Assessing Potential Mitigation Options for Dam Embankment Operations

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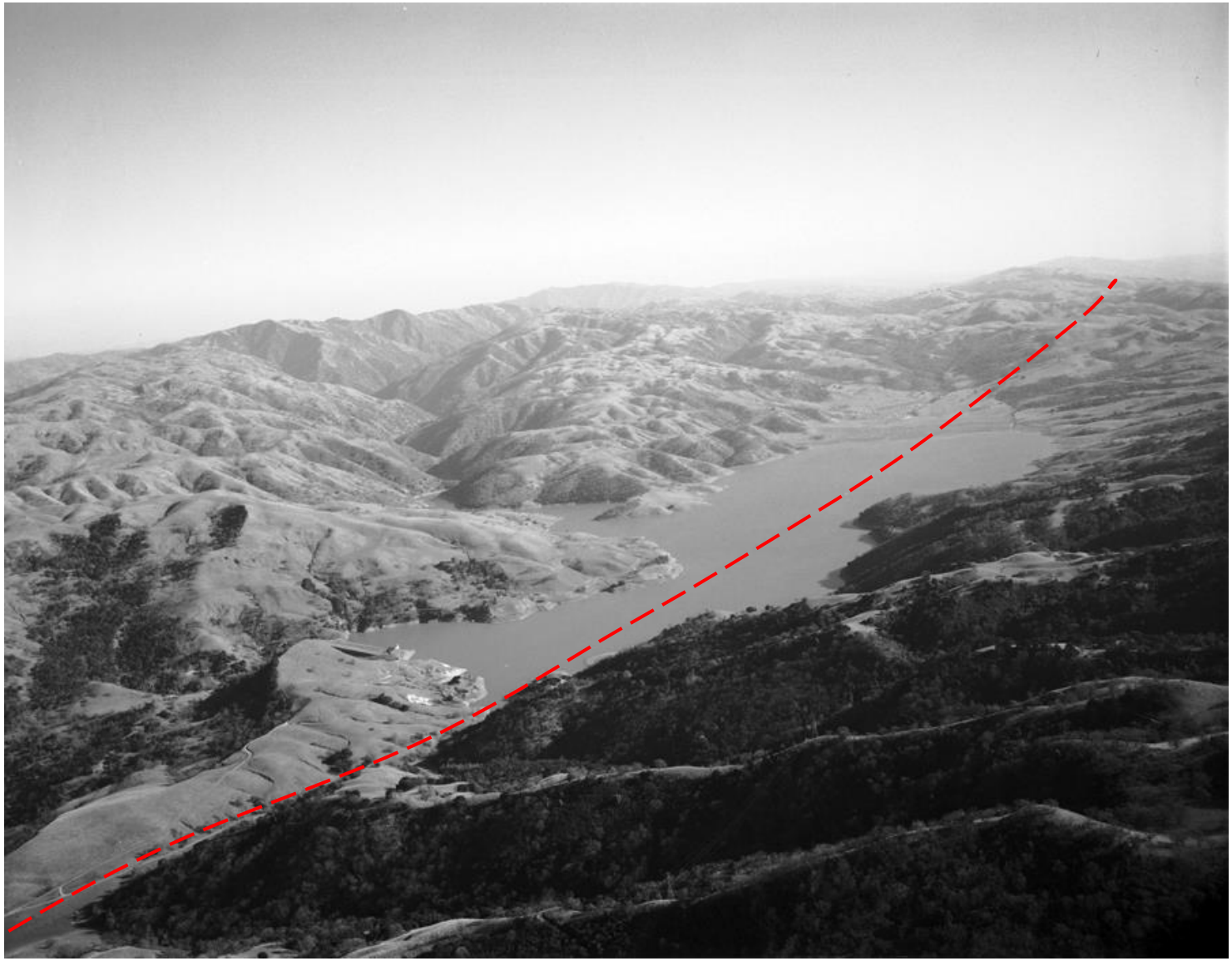
Discussion Points

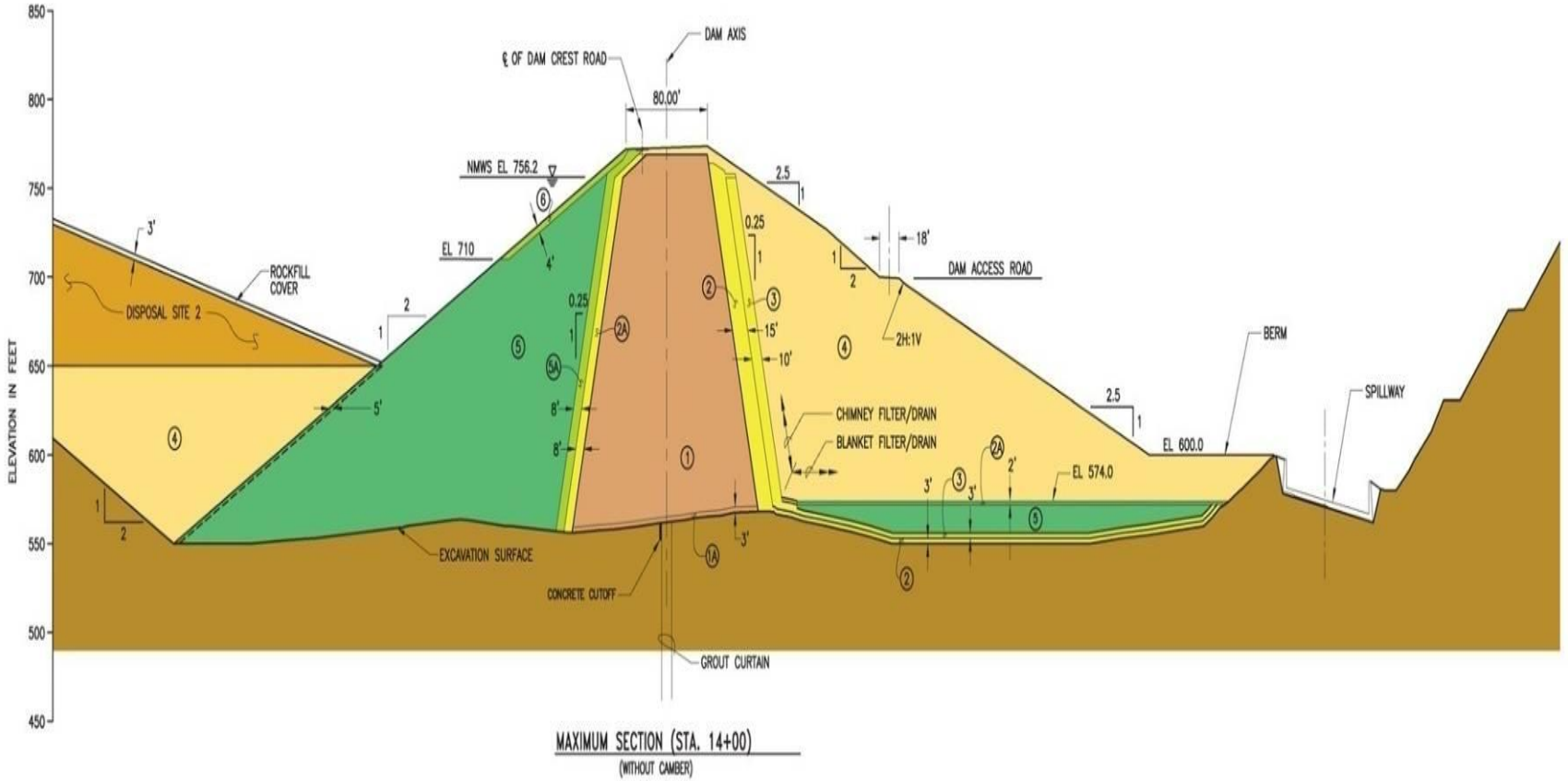
- Quick Overview with Exposure Data Summary
- Project Setting – with Sensitive Areas to the North
- Evaluation of Embankment Production/Mitigation
  - Methods and Assumptions
  - Exceedance Criteria: Schedule and Cost Implications
  - Results

Calaveras Reservoir

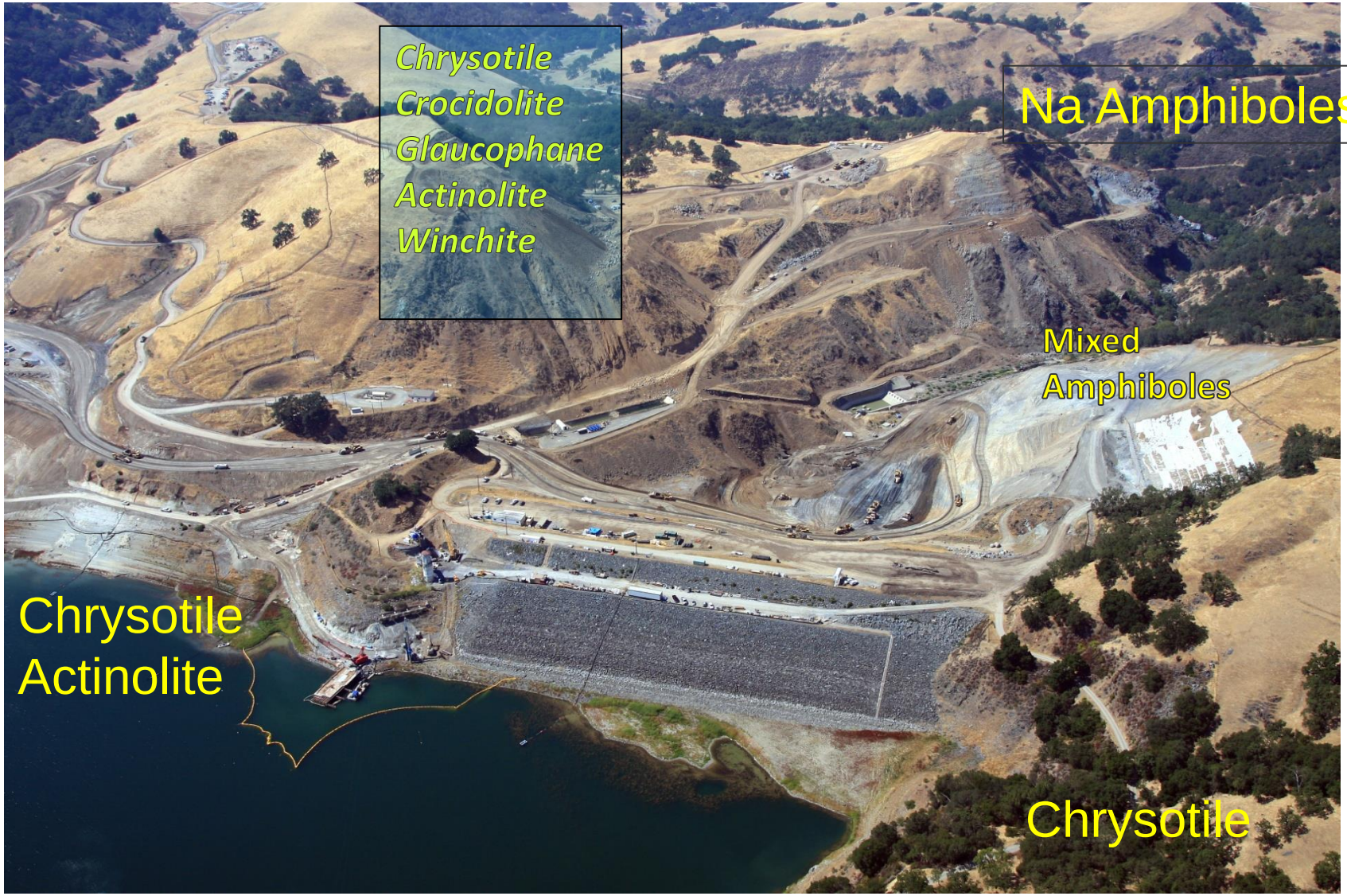
Calaveras Fault



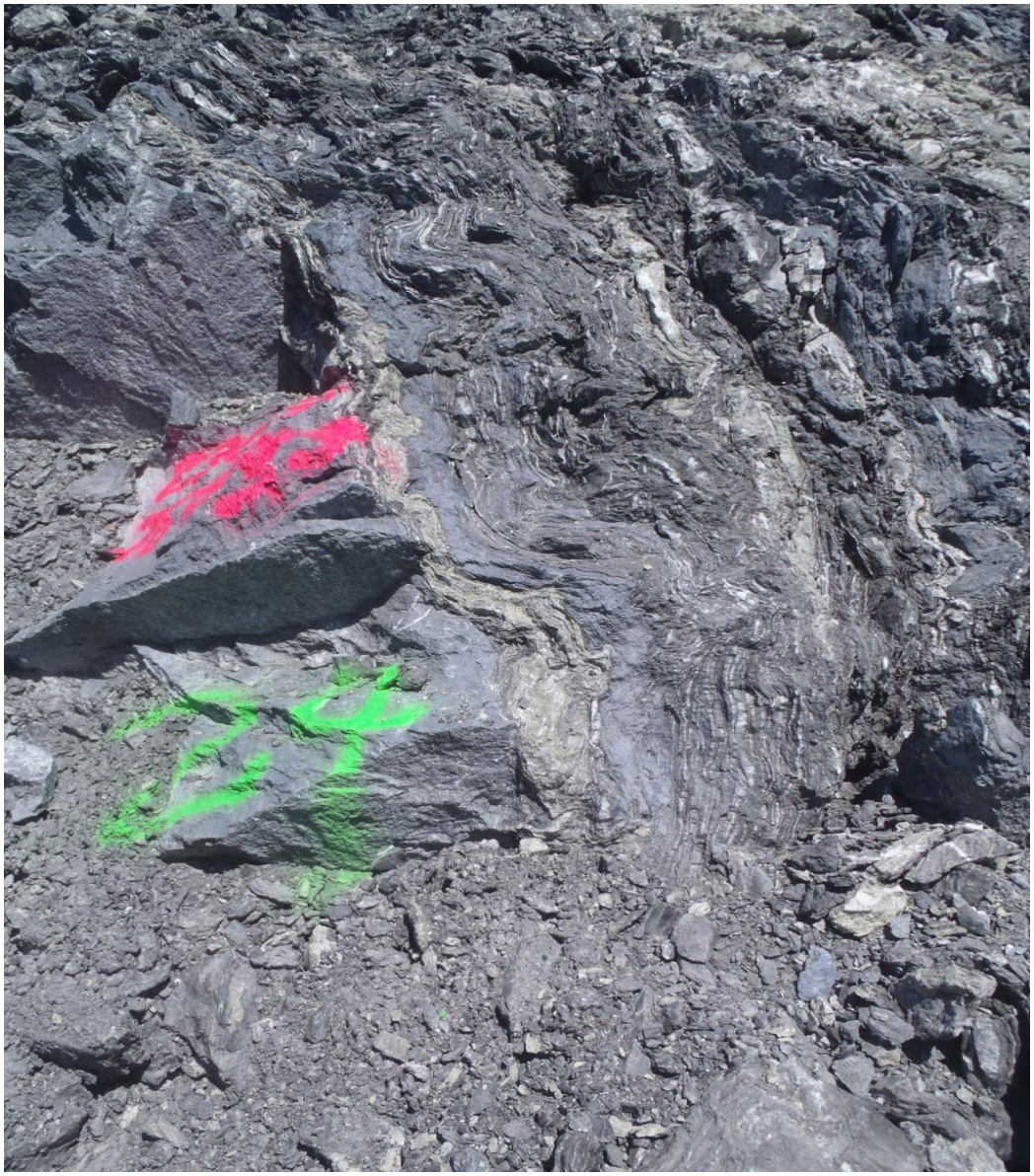
Replacement Dam



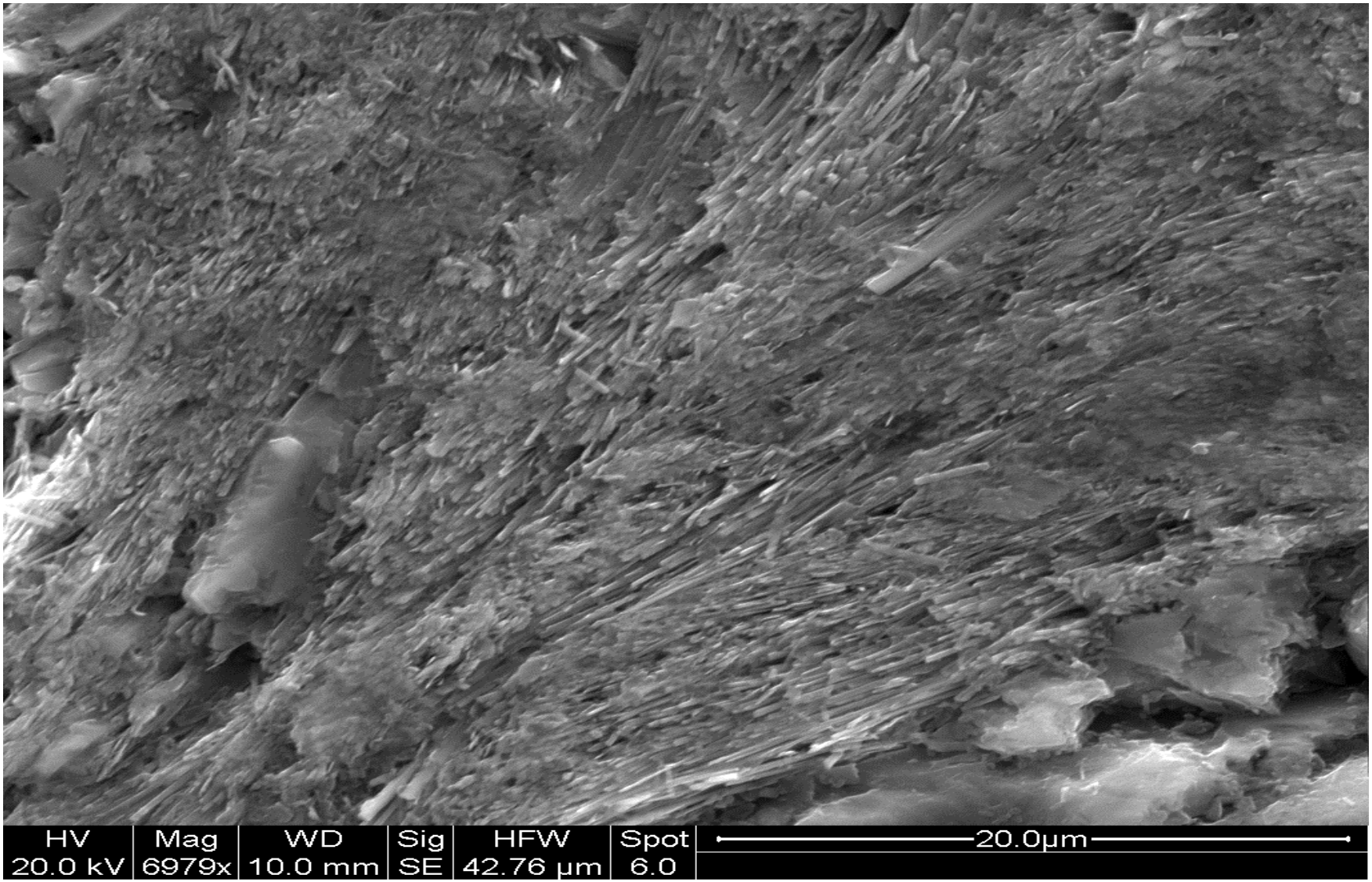
Asbestos Speciation



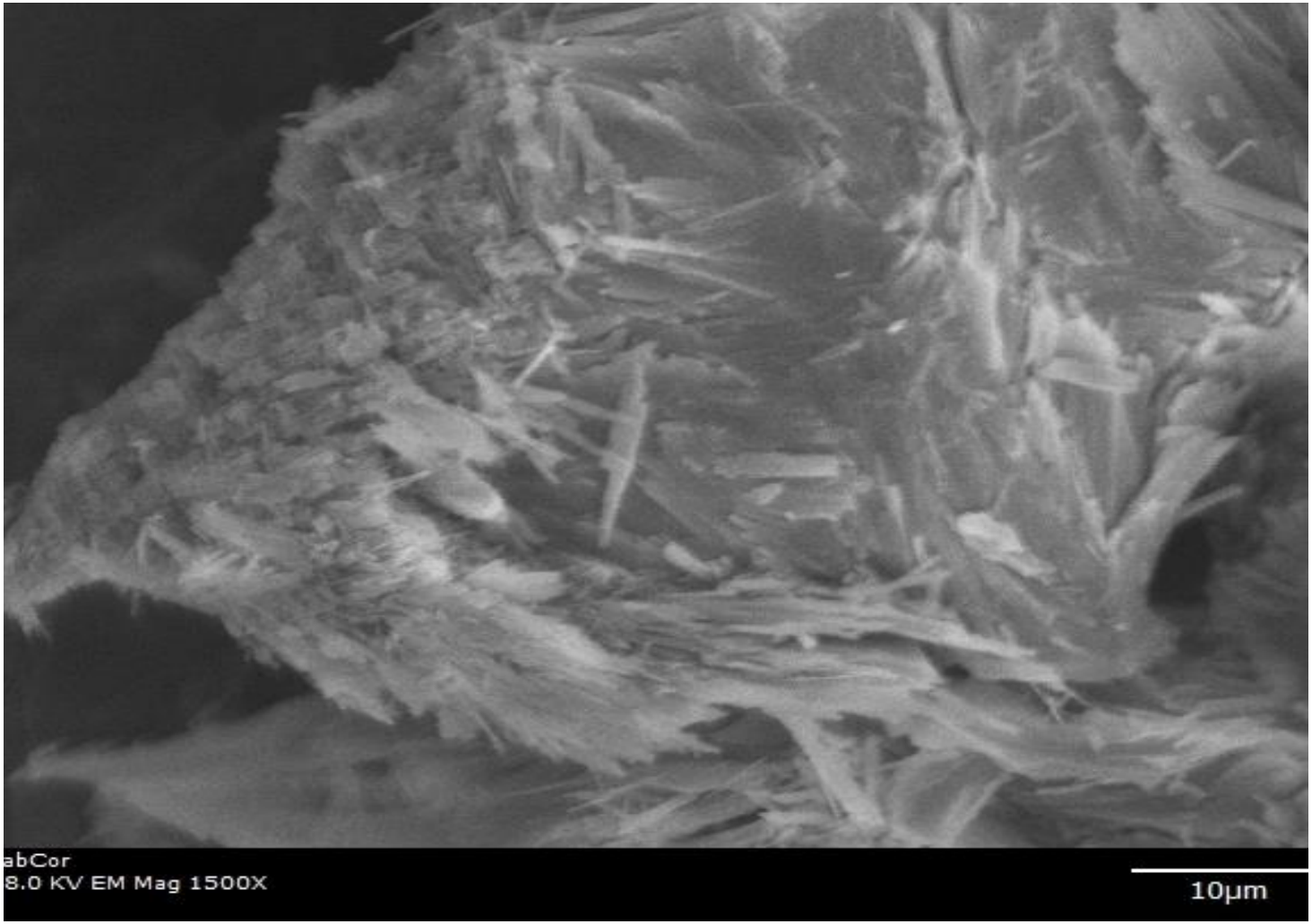
Foliated Blueschist



Scanning Electron Micrograph of Blueschist



Scanning Electron Micrograph Blueschist



Zone 5 Embankment Operations

Left Abutment and Spillway Keys

Work Place Monitoring

Over 2,000 samples collected as of May 2014. Of which, 1294 were breathing zone samples, 187 were overloaded.

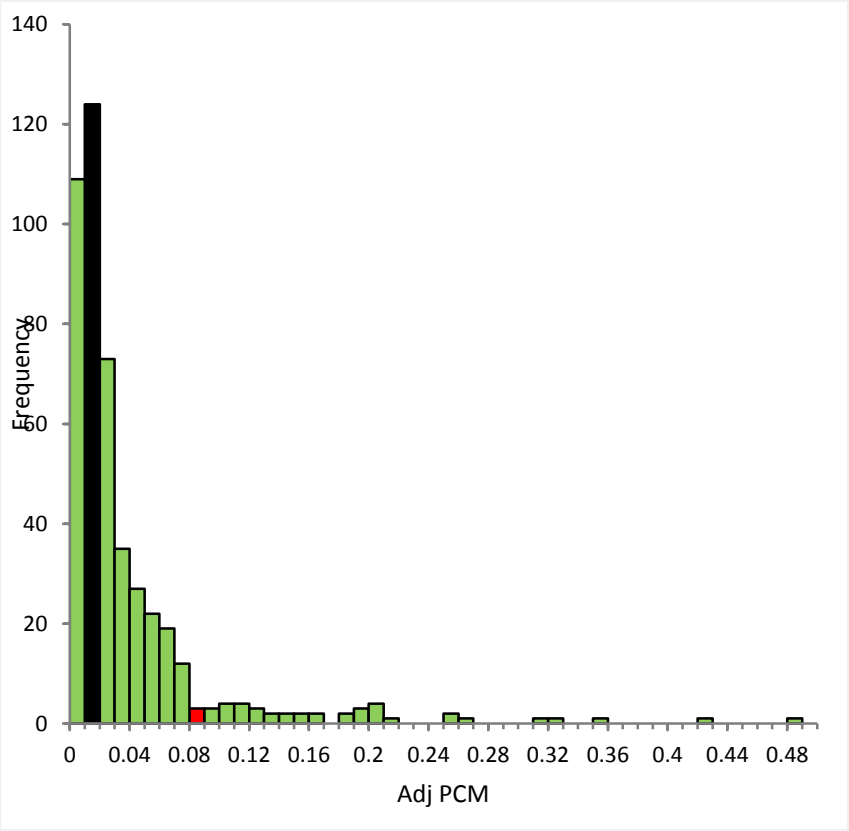
- Sampling by job category, operation, and geologic unit
- Differences in exposures between amphibole and serpentine groups

	Serpentine Group (Chrysotile)	Amphibole Group (Blueschist)
Total PCM Samples	700	407
AdjPCM (NIOSH 7402)	366	315
Min (7402)	0.0005 (f/cc)	0.0006 (f/cc)
Max (7402)	0.5898 (f/cc)	1.813 (f/cc)
Median (7402)	0.0184 (f/cc)	0.0496 (f/cc)
Geometric Mean(7402)	0.0172 (f/cc)	0.0529 (f/cc)

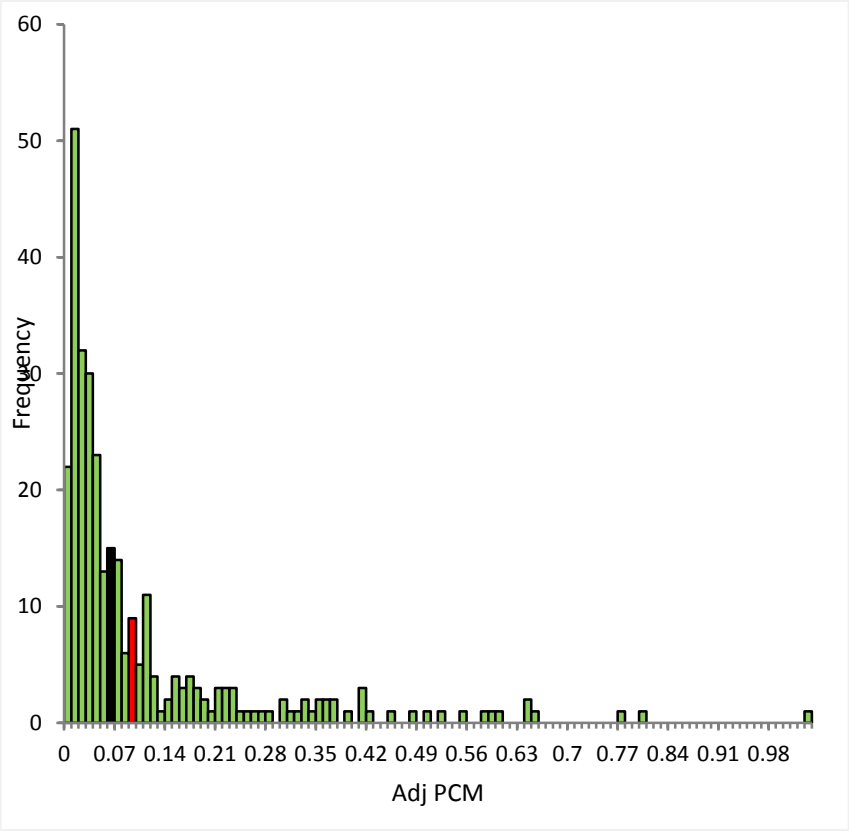
NIOSH 7402 Adjusted PCM Results

[* Highest 15 results (>1 f/cc) removed for Visual Purposes]

Other Franciscan (Chrysotile)
n= 366 samples



Amphibole n = 315 samples*

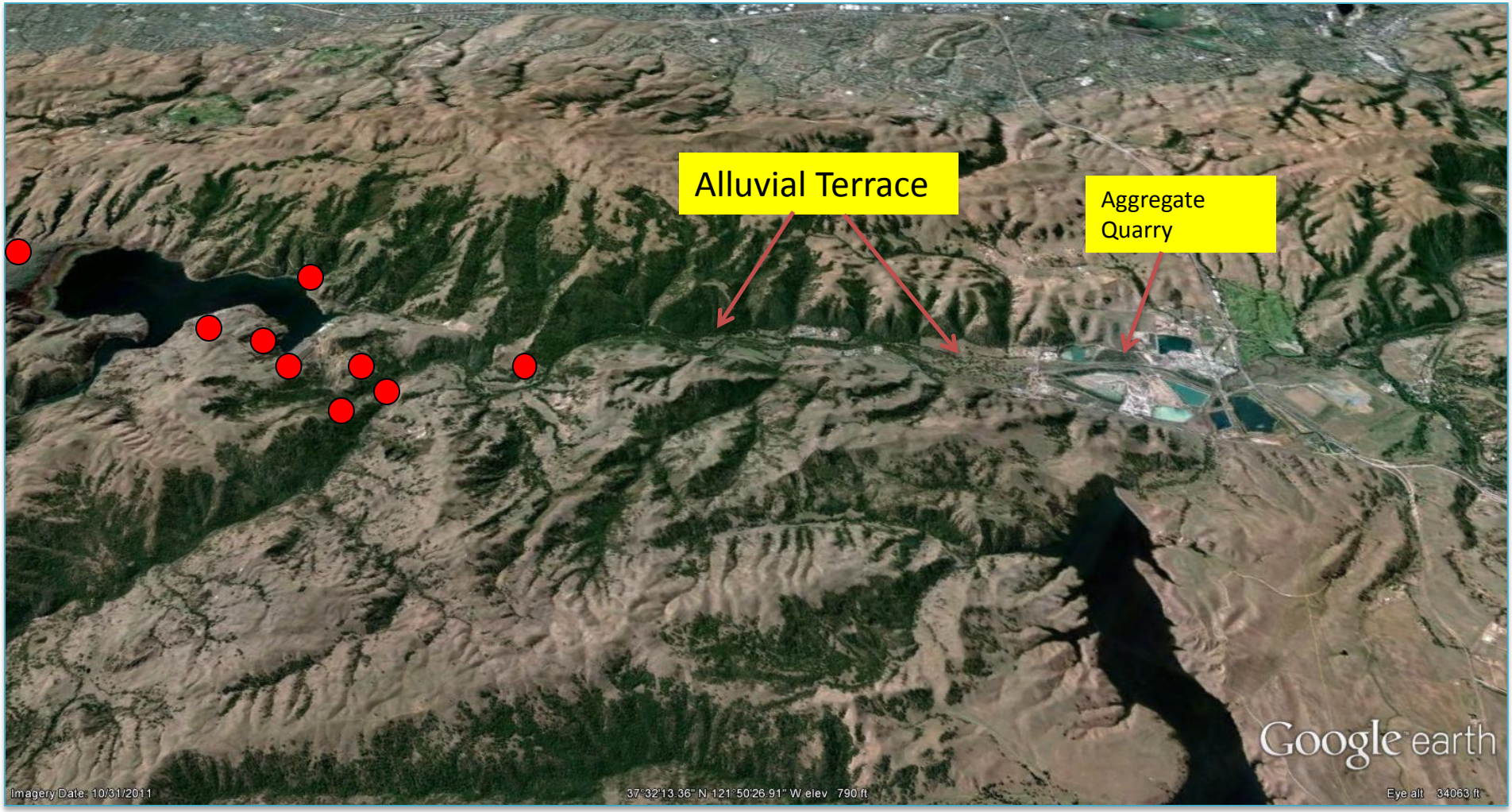


Black = Median Concentration, Red = OSHA PEL

Production
Embankment Operations

- Summer Months 2013
  - First “Real” Look at Zone 5 Production
  - Exceedance Day Requirements
  - Trigger Concentrations
    - Vary from 0.0015 s/cc to 0.0068 s/cc

Regional Setting
Perimeter Monitoring



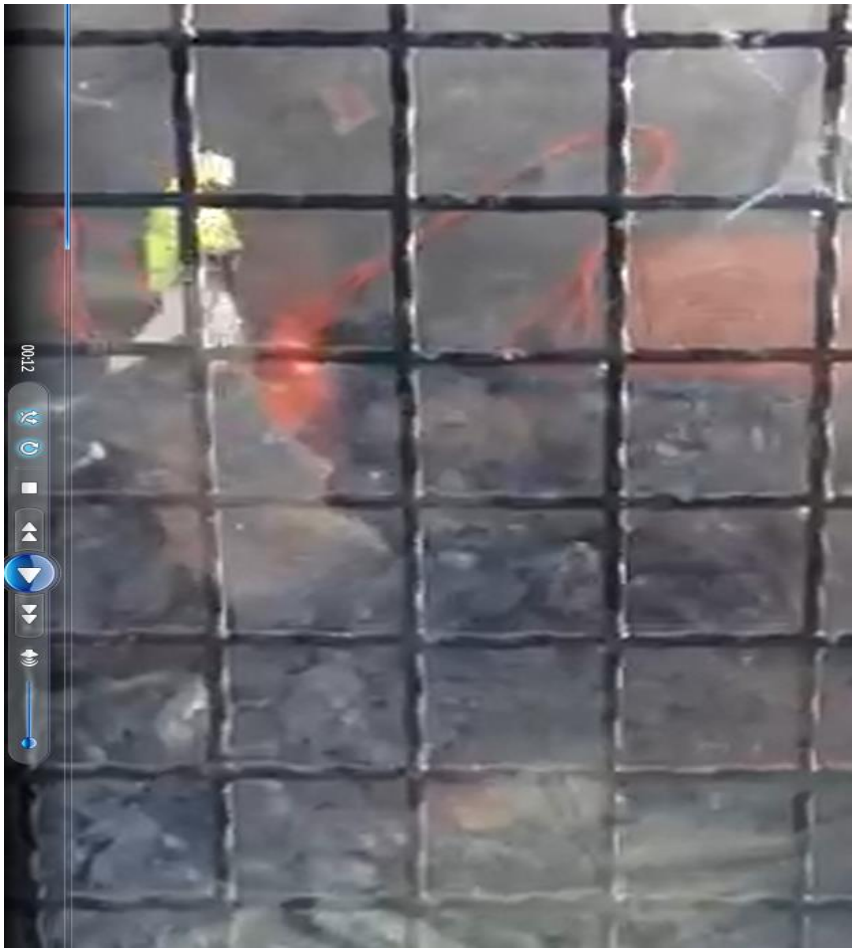
Project Setting
(HR to the North)

Decision to Evaluate Alternative Technology

Existing Controls

Controls under Evaluation

Alternative Technology Issue



Approach for Developing Quantitative Relationships

- Three Step Process
  - Develop Production Emission Factors
  - Evaluate/establish relationship of Operational Emissions to Trigger Criteria,
  - Calibrate – if Possible

Emission Factors

- Site Specific and Operation Specific Measurements
  - Concentrations at Distance
  - Wind speed / Direction
  - Atmospheric Stability Class
  - Collect other information: dump duration, number of dumps, time of generating activities, etc.
- Calculate Emission Factors
  - Use of SCREEN3 for Dispersion Constants

Measurements

Air and wind speed measurements are taken downwind at several distances downwind (sample array) from operations of interest.

Dozens of operations/equipment isolated to develop emissions information

Example Operations

Operation (s)
Blasting
Drilling
Loading
Rock Breaking / Sorting
Slope Shaping
Loadout (multiple tools)

Evaluating Zone 5 Operations

1. Adding Emitting Components

Assumptions: 7000 yards per day, 28 yards per load, 250 loads per 10 –hour day.

•Stilling Basin – hoe-ram, dozer, excavator loading trucks

• Dumping at the Dam Base

•Dozing and Compacting at the Dam

Activity	Emission Factors (structures/sec)
Stilling Basin: Hoe Ram and Excavator Dozer – pushes material to excavator Load Trucks (averaged over 10 hrs)	 2.4E +09 5.5 E +09 2.0 E +08
Dam: Dumping (average over 10 hours) Dozing and Compaction	 2.0 E +08 5.5 E +09
Total Emissions	1.4 E + 10

Zone 5 Evaluation

2. Direct Measurement

Range of Emission Estimates:

3.1 x 10E+08 s/sec to
3.1 x 10E+10 s/sec
Average = 7.6 x 10E+09
(12 trials)

Zone 5 Evaluation

3. Indirect Measurement

(Exposure Monitoring)

Consider

a. 1 f/cc = 1E+06/m3

b. 50 m wide by 10m high

1 meter slice of that air = 500 million fibers

or

5,000 million structures

(5E+09 structures)

Modeling Emissions

Complex Terrain Model:

-Elevation Data

-Site Specific Meteorology

-Upper Air Profile

-Surface Characteristics

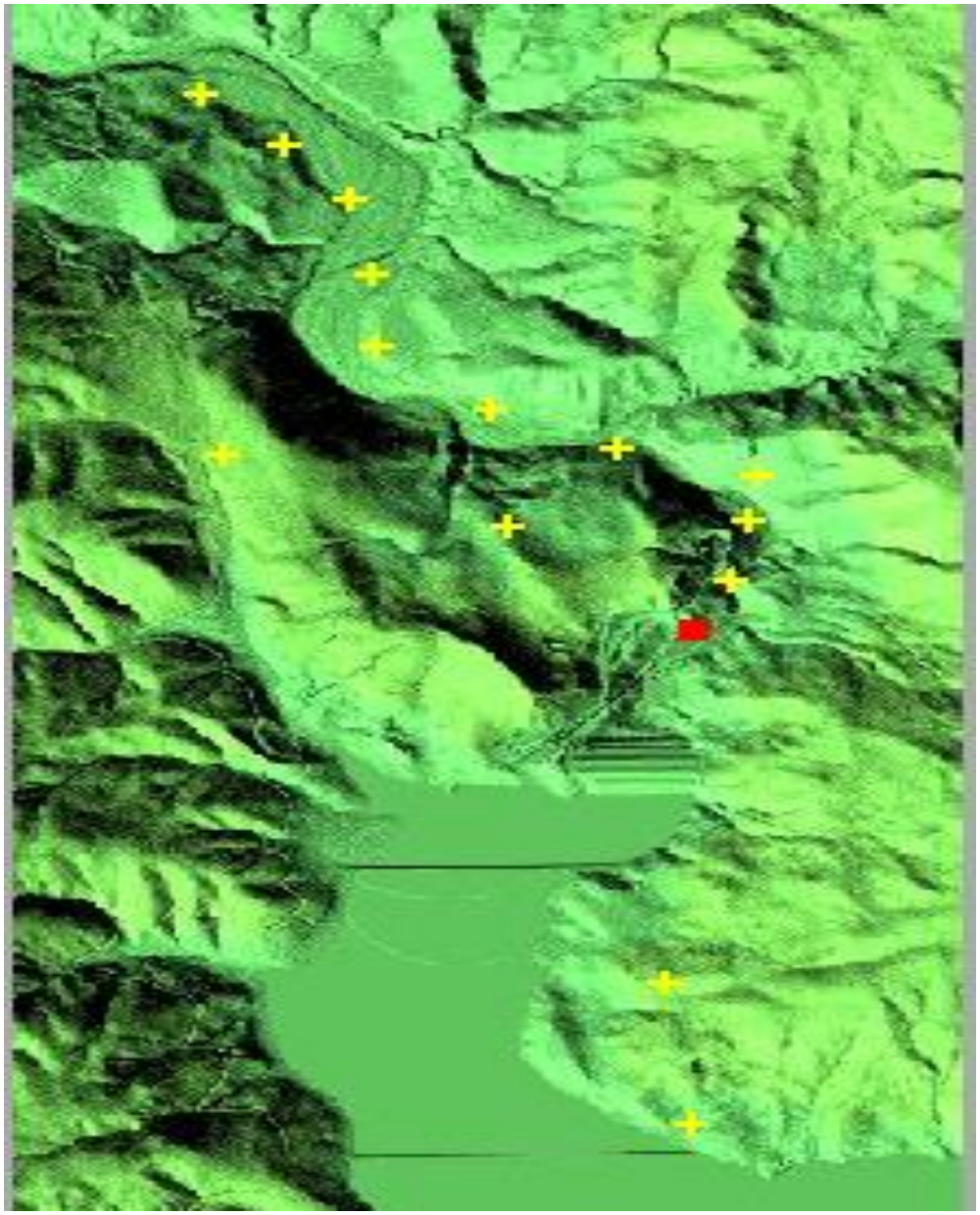
Source:

-Variable Source

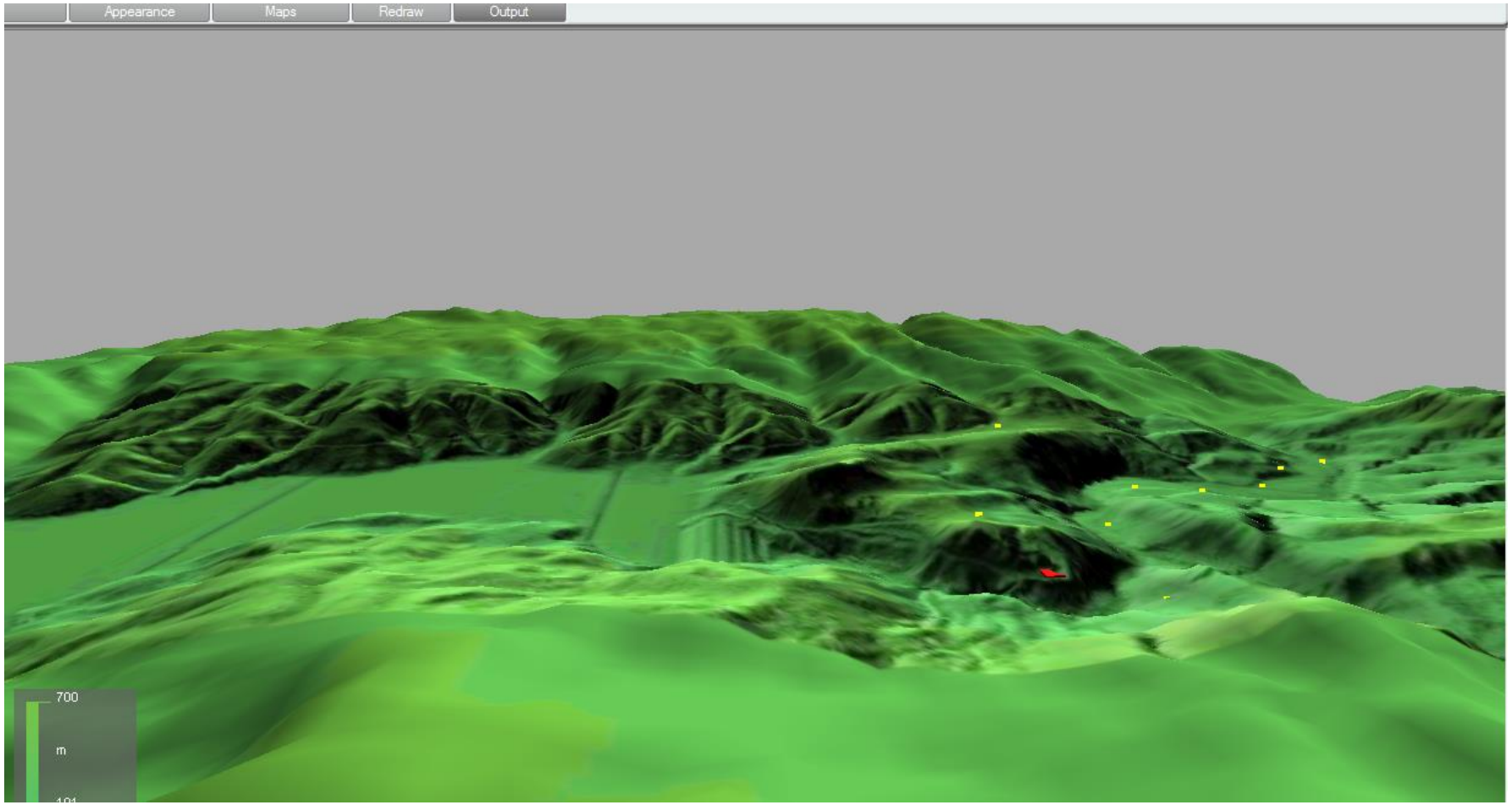
-Measured Emission Rates

Receptor Array
North Measurement Point

Output-Daily 24 hour average conc.



Model's Interpretation of Digital Elevation Data



Z5 Production

Largest Emitter

Volume Source

Dozers:

-Front Facing Fan blowing out towards the blade

-Exhaust Stacks

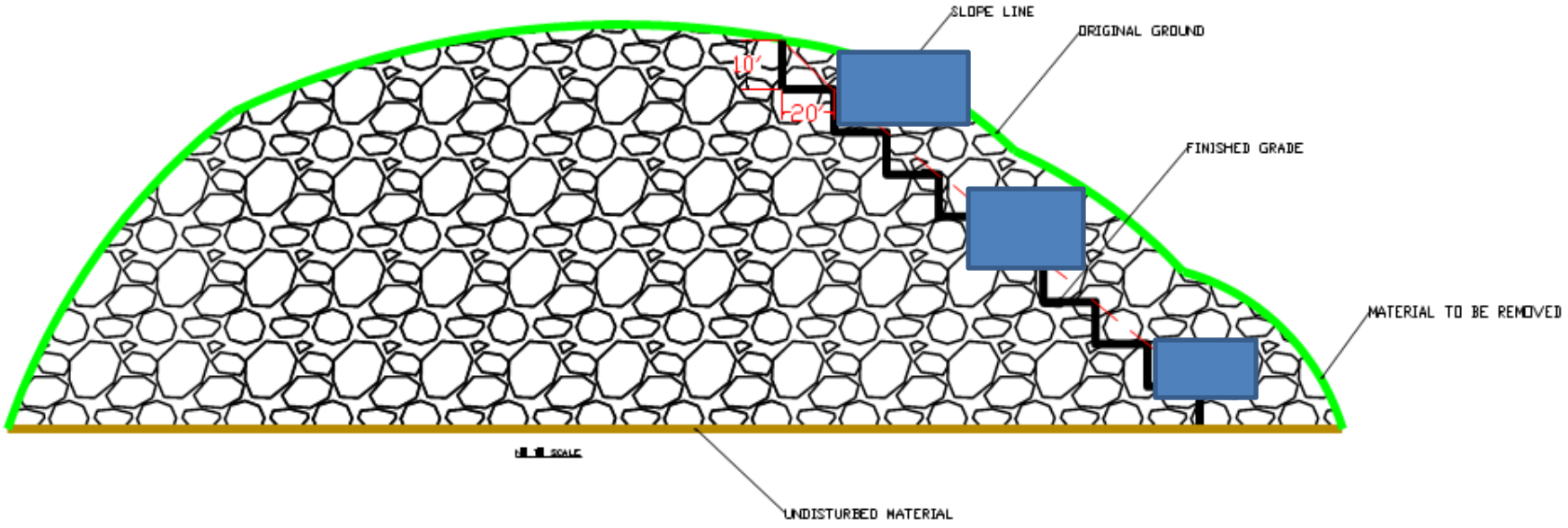
Excavators:

-Cooling Fans directed inside of the machinery

-Exhaust Stacks

Obstacles in the Field

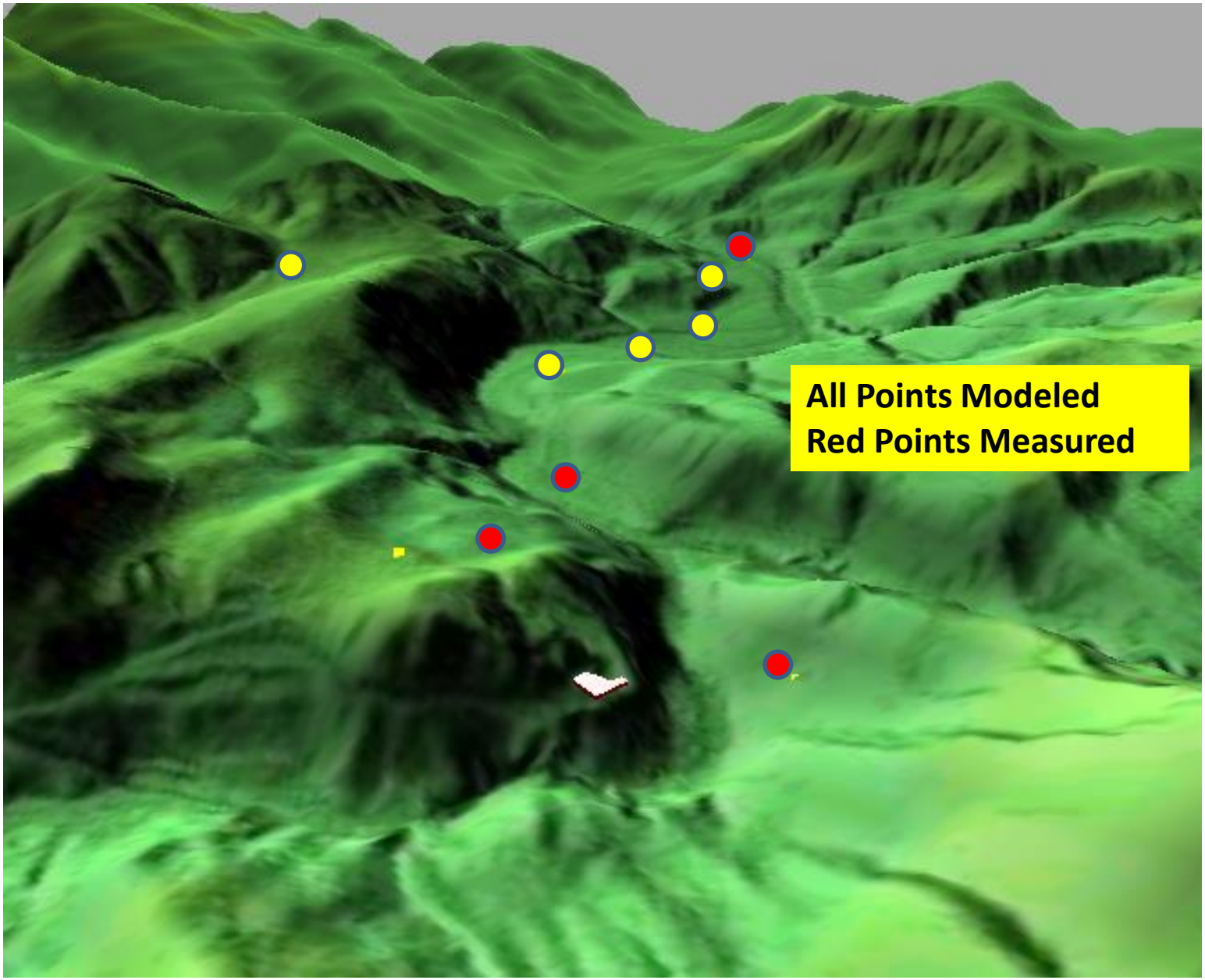
Therefore Considerable Mixing as Wind Washes through the Operation



DRAGADOS USA | FLATIRON | SUKUT CONSTRUCTION, INC. a joint venture

DFS-JV

SHEET ___ OF ___


All Points Modeled
Red Points Measured

Compare
Modeled versus Measured Z5 Operations

Note: P-4 Experience 15 overloads over the 3 month Period

Three Month 24 hr. Average June 1, 2013 to Aug 31, 2013

(S/m3)	HR-N	P-4*	P-5	P-11	Avg. P4 & P11
Modeled	1,124	26,122	7,034	13,033	19,578
Measured	1,260	8500	5,140	20,080	14,290

Three Month 24 hr. Average June 1, 2013 to Aug 31, 2013

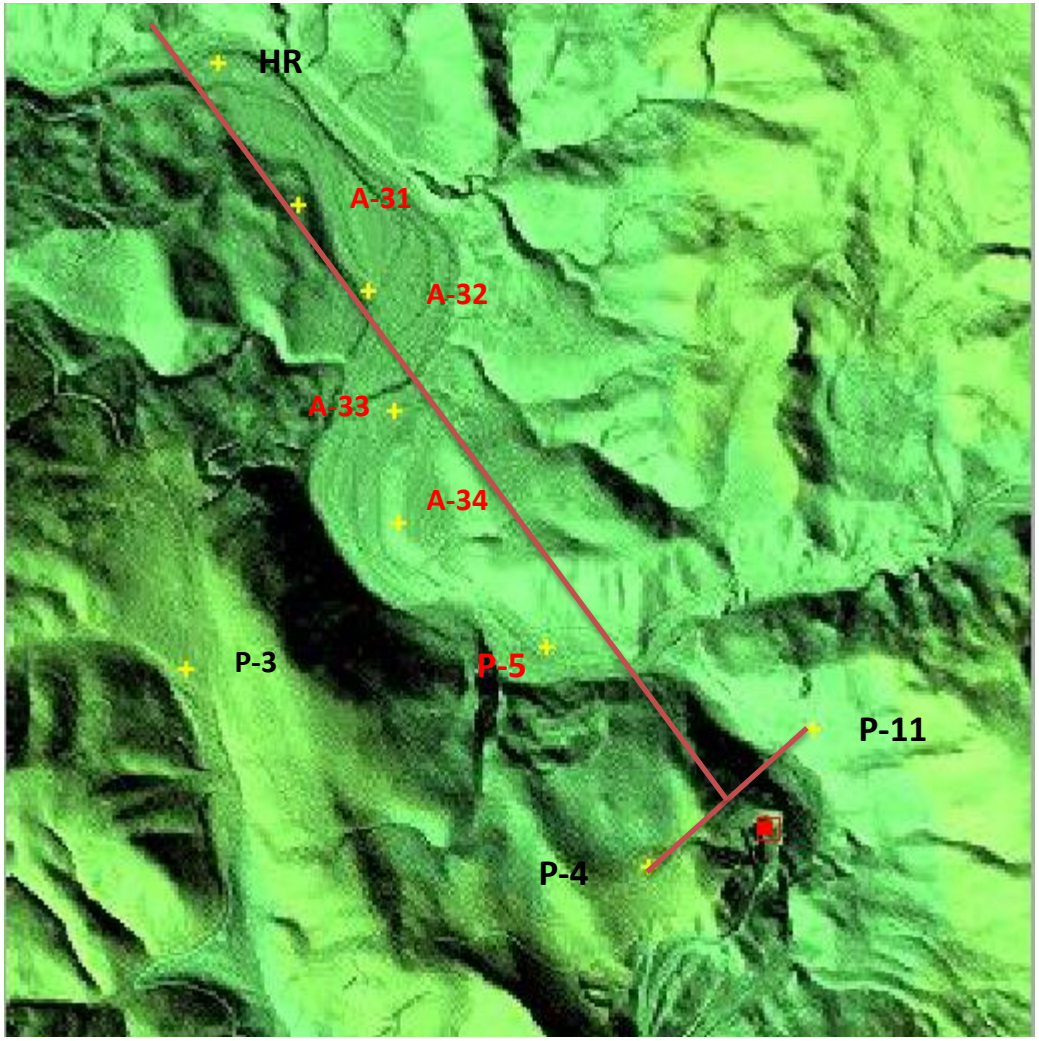
(Modeled Values Substituted for P-4 Overloads which are blank cells)

(S/m3)	HR-N	P-4	P-5	P-11	Avg. P4 & P11
Modeled	1,124	26,122	7,034	13,033	19,578
Measured	1,260	15,213	5,140	20,080	17,647

Now Look at Concentrations vs. Distance

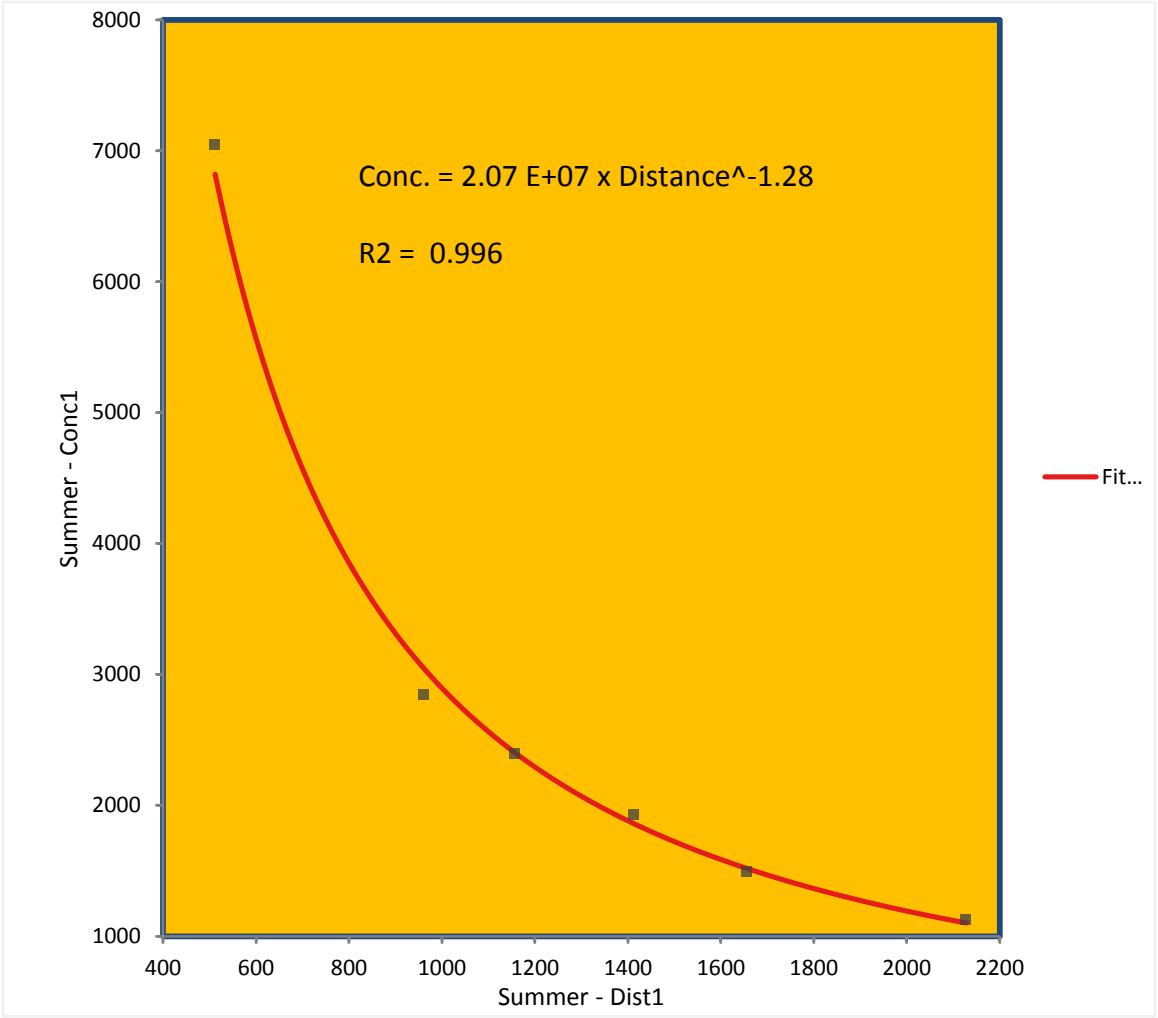
All Points Modeled

P-Stations and HR are Measurement Points



Modeling the Stilling Basin Z5 Load Out Summer 2013 (June – August)

Summer		
Station	Dist1 (m)	Modeled Conc. (s/m3)
P4/11	0	19577.5
P5	512	7034
a34	962	2845
a33	1157	2391
a32	1412	1927
a31	1657	1494
HR	2128	1124



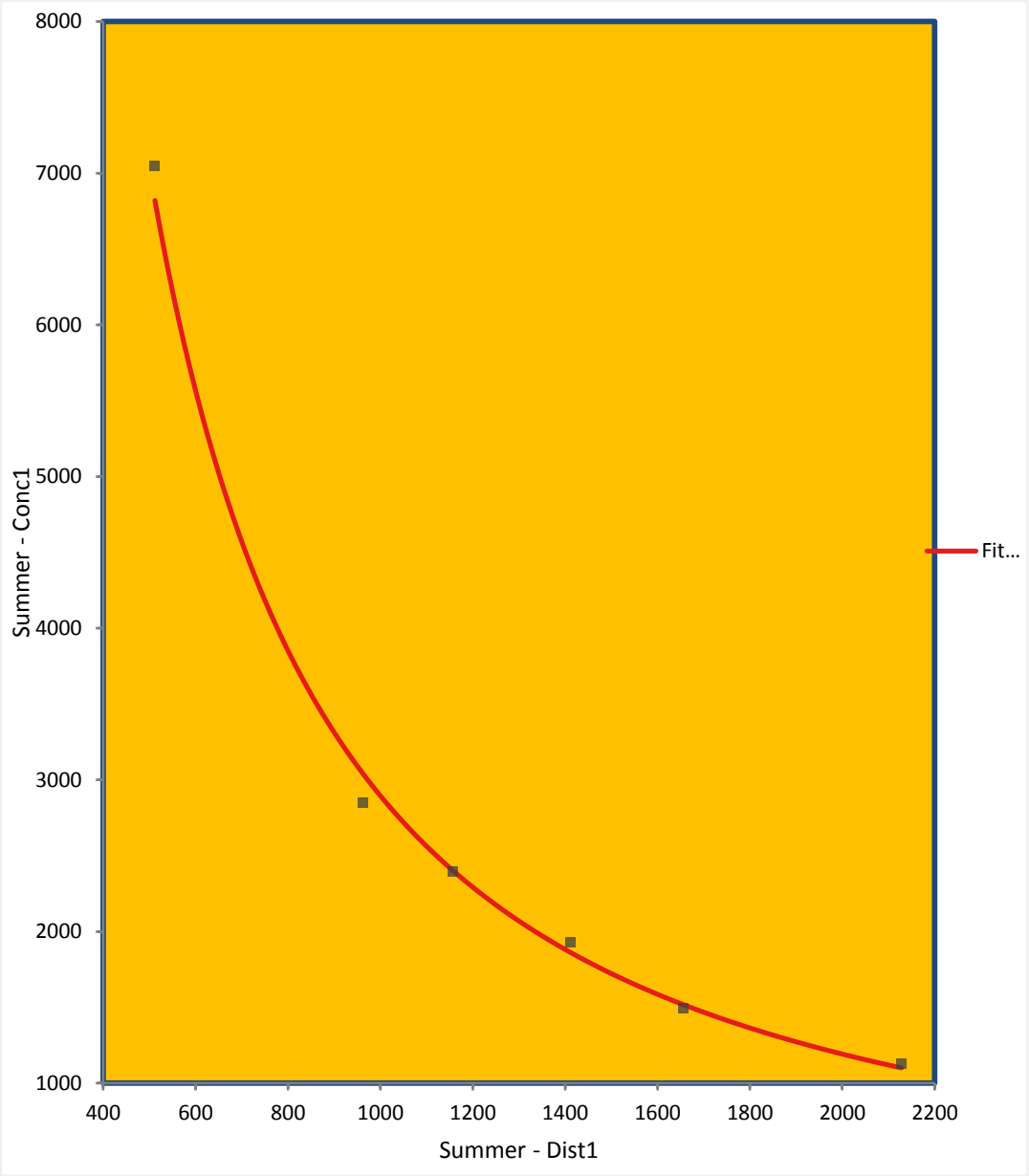
Focus on the Properties (Note the Rate of Change)

Concentration Decay with Distance is a Function of:

- Meteorology over the Period
- Terrain over the Distance
- Source Release Characteristics
  - Location
  - Elevation
  - Lateral and Vertical Dimensions

Its Most Useful Property:

- Shape of the Decay is **Independent of Release Rate, and,**
- Concentration at a discrete point is **Linearly Related** to the **Source Emission Rate**



Plot the Ln Concentration versus Distance

Summer		
Station	Dist1	lnConc1
P4/11	0	9.882136
P5	512	8.859789
a34	962	7.953318
a33	1157	7.779467
a32	1412	7.56372
a31	1657	7.309212
HR-N	2128	7.024649

Line of Best Fit:

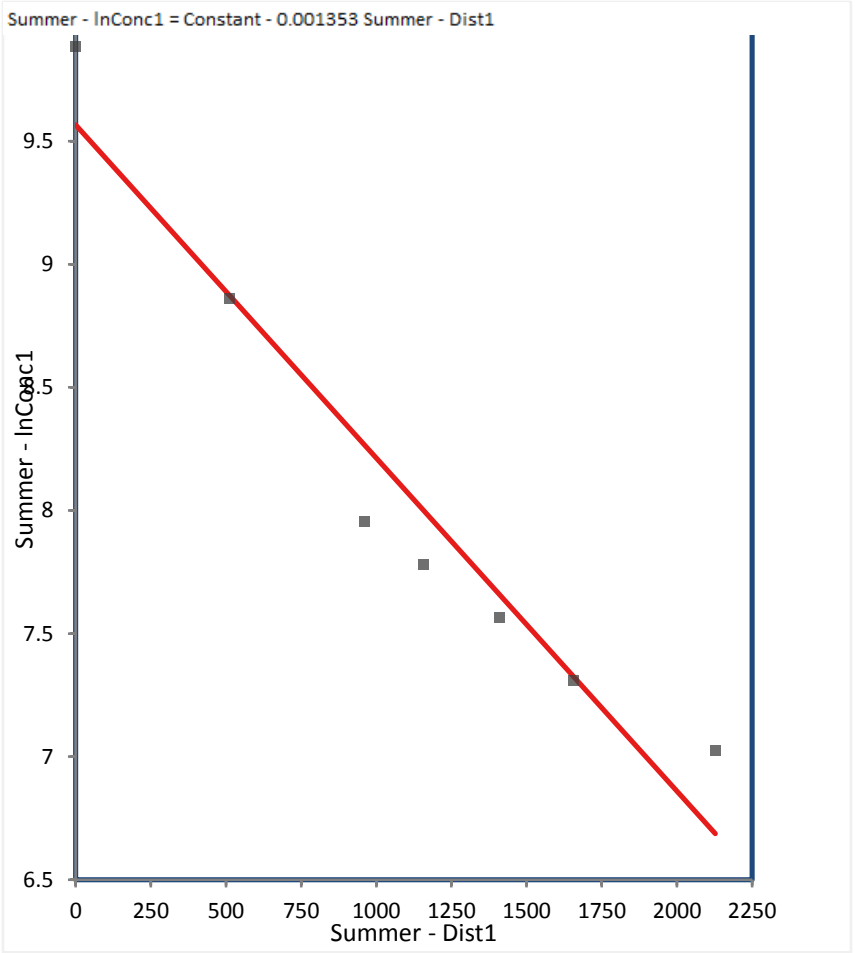
Ln Conc. = 9.556 – 1.353E-03*Distance

R2 = 0.938

Note :

The slope of this line is the average concentration decay rate over the distance .

We call that the average Decay Constant (-0.001353) for the Summer Period



Use Exponential Decay Model to Estimate Critical Concentrations

Exponential Decay:

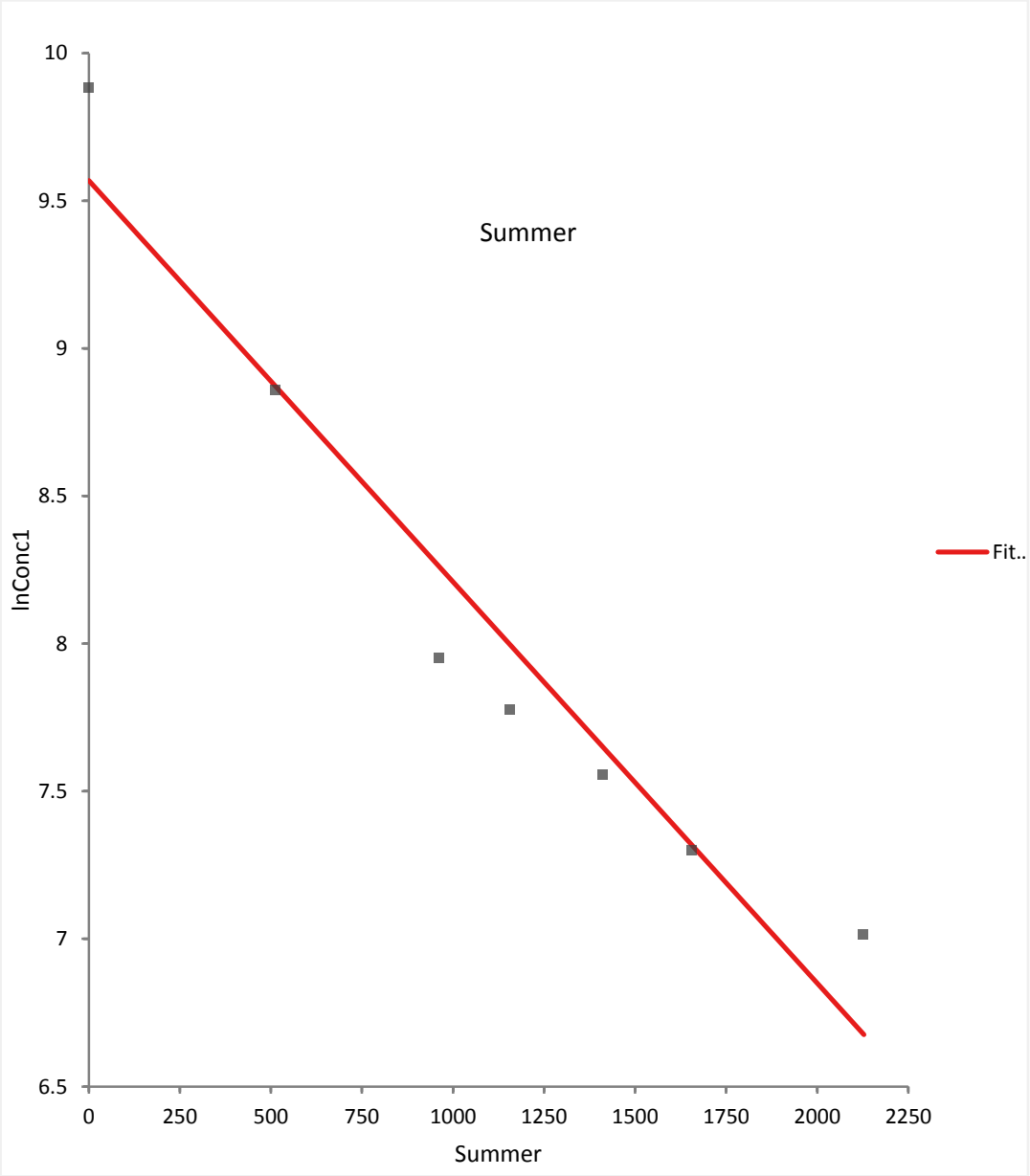
$$\frac{N_c}{N_p} = e^{-\gamma * Dist}$$

Where Nc is the "risk-based" concentration at HR, and Np is the project perimeter concentration (critical concentration) protective of the receptor at some distance downwind. Gamma is the average Decay Constant.

$$\frac{1500}{Np} = e^{-0.001353(2128)}$$

Solving for No: 26,700 s/m3 or 0.027s/cc

Note: Over the modeling period, south wind 79.5% of the time.



Critical Perimeter Concentrations

Repeat the Process for Spring, Fall, Winter

Average Period 24-hour Critical Concentrations- below which are protective of some hypothetical receptor (HR) 2128 meters to the north

Season	R^2 Corr.	Average Decay (K)	Distance To HR (M)	Period Average Critical Perimeter Concentration to Exceed HR TML (s/cc)
Spring	0.903	-0.00081	2128	**0.008354**
Summer	0.938	-0.00135	2128	**0.0267**
Fall	0.943	-0.00044	2128	**0.003842**
Winter	0.834	-0.00036	2128	**0.003216**
Average				**0.011 s/cc**

Scrubbing Efficiency

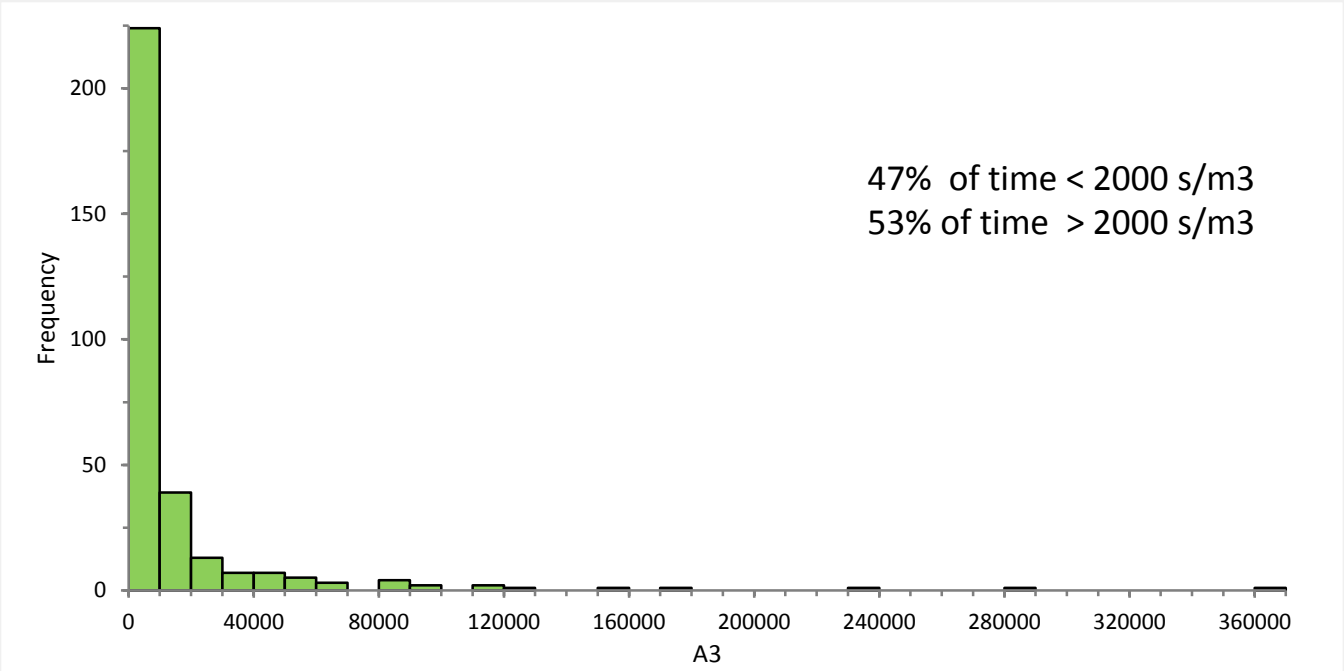
Recall (From Decay):

The concentration at a point distant from the source is linearly related to the emission rate of the source

Therefore Dust Controls need to remove 60% to 70% above and beyond current method.

Average P4/P11	Modeled Conc. (s/m3)	Required Concentration (s/m3)	% Reduction Required
Min	359		
Max	331,159		
Median	24,815	10,500	58%
Average	33,559	10,500	69%

Frequency Distribution of Modeled HR
24- hour Average
Concentrations Over 2013
(312 Operational Days – Sundays Excluded)

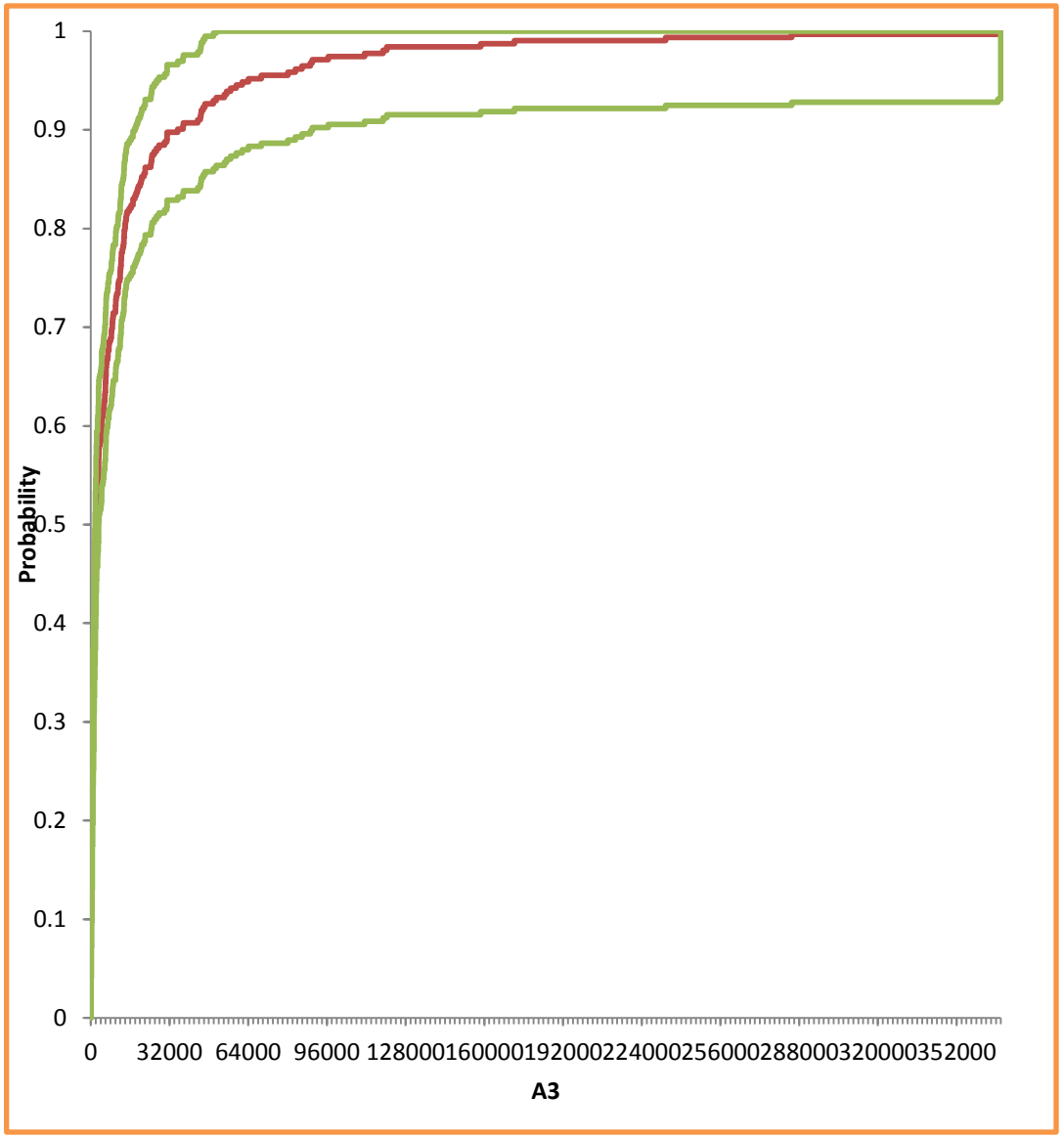


N	312						
	Minimum	1st quartile	Median	3rd quartile	Maximum	IQR	
HR	11.35874	734.248520	2199.093610	11871.286148	368800.65623	11137.037628	

Cumulative Probability Function

One year Zone 5 Simulation

Sensitive Receptor Location



Likelihood of Success

Current Risk-Based Concentration with Current Controls

Assumes:

Four Year Exposure Duration

Residential Exposure Scenario

Exposure Onset - Birth

All Receptors - Likelihood of Success:

Resident	**0.0013 s/cm3**	**37%**
Worker	0.018 s/cm3	84%
Cyclist	0.608 s/cm3	100%
Hiker	1 s/cm3	100%

Likelihood of Success

Future Risk-Based Concentrations With Current Controls

Assumes:

Six Year Duration

All Receptors Considered- Likelihood of Success:

Resident	**0.0009 s/cm3**	**29%**
Worker	0.0125 s/cm3	78%
Cyclist	0.429 s/cm3	100%
Hiker	0.720 s/cm3	100%

Likelihood of Success

Risk-Based Concentrations and New Controls Reduce Emissions by 25%

Assumes:

Six Year Duration

All Receptors Considered- Likelihood of Success:

Resident	**0.0009 s/cm3**	**35%**
Worker	0.0125 s/cm3	83 %

Alternative Strategies

- Do Nothing
  - Shutdowns (50 forecast)
  - Longer Project – Driving RBCs Lower
- Import 600K yds (60,000 trucks)
  - EIR Process
  - Elevated Accident Risks (Roadway Shutdowns?)
- Re-Evaluate Risk Based Triggers (Alternative Receptors)
  - Move Residents (*)
- Combinations
  - Suspect some Import for mitigation plus RBCs

Thanks for Listening