Remedial Action

Remedial Action

- Remediation Overview – Jim Russell, P.E.
- RAC Purchase Orders – James Treadwell, P.E.
- Tips for RAC Purchase Orders – Chuck Williams, FCCM
- Source Removal Purchase Orders – Natalie Monteiro, P.E. and Tamara Blyden
- Tips or SR Purchase Orders – Chuck Williams, FCCM
- PARM/NAM – John Wright, P.E.
- System Performance – John Wright, P.E.

- Remediation Overview
- Technologies and Equipment

2019 Petroleum Restoration Program Meeting

- James B. Russell, P.E.
- Engineer III
- Orange County
- Environmental Protection Division (OCEPD)

How do we clean it up?

- Types of Soil Clean-up
- Types of Groundwater Clean-up

- There are multiple technologies available to remediate a contaminated site
    - *In-situ – in place
    - *Ex-situ – out of place/on site or off site

Soil

- Stabilization
  - Encapsulation/Fixation
  - Vitrification
- Excavation
  - Conventional
  - LDA
- Vapor Extraction

Soil

- Bioremediation
  - Blending
  - Biopiles
  - Landfarm
- Chemical Oxidation
  - Direct Injection
  - Blending

Groundwater

- Air Sparge
- Pump and Treat
- Dual Phase
- Multi Phase
- Bioremediation
- Chemical Oxidation
- Thermal

Stabilization

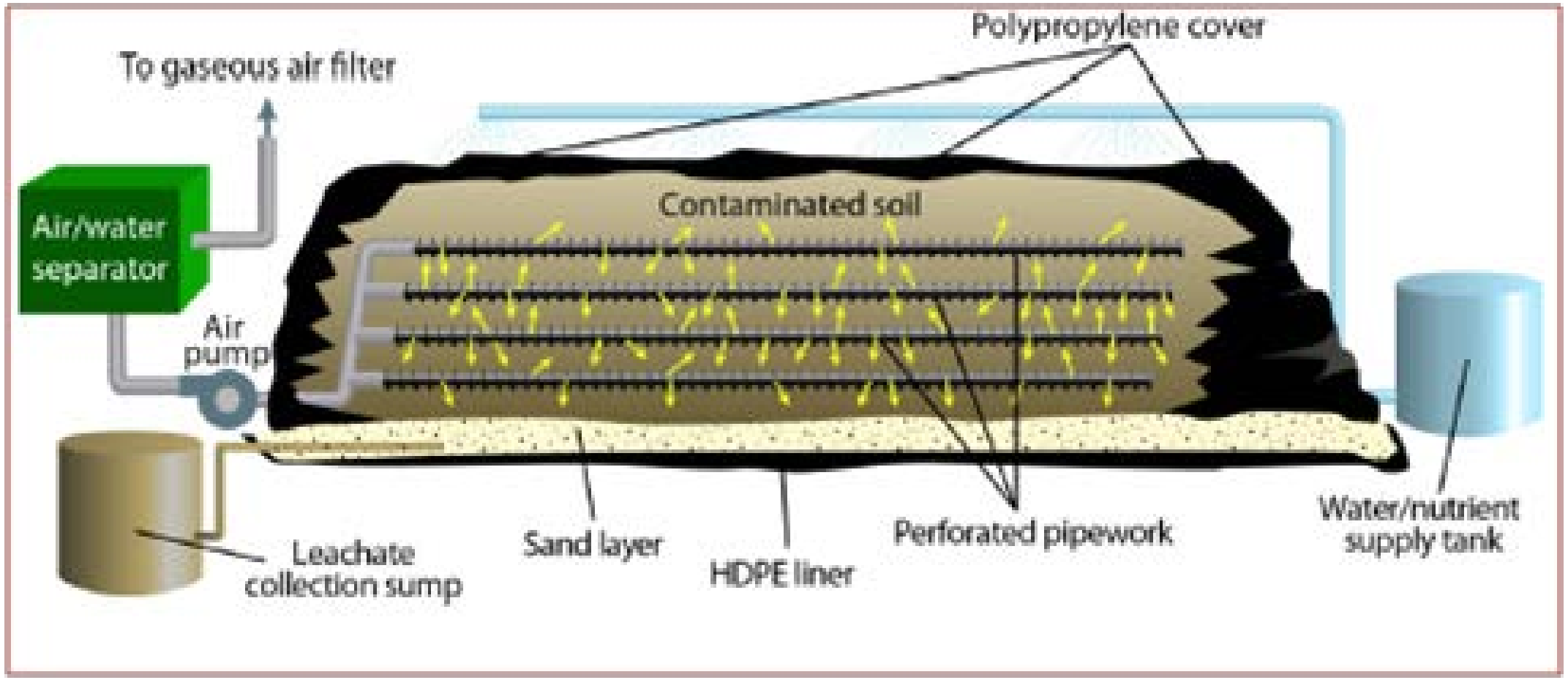
- Encapsulation/Fixation
  - Slurry Wall
    - Trenched
    - Cast
  - Polymer/Cement
    - Blending
    - Direct Injection
- Vitrification
  - High Heat and Energy

Slurry Walls

Slurry Walls

Blending

Biopile


Polypropylene cover
To gaseous air filter
Air/water separator
Contaminated soil
Air pump
Water/nutrient supply tank
Leachate collection sump
Sand layer
HDPE liner
Perforated pipework

Landfarming

Vitrification

Photo provided by Georgia Tech Research Institute.

Cross section of a vitrified monolith from the Savannah River Site demonstration.

Excavation

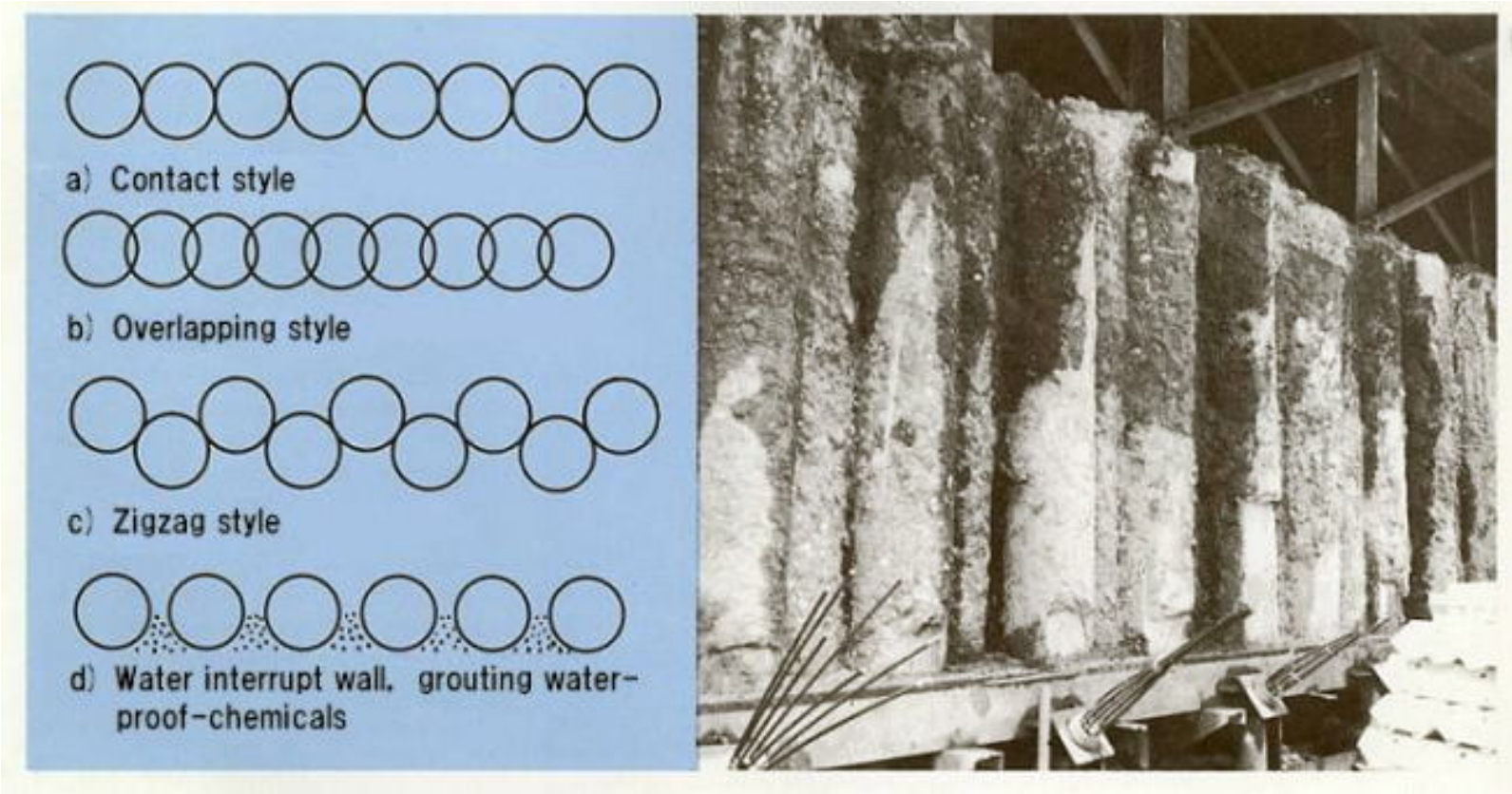
- Conventional
  - With Shoring
    - Sheet Pile
      - Unbraced
      - Braced
    - LDA
  - Without Shoring
    - Side Slopes (OSHA)
      - Soil Type

Excavation

- With Dewatering
  - Ingress/Egress

Excavation

- LDA
  - Overlap
  - As Chambers



LDA with Casing

Air Sparge/Soil Vapor Extraction

- Most Commonly Used Technology
- Best In Sandy Lithology

Key Design Parameters:

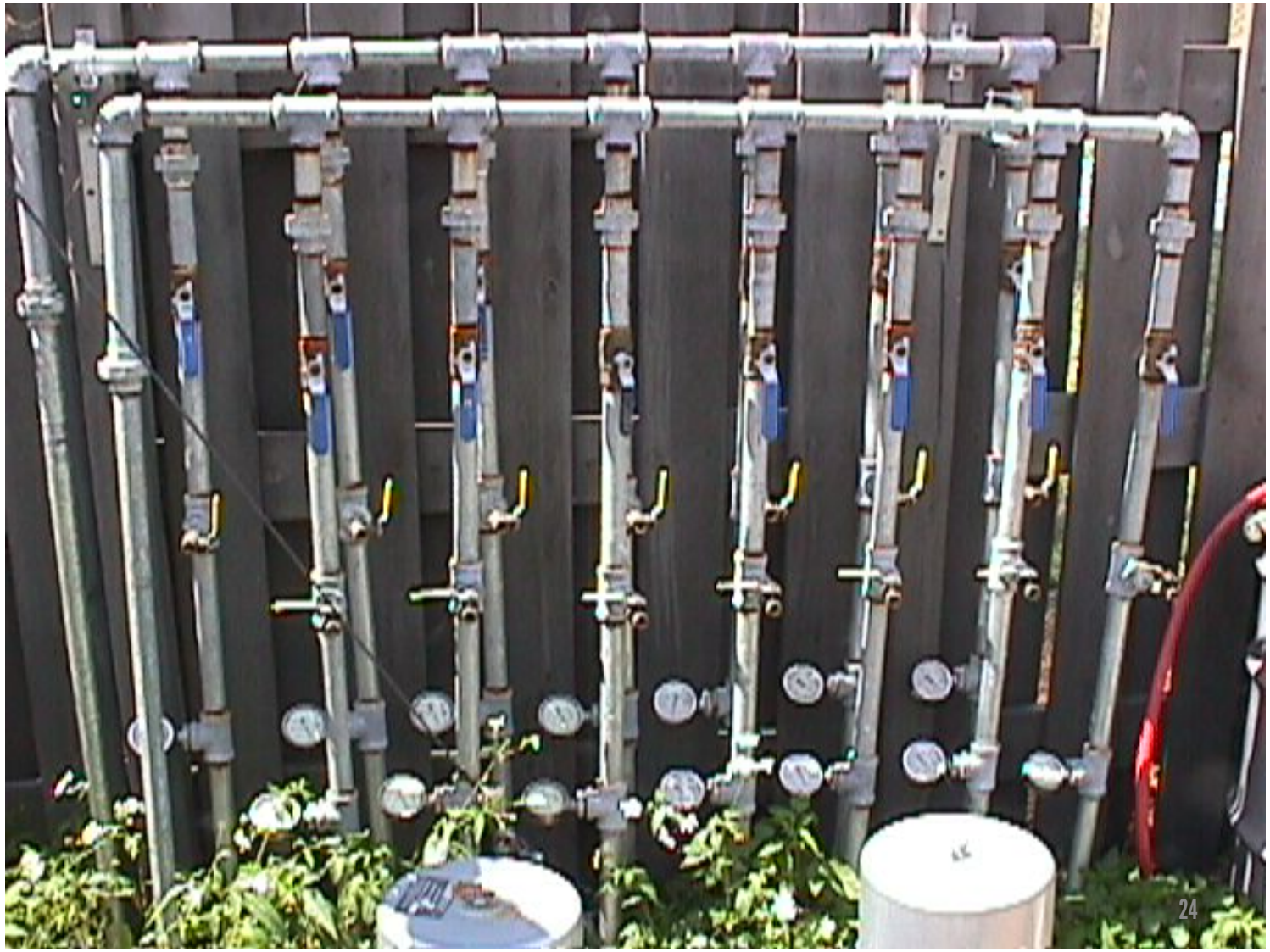
- Well Depth/Screen Interval
- Well Spacing
- Radius of Influence (ROI)
- Overlap
- Air Flow: Volume and Pressure

What's the Air Flow?

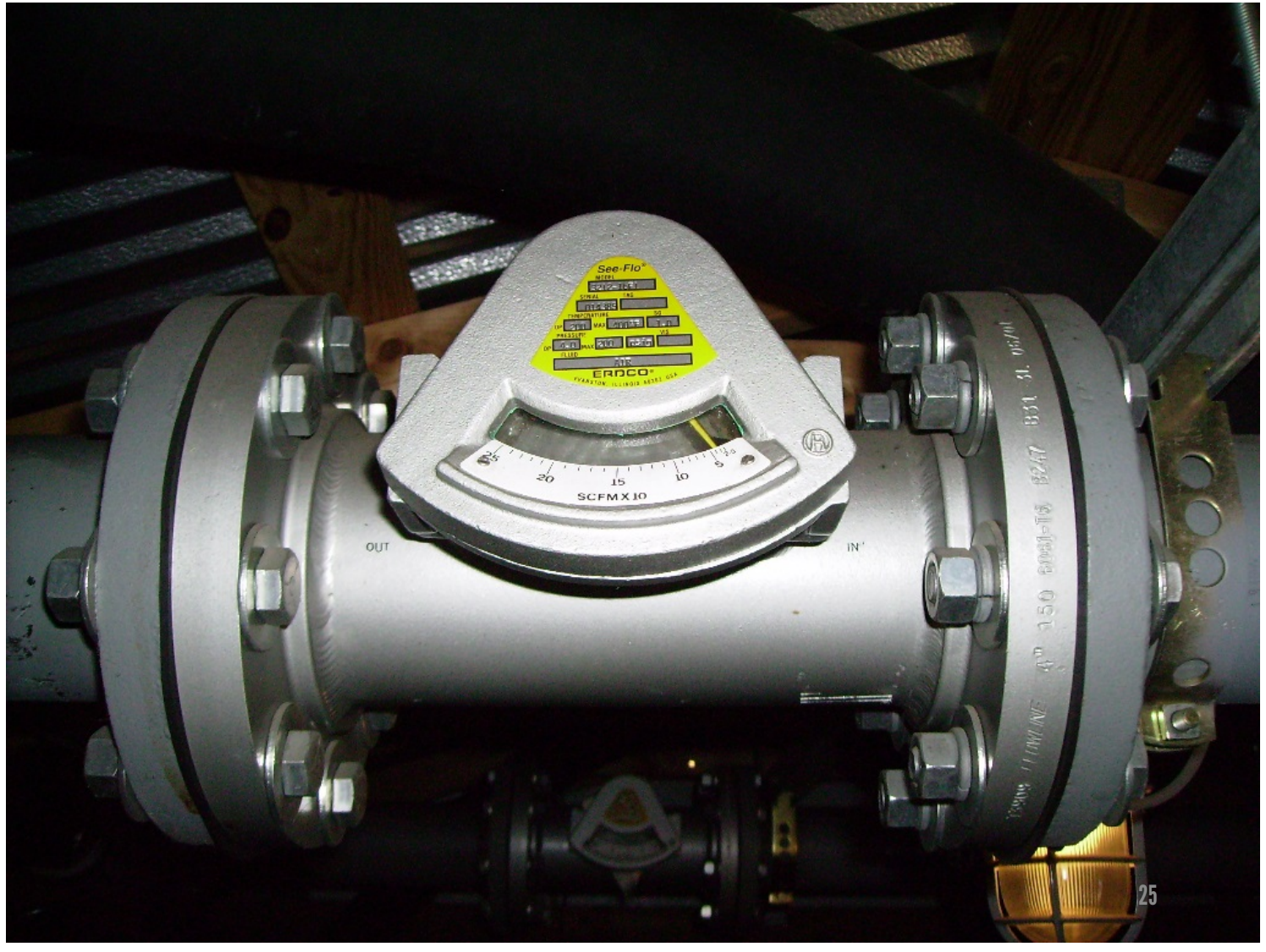
There are multiple ways to obtain flow readings:

- Anemometer
- Direct Read
- Rotameter
- Differential Pressure

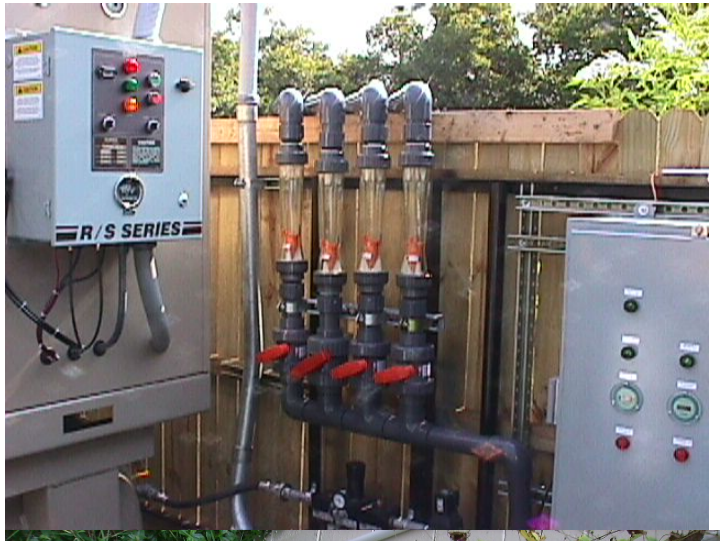
Anemometer



Direct Read



Rotameter

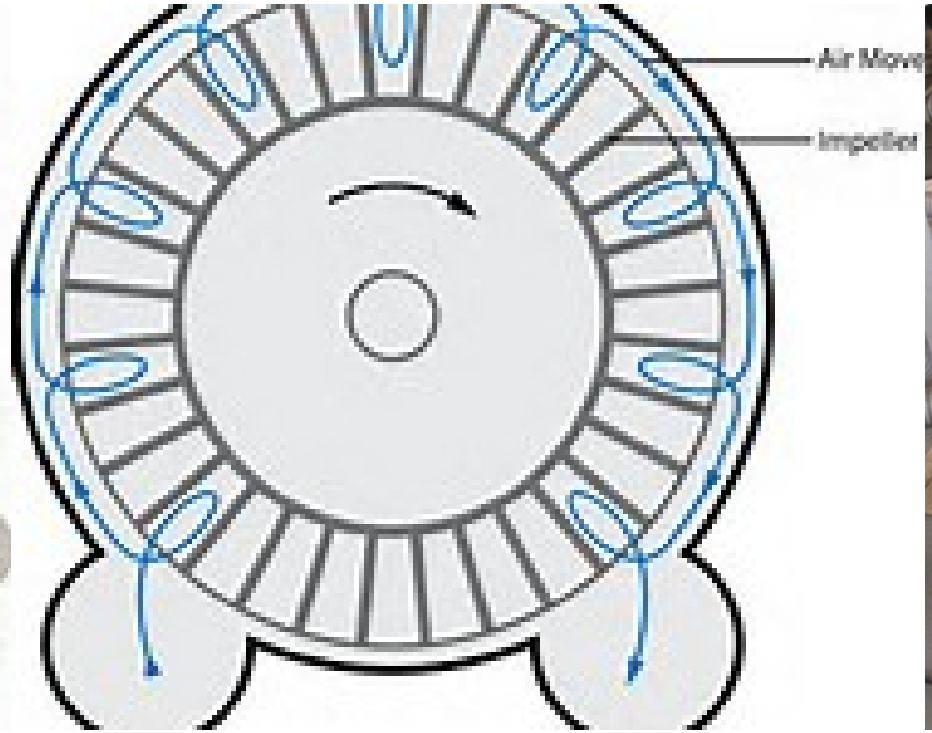


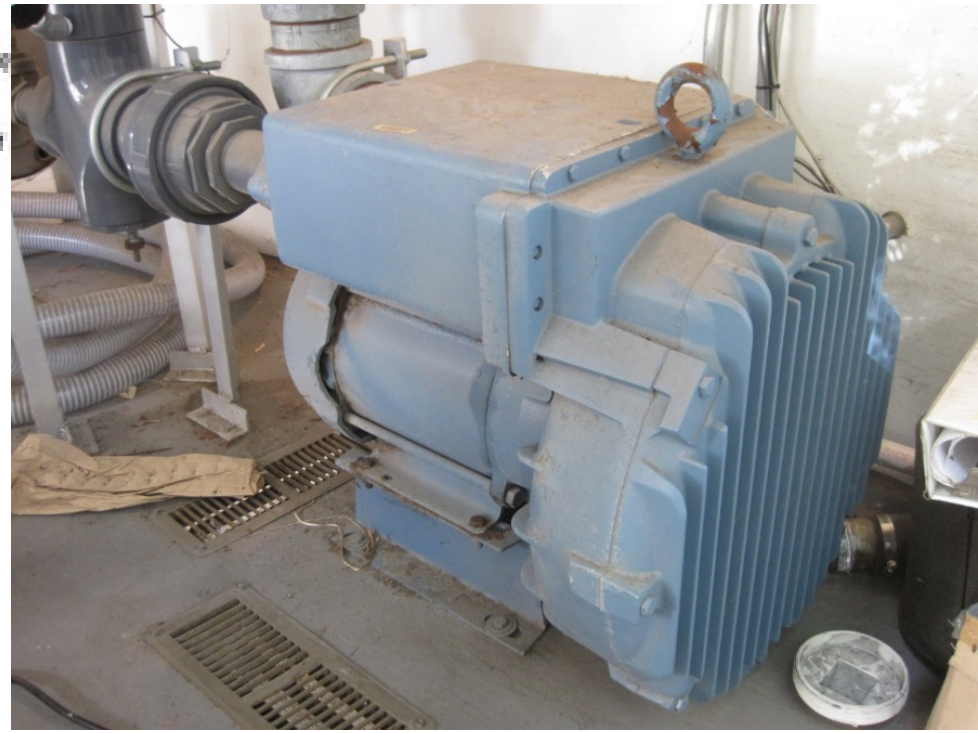
Differential Pressure

Types of Blowers and Compressors

- Regenerative
- Centrifugal/Multistage
- Rotary Vane
- Rotary Lobe
- Rotary Claw
- Rotary Screw

Regenerative





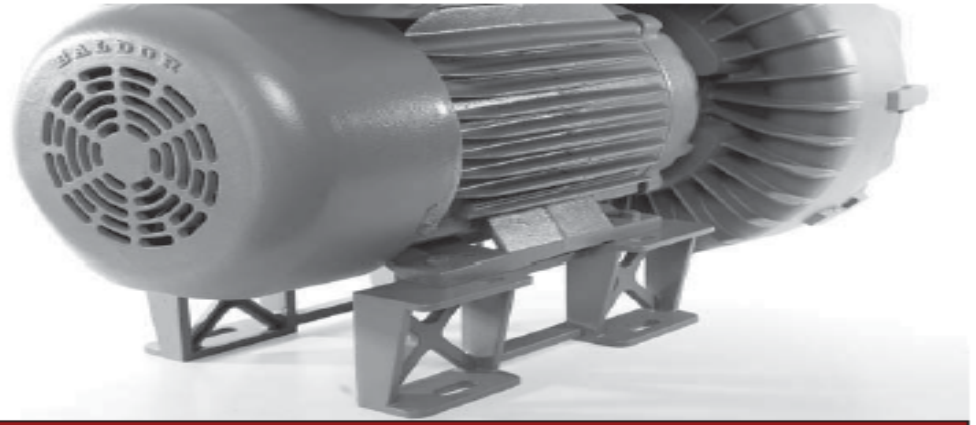
- International voltage & frequency (Hz)
- Chemical duty, high efficiency, inverter duty or industry-specific designs
- Various horsepowers for application-specific needs

BLOWER OPTIONS

- Corrosion resistant surface treatments & sealing options
- Remote drive (motorless) models
- Slip-on or face flanges for application-specific needs

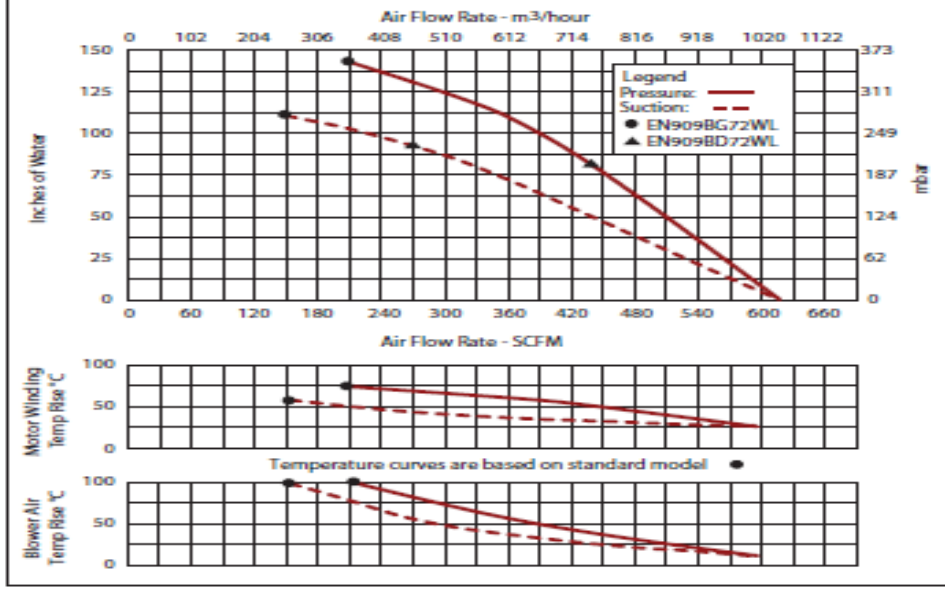
ACCESSORIES

- Flowmeters reading in SCFM
- Filters & moisture separators
- Pressure gauges, vacuum gauges, & relief valves
- Switches - air flow, pressure, vacuum, or temperature
- External mufflers for additional silencing
- Air knives (used on blow-off applications)
- Variable frequency drive package

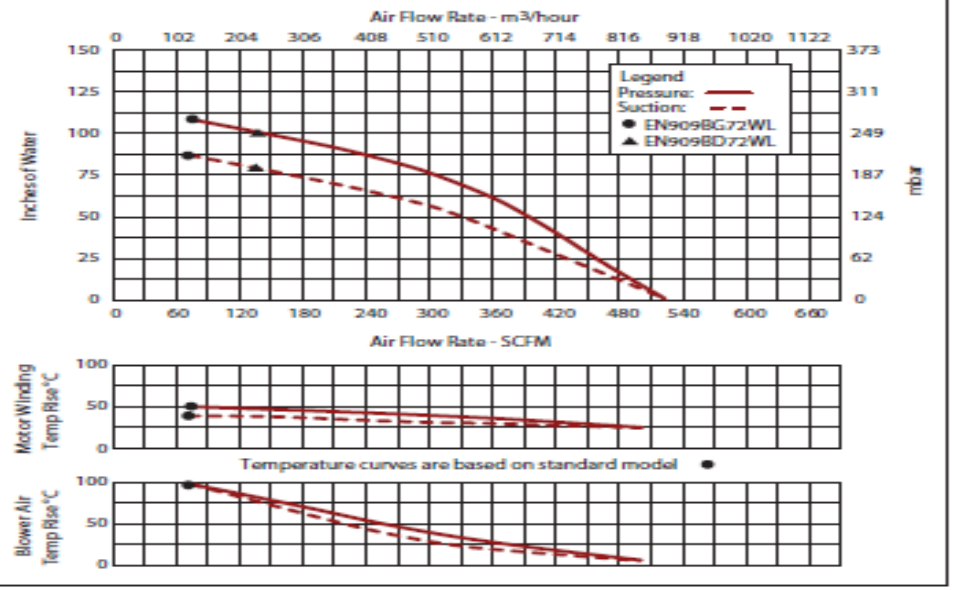


Blower Performance at Standard Conditions

60 Hz



50 Hz



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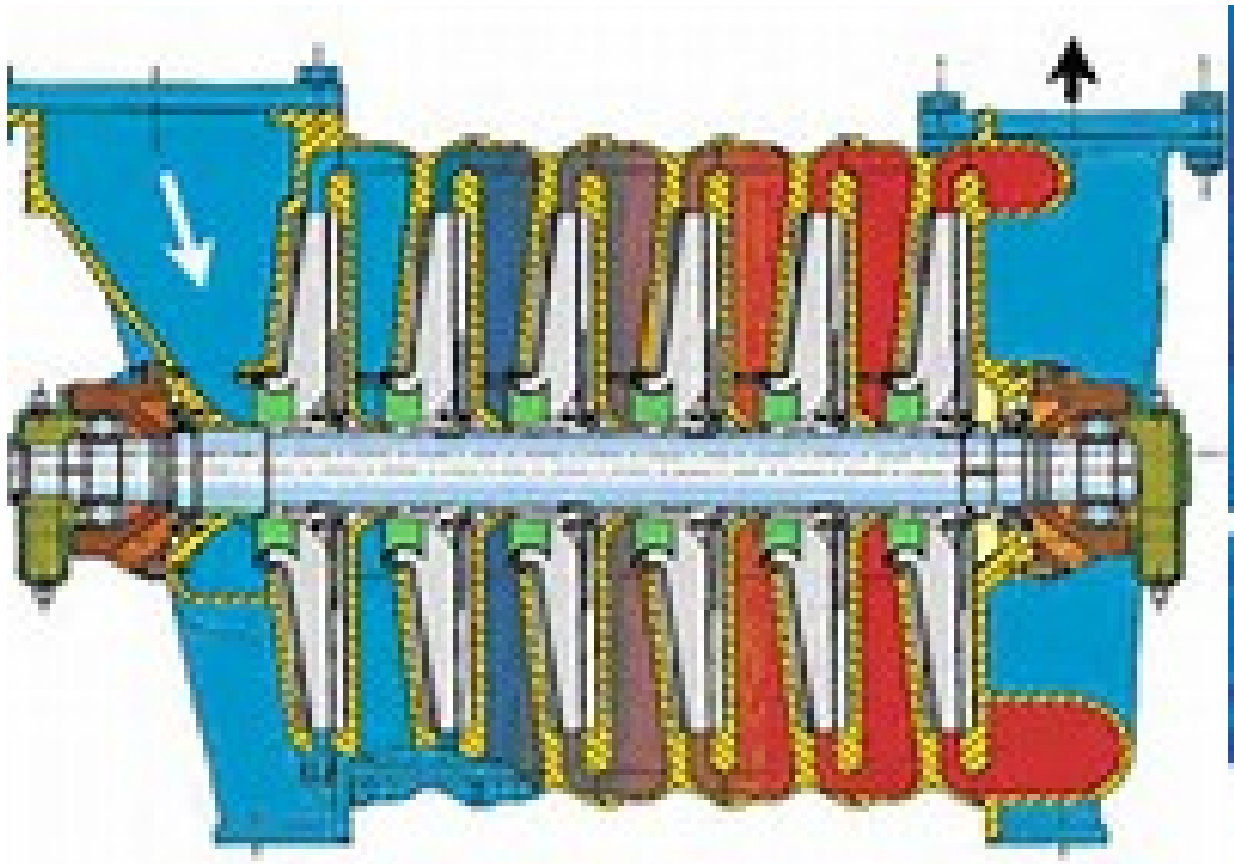
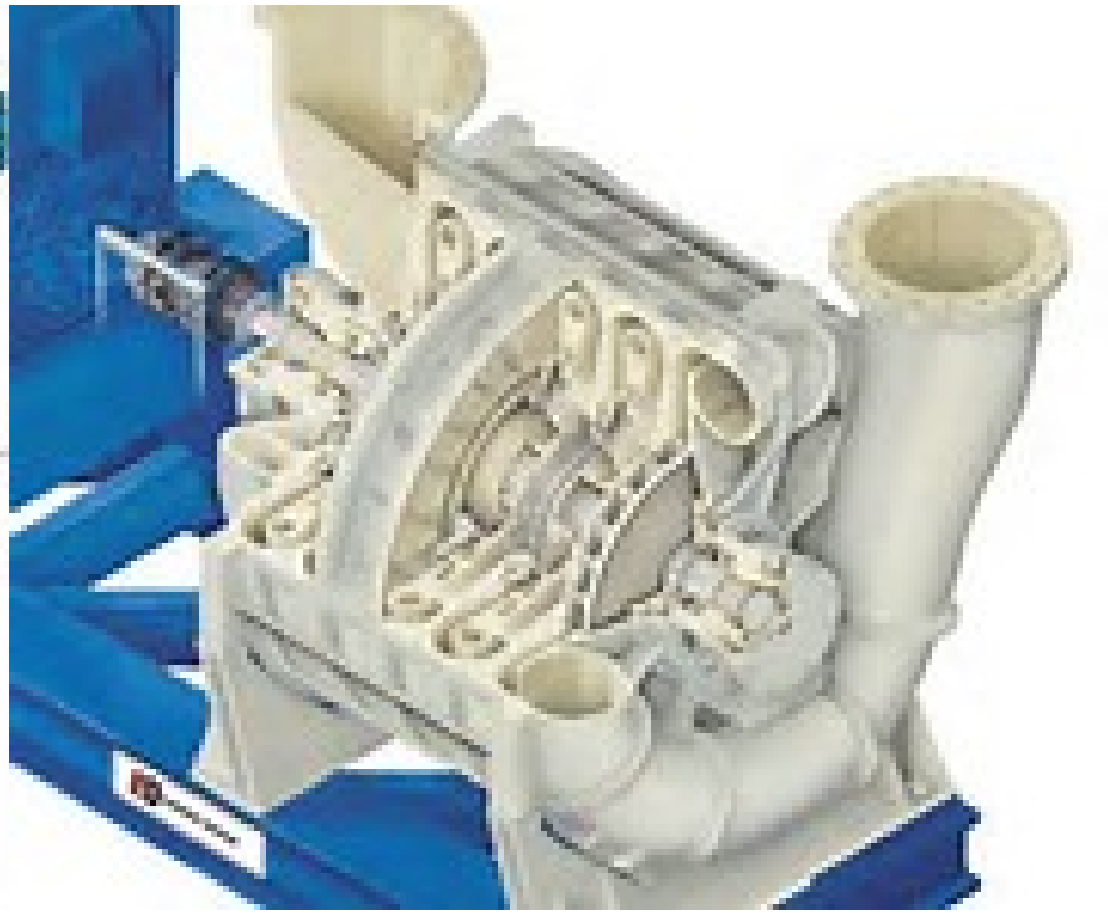
www.ametekdfs.com

AMETEK®
PRECISION MOTION CONTROL
DYNAMIC FLUID SOLUTIONS

Centrifugal Multistage

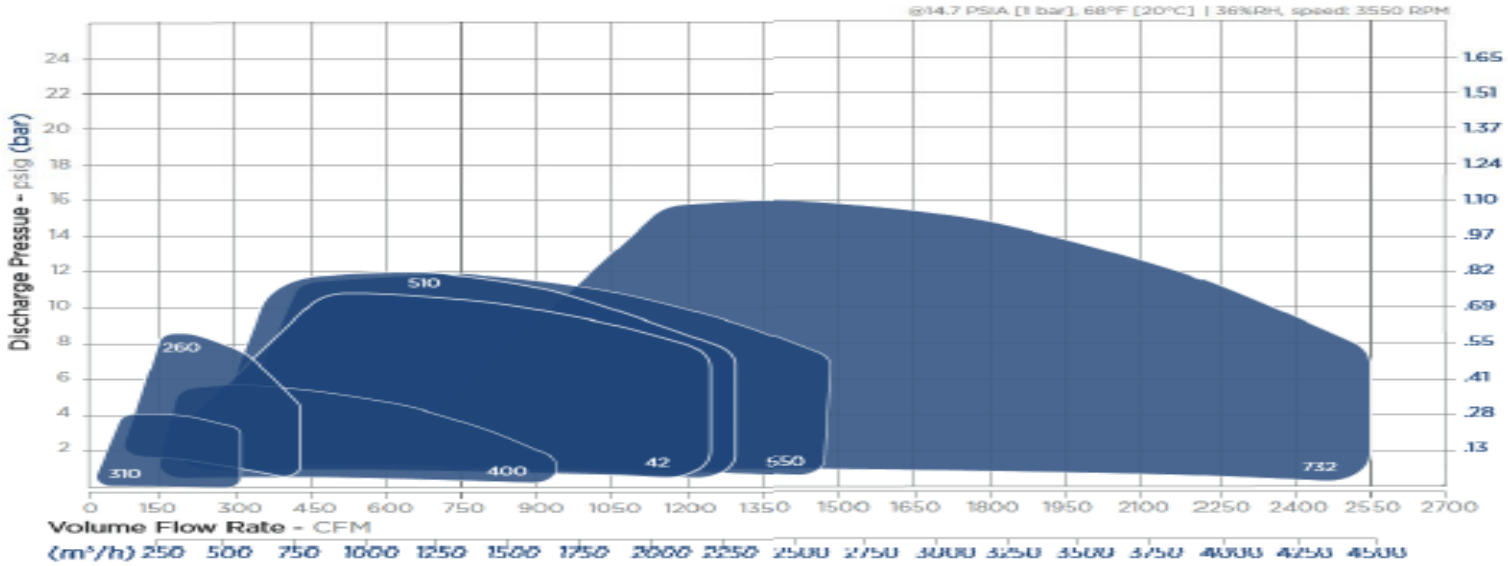




Centrifugal Multistage

PERFORMANCE & SPECIFICATIONS

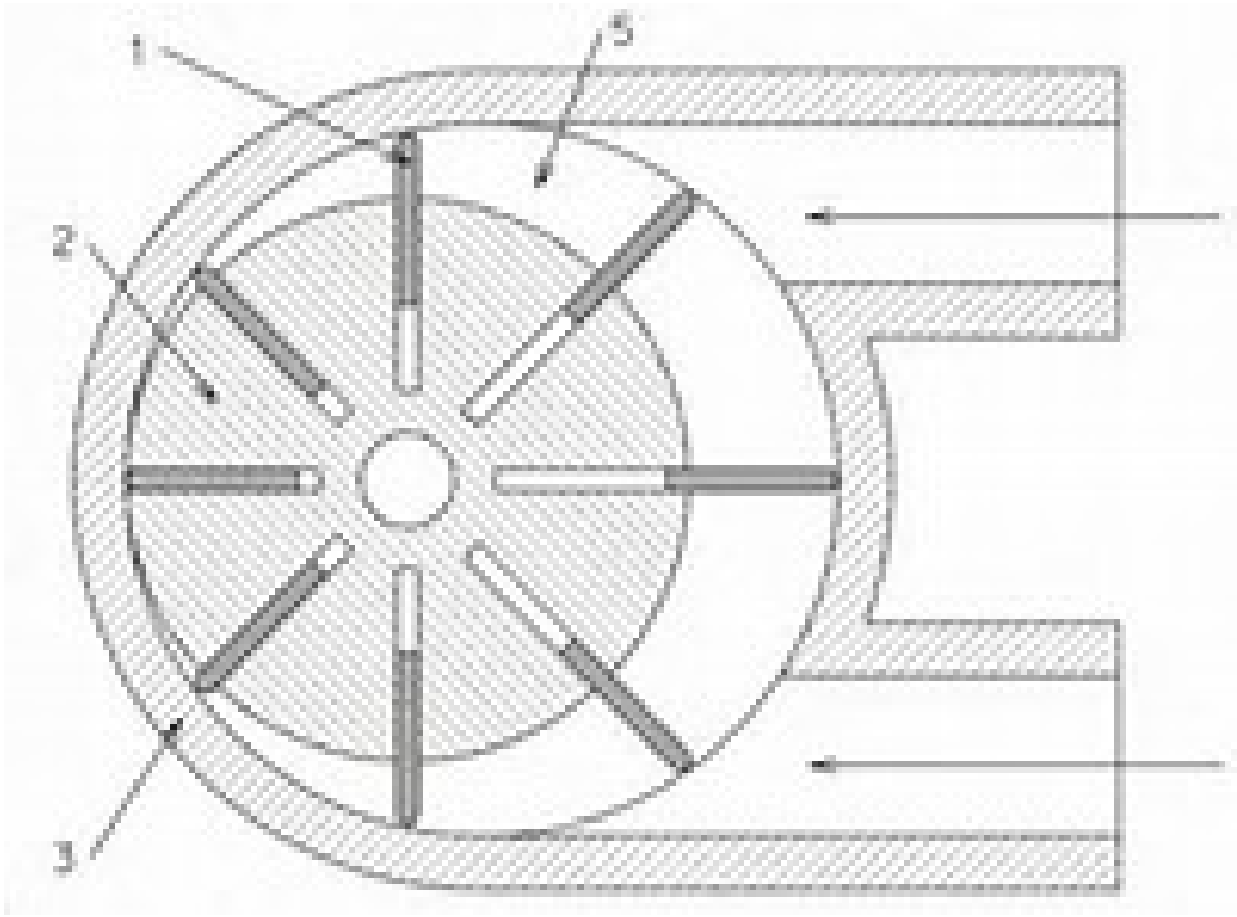
Small Inlet Models: 2.5 to 6 in (6.35 to 15.21 cm)

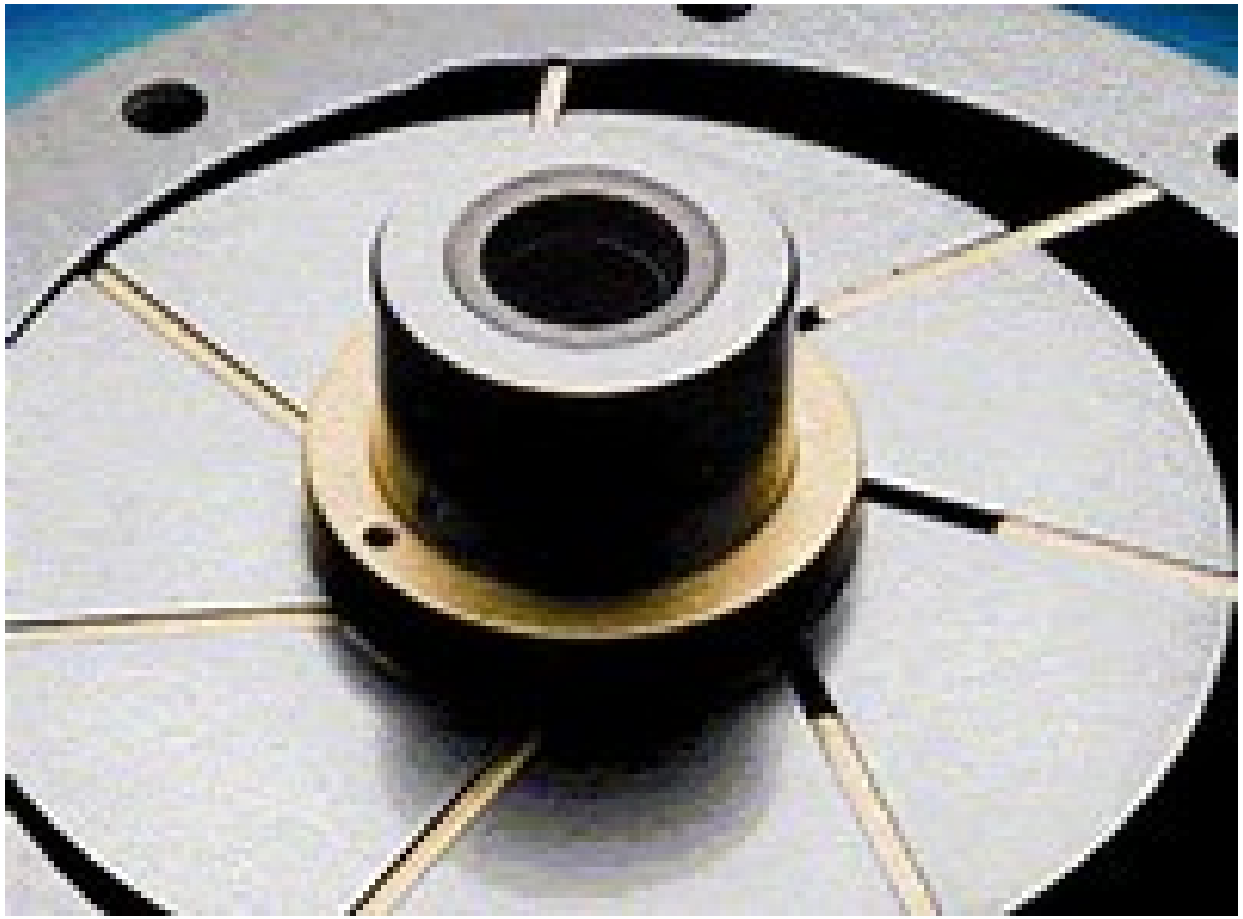


Blower Model	310	260	400	42	510	550	732
Blower/Exhauster Capacity							
Minimum Flow (cfm)	60	100	70	50	150	200	400
Maximum Flow (cfm)	450	440	1,050	1,200	1,300	1,300	2,400
Minimum Flow (m³/h)	405	170	120	85	255	340	650
Maximum Flow (m³/h)	765	680	1,785	2,050	2,210	2,210	4,100
Maximum Pressure (psig)	7.4	8.6	7.2	9.75	11.8	11.8	15.2
Maximum Pressure (bar)	0.6	0.6	0.51	0.67	0.81	0.81	1.05
Maximum Vacuum (inHg)	11.2	11.2	9.9	12	13.7	13.7	15
Maximum Vacuum (mmHg)	284	284	251	300	348	348	380
Maximum Number of Stages	11	5	10	8	10	10	10
Design Benefits							
Single Baffle Ring						■	■
Multiple Baffle Rings (MBR)							■
Balance Piston	No	No	No	No	No	No	8-10 STG
Lubrication	Grease	Grease	Grease	Grease/Oil	Grease/Oil	Grease/Oil	Grease/Oil
Auto-Lubrication System	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Labyrinth Seal	■	■	■		■	■	■
Carbon Ring Seal				■	○	○	○
MAX (Mechanical Axial) Seal	No	No	No	No	Yes	Yes	Yes
Connections							
Inlet (125# ANSI)	3"	2 1/2"	5"	6"	5"	6"	6"
Outlet (125# ANSI)	3"	2 1/2"	5"	6"	5"	5"	6"

Information is approximate and subject to change without notice. Performances noted here are typical and not job specific.
Consult with a HOFFMAN & LAMSON Representative for job specific blower or exhauster performance sizing.
■ = Standard ○ = Optional

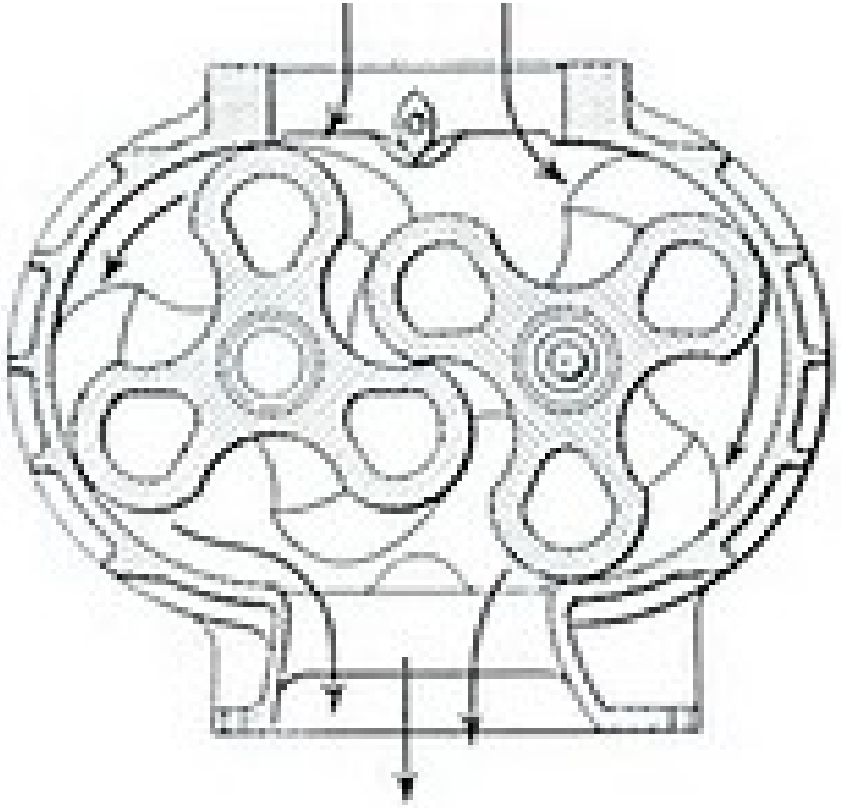
Rotary Vane

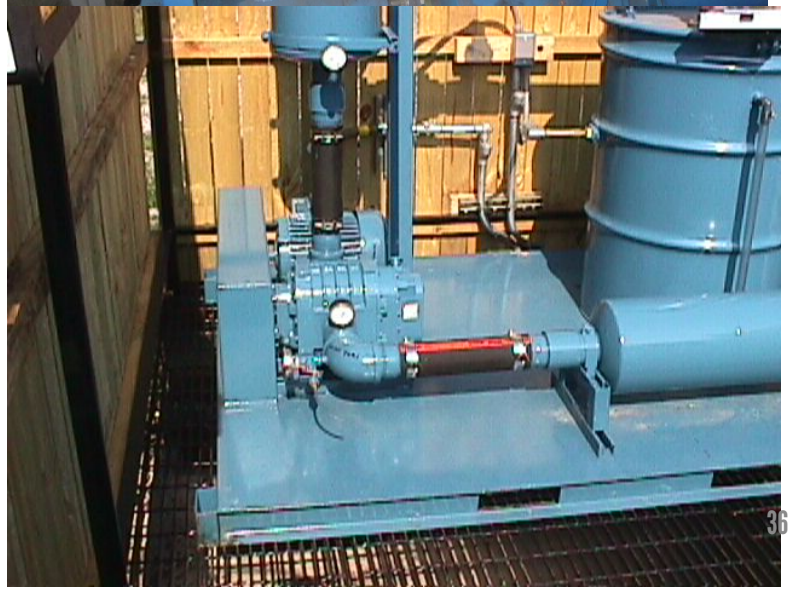




Rotary Vane

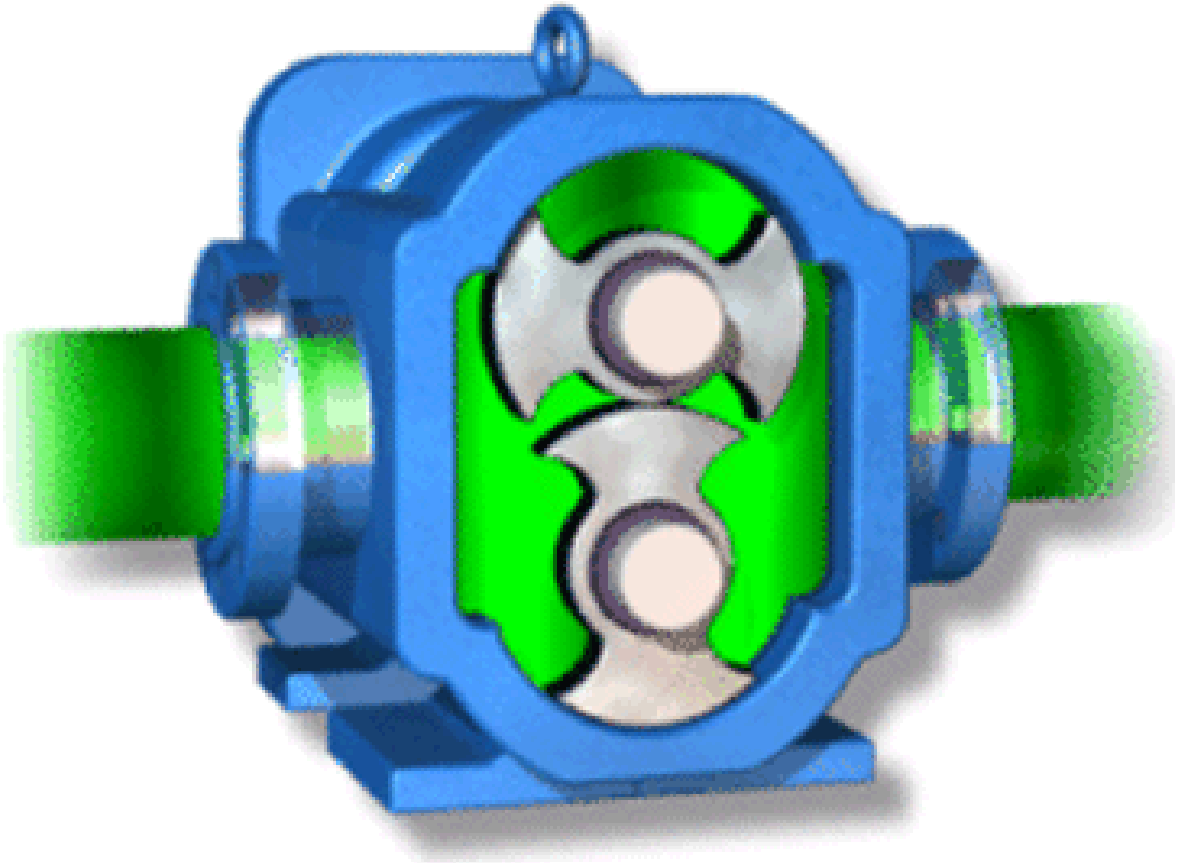
Rotary Lobe





Rotary Lobe

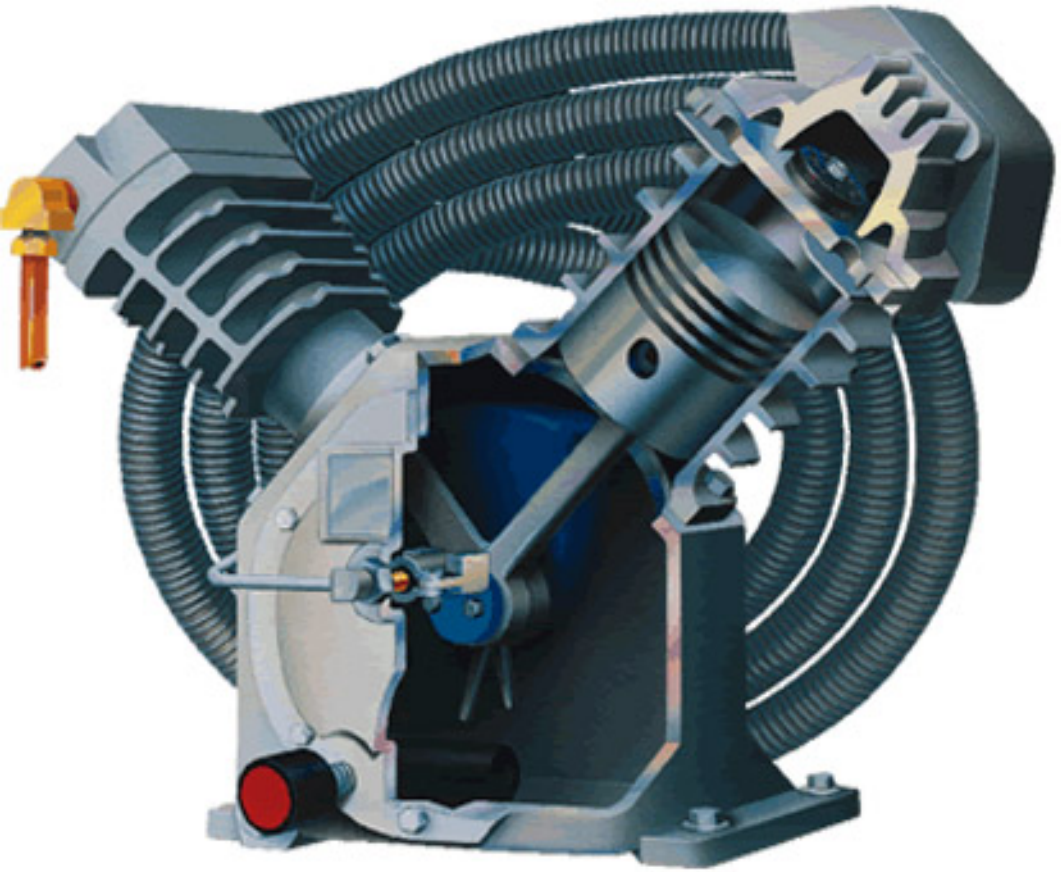
Rotary Lobe



Rotary Claw

Rotary Screw

Reciprocating



DTLF 200–500 Series

BECKER

ISO 9001 Certified
CE Compliant

100% OIL-LESS COMPRESSORS

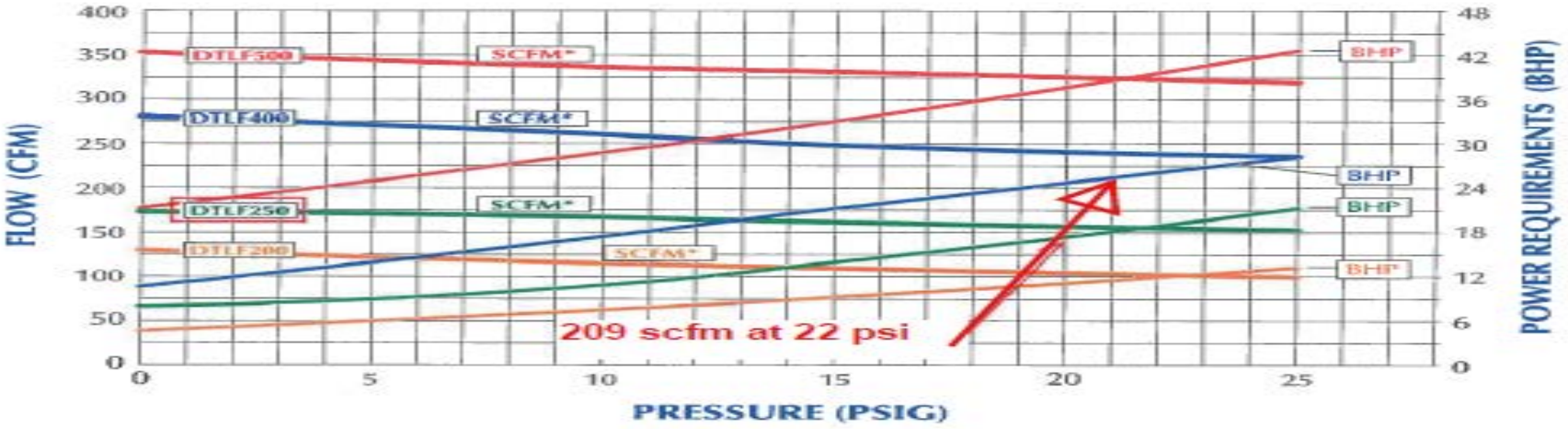
The Becker DTLF 200–500 series units are 100% oil-less, dry rotary vane compressors. They are designed to operate on a continuous basis throughout a pressure range from atmospheric pressure to a maximum of 25 PSIG.

The DTLF series compressors are direct drive units and are supplied with TEFC flange mounted electric motors. Each pump is equipped with an integral pressure relief valve, a 4 micron inlet filter, inlet and discharge silencers, and vibration isolators as standard equipment. All Becker DTLF series compressors use long-life, self-lubricating graphite composite vanes.

These 100% oil-less, or dry, pumps are ideal for applications where oil in the discharge air would be objectionable, and should be used where air is the gas, and where operation is 25 PSIG or below.

Applications include those where generation of high pressure compressed air is not practical or cost effective, and those where regenerative blowers can not reach a high enough pressure. These applications include graphic arts, environmental/sparging, aeration, and pneumatic conveying, among others.

DTLF compressors are available in various central system configurations. Vacuum and combined pressure/vacuum versions are also available. Contact the factory for details.



* @ 29.92" Hg Bar. Pr.; 68°F; 36% R.H.; 0.075#/ft³

Becker Pumps Corp. • 100 East Ascot Lane • Cuyahoga Falls, Ohio 44223-3768
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Groundwater Remediation

- Pump and Treat
- Dual Phase
- Multi Phase
- Air Sparge
- Chemical Oxidation
- Bioremediation

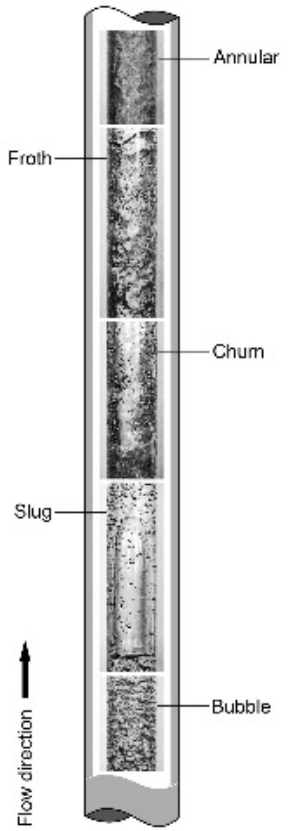
Pump and Treat

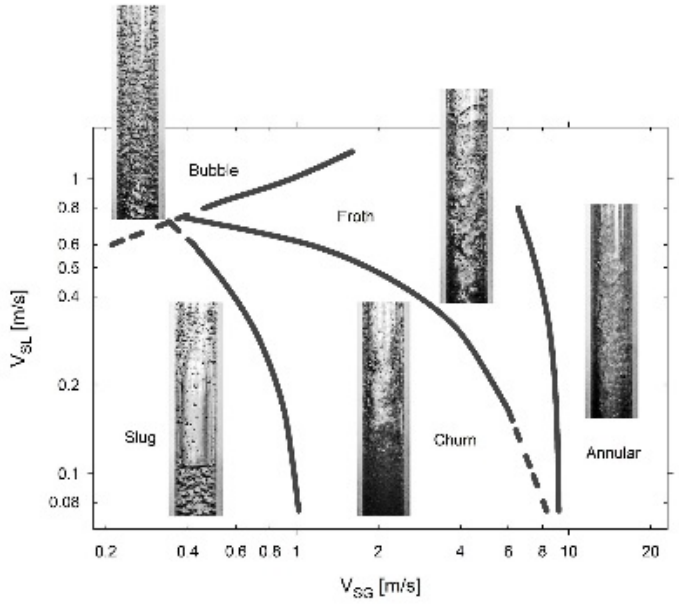
- Old Technology
- Good for Hydraulic Control
- Mass Removal/Cleanup Typically Very Slow

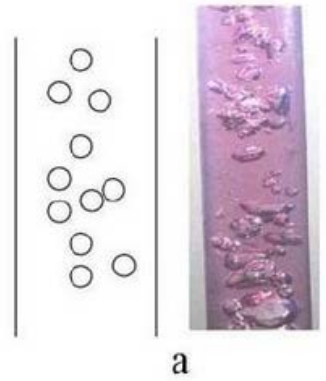
Pump and Treat

- Submersible Pump
- Surface Pump
  - Head
  - Flow Rate
  - Well Spacing
  - Drawdown

Dual Phase/Multi Phase



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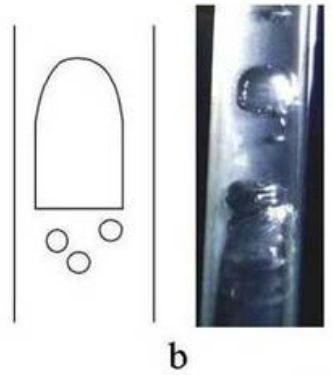
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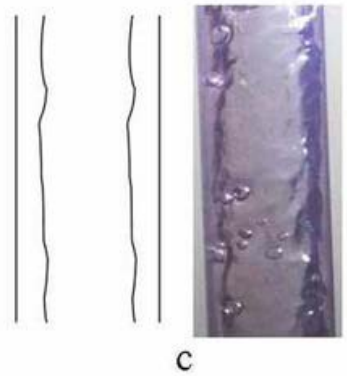
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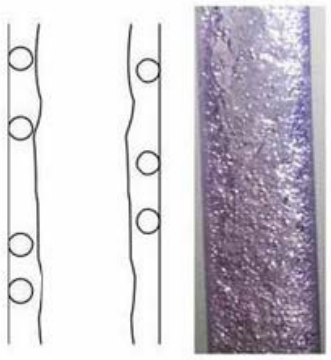
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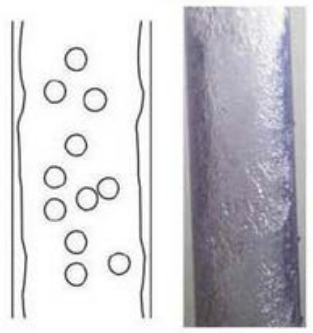
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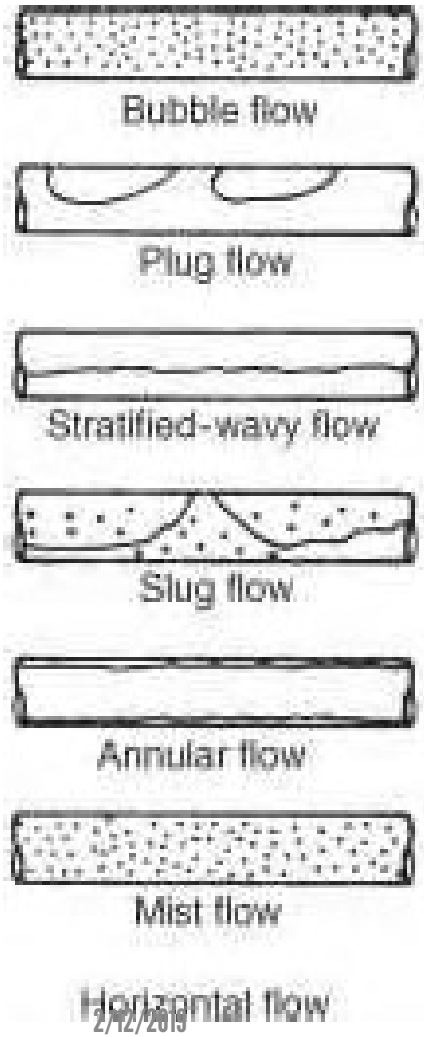
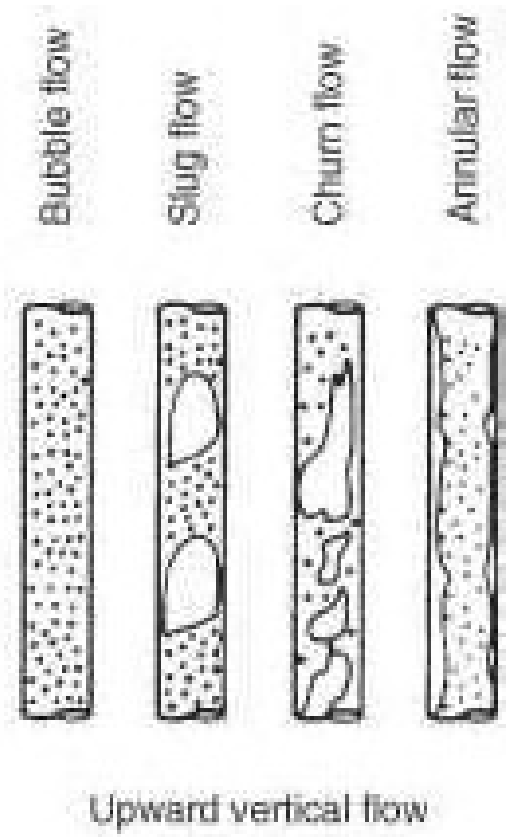
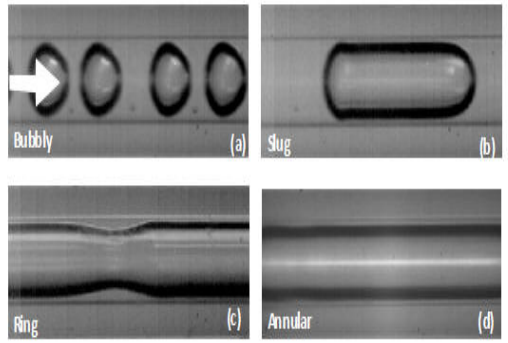
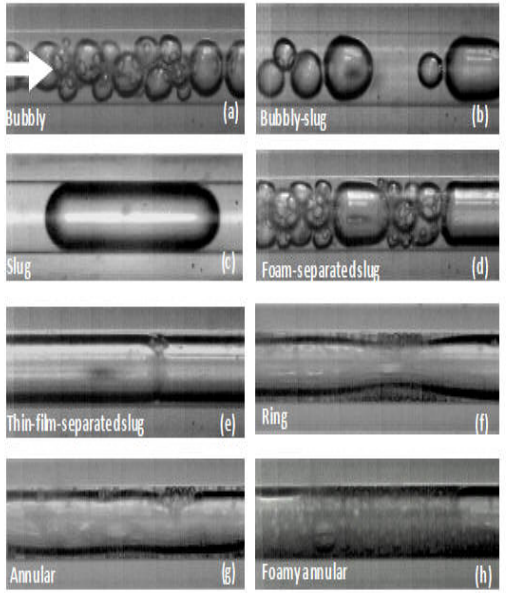
Dual Phase/Multi Phase



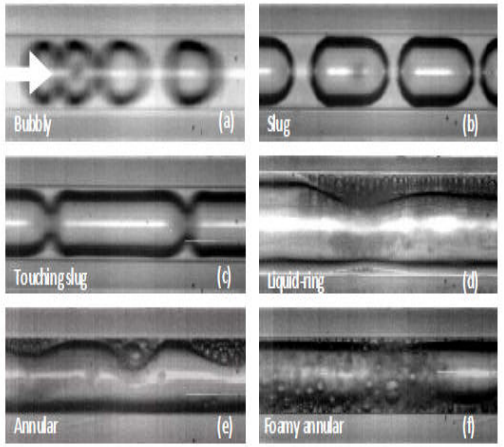




Two phase flow patterns with pure water

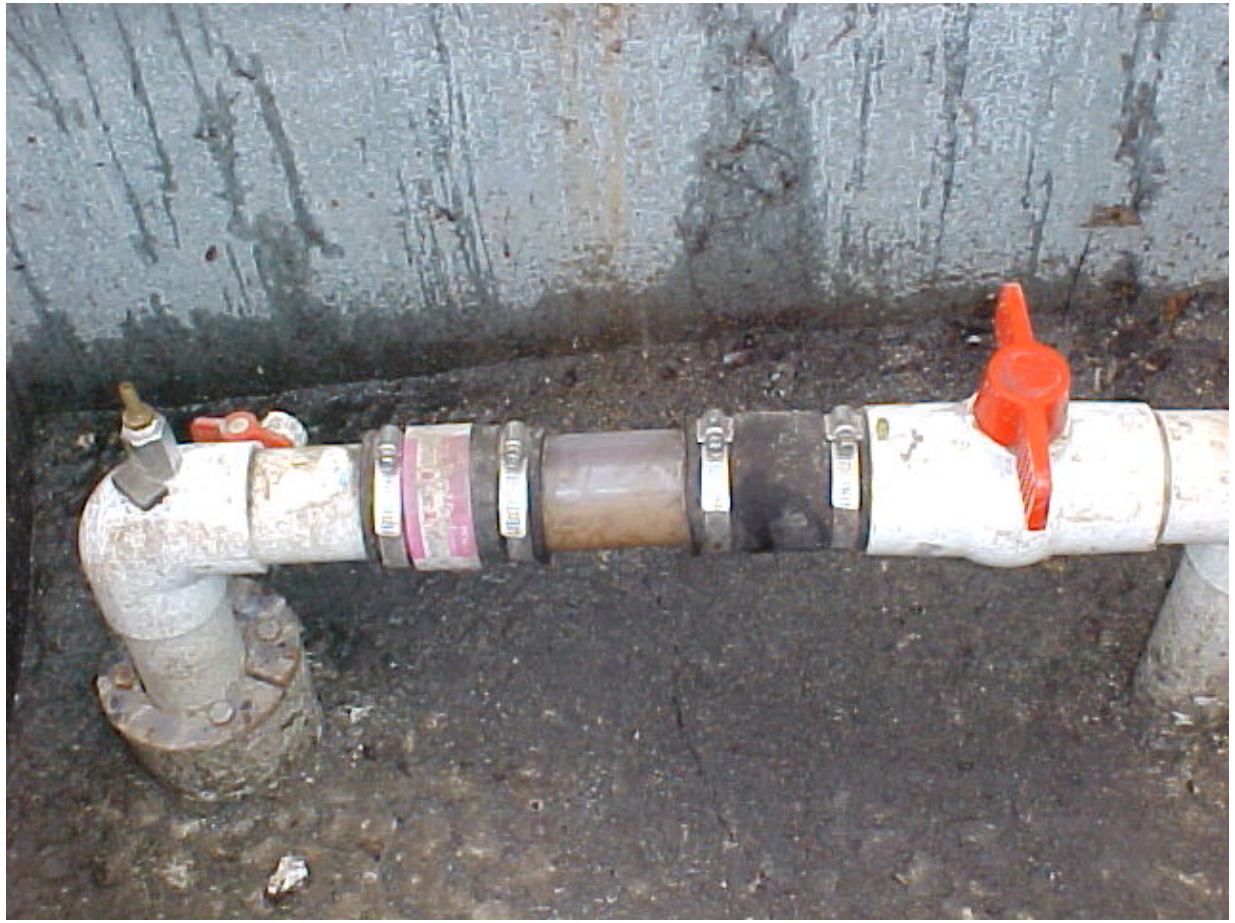


Two phase flow patterns with 1000 wppm



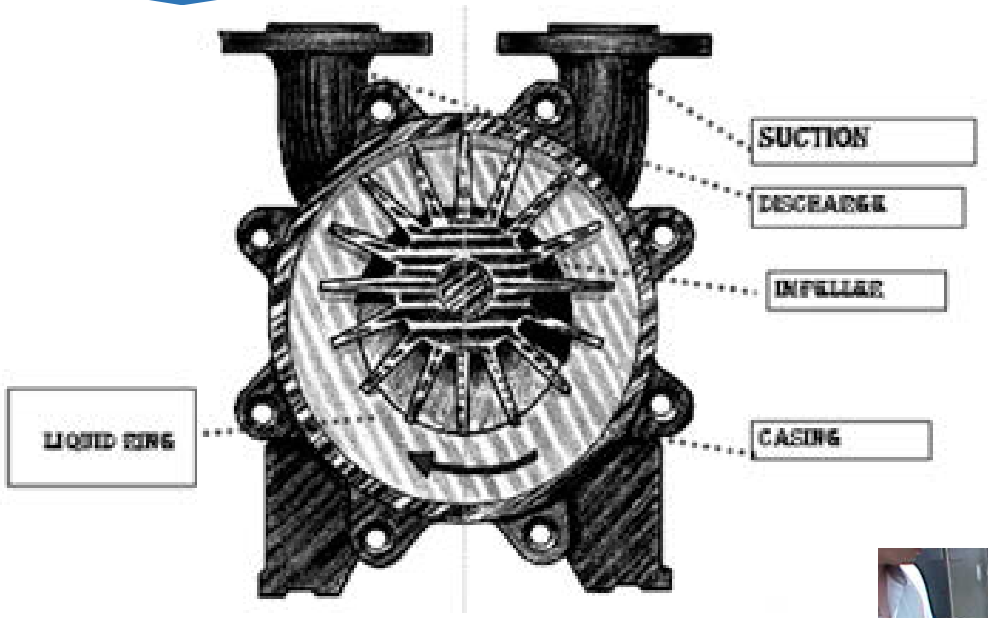
Two phase flow patterns with 400 wppm

Well Head Configurations



Rotary Lobe/Claw

Liquid Ring Pump



Direct Observation

Off Gas Treatment - Granular Activated Carbon

Off Gas Treatment Catalytic Oxidizer

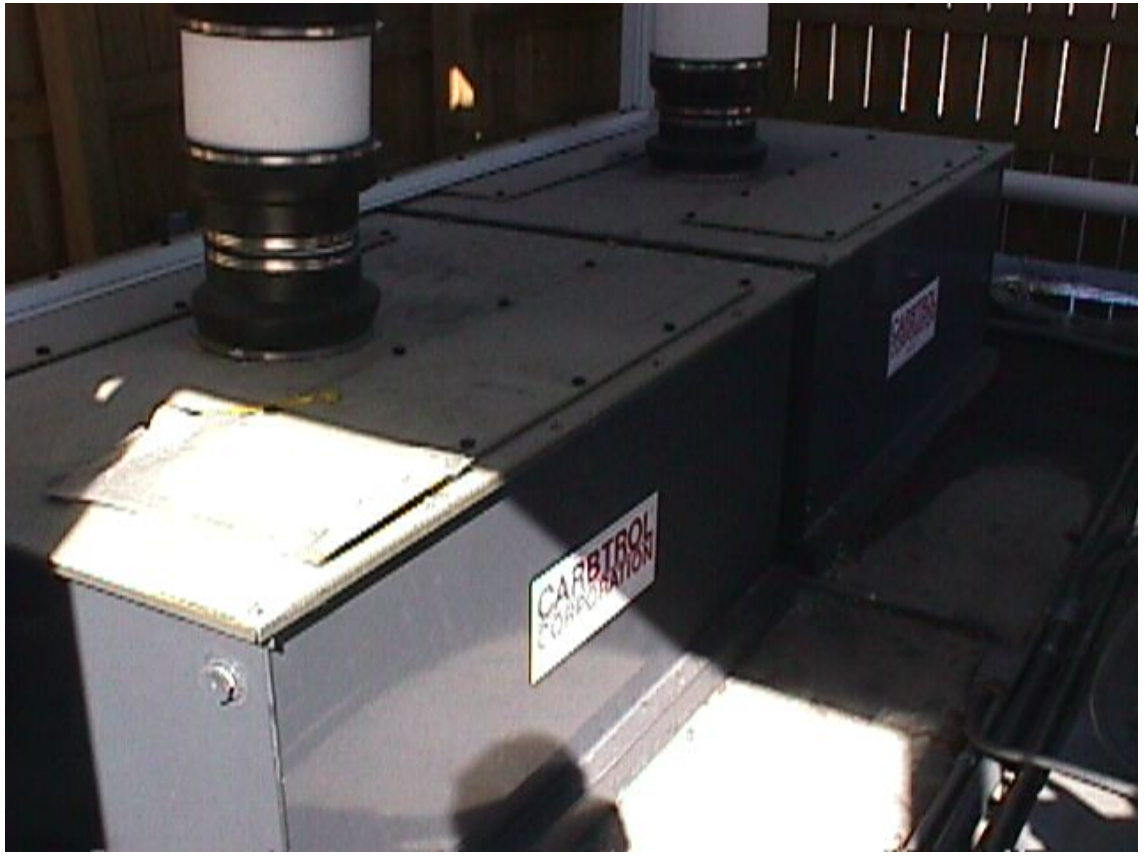
Off Gas Treatment Thermal Oxidizer

Water Treatment

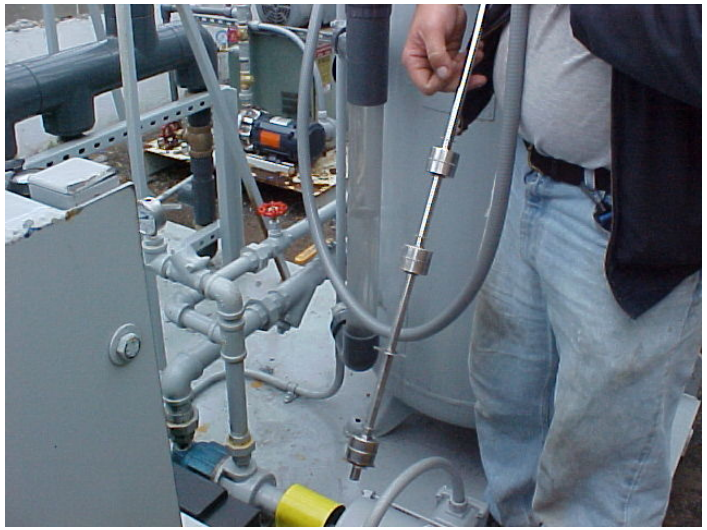
Air Stripping Tower

Tray Strippers

Diffused Aerators



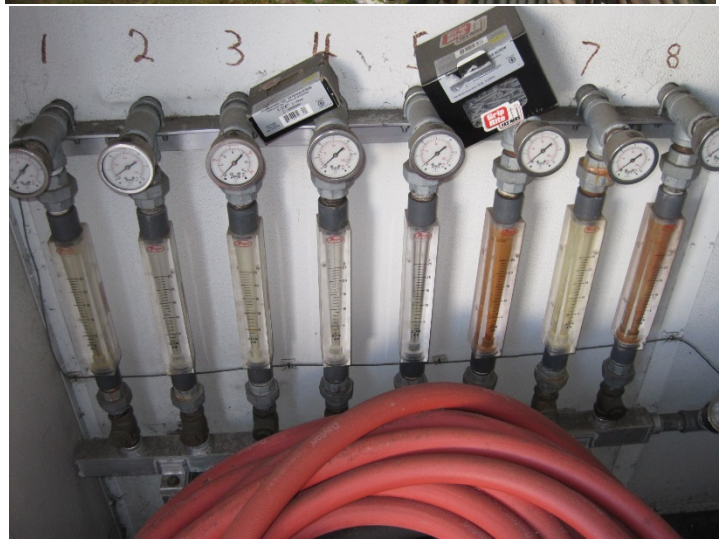
Level Controls



Chemical Oxidation

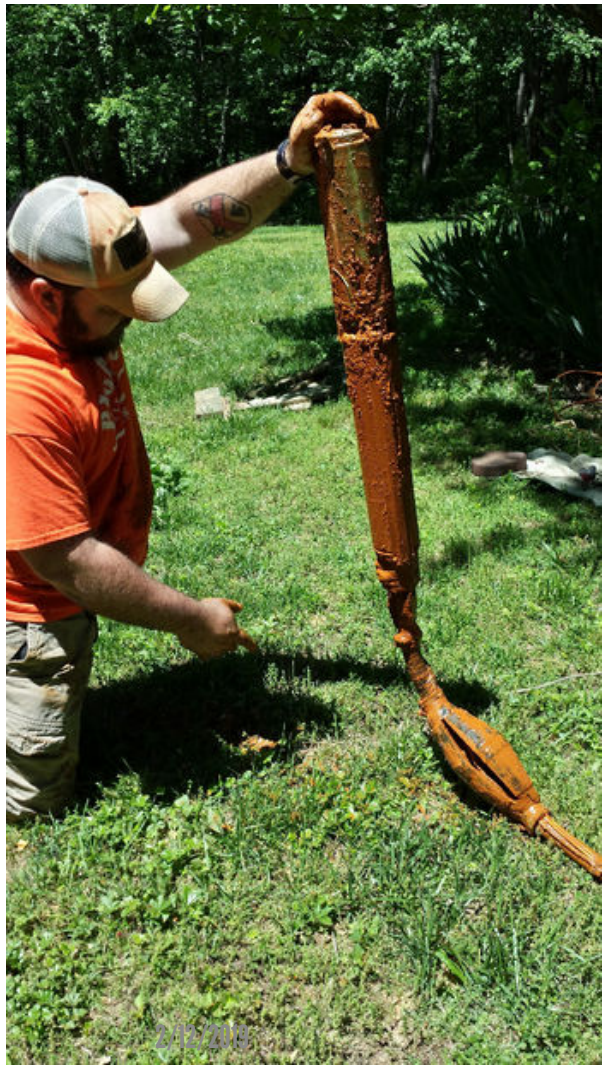
Totalizing Flow Meters

Typical Fouling

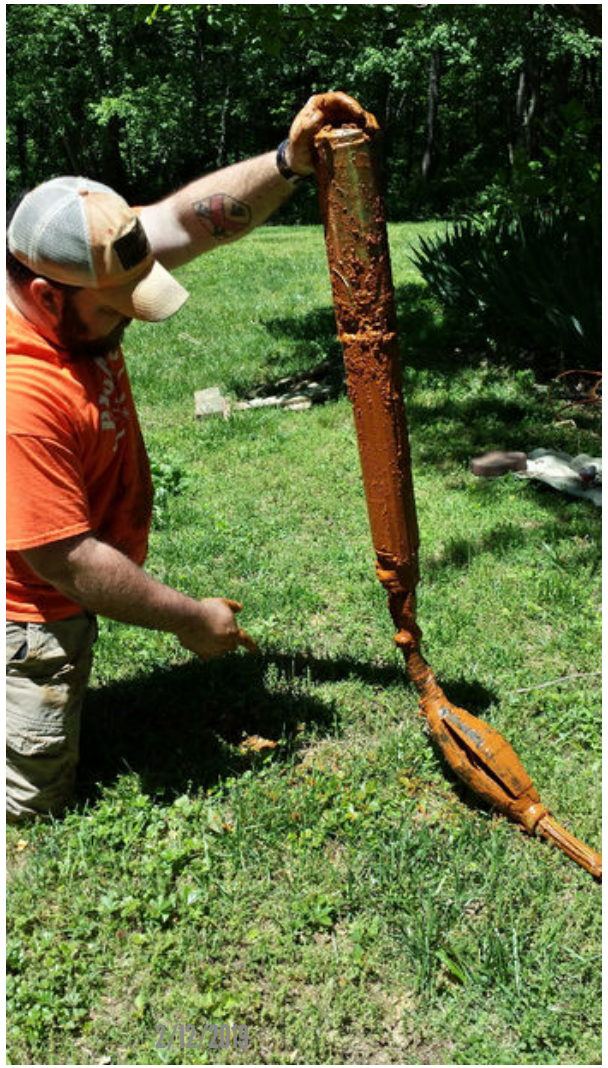


Dual Phase Water Fouling

Submersible Pump Fouling



Submersible Pump Fouling



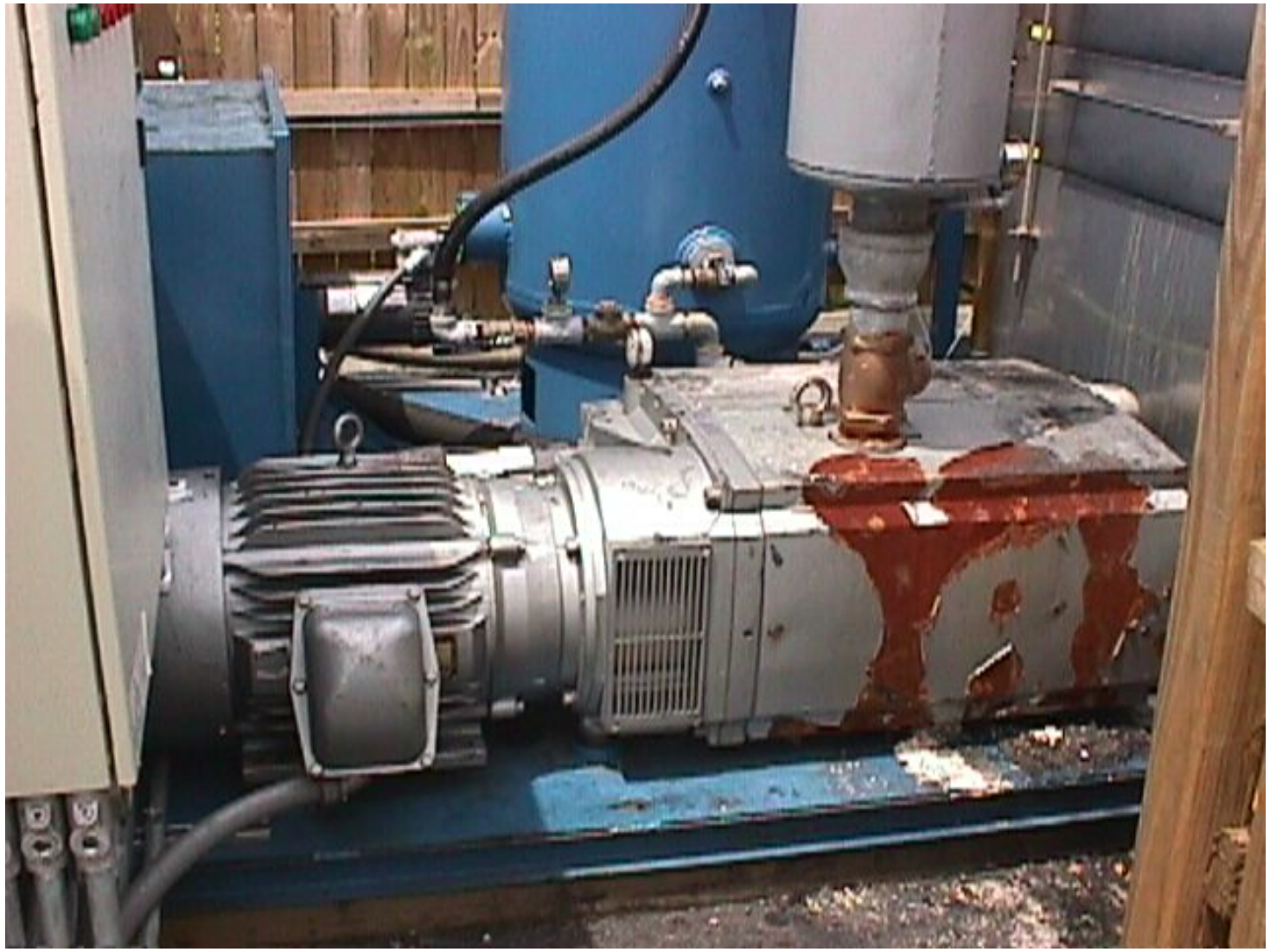
AS/SVE Performance Issues

- Treatment Wells Screened Inappropriately:
  - AS Wells Too Far Below Contamination
  - SVE Wells Recovering Too Much Water
- Undersized Equipment Used
- Technology Used at a Site with Too Much Clay

MPX Fouling

Regen Repair

Not The Correct Application



Details are Critical

Questions?

Contact Information

James Russell

407-836-1458

James.Russell@ocfl.net

Remedial Action Construction

Florida Department of Environmental Protection

Petroleum Restoration Program

James Treadwell

February 4-7, 2019

RAC SPI Items – Well Installation

- Mobilizations:
  - LD Vehicle
  - Drill Rig and Support Vehicles:
    -Incl. LD Vehicle, HD Truck, and Work Trailer

RAC SPI Items – Well Installation

- Split Spoons
- Borings
- Well Installation
- Pre-Drilling Meeting, if needed

RAC SPI Items – Construction

- Mobilizations:
- LD Vehicle, HD Truck
- Work Trailer
- Excavator
- Mini-Excavator

RAC SPI Items – Construction

- Soil Disposal Sampling, if needed
- Removal of Asphalt and Concrete
- T&D Mixed Debris
- T&D Soil, if needed

RAC SPI Items – Construction

- Paving and Grass Replacement
- Trenching
- Plumbing and Electrical in Trench
- Utility Connection
- Utility Drop

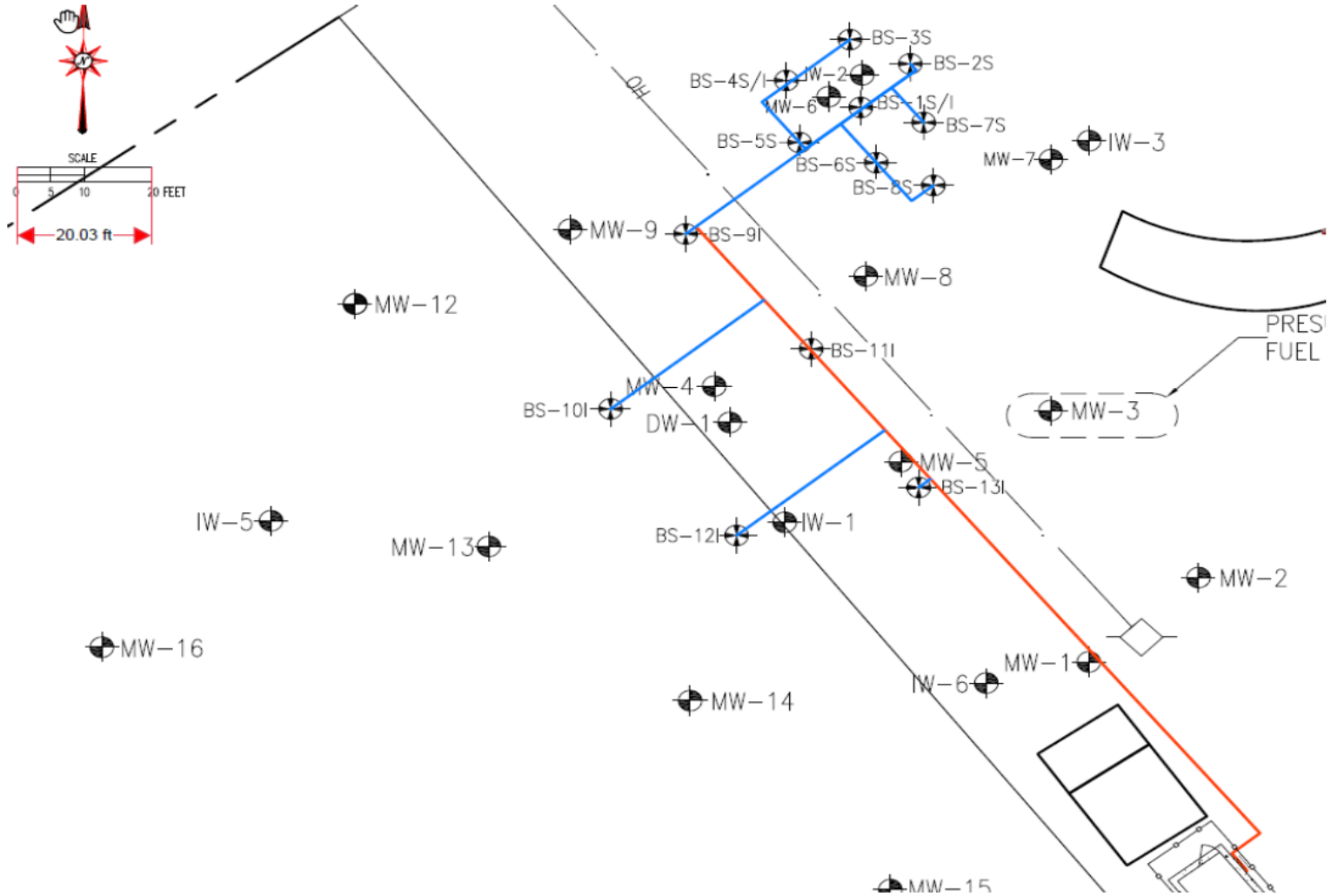
RAC SPI Items – Startup

- Mobilization LD Vehicle
- System Sample Lab Analysis
- System Installation/Integration/Startup
- Compound Construction

RAC SPI Items – Startup

- RA Startup Report
- PE Oversight for Integration and Startup
- PE Seal As-Builts

Trench Measurement



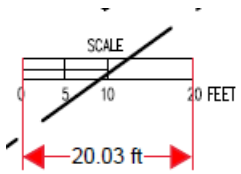
Trench Measurement

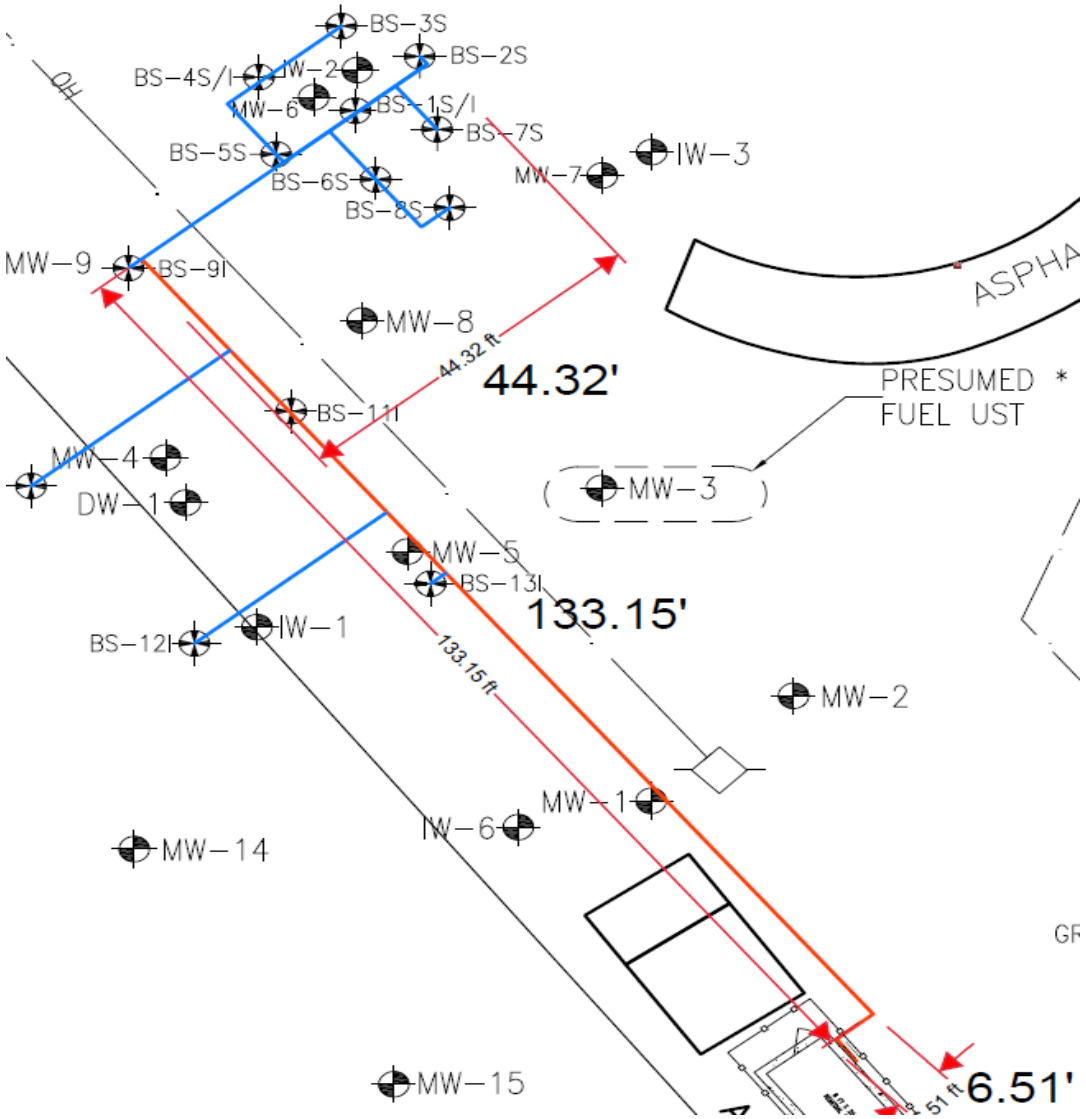
Trench Segment	Number of Pipes in Trench	Length of Trench Segment (feet)	SPI Item 15-1.a. Trenching Installation of trench containing 1-10 Plumbing Lines (linear foot of trench)	SPI Item 15-1.b. Trenching Installation of trench containing 11-20 Plumbing Lines (linear foot of trench)	SPI Item 15-1.c. Trenching Installation of trench containing 21-30 Plumbing Lines (linear foot of trench)	Additional pipes >30	ADDITIONAL bundle of 1-10 lines	SPI Item 15-1.d. Trenching Installation of additional bundle of 1-10 lines greater than 30 lines in trench (linear foot of trench)	
A	15	143	0	143	0	0	0	0	
B	1	3	3	0	0	0	0	0	BS-13I
C	1	29	29	0	0	0	0	0	BS-12I
D	1	30	30	0	0	0	0	0	BS-10I
E	10	46	46	0	0	0	0	0	BS-9I to BS-2S
F	4	27	27	0	0	0	0	0	BS-5S to BS-3S
G	2	22	22	0	0	0	0	0	BS-8S
H	1	8	8	0	0	0	0	0	BS-7S
I			0	0	0	0	0	0	

Trench Measurement

V			0	0	0	0	0	0
Actual Footage of Trench	308		165	143	0			0
10% Contingent (rounded)	31		17	14	0			0
Total Scoped Units	339		182	157	0			0
			SPI Item 15-1.a.	SPI Item 15-1.b.	SPI Item 15-1.c.			SPI Item 15-1.d.

Trench Measurement

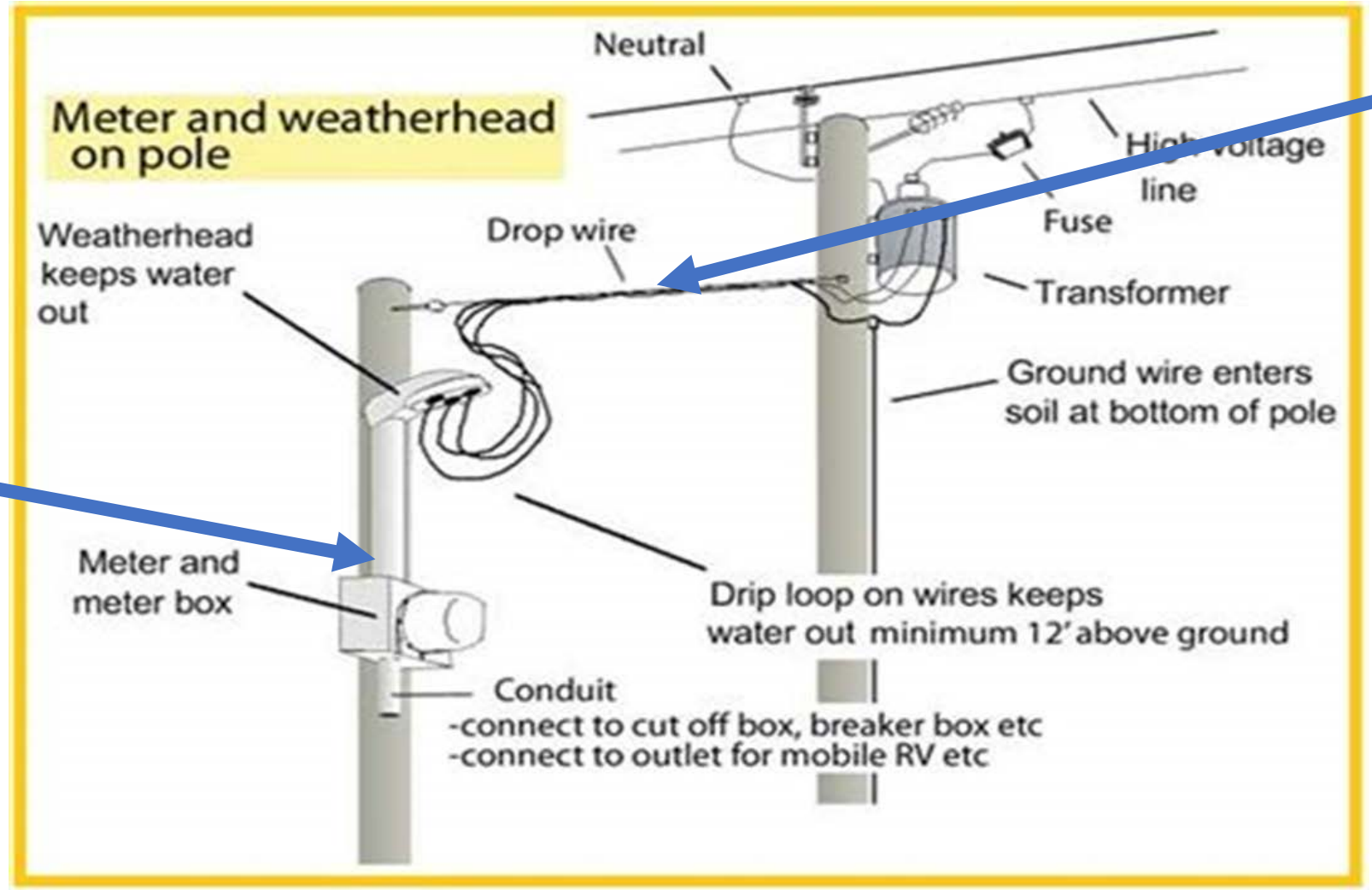




Utility Connect and Utility Drop

Utility Drop

Utility Connection



Contact Information

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TIPS FOR RA & SR POs

Chuck Williams
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Florida Department of Environmental Protection
Petroleum Restoration Program
ATC Contracts Section

RAC/O&M Cleanup Phases & Timeframes

- RAC POs include 1st quarter O&M & ≤ $325K e-quote threshold (excluding contingent funding)
- No longer requires one year O&M
- Original POs ≤ 18 months from issue to FD due date
- COs ≤ 24 months from issue to PO's end date

RAC/O&M Quotes

- 1 if ≤ $2,500* (2 if in-house) & 3 if > $2,500* *(*aggregate of all quotes in PO for same vendor)*
- Vendor name, date, contact, legible, all pages, pay item #
- Must not expire before PO issuance & ≤ 6 months old
- Sufficient details, specs, rental period, breakdown* *(*materials require units and unit rates)*

RAC/O&M Quotes

- No confidential disclaimers in quotes or e-mails per Directive 301 *(replace or author strike/comment/sign)*
- Add tax & shipping only if quote specifically excludes
- No insurance on rental equipment *(overhead)*
- Multiple quotes must have same scope/specifications
- "Sole source" quotes > $2,500 require justification

RAC/O&M Quotes

- Fuel quotes specify location, type & price/gallon
  (ATC should provide fuel usage calculations)
- Compound construction/fencing (15-7) is “materials” only
- Lowest “aggregate” quote for multiple pay items OK if total cost is lowest of 3, but need to add statement in MFMP
- Quotes should not show rates included in contract

RAC/O&M Quotes

- Utility "drop" (15-8) for "utility" to provide required power to area *(i.e., 3-phase)* – 1 quote
- Utility "connection" (15-9) for "electrician, material & labor" to provide/install pole or pedestal, meter/disconnect box, ground & connect to nearest "utility" – 3 quotes
- 15-9 should <u>not</u> include costs beyond disconnect/meter box

RAC/O&M Quotes

- Clarification of 15-9 Exclusions
  - Labor & equipment for electrical connections to system & between components is part of System Integration & Startup
  - Materials (wire & conduit) beyond disconnect/meter in trench should be pay item 15-3
  - Same materials above ground should be pay item 22-X

RAC/O&M Quotes

- Clarification of 15-9 Exclusions – Trenching
  - If materials installed in standard trench (2'X), install cost covered by trenching pay items 15-1.x (per foot)
  - If materials installed in a much smaller trench, trenching & installation" should be in pay item 22-X
  - If materials installed above ground, install cost should be in pay item 15-2.a (per foot)

RAC/O&M Quotes

Acceptable 15-9 quote:

"WE ARE PLEASED TO SUBMIT THE FOLLOWING PROPOSAL TO INSTALL (1) 200 AMP 120/240 VOLT THREE PHASE POWER POLE AT THE ABOVE REFERENCED SITE. POWER POLE WILL INCLUDE RISER, METER AND 200 AMP FUSED DISCONNECT.

CONTINGENCIES AND EXCLUSIONS: NO OVERTIME, APPLICABLE TAX IS INCLUDED, NO PERMIT FEE IS INCLUDED, NO ENGINEERED SEALED DRAWINGS ARE INCLUDED, SUBJECT TO COMMODITIES ESCALATION.

*We Propose hereby to furnish material and labor - complete in accordance with above specifications, for the sum of: ($2,495.00****)".*

RAC/O&M Quotes

Unacceptable 15-9 quote:

"Electric Service Installation: Provide lump sum price including all mobilizations to the site, labor, and equipment necessary to fully install and connect the remedial system to the electric service. This includes permitting, installation of conduit from the riser assembly to the trailer, running all necessary conductors from the hand hole to the trailer, all electrical connections. Contractor will be responsible for correcting any deficiencies found during the final inspection."

Lump Sum Price: $3,400.00

RAC/O&M Tables

- WS & SAS tables - include system water/air samples & should specify samples for “expedited turnaround”
- SAS table - Encore™ soil samplers are not subject to “expedited turnaround”, only analyses
- O&MP table - specify pressure/flow rates & hour meter readings for system run time *(per approved RAP)*

RAC/O&M Tables

- RAC table - include system(s) w/correct size & duration *(< or > 6 months)*
- RAC table - additional removal/loading of concrete > 4" (12-2) is for all over 4", not per 1" like concrete paving (13-4)
- RAC table must be consistent with SPI & other tables *(use notes section for clarifications)*

RAC/O&M Not Authorized/Duplication

- ADaPT EDDs are <u>not</u> required for system air & water samples
- "Trenching" pay items (15.A) <u>include</u>:
  - Pea gravel, backfill material & poly sheeting
  - Installation, connection & testing of plumbing & electrical lines
  - Backfilling & compaction
  - Debris removal *(excluding surface concrete/pavement)*

RAC/O&M Not Authorized/Duplication

- "System integration & startup" (15.B) <u>includes</u>:
  - System related sampling of water, vapor, air
  - Connecting all equipment, plumbing, utilities & electric to treatment/recovery/discharge points
  - Installation of telemetry for remote access
  - Installation of GW pre-treatment for scale/bacteria

RAC/O&M Not Authorized/Duplication

- "System integration & startup" (15.B) includes (cont.):
  - Installation of "add-on" pay items *(GW/vapor treatment)*
  - Labor/equipment for compound/fence construction
  - Startup assistance by equipment rep/specialist
  - System testing, troubleshooting & optimization *(O&MPs)*

RAC/O&M Not Authorized/Duplication

- System integration & startup pay items (15.B) not applicable to "subsequent" startups after down time for repairs/mods
- Initial & final mob/demob of remediation equipment must use contract pay items, HD truck/trailer (3)
- RA equipment/system use pay items (18) include:
    - All equipment, material and non-O&M labor

RAC/O&M Not Authorized/Duplication

- RA equipment/system use pay items (18) include (cont.):
  - All down well pumps
  - Carbon "polishing" equipment for GW & initial carbon
  - Major repair/replacement items/equipment & associated mobs, even if entire system needs to be replaced
  - Liability insurance & liability/damage waivers

RAC/O&M Not Authorized/Duplication

- GW treatment-add on (18-29 - 18-34) is only for robust air stripping equipment & large GW volumes
  - Carbon/vessels for smaller volumes (22-X) if > "polishing"
- Vapor carbon treatment-add on (18-35 thru 18-40), includes vessels, fittings & initial load of carbon

RAC/O&M Not Authorized/Duplicate

- Mobs & per diem for PE oversight <u>included</u> in “short term/ episodic” (16.B) & “system O&M” packages (17)
- System O&M package pay items (17) <u>include</u>:
  - Mobilizations & per diem *(exception during first month)*
  - Telemetry service fees and daily *(business)* monitoring
  - System related sampling of water/air for all recovery/ treatment/ discharge points

RAC/O&M Not Authorized/Duplicate

- System O&M package pay items (17) include (cont.) :
  - System & treatment/recovery point performance parameter data collection & DTW in select MWs
  - System maintenance, adjustments, calibration, minor repairs, trouble shooting & re- starts

RAC/O&M Not Authorized/Duplicate

- Concrete paving (13) shall meet the strength & reinforcement specs in RAP & PRP standard specs
  - No added costs for higher strength or reinforcement *(>3,000 psi, fiber mesh or rebar)*
  - Exception for steel rebar interval "tie-ins" in existing concrete adjacent to new concrete *(reimbursable)*

RAC/O&M SPI Related

- Additional laboratory surcharge (9-75 - 9-77) quantity = sum of the cost of all affected analyses in the task (7d/3d/1d)
- Reimbursable pay items (22-X) - do not include vendor name
- Cleanup related "per diem" use 4-1.A not 4-1.B
- Repetitive reimbursable items use the same pay item #, not sequential #s *(i.e., carbon change out)*

RAC/O&M SPI Related

- Use “designated” reimbursable pay item #s, not 22-X:
  - 2-3 PLS
  - 9-74 Other analysis
  - 14-3 Materials to be injected
  - 15-3 Materials in trench
  - 15-3.a Traffic bearing trench plates
  - 15-3.b Infiltration gallery install
  - 15-7 Compound construction & fencing materials
  - 15-8 Utility drop
  - 15-9 Utility connection
  - 15-10 Utility disconnect

RAC/O&M Miscellaneous

- RAC & O&M POs should include all reasonably anticipated costs *(i.e., trench & compound /fence materials, fuel for generator, utility connection , carbon change /disposal)*
- Drilling RA wells (AS/MPX/SVE/INJ) does require a pre-drill meeting, telecon or statement that all parties agree one is not necessary *(in each task with drilling)*

RAC/O&M Miscellaneous

- RAC SOWs should specify per approved RAP w/approval date (*RAP docs & approval in OCULUS)*
- Vapor carbon add-on has 3 sizes, >2,000 # need quote(s)
- Sizes for system O&M packages & PE oversight of system integration & startup based on table in section 17 of ATC scope of service *(# points & technologies)*

RAC/O&M Miscellaneous

- Size for RA system use based on tables in section 18 of ATC scope of service *(flows, HP, legs, #)*
- Use larger size if one or more parameters meets larger size
- Be sure the "sizes" are consistent in tables and SPI
- As-built drawings are included in the RA startup report
    - Add PE review of as-built drawings (21-29)

RAC/O&M Miscellaneous

- 4 hrs/week for on-site PE oversight during the "trenching" (15.A) portion of the RAC & mob may be allowed *(not part of "remediation system integration & startup" (21-6))*
- Use pay items that are best value to State *(i.e., short term AS/SVE system for 12 weeks + PE oversite is 2 x cost of 3 months system + O&M + PE oversight)*
- Crane for system placement is reimbursable expense

RAC/O&M Miscellaneous

- Infiltration Gallery Installation (15-3.b) is for costs not covered by other contract pay items *(reimbursable)*
- If gallery installed in trenching use trenching pay item (15-1.a) (*install , pipe, pea gravel, backfill, compaction & poly sheet)*
  - Use 15-3.b for materials and system controls
  - Use applicable paving/cover pay items for resurfacing (13)

RAC/O&M Miscellaneous

- If gallery installed in excavation *(not a trench)*
  - Use conventional soil excavation & loading pay item (10-7)
  - Use gravel/stone/backfill/compaction pay items (10)
  - Use 15-3.b for materials, system controls
  - Use contract labor rates (20) *(*if not in sub quote)*
  - Use paving/cover pay items for resurfacing (13)

RAC/O&M Miscellaneous

- Removal & Disposal of PCW or Product (bulk)
  - Use 12-14 (PCW) or 12-16 (Product) loaded rates (mob included) for pump out/T&D of tanks, pits, RWs, OWSs
  - May use quote(s) with all costs (mob, truck/operator, disposal etc.) if vac truck/operator required on site for extended period to pump multiple wells, low yield wells or well/pit events with intervals of recharge

RAC/O&M Miscellaneous

- Removal & Disposal of PCW or Product (bulk) (cont.)
  - Pay items 12-14 or 12-16 cannot be combined with reimbursable quote(s) for mob and/or time on site.

Injection Not Authorized/Duplication

- "In-situ injection" pay items (14-1 - 14-2.a) include:
  - Labor, equipment, set up/dismantling equipment
  - Material prep, mixing, injection & application
  - Grout sealing boreholes (if applicable)
  - DPT rig & support vehicles (if applicable)
- The injection pay items (14) must be used, even if "proprietary"

Injection Miscellaneous

- "GW injection system" pay items (14-4 & 14-5) require:
  - Manifold w/multiple legs with pressure gauges & flow meters
  - Transfer pump/mixing system for potable water injection solution to each treatment point
  - Continuous or pulsed injection via manifold to each leg
- GW injection systems (14-4 & 14-5) are by week or month
  - May be prorated for partial weeks

Injection Miscellaneous

- If using system, determine if short or long term
- "Short term" GW injection systems *(< 6 months)*
  - Combine with "injection into existing points" (14-2 or 14-2.a) or with "system O&M package" (17), whichever is best value
  - Does not qualify for system integration & startup (15.B)
  - Typically uses temporary hoses not trenching (15.A)

Injection Miscellaneous

- "Long term" GW injection systems *(≥ 6 months)*
  - Combine with system O&M package (17)
  - Do not combine with "injection into existing points" (14-2/2a)
  - May qualify for system integration & startup (15.B) if majority of "included" activities are performed
  - May use trenching if applicable (15.A)

Injection Miscellaneous

- If needed, 3 hrs/week for on-site PE oversight during in-situ injections (14) & mob may be allowed if not also getting PE oversite of system O&M *(long term)*

Contact Information

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Source Removal

Florida Department of Environmental Protection

Petroleum Restoration Program

February 4-7, 2019

Source Removal

Conventional and Large Diameter Auger

- Lithology (clay vs sand; in-situ vs excavation)
- DTW (shallow vs deep; dewatering)
- Accessibility (structures, utilities, business ops)
- Timeliness & Cost (3-6 months vs O&M)
- Size of soil / GW Plume

Source Removal

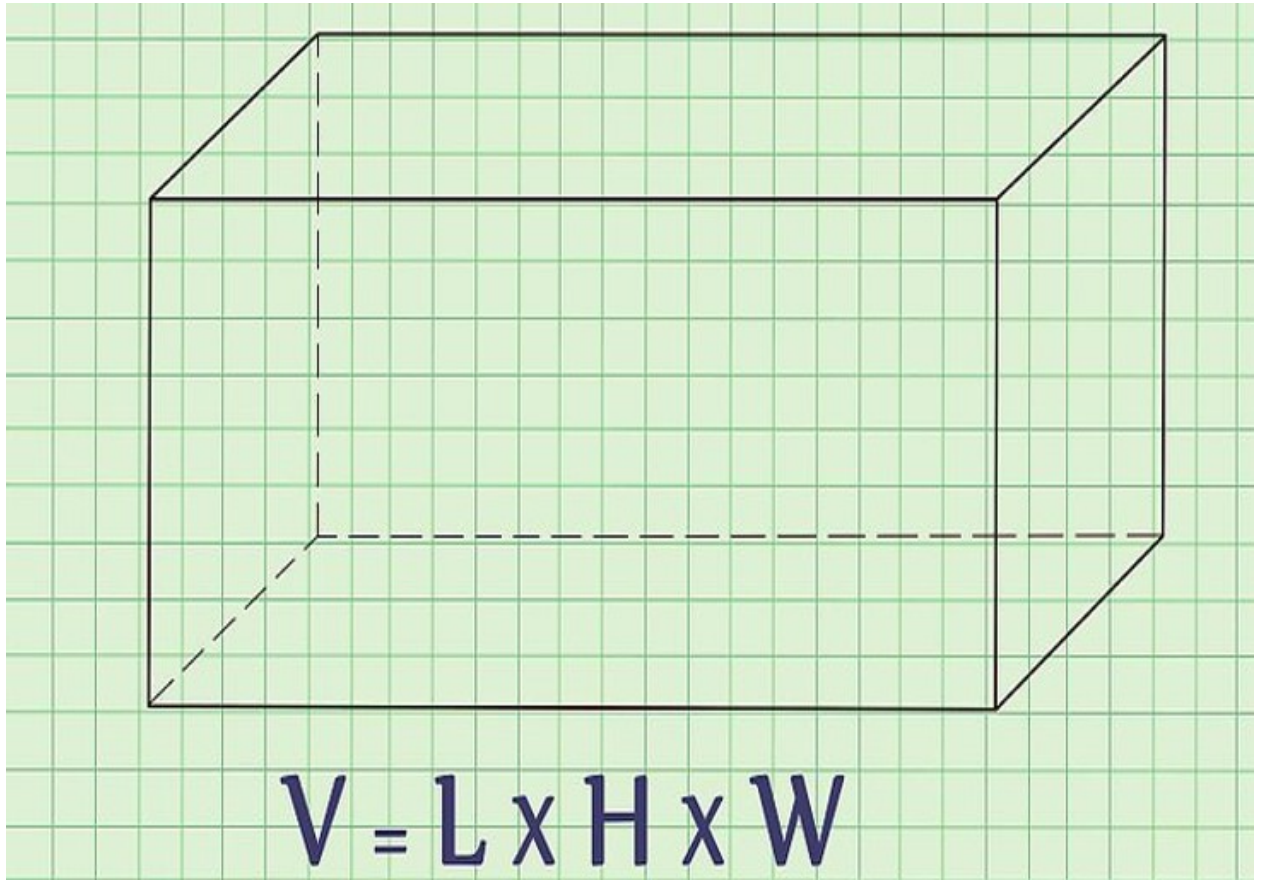
Conventional Excavation

1. Backhoe/Excavator
2. Dewatering w/NPDES
3. Sheet piling/Sloping
4. Footprint
5. OVA screening w/threshold – extend/curtail excavation
6. Confirmatory sidewall samples
7. Backfill sampling

Soil Excavation

Excavation, Dewatering and Sheet Piling

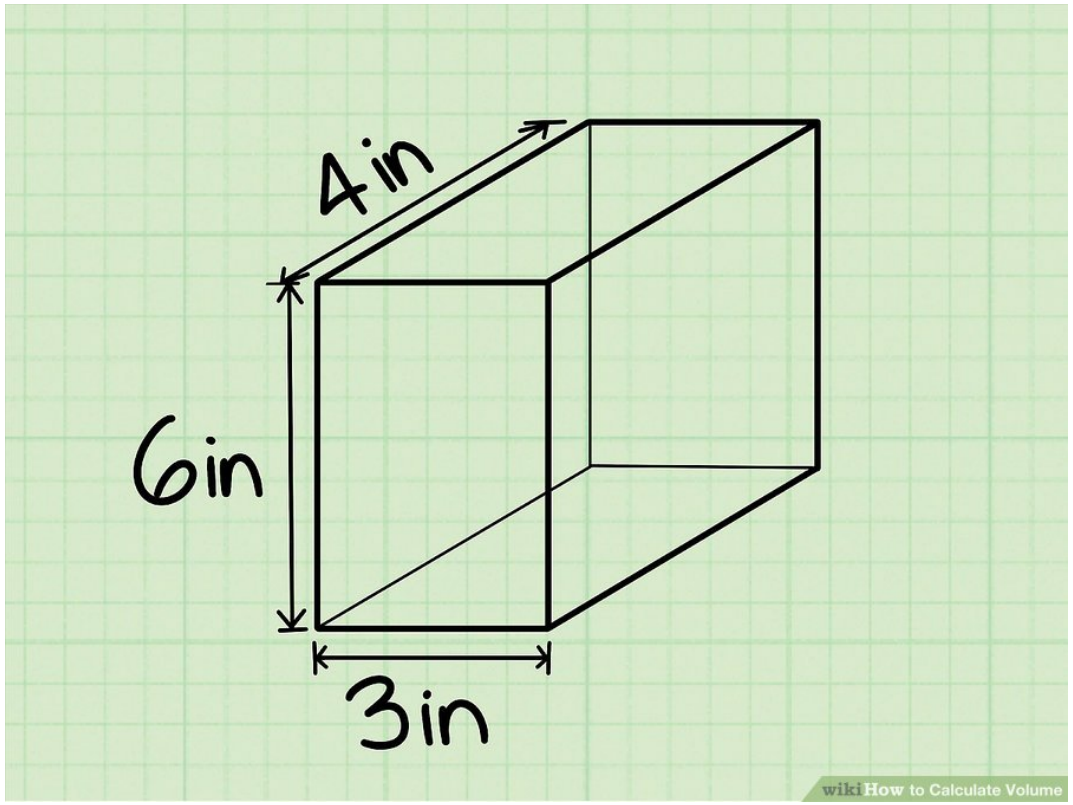
Volume of a Conventional Excavation



= 5ft x 4ft x 3ft

$=60ft^3$

Volume of a Conventional Excavation



$\ell = 4in, w = 3in, h = 6in$

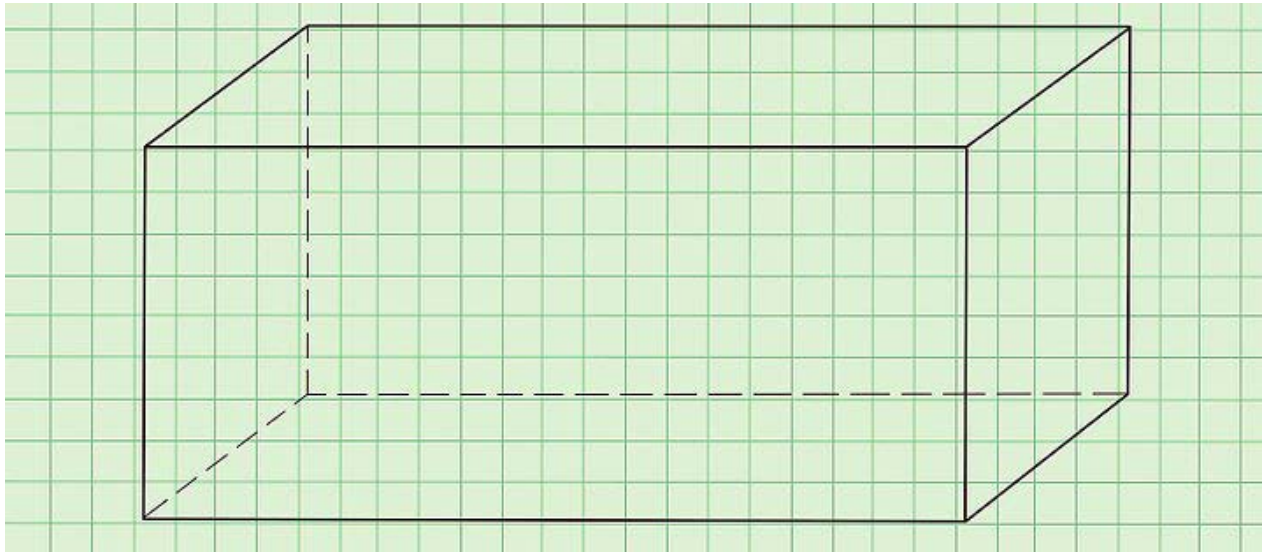
$V = \ell wh$

$V = 4 \times 3 \times 6$

$V = 72$

wikiHow to Calculate Volume

Conventional Worksheet/ Example



L = 20 ft; W = 10 ft; D = 10 ft

Volume = (20 ft)(10 ft)(10 ft)= 2000 ft^3

3 ft/yard => V = (2000 ft^3)(yd^3/27 ft^3) = 74 yd^3

SR table

Area 1 = soil for T&D

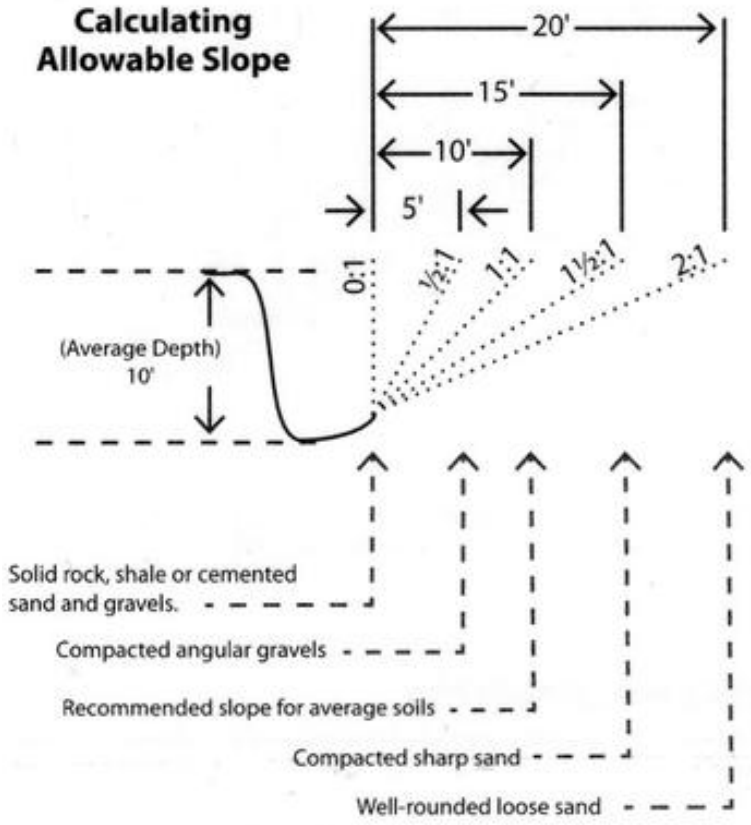
Conventional Excavation Volume	Area 1	Area 2	Area 3	Total
Excavation Length (feet)	20			
Excavation Width (feet)	10			
Excavation Area (square feet)	200		0	
Excavation Depth (feet)	10			
Maximum Excavation Volume (cubic yards†)	75		0	75
LDA Excavation Volume*	**Area 1**	**Area 2**	**Area 3**	**Total**

SLOPING REQUIREMENTS

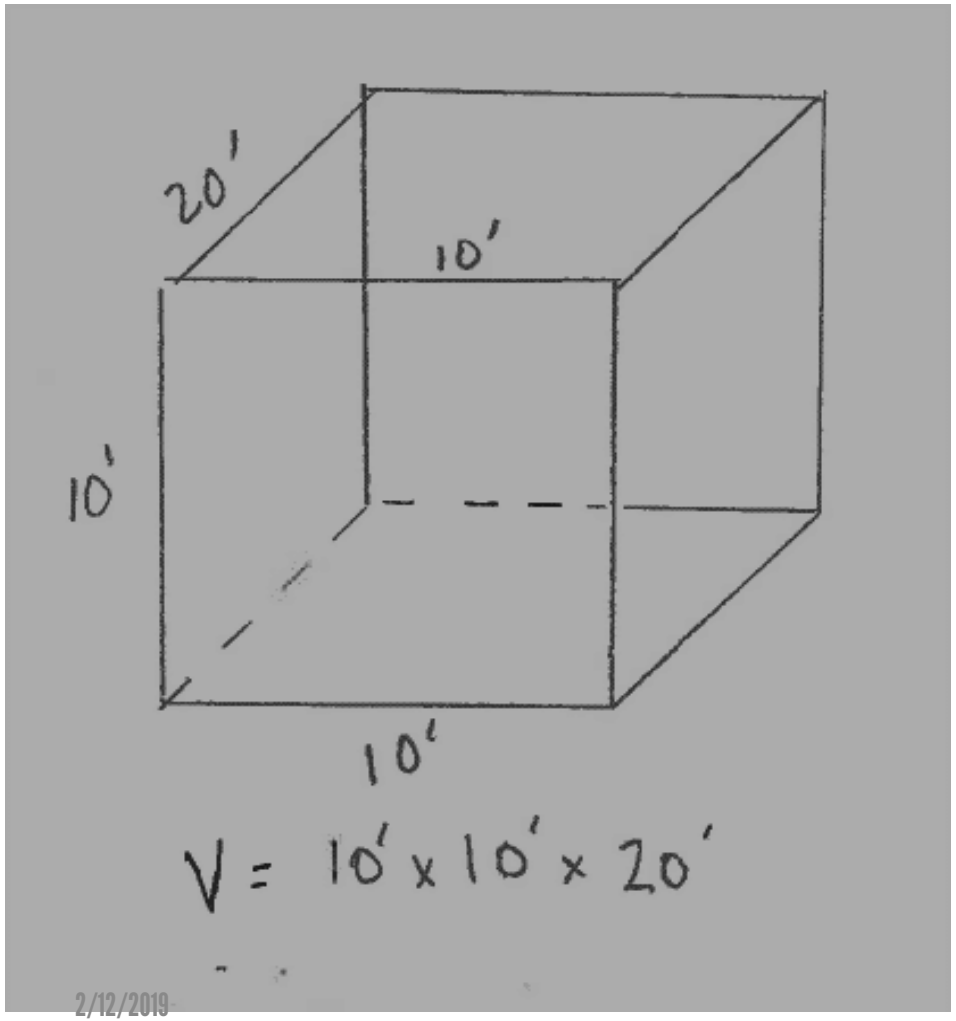
Determining Soil Type		
Type	Description	Examples
A	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater.	Clay, silty clay, sandy clay, clay loam and in some cases: silty clay loam and sandy clay loam.
B	Cohesive soils with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	Angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases silty clay loam and sandy clay loam.
C	Cohesive soils with unconfined compressive strength greater than 0.5 tsf or less.	Granular soils such as gravel, sand and loamy sand; submerged soil or soil from which water is freely seeping; submerged rock that is not stable.

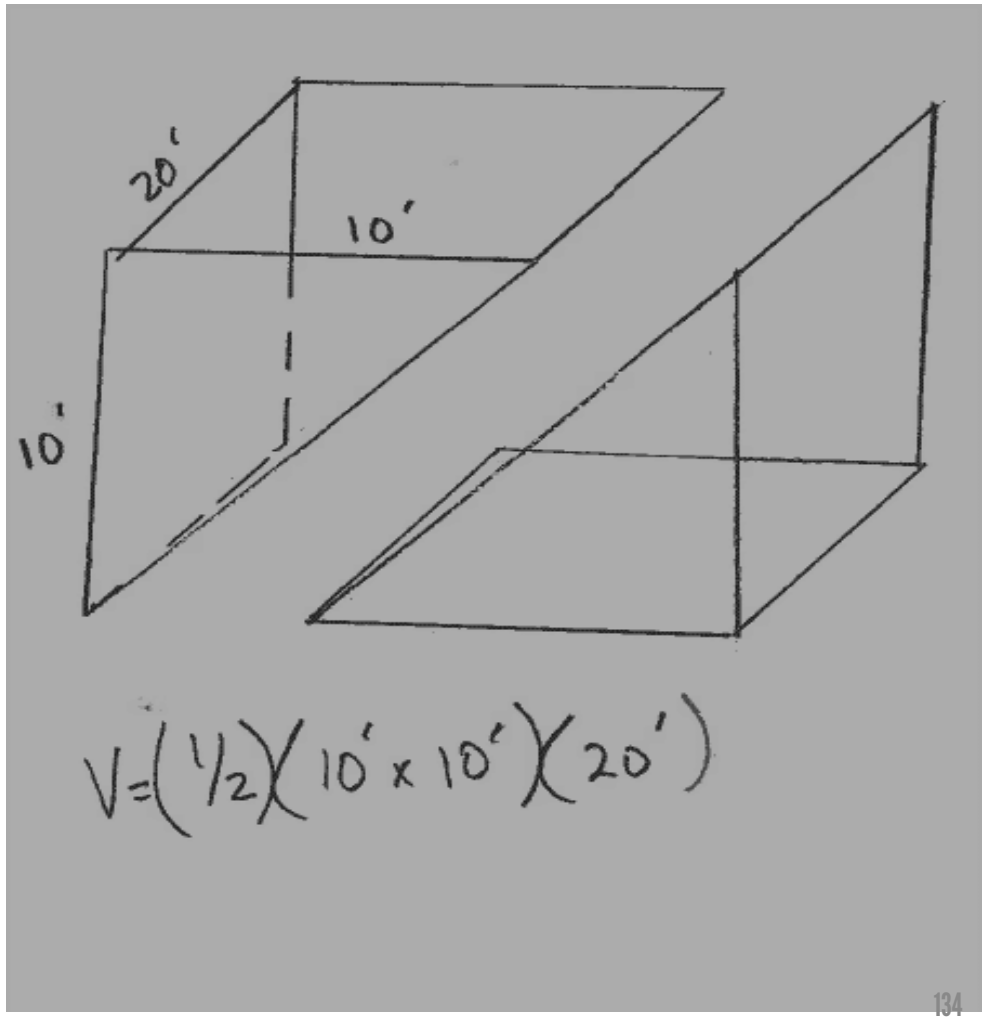
Allowable Slopes	
Soil or Rock Type	Maximum Allowable Slope
Stable Rock:	Vertical
Type A	75%
Type B	100%
Type C	150%

Applies to excavations that are less than 20' in depth. Those that are greater in depth should be designed by a registered professional.



Sloping Worksheet/ Example





SR table

Area 1 = soil for T&D Area 2 = soil for sloping

Conventional Excavation Volume	Area 1	Area 2	Area 3	Total
Excavation Length (feet)	20	20		
Excavation Width (feet)	10	5		
Excavation Area (square feet)	200	100	0	
Excavation Depth (feet)	10	10		
Maximum Excavation Volume (cubic yards†)	75	38	0	113
LDA Excavation Volume*	Area 1	Area 2	Area 3	Total

FDEP Facility ID#: 128711211 **STCM Facility Name:** Convention Excavation with Sloping

Any blank fields are not applicable to the scope of work.

Source Removal Table

SPI Section 10

Sheet Piling

Sheet Piling Length (feet)				
Sheet Piling Depth (feet)				
Sheet Piling Area (square feet†)	**0**			
Sheet Piling Duration (number of days/weeks/months)				
Conventional Excavation Volume	**Area 1**	**Area 2**	**Area 3**	**Total**
Excavation Length (feet)	20	20		
Excavation Width (feet)	10	5		
Excavation Area (square feet)	200	100	0	
Excavation Depth (feet)	10	10		
Maximum Excavation Volume (cubic yards†)	**75**	**38**	**0**	**113**
LDA Excavation Volume*	**Area 1**	**Area 2**	**Area 3**	**Total**
Diameter of LDA (feet)				
LDA boring area (square feet)	0.0	0.0	0.0	
LDA Depth (feet)				
One LDA boring volume - (cubic yards)	0.0	0.0	0.0	
Number of LDA borings				
Maximum Excavation Volume* (cubic yards†)	**0**	**0**	**0**	**0**

Flowable Fill, Backfill, Clean Overburden, Pea Gravel, #57 Stone

Flowable Fill Based on Maximum Volume (cubic yards)	0	
Flowable Fill to allow for Contingency (10%) (cubic yards)	0	
Maximum Clean Backfill Volume (cubic yards†)	**0**	
Clean Backfill based on Maximum Excavation (cubic yards)	113	
Clean Backfill to allow for Compaction (20%) (cubic yards)	23	
Clean Overburden for Reuse (cubic yards)	**38**	
Pea Gravel or #57 Stone (cubic yards)		*(enter 0 tons† in SPI)*
Maximum Clean Backfill Volume (cubic yards†)	**98**	

Dewatering

Groundwater Treatment Technology			
Number of Dewatering Points			
Depth of Dewatering Points			
Point of Discharge			
Permits Required? (NPDES, Local, etc)			
Dewatering Duration (number of days/weeks/months)			

SPI Section 12

Surface Removal

Concrete Removal and Loading (square feet)	**200**	
Concrete Removal and Loading >4" (square feet)	**200**	
Asphalt Removal and Loading (square feet)		
Mixed Debris for Transport and Disposal (tons†)	**6**	

Transport and Disposal

Maximum Excavation Mass @ 1.4 tons/cy (tons)	105.0	
Contingent Transport and Disposal (10%) (tons)	10.5	
Maximum Transport and Disposal (tons†)	**116**	

SPI Section 13

Resurfacing

Asphalt Paving 2" thickness (square feet).	**0**	*(calculation includes 10% contingency)*
Asphalt Paving additional 1" thickness (square feet).		
Concrete Paving 4" thickness (square feet)	**220**	*(calculation includes 10% contingency)*
Concrete Paving additional 1" thickness (square feet)	**440**	
Grass - Sod or Seed and Mulch (square feet)		

Notes:

* LDA volumes for pay items 10-9 through 10-12.b are calculated and will be paid based on auger diameter and boring depth.
Area 1 is for the volume of soil to be excavated and disposed. Area 2 is the volume of soil to be removed for sloping & reused as clean backfill

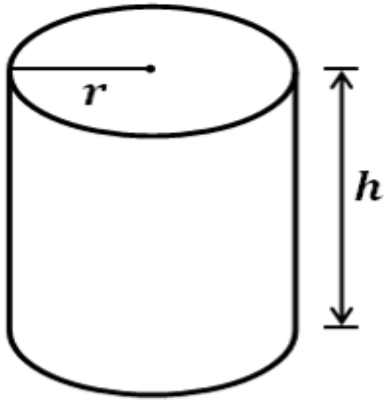
Large Diameter Auger (LDA)

Large Diameter Auger (LDA)

- LDA rig
- Soil “drilled” out
- 5’ diameter and 39” diameter
- Uncased and Cased
- Footprint
- OVA screening optional – step out/step in, terminate, extend borings
- Confirmatory samples (prior to excavation preferred)
- Flowable Fill (80-120 psi)
- Backfill sampling for batch samples

Volume of a Cylinder

Volume of a Cylinder



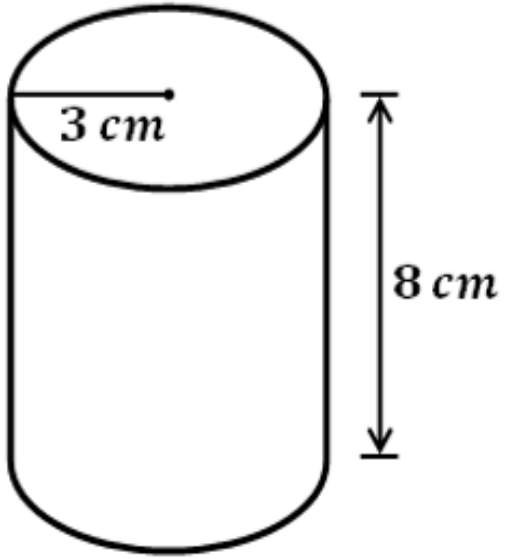
$$Volume = h \times \pi \times r^2$$

h = *height of the cylinder*

$\pi\ (pi) = 3.14$

r = *radius of the base circle*

Example:



$$V = h \times \pi \times r^2$$

$$= 8 \times 3.14 \times 3^2$$

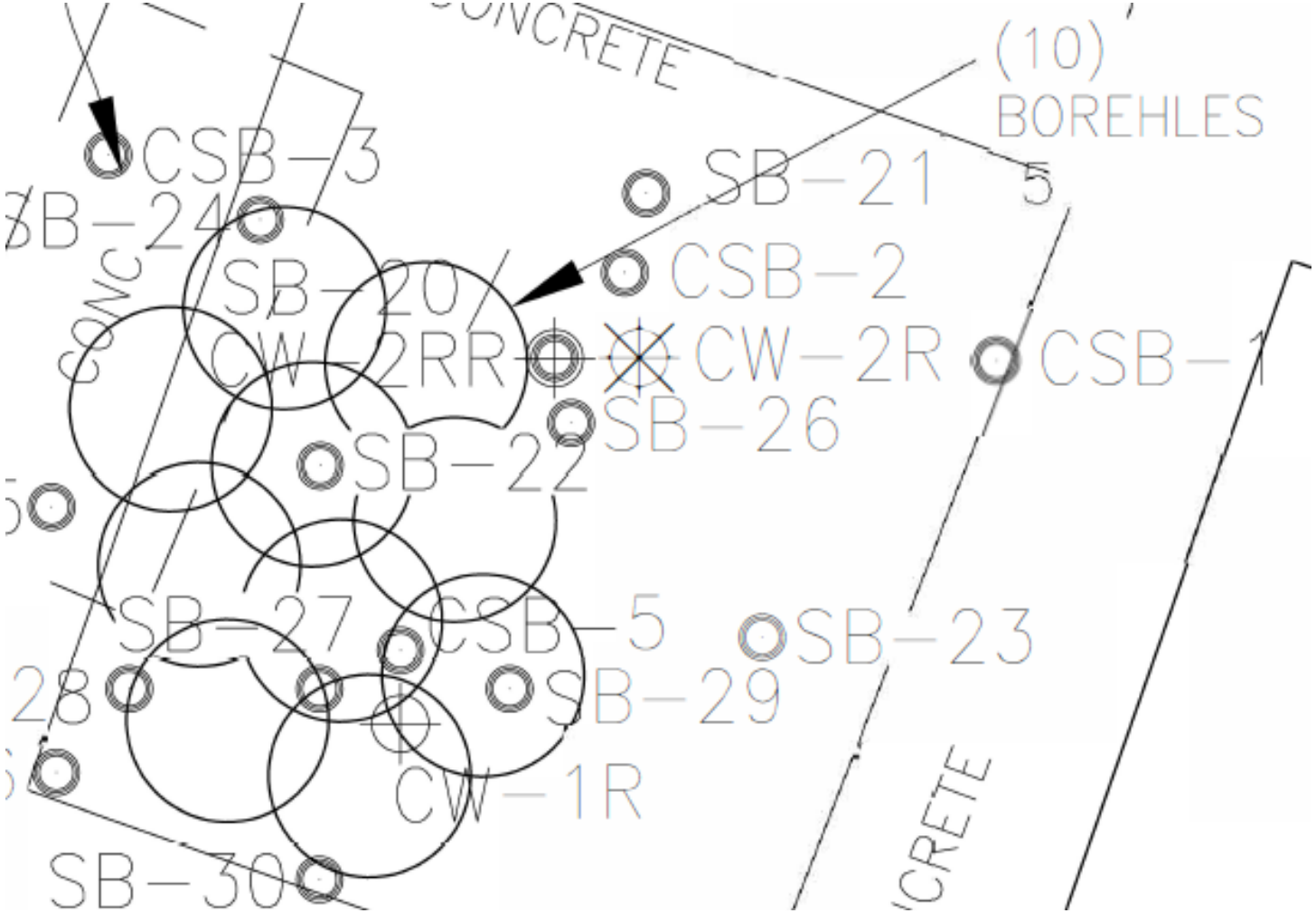
$$= 8 \times 3.14 \times 9$$

$$= 226.08\ cm^3$$

LDA without Casing Example

- 5 foot diameter LDA
- 9 LDAs to 20 ft bls
- Volume of one LDA = $\pi r^2 D = \pi(2.5)^2(20) = 392.5\ ft^3$
- Total Volume = $(9)(392.5\ ft^3) = 3532.5\ ft^3 = 131\ yd^3$

LDA LAYOUT


CONCRETE
(10)
BOREHLES
CSB-3
SB-21
SB-24
SB-20
CSB-2
CW-2RR
CW-2R
CSB-1
SB-26
SB-22
SB-27
CSB-5
SB-23
SB-29
CW-1R
SB-30

LDA with Casing Example

- 5’ diameter LDA
- 10 LDAs to 15’ bls
- 8 outer borings- casing for top 5’-5.3 diameter
- 2 inner boring without casing to 15’ bls
- Total Volume with casing one LDA= $\pi r^2 D = \pi(2.65)(5) = 4.1 yd^3$

Source Removal Table

	Outer Borings Casing		Inner Borings No Casing	
LDA Excavation Volume*	**Area 1**	**Area 2**	**Area 3**	**Total**
Diameter of LDA (feet)	5.3	5.0	5.0	
LDA boring area (square feet)	22.3	19.6	19.6	
LDA Depth (feet)	5.0	10.0	15.0	
One LDA boring volume - (cubic yards)	4.1	7.3	10.9	
Number of LDA borings	8	8	2	
Maximum Excavation Volume* (cubic yards†)	**34**	**59**	**22**	**115**

10-9 throu

Flowable Fill, Backfill, Clean Overburden, Pea Gravel, #57 Stone	
Flowable Fill Based on Maximum Volume (cubic yards)	115
Flowable Fill to allow for Contingency (10%) (cubic yards)	12

Any blank fields are not applicable to the scope of work.

Source Removal Table				
SPI Section 10				
Sheet Piling				
Sheet Piling Length (feet)				
Sheet Piling Depth (feet)				
Sheet Piling Area (square feet†)	**0**			
Sheet Piling Duration (number of days/weeks/months)				
Conventional Excavation Volume	**Area 1**	**Area 2**	**Area 3**	**Total**
Excavation Length (feet)				
Excavation Width (feet)				
Excavation Area (square feet)	0	0	0	
Excavation Depth (feet)				
Maximum Excavation Volume (cubic yards†)	**0**	**0**	**0**	**0**
LDA Excavation Volume*	**Area 1**	**Area 2**	**Area 3**	**Total**
Diameter of LDA (feet)	5.3	5.0	5.0	
LDA boring area (square feet)	22.3	19.6	19.6	
LDA Depth (feet)	5.0	10.0	15.0	
One LDA boring volume - (cubic yards)	4.1	7.3	10.9	
Number of LDA borings	8	8	2	
Maximum Excavation Volume* (cubic yards†)	**34**	**59**	**22**	**115**
Flowable Fill, Backfill, Clean Overburden, Pea Gravel, #57 Stone				
Flowable Fill Based on Maximum Volume (cubic yards)	115			
Flowable Fill to allow for Contingency (10%) (cubic yards)	12			
Maximum Clean Backfill Volume (cubic yards†)	**127**			
Clean Backfill based on Maximum Excavation (cubic yards)	0			
Clean Backfill to allow for Compaction (20%) (cubic yards)	0			
Clean Overburden for Reuse (cubic yards)				
Pea Gravel or #57 Stone (cubic yards)		*(enter 0 tons† in SPI)*		
Maximum Clean Backfill Volume (cubic yards†)	**0**			
Dewatering				
Groundwater Treatment Technology				
Number of Dewatering Points				
Depth of Dewatering Points				
Point of Discharge				
Permits Required? (NPDES, Local, etc)				
Dewatering Duration (number of days/weeks/months)				
SPI Section 12				
Surface Removal				
Concrete Removal and Loading (square feet)	**500**			
Concrete Removal and Loading >4" (square feet)	**500**			
Asphalt Removal and Loading (square feet)				
Mixed Debris for Transport and Disposal (tons†)	**14**			
Transport and Disposal				
Maximum Excavation Mass @ 1.4 tons/cy (tons)	161.0			
Contingent Transport and Disposal (10%) (tons)	16.1			
Maximum Transport and Disposal (tons†)	**178**			
SPI Section 13				
Resurfacing				
Asphalt Paving 2" thickness (square feet).	**0**	*(calculation includes 10% contingency)*		
Asphalt Paving additional 1" thickness (square feet).				
Concrete Paving 4" thickness (square feet)	**550**	*(calculation includes 10% contingency)*		
Concrete Paving additional 1" thickness (square feet)	**1100**			
Grass - Sod or Seed and Mulch (square feet)				

Notes:

* LDA volumes for pay items 10-9 through 10-12.b are calculated and will be paid based on auger diameter and boring depth. Casing will based on top five (5) feet for all the outer borings. The two inner borings will not be using casing.

† *Values are rounded up to the next whole number.*


KOMATSU

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TIPS FOR RA & SR POs

Chuck Williams
Environmental Consultant, FCCM
Florida Department of Environmental Protection
Petroleum Restoration Program
ATC Contracts Section

SR Cleanup Phases & Timeframes

- Soil SR POs must include site restoration & well replace & ≤ $325K e-quote threshold (excluding contingent funding)
- No longer add concurrent PARM
- Original POs ≤ 18 months from issue date to final deliverable due date
- COs ≤ 24 months from issue date to the PO's end date

SR Quotes

- 1 quote if ≤ $2,500* (2 if in-house) & 3 if > $2,500*
  *(*aggregate of all quotes in PO for same vendor)*
- Vendor name, date, contact, legible, all pages, add pay item #
- Must not expire before PO issuance & ≤ 6 months old
- Require sufficient details, specifications, rental period, breakdown* *(*materials require units and unit rates)*

SR Quotes

- No confidential disclaimers in quotes or e-mails per Directive 301 *(replace or author strike/comment/sign)*
- Add tax & shipping only if quote specifically excludes
- No insurance on rental equipment *(overhead)*
- Multiple quotes must have same scope/specifications
- "Sole source" quotes > $2,500 require justification

SR Quotes

- Fuel quotes should specify location, type & price per gallon
  - ATC should provide fuel usage calculations
- Lowest “aggregate” quote for multiple pay items may be approved if total cost is lowest of 3, add statement in MFMP
- Quotes should not show rates included in contract

SR Tables

- SAS table - Encore™ soil samplers not subject to “expedited turnaround”
- SR table - additional removal/loading of concrete > 4” (12-2) for all over 4”, not per 1” like concrete paving (13-4)
- SR tables must be consistent with SPI & other tables *(use notes section for clarifications)*

SR SPI Related

- Additional laboratory surcharge (9-75 - 9-77) quantity = sum of the cost of all affected analyses in task *(7d/3d/1d)*
- Reimbursable pay items (22-X) - do not include vendor name in description
- Cleanup related "per diem" use 4-1.A, not 4-1.B
- Repetitive reimbursable items use the same pay item #

SR Not Authorized/Duplication

- "Soil Source Removal" pay items (10) include:
  - Temporary security fencing *(6 foot)*
  - Safety devices *(barricades, lights, signs, trench boxes/plates)*
  - May use trench boxes for shoring if not soley as safety devices
  - Storm water & erosion control
  - On site storage, roll off boxes or tanks < 2,000 gal
  - Sampling/testing of backfill or flowable fill

SR Not Authorized/Duplication

- Concrete paving (13) shall meet the strength & reinforcement specs in RAP & PRP standard specs
  - No added costs for higher strength or reinforcement *(>3,000 psi, fiber mesh or rebar)*
  - Exception for steel rebar interval "tie-ins" in existing concrete adjacent to new concrete *(reimbursable)*

SR Miscellaneous

- Dewatering system (10-18 thru 10-23):
  - Base cost includes 12 well points x # days/weeks
  - Add # additional points x # days/weeks for base ÷ by 2 (ru)
  - Example 41 points for 3 weeks - base 3 weeks of 10-20,then use 44* sets of 10-21 *(*41-12 = 29 x 3 = 87 ÷ 2 = 43.5, round to 44)*
- GW treatment package (16) allowed for SR dewater

SR Miscellaneous

- LDA Excavation & loading has 6 options based on total cubic yards, casing & driven casing (10)
  - ≤ vs. > 300 cubic yards based on total volume of the LDA excavation not the subset with surface casing or driven casing
  - If casing is not for the entire LDA, “with surface casing” or “with driven casing” is based only on depth interval with casing
- ADaPT EDDs not required for clean backfill samples

SR Miscellaneous

- T&D for additional soil based on weight tickets after leaving site may be allowed by RFC if:
  - RFC is received within 2 working days of day the additional soil was transported off site
  - The volume/weight of additional soil is ≤ 20% authorized in PO
- May allow 4 hrs/week on-site PE oversight during SR (10)

SR Miscellaneous

- Which pay items include/exclude “mobilization”?
  - Materials transportation/delivery (mobilization included)
    (*vac trucks, dump trucks, flowable fill, clean fill, contaminated soil T&D, PCW T&D, product T&D, new carbon, gravel, stone, rock, tank R&D, MD/Concrete T&D, asphalt/concrete removal, loading & paving, sod/seed/mulch, roll off del, p/u & rent*)

SR Miscellaneous

- Which pay items include/exclude “mobilization”?
  - Equipment mobilization (mobilization allowed)
    (light & HD trucks/trailers, drill/DPT/LDA rigs, excavators, loaders, cranes, remediation equipment (except episodic 16.B & O&M 17 & repair/replace for PT/episodic 16 & RA equipment 18)

SR Miscellaneous

- Construction Drawings and Specs Report typically not allowed for SRs, but exceptions include:
  - Additional scope required for stabilization such as shoring (steel panel or LDA)
  - Specifically required by permitting entity
  - Add justification in SOW task description

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Post Action Remediation Monitoring (PARM)

John Wright, P.E.

Post Active Remediation Monitoring

Following a Source Removal:

- 1 Groundwater Sampling Event is Required if NO Previous Groundwater Contamination Existed
- 4 Quarters of Groundwater Sampling are Required if Previous Groundwater Contamination Existed

Post Active Remediation Monitoring

Following Operation of a Remediation System:

- 4 Quarters of Groundwater Sampling are Required
- Soil Sampling is Required if Previous Soil Contamination Existed

Post Active Remediation Monitoring

Following a Chemical Injection:

- Follow the Underground Injection Control (UIC) Memo
  -Groundwater Monitoring for Chemical Components and Byproducts (Specified in the Product Acceptance Letter)

Contact Information

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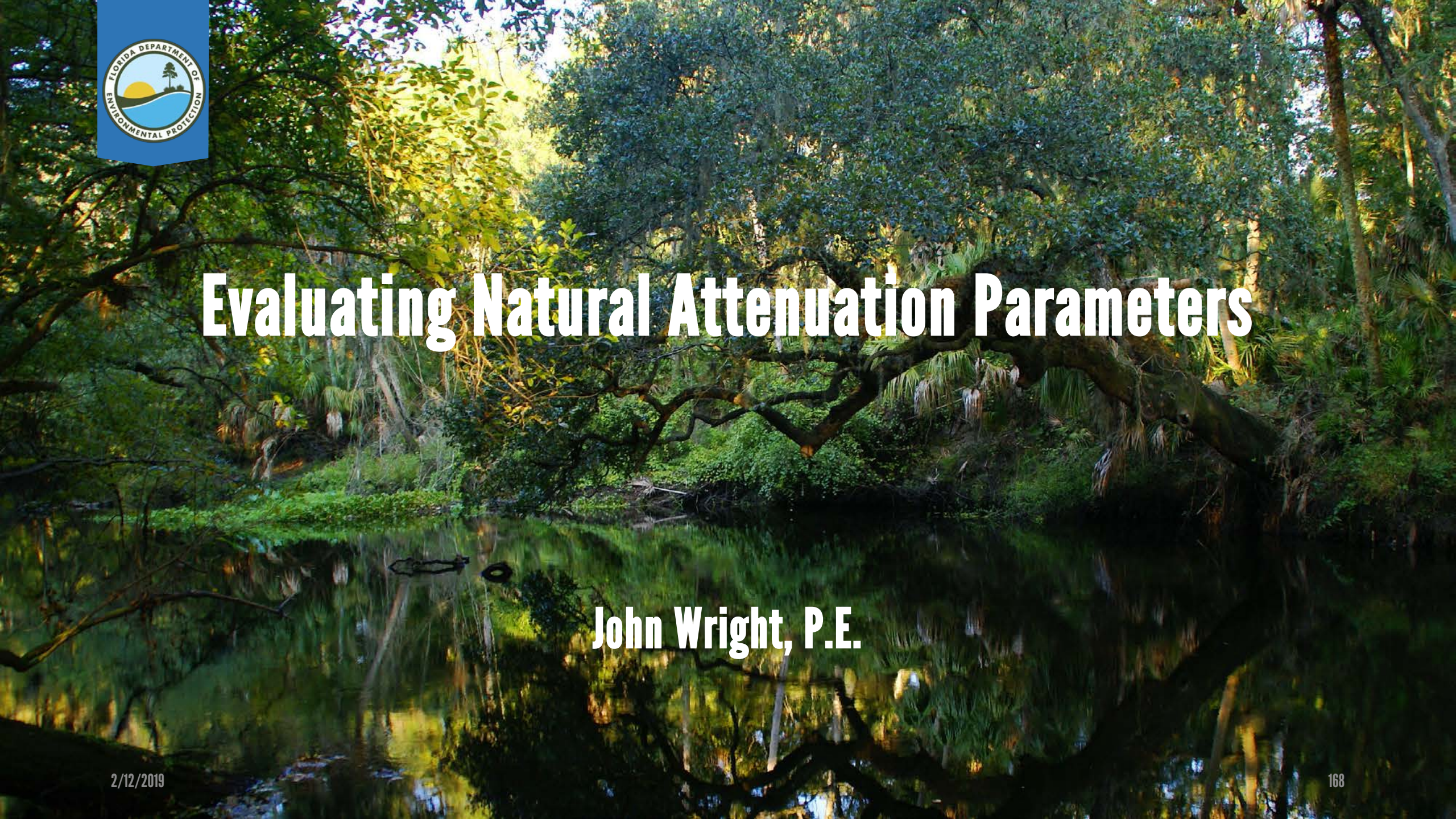


Evaluating Natural Attenuation Parameters

John Wright, P.E.

Natural Attenuation Parameters

- Dissolved Oxygen (DO)
- Nitrate
- Nitrite
- Manganese
- Insoluble Iron (Iron III)
- Dissolved Iron (Iron II)
- pH
- Oxidation Reduction Potential (ORP)
- Temperature

Biodegradation

Aerobic Biodegradation:

AEROBIC BIODEGRADATION

Aerobic Biodegradation
ORP = 820 mV

FIGURE 1
Oxidation Reduction Potentials for Electron Receptors (Acceptors)

$O_2 + 4H^+ + 4e$ ——$2H_2O$

Benzene Oxidation Example:

$$15\ O_2 + 2C_6H_6 \rightarrow 12CO_2\ (g) + 6H_2O$$

Biodegradation

Anaerobic Biodegradation:

ANAEROBIC BIODEGRADATION

Nitrate Reduction "Denitrification"
ORP = 740 mV

$2NO_3 + 12H^+ + 10e^- \longrightarrow N_2 + 6H_2O$

Manganese Reduction
ORP = 520 mV

$MnO_2\,(s) + HCO_3 + 3H^+ + 2e \longrightarrow MnCO_3(s) + 2H_2O$

Iron Reduction
ORP = -50 mV

$FeOOH(s) + HCO_2^- + 2H^+ + e^- \longrightarrow FeCO_3 + 2H_2O$

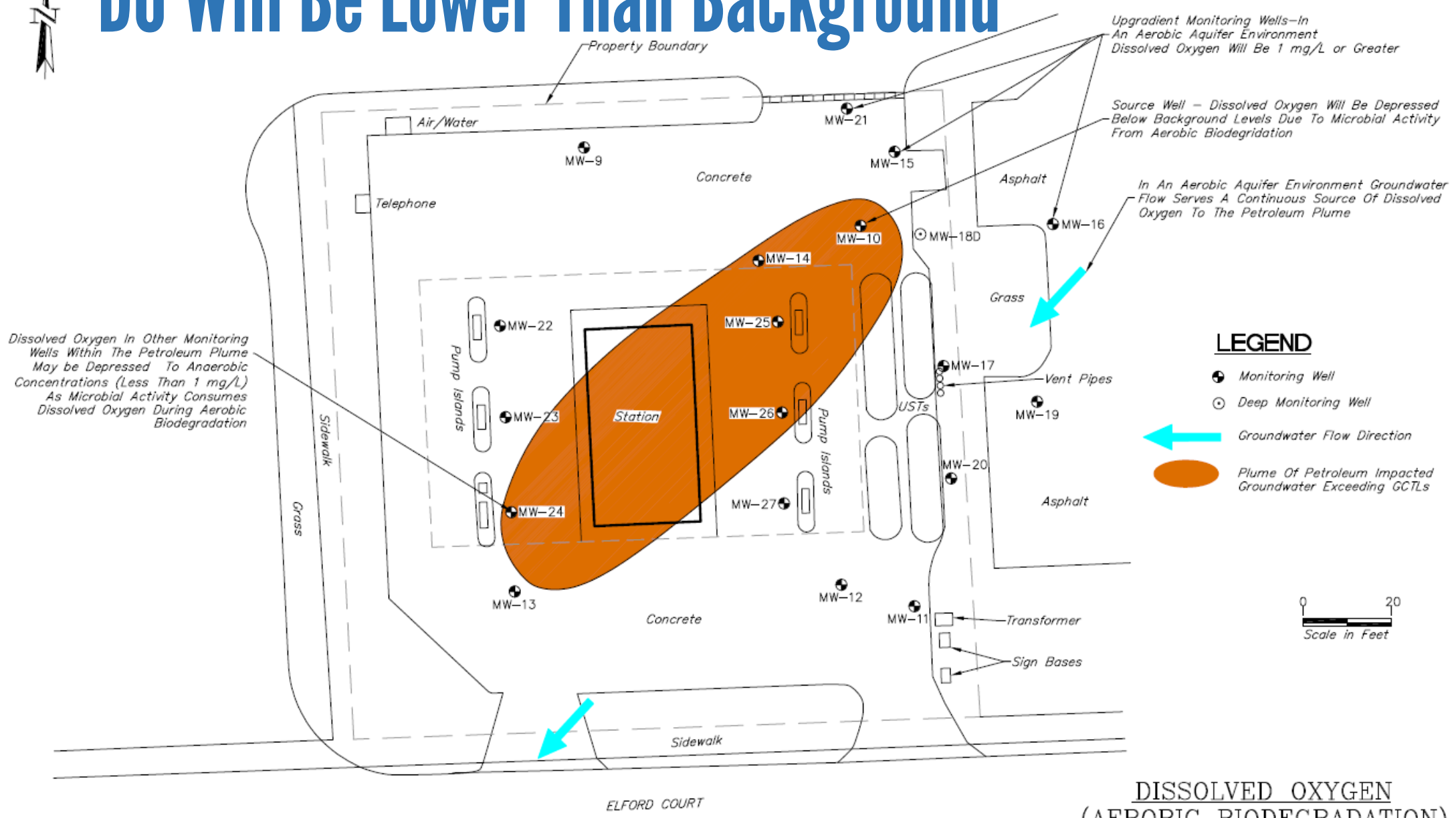
Sulfate Reduction
ORP = -220 mV

$SO_4^{2} + 9H^+ + 8e^- \longrightarrow HS + 4H_2O$

Carbon Dioxide Reduction "Methanogenisis"
ORP = -240 mV

$CO_2 + 8H^+ + 8e^- \longrightarrow CH_4 + 2H_2O$

DO Will Be Lower Than Background



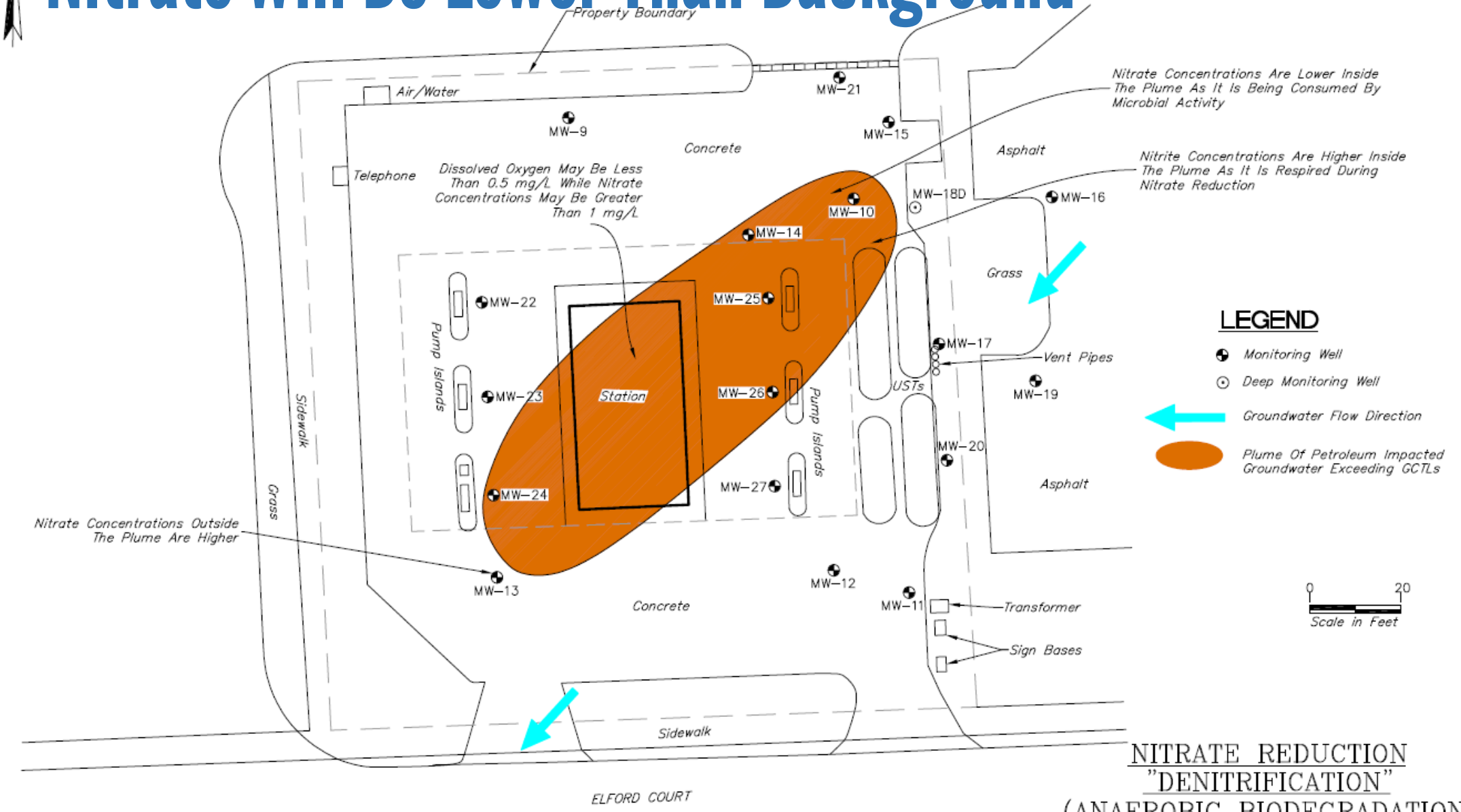
DISSOLVED OXYGEN
(AEROBIC BIODEGRADATION)
AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

2/12/2019

091917

Nitrate Will Be Lower Than Background

FIGURE 4

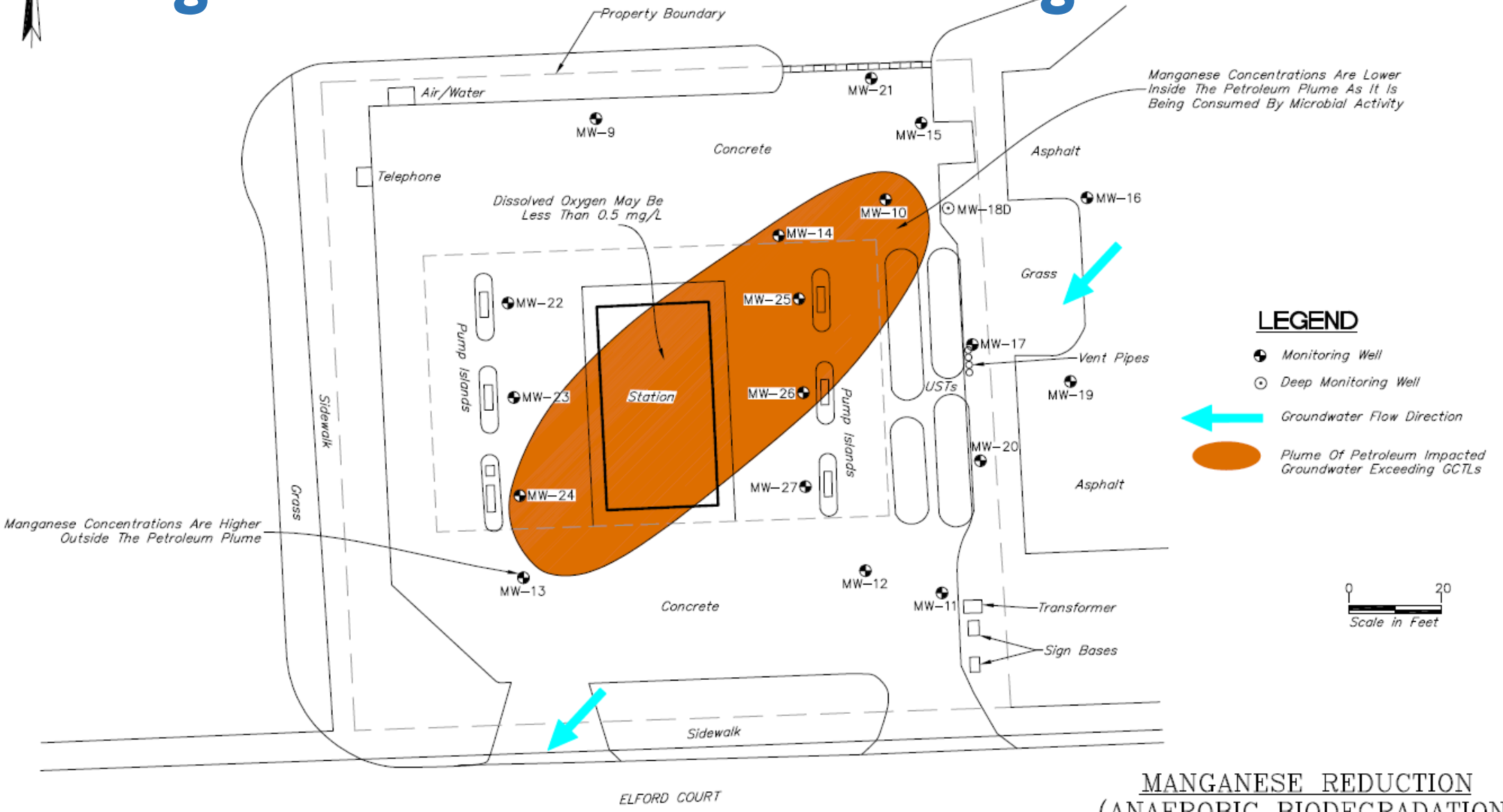


NITRATE REDUCTION
"DENITRIFICATION"
(ANAEROBIC BIODEGRADATION)

AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

Manganese Will Be Lower Than Background

FIGURE 5



MANGANESE REDUCTION
(ANAEROBIC BIODEGRADATION)

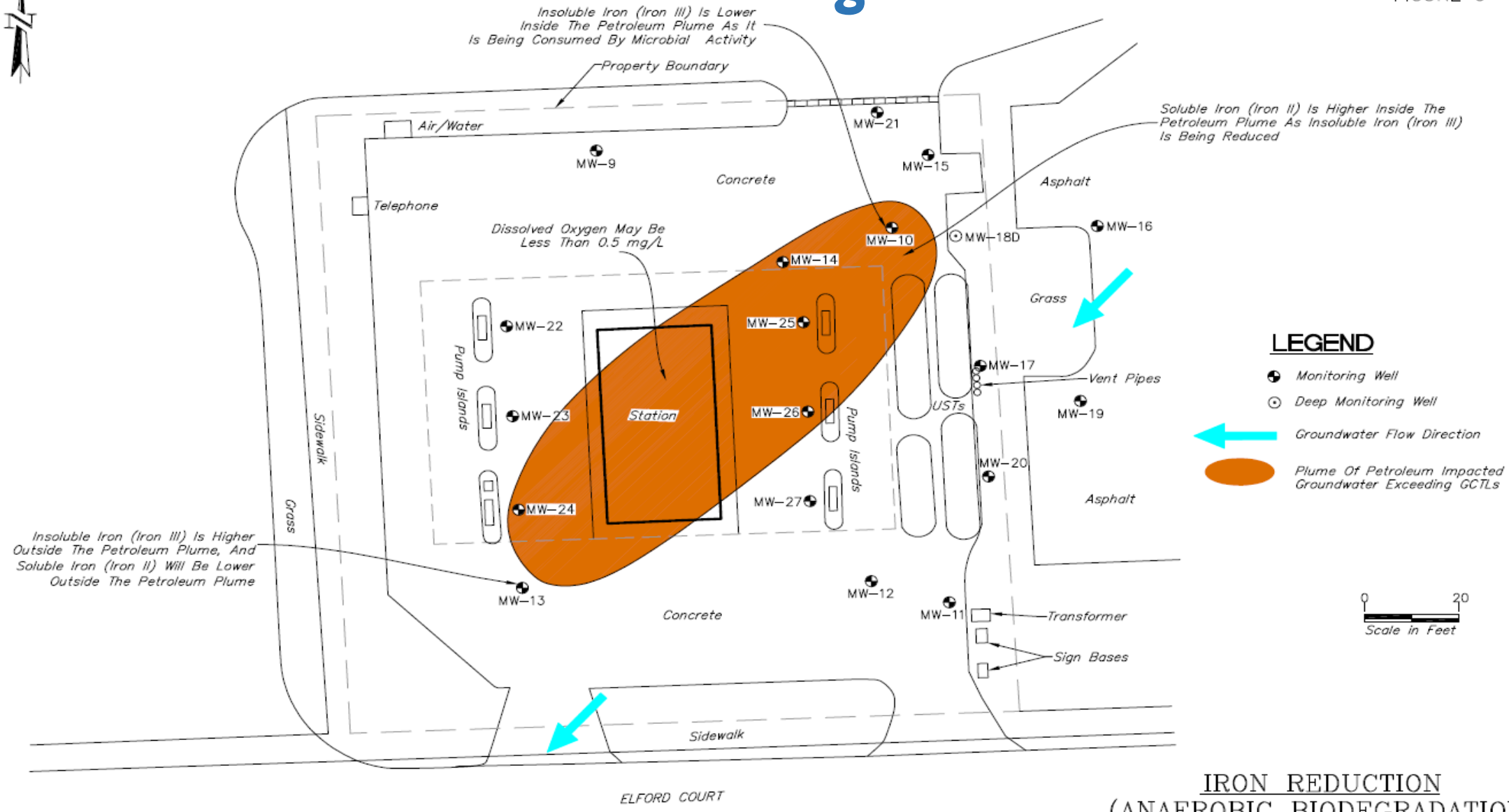
AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

2/12/2019

091917

Iron III Will Be Lower Than Background

FIGURE 6

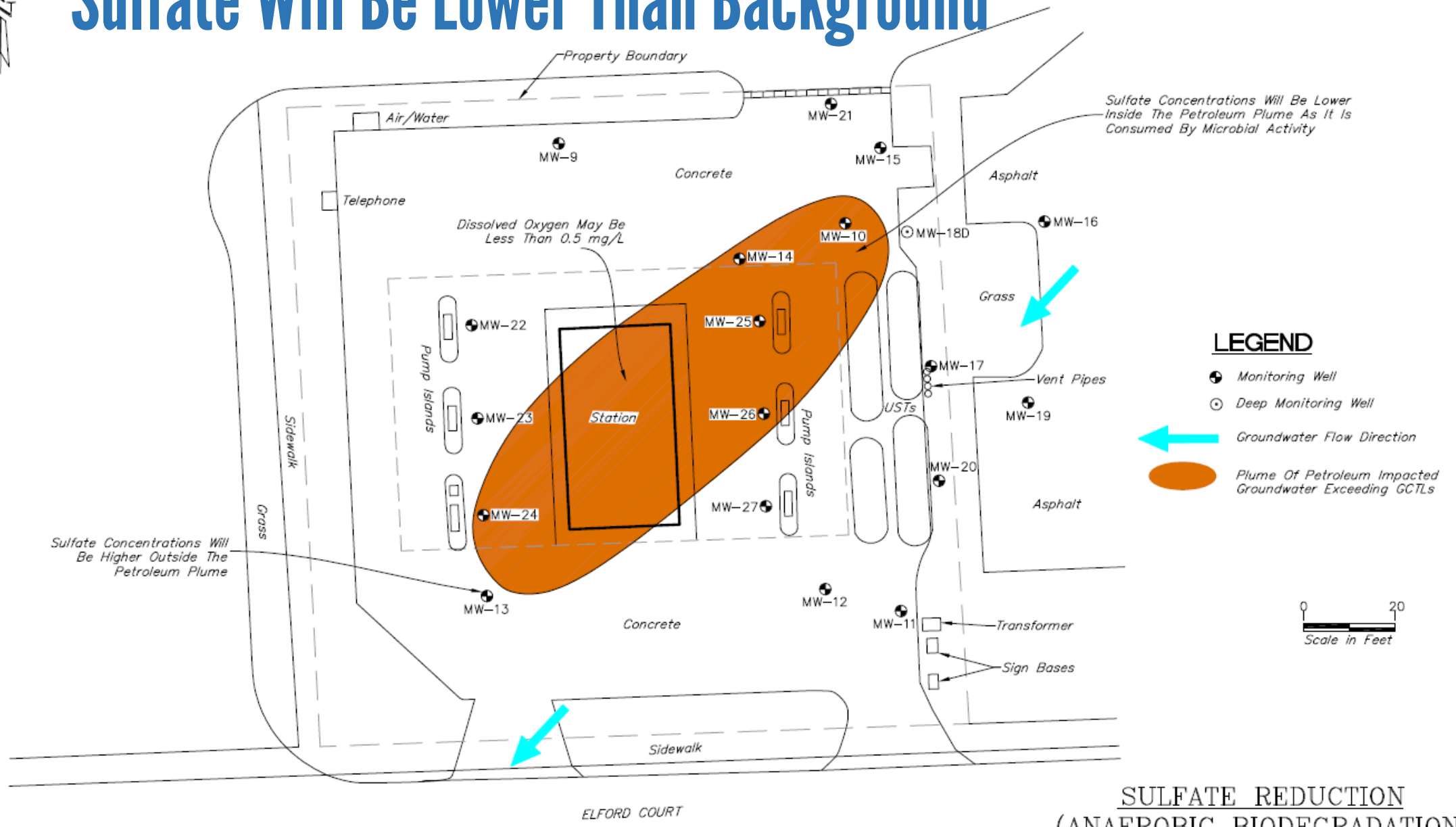


IRON REDUCTION
(ANAEROBIC BIODEGRADATION)

AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

Sulfate Will Be Lower Than Background

FIGURE 7

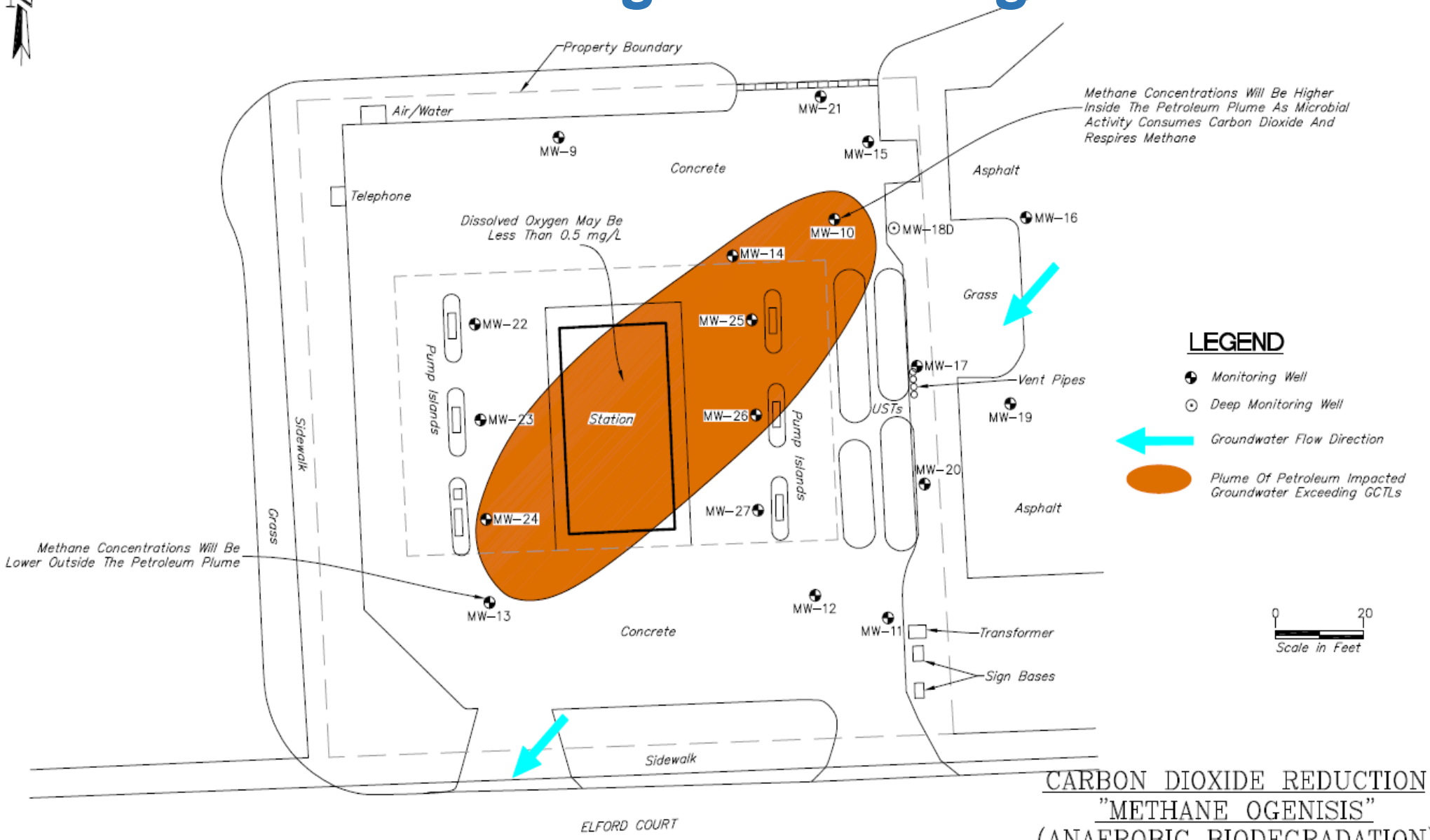


SULFATE REDUCTION
(ANAEROBIC BIODEGRADATION)

AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

Methane Will Be Higher Than Background

FIGURE 8



CARBON DIOXIDE REDUCTION
"METHANE OGENISIS"
(ANAEROBIC BIODEGRADATION)

AARON'S DODGE & DATSUN
1160 ELFORD COURT
DELRAY BEACH, FLORIDA

References:

- Division of Waste Management, Petroleum Restoration Program, Technical Protocol for Evaluating Natural Attenuation Parameters at Sites with Petroleum Contaminated Groundwater, January 2018

Contact Information

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System Performance

Florida Department of Environmental Protection
Petroleum Restoration Program

Performance - Not Just Runtime

- If system is running, is it performing?
- Key things to verify:
  - Mass recovery
  - Dissolved oxygen, pressures, and flows
  - Depth to water and plume capture

System Runtime

- Must be > 80% to receive full payment
- Calculated in RA report tables 2, 3a, 3b and 3c
- If runtime < 80% proration is required for:
  - Section 17 - O & M
  - Section 18 - System Use (unless state owned)
  - Section 21-8 PE Oversight of O & M

Approved Downtime

- Approved downtime is entered into runtime calculation tables

- Approved downtime allowed for:
  - Annual sampling
  - Severe weather
  - Conditions outside control of contractor

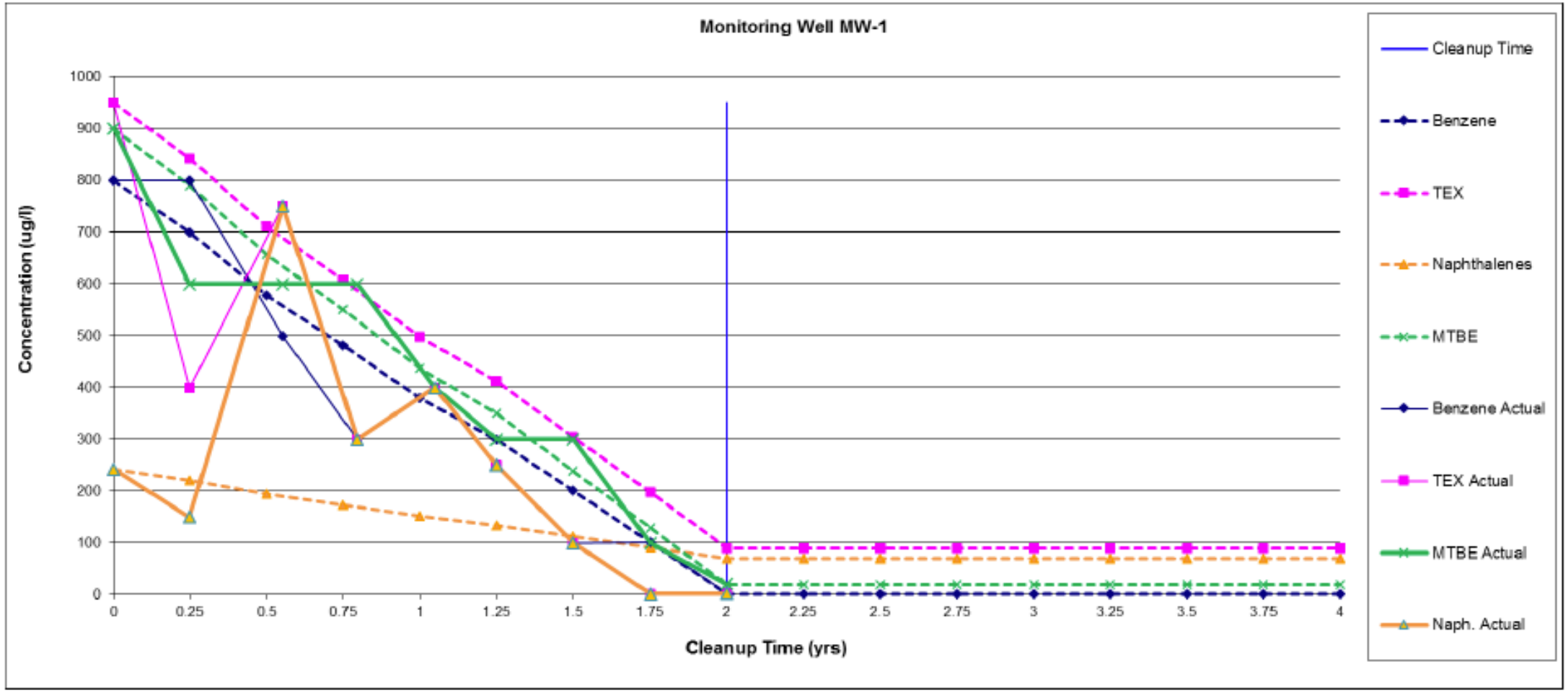
Milestones

TABLE 1B: SITE PERFORMANCE SUMMARY			
Facility Name:	DEP BMC	Startup Date:	2/12/2006
Facility Address:	2600 Blairstone Road, Tallahassee	System Type:	0
FDEP FAC ID:	123456789		

Key Wells Meeting All Milestones (yes/no)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
MW-1																
MW-2																
MW-3																
MW-4																
MW-5																
MW-6																
MW-7																

Milestones


Monitoring Well MW-1
Concentration (ug/l)
1000
900
800
700
600
500
400
300
200
100
0
0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5
3.75
4
Cleanup Time (yrs)
Cleanup Time
Benzene
TEX
Naphthalenes
MTBE
Benzene Actual
TEX Actual
MTBE Actual
Naph. Actual

Options To Enhance System

- Pulsing the system
  - Zoned operation
  - Cycle the entire system
- Add treatment points/modify flow
- Switching to episodic treatment
  - Allows use of smaller equipment
- Changing to bio-sparging
  - Uses less power and equipment
  - Vapors may be an issue
  - Difficult with shallow water table

Data Required During O&M

- System influence parameters
  - Water/product levels
  - Dissolved oxygen
  - Recovered vapor concentrations
- Groundwater quality - monitoring wells
  - Source area and down gradient
  - Sampled quarterly for the first year
- Regulatory requirements
  - Air emission treatment for at least 30 days
  - May be discontinued if less than 13.7 pounds/day
  - Treated water discharge sampling

Options During RA

- 62-780.700, F.A.C., allows the following to be proposed and justified during RAP implementation
- Supplemental assessment
  - Collect soil data
  - Additional monitoring wells
- RAP modification
  - Add treatment wells – deeper, shallower
  - Source removal
  - Add innovative technology - biological or chemical treatment
- Natural Attenuation Monitoring (NAM)

When To Turn A System Off

- Evaluate groundwater data
  - Toluene most biodegradable
  - Xylenes least biodegradable
  - Look for high baseline concentrations
- Evaluate vapor influent data
  - Are you recovering any mass?
  - Does pulsing change recovery?
- Collect soil confirmation data

Discussion Topics

- What are the critical things to look at in a startup report?
- How do we evaluate system efficiency?
- What are critical things to look for in an annual report?
- How do we decide when it is time to turn a system off?

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FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION