NOA at the Calaveras Dam Replacement Project (CDRP)

(In 50 minutes or Less!)

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Overview

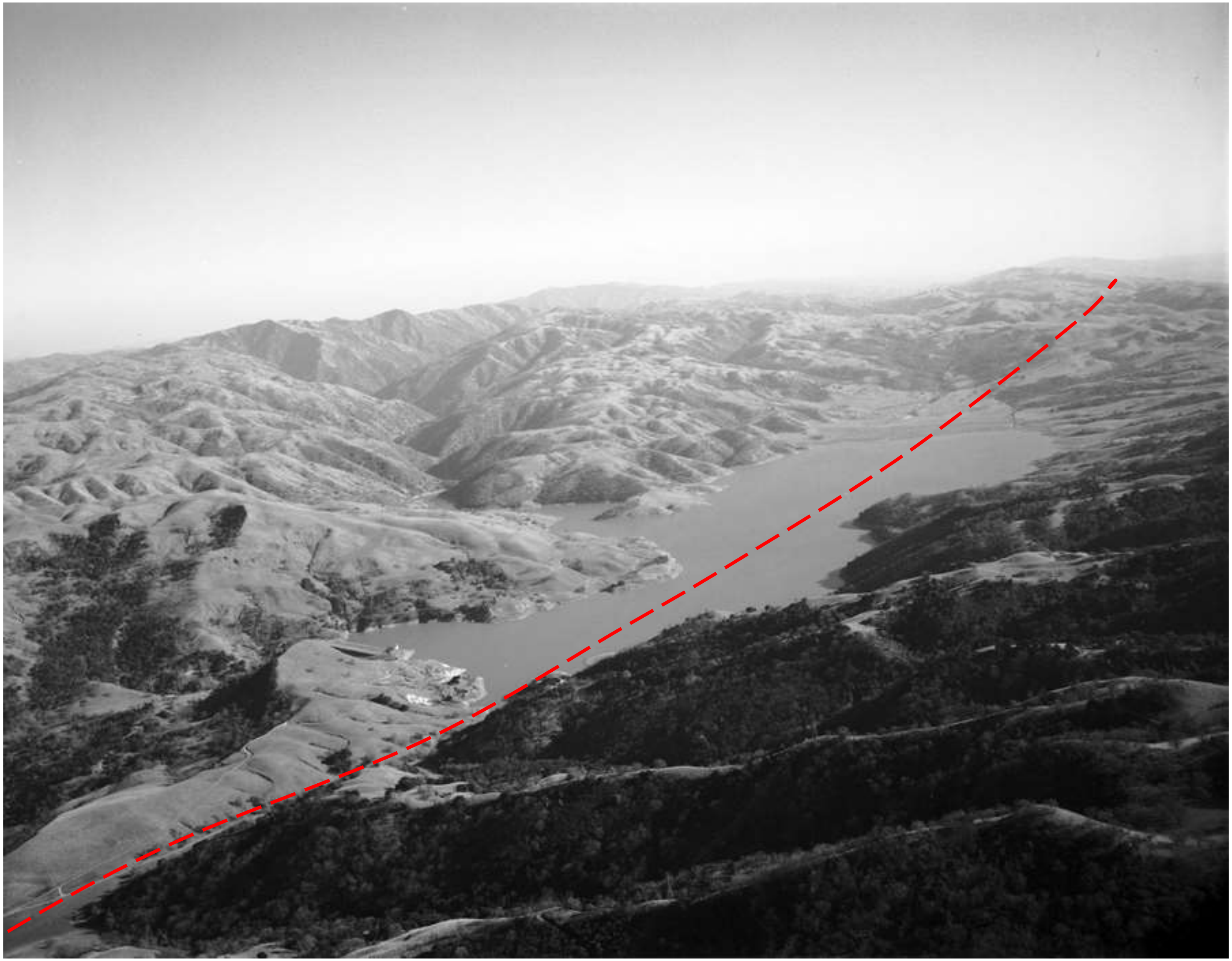
- Two Part Discussion

  – Part 1 – Overview and NOA Program Management

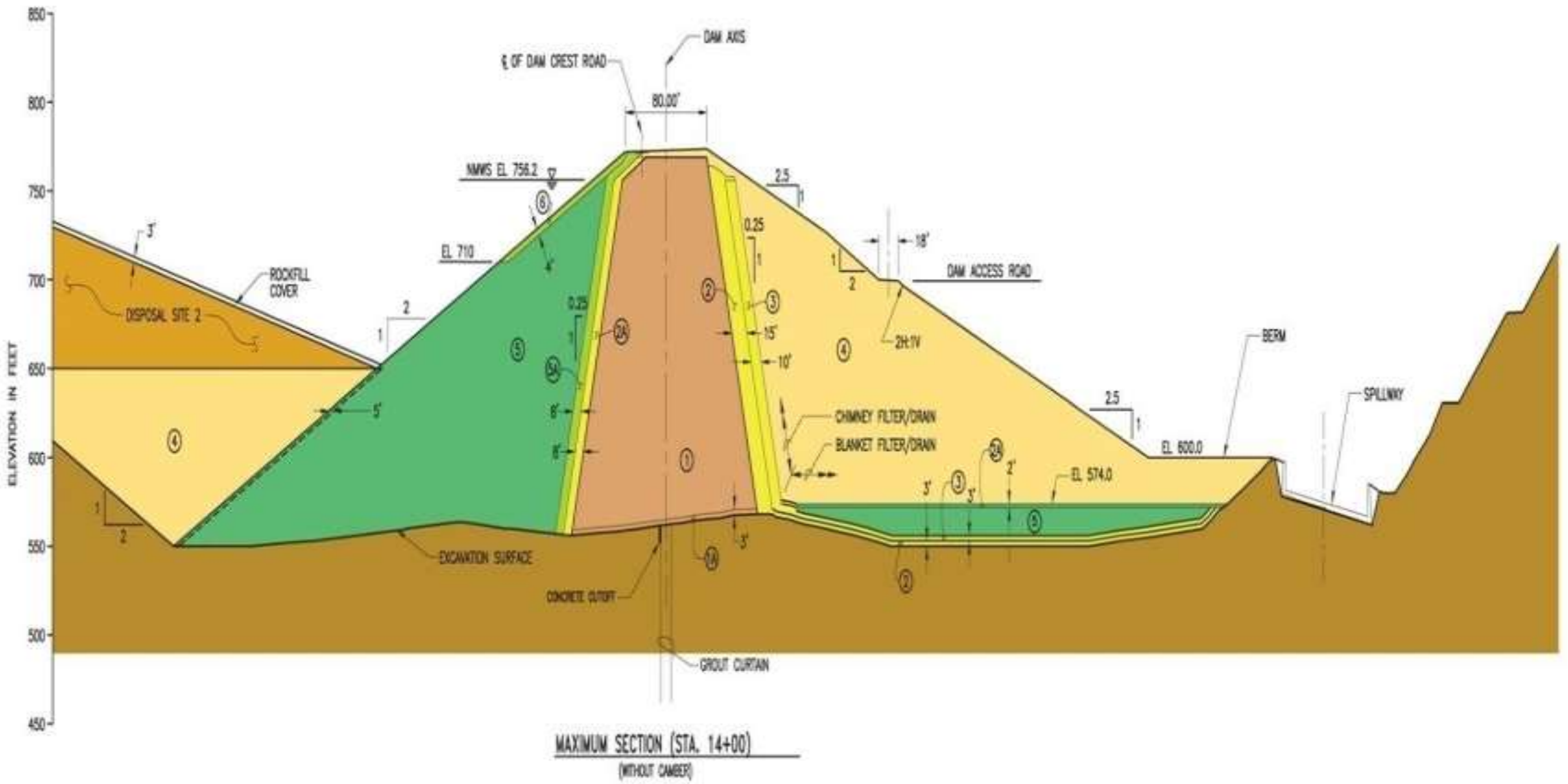
  – Part 2 – Discussion Concerning “How Best to Establish Risk-Based Perimeter Concentration Criteria”

Quick Orientation

Calaveras Fault

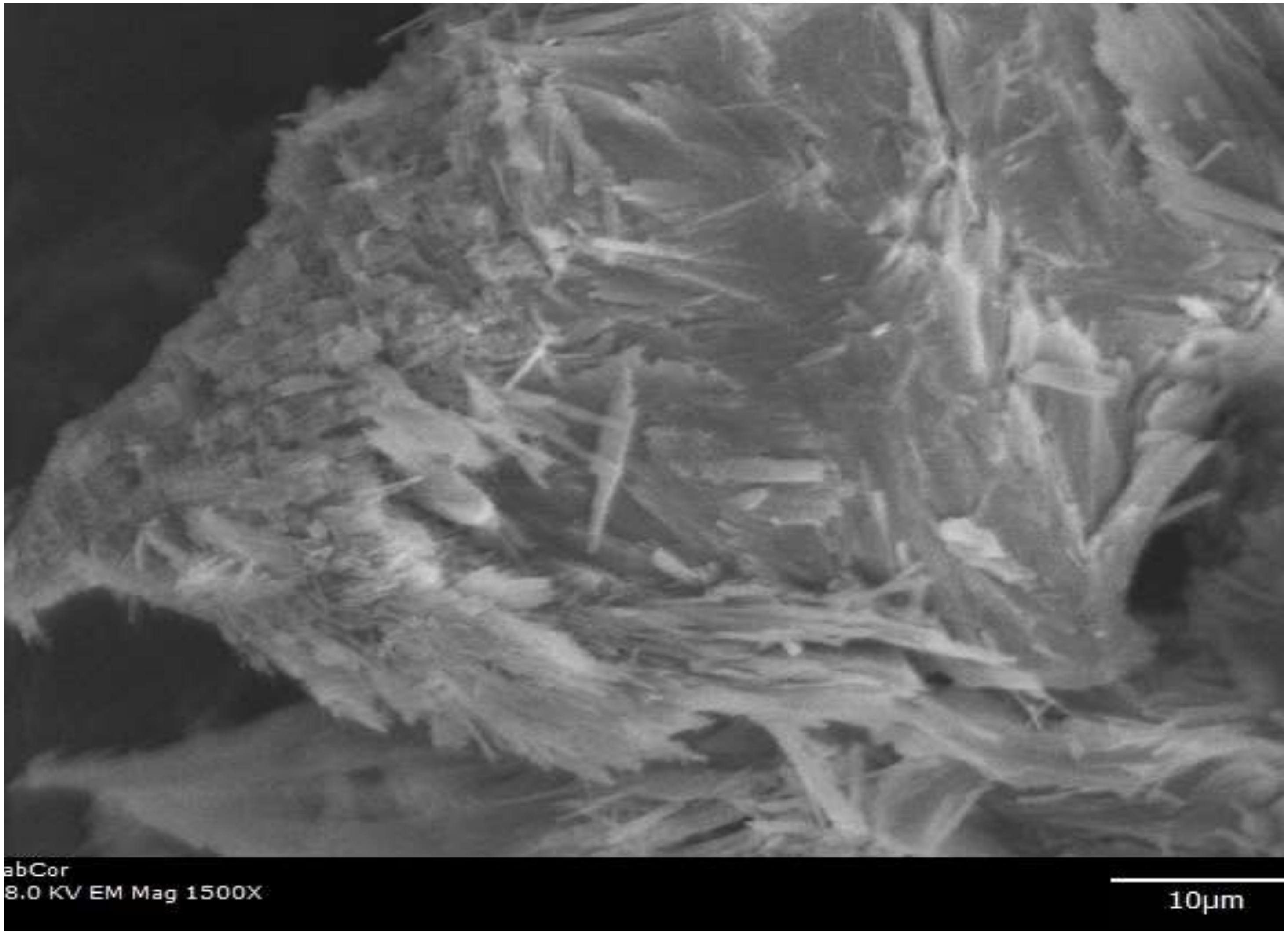


Replacement Dam



Calaveras Dam

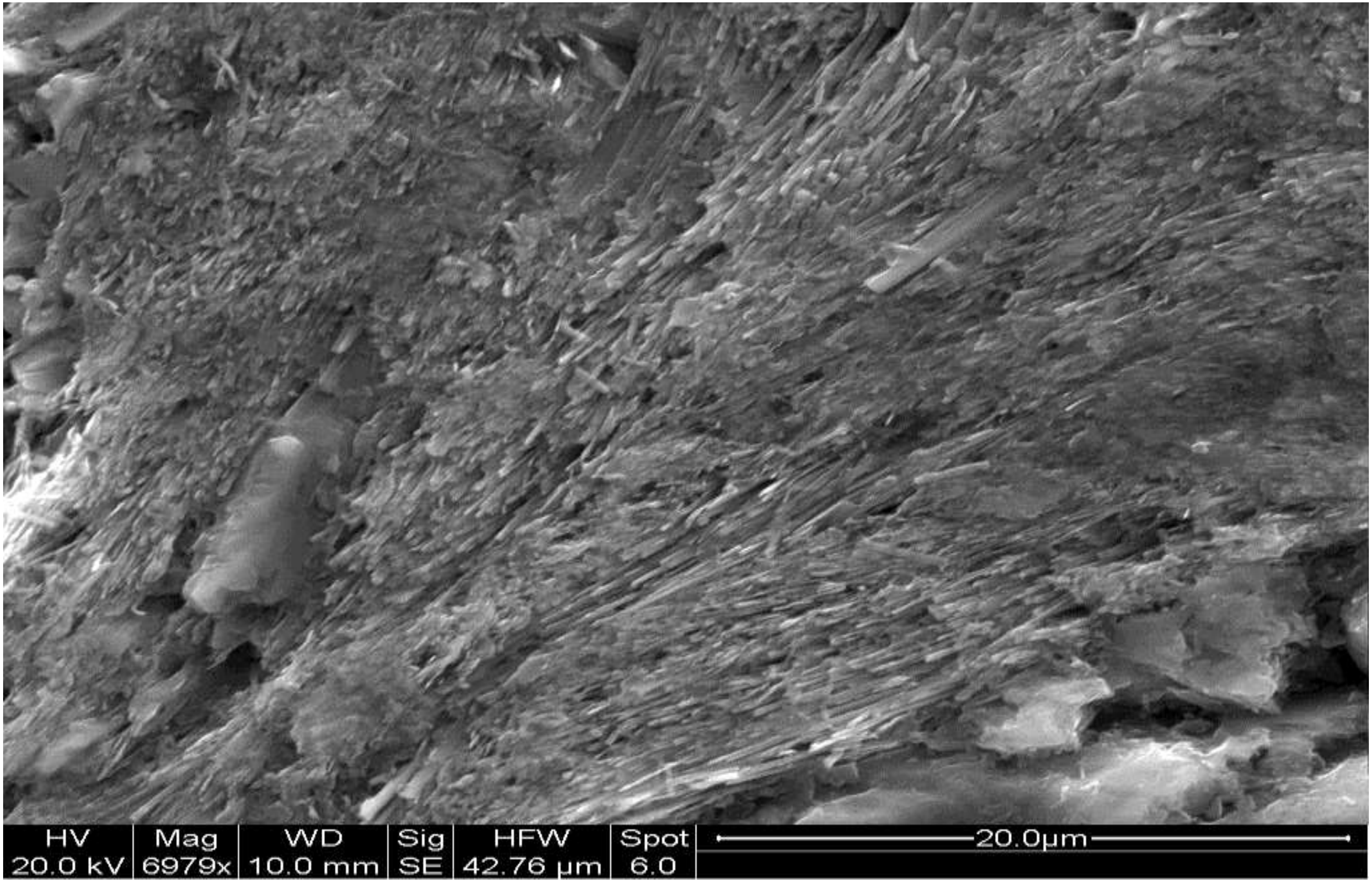
Blueschist



BlueSchist

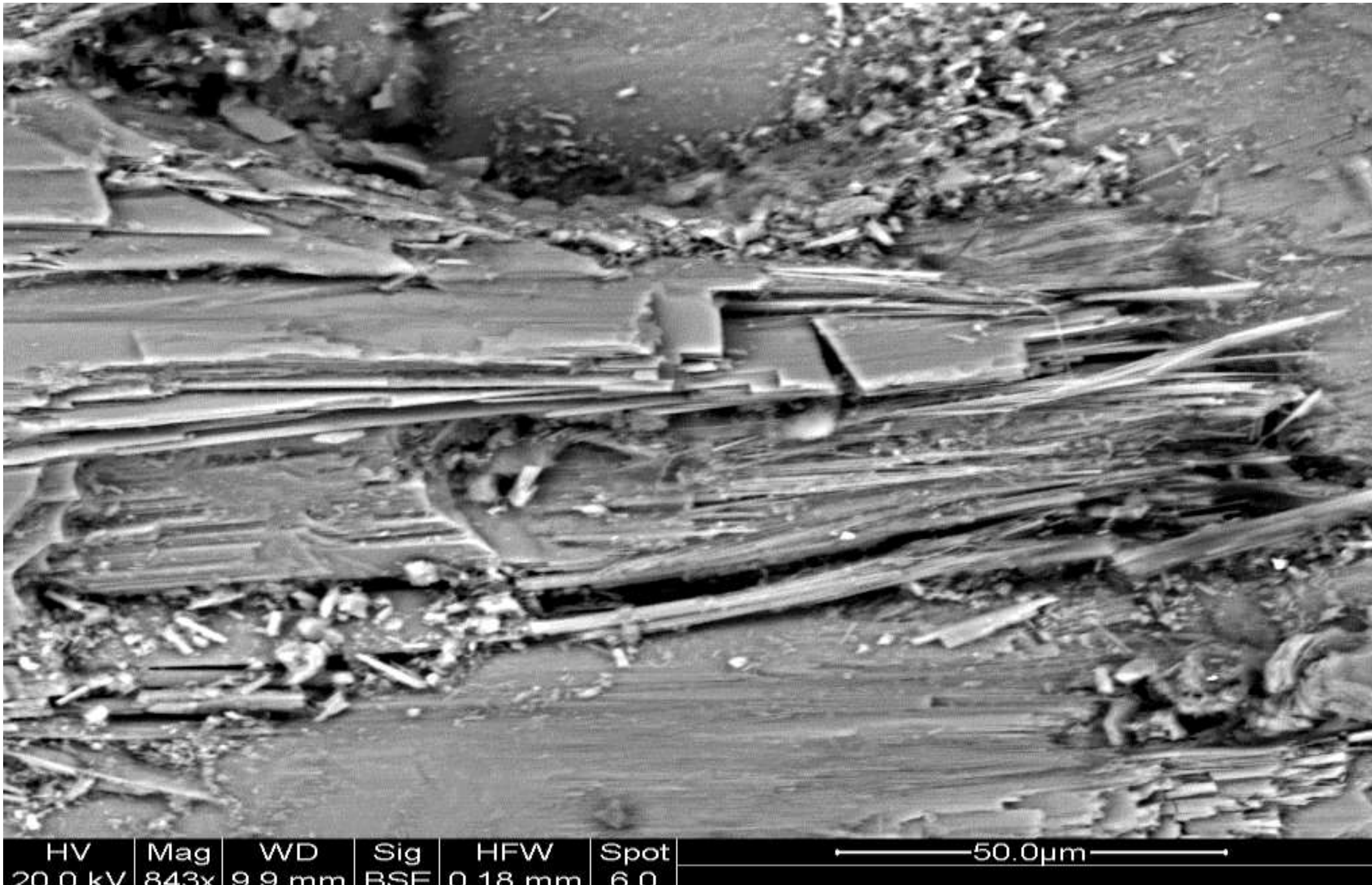

10 µm
EHT = 5.00 kV
WD = 8.3 mm
Signal A = SE2
Mag = 1.79 K X
Date :22 Nov 2013
Sample ID =
ZEISS

Thin Section of Blueschist



Foliated Blueschist

Actinolite (Amphibolite)



Highly Weathered Serpentine

Existing Dam Before Construction

Right Abutment and Spillway Keys

Left Abutment and Spillway Keys

Operations

Blast Drilling Operations

Pneumatic Drill with Misting and Dust Collection System

Drilling (Bauer Rig – Three foot Diameter Auger)

Seventy to eighty foot depths through Serpentinite

Blast Drilling with Water Canon Support

Thirty foot Depths with Pneumatic Rigs

Borrow Area B Amphibole Group

Blasting

BAB Amphibole Group

Production Zone 5 Load Out Stilling Basin

Scraper Run – Right Abutment

Rock Crushing – Borrow Area B

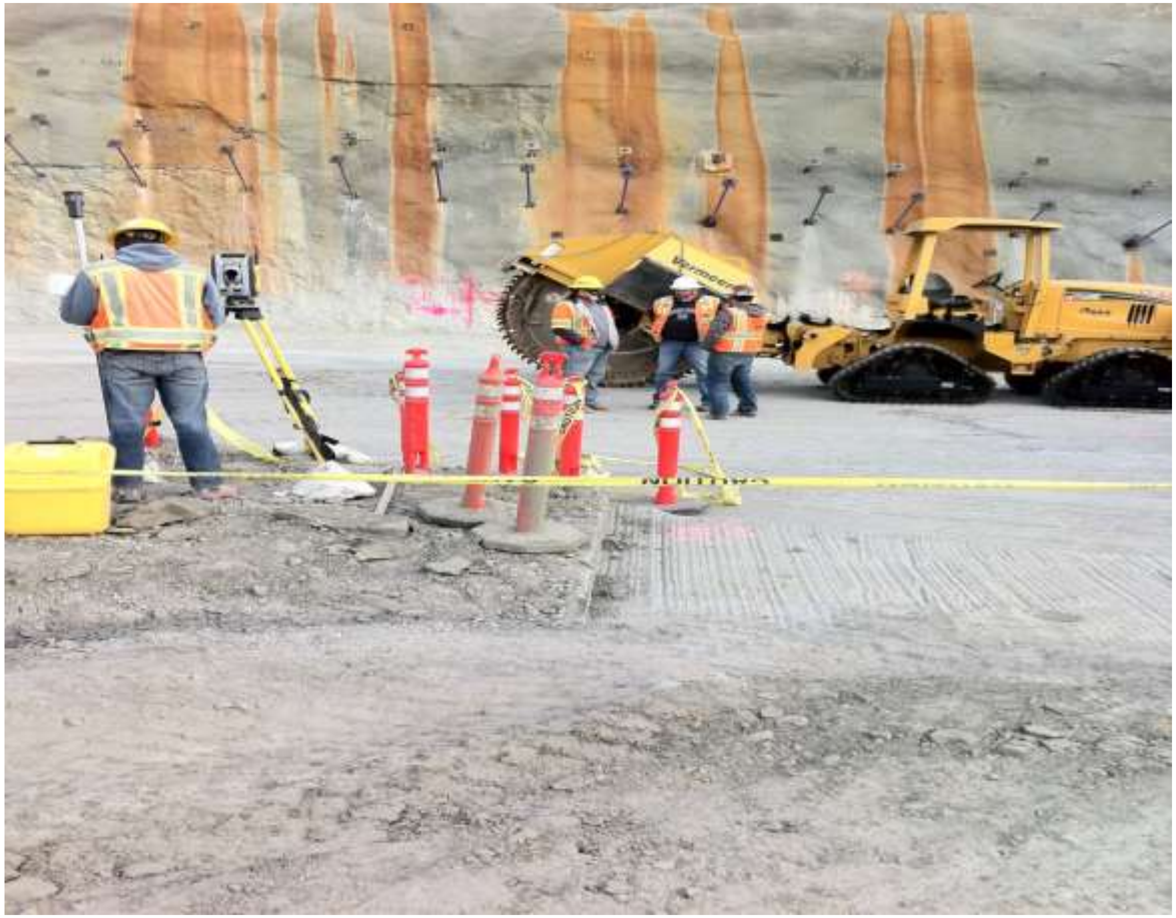
Grinding Operations

Spillway – Grinding to grade

Core Trench

Ten foot depth, 400 feet in length, three feet in width

Trenched through Franciscan including Serpentinite and Blueschist



Trenching

Keyway Excavation

Naturally Occurring Chrysotile

Pioneering through Brecciated Serpentinite

NOA Program Components

- NOA Management Program
  - Training
  - Medical Surveillance
  - Work Place Monitoring
  - PPE
  - Dust Control
  - Site Controls
- Characterize Emissions
- Risk Assessment

Medical Surveillance

- Primarily Zone 5 Participants
  - Onsite
    - Pulmonary Function
    - Blood Pressure
    - Drug Screen
  - Offsite
    - Medical Questionnaire
    - Physical (Physician)
    - Chest X- Ray

Work Place Monitoring

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

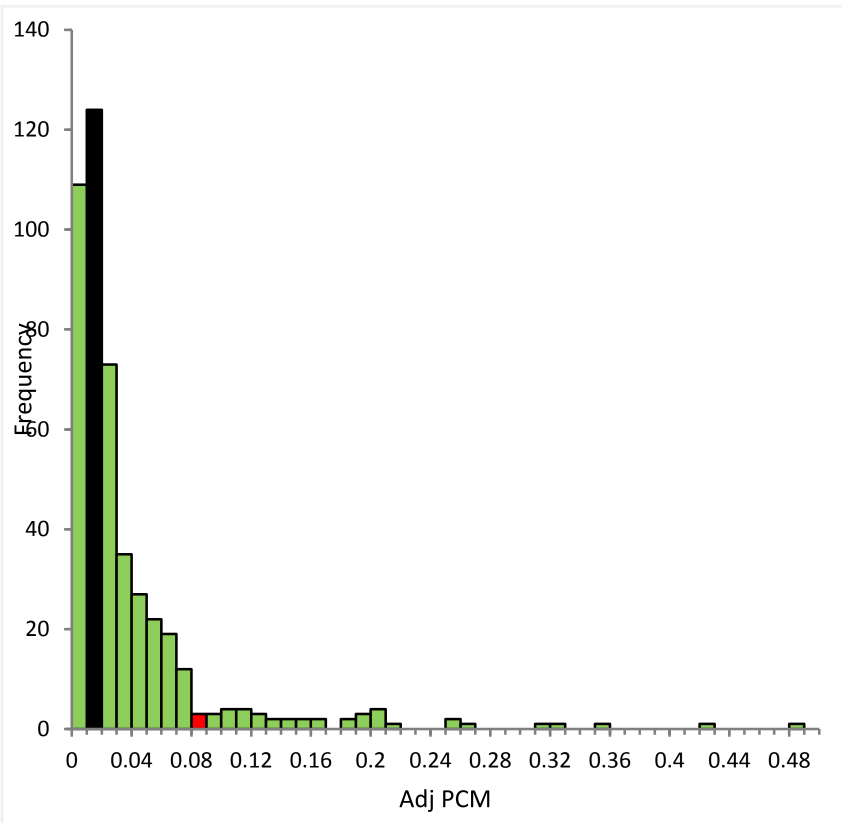
- Sampling by job category, operation, and geologic unit
- We have found very large differences in exposures between amphibole and serpentine groups
- Data in table reflect the differences

	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)
Average (7402)	0.0356 (f/cc)	0.124 (f/cc)
Std. Dev	0.063	0.223

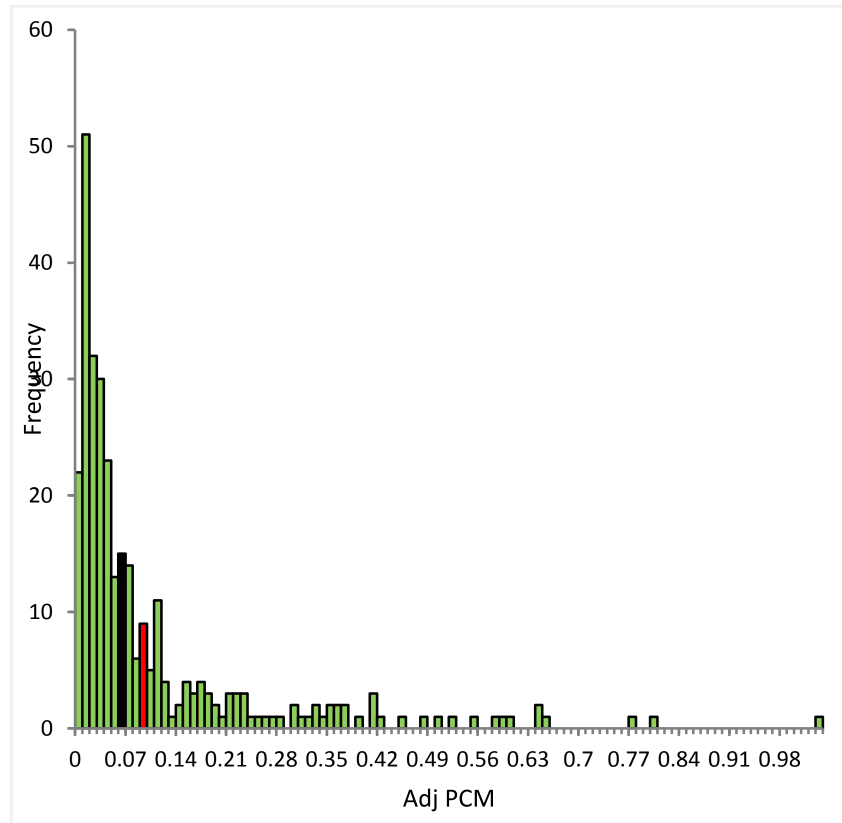
NIOSH 7402 Adjusted PCM Results

[* 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

High Exposure Operations & Job Classifications

Operations (Decreasing Order):

Drilling – Pneumatic Drill Rigs

Rock Crushing

Zone 5 Load-out

Dozing

Foundation Cleaning

Slope Scaling

In-Situ Gradation Testing

Classifications (Decreasing Order)

Laborer

Drill Operators- remote Control Drill

Operator – Dozer

Operator – Excavator

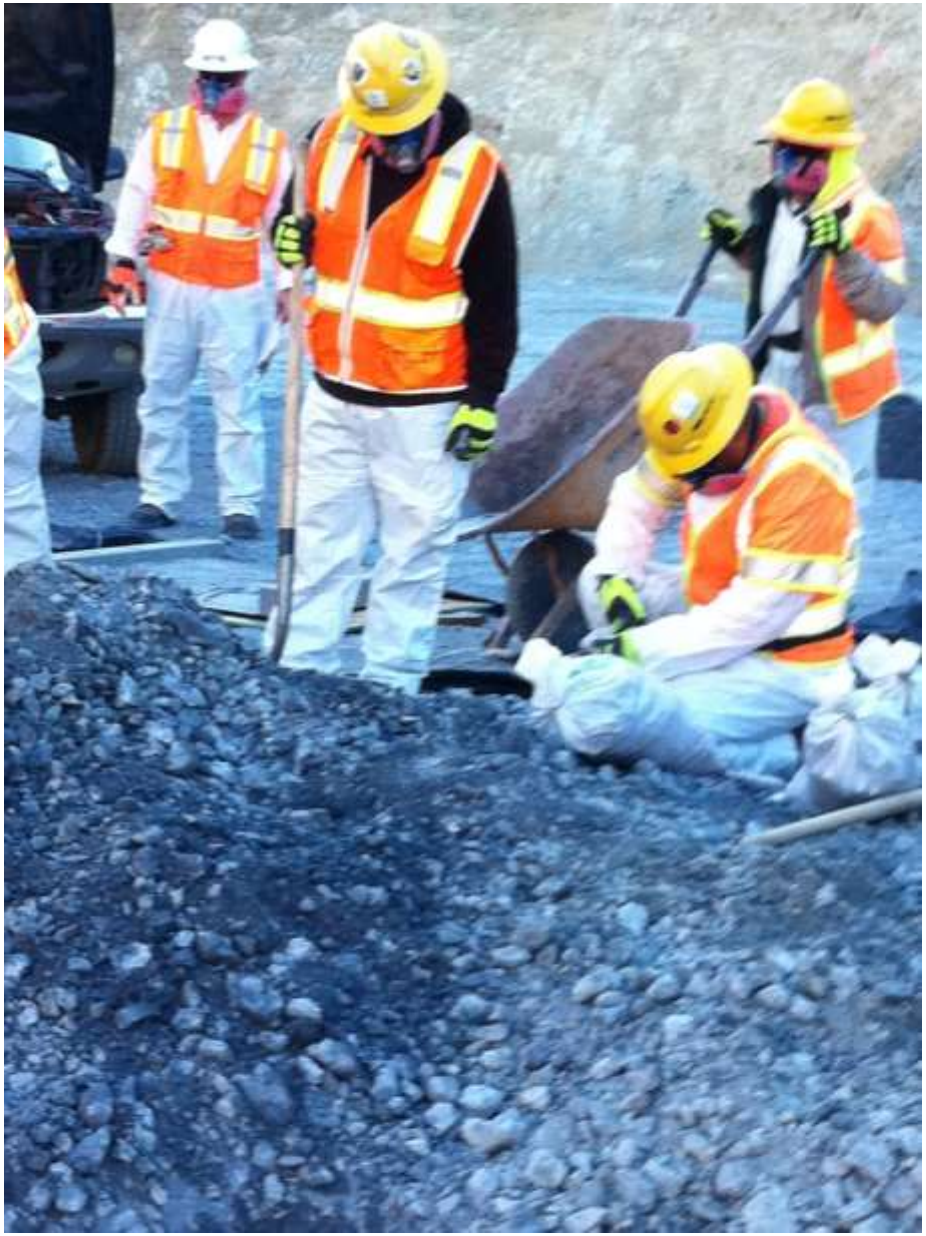
Drill Operator – closed Cab

Air Concentrations Determine the Level of Protection

Gradation Testing:

½ face APR (PF = 10)

In general, ½ face APR and Tyveks provide adequate protection for most of our operations



PAPR (PF 25)

“Go To” Piece of Equipment

- Comfortable, 2.5 times more protective than ½ Face
- Subs Showing up with Beards, etc.
  (Shot-Crete in a Regulated Area)
- Not used in excavation where uneven footing is the rule, and where vision absolutely cannot be impaired

Full Face APR (PF 50)

CDRP uses these sparingly:

Dangerous

- **Heat**
- **Vision**
  - **Fogging**
  - **Distortion**
- **Hot & Uncomfortable**
- **Will not use in Excavation**

PAPR (PF – 1000)

Used Sparingly-

Primarily When I am Uncertain and/or Paranoid

Example: Core Trench

Dust Controls

Dust Controls

Dust Boss:

100 liters per minute

50 – 200 micron droplets

Face velocity of 100 mph

Dust Control
Pneumatic Drill

Power Washer-3500 – 4500 psi

200 – 300 mph velocity

Aerosol size 10 – 50 microns

Dust Control Technology Testing at DS7 – Condensation Nuclei

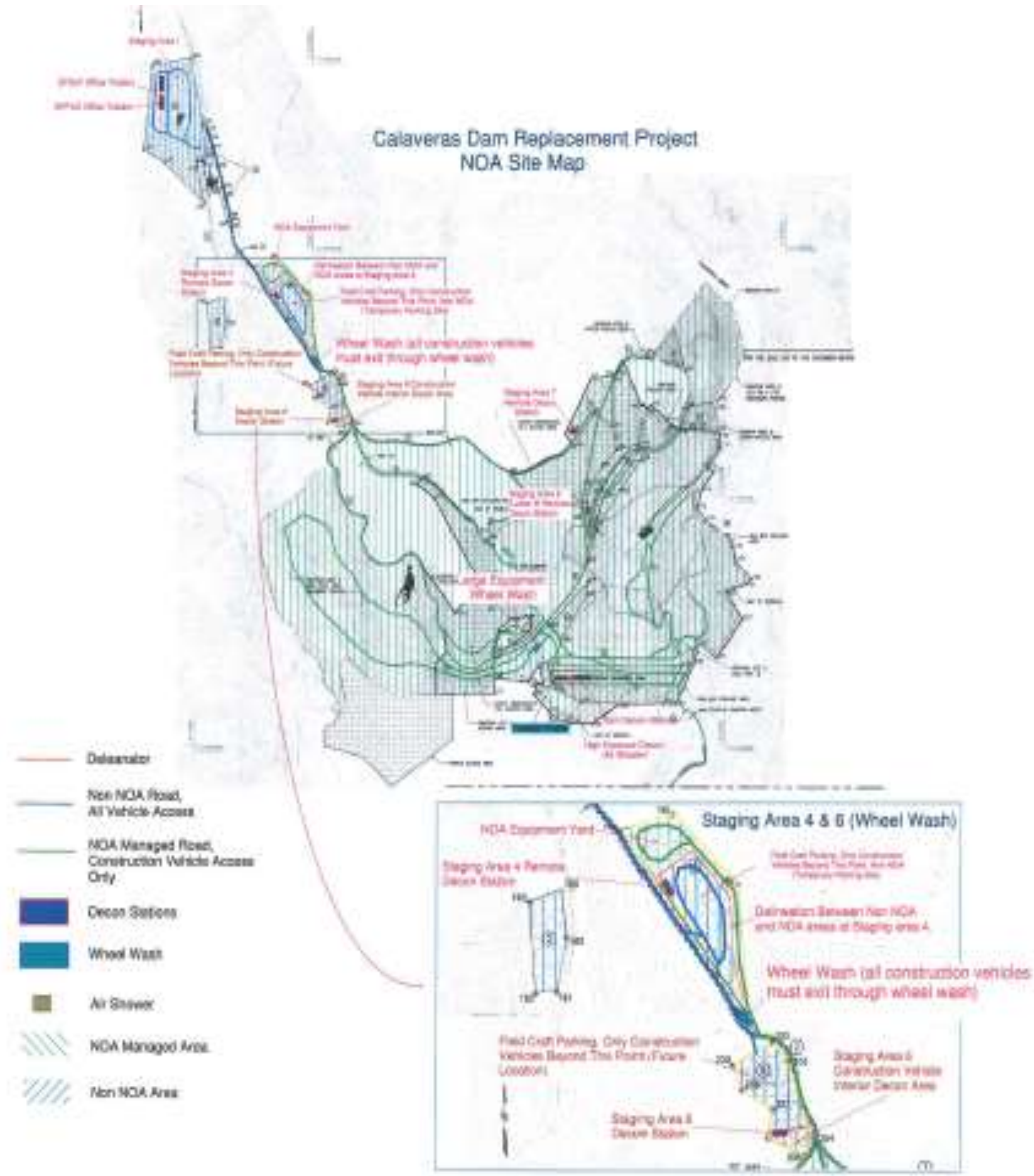
Dust Control Technology Implemented in the Still Basin Excavation

Site Controls

Development of a Site Configuration Strategy Document :

Taking into account how the Project will be built out-

- Minimize NOA Migration out of the project
- Minimize NOA Migration out of source locations
- Flow of traffic
- Location of Decon Stations
- Location of Wheel Washes and Tracked Equipment Decon Pads.
- Designation of Authorized Entrants vs Crafts Workers
- Parking for Crafts
- Procedures

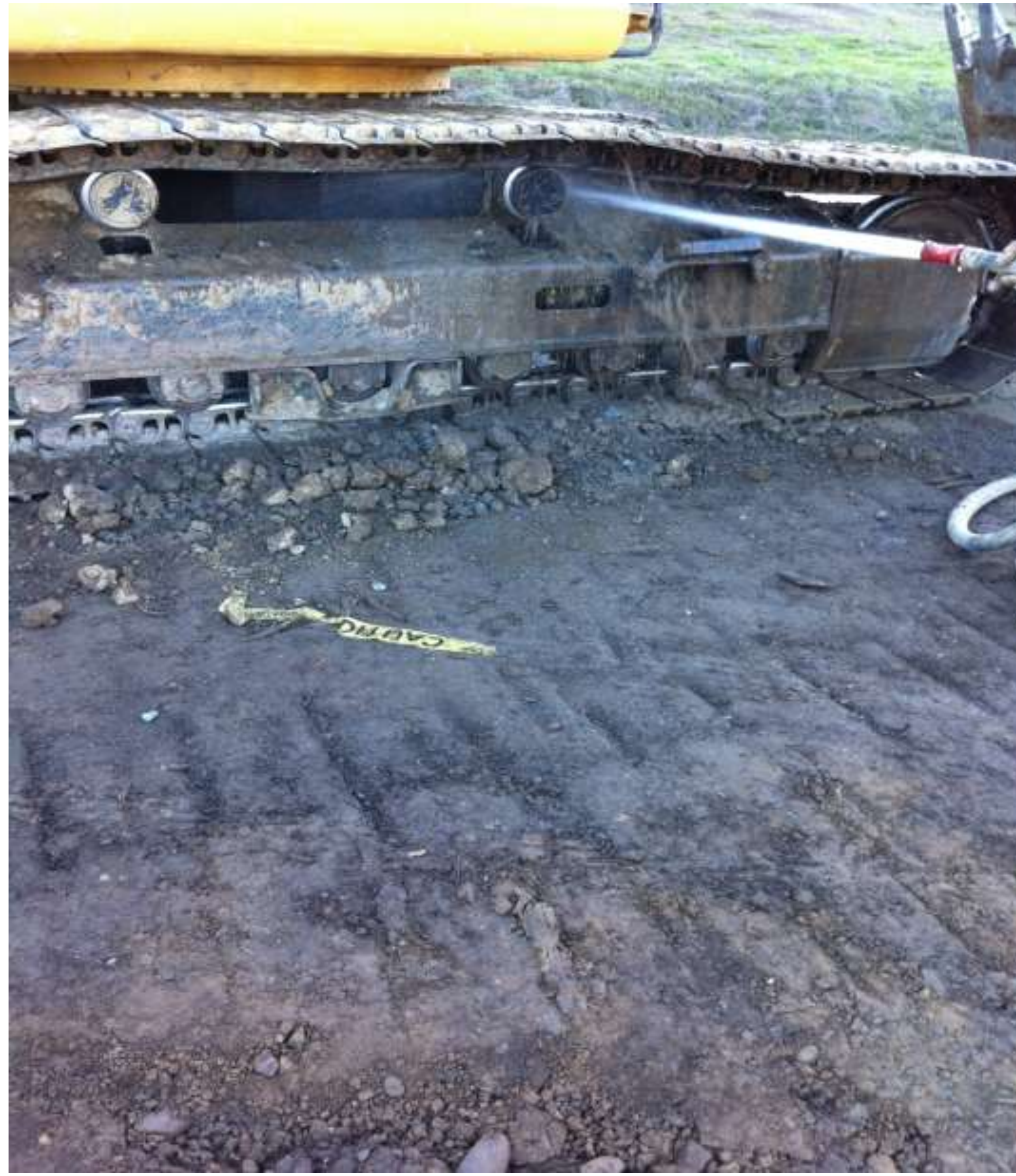


Site Controls- Gross Decontamination

CDRP had Several Non-contiguous Areas of NOA Units, with Non-NOA in between

To minimize NOA transfer to non-NOA Areas –Gross Decon required before leaving NOA areas

(Greater the areal spread – the larger the " re-suspension problem becomes")



Decon

Wheel Wash – Fresh Water

All site entrants leave through the wheel wash

Tracked Equipment Decon Pad

All equipment leaving the site is deconned at this facility

Fixed DECON Station

Boot Wash – Project Water
HEPA

Benches – Storage - Wipes

Air Shower

Decon required before entering this facility, designed to fluff clothing and re-suspend fiber. Finishing Step for High Exposure Operations. Air is cleaned by a factor of 1000 in 4 seconds.

Cab Cleaning

Cab interiors are routinely scheduled for cleaning

Part II

- How to Develop Critical Perimeter Concentrations – Protective of Offsite Receptors ?
- How to Define Scrubbing Efficiency in Order to Achieve NOA Success?
- Discussion Points:
  - Project Setting – with Hypothetical Receptor (HR) to the North
  - Methods and Assumptions
  - Critical Concentrations
  - Results

Regional Setting
Perimeter Monitoring

Project Setting
(HR to the North)

Risk Assessment

- Risk Assessment Requires Exposure Point Estimation at Sensitive Locations Offsite
  - Use of Predictive Tools
    - Knowledge of Operational Emissions
    - Knowledge of Meteorological Conditions
    - Knowledge of Site Characteristics (for Refined Modeling)
      - Topography, surface roughness, land uses

Critical Concentration Development

- Three Step Process
  - Develop Risk-based Criteria
    - May use structures as an indicator for fiber (structure to fiber ratio)
    - May establish perimeter concentration criteria protective of offsite receptors (control banding)
  - Develop Emissions Inventory
  - Use of Refined Tools to Evaluate onsite/offsite impacts

Risk-Based Criteria

- Completed by the Owner
  - General Method:
    - $ELCR = Ac\ x\ IUR$
      - Set Target Risk and Calculate Ac (f/cc)
      - IUR is based on onset of and duration of exposure (EPA)
- For this Discussion-
    - We are going to use 0.0015 s/cc as the “concentration of concern” at location HR.
      - (incorporates structure to fiber ratio, project duration, exposure assumptions, attenuation with distance)

Proposed Approach

- Use of Site Specific Information

  Operational Specific Measurements (Z5 Source)

  Dam Top Meteorology

  National Elevation Data Set

- Combine With Refined Modeling Methods

  Source/Production Assumptions
  Actual Source Operational Conditions

- Calibration ?

  Compare to Empirical Data from Established locations
  and set up a Station at a distance to North

Source Data

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

Emissions Inventory
Box Model & Gaussian Dispersion

Both models used to estimate emission rates from various operations.

$$C_{\frac{s}{m3}} = \frac{G_{s/sec}}{H_m \times W_m \times U_{m/s}}$$

Box Model is used when measurements are very close to the operation.

Gaussian Model is used at greater distances down wind from the operation.

$$\chi = \frac{Q}{\pi \sigma_y \sigma_z \mu}$$

Sigma Y and Z are a function of distance and Stability Class

Site Specific Measurements

Combination of air sampling with wind speed and direction measurements.

Anemometer: Kestrel Weather Tracker with portable vane mount.

Provides and data logs key information at the point of measurement.

Measurements

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

Solar Insolation and Stability Class

Wind Speed	*Day*			*Night*	
at 10 meters	Solar Insolation			Cloud Cover	
($m\ s^{-1}$)	Strong	Moderate	Slight	>50%	<50%
<2	A	A - B	B	E	F
2 – 3	A – B	B	C	E	F
3 – 5	B	B – C	C	D	E
5 – 6	C	C – D	D	D	D
>6	C	D	D	D	D

Stability is D for completely overcast conditions during day or night.

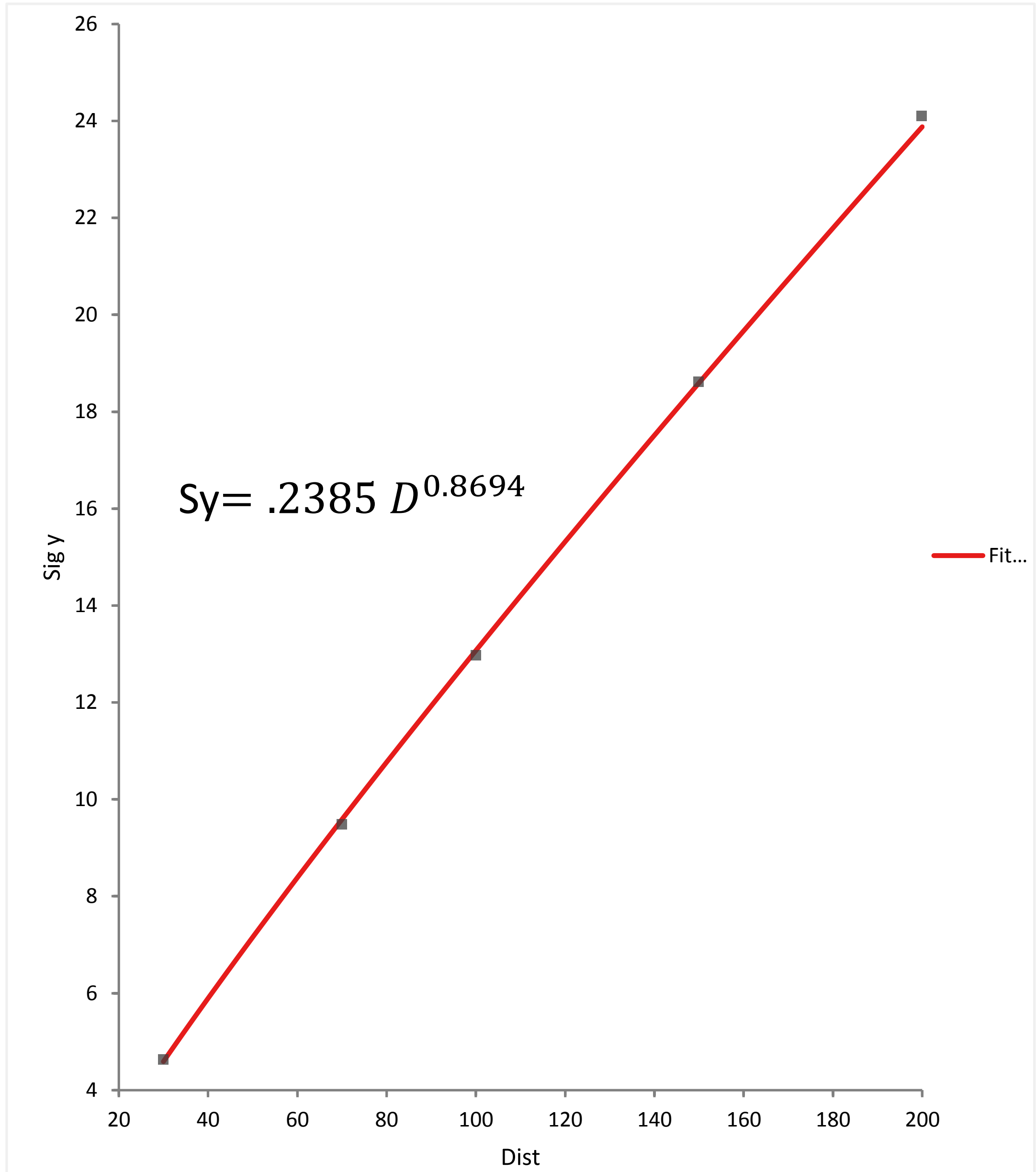
Derivation of Dispersion Coefficients (Sreen3 Model)

Sigma Y Dispersion Co-efficient

For Stability Class C at wind speed of 2 meters/second and for a Scraper Haul.

Volume Dimensions for Equipment Heading towards the Observer, in the Direction of the Wind.

(Modeled as a Volume Source with release height of 1.52 meters, initial height of 3.1 meters and initial width of 3.1 meters).



Total Emission Rates
Adding Emitting Components

Zone 5 Excavation & Load-out:

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

Direct Measurement

Zone 5 Excavation and Load-Out Structures:

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)

Blast Data

Evaluated in two ways

Examined yield of material and amount of explosive

- Emissions Estimates

  Screening Level EPA Modeling:

Blast Date	Emissions Estimate
22-Feb	4.5E+09 s/sec
27- April	2.2E+11 s/sec
11-May	6.4E+10 s/cc

Blast Date	
22-Feb	3.7E+09 s(sec-lb-yd3)-1
27- April	1.7E+11 s(sec-lb-yd3)-1
11-May	4.4E+10 s(sec-lb-yd3)-1

Volume Sources

Forward Facing Fan	Forward Facing Fan
	

Largest Source of Emissions
Zone 5 Load Out

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

Indirect Direct Measurement (Exposure)

Zone 5 Excavation and Load-Out

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)

Example of Source Data Tracked

Source	Source Description
DZLB-1	Dozing Area 50 m by 36.6 Zone 5 ; or SB Load out with Excavator, Dozer, RTs
DZLB-2	Dozing Area 50 m by 36.6 Zone 5 ; or SB Load out with Excavator, Dozer, RTs
DZLB-3	Dozing Area 50 m by 36.6 Zone 5 ; or SB Load out with Excavator, Dozer, RTs

	Volume					
	Screen	Screen	Field Estimates			
R-Ht	Lateral	Verticle	Rel-Ht	Lateral	Vertical	
4	11.63	2.33	4	50	5	
4	11.63	2.33	4	50	5	
4	11.63	2.33	4	50	5	

	Distance (m)	Sz	Sy	f/sec	s/sec
DZLB-3	50	16.71	7.81	3.73E+08	4.99E+09
DZLB-3	50	16.71	7.81	9.81E+08	1.33E+10
DZLB-3	50	16.71	7.81	1.55E+09	2.50E+10
DZLB-3	50	16.71	7.81	2.93E+09	3.10E+10

Modeling Emissions (What Are CDRP Contributions to HR and what should the critical concentrations be at North Perimeter?)

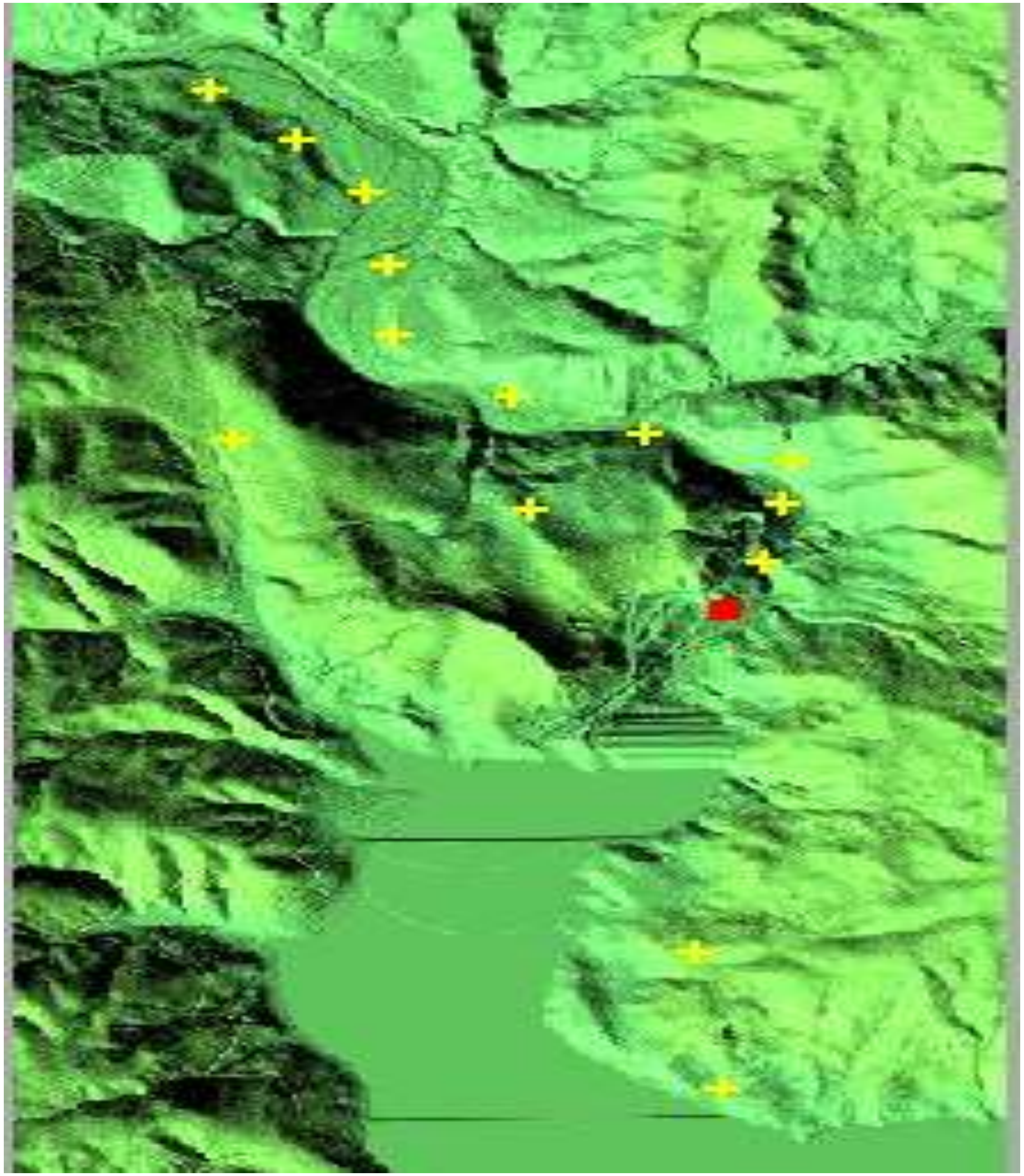
Refined Model – Complex Terrain Aermod Incorporates:
-Elevation Data (NED 1/9 arc sec)
-Site Specific Meteorology
-Upper Air Profile (Oakland)
-Surface Characteristics

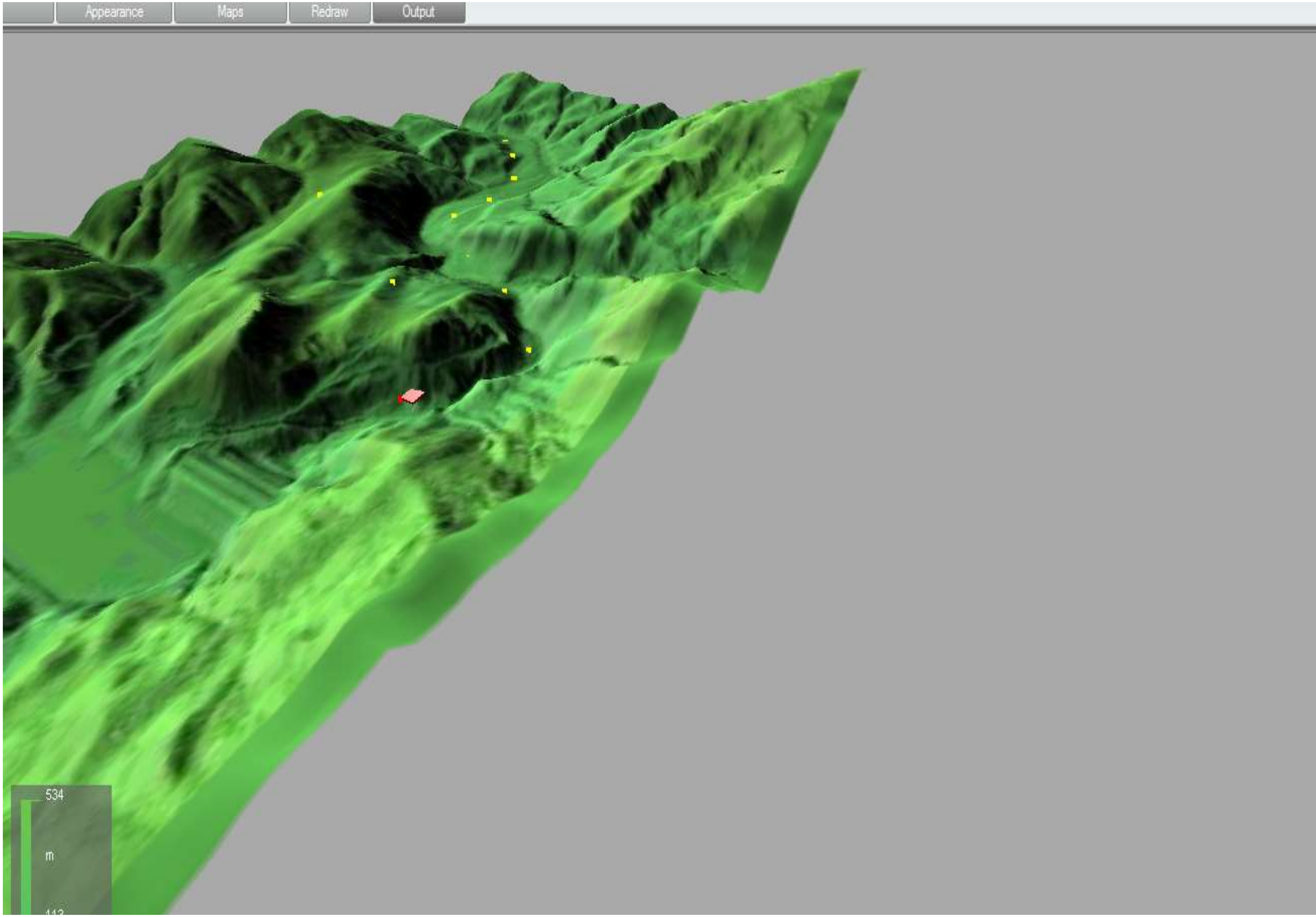
Source- Zone 5 Load Out (SB)
-Variable – set to 9 hrs. per day
6 days per week, 3 months (June – August), with Elevation Change
-Measured Emission Rates

Receptor Array (long./lat./elevation for each)

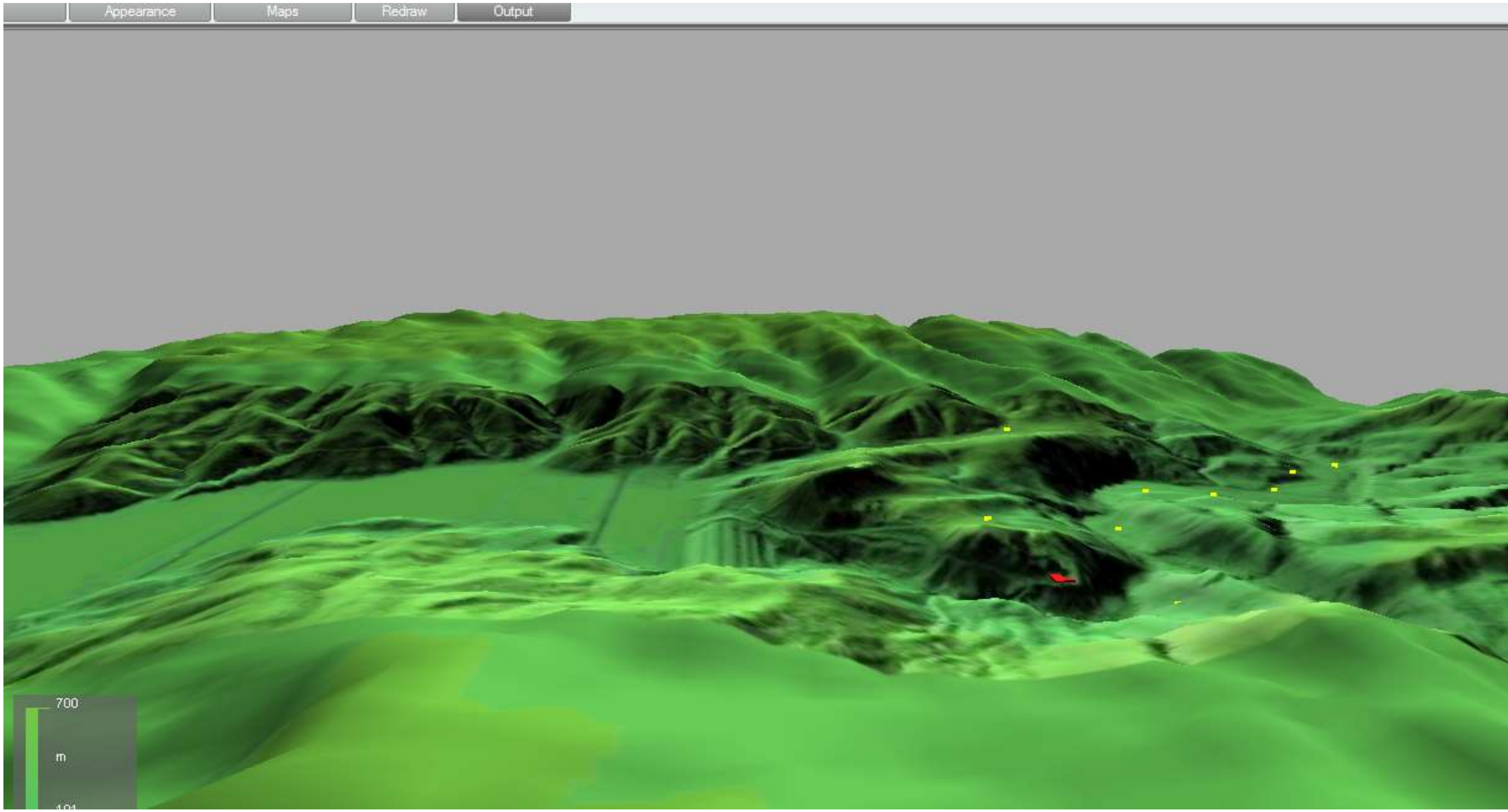
Set Up Station North (HR) to collect data.

Output-Daily 24 hour average conc.



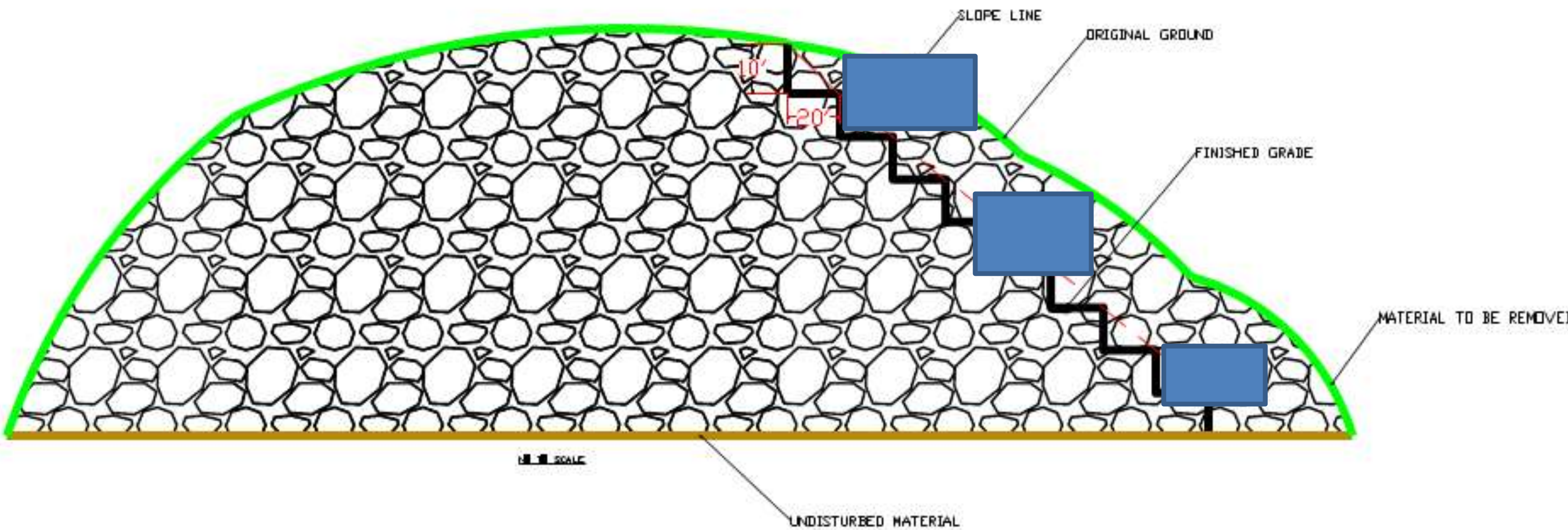


Appearance
Maps
Redraw
Output
534
m


Appearance
Maps
Redraw
Output
700
m

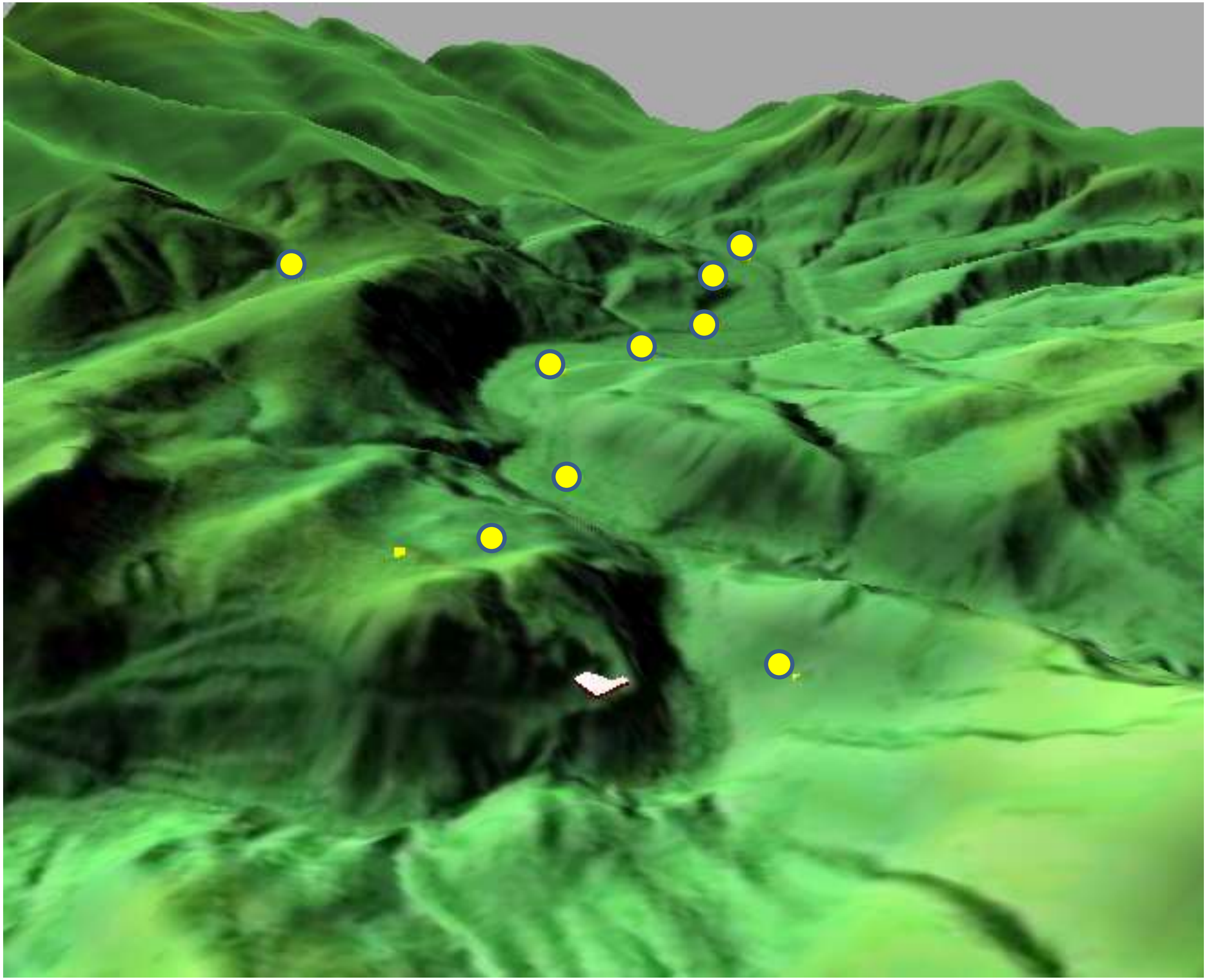
Run AERMOD to Match Operations

- Incorporate Source Data (Z5- Load Out)
  - Emissions Rate (3.1+E10 s/sec)
  - Initial Dimensions of the Release
  - Latitude, Longitude, with Changing Elevation
  - Operates 6 days/week, 8 hours/day
  - June 1 – August 31 of 2013 (for Comparison)
- Incorporate Dam Top 2013 Meteorology with Upper Air Profile from Oakland Airport
- Incorporate 1/9 Arc Second NED (National Elevation Data Set)
- Incorporate a Receptor Array to the North
- Run Output for daily 24 hour average concentrations



DFS-JV

SHEET ___ OF ___



June Example
Modeled 24-hour Average Concentration Data

Date	p4	p5	p11	a35	a34	a33	a32	a31	N-2228	s1	s2	p7	p8
13060124	951.1487	12063.46	1724.104	2771.56	662.8818	1306.265	1737.992	1115.619	541.0893	26881.68	3564.871	752.6627	641.6244
13060324	6543.254	27522.64	11720.07	7463.063	2962.844	2917.784	2481.535	1801.987	1234.325	98031.25	18641.06	112.464	63.52148
13060424	18636.1	24679.6	3618.834	7401.194	3319.727	2730.433	2122.023	1554.151	1169.562	44301.36	6648.476	89.01001	50.39349
13060524	10476.53	27139.44	8283.791	7446.294	3825.206	2883.632	2051.642	1596.903	1281.775	77190	13865.23	93.0096	53.51314
13060624	3055.145	35657.56	10968.4	5076.66	1507.217	1667.524	1519.343	981.7439	611.1629	969.9971	18488.44	113.1889	65.93319
13060724	1491.316	15054.2	54870.53	3011.158	1047.086	1221.144	1119.16	850.4097	628.1202	16547.43	92670.97	183.3188	125.1869
13060824	11669.55	5091.774	998.9436	10178.79	5818.392	5355.28	4002.858	3846.125	3459.053	11764.94	1929.967	147.1345	108.3721
13061024	285.4927	18983.05	29390.51	514.1976	86.08894	108.7261	116.4014	54.72028	25.14384	53098.98	39979.93	42.16668	24.79771
13061124	20253.28	22745.9	7743.23	8425.977	4499.663	3253.623	2314.874	1841.995	1519.122	70165.3	13070.56	117.8327	67.73254
13061224	23281.88	5950.077	20324.05	5493.449	3517.949	1862.867	1136.393	880.1587	715.6432	88978.92	27570.55	134.4061	88.05214
13061324	796.4954	7943.621	17227.56	710.3719	223.4662	223.3725	229.0085	145.2476	98.81618	38668.43	33469.87	627.1796	535.516
13061424	1196.784	1234.581	1952.817	558.0345	261.7115	179.7239	123.0711	91.64923	70.55565	25356.67	4036.557	1043.626	762.5018
13061524	10139.99	23979.53	2806.628	12350.71	6037.548	5108.906	3765.721	2943.129	2332.151	36896.13	5517.851	93.83327	52.61053
13061724	1330.559	17360.19	7292.411	1151.764	213.285	252.1263	254.5836	126.2226	60.9	68926.41	12625.73	115.2717	69.69102
13061824	2600.446	7581.553	18587.47	1239.858	625.8825	460.3247	341.1968	271.3042	221.9274	33299.41	31669.28	499.463	304.2401
13061924	4791.839	12314.79	14768.44	8507.923	4148.276	4742.187	4316.554	3758.382	3008.117	98003.48	25032.93	248.8574	183.578
13062024	9742.366	13958.33	15403.49	8340.701	8405.796	4906.349	2742.325	2867.428	3322.764	8256.565	26301.73	331.1524	248.2137
13062124	2925.381	27778.95	13949.46	8063.594	2722.555	4137.291	4533.703	3432.672	2226.619	22201.8	24863.66	1421.235	979.5992
13062224	11191.7	526.9261	818.2773	359.2128	317.311	108.0733	77.2787	64.52814	54.55681	10561.71	1666.305	485.9171	407.2047
13062424	4916.501	37980.58	11443.35	9900.258	5135.729	4381.497	2856.287	2530.183	2321.372	2009.549	17848.98	60.64312	36.07859
13062524	261.296	25557.57	19415.66	553.2547	89.22064	107.0787	115.335	52.30833	23.93256	21660.73	27139.77	40.5118	25.40563
13062624	858.2785	25818.1	22440.77	2415.491	388.507	655.6354	784.9664	423.7613	193.4279	89485.17	42701.99	165.1476	108.6714
13062724	1937.283	16775.36	11980.19	4123.581	1655.245	2269.368	2395.734	1902.261	1356.711	4073.046	23425.49	528.8212	431.5947
13062824	766.802	24348.93	7229.727	5159.53	626.3886	2527.038	4415.196	2626.591	978.9804	67736.12	12739.07	288.3319	215.4256
13062924	3482.952	31733.49	59602.37	3759.99	1687.437	1658.982	1598.215	1213.681	912.6048	68548.55	70083.06	1365.098	1068.956

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

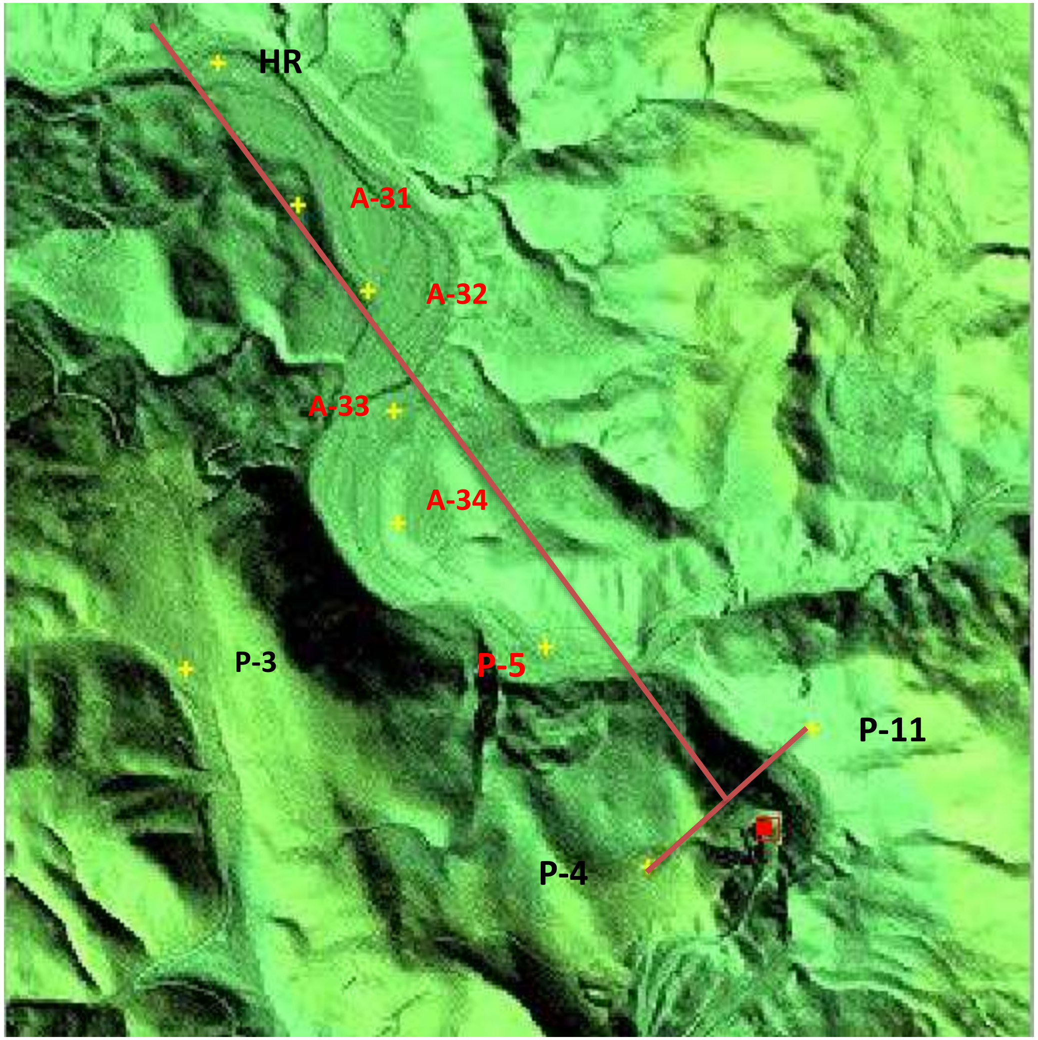
(S/m3)	HR-N	P-4*	P-5	P-11	Avg. P4 & P11
Modeled	1,112	26,122	7,034	13,033	19,578
Measured	1,260	8500	5,140	20,080	14,290

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

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

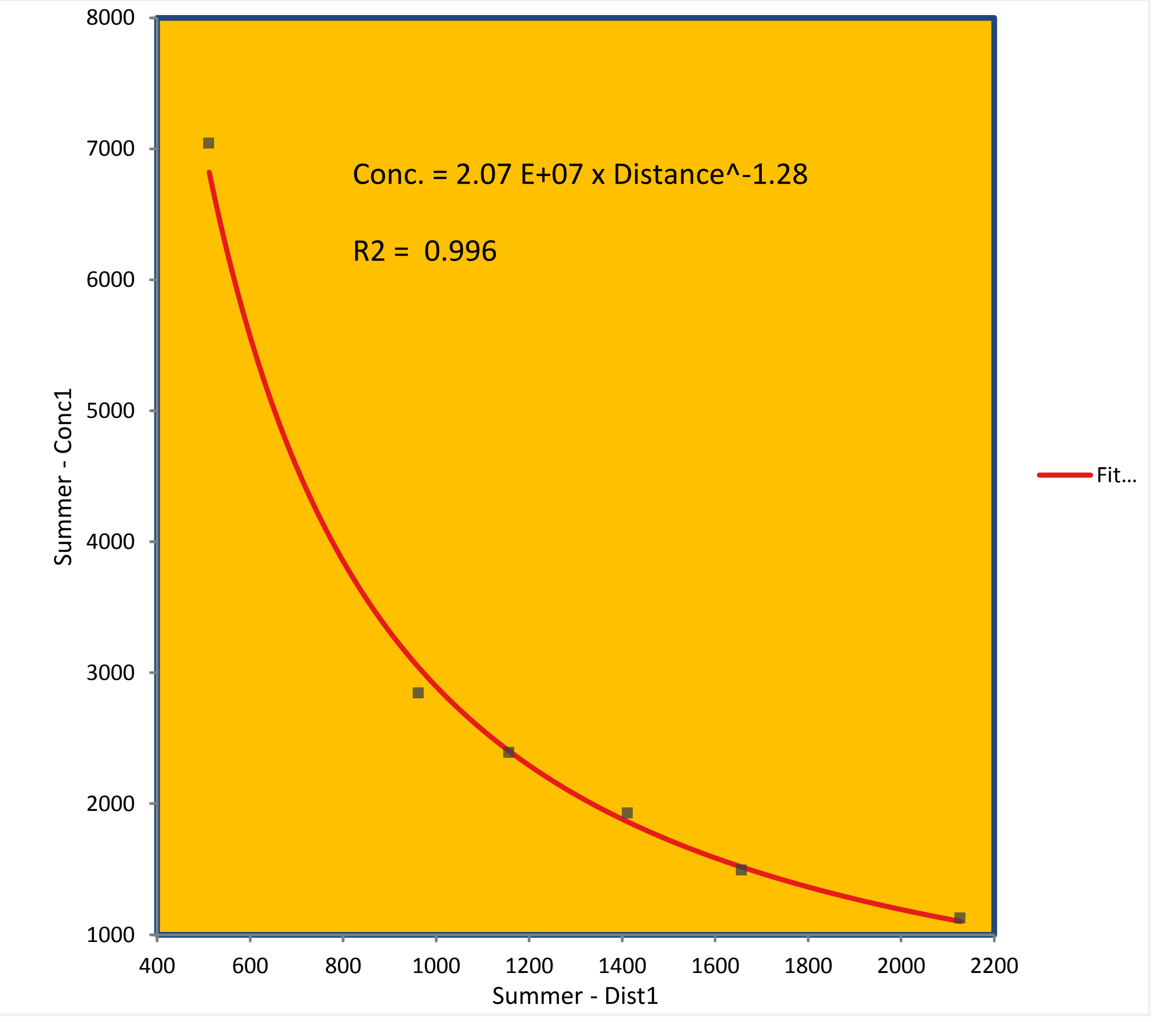
(S/m3)	HR-N	P-4	P-5	P-11	Avg. P4 & P11
Modeled	1,112	26,122	7,034	13,033	19,578
Measured	1,260	15,213	5,140	20,080	17,647

Now Look at Concentrations vs. Distance



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)

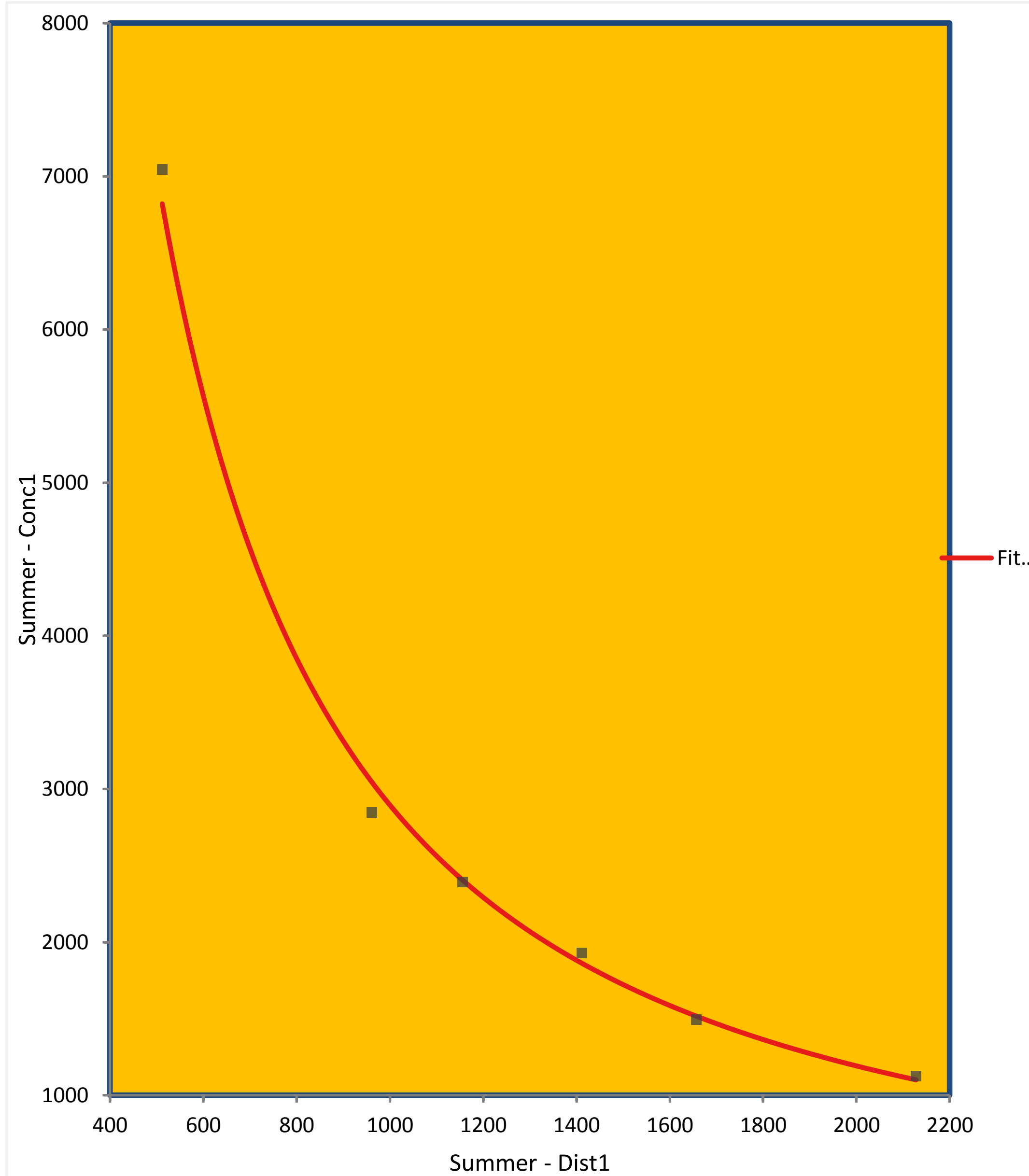
Concentration Decay with Distance is a <u>Function</u> of:

- 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**



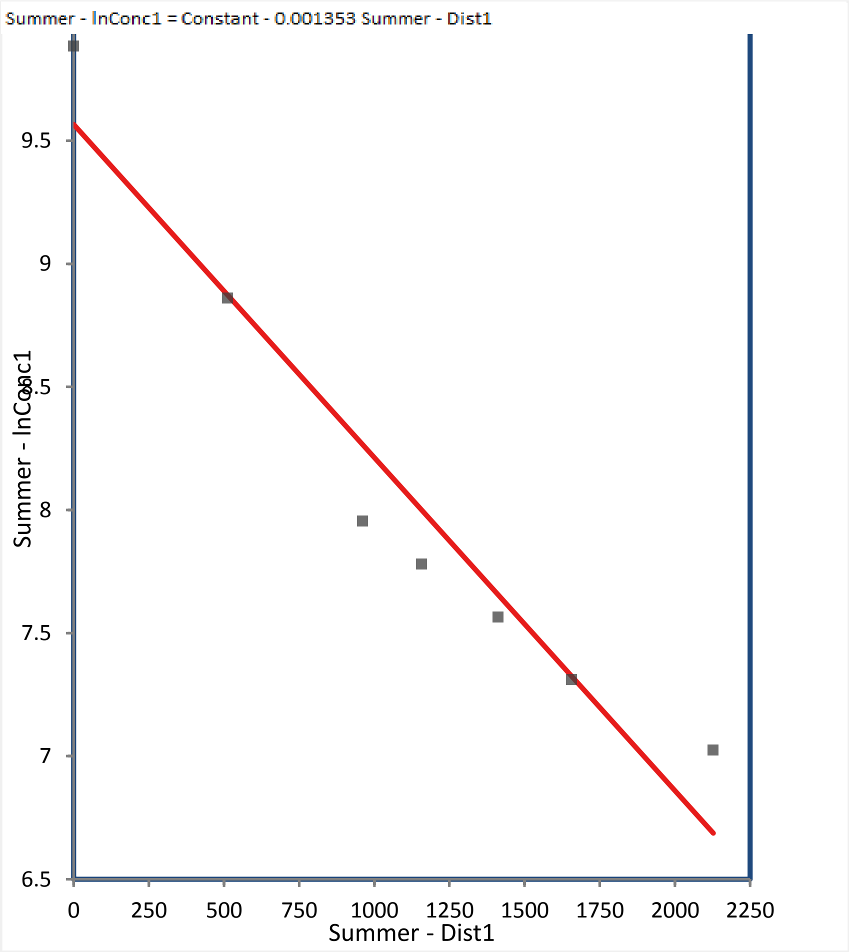
Plot the Ln Concentration versus Distance

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:

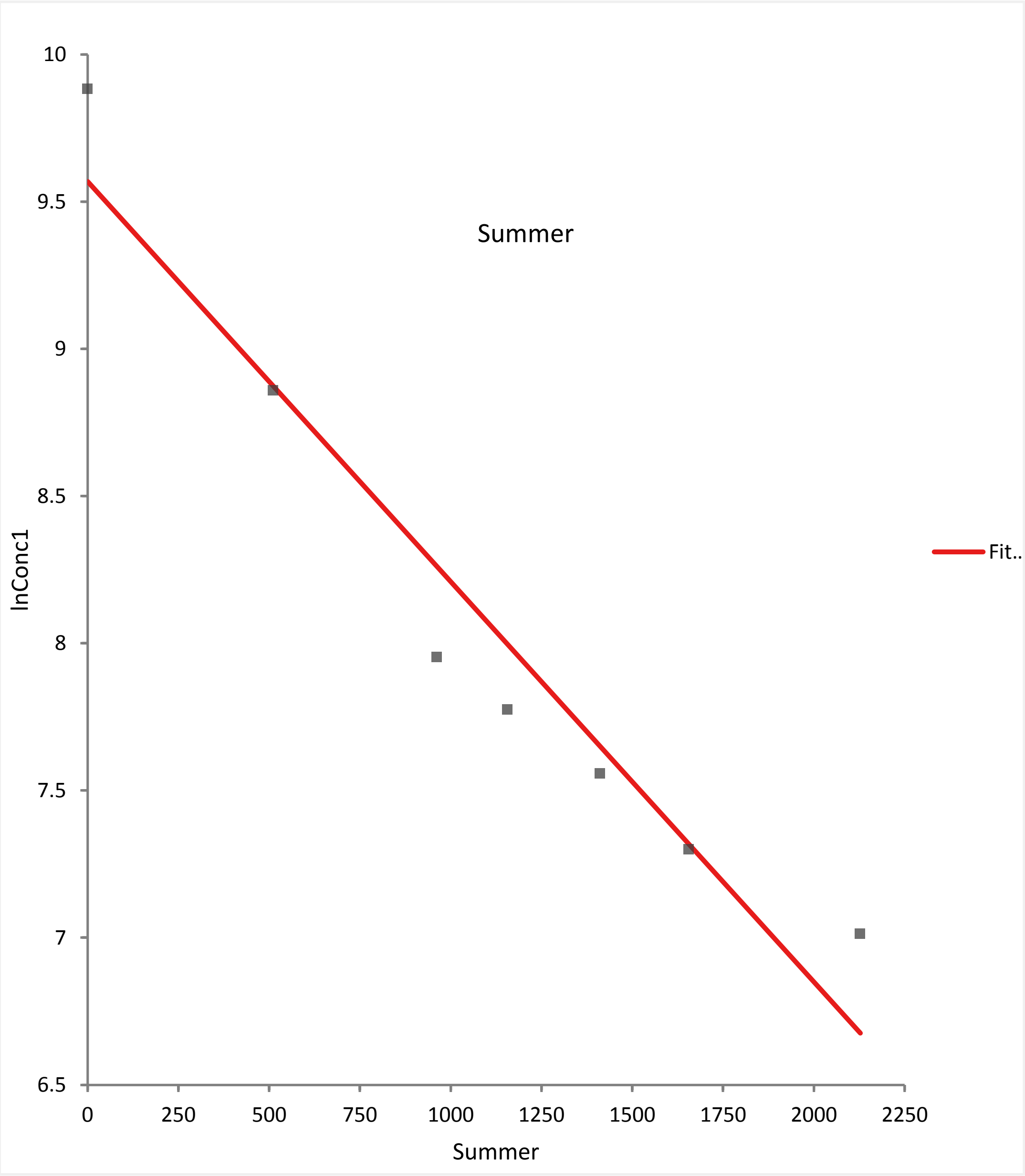
$$\frac{N_c}{N_p} = e^{-\gamma * Dist}$$

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.

$$\frac{1500}{No} = \ e^{-0.001353(2128)}$$

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

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

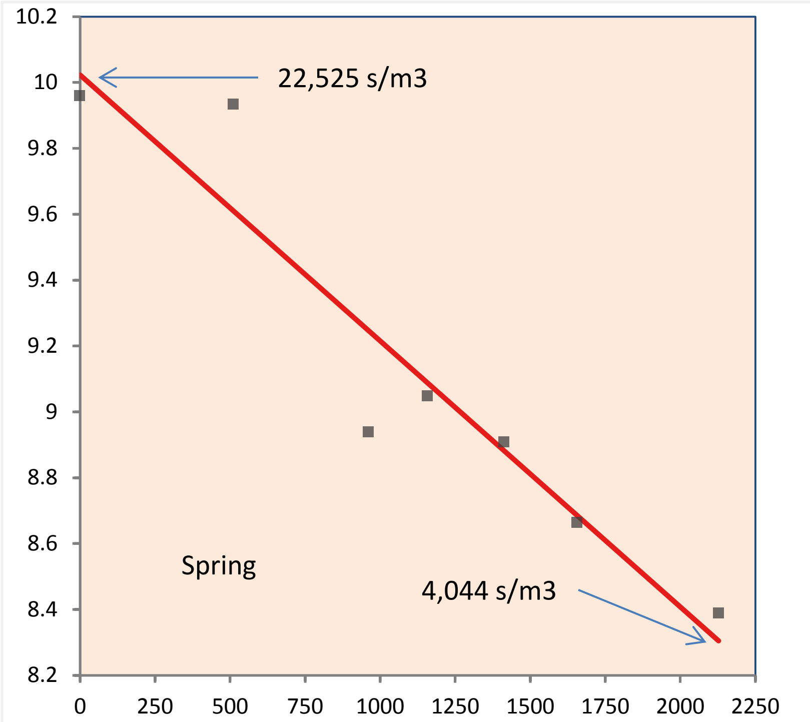


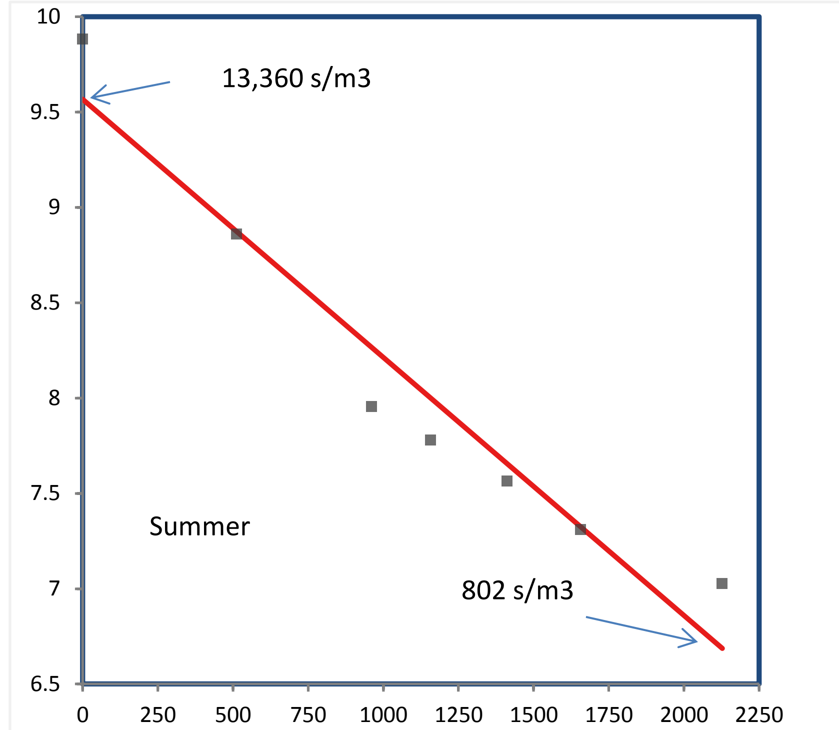
Critical Perimeter Concentrations

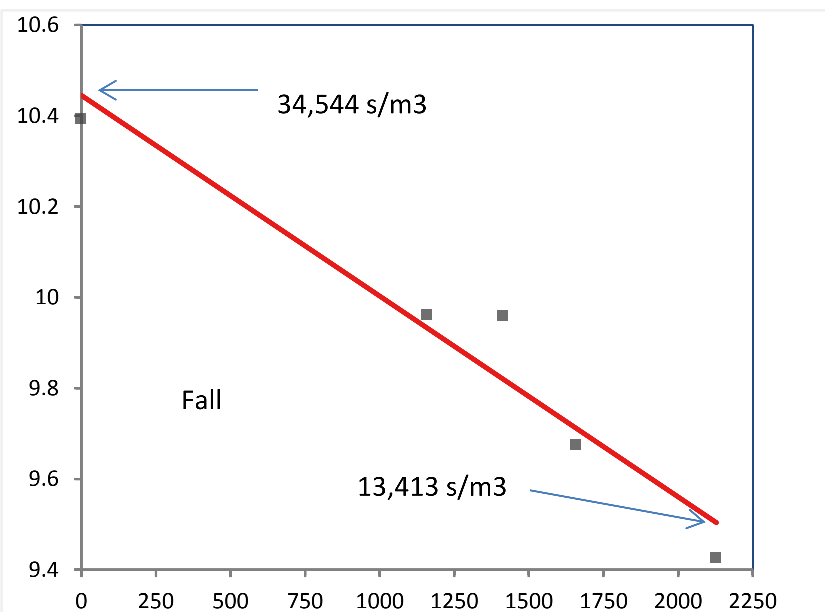
Repeat the Process for Spring, Fall, Winter

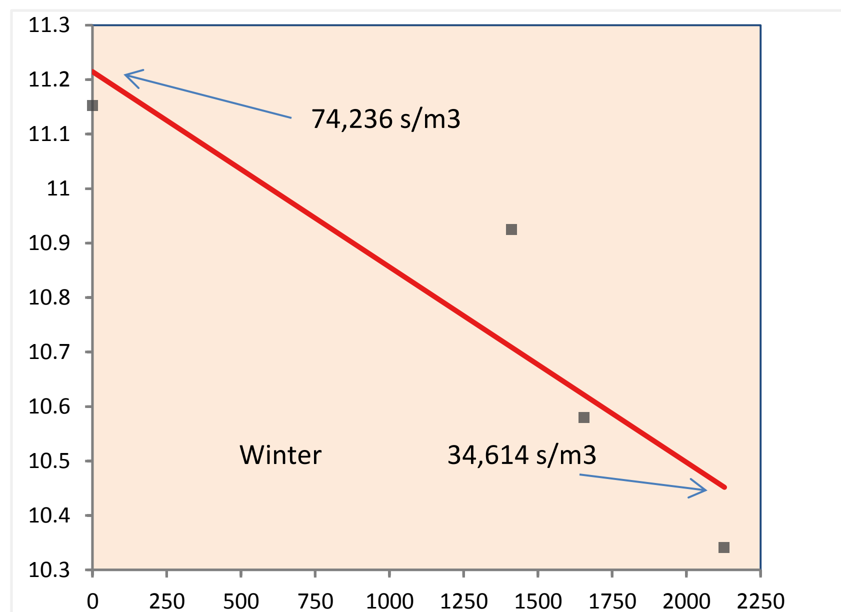
Average Period 24-hour Critical Concentrations- below which are protective of some hypothetical receptor (HR) 2128 meters to the north

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**


22,525 s/m3
Spring
4,044 s/m3
10.2
10
9.8
9.6
9.4
9.2
9
8.8
8.6
8.4
8.2
0
250
500
750
1000
1250
1500
1750
2000
2250

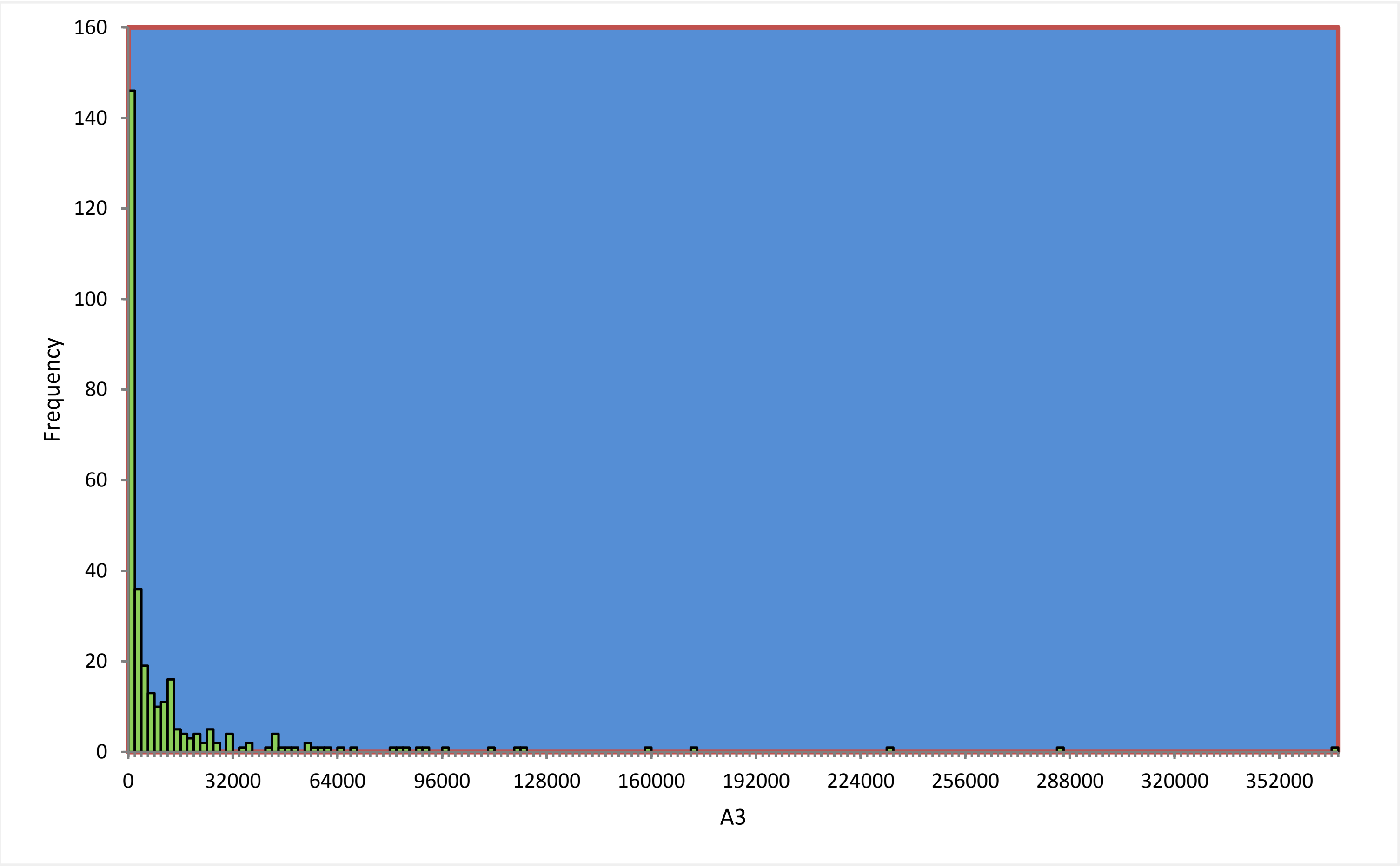

13,360 s/m3
Summer
802 s/m3
10
9.5
9
8.5
8
7.5
7
6.5
0
250
500
750
1000
1250
1500
1750
2000
2250


34,544 s/m3
Fall
13,413 s/m3
10.6
10.4
10.2
10
9.8
9.6
9.4
0
250
500
750
1000
1250
1500
1750
2000
2250


74,236 s/m3
Winter
34,614 s/m3
11.3
11.2
11.1
11
10.9
10.8
10.7
10.6
10.5
10.4
10.3
0
250
500
750
1000
1250
1500
1750
2000
2250

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

- 47 % of the time HR concentrations are between 0 – 2000 s/m3.
- 57 % of the tine HR is greater than 2,000 s/m3 (TML=1500)



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%

Zone 5 Load Out limited to (9.3E+09 s/sec)

Average P4/P11	Conc. (s/m3)	Required Concentration (s/m3)	% Reduction Required
Min	359		
Max	331,159		
Median	24,815	10,050	58%
Average	33,559	10,050	69%

Conclusions

- Modeling Can Help Define Specific Project Areas:
  - Development of Critical Concentrations at Project Boundaries
  - Development of “Safe Zones” about Emitting Operations
- Modeling Can Be Useful for Risk Assessment
  - Predicting Concentrations Offsite
  - Combine with Potency Estimates for Risk Projections
- Limitations
  - NOA Emissions Inventories are Non-existent
  - Data Inputs Can be Expensive (Meteorology)
  - Screening Versus Refined
    - Learning Curve

Questions?