# Passive Treatment Systems on Life Support Pulling the Plug & Rebuilding

## Case Study

Boise Idaho: June 4th-7th, 2023

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# Overview

- Background
  - Aging Population of Passive Treatment Systems
  - Site Examples
- System Diagnostics / Evaluation
- Design Considerations
  - System Evaluation (water quality & flow)
  - New Technologies
  - Select Treatment Components
  - Existing Footprint Constraints
- Limestone Recovery & Reuse Potential
- Highlight 3 Rebuild/design Case Studies

# Background

- PTS Movement
  - Late 1990's & Early 2000's
  - Large fraction of 20 yr old systems - 'Geriatric'
- System Life Cycle
- Examples of Rebuilt Systems or Current Rebuild/design Projects
  - Puritan, Oven Run B, Richards, Ferris, SR114, SR81, Dream Mountain, Jennings, Maiden, Barkley Road, 3888, Big Run

# Diagnostics

- Site Maintenance History / Logs
  - Type, Frequency, & Result
- System Diagnostics
  - Water Quality & Flow (In and Out)
  - Bypass / Overflow
- Visual Inspection of Treatment Media
  - Test Pits
  - (system necropsy)

# Evaluation

- How is the System Performing?
  - Water Quality – Effluent
    - pH, Alk vs Acid
  - Actual Flow vs Design Flow

  - Any Structural Damage to Components
    - Pipes, Valves, Embankments, Spillways
  - Time Between Major Maintenance Events

Should you pull the plug?

# Design Considerations

- Inlet Water Quality & Quantity
  - Changes in Raw Water Quality?
  - Flow - H Flumes

- New Technology Considerations
  - Treatment Tech (Solar Powered Flushing)
  - Remote Monitoring (Flow, pH, Water Levels)

- Treatment Component Selection
  - Not Always the Same as Existing

# Design Considerations

- System Footprint
  - Space Constraints
  - Reconfigure, Expand, Combine, Add
  - Available Elevation
- Spent Media Placement / Disposal
  - Organics - Spread Onsite & Revegetate
- Sludge Cells

# Limestone Recovery & Reuse

- Site Specific
  - Potentially Thousands of Tons of Hi-Cal Limestone Already on Site
- Treatment Stone
  - Wash & Reuse – (Wash ~$5/Ton)
  - Flip Screen & Reuse – (Flip Screen ~$8/Ton)
- Recovery Rate
  - ~70% of Existing Stone (budget value)
  - Porosity & Fines

# Component Acronyms

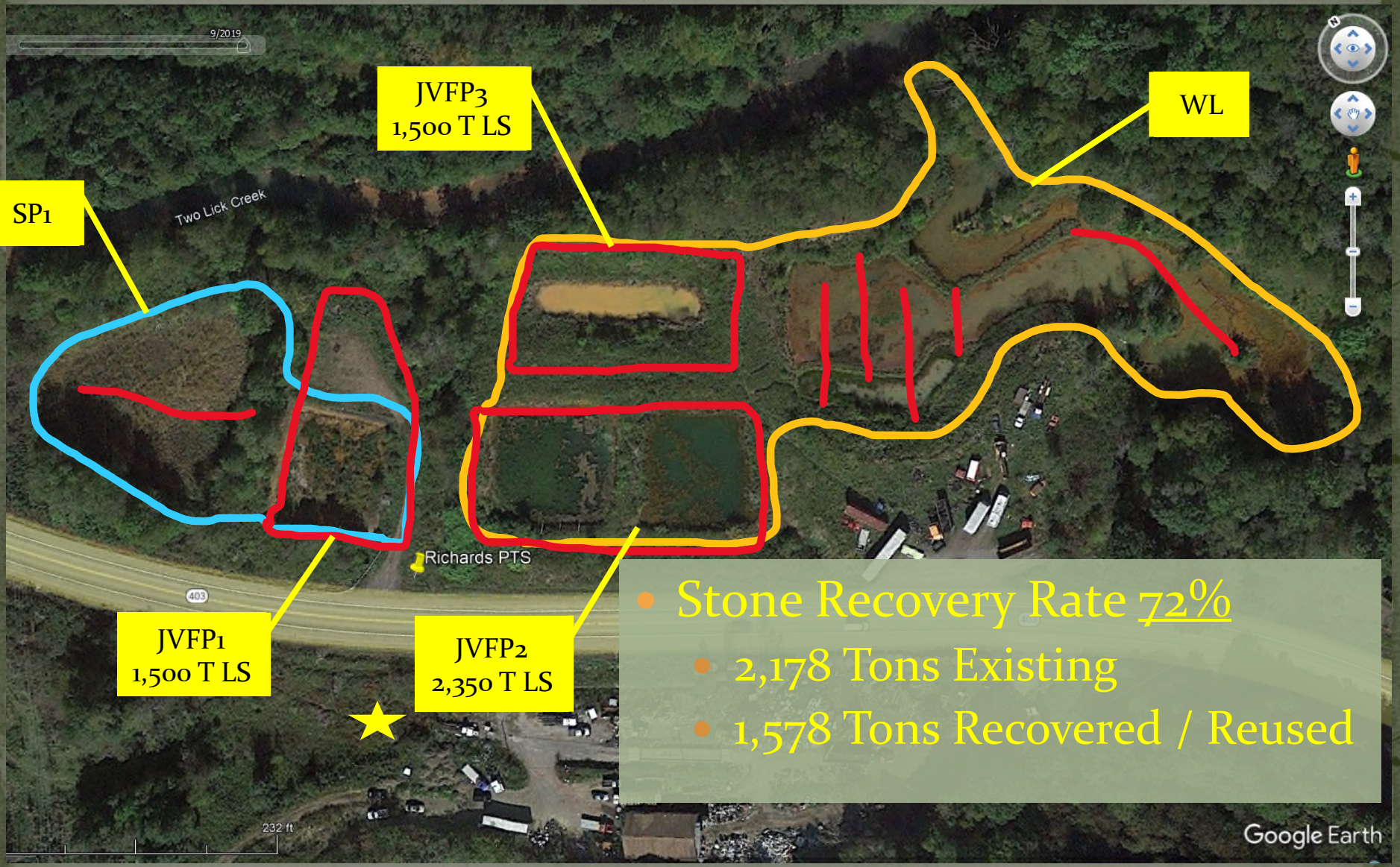
- Vertical Flow Reactor (VFR)
- Auto-Flushing Vertical Flow Pond (AFVFP)
- Settling Pond (SP)
- Jennings Vertical Flow Pond (JVFP)
- Wetland (WL)
- Successive Alkalinity-Producing System (SAPS)

Flow: Design ~300 gpm [Max 747 gpm | Avg 117 gpm]
pH: 2.5
Acid: 215 mg/L [Max 1,021 lb/d | Avg 166 lb/d]
TFe: 37 mg/L
TAl: 17 mg/L
TMn: 2 mg/L

# Case Study #1: Richards

- Pre Rebuild
  - Phase 1 [1999] – VFR1 (Layered) to Polishing Pond
  - Phase 2 [2001] – Added VFR2A & VFR2B (Layered), Sludge Pond, Wetland, & Collection System
- Maintenance History
  - Flow bypassing [2015]
  - Stir / Fluff Organics [2017]
  - Pulled the plug [2018]
- Rebuild [2020]
  - Reconfigure Collection (3-way flow splitter)
    - Capture upwelling in channel – route to WL
  - Expand system to have 3 Larger JVFPs (Mixed Media)
  - Improve both wetlands (directional barriers)

# Case Study #1: Richards




- Stone Recovery Rate 72%
  - 2,178 Tons Existing
  - 1,578 Tons Recovered / Reused

# Case Study #1: Richards

- 3 – Way Flow Splitter
  - 1 Water Level Reading (Staff Gauge)
  - 28% - 28% - 44%
    - 74° V Notch (x2) & 90 ° V Notch (x1)

Flow: Design 600 gpm, Avg 300 gpm
pH: 3
Acid: 114 mg/L (263 lb/d)
TFe: 6 mg/L
TAl: 12 mg/L
TMn: 1 mg/L

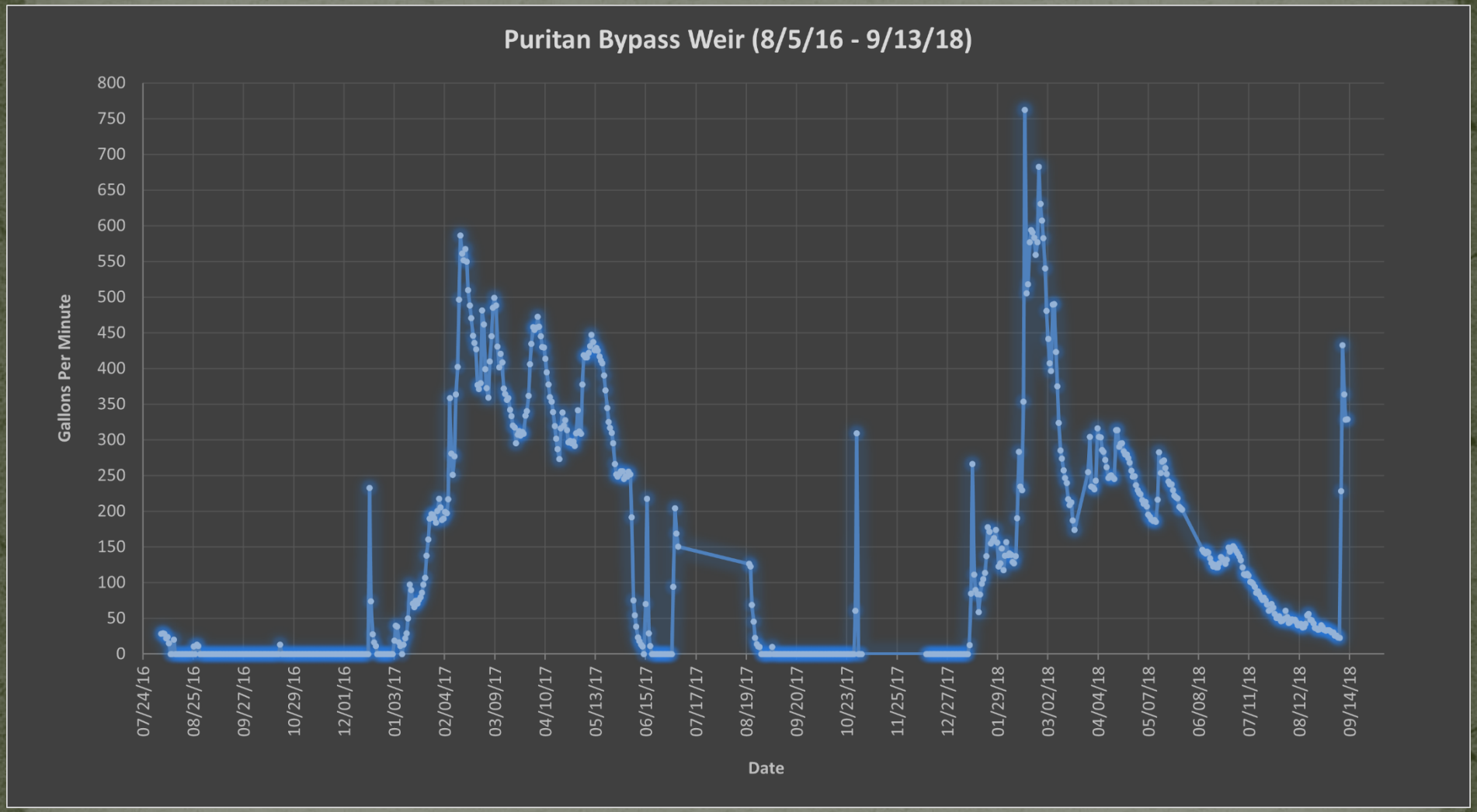
# Case Study #2: Puritan

- Pre Rebuild
  - FeAlMn Bed [2012] (single component)

- Ex. System was too Small
  - Flows were restricted/ bypass at the collection point
    - Only ~100gpm to system

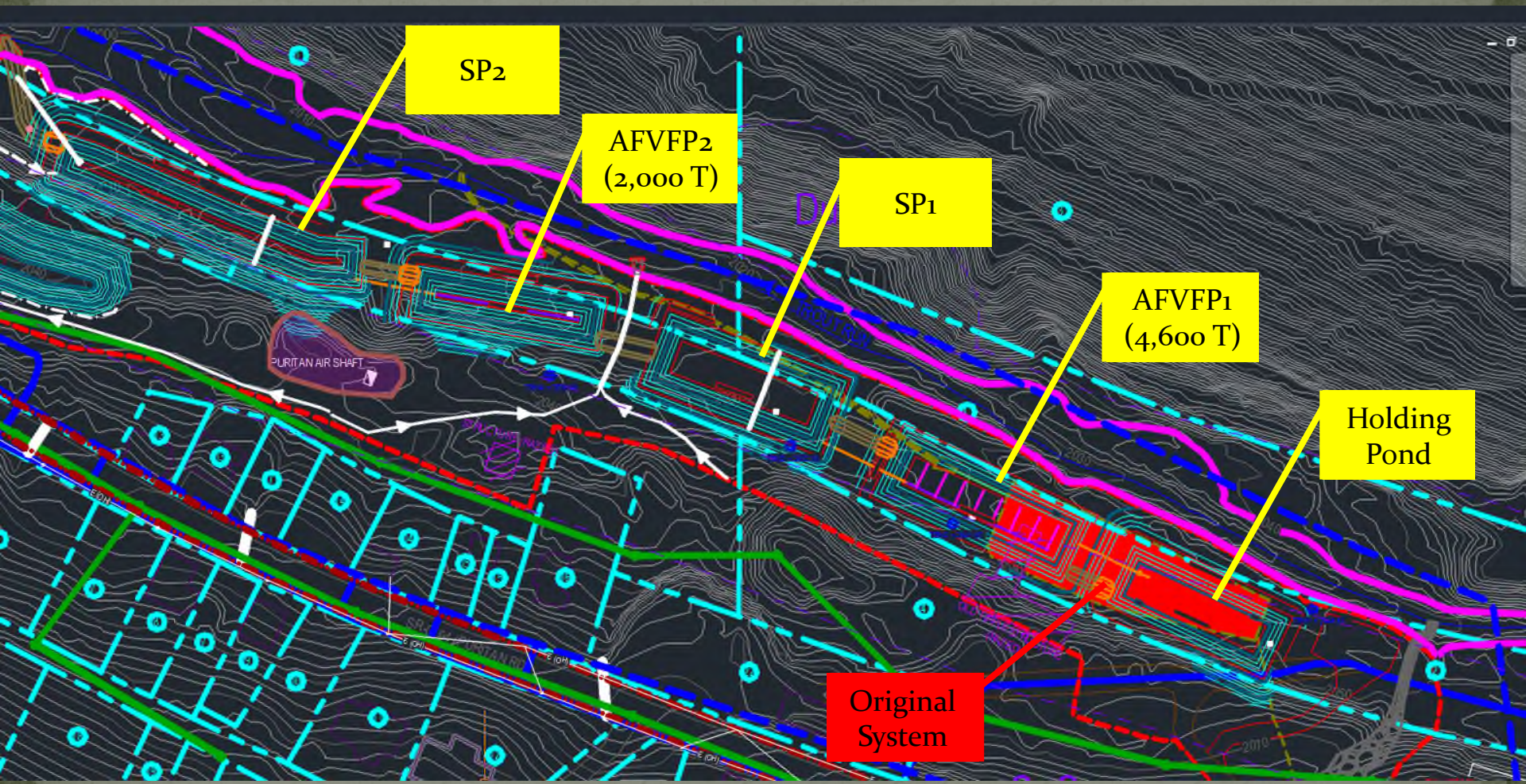
- Rebuild [2020]
  - BOLTS (Batch Operating Limestone Treatment System)
  - H-Flume
  - Holding Pond – AFVFP1, SP1, AFVFP2, SP2

# Case Study #2: Puritan




- Graph Depicts Daily Avg Overflow to Trout Run
- Max Recorded Flow 1,599 gpm

# Case Study #2: Puritan



# Case Study #2: Puritan

- Stone Recovery & Reuse
  - Reused 2,907T / Purchased 3,693T
- Stone Recovery Rate 71%
  - 4,087 Tons Existing
  - 2,907 Tons Recovered / Reused
- Utilize Solar Power & Master/Slave Radio Communication for Controls
  - (Stand Alone Units - No Telemetry Currently Used)


# Is It Really Broken?

| Site | Date | Point | Flow gpm | pH | Acid mg/L | Fe mg/L | Mn mg/L | Al mg/L | Acid Load lb/d |
|---|---|---|---|---|---|---|---|---|---|
| **Puritan** | 9/15/20 | Raw | 97 | 3.5 | 81 | 16 | 1 | 4 | 94 |
| | 9/15/20 | Treated | 97 | 8.1 | -100 | <1 | <1 | <1 | -116 |
| | 05/18/23 | Raw | 260 | 3.0 | 520 | 27 | 2 | 19 | 1,625 |
| | 05/18/23 | Treated | 260 | 4.5 | 260 | 7 | 2 | 13 | 814 |
| Current Acid Load Reduction = 811 lb/d<br>Design Acid Load Reduction = 822 lb/d | | | | | | | | | |

- System is Performing at Design Acid Load Capacity
- Max Acid Concentration | Load prior to system construction was (150 mg/L | 234lb/d)

Flow: Design 367 gpm, Avg 158 gpm
pH: 2.8
Acid: 320 mg/L [Max 2,467 lb/d | Avg 533 lb/d]
TFe: 28 mg/L
TAl: 25 mg/L
TMn: 11 mg/L

# Case Study #3: Oven Run B

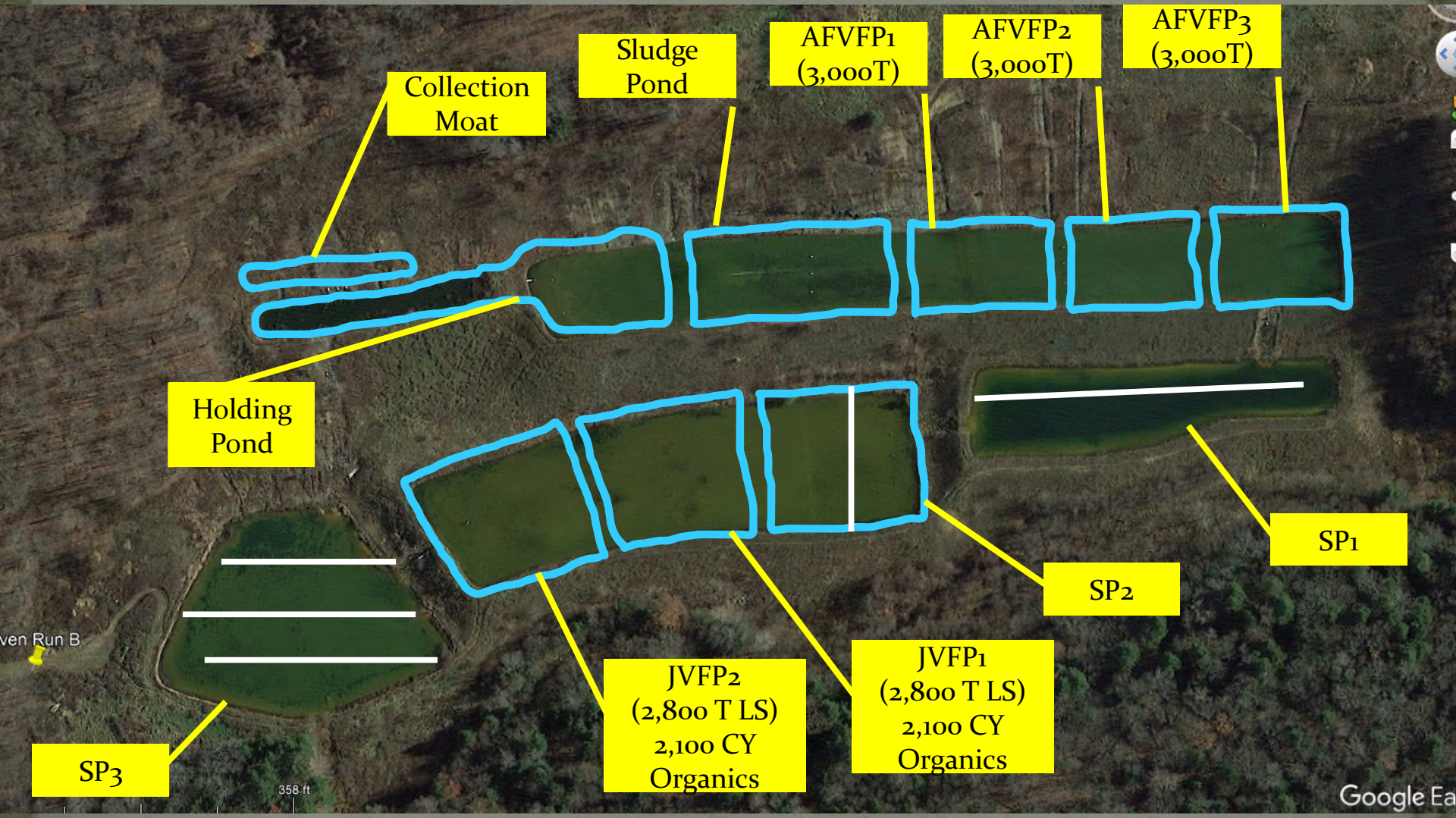
- Pre Rebuild [1999]
  - Collection Pond – SAPS1 – SP1 – SAPS2 – SP2
- Rarity = Failure From Being too LARGE
  - Surface Areas: SAPS1 = 1.98 Ac
    SAPS2 = 1.85 Ac
- Rebuild [2022]
  - Collection Moat – H Flume – Holding Pond – Sludge Pond - 3 AFVFPs – SP1 – SP2 – JVFP1 – JVFP2 – SP3

# Case Study #3: Oven Run B

- 3 Staggered AFVFPs (Parallel)
  - 3,000 Tons LS Each
  - Adjustable Hold times (12-hour)
    - Fill on 8hr Staggered Offset
- 2 JVFPs (Parallel)
  - 2,800 Tons LS Each

- Stone Recovery Rate 82%
  - 19,886 Tons Existing
  - 16,257 Tons Recovered
    Reused

# Case Study #3: Oven Run B




Redesigned Site Configuration (14,600 Ton LS)

# Case Study #3: Oven Run B

# The Results of Rebuilding

| Site | Point | Flow gpm | pH | Acid mg/L | Fe mg/L | Mn mg/L | Al mg/L | Acid Load lb/d |
|---|---|---|---|---|---|---|---|---|
| **Oven Run B** | Raw | 315 | 2.9 | 582 | 21 | 8 | 21 | 2,160 |
| | Treated | 315 | 6.8 | -53 | <1 | 2 | <1 | -294 |
| **Puritan** | Raw | 97 | 3.5 | 81 | 16 | 1 | 4 | 94 |
| | Treated | 97 | 8.1 | -100 | <1 | <1 | <1 | -116 |
| **Richards** | Raw | 143 | 3.2 | 158 | 18 | 2 | 16 | 272 |
| | Treated | 143 | 6.9 | -96 | 9* | 2 | <1 | -165 |

Oven Run B 5/11/23, Puritan 9/15/20, Richards 12/17/21 *Fe contribution from post VFP1/2 source

# Conclusions

- Monitoring or Snap-Shots of systems throughout the design life helps aid in end-of-life decisions

- Pulling the Plug for Redesign
  - Knowing When to Make the Call
    - Maximize existing resources
    - Timing – Grant Funding etc
  - Redesign to Improve
    - Performance (Change) – Maintenance - Monitoring

- Limestone Reuse & Recovery
  - Recovery Rate 70%
  - Porosity – Void Volumes

# Questions

## Thank You & Acknowledgements

PA DEP BAMR
Trout Run Watershed Association (Dennis Beck)
Blacklick Creek Watershed Association (Dennis Remy)
Stream Restoration Incorporated
Earth Shapers, LLC (Contractor)
BioMost, Inc.
Stonycreek-Conemaugh River Improvement Project (SCRIP)
Somerset County Conservancy
Iron Horse Salvage
Landowners