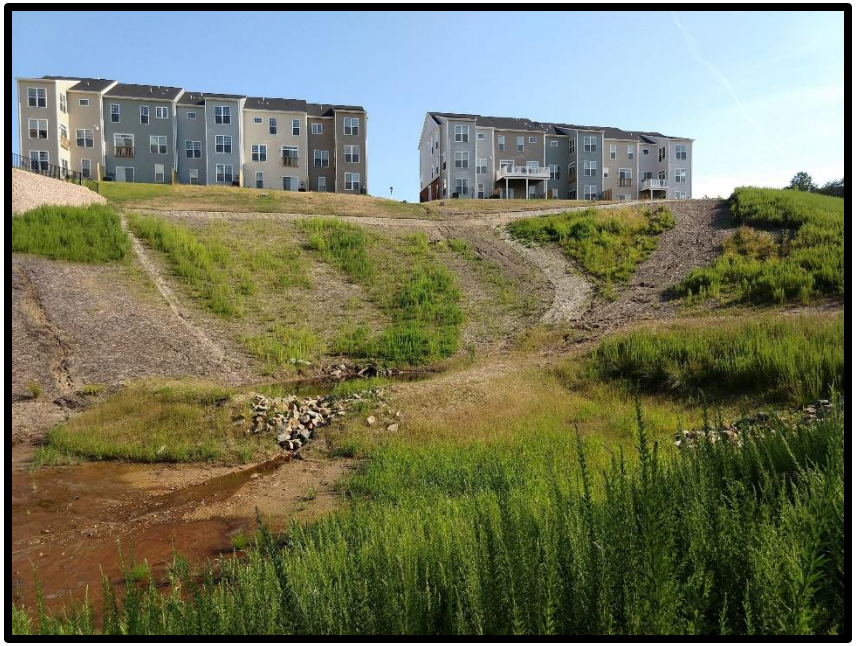


Faint iron staining on sidewalk leading into Embrey Mill subdivision

Dead sod behind 911 Corriander Ln

Material beneath sod (weathered Quantico slate)

Courtyards at Colonial Forge and associated stormwater pond



Google Earth image of site in 2017

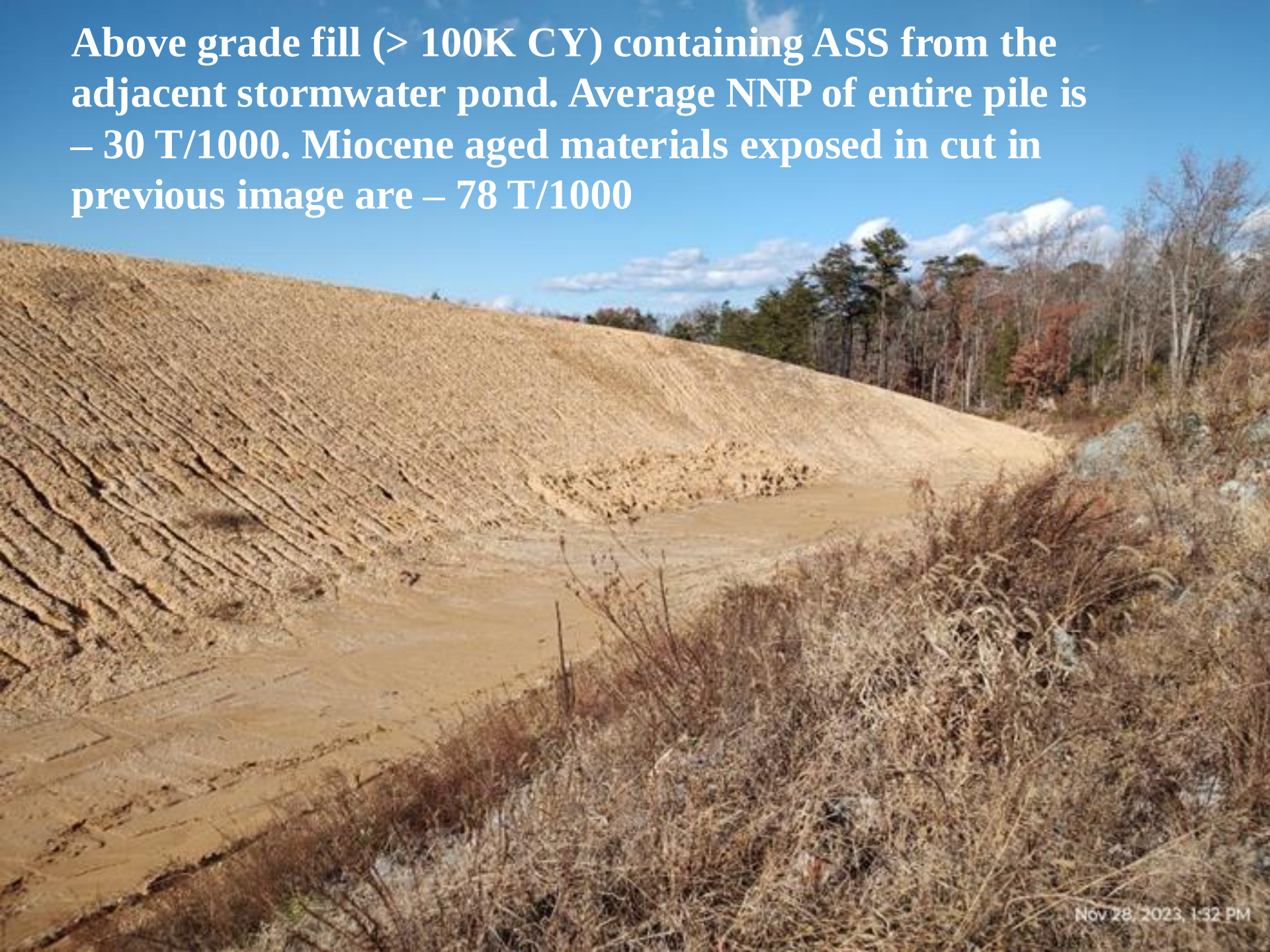
Cosner’s Corner

Southpoint Shopping Center (KBI music)


Stafford/Spotsy/F’burg Regional Landfill (R Board / 3). Dark material was “final soil cover” (not ADC) placed over the plastic liner in 2021.


Local Source of the “Topsoil”. Downhill stream and wetlands were adversely impacted.

Recently excavated SW basin in Spotsylvania County in Chesapeake Gp sediments.


Above grade fill (> 100K CY) containing ASS from the adjacent stormwater pond. Average NNP of entire pile is – 30 T/1000. Miocene aged materials exposed in cut in previous image are – 78 T/1000
Nov 28, 2023, 1:32 PM

Great Oaks Subdivision in Fredericksburg Virginia

Second round of sod placed over pH 2.5 soils at Great Oaks.


Stream draining
Great Oaks.

In the late summer of 2005 a homeowner in Fredericksburg contacted us…

… to find out how he could make his yard grow.

Similar to Stafford Airport we did a PPA test on his soil, which yielded values as high as 38 ton $CaCO_3$/ac. But you can't spread biosolids in a subdivision!

We recommended:

- **25 – 30 ton/ac lime**
- **300 lbs/ac P**
- **compost if possible**
- **topsoil was also applied**

Cost ~ $7000

Remediated yard, summer 2006

Neighbor's yard, Summer 2006

Sampling Protocol for "Risky Areas"

- **Run total S on all intact strata that are gray/dark and/or less than Value 4 and chroma 2.5 color. This test should also be run on any mixed fill/strongly variegated red/gray materials, even if brightly colored. Just request "total-S"; should be ~$15.**

- **Sample to determine changes in depth within a given strata. Also need to sort out lateral variability if multiple cores/locations are available.**

- **If total-S is > 0.20%, run potential acidity (ABA).**

Australian Government Initiative

WATER QUALITY AUSTRALIA

National Acid Sulfate Soils Guidance

National acid sulfate soils sampling and identification methods manual

June 2018

Remediation Alternatives

- Avoid it whenever possible!
- Remove and place it below the water table and/or an impermeable cap as soon as possible.
  - Don't leave ASS exposed more than several weeks
  - Add a lime coating to exposed surfaces immediately to retard onset of "fast reaction" when pH drops below 4.5.
  - Ensure that the fill will not receive oxygenated groundwater from upgradient; isolate it.
  - Simply placing it below a vegetated cap will not keep long-term acidic water from moving downgradient. *The bugs that do this work only need 1% O_2 p.p.*

Lime and Organic Amendments

- Hybrid approaches such as adding a “lime blanket” at 10 to 15 tons per acre beneath a returned topsoil layer (6 to 12”) can be quite effective at revegetation, but may not limit downslope acid discharge seeps.
- Beware of “voodoo juice” approaches involving anti-microbial agents, other “magic bugs” or particularly “liquid lime” recommended at gallons per acre vs. tons.
- Don’t let anyone tell you that your solution is the use of acid tolerant vegetation. Unless you want to grow *Phragmites sp*. and periodically flood your site, nothing else works.

Avoidance & Management Summary

- **Gray/reduced materials from documented moderate to high risk strata should be tested for total S. If over 0.20 %; run full ABA.**

- **Presence of an abrupt linear contact with either Fe-stone (ferricrete) or continuous bright red to flame orange colors above the contact is commonly a marker of ASS.**

- **The cost of remediation via liming/compost additions etc. can be > $10,000 per acre of exposure. VDOT often just rip-raps it.**

Avoidance & Management Summary

- **In addition to the color/morphological indicators, if you see jarosite or your fingers smell like burned matches when the soil dries, you're in it!**

- **Very few environmental professionals (beyond soil science) are even aware of this issue, but many are quickly finding out how expensive this is for their clients!**

- **If exposed to surface conditions, you are not going to stop the acidification process and associated toxic soil and water conditions.**

Management of Acid-Forming Sediments at the Stafford Airport Expansion Project in Virginia

W. Lee Daniels

VIRGINIA TECH

TerraScience LLC

School of Plant & Environmental Sciences

wdaniels@vt.edu; 540-231-7175

http://www.landrehab.org

Collaborators:

Steve Petersen & Dirk Myer; Talbert & Bright Engineers

Bill Griffith, DEA, Legacy Engineering