TECHNICAL GUIDANCE

GROUND WATER REMEDIAL INVESTIGATIONS UNCONSOLIDATED DEPOSITS OF NEW JERSEY

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Active Environmental Technologies, Inc.
Remediation Design & Construction

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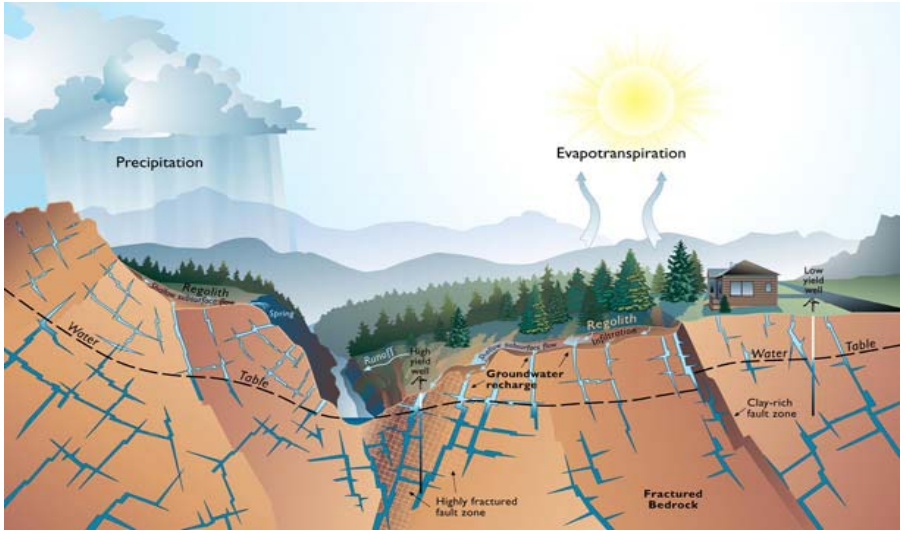
THE OLD DAYS...GONE BYE...



TECHNICAL REGULATIONS REQUIRE A REMEDIAL INVESTIGATION OF GROUND WATER (7:26E-4.4)

WHEN ?

1. Previous Ground Water Sample Exceeds **Any** GW Quality Standards
2. Soil Sample Within 2.0' of Saturation Zone/Bedrock Exceeds Soil Standards
3. Soil Contamination Exceeds Standards & To Be Left In-Place
4. Any Contaminant Water Solubility Greater Than 100 mg/liter

REMEDIAL INVESTIGATION
Ground Water (Section 3.0)

PURPOSE :

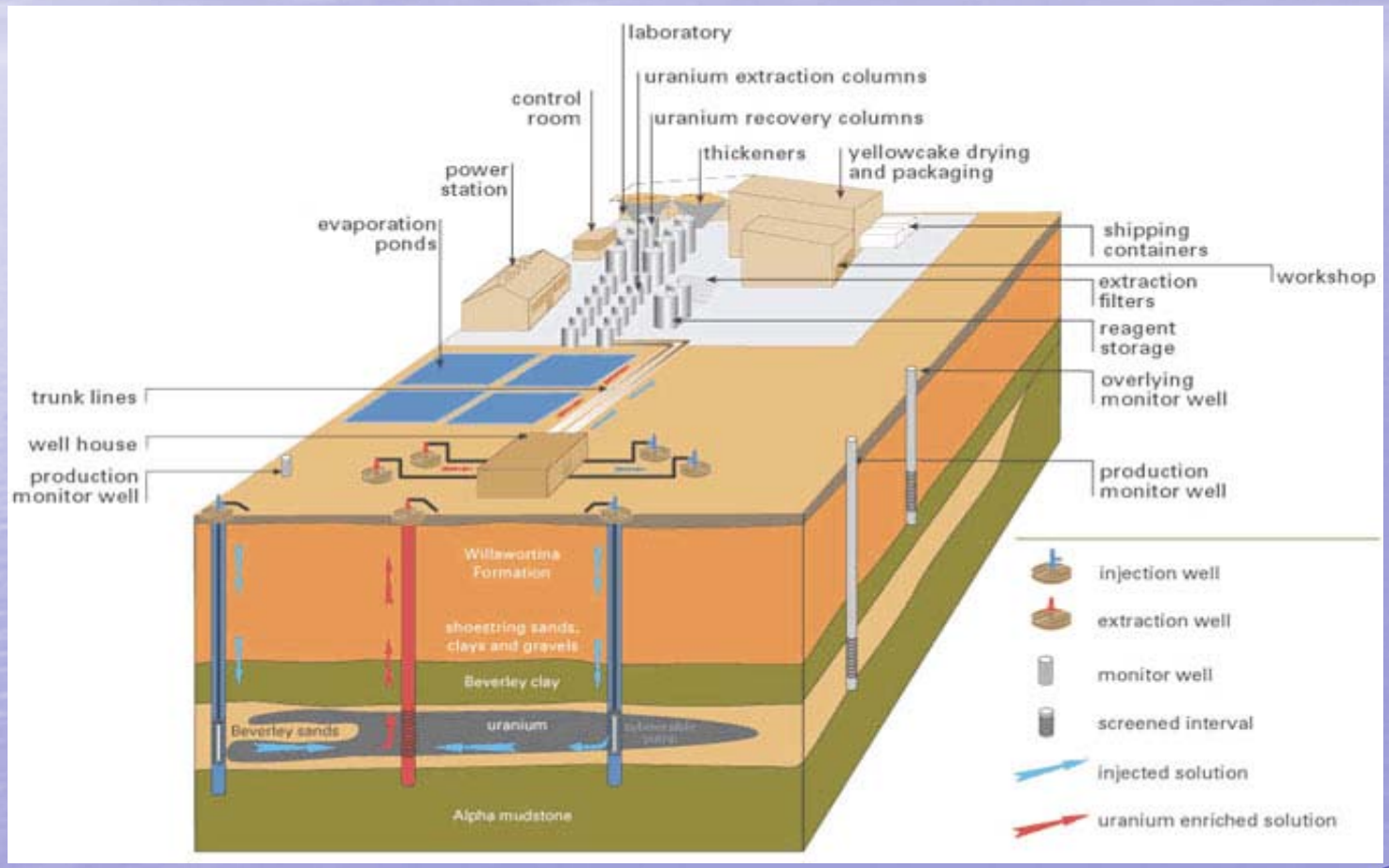
- Characterize Site Hydrostratigraphic Units
- Delineate Ground Water Contamination
- Identify Sources of Ground Water Contamination

KEY TO ANY REMEDIAL INVESTIGATION

"Hydrogeological Model"

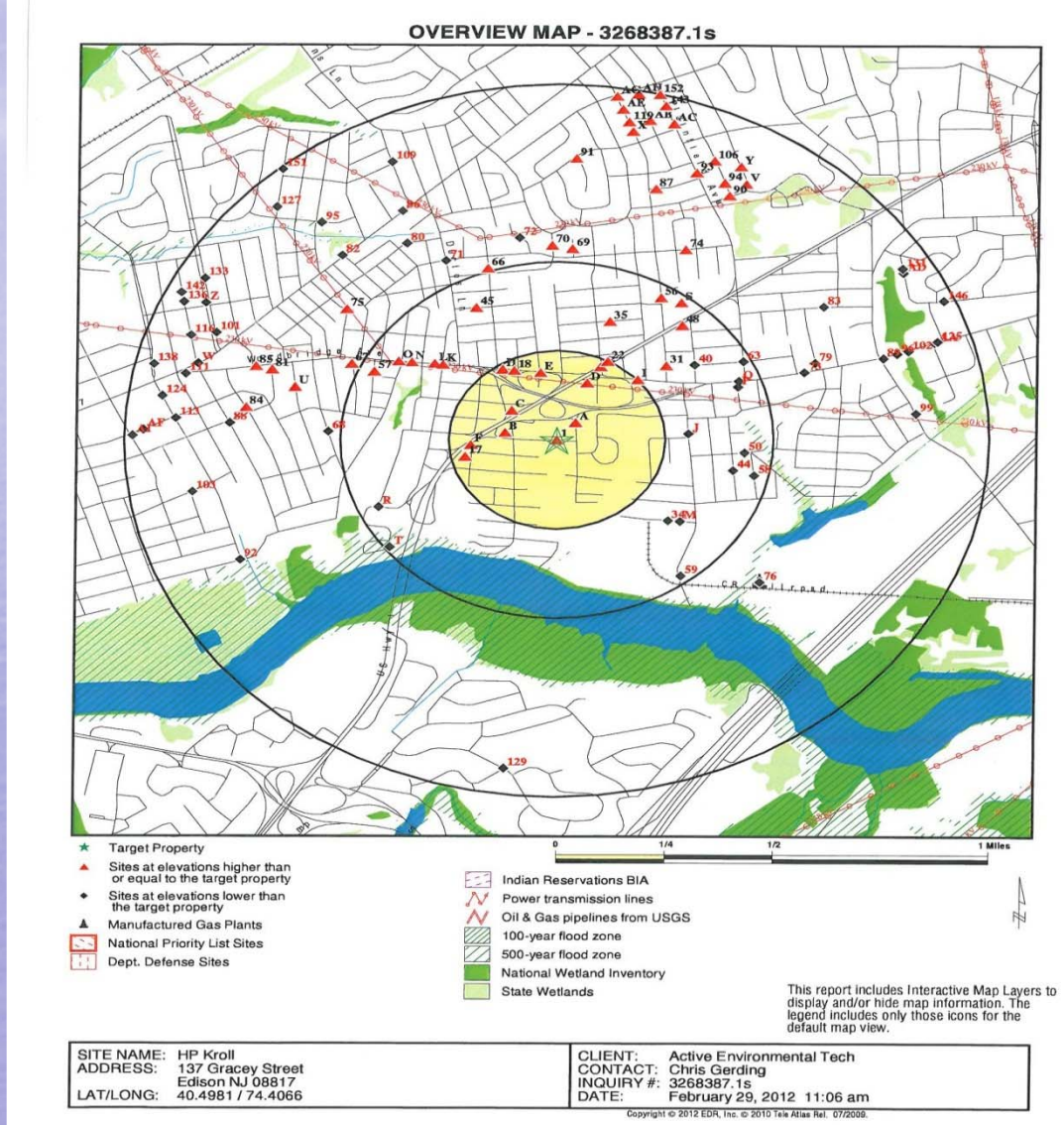
(NOTE : New Guidance Appendix - Details Methodologies)

3D HYDROGEOLOGICAL MODEL
DEVELOPED FROM OTHERS' INFORMATION



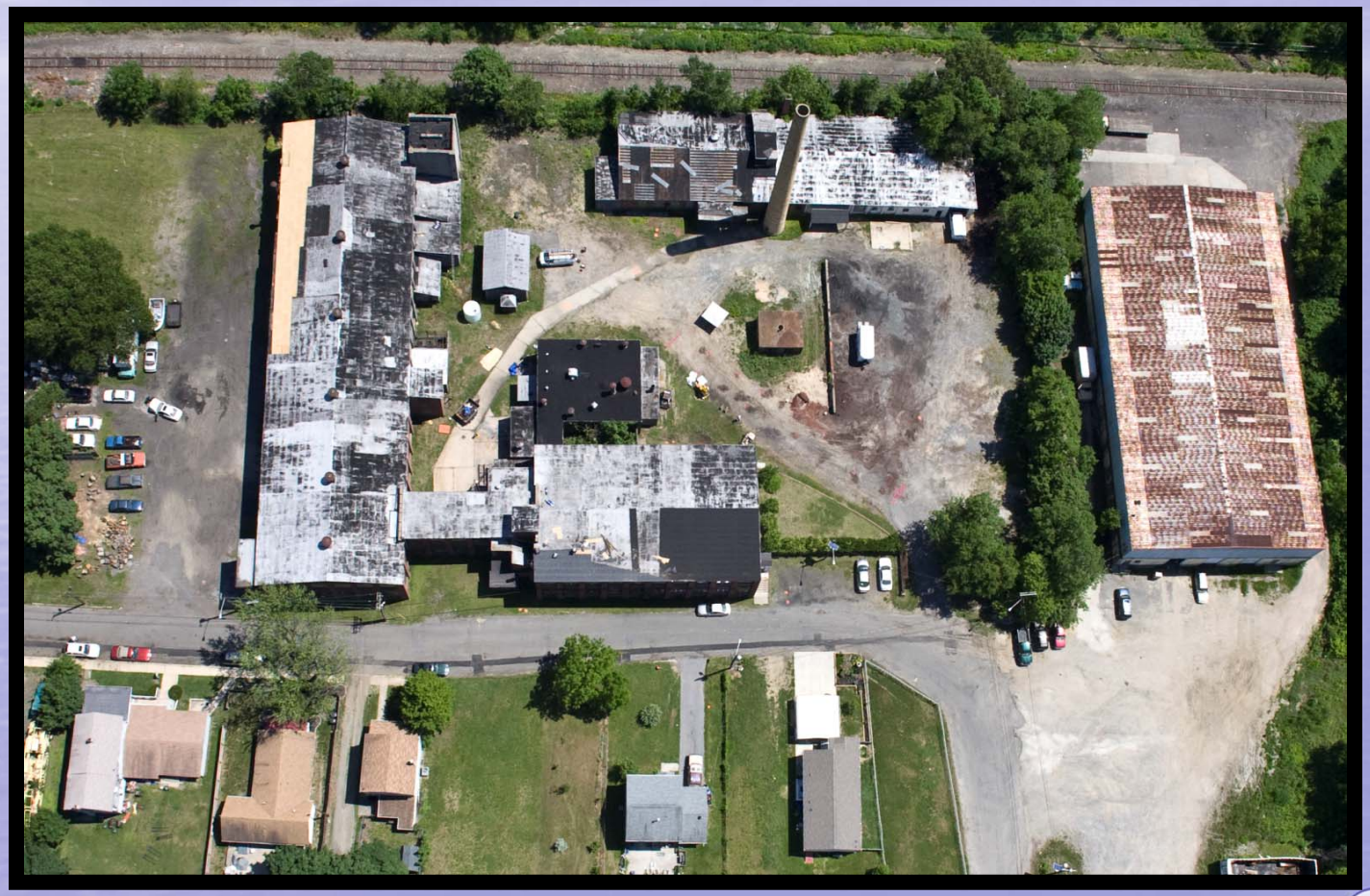
IDENTIFY DRAINAGE

START A CONCEPTUAL MODEL



RECEPTORS

DEFINE SITE CONDITIONS & SITE INVESTIGATION (MUST)



LOCATION AND TYPES OF UNCONSOLIDATED AQUIFERS NEW JERSEY

FOUR MAJOR TYPES OF UNCONSOLIDATED AQUIFERS

Coastal & Beach Deposits (South Jersey)

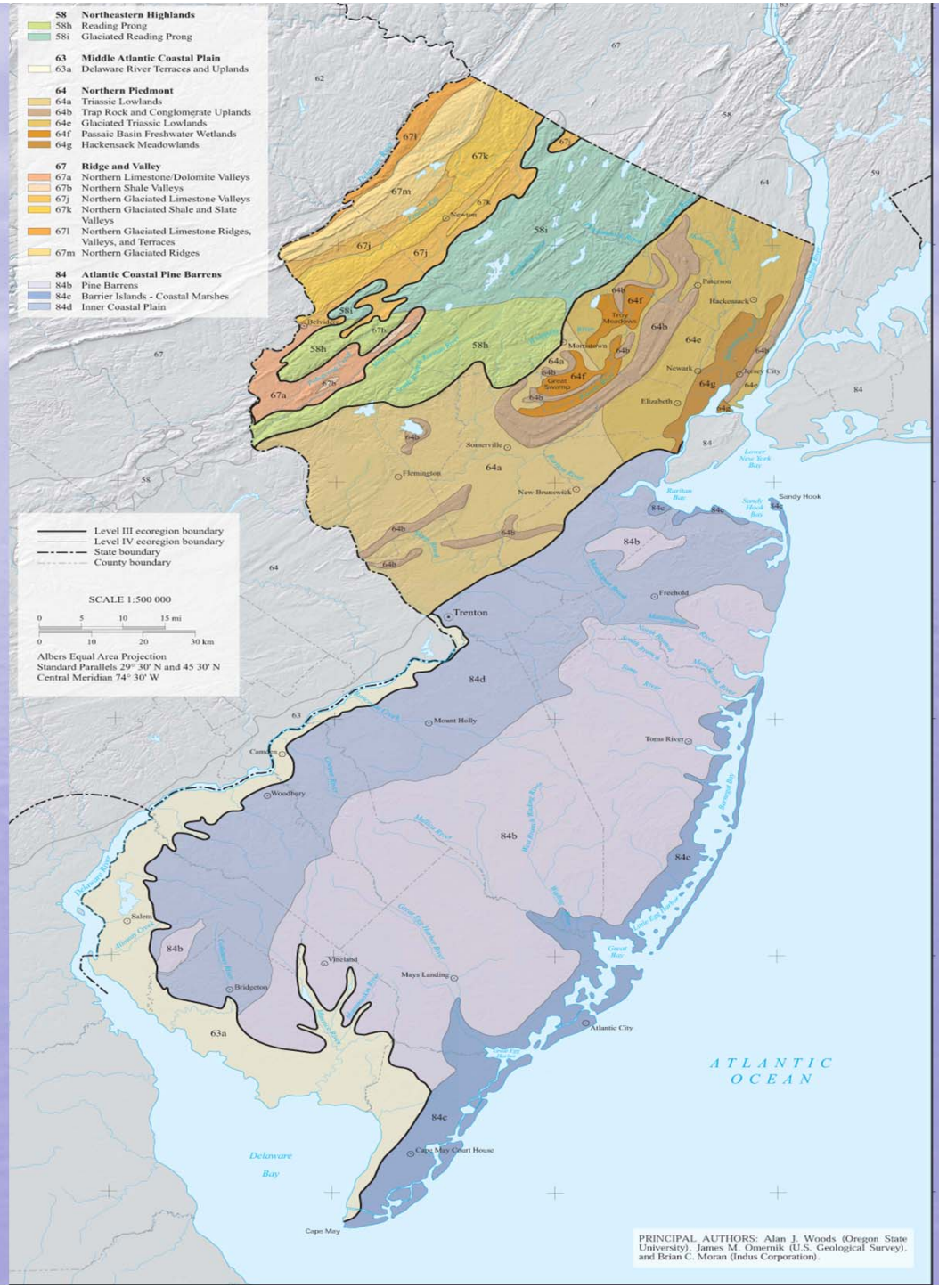
Glacial Deposits (North Jersey)

Residual Soils (Central & North Jersey)

Upper Weathered Bedrock (Acting As An Unconsolidated Aquifer)

NOTE: New Reference Source(s) In Guidance As Appendix

GEOLOGIC MAP



North Jersey

Glacial Deposits

Outwash
Lacustrine
Glacial Till

Residual Soils

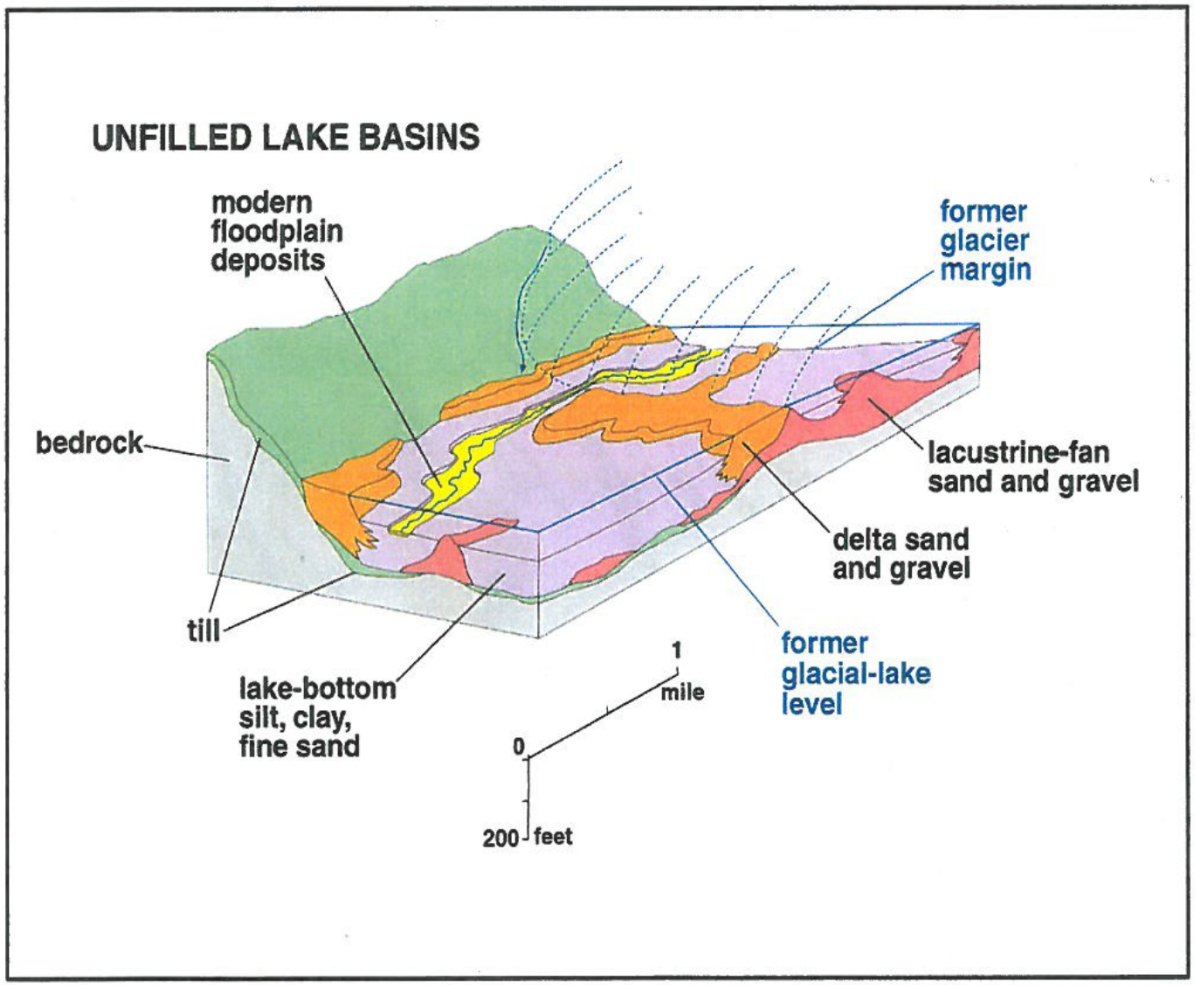
Weathered Bedrock

South Jersey

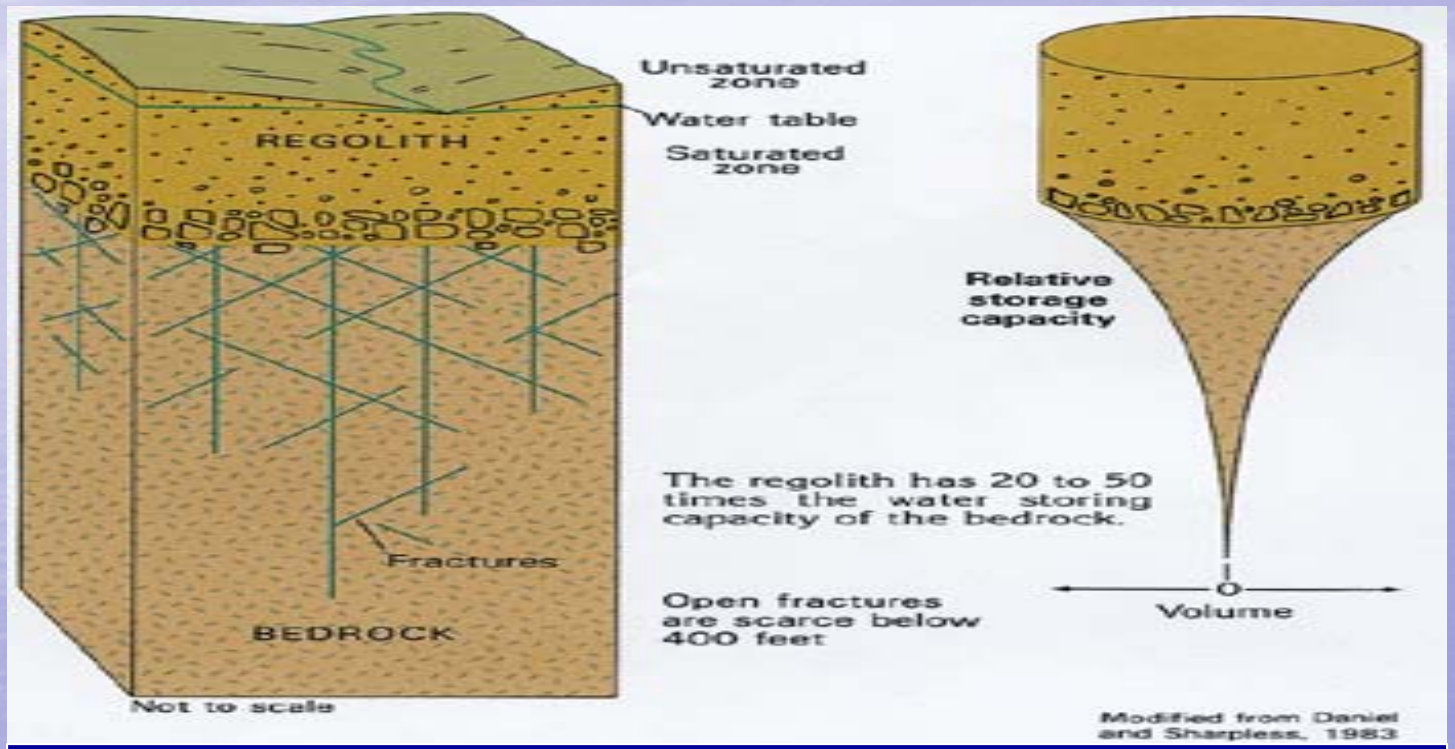
Interior Coastal

Outer Coastal

GLACIAL HYDROGEOLOGICAL MODEL



CONCEPTUAL MODEL: THINK ? ……CONTAMINANT MASS REMOVAL



LNAPL MASS – UNCONSOLIDATED SOILS/RESIDUAL BEDROCK

IMMEDIATE ACTION SOMETIMES NECESSARY

- Potable Well (10 feet Away)
- Vapor Hazard In Home
- Sump in Basement
  (Free Product Exists)
- Residual Soil Contaminated
- Bedrock Grossly Contaminated
- Remove Free Product
- Excavate Residual Soil &
  Weathered Bedrock While
  Dewatering Free Product

The Triad Approach

"Triad approach is a process that integrates systematic planning, dynamic work plans, and real-time measurements to achieve more timely and cost effective site characterization and cleanup."

ACTIVE ENVIRONMENTAL TECHNOLOGIES, Inc.

TRIAD APPROACH
REMEDIAL INVESTIGATIONS

REVISED : November 27, 2007
FINALIZED W/ OWNER : November 29, 2007
FINALIZED W /NJDEP : December 18, 2007
REMEDIATION PER NJDEP September 22, Final w/ Permit By Rule : Novembe 20, 2008
Final Full Scale Remediation : October 25,2009

	TECHNICAL TASK	BUDGET	COST	SCHEDUEL (Years)
1	**TRIAD - REMEDIAL INVESTIGATION & REMEDIATION**	**$854,401.60**	$672,245.00	
2	**RI-1 , CONCEPTUAL MODEL BASED ON OTHERS**	**$7,114.00**	$0.00	
7	**RI-2, MOBILIZATION**	**$2,420.00**	$0.00	
14	RI-3 , AOC-1 Former Sodium Hydroxide Container	$7,147.00	$0.00	
18	RI-4, AOC-2 Transformers	$255.00	$255.00	
20	RI-5, AOC-3 Well Couplet Degreasing Operation	$11,142.00	$0.00	
27	RI-6, AOC -3 Chromium Plating Operation	$1,340.00	$0.00	
30	RI-7, AOC-4 Chemical Storage Closets & One Additional Drum Storage area	$0.00	$0.00	
32	RI-8, AOC-5 Test Pits of Historical Fill	$13,889.00	$0.00	
37	RI-9, AOC-6 Deep Companion Well for Additional Site Ground Water	$13,679.60	$0.00	
43	RI-10, AOC-7 Magnetometer & Test Pits Former Drum Storage Area	$3,437.00	$0.00	
48	RI-11, AOC - 8 ACM & Lead Base Paint At Blds. (Active Coordinate/ Sub Pass Thru)	$4,050.00	$0.00	
55	RI-12, AOC-9 Two Well Couplets Off Site define Background Soil & GW (2,500 Credit)	$11,061.00	$0.00	
62	RI-15, AOC-10 Water Cooled Compressor (NEW)	$590.00	$0.00	
66	RI-16, AOC-11 Roof Vents (NEW)	$1,180.00	$0.00	
70	RI-17, AOC-12 Turnings Storage Interior and Exterior (NEW)	$1,130.00	$0.00	
76	**RI-13, Additional Delineation**	$27,460.00	$0.00	
85	**RI-14 , RIW Report**	$15,940.00	$5,780.00	
100	**RI-18 , Remedial Investigation Ground Water**	**$14,710.00**	$340.00	
101	**Preparation & Meeting With NJDEP (Review Findings To Date and Present I**	$720.00	$0.00	TOB, MTH ,CG
102	**Access Agreement**	$340.00	$340.00	MTH
103	**Well Permits , Install New Well Couplet At The Nan Home , survey well & sit**	$5,350.00	$0.00	TOB/MTH/ Kendrick Drilling
104	**Aquifer Test @ MW-4 (12 hour pumping and 12 hour recovery)**	$4,500.00	$0.00	MTH/TOB/ Kendrick Drilling
105	**Soil Analysis - Shelby Tube / Vertical Permeability**	$1,200.00	$0.00	VAL LABS
106	**Ground Water Sampling @ New Well Couplet (VO+10 and IN-SITU GW Sam**	$2,000.00	$0.00	MTH
107	**Analysis of GW Data**	$600.00	$0.00	MTH
108	**RI-19, PILOT TESTING**	**$20,700.00**	$0.00	
114	RI-20, Cap Area of TP-1 &2 (4" concrete cap 20 ft by 47 ft)	$7,370.00	$7,370.00	
117	**RI -21 , FULL SCALE TREATMENT TEST**	**$630,000.00**	$630,000.00	
121	**RI-22, Report/ NJDEP UPDATES / NFA w Natural attenuation**	$28,500.00	$28,500.00	
125	CO-1 Downgradient Contaminant Assessment (Extent Of Contamination)	$6,000.00	$0.00	
127	CO-2 Additional Delineation (Upgradient Of Nah Property)	$25,287.00	$0.00	

Project: Schedule and cost W Remed
Date: Tue 4/3/12

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Progress	
Split	External Tasks	Inactive Summary	Manual Summary	Deadline	
Milestone	External Milestone	Manual Task	Start-only		
Summary	Inactive Task	Duration-only	Finish-only		

REMEDIAL INVESTIGATION APPROACH FOR UNCONSOLIDATED AQUIFERS

Initial Hydrostratigraphic Model Complete

- Initial Concepts Developed
- Data Gaps & Limitations Identified

Site Specific Data Needed To Update The Site Model:

- Determine Ground Water Flow Direction
- Delineate the Contaminant Plume
- Determine Hydrostratigraphic Properties of Each Unit
- Design and Install Monitoring Network

Determine Ground Water Flow Direction

KEEP IN MIND THE FOLLOWING :

Are Wells Screened In Same Units ?

Do We Have Sufficient Background Data ?

Are The Plume Limits Understood (Horizontal & Vertical) ?

Do We Have Any Side Gradient Issues ? Pumping Wells

Are the Down Gradient Conditions Know ?

Where Will Additional Wells Be Needed ?

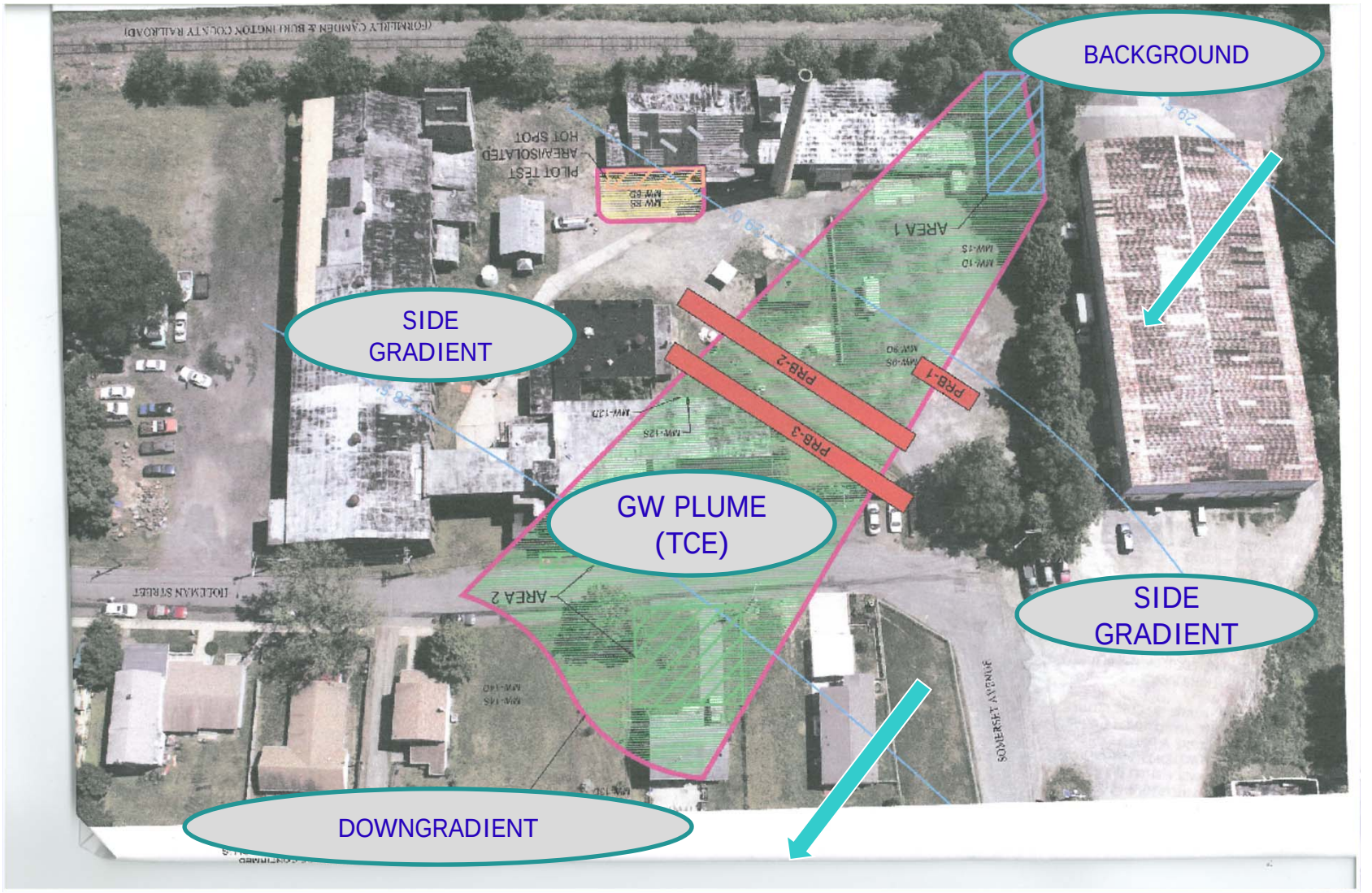
Installation of Monitoring Well Network

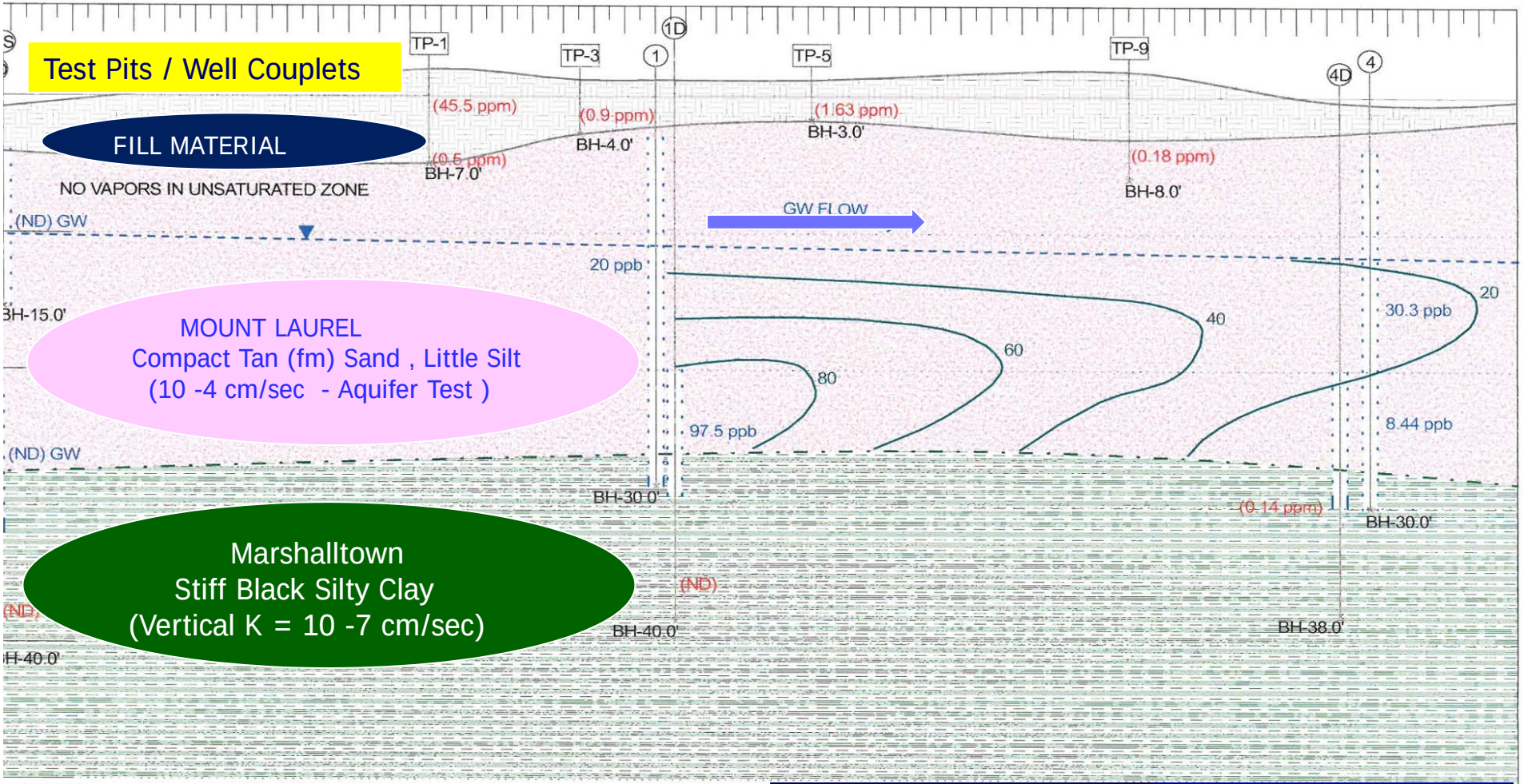
USE UPDATED HYDROSTRATIGRAPHIC MODEL

- Monitor Contaminant Plume
- Document Ground Water Flow Direction(s) in each water-bearing unit
- Document Vertical Gradients
- Evaluate Effectiveness of the Remedial Action

NOTE : ALWAYS WORK TOWARDS REMEDIATION SOLUTION

GENERALIZED SITE CONDITIONS





INTERVAL
CHANGE IN GEOLOGIC FORMATION
GROUNDWATER TABLE
TCE CONCENTRATION IN SOIL
TCE CONCENTRATION IN GROUNDWATER

TP-1 = TEST PIT

1 = MONITORING WELL LOCATION

80 = TCE ISOCONCENTRATION (PPB)

Horizontal GW Velocity

Mt Laurel - 10 feet per Year

Gamma Logs - Clay vs. Sand
Injection Test (Bottom Up)
Soil Lab – Kv Testing
Soil & GW Analytical Lab.

Active Environmental Technologies, Inc.
203 Pine Street
Mount Holly, New Jersey 08060
(609) 702-1500

HYDROGEOLOGIC MODEL
ARROW SAFETY
MOUNT HOLLY, BURLINGTON COUNTY, NJ

FILE	DATE	DRAWN BY	DRAWING NO.
ARROW SAFETY	08/27/08REV	KMG	HYD 1
SCALE	PROJECT NO.	CHECKED BY / DATE	SHEET / OF
Vertical: 1"=10' Horizontal: 1"=50'	4007		1 / 1

REV. NO.

DRILLING SENTINEL MONITORING WELL

PRESENTATION & ANALYSIS CONTAMINANT PLUM INFORMATION

Make Sure Ground Water Contour Map Is Representative

Tabulate All Data

Do a Plan View of Contaminant Distribution in GW/Soil

Prepare Transects Perpendicular to GW Flow Direction (Flow Net)

Prepare Transect On GW Contour (Seepage Face)

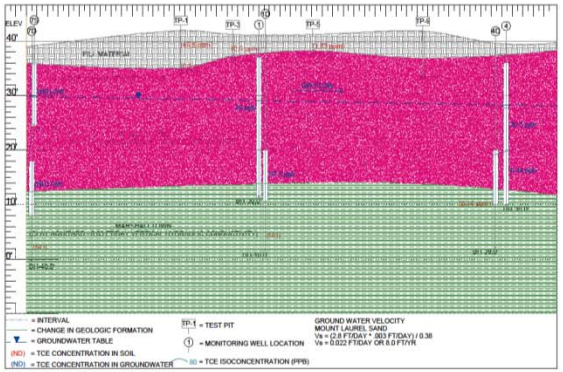
Evaluate Data (Unknown Contamination, Background, etc.)

Evaluate Limitations (Hydraulic Conductivity Sensitive Variable)

FINALIZE HYRDROGEOLOGICAL MODEL & SELECTION OF REMEDIAL ACTION

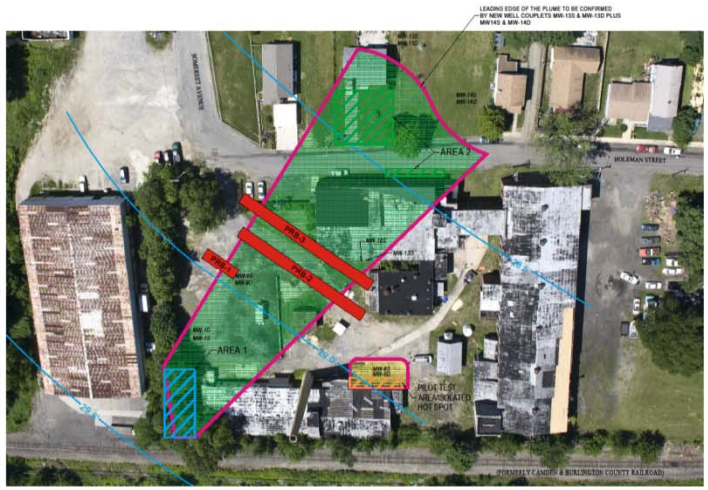
NOTES:

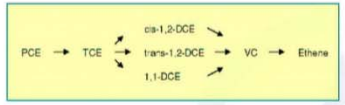
1) FLYING MEDIA (717) 475-2482 OF LANCASTER, PENNSYLVANIA UTILIZED A HELICOPTER TO PROVIDE AN AERIAL PHOTOGRAPH OF THE EHC INJECTIONS.
2) S&S SUBSURFACE INVESTIGATIONS (610) 736-8762 OF NEW JERSEY AND PENNSYLVANIA HANDLED THE DRILLING, MIXING AND INJECTION WORK AT THE SITE.
3) ACTIVE ENVIRONMENTAL TECHNOLOGIES, INC (609) 702-1500 OF MOUNT HOLLY, NJ COMPLETED THE CONTAMINANT DELINEATION, GROUND WATER FATE AND TRANSPORT ANALYSIS, PILOT TESTING, REMEDIATION COST BENEFIT ANALYSIS, PERMITTING, REGULATORY UPDATES TO THE NJDEP DESIGN AND OVERSIGHT OF THE REMEDIATION.
4) ADVENTUS AMERICA, INC. OF UNION, NEW JERSEY (908) 688-8543 PROVIDED THEIR PATENTED EHC MATERIAL, DETAILED DESIGN AND TECHNICAL ASSISTANCE CONCERNING THEIR PRODUCT AND ITS GEOCHEMISTRY. ADVENTUS HAS WON SEVERAL AWARDS FOR THEIR TECHNOLOGY AND IS CONSIDERED A BEST AVAILABLE TECHNOLOGY (BAT) FOR REMEDIATING TCE CONTAMINATED SITES.
5) GUZZI ENGINEERING OF MEDFORD, NEW JERSEY PROVIDED ENGINEERING SUPPORT, AS WELL AS SURVEYING, MAPPING AND GRAPHIC AIDS.
6) THE UPPER MOUNT LAUREL SAND IS THIRTY FEET THICK AT THE SITE. THE GROUND WATER QUALITY IN UPPER UNIT IN THE MOUNT HOLLY, NJ AREA IS SEVERELY DEGRADED DUE TO MANY INDUSTRIAL AND COMMERCIAL SITES. THE UPPER MOUNT LAUREL IS NOT USED AS A WATER SOURCE. THE NEAREST SURFACE WATER DISCHARGE AREA IS APPROXIMATELY 2,000 FEET AWAY. THE MOUNT LAUREL SAND IS AN UNCONFINED UNIT. THE HYDRAULIC CONDUCTIVITY OF THE MOUNT LAUREL SAND IS ON THE ORDER OF 10-3 CM/SEC, HAS A POROSITY OF 30% AND A SHALLOW GRADIENT OF 0.003 FT/FT TO THE NORTHEAST. THE DEPTH TO GROUND WATER IS TEN (10) FEET BELOW GROUND SURFACE. THUS THE GROUND WATER IMPACTED ZONE IS 20 FEET THICK. THE UPPER MOUNT LAUREL MOUNT IS UNDERLAIN BY THE MARSHALLTOWN AQUITARD THAT IS APPROXIMATELY 50 FEET THICK HAS AN EXTREMELY LOW HYDRAULIC CONDUCTIVITY VALUE OF 10-7 CM/SEC AND IS AN EFFECTIVE AQUITARD.
7) TCE CONCENTRATIONS RANGE FROM NON-DETECT TO AS HIGH AS 325 PARTS PER BILLION (PPB). THE LEADING EDGE OF THE PLUME HAS A TCE CONCENTRATION OF 11.6 PPB.
8) A PILOT TEST WAS DONE IN THE AREA OF MW-65 AND 60. WHERE AN ISOLATED HOT SPOT WAS DEFINED FOUR INJECTION SITES WERE COMPLETED AND APPROXIMATELY 300 GALLONS OF EHC SLURRY WAS INJECTED AT EACH LOCATION. BASED ON GROUND WATER SAMPLING DATA THE INJECTIONS CREATED A REDUCING CONDITION AND THE CONCENTRATION IN THE SHALLOW ZONE DECREASED FROM 41.7 PPB TCE TO 28.3 PPB IN A FIVE MONTH PERIOD. AT MW-60, THE TCE CONCENTRATION DECREASES FROM 0.88 PPB TO NON-DETECT (ND) OVER THE SAME PERIOD. THE RESULTS WERE VERY FAVORABLE AND A FULL SCALE INJECTION PROGRAM WAS INITIATED ON MAY 10, 2010.
9) THE FULL SCALE INJECTION WORK INCLUDED DEFINING THE GEOCHEMISTRY OF THE HYDROGEOLOGIC SYSTEM, EXTENT OF THE PLUME AND THE DEVELOPMENT OF A REMEDIATION PROGRAM.
10) AN UNDERSTANDING OF THE TECHNOLOGY BEHIND THE FULL SCALE IN-SITU CHEMICAL REDUCTION (ISCR) IS AS FOLLOWS. A CONTROLLED-RELEASE SOLID CARBON AND ZERO VALENT IRON (ZVI) PARTICLES ARE USED TO YIELD A HIGHLY EFFECTIVE MATERIAL FOR STIMULATING THE REDUCTIVE DECHLORINATION OF OTHERWISE PERSISTENT ORGANIC SOLVENTS PRESENT IN GROUNDWATER. THE AREA OF THE PLUME(S) IS WELL DEFINED AS ARE THE AQUIFER PROPERTIES. BASED ON THE SITE'S HYDROGEOLOGIC CONDITION A MATERIAL KNOWN AS ECH^{2} IS BEING EMPLOYED AS A PERMEABLE REACTIVE BARRIERS (PRB), INJECTED INTO GROUNDWATER AT THE CONTAMINANT SOURCE ZONE (I.E. AREA 1) AND DOWN GRADIENT (AREA 2). FOLLOWING PLACEMENT OF ECH^{2} INTO THE SUBSURFACE ENVIRONMENT, INDIGENOUS HETEROTROPHIC BACTERIA CONSUME THE ORGANIC COMPONENT OF ECH^{2} AND CONSUME DISSOLVED OXYGEN THEREBY REDUCING THE REDOX POTENTIAL IN GROUNDWATER. IN ADDITION, THESE BACTERIA FERMENT CARBON AND RELEASE A VARIETY OF VOLATILE FATTY ACIDS (ACETIC, PROPIONIC, BUTYRIC) INTO THE GROUNDWATER PLUME WHICH SERVE AS ELECTRON DONORS FOR OTHER BACTERIA, INCLUDING DEHALOGENATORS AND HALORESPIRING SPECIES. FINALLY, THE SMALL ZVI PARTICLES PROVIDE SUBSTANTIAL REACTIVE SURFACE AREA THAT STIMULATES DIRECT CHEMICAL DECHLORINATION AND AN ADDITIONAL DROP IN THE REDOX POTENTIAL OF THE GROUNDWATER. THESE PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES COMBINE TO CREATE A STRONGLY REDUCING (E.G., UP TO -550 MV E_H) ENVIRONMENT THAT STIMULATES BOTH CHEMICAL AND MICROBIOLOGICAL DECHLORINATION OF TCE SOLVENT IN GROUNDWATER FOUND AT THE ARROW SAFETY DEVICE SITE. IN SITU CHEMICAL REDUCTION (ISCR) IS DEFINED AS THE COMBINED EFFECT OF STIMULATED BIOLOGICAL OXYGEN CONSUMPTION (VIA "FERMENTATION" OF COMPLEX ORGANIC CARBON SOURCES), DIRECT CHEMICAL REDUCTION WITH REDUCED METALS, AND THE CORRESPONDING ENHANCED DECOMPOSITION REACTIONS THAT ARE REALIZED AT THE LOWERED REDOX (E_H) CONDITIONS.
11) THE PERFORMANCE OF THE IN-SITU INJECTIONS AT THE SOURCE AREA (AREA 1), PASSIVE REACTIVE BARRIER (PRB) AND DOWN GRADIENT (AREA 2) IS ACCOMPLISHED BY MONITORING THE GROUND WATER QUALITY. THE GROUND WATER WILL BE MONITORED TO ENSURE AN ANAEROBIC CONDITION EXIST AND MORE IMPORTANTLY THAT THE CONCENTRATION OF TCE CONTINUES TO DECREASE OVER TIME. THE PERFORMANCE MONITORING NETWORK INCLUDES MW-15, MW-ID, MW-65, MW-60, MW95, MW90, MW 125, MW-120, MW-135, MW-130 AND MW-145 AND MW-140. THE GROUND WATER WILL BE MONITORED FOR THREE YEARS BEGINNING IN SEPTEMBER 2010. WE EXPECT A NINETY PERCENT OR MORE REDUCTION IN TCE CONCENTRATION. WE WILL WORK WITH THE NJDEP AND EITHER APPLY FOR A NO FURTHER ACTION (NFA), VARIANCE REQUEST OR A CEA NATURAL ATTENUATION.



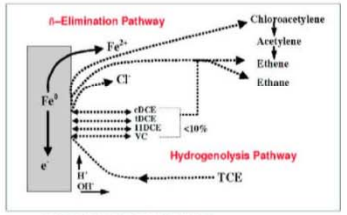
NORTH/SOUTH HYDROGEOLOGIC CROSS SECTION

USGS QUADRANGLE SCALE 1"=2000'
MOUNT HOLLY QUADRANGLE





PCE/ TCE DEGRADATION SCHEMATIC
SEQUENTIAL REDUCTIVE DEHALOGENATION UNDER ANAEROBIC CONDITIONS



PCE/TCE DEGRADATION SCHEMATIC

GRAPHIC SCALE
(IN FEET)
1 inch = 40 ft.

Dante Guzzi Engineering Associates
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telephone (609) 654-4440 facsimile (609) 654-7702
www.guzzingineering.com

Active Environmental Technologies Inc.

FULL SCALE TREATMENT PLAN
REMEDIATION OF TCE CONTAMINATED GW
BLOCK 66.02, LOT 2
MOUNT HOLLY TOWNSHIP
BURLINGTON COUNTY, NEW JERSEY

FILE	DATE	DRAWN BY
2808HOLEMAN-FSTREM	07/15/2010	MM
SCALE	PROJECT NO.	CHECKED BY / DATE
AS SHOWN	P-05-446	DG 07/15/2010

DRAWING NO. G8
REV. NO.
SHEET 8 OF 8