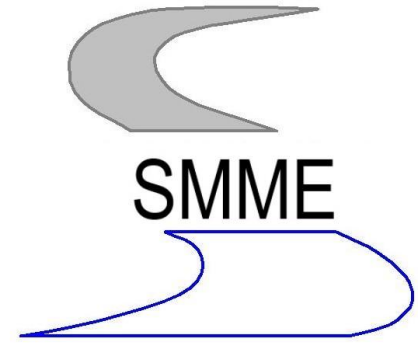




NEW REMEDIATION TECHNOLOGIES AND NATURAL-BASED SITE CLEAN-UP

September 23, 2025; 3:30 PM to 5:00 PM

Section 3B; Room 111B

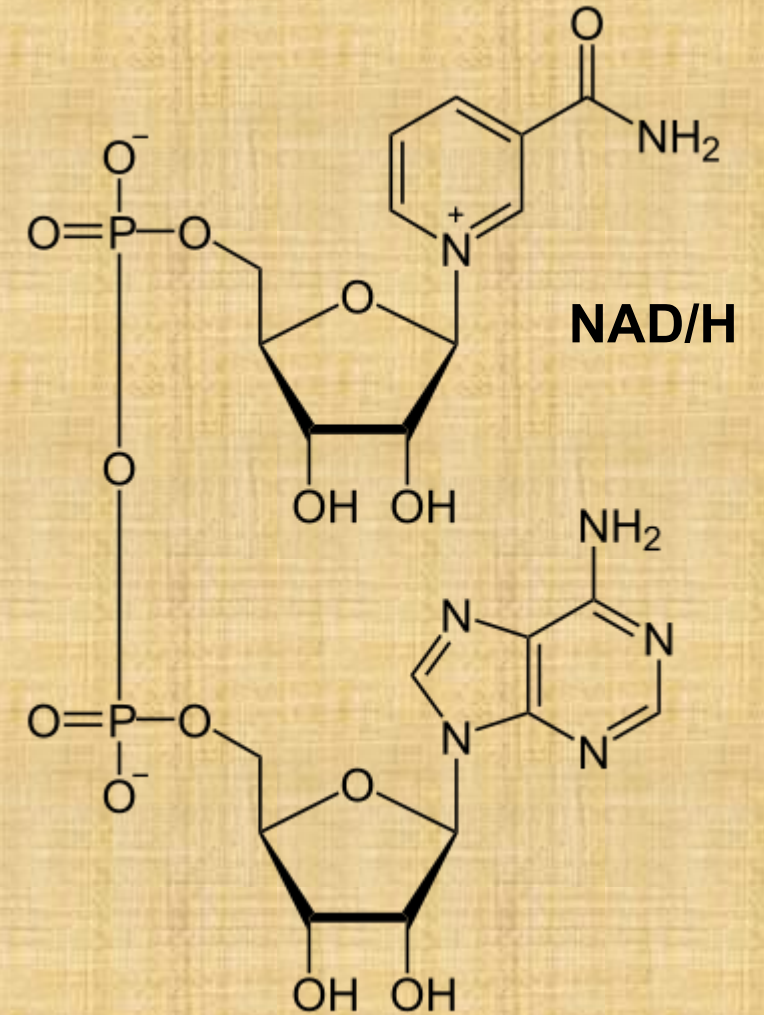
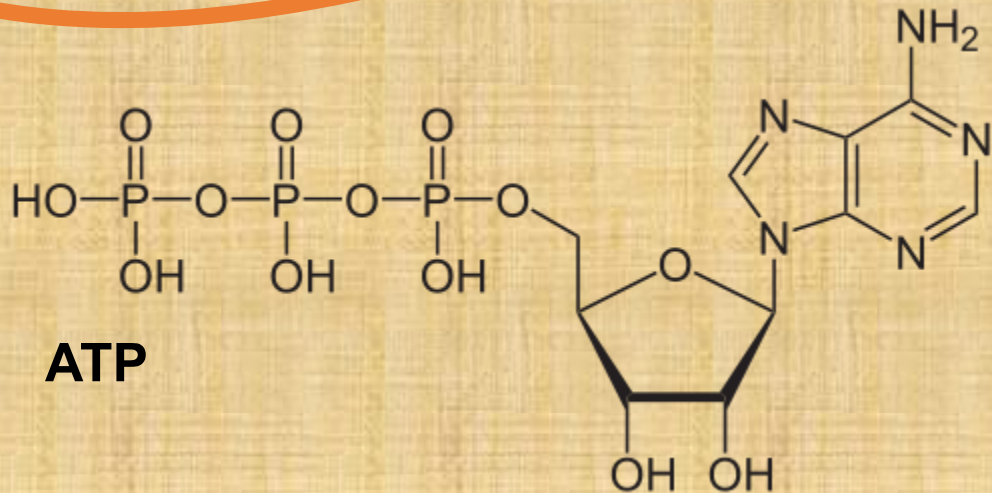


Richard B. Smith

Vice-President and Principal Engineer

Smith Monitoring & Maintenance Engineering, Inc. (SMME)

Nutrient Enhanced Biological Stimulation N.E.B.S.



Presented by:

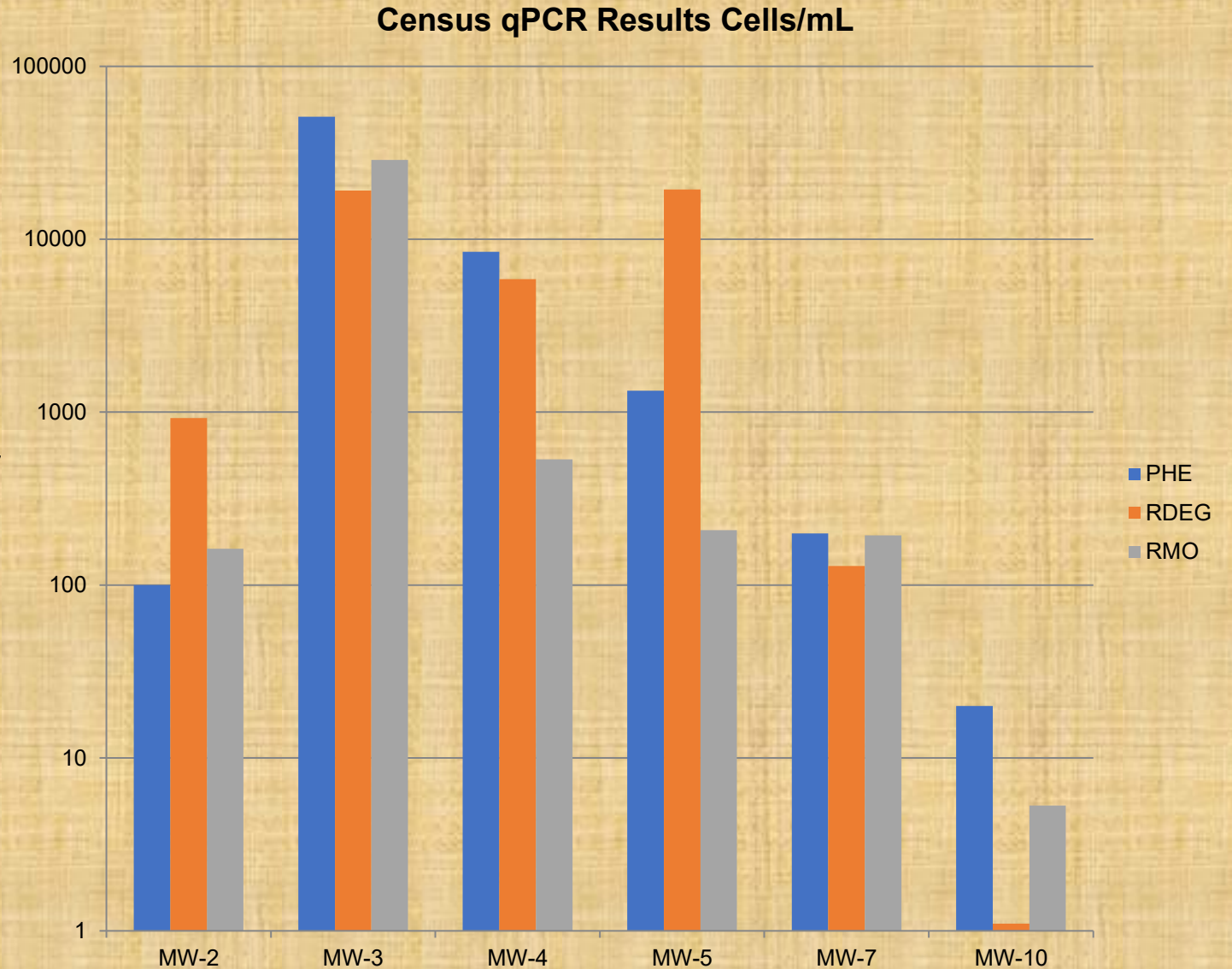
Richard Smith, PE, SMME, Inc.

N.E.B.S. Process Overview

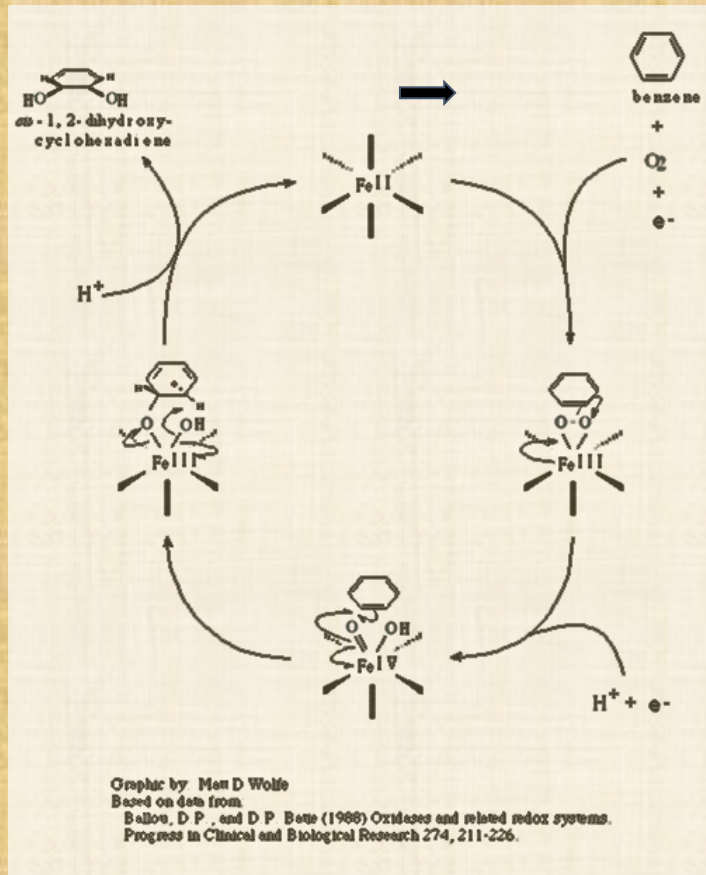
- First stage includes nutrient injection to stimulate indigenous bacteria cell division and metabolism.
- Independently controlled, pulsed air sparge. Flows from 0.5 to 2.0 cfm per injector.
- PLC controlled dosage:
 - Air/Oxygen
 - Nitrous Oxide
 - Orthophosphate
 - Methane/Propane/Butane

Building a Population

- Bacteria Nutrient Molar Ratio: $C_{64}N_{13}P$
- Addition of Nitrous Oxide and OP slow dose/low dose.
- Establish Cell Counts of more than 10^6 cells/mL.
- Build Aerobic Population until Respiration Rates are Maximized. Establish an Oxygen Demand.
- Cease nutrient addition when active sparge zone $DO \approx 2$ mg/L.



Support of Aerobic Respiration



- $2C_6H_6 + 15O_2 \Rightarrow 12CO_2 + 6H_2O + DG$
- More Oxygen Creates H_2CO_3 .
- Average Delivery of 120-150 Pounds of O_2 per Month per Well (based on 10' submergence).
- Design Treatment Rate of 5 # O_2 / # TPH.

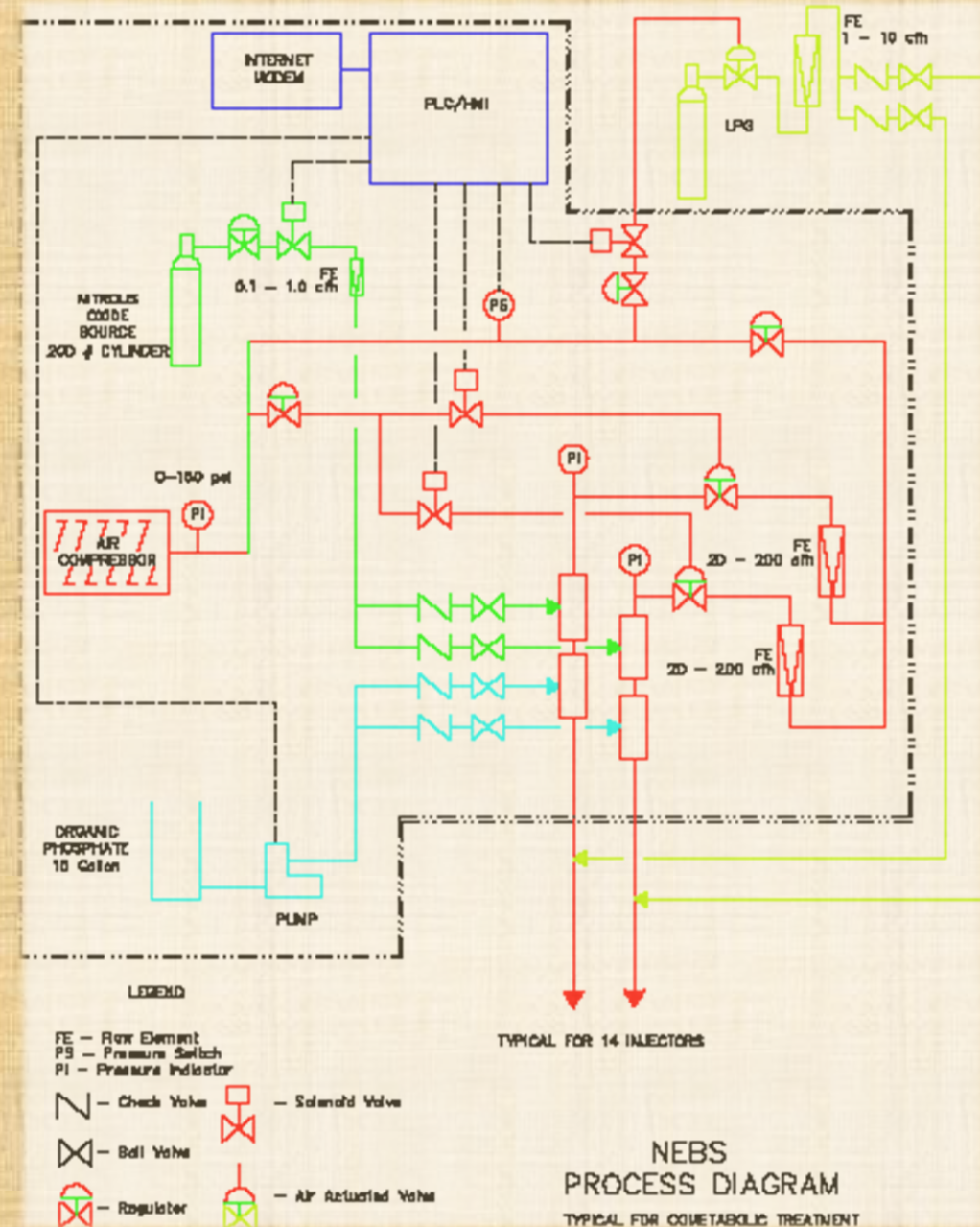
P&ID

PLC Controlled.

Independent gas flow regulation.

Isolatable nutrient and co-metabolite delivery.

Cellular/Internet comm.
to/from HMI/auto-dialer.



HMI Example

NEBS

System Hours

SV Control

Nutrient Control

Designed and Constructed by SMME, Inc.

Site Map

System Hours

0

LOW PRESSURE RUN

Compressor

0

SV - 1

0

SV - 4

0

SV - 2

0

SV - 5

0

SV - 3

0

SV - 6

0

Sparge Valve Control

(Input seconds)

SV - 1

OFF

ON

0

OFF

0

SV - 2

OFF

ON

0

OFF

0

SV - 3

OFF

ON

0

OFF

0

SV - 4

OFF

ON

0

OFF

0

SV - 5

OFF

ON

0

OFF

0

SV - 6

OFF

ON

0

OFF

0

Nutrient Control

PHOS. PUMP

OFF

N2O VALVE

OFF

PHOS. Pump Prime

OFF

N2O FLOW CHECK

OFF

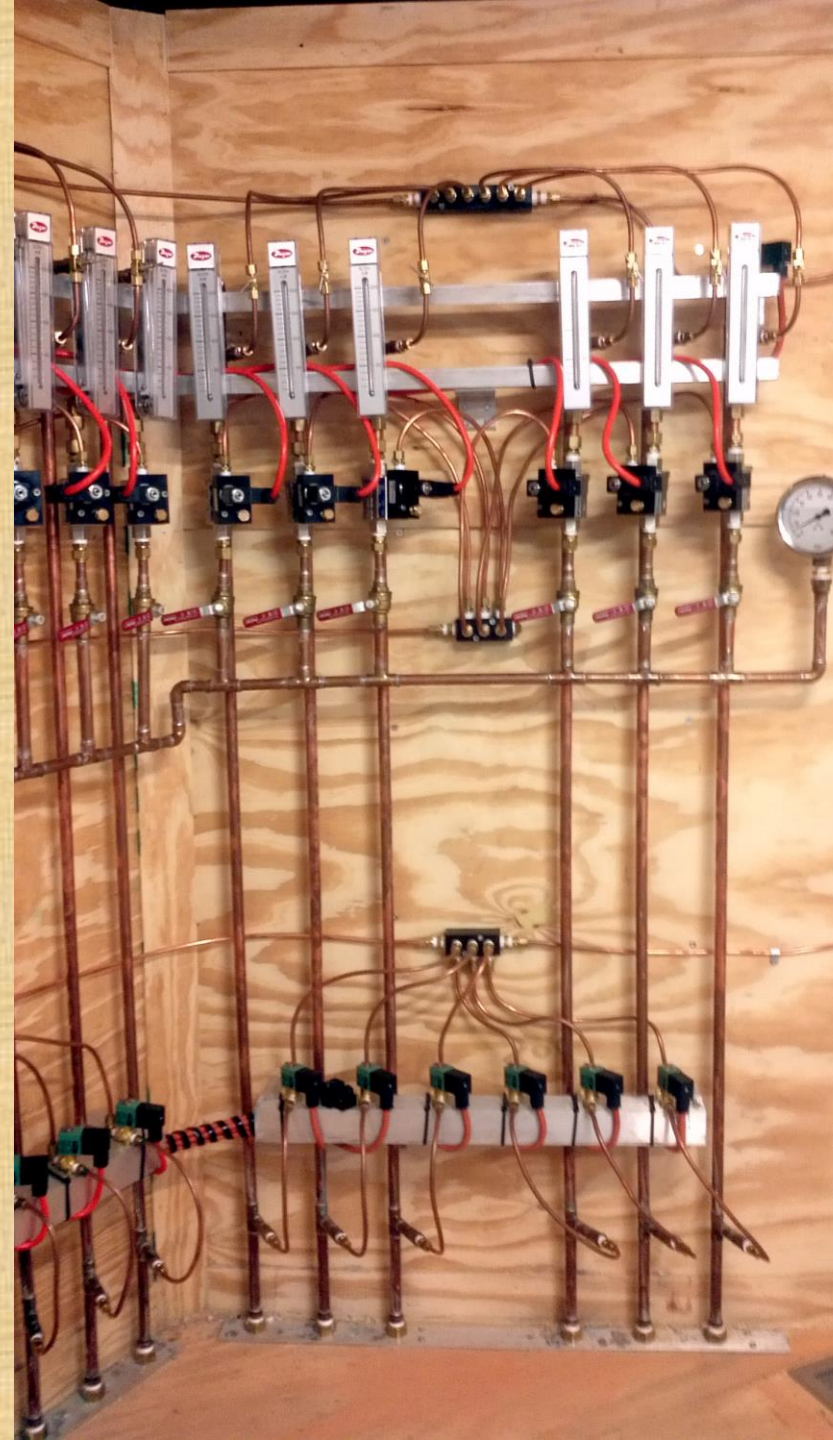
Process Control Testing

- Recommend monthly field analysis of DO, pH and nutrients for process control.
- Can include qPCR to confirm target bacteria populations are forming.
- Thermal profiling in areas of significant soil impact.



Sustained High-Rate Natural Attenuation

- NEBS is the application of activated sludge concepts to soil and groundwater treatment.
- Advances bioremediation from a polishing process to a replacement of physical removal processes (MPE, SVE) and chemical oxidation, at a fraction of the cost.
- Many sites start with measurable product or product forming conditions.
- So far, the “hottest” site contained at least 14,000 pounds as TPH.
- Soil conditions range from fractured rock (shallow limestone in North AL/PA) to highly plastic clay (Yazoo Clay in Miss.)





Since adopting a revised system design in 2013 we have an 91% closure rate.

SMME, Inc.

www.Bioremediationsmme.com

(404) 229-3096

rick@smmeinc.com

riley@smmeinc.com

