Broadband Communications Design Strategies & Considerations for ITS Applications in Caltrans District 2

Sac Canyon Wireless Expansion

California Department of Transportation, District 2

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2023 Western States Rural Transportation Technology Implementers Forum

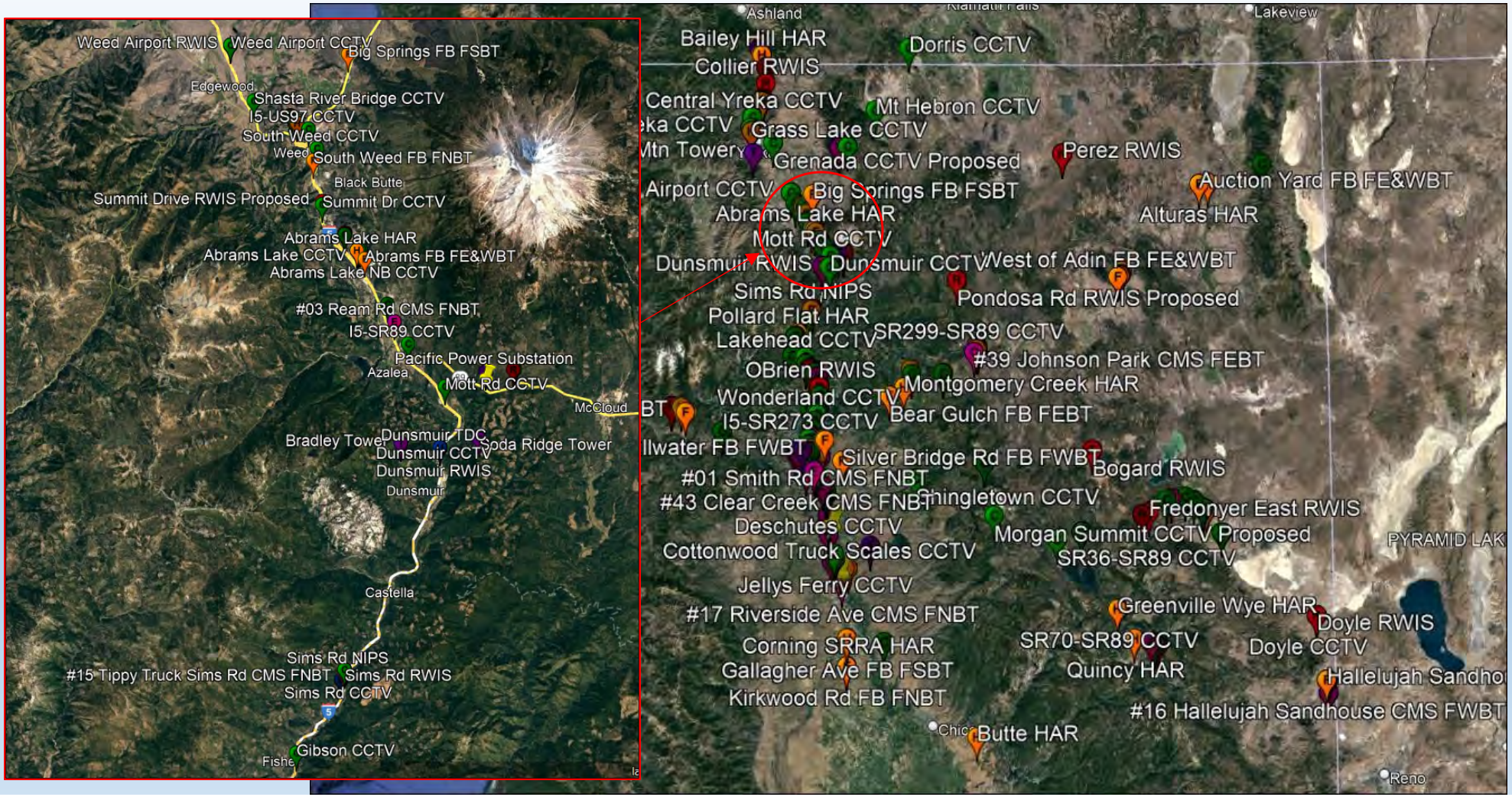
Acronyms

- ADA – Americans with Disability Act
- ATS – Automatic Transfer Switch
- CHP – California Highway Patrol
- COBI – California Oregon Broadcasting Inc
- DES – Division of Engineering Services
- DFM – Department Furnished Materials
- DO – District Office
- GEM – Ground Enhancement Material
- LOS – Line of Sight
- NLOS – No Line of Sight
- PIF – Public Information Finding
- RTL – Ready to List
- R/W – Right of Way
- SFM – State Fire Marshal
- TCE – Temporary Construction Easement
- UFER – Concrete-Encased Electrode (Herbert G. Ufer - engineer who discovered)
- USFS – United States Forest Services

Background

Purpose

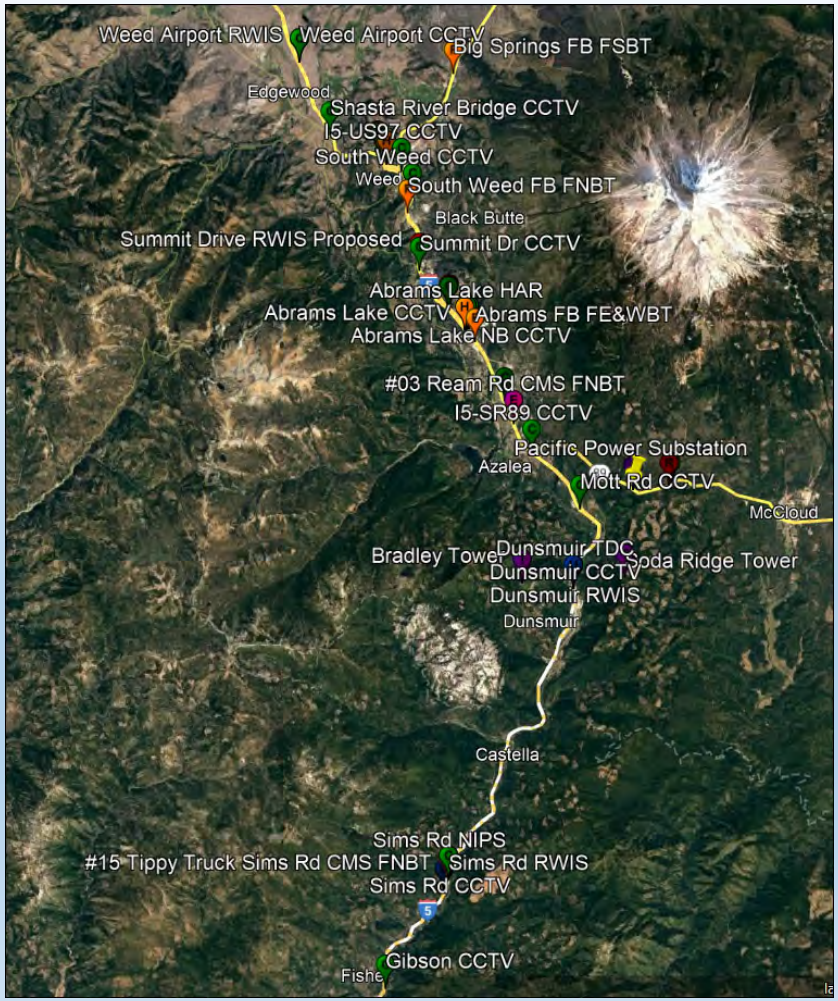
- MW expansion as discussed in the first presentation by Jeremiah
- Coverage for elements along I-5 in northern part of District



Background

Purpose

- MW expansion as discussed in the first presentation by Jeremiah
- Coverage for elements along I-5 in northern part of District
- Sha & Sis Counties I-5 (~30 Miles)
  - CCTV: 10 Existing & 4 Planned
  - CMS: 4 Existing & 3 Planned
  - HAR & FB: 4 Existing
  - RWIS/NIPS: 3 Existing & 1 Planned
- Sis County SR-89 (~5.5 Miles)
  - CCTV: 1 Existing & 1 Planned
  - RWIS/NIPS: 1 Existing & 1 Planned



Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → ???

- Next mountain top options
  - Mt Bradley
  - Lower Bradley
  - Soda Ridge
  - Grey Butte

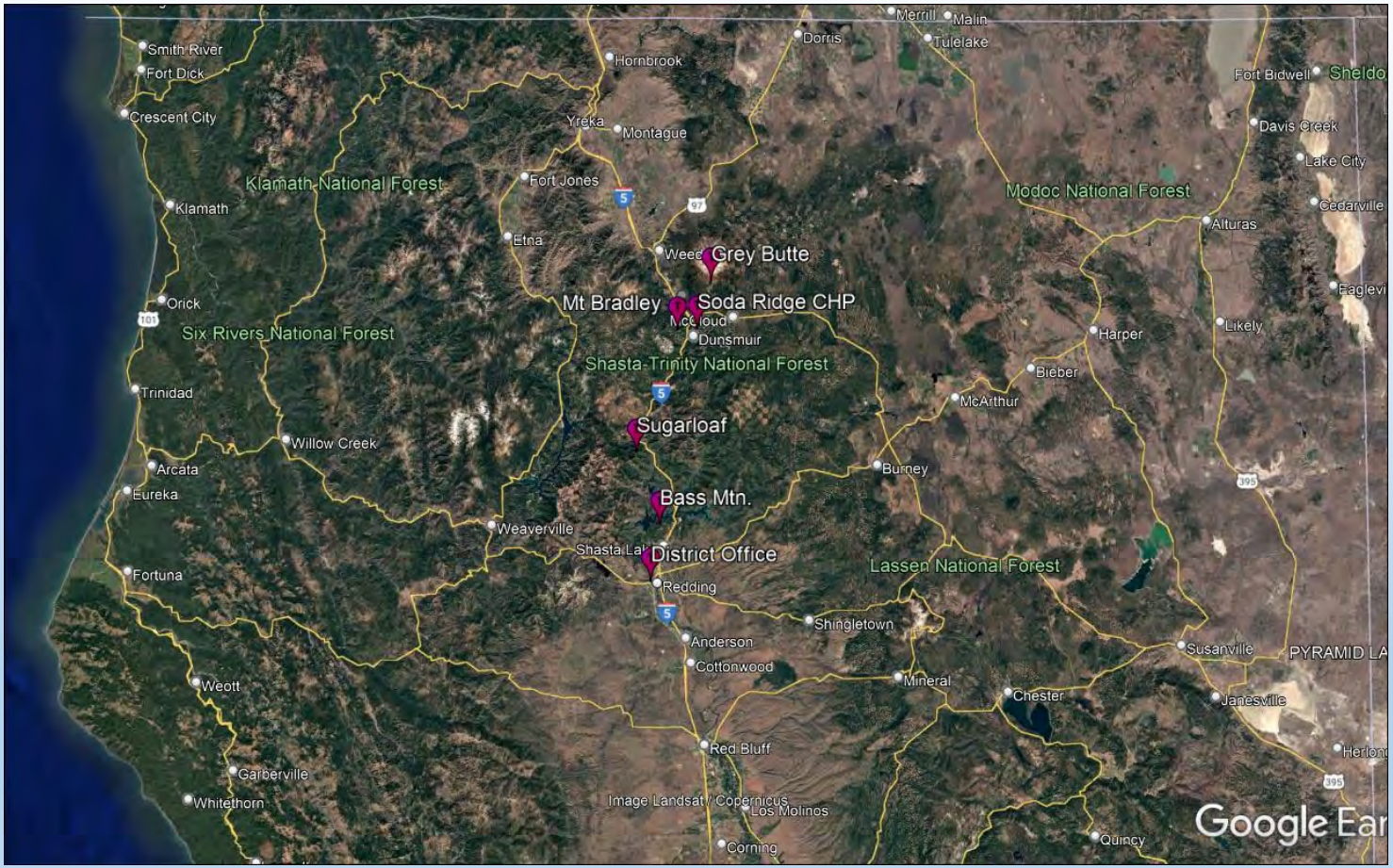
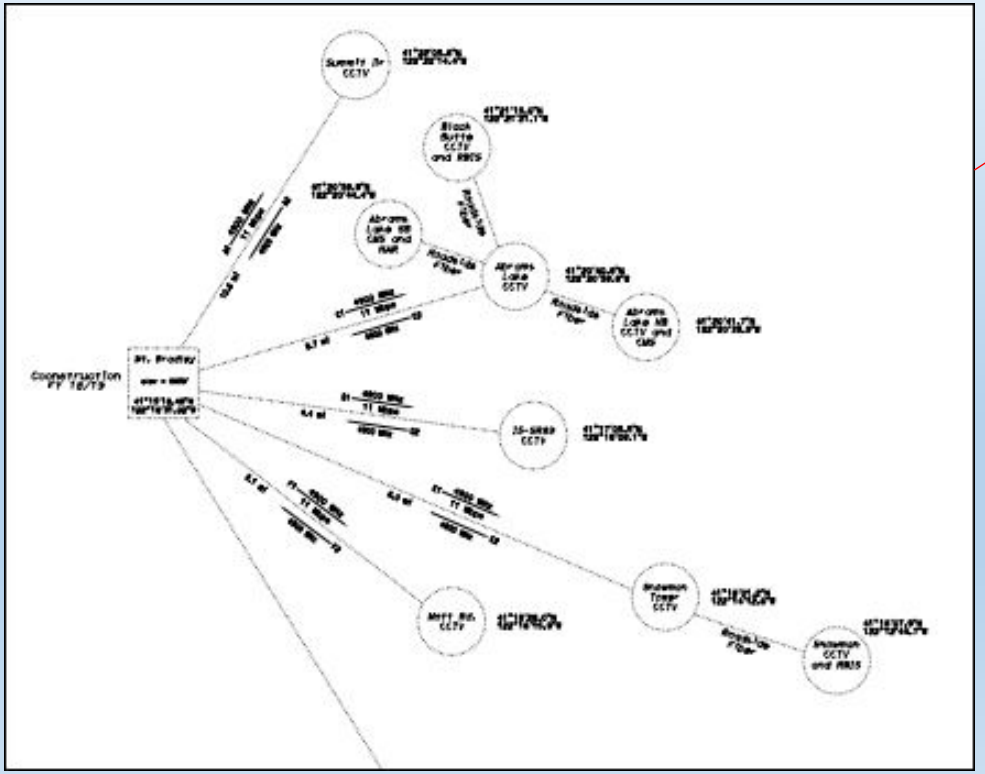


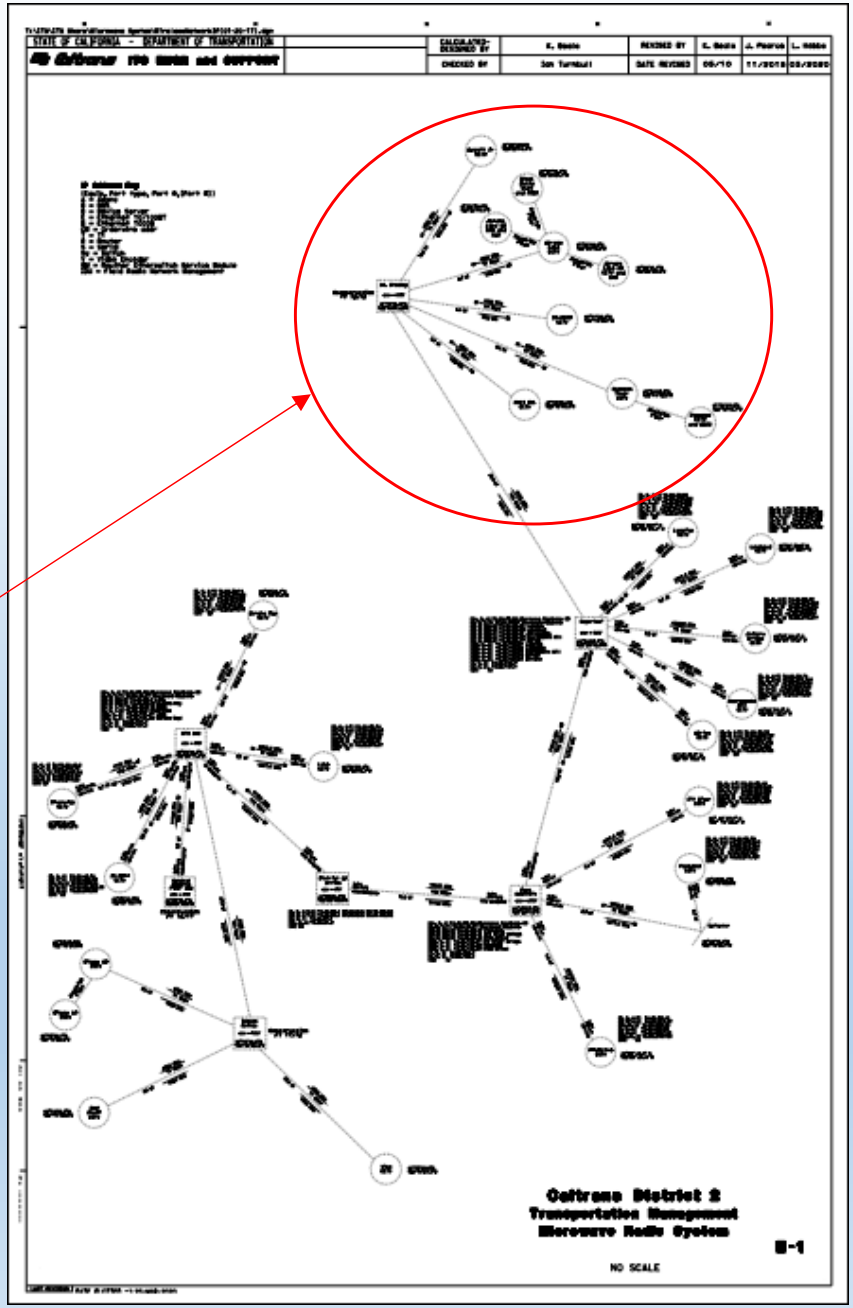
Image curtesy of Google Earth

Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → ???

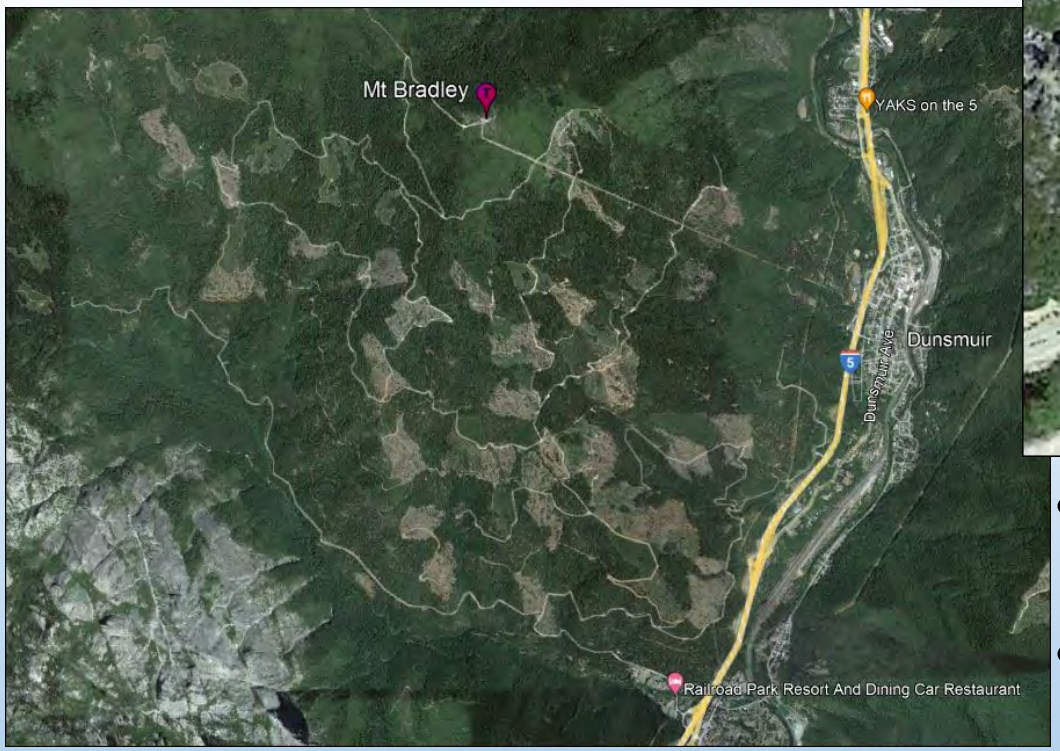
- Block diagram of the next mountain top and roadside elements it will cover





Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → Mt Bradley

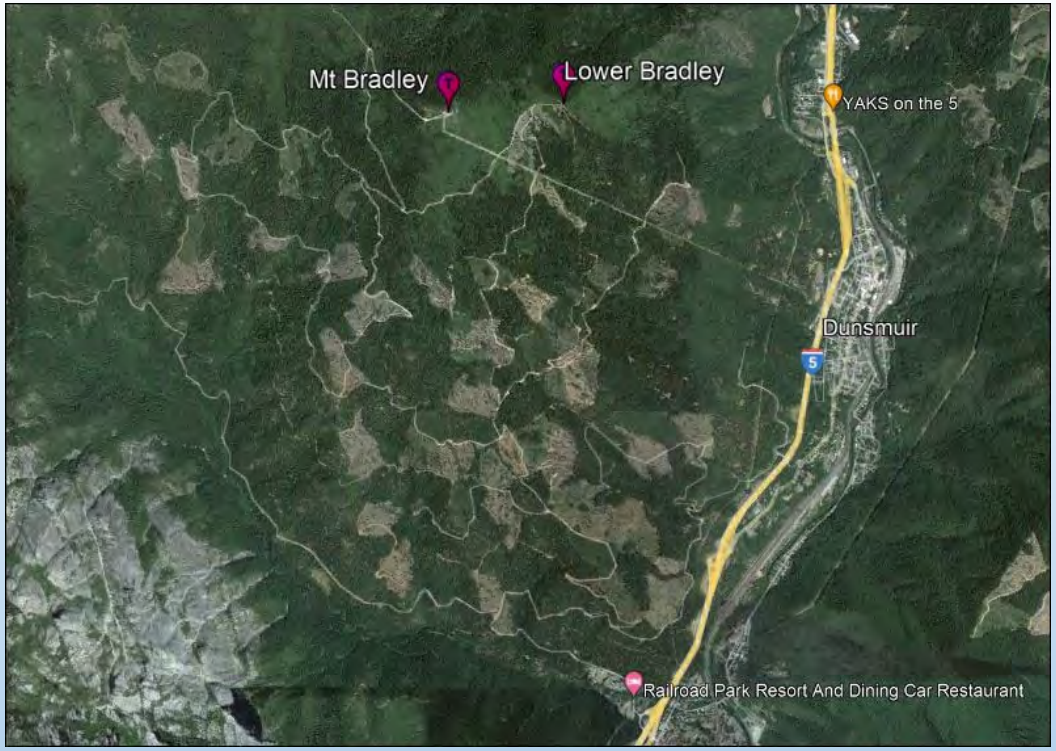


- 10-acre USFS parcel on private logging industry land
- Existing radio tower and vault are not adequate
- Overlooks Siskiyou area (good elevation ~5,500ft)
- Close to I-5; 7-mile maintained dirt road

Images curtesy of Google Earth

Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → Lower Bradley

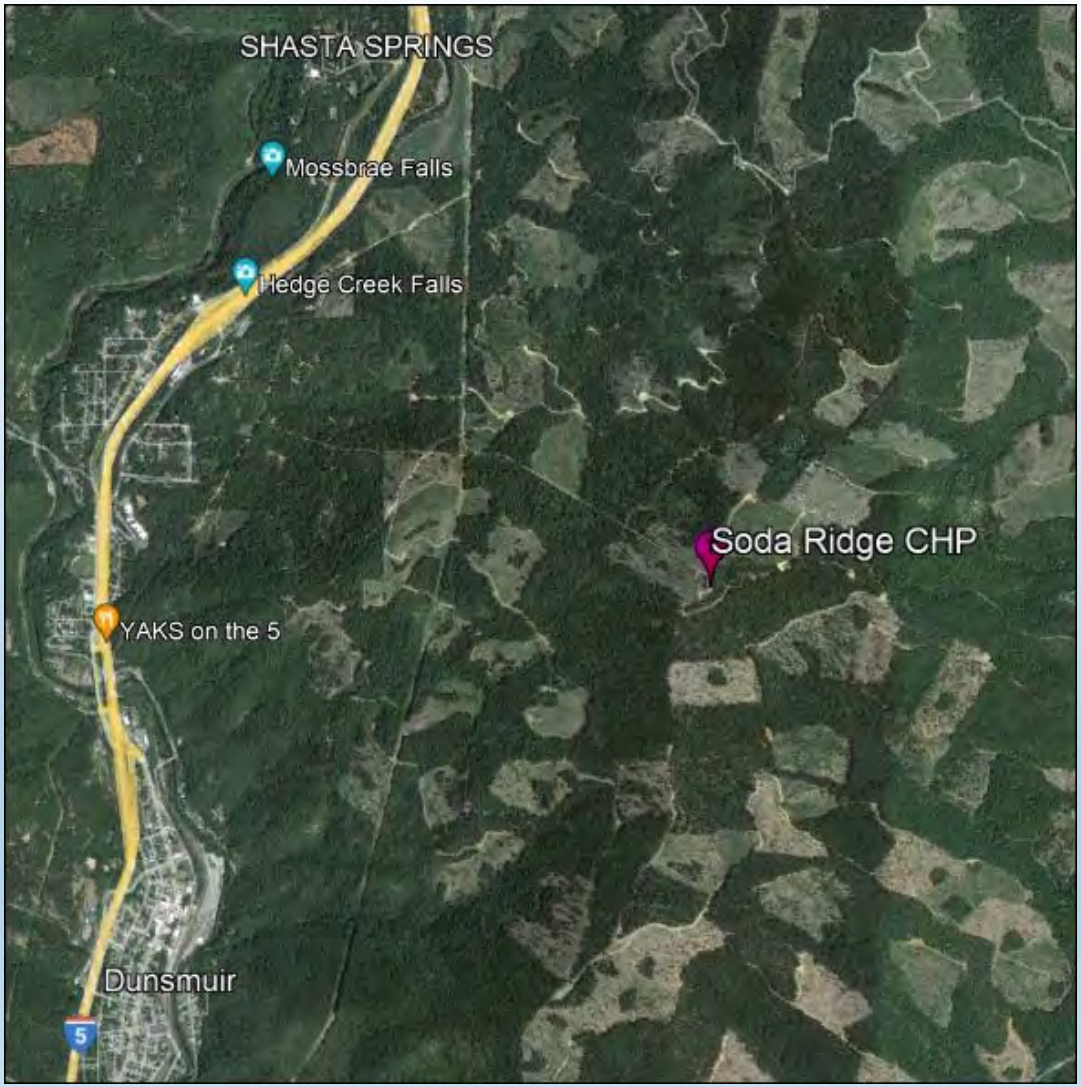


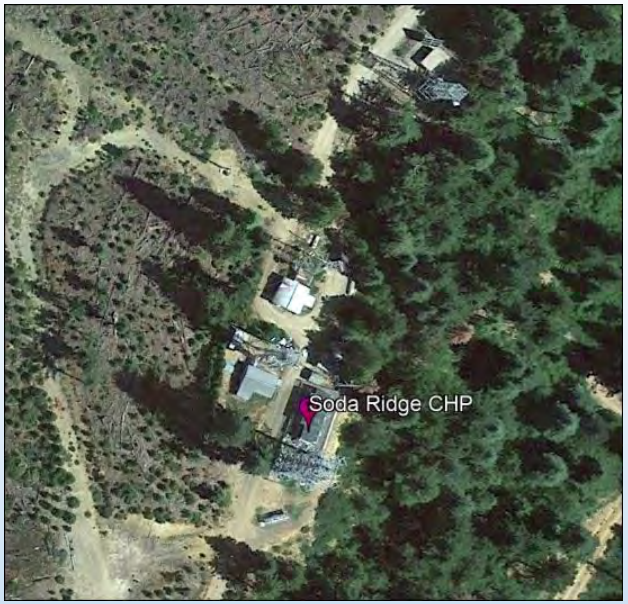
- Privately owned site on private property
- Existing tower and vault are not adequate
- Overlooks Siskiyou area (moderate elevation ~4,500ft)
- Close to I-5; 5.5-mile maintained dirt road

Images curtesy of Google Earth

Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → Soda Ridge



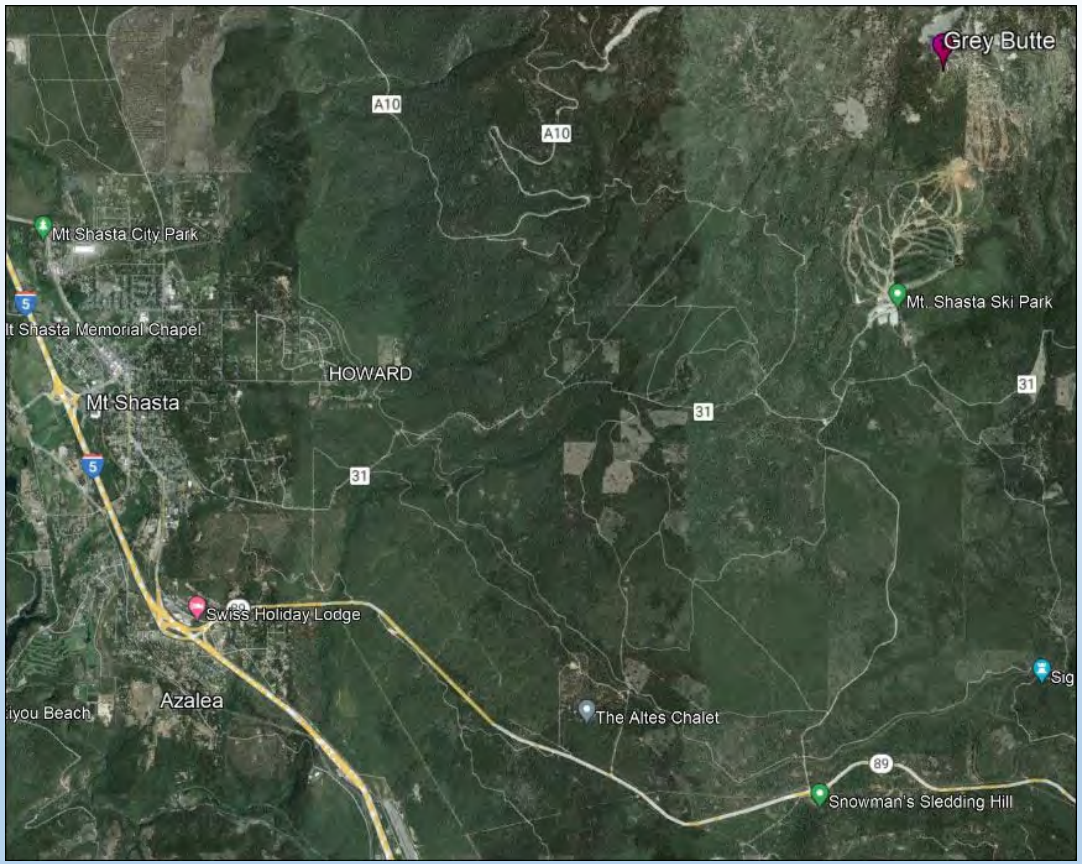


- State owned (CHP)
- Existing radio tower and vault are adequate
- Overlooks Siskiyou area (moderate elevation ~4,600 ft)
- Close to I-5; 5.5-mile maintained dirt road

Images curtesy of Google Earth

Site Evaluation

District Office (DO) → Bass Mtn → Sugarloaf → Grey Butte



- USFS owned vault and tower
- Existing tower and vault are not adequate
- Overlooks Siskiyou area (high elevation ~7,900 ft)
- Further from I-5; access through ski park on tribal lands
- Poor winter access

Images curtesy of Google Earth

Preliminary Path Analysis

Sugarloaf → Mt Bradley

- Line of Sight (LOS) verified in the field

Preliminary Path Analysis

Sugarloaf → Mt Bradley

- LOS verified by software
- 22.36 Miles

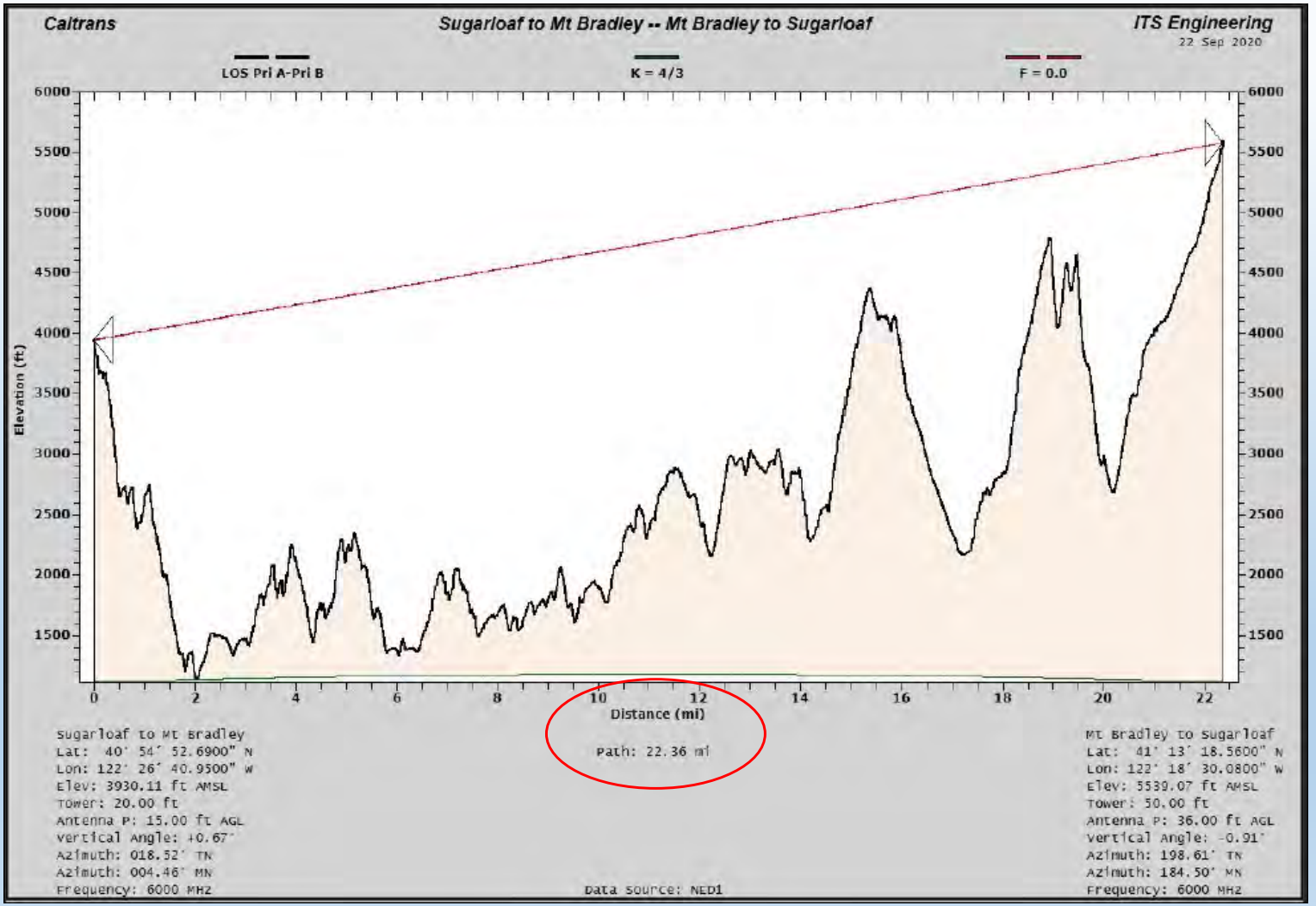


Image curtesy of [Microwave Path Analysis & SCADA - Micropath Pathanal 5]

Preliminary Path Analysis

Sugarloaf → Mt Bradley

- LOS verified
- 22.36 Miles
- 99.999% Uptime (Five nines) calculated by software

Caltrans **Link Analysis** **ITS Engineering**

		Sugarloaf to Mt Bradley	Mt Bradley to Sugarloaf
Location			
Call Sign			
Latitude		40 54 52.69 N	41 13 18.56 N
Longitude		122 26 40.95 W	122 18 30.08 W
Latitude		40.91463611°	41.22182222°
Longitude		-122.44470833°	-122.30835556°
Azimuth - TN / MN	(°)	018.52 / 004.46	198.61 / 184.50
Elevation - AMSL	(ft)	3930.11	5539.07
Tower - AGL	(ft)	20	50
Radio Model		Aviat-Eclipse IR 600v4	Aviat-Eclipse IR 600v4
Antenna Type		CommScope HX6-6W-6GR	CommScope HX6-6W-6GR
Tx Antenna Pri - AGL	(ft)	15.00	36.00
Rx Antenna Pri - AGL	(ft)	15.00	36.00
Transmission Line Type		EWP52-58	EWP52-58
Transmission Line Length	(ft)	48.00	50.00
Vertical Angle	(°)	0.67	-0.91
Antenna Polarization		Vertical	Vertical
Frequency - Pri	(MHz)	6000	6000
Diversity Type		None	
Path Length	(mi/km)	22.36 / 35.99	
ERP	(dBW)	36.02	36.00
ERP / EIRP	(dBm)	66.02 / 68.17	66.00 / 68.15
System Gains		**Site A to B**	**Site B to A**
Tx Power	(dBm)	31.50	31.50
Tx Antenna Gain	(dBi)	39.10	39.10
Rx Antenna Gain	(dBi)	39.10	39.10
Total System Gain	(dB)	109.70	109.70
System Losses		**Site A to B**	**Site B to A**
Tx Line Loss	(dB)	0.57	0.59
Tx Jumper Loss	(dB)	0.46	0.46
Tx Misc / Safety Loss	(dB)	0.50	0.50
Tx Connector Loss	(dB)	0.90	0.90
Rx Line Loss	(dB)	0.59	0.57
Rx Jumper Loss	(dB)	0.46	0.46
Rx Misc / Safety Loss	(dB)	0.50	0.50
Rx Connector Loss	(dB)	0.90	0.90
Diffraction Loss	(dB)	0.00	0.00
Foliage Loss	(dB)	0.00	0.00
Free Space Path Loss	(dB)	139.15	139.15
Atmospheric Absorption Loss	(dB)	0.31	0.31
Total System Loss	(dB)	144.34	144.34
Path Calculations		**At Site B**	**At Site A**
Receive Signal Level - RSL	(dBm)	-34.64	-34.64
Rx Threshold Level	(dBm)	-72.50	-72.50
Flat / Thermal Fade Margin	(dB)	37.86	37.86
Dispersive Fade Margin	(dB)	0.00	0.00
Dispersive Fade Occurence Factor		1.00	
Effective Fade Margin	(dB)	37.86	37.86
Worst Month Multipath Availability	(%)	99.99928	99.99928
Worst Month Multipath Unavailability	(sec)	18.68	18.68
Annual Multipath Availability	(%)	99.99978	99.99978
Annual Multipath Unavailability	(sec)	69.52	69.52
Annual 2-Way Multipath Availability	(%)	99.99956	
Annual 2-Way Multipath Unavailability	(sec)	139.05	

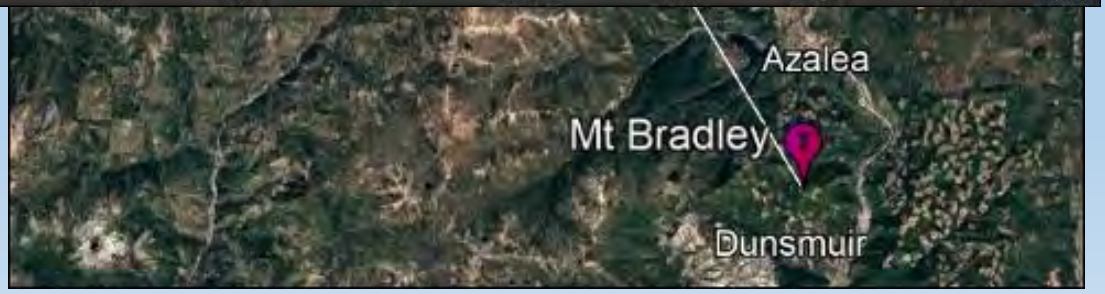
Multipath Fading Method: Barnett - Vigants
Terrain Roughness (w): 140.00
Fade Occurrence Factor (Po): 4.399E-002
Avg. Annual Temp: 60° F / 16° C
Climate Factor: 1.00
C Factor: 0.26

Image curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 5

Preliminary Path Analysis

Mt Bradley → Antelope

- Potential future mountain top
- LOS Verified
- 32.3 Miles

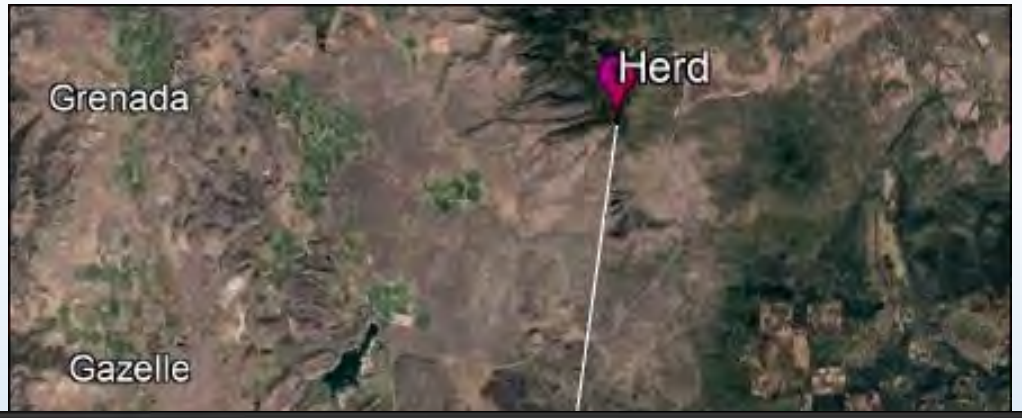


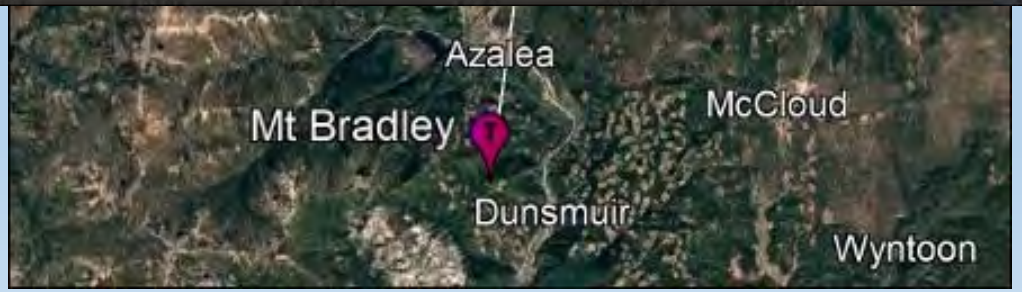
Images curtesy of Google Earth

Preliminary Path Analysis

Mt Bradley → Herd

- Potential future mountain top
- No Line of Sight (NLOS)
- 29 Miles



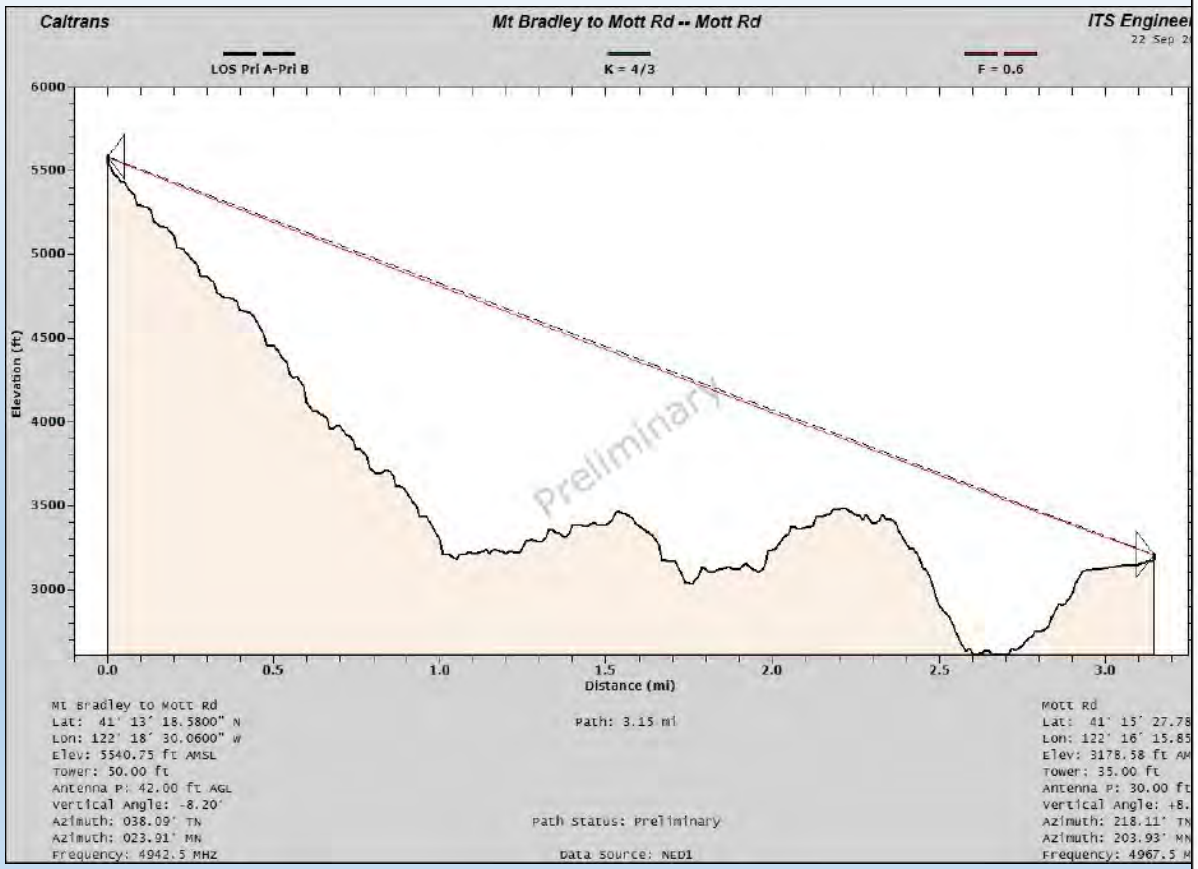


Images curtesy of Google Earth

Preliminary Path Analysis

Mt Bradley → Mott Rd

- LOS verified
- 3.15 Miles
- Five nines calculated



Caltrans — Link Analysis — ITS Engineering

Path Status: Preliminary

		Mt Bradley to Mott Rd	Mott Rd
Location			
Call Sign			
Latitude		41 13 18.58 N	41 15 27.78 N
Longitude		122 18 30.06 W	122 16 15.85 W
Latitude		41.22182778°	41.25771667°
Longitude		-122.30835000°	-122.27106944°
Azimuth - TN / MN	(°)	038.09 / 023.91	218.11 / 203.93
Elevation - AMSL	(ft)	5540.75	3178.58
Tower - AGL	(ft)	50	35
Radio Model		Moseley-NX-GEN-S	Moseley-NX-GEN-S
Antenna Type		RadioWaves HP2-4.7	RadioWaves HP2-4.7
Tx Antenna Pri - AGL	(ft)	42.00	30.00
Rx Antenna Pri - AGL	(ft)	42.00	30.00
Transmission Line Type		LDF4.5-50	LDF4-50A
Transmission Line Length	(ft)	55.00	75.00
Vertical Angle	(°)	-8.20	8.17
Antenna Polarization		Vertical	Vertical
Frequency - Pri	(MHz)	4942.5	4967.5
Diversity Type		None	
Path Length	(mi/km)	3.15 / 5.06	
ERP	(dBW)	1.32	0.10
ERP / EIRP	(dBm)	31.32 / 33.47	30.10 / 32.25
System Gains		**Site A to B**	**Site B to A**
Tx Power	(dBm)	8.00	8.00
Tx Antenna Gain	(dBi)	29.60	29.60
Rx Antenna Gain	(dBi)	29.60	29.60
Total System Gain	(dB)	67.20	67.20
System Losses		**Site A to B**	**Site B to A**
Tx Line Loss	(dB)	2.34	4.12
Tx Jumper Loss	(dB)	0.30	0.00
Tx Misc / Safety Loss	(dB)	0.50	0.50
Tx Connector Loss	(dB)	0.99	0.74
Rx Line Loss	(dB)	4.12	2.34
Rx Misc / Safety Loss	(dB)	0.50	0.50
Rx Connector Loss	(dB)	0.74	0.99
Diffraction Loss	(dB)	0.00	0.00
Foliage Loss	(dB)	0.00	0.00
Free Space Path Loss	(dB)	120.44	120.48
Atmospheric Absorption Loss	(dB)	0.04	0.04
Total System Loss	(dB)	129.95	130.00
Path Calculations		**At Site B**	**At Site A**
Receive Signal Level - RSL	(dBm)	-62.75	-62.80
Rx Threshold Level	(dBm)	-85.80	-85.80
Flat / Thermal Fade Margin	(dB)	23.05	23.00
Dispersive Fade Margin	(dB)	0.00	0.00
Dispersive Fade Occurence Factor		1.00	
Effective Fade Margin	(dB)	23.05	23.00
Worst Month Multipath Availability	(%)	99.99995	99.99995
Worst Month Multipath Unavailability	(sec)	1.30	1.32
Annual Multipath Availability	(%)	99.99998	99.99998
Annual Multipath Unavailability	(sec)	4.83	4.91
Annual 2-Way Multipath Availability	(%)	99.99997	
Annual 2-Way Multipath Unavailability	(sec)	9.75	
Rain - Crane - 2003		**At Site B**	**At Site A**
Rain Region		RED BLUFF, CALIFORNIA	
Rain Rate	(mm/hr)	2193.86	2121.70
Rain Flat Fade Margin	(dB)	23.05	23.00
Rain Attenuation	(dB)	23.05	23.00
Rain Availability	(%)	99.99987	99.99987
Rain Unavailability	(min/yr)	0.70	0.67

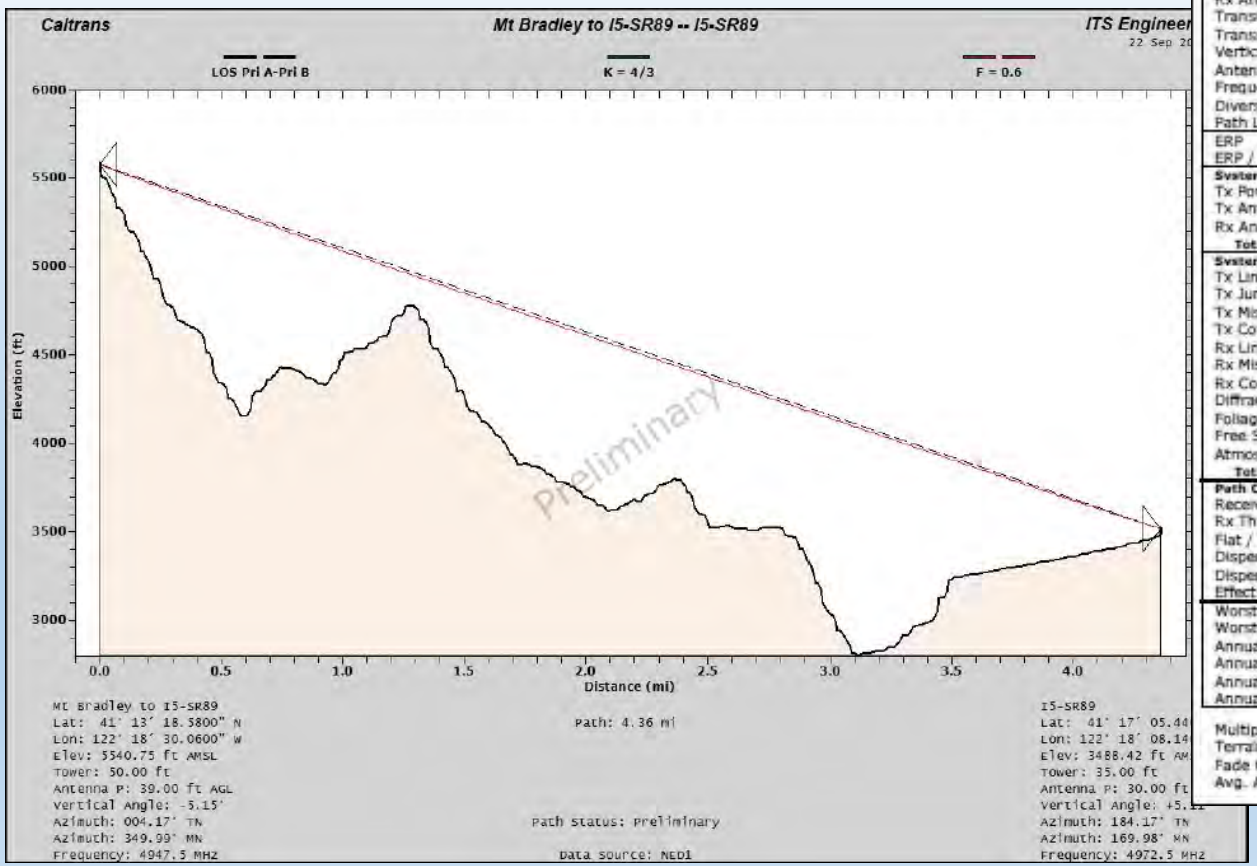
Multipath Fading Method: Barnett - Vigants
Terrain Roughness (w): 140.00
Fade Occurrence Factor (Po): 1.01E-004
Avg. Annual Temp: 60° F / 16° C
Climate Factor: 1.00
C Factor: 0.26

Image curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 5

Preliminary Path Analysis

Mt Bradley → I5-SR89

- LOS verified
- 4.36 Miles
- Five nines calculated



Caltrans — Link Analysis — ITS Engineering

Path Status: Preliminary		Mt Bradley to I5-SR89	I5-SR89
Location			
Call Sign			
Latitude		41 13 18.58 N	41 17 05.44 N
Longitude		122 18 30.06 W	122 18 08.14 W
Latitude		41.22182778°	41.28484444°
Longitude		-122.30835000°	-122.30226111°
Azimuth - TN / MN	(°)	004.17 / 349.99	184.17 / 169.98
Elevation - AMSL	(ft)	5540.75	3488.42
Tower - AGL	(ft)	50	35
Radio Model		Moseley-NX-GEN-S	Moseley-NX-GEN-S
Antenna Type		RadioWaves HP2-4.7	RadioWaves HP2-4.7
Tx Antenna Pri - AGL	(ft)	39.00	30.00
Rx Antenna Pri - AGL	(ft)	39.00	30.00
Transmission Line Type		LDF4.5-50	LDF4-50A
Transmission Line Length	(ft)	64.00	88.00
Vertical Angle	(°)	-5.15	5.11
Antenna Polarization		Vertical	Vertical
Frequency - Pri	(MHz)	4947.5	4972.5
Diversity Type		None	
Path Length	(mi/km)	4.36 / 7.02	
ERP	(dBW)	0.94	-1.12
ERP / EIRP	(dBm)	30.94 / 33.09	28.88 / 31.03
System Gains		**Site A to B**	**Site B to A**
Tx Power	(dBm)	8.00	8.00
Tx Antenna Gain	(dBi)	29.60	29.60
Rx Antenna Gain	(dBi)	29.60	29.60
Total System Gain	(dB)	67.20	67.20
System Losses		**Site A to B**	**Site B to A**
Tx Line Loss	(dB)	2.72	5.33
Tx Jumper Loss	(dB)	0.30	0.00
Tx Misc / Safety Loss	(dB)	0.50	0.50
Tx Connector Loss	(dB)	0.99	0.75
Rx Line Loss	(dB)	5.33	2.72
Rx Misc / Safety Loss	(dB)	0.50	0.50
Rx Connector Loss	(dB)	0.74	0.99
Diffraction Loss	(dB)	0.00	0.00
Foliage Loss	(dB)	0.00	0.00
Free Space Path Loss	(dB)	123.28	123.32
Atmospheric Absorption Loss	(dB)	0.05	0.05
Total System Loss	(dB)	134.41	134.46
Path Calculations		**At Site B**	**At Site A**
Receive Signal Level - RSL	(dBm)	-67.21	-67.26
Rx Threshold Level	(dBm)	-85.80	-85.80
Flat / Thermal Fade Margin	(dB)	18.59	18.54
Dispersive Fade Margin	(dB)	0.00	0.00
Dispersive Fade Occurence Factor		1.00	
Effective Fade Margin	(dB)	18.59	18.54
Worst Month Multipath Availability	(%)	99.99963	99.99962
Worst Month Multipath Unavailability	(sec)	9.65	9.81
Annual Multipath Availability	(%)	99.99989	99.99988
Annual Multipath Unavailability	(sec)	35.91	36.53
Annual 2-Way Multipath Availability	(%)	99.99977	
Annual 2-Way Multipath Unavailability	(sec)	72.43	

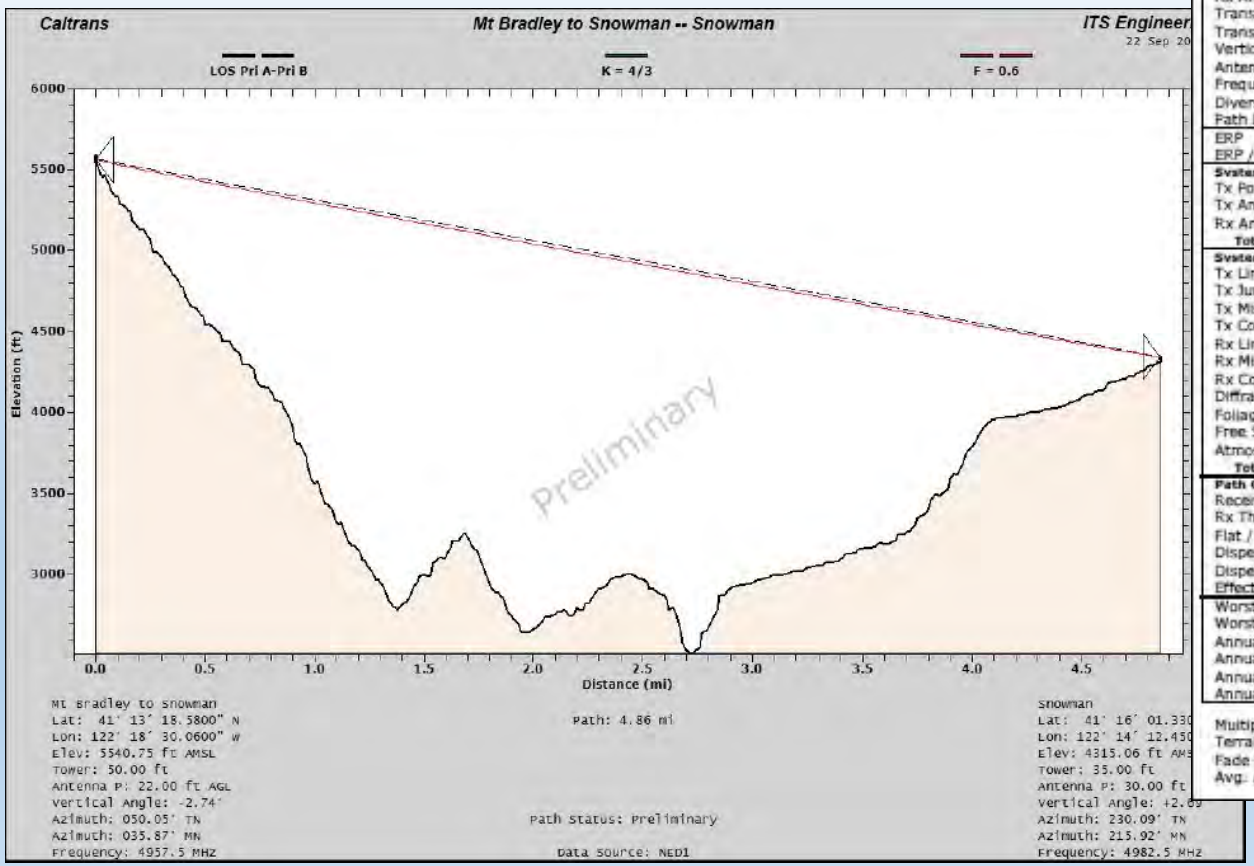
Multipath Fading Method: Barnett - Vigants
Terrain Roughness (w): 140.00
Fade Occurrence Factor (Po): 2.689E-004
Avg. Annual Temp: 60° F / 16° C
Climate Factor: 1.00
C Factor: 0.26

Image curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 5

Preliminary Path Analysis

Mt Bradley → Snowman West

- LOS verified
- 4.86 Miles
- Five nines calculated



Caltrans — Link Analysis — ITS Engineering

Path Status: Preliminary

		Mt Bradley to Snowman	Snowman
Location			
Call Sign			
Latitude		41 13 18.58 N	41 16 01.33 N
Longitude		122 18 30.06 W	122 14 12.45 W
Latitude		41.22182778°	41.26703611°
Longitude		-122.30835000°	-122.23679167°
Azimuth - TN / MN	(°)	050.05 / 035.87	230.09 / 215.92
Elevation - AMSL	(ft)	5540.75	4315.06
Tower - AGL	(ft)	50	35
Radio Model		Moseley-NX-GEN-S	Moseley-NX-GEN-S
Antenna Type		RadioWaves HP4-4.7	RadioWaves HP3-4.7
Tx Antenna Pri - AGL	(ft)	22.00	30.00
Rx Antenna Pri - AGL	(ft)	22.00	30.00
Transmission Line Type		LDF4.5-50	LDF4-50A
Transmission Line Length	(ft)	44.00	88.00
Vertical Angle	(°)	-2.74	2.69
Antenna Polarization		Vertical	Vertical
Frequency - Pri	(MHz)	4957.5	4982.5
Diversity Type		None	
Path Length	(mi/km)	4.86 / 7.82	
ERP	(dBW)	5.09	0.07
ERP / EIRP	(dBm)	35.09 / 37.24	30.07 / 32.22
System Gains		**Site A to B**	**Site B to A**
Tx Power	(dBm)	8.00	8.00
Tx Antenna Gain	(dBi)	32.90	30.30
Rx Antenna Gain	(dBi)	30.30	32.90
Total System Gain	(dB)	71.20	71.20
System Losses		**Site A to B**	**Site B to A**
Tx Line Loss	(dB)	1.87	4.83
Tx Jumper Loss	(dB)	0.30	0.00
Tx Misc / Safety Loss	(dB)	0.50	0.50
Tx Connector Loss	(dB)	0.99	0.75
Rx Line Loss	(dB)	4.83	1.87
Rx Misc / Safety Loss	(dB)	0.50	0.50
Rx Connector Loss	(dB)	0.74	1.00
Diffraction Loss	(dB)	0.00	0.00
Foliage Loss	(dB)	0.00	0.00
Free Space Path Loss	(dB)	124.24	124.28
Atmospheric Absorption Loss	(dB)	0.06	0.06
Total System Loss	(dB)	134.03	134.09
Path Calculations		**At Site B**	**At Site A**
Receive Signal Level - RSL	(dBm)	-62.83	-62.89
Rx Threshold Level	(dBm)	-85.80	-85.80
Flat / Thermal Fade Margin	(dB)	22.97	22.91
Dispersive Fade Margin	(dB)	0.00	0.00
Dispersive Fade Occurence Factor		1.00	
Effective Fade Margin	(dB)	22.97	22.91
Worst Month Multipath Availability	(%)	99.99981	99.99981
Worst Month Multipath Unavailability	(sec)	4.89	4.97
Annual Multipath Availability	(%)	99.99994	99.99994
Annual Multipath Unavailability	(sec)	18.19	18.51
Annual 2-Way Multipath Availability	(%)	99.99988	
Annual 2-Way Multipath Unavailability	(sec)	36.70	

Multipath Fading Method: Barnett - Vigants
Terrain Roughness (w): 140.00
Fade Occurrence Factor (Po): 3.732E-004
Avg. Annual Temp: 60° F / 16° C
Climate Factor: 1.00
C Factor: 0.26

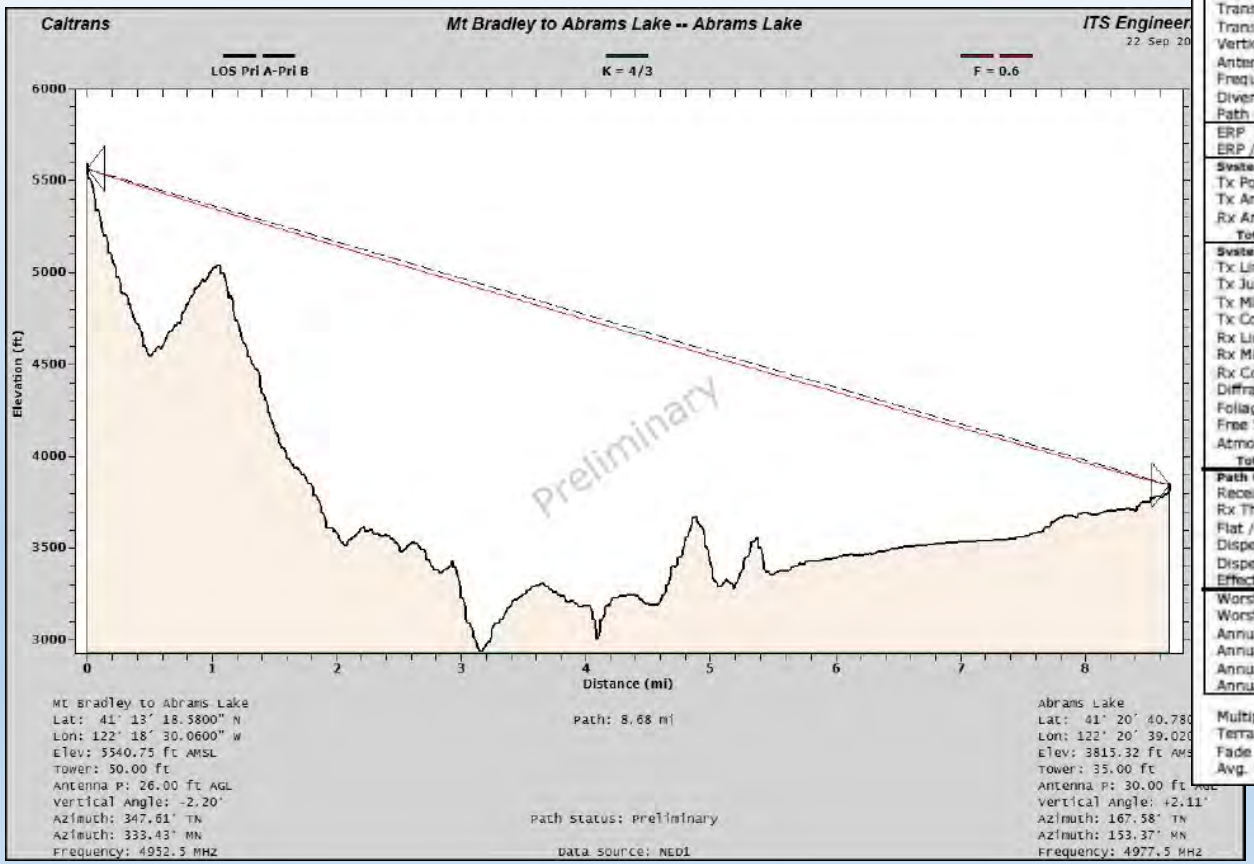
Preliminary

Image curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 5

Preliminary Path Analysis

Mt Bradley → Abrams Lake

- LOS verified
- 8.68 Miles
- Five nines calculated



Caltrans — Link Analysis — ITS Engineering

Path Status: Preliminary

		Mt Bradley to Abrams Lake	Abrams Lake
Location			
Call Sign			
Latitude		41 13 18.58 N	41 20 40.78 N
Longitude		122 18 30.06 W	122 20 39.02 W
Latitude		41.22182778°	41.34466111°
Longitude		-122.30835000°	-122.34417222°
Azimuth - TN / MN	(°)	347.61 / 333.43	167.58 / 153.37
Elevation - AMSL	(ft)	5540.75	3815.32
Tower - AGL	(ft)	50	35
Radio Model		Moseley-NX-GEN-S	Moseley-NX-GEN-S
Antenna Type		RadioWaves HP4-4.7	RadioWaves HP3-4.7
Tx Antenna Pri - AGL	(ft)	26.00	30.00
Rx Antenna Pri - AGL	(ft)	26.00	30.00
Transmission Line Type		LDF4.5-50	LDF4-50A
Transmission Line Length	(ft)	48.00	88.00
Vertical Angle	(°)	-2.20	2.11
Antenna Polarization		Vertical	Vertical
Frequency - Pri	(MHz)	4952.5	4977.5
Diversity Type		None	
Path Length	(mi/km)	8.68 / 13.97	
ERP	(dBW)	16.92	12.07
ERP / EIRP	(dBm)	46.92 / 49.07	42.07 / 44.22
System Gains		**Site A to B**	**Site B to A**
Tx Power	(dBm)	20.00	20.00
Tx Antenna Gain	(dBi)	32.90	30.30
Rx Antenna Gain	(dBi)	30.30	32.90
Total System Gain	(dB)	83.20	83.20
System Losses		**Site A to B**	**Site B to A**
Tx Line Loss	(dB)	2.04	4.83
Tx Jumper Loss	(dB)	0.30	0.00
Tx Misc / Safety Loss	(dB)	0.50	0.50
Tx Connector Loss	(dB)	0.99	0.75
Rx Line Loss	(dB)	4.83	2.04
Rx Misc / Safety Loss	(dB)	0.50	0.50
Rx Connector Loss	(dB)	0.74	1.00
Diffraction Loss	(dB)	0.00	0.00
Foliage Loss	(dB)	0.00	0.00
Free Space Path Loss	(dB)	129.27	129.31
Atmospheric Absorption Loss	(dB)	0.11	0.11
Total System Loss	(dB)	139.28	139.33
Path Calculations		**At Site B**	**At Site A**
Receive Signal Level - RSL	(dBm)	-56.08	-56.13
Rx Threshold Level	(dBm)	-85.80	-85.80
Flat / Thermal Fade Margin	(dB)	29.72	29.67
Dispersive Fade Margin	(dB)	0.00	0.00
Dispersive Fade Occurence Factor		1.00	
Effective Fade Margin	(dB)	29.72	29.67
Worst Month Multipath Availability	(%)	99.99977	99.99977
Worst Month Multipath Unavailability	(sec)	5.87	5.97
Annual Multipath Availability	(%)	99.99993	99.99993
Annual Multipath Unavailability	(sec)	21.84	22.22
Annual 2-Way Multipath Availability	(%)	99.99986	
Annual 2-Way Multipath Unavailability	(sec)	44.05	

Multipath Fading Method: Barnett - Vigants
Terrain Roughness (w): 140.00
Fade Occurrence Factor (Po): 2.123E-003
Avg. Annual Temp: 60° F / 16° C
Climate Factor: 1.00
C Factor: 0.26

Image curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 5

Preliminary Path Analysis

Mt Bradley → Dunsmuir

- No LOS

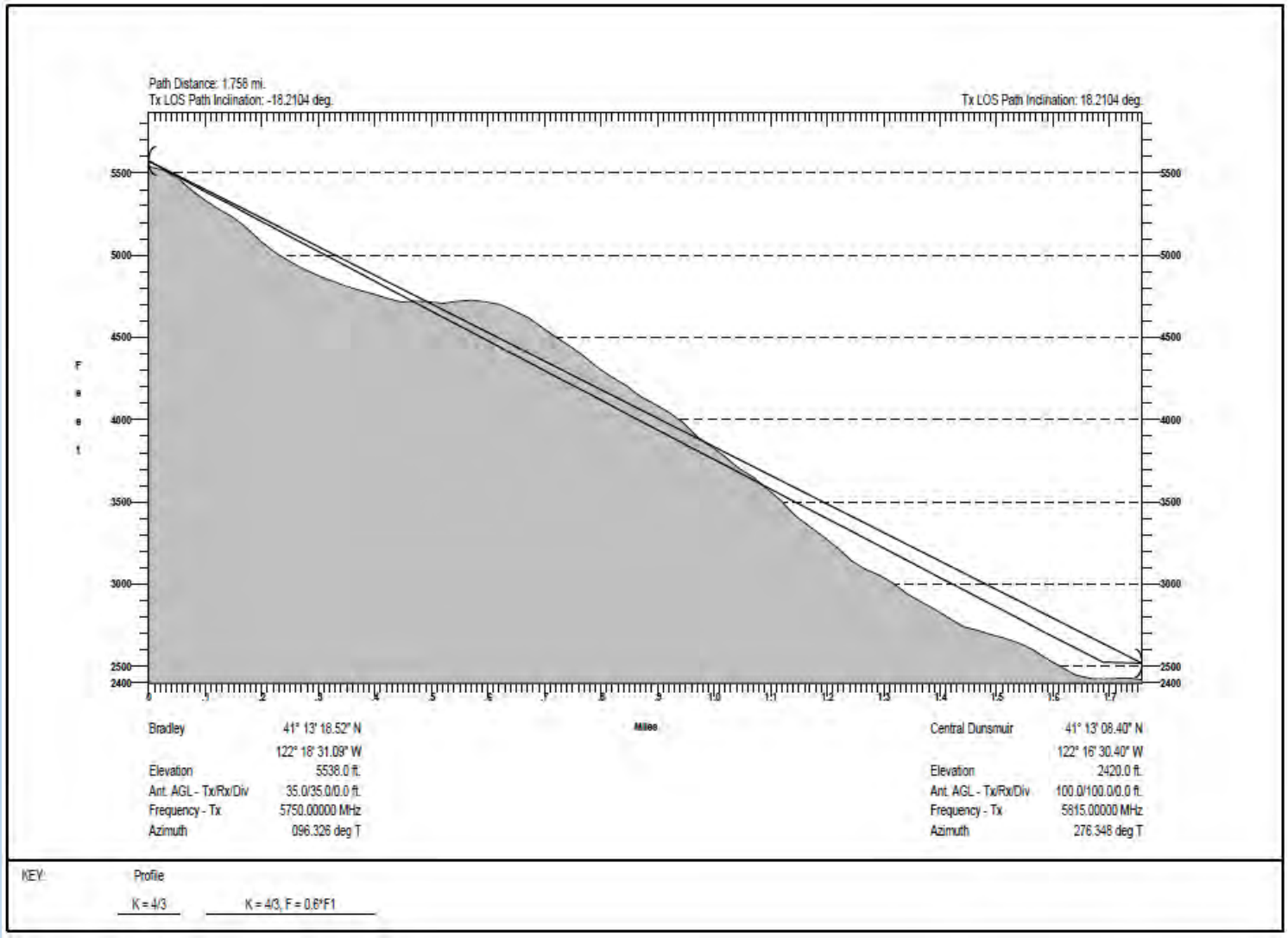


Image curtesy of [Microwave Path Analysis & SCADA - Micropath Pathanal 5]

Preliminary Path Analysis

LOS and Tower Heights

- Mt Bradley LOS to 12 Roadside and 1 Mountain Top
- Grey Butte LOS to 6 Roadside and 0 Mountain Top
- Soda Ridge LOS to 8 Roadside and 2 Mountain Top

Next Mountain Top Links	Mt Bradley	Grey Butte	Soda Ridge CHP
Antelope	25	NA	25
Herd	NA	NA	NA
Gunsight	NA	NA	NA
Hatchet	NA	NA	NA
Humbug	NA	NA	25
	1	0	2

Roadside Links	Mt Bradley	Grey Butte	Soda Ridge CHP
Abrams Lake	35	NA	70
Black Butte	35	NA	70
Castle Crags	50	70	NA
Central Mt Shasta	35	70	35
Crag View	NA	NA	50
Dead Horse	NA	70	NA
Deetz	35	NA	70
Dunsmuir	NA	NA	70
I5-SR89	35	35	35
Mott	35	80	35
Ream Rd	35	35	NA
Sims	NA	NA	NA
Snowman	70	70	70
Snowman West	35	35	40
South Dunsmuir	NA	70	70
Summit	70	NA	35
Sweetbrier	50	70	70
Weed Water Tower	70	NA	NA
	12	6	8

Preliminary Path Analysis

Site User Coordination

Mt Bradley

- Roseburg Timber

- US Forest Service (USFS)

- California Oregon Broadcasting Inc (COBI)

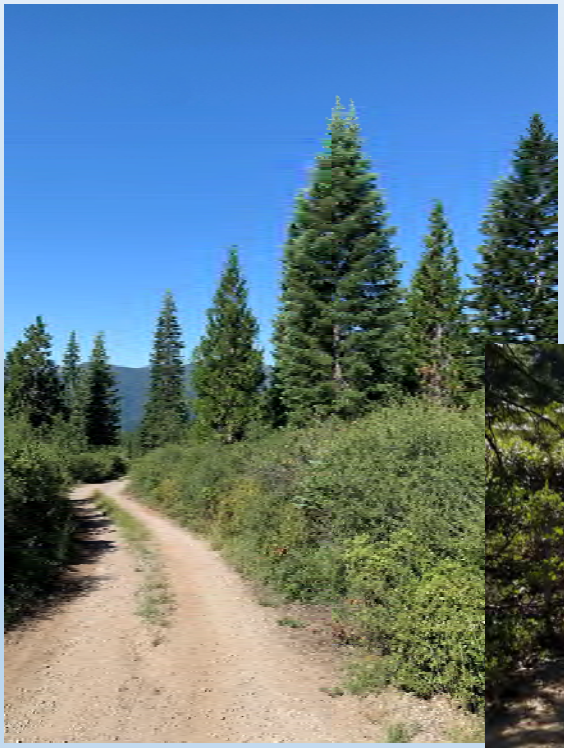
Soda Ridge

- California Highway Patrol (CHP)

Preliminary Path Analysis

Mt Bradley Access

- Long road with lots of turns and branches
- Three gates
- Road conditions well maintained



Preliminary Path Analysis

Mt Bradley Vault and Tower

- Small homemade tower
- Small old building, inadequate space
- Inadequate environmental control or backup power

Preliminary Path Analysis

Mt Bradley LOS to Roadside Elements

Mountain Top Site Decisions

Mt Bradley Additional Considerations

- Need to replace the existing ancient, unreliable, underground, undersized electrical service to the site

Mountain Top Site Decisions

Mt Bradley Additional Considerations

- Electrical utility service point is at the Dunsmuir HS
- Private line from this point on

Mountain Top Site Decisions

Mt Bradley Additional Considerations

- Agree to USFS Special Use Permit
- No outside private agency allowed in vault or on tower
- Inform USFS of vault/tower occupants every year
- Site alterations must be approved
- Expires in 2048, NOT renewable

State of California
CALIFORNIA STATE TRANSPORTATION AGENCY

Memorandum

Making Conservation a California Way of Life.

To: Jeremiah Pearce
ITS

Date: July 18, 2019
File: 02-Sis-Var- PM Var
E.A. 4G630
Parcel 14805(14809)

From: DEPARTMENT OF TRANSPORTATION
William Walker, Senior Right of Way Agent
Project Delivery, Redding (MS#35)

Subject: Special Use Permit and Communications Site Lease

Project Limits: "In Shasta and Siskiyou Counties at various locations."

Attached is a copy of the Special Use Permit for Mt. Bradley & Snowman's Summit signed by:

Scott Russell
Forest Supervisor
Shasta-Trinity National Forest
3644 Avtech Parkway
Redding, CA 96002

Contact: Stacy Smith- 530-926-9643

Improvements Purchased: None.
Construction Contract Work: None.
Excess Land Acquired: None.
Excess Land Exchanged: None.
Acquisition Agent: Kelly Babcock

***Please note USFS stipulations (see attached documentation for the complete list):**

- **No land use fee will be required unless The State allows an outside private agency to inhabit the shelter and tower.**
- **Caltrans must provide a snapshot of all occupants located in the Mt. Bradley equipment shelter on September 30 of each year.**
- **Communication Site Lease will expire 12/31/2048. The lease is not renewable. Request for new lease must be sent to The Forest Service one year prior to lease expiring.**
- **Any alternations of the facilities must be approved by The Forest Service prior to implementation. The Forest Service may require NEPA to be completed depending on the scope of work.**

Attachment
c. RE file w/attachments

"Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability"

Mountain Top Site Decisions

Mt Bradley Additional Considerations

- Coordinate with COBI to replace existing tower, and possible co-locate in new vault
- Coordinate with all mountain top users for electrical utility replacement

Radio Specification

Caltrans Standard Equipment

- As discussed in the previous presentation by Keith
- Use Aviate transceivers with Andrew dishes for backhaul link
- Use Mosely transceivers with RadioWaves dishes for roadside links

Design

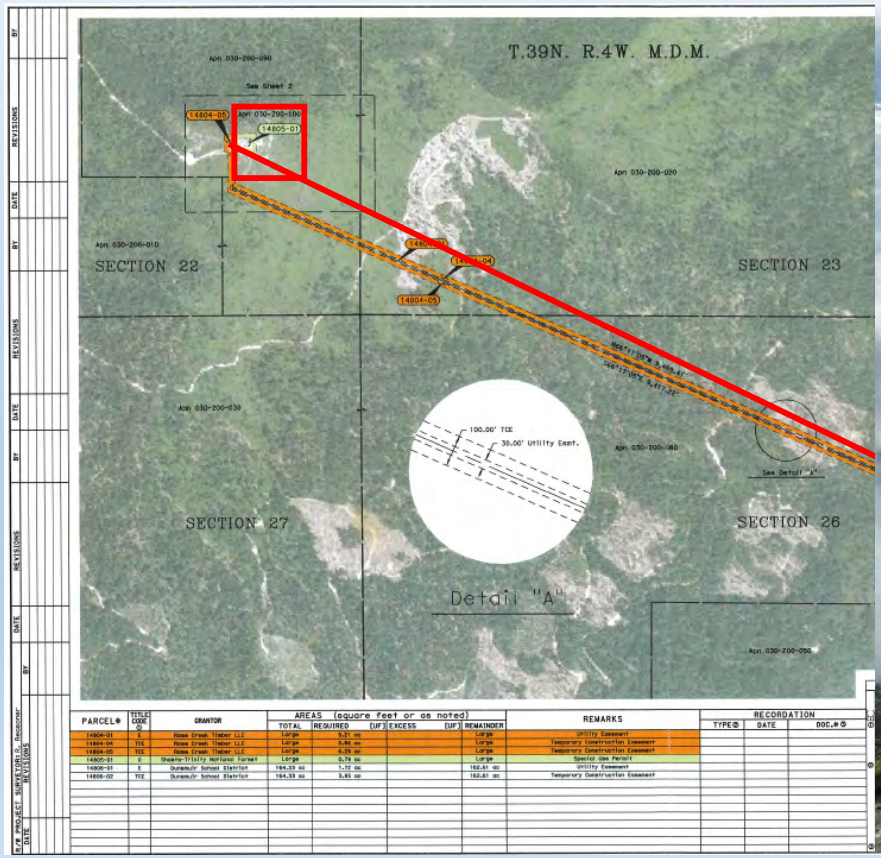
ITS Field Element Network Communications Special Design

- Supported by Civil management and design
- Not a typical design for Caltrans
- Changed project manager at least 3 times
- Changed project engineer at least 3 times

Design

ITS Field Element Network Communications Special Design

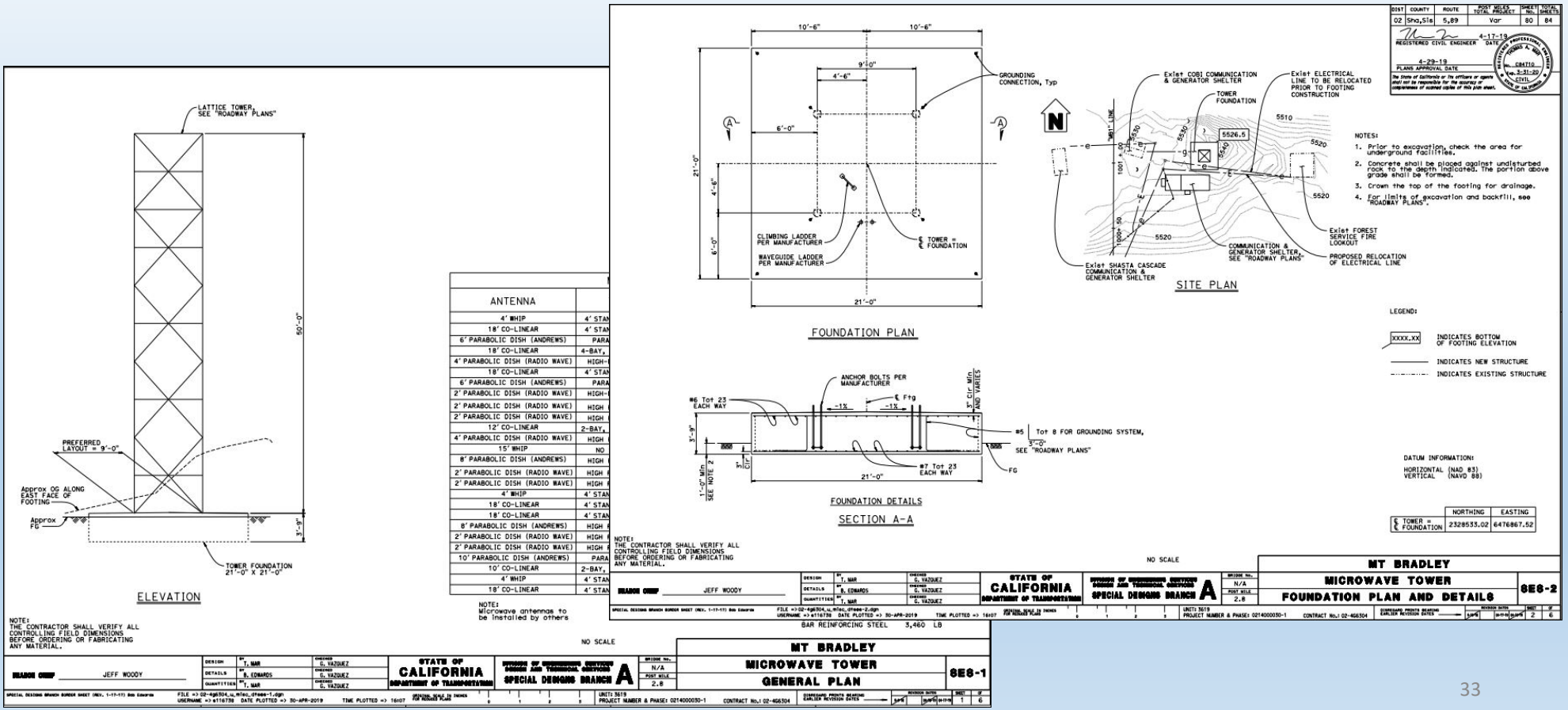
- Right-of-Way dealing with logging company and high school to get path for utility approved
- Had to purchase the trees from logging company and high school
- USFS would not allow power lines to cross their property



Design

ITS Field Element Network Communications Special Design

- Not a typical design for Division of Engineering Services (DES)
- Tasked with designing a tower foundation at the top of a granite mountain
- Ended up paying Valmont to design the foundation with DES review and plan sheets



Design

ITS Field Element Network Communications Special Design

- Access to site not always easy
- Requires 4x4 vehicles to access
- Can be inaccessible due to weather
- Trees fall across road requiring dragging off or cutting up

Design

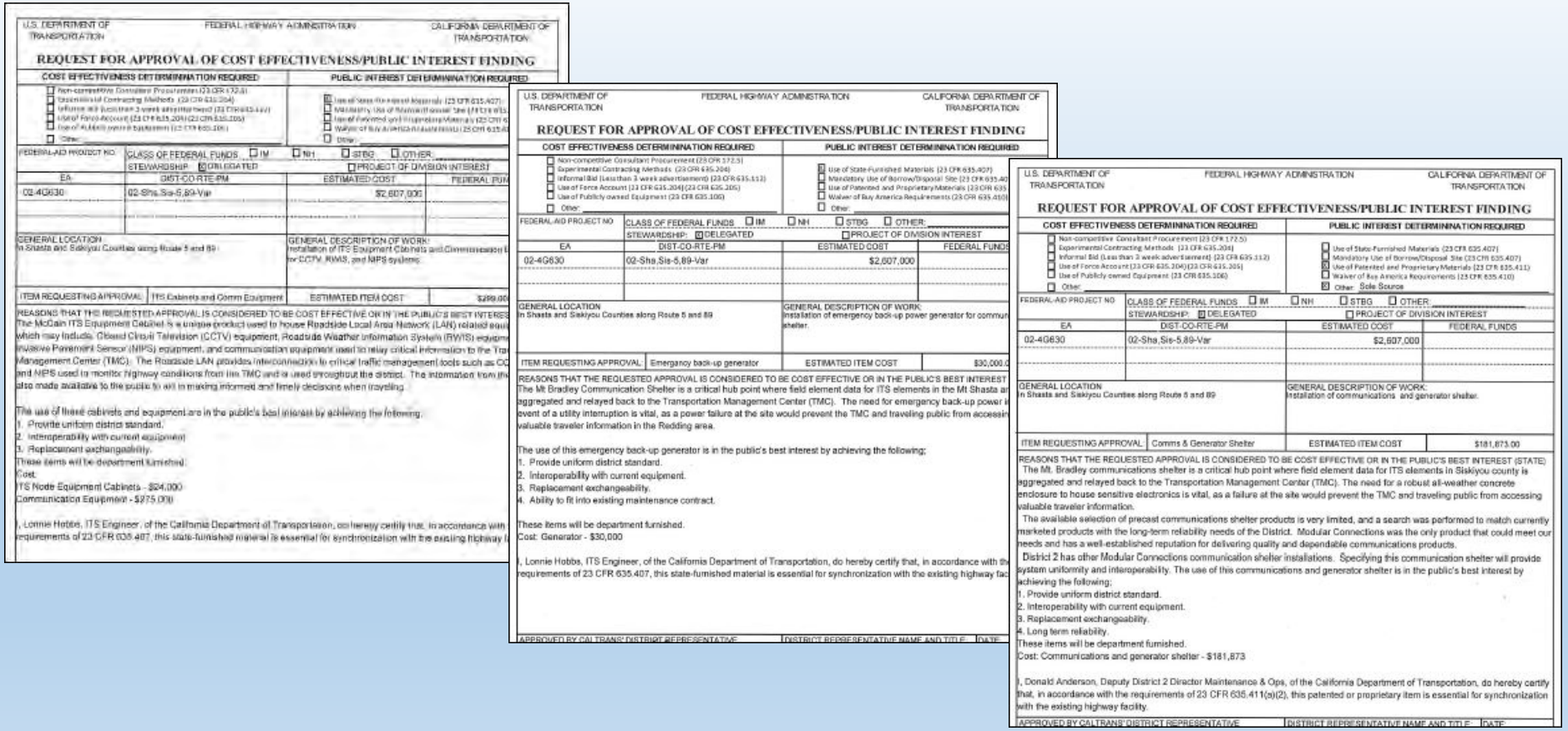
ITS Field Element Network Communications Special Design

- Preferred Manufacturers
- Valmont Tower (Identical installation at I5-SR44 Bluffs)
- Modular Connections Prefabricated Vault (Similar installation at Bass Mtn and I5-SR44 Bluffs)
- Cummins Generator (Similar installation at Bass Mtn and I5-SR44 Bluffs)

Design

ITS Field Element Network Communications Special Design

- Department Furnished Materials (DFM) require Public Information Finding (PIF)



U.S. DEPARTMENT OF TRANSPORTATION — FEDERAL HIGHWAY ADMINISTRATION — CALIFORNIA DEPARTMENT OF TRANSPORTATION

REQUEST FOR APPROVAL OF COST EFFECTIVENESS/PUBLIC INTEREST FINDING

COST EFFECTIVENESS DETERMINATION REQUIRED	PUBLIC INTEREST DETERMINATION REQUIRED
☐ Non-competitive Consultant Procurement (23 CFR 172.5) ☐ Experimental Contracting Methods (23 CFR 635.204) ☐ Informal Bid (Less than 3 week advertisement) (23 CFR 635.112) ☐ Use of Force Account (23 CFR 635.204)(23 CFR 635.205) ☐ Use of Publicly owned Equipment (23 CFR 635.106) ☐ Other:	☐ Use of State-Furnished Materials (23 CFR 635.407) ☐ Mandatory Use of Borrow/Disposal Site (23 CFR 635.407) ☐ Use of Patented and Proprietary Materials (23 CFR 635.411) ☐ Waiver of Buy America Requirements (23 CFR 635.410) ☐ Other:

FEDERAL-AID PROJECT NO: CLASS OF FEDERAL FUNDS ☐ IM ☐ NH ☐ STBG ☐ OTHER:
STEWARDSHIP: ☒ DELEGATED ☐ PROJECT OF DIVISION INTEREST

EA	DIST-CO-RTE-PM	ESTIMATED COST	FEDERAL FUNDS
02-4G630	02-Sha,Sis-5,89-Var	$2,607,000	

GENERAL LOCATION: In Shasta and Siskiyou Counties along Route 5 and 89

GENERAL DESCRIPTION OF WORK: Installation of communications and generator shelter.

ITEM REQUESTING APPROVAL: Comms & Generator Shelter — ESTIMATED ITEM COST: $181,873.00

REASONS THAT THE REQUESTED APPROVAL IS CONSIDERED TO BE COST EFFECTIVE OR IN THE PUBLIC'S BEST INTEREST (STATE):
The Mt. Bradley communications shelter is a critical hub point where field element data for ITS elements in Siskiyou county is aggregated and relayed back to the Transportation Management Center (TMC). The need for a robust all-weather concrete enclosure to house sensitive electronics is vital, as a failure at the site would prevent the TMC and traveling public from accessing valuable traveler information.

The available selection of precast communications shelter products is very limited, and a search was performed to match currently marketed products with the long-term reliability needs of the District. Modular Connections was the only product that could meet our needs and has a well-established reputation for delivering quality and dependable communications products.

District 2 has other Modular Connections communication shelter installations. Specifying this communication shelter will provide system uniformity and interoperability. The use of this communications and generator shelter is in the public's best interest by achieving the following;

1. Provide uniform district standard.
2. Interoperability with current equipment.
3. Replacement exchangeability.
4. Long term reliability.

These items will be department furnished.
Cost: Communications and generator shelter - $181,873

I, Donald Anderson, Deputy District 2 Director Maintenance & Ops, of the California Department of Transportation, do hereby certify that, in accordance with the requirements of 23 CFR 635.411(a)(2), this patented or proprietary item is essential for synchronization with the existing highway facility.

APPROVED BY CALTRANS' DISTRICT REPRESENTATIVE | DISTRICT REPRESENTATIVE NAME AND TITLE | DATE

Design

ITS Field Element Network Communications Special Design

- Contractor Furnished Materials require specifications written around preferred manufacture with agreed price and allows for alternative at contractor's discretion

87-16.02G Agreed Price Arrangement

The successful bidder can obtain the following communications and generator shelter equipment from the manufacturer/supplier, Modular Connections, 1090 Industrial Blvd., Bessemer, AL 35022, Telephone (205) 980-4565. The price quoted by the manufacturer/supplier for the communications shelter, FOB Destination, Net 30 is $181,873.00, not including sales tax.

The above price will be firm for orders placed on or before 06/01/2020, provided delivery is accepted within 90 days after the order is placed.

Qty	Description	Extended Price
1	Monolithic 12'x22' regular weight concrete shelter (Communication)	$106,967.00
LS	HVAC	
LS	Controls and automation	
LS	Electrical (interior) including lighting	
LS	Power	
LS	Cable runway	
LS	Interior ground	
LS	Roof access	
LS	Project Management	
LS	Design and permitting	
LS	Assembly	
LS	Testing	
1	Monolithic 12'x12' regular weight concrete shelter (Generator)	$58,621.00
LS	Electrical (interior) including lighting	
LS	Automatic transfer switch	
LS	Project Management	
LS	Design and permitting	
LS	Assembly	
LS	Testing	
1	Estimated freight/shipping/handling	$32,000.00
	TOTAL	$197,588.00

Design

ITS Field Element Network Communications Special Design

Ground System Design

- Detailed presentation at 2009 Forum but Jeremiah Pearce “Ground System Design and its Role in ITS”
- Motorola R56 Standards & Guidelines Chapter 4 “Site Design & Development” and Chapter 6 “External Grounding”
- Lightning protection
- Electrical safety
- Signal propagation (not a concern for this site)
- Granite “soil”

TABLE 4-1 SOIL RESISTIVITY FOR VARIOUS SOIL TYPES

Soil Type	Resistivity (kΩ-cm) Minimum	Average	Maximum
Ashes, brine, or cinders	0.590	2.37	7.0
Clay, gumbo, loam, or shale	0.340	4.06	16.3
Clay, gumbo, loam, or shale with varying portions of sand and gravel	1.02	15.8	135.0
Gravel, sand, or stone with little clay or loam	59.0	94.0	458.0

NOTE: “Gumbo” is soil composed of fine-grain clays. When wet, the soil is highly plastic, very sticky, and has a soapy appearance. When dried, is develops large shrinkage cracks.

Design

ITS Field Element Network Communications Special Design

- Testing for soil resistivity
- 4-point Wenner method

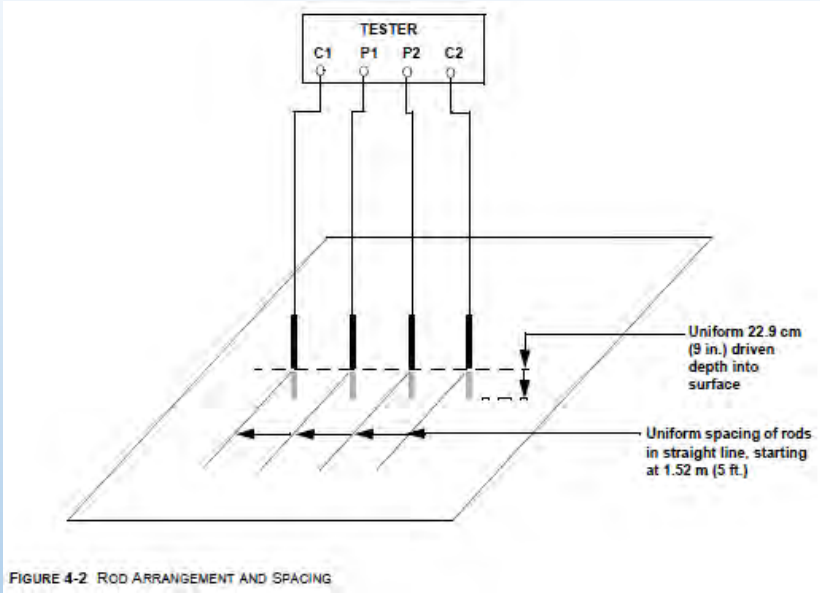


FIGURE 4-2 ROD ARRANGEMENT AND SPACING

$\rho = 191.5 \times A \times R$

where: ρ = soil resistivity in Ω-cm
A = Distance between test rods (in feet)
R = Resistance obtained from tester (in ohms)

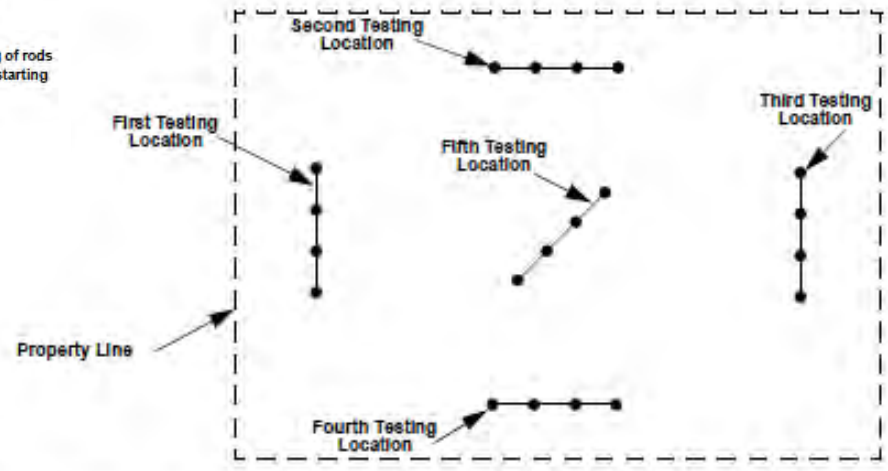
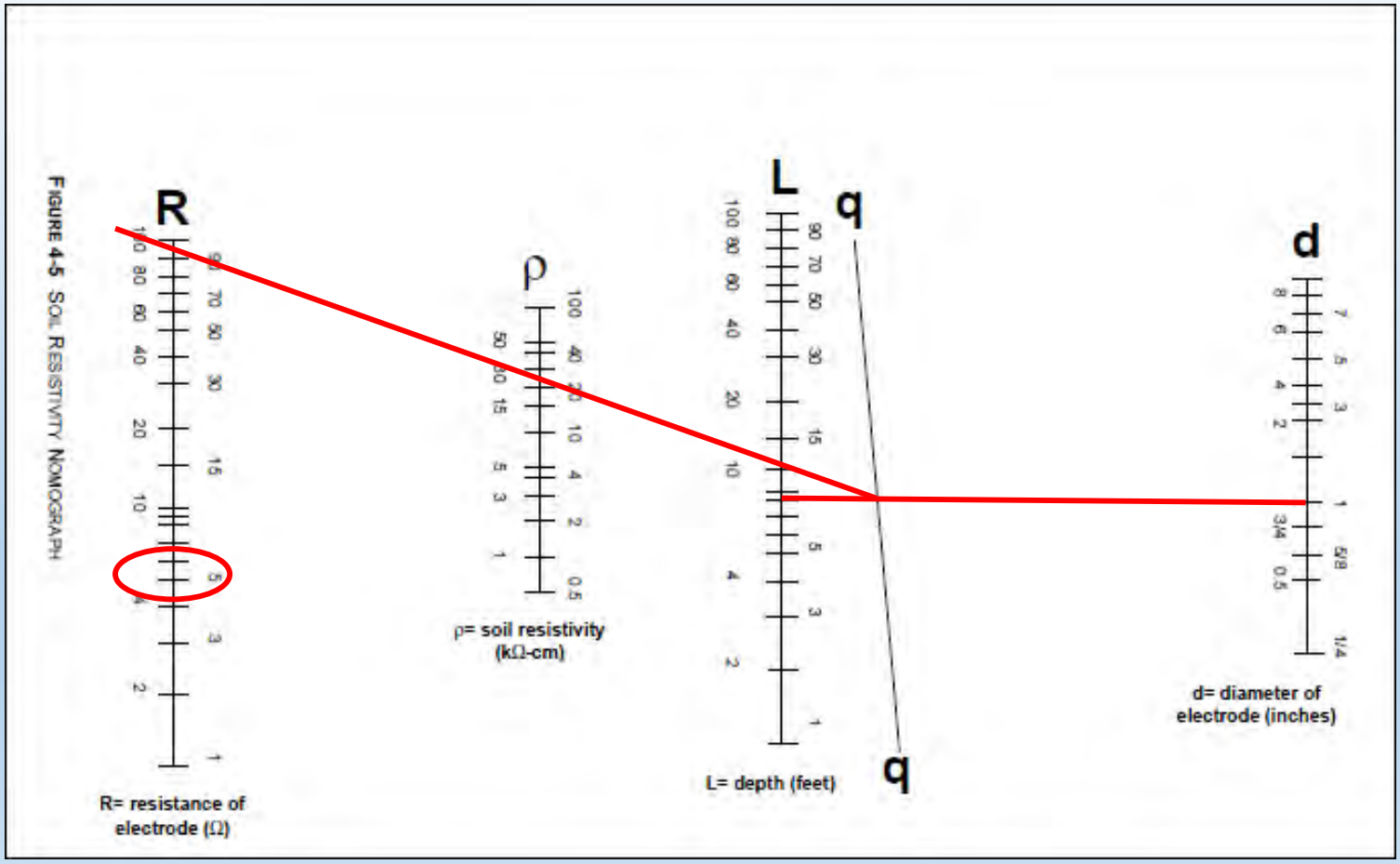


FIGURE 4-3 RECOMMENDED MULTIPLE SAMPLING PATTERN ACROSS SITE

Design

ITS Field Element Network Communications Special Design

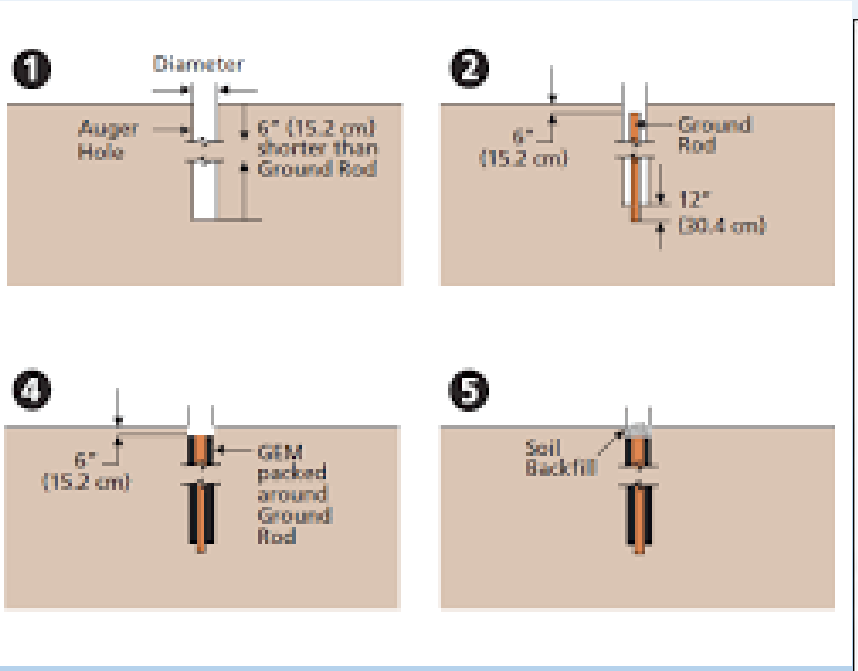
- Soil resistivity nomograph
- Single grounding electrode system resistance

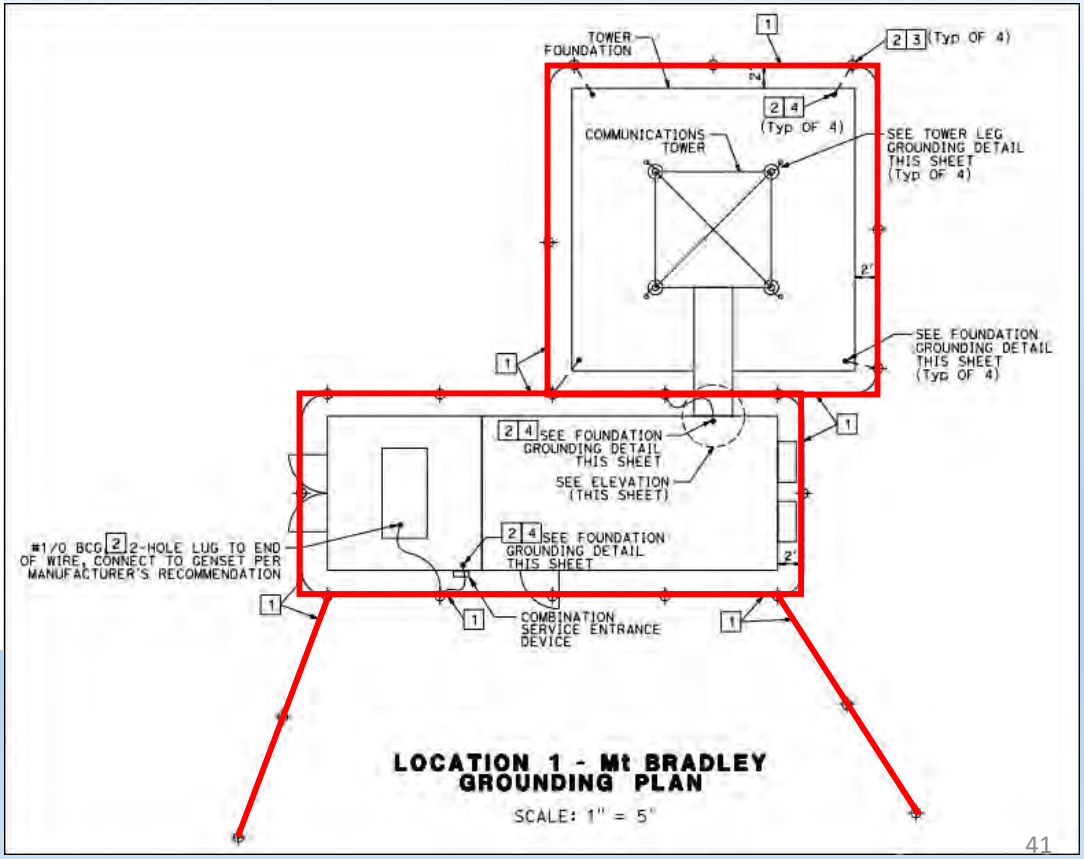


Design

ITS Field Element Network Communications Special Design

- 6.3.2.4 External Ground Ring
  - ... should encircle the site structures and provides a means of bonding ground rods together and bonding other grounding electrode system components together, improving the overall grounding electrode system.





Design

ITS Field Element Network Communications Special Design

- Multiple grounding electrode system resistance calculation
- Electrodes in a straight line (radial from vault and/or tower)

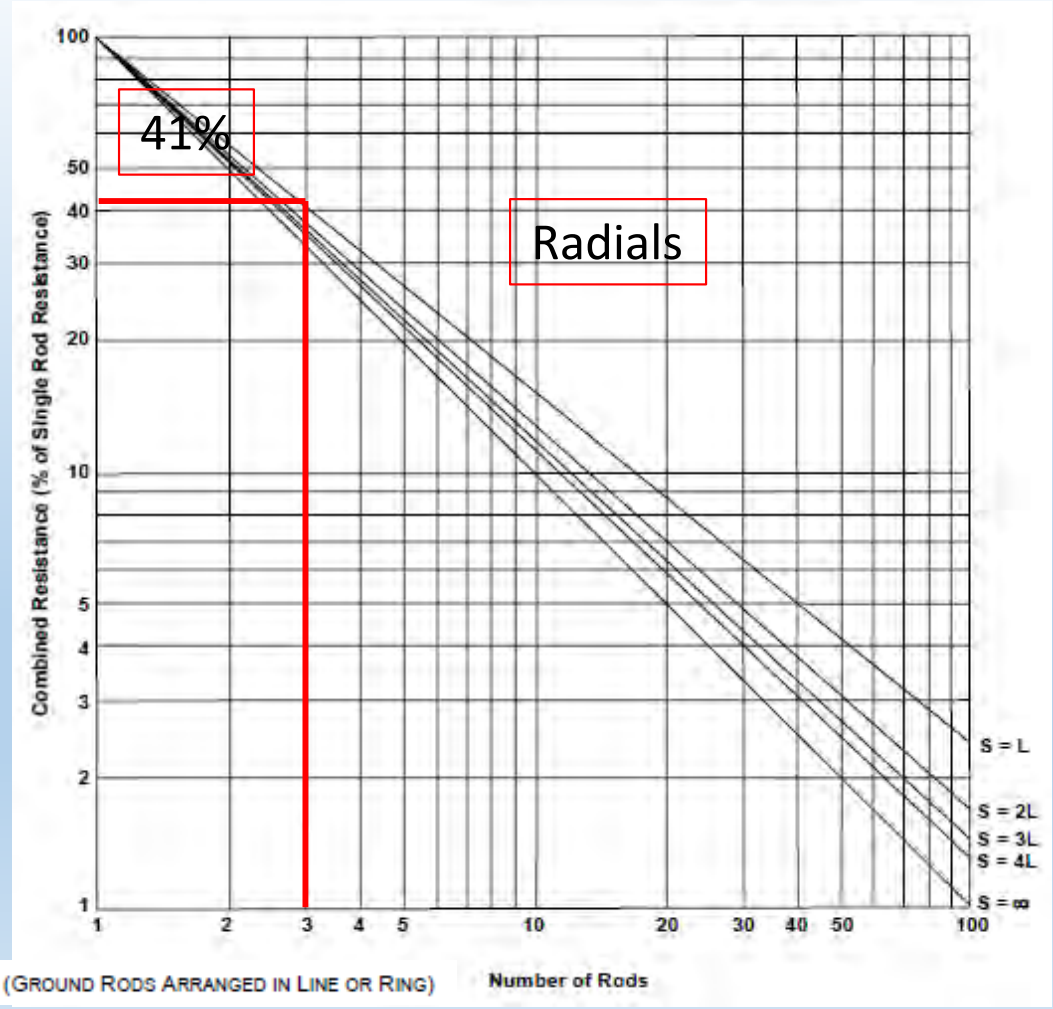
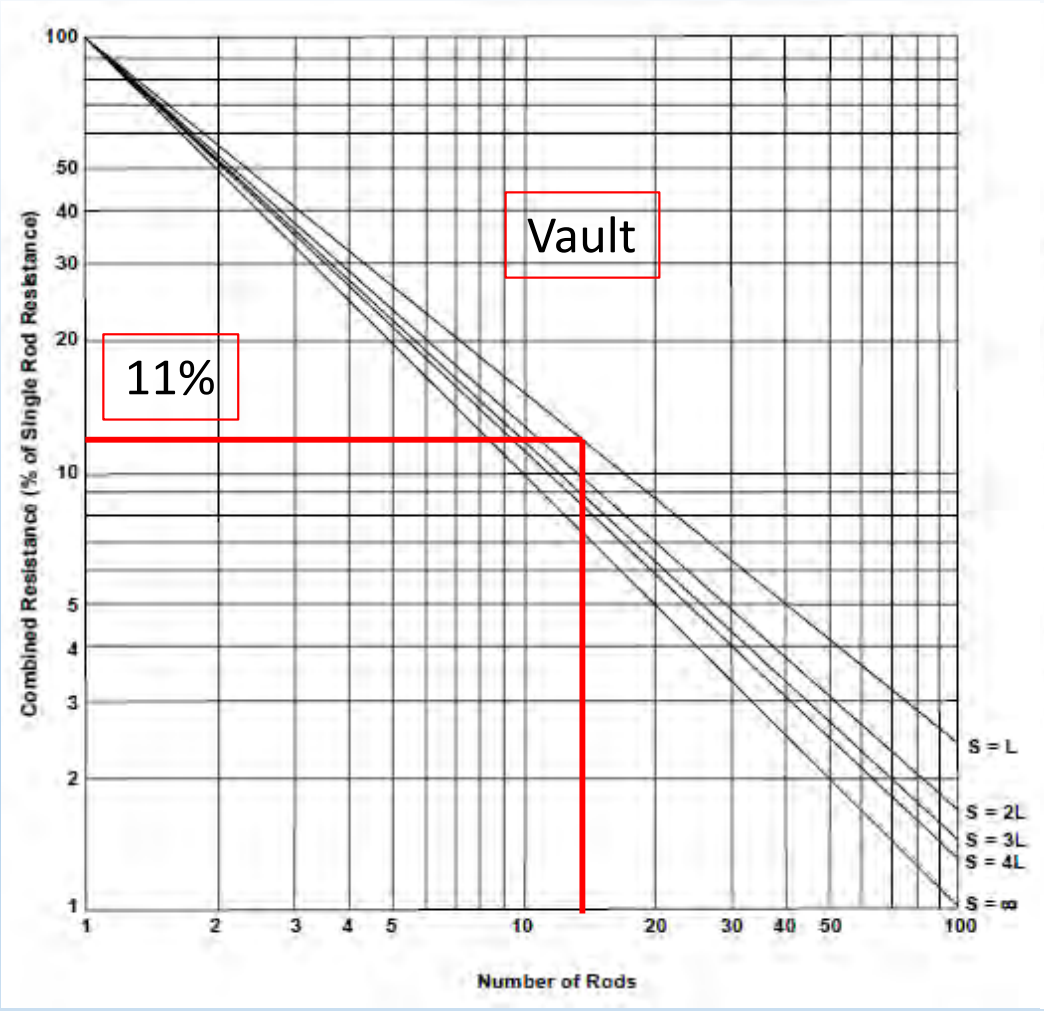


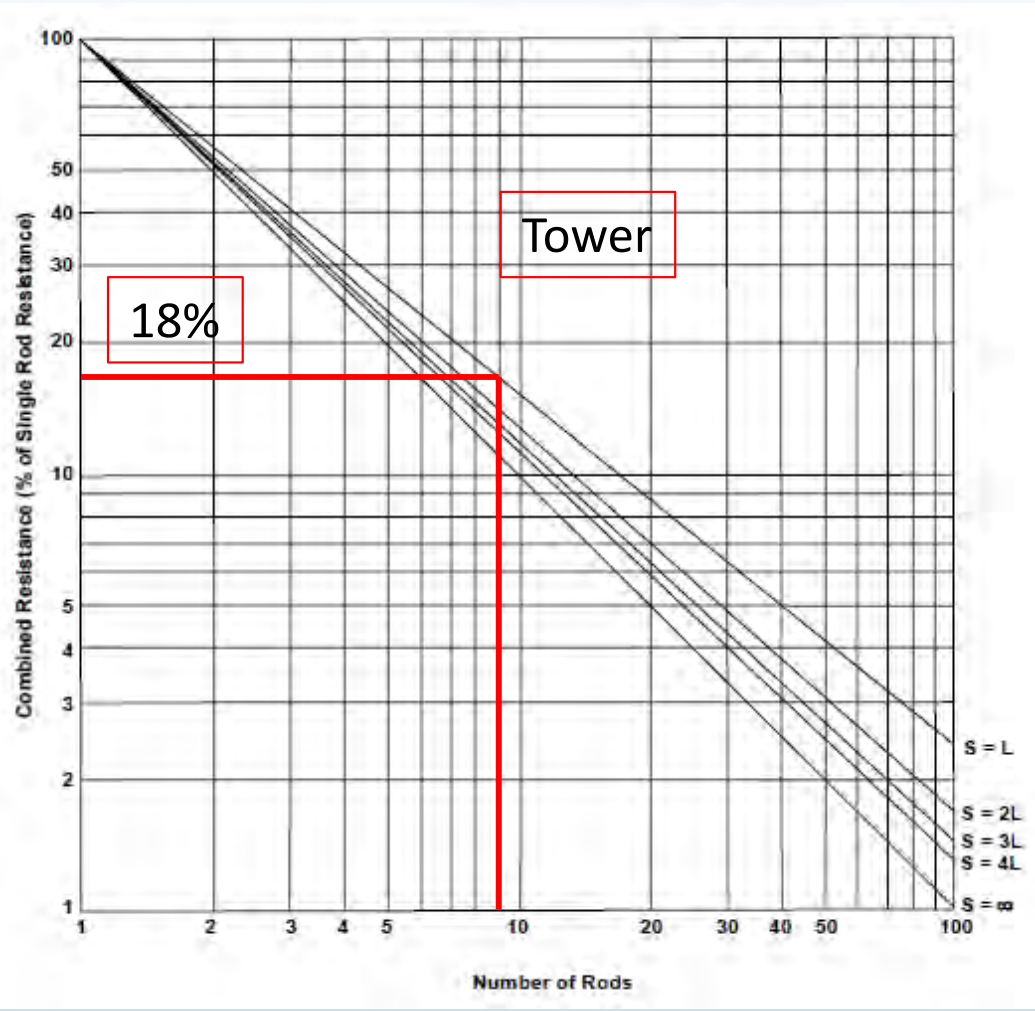
FIGURE 4-7 COMBINED RESISTANCE GRAPH (GROUND RODS ARRANGED IN LINE OR RING)

Design

ITS Field Element Network Communications Special Design

- Multiple grounding electrode system resistance calculation
- Electrodes in a ring (around vault and/or tower)





Design

ITS Field Element Network Communications Special Design

- Calculating system resistance of a complex system
  - Subsystem 1 = Vault Ring
  - Subsystem 2 = Radial 1
  - Subsystem 3 = Radial 2
  - Subsystem 4 = Tower Ring
  - 22 total ground rods used

$$R_{total} = \frac{1}{1/R_{subsystem\ 1} + 1/R_{subsystem\ 2} + 1/R_{subsytem\ 3}}$$

	Figure 4-5 Resistance	Figure 4-7 % of single	Resistance	Inverse	Final Resistance
Vault Ring	95	11	10.45	0.10	
Vault Radial 1	95	41	38.95	0.03	
Vault Radial 2	95	41	38.95	0.03	
Tower Ring	95	18	17.1	0.06	
			Total	0.21	4.87

Design

ITS Field Element Network Communications Special Design

- 6.3.1.4 Concrete-Encased Electrodes (UFER)
  - ...enhance the effectivity of the grounding electrode system in two ways: the concrete absorbs and retains...; and the concrete provides a much larger surface area in direct contact with the surrounding soil. ...helpful at sites with high soil resistivity
  - ...**shall** be encased by at least 2 in. of concrete, ...near the bottom of a concrete foundation or footing that is in direct contact with the earth.
  - ...**shall** be at least 20 ft. of...steel reinforcing bars or rods at least 0.5 in. in diameter.
  - ...**shall** be bonded to any other grounding electrode system at the site.

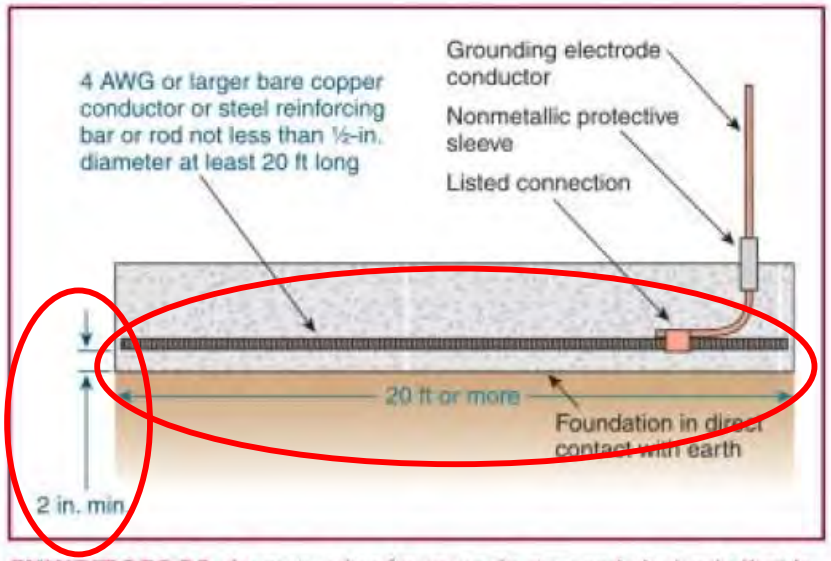
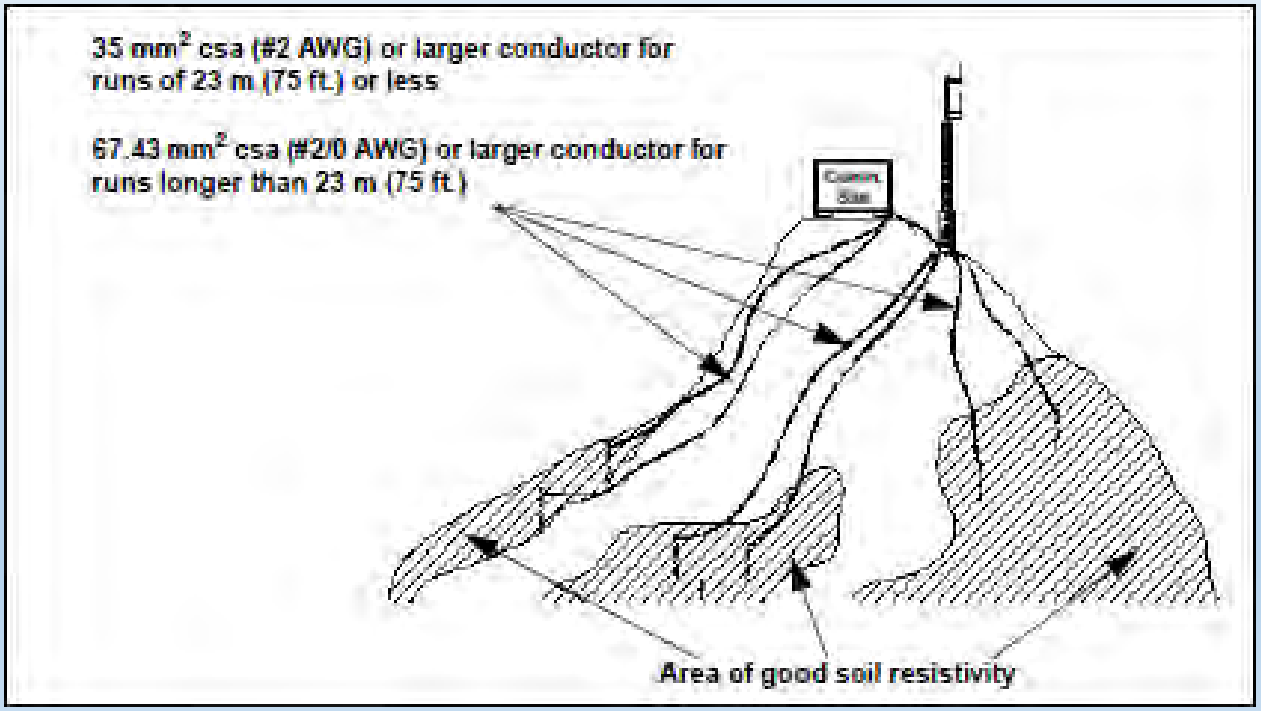


EXHIBIT 250.23 *An example of a concrete-encased electrode that is required to be incorporated into the grounding electrode system.*

Design

ITS Field Element Network Communications Special Design

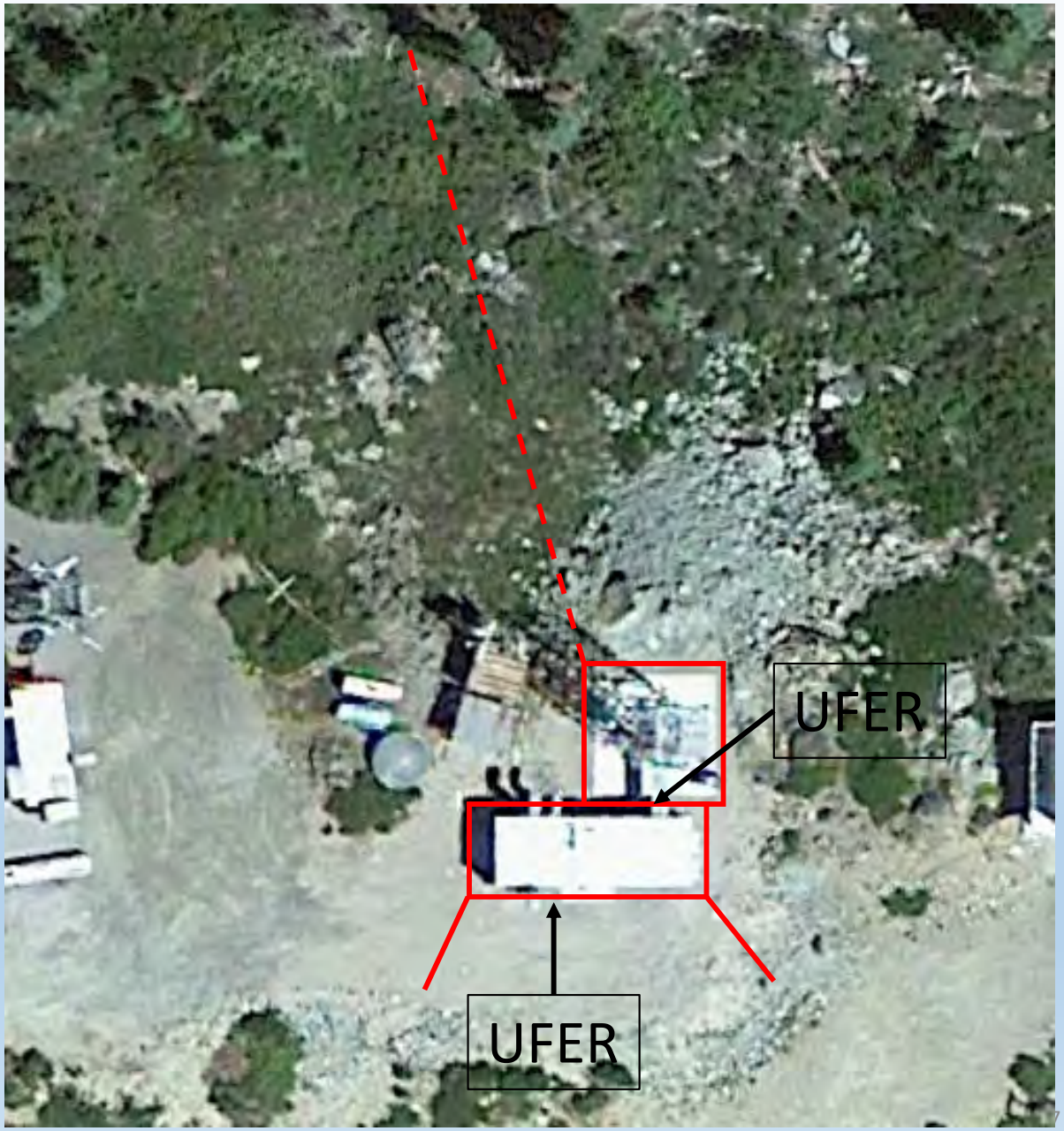
- 6.4.11.7 Stone Mountain Tops
  - ...components buried as deep as the soil will allow and encasing all components with a ground enhancing material.
  - ... radial extensions from the building throughout the property...
  - ...concrete encased electrodes... (UFER)
  - ...down conductors to a lower area where there is usable soil.



Design

ITS Field Element Network Communications Special Design

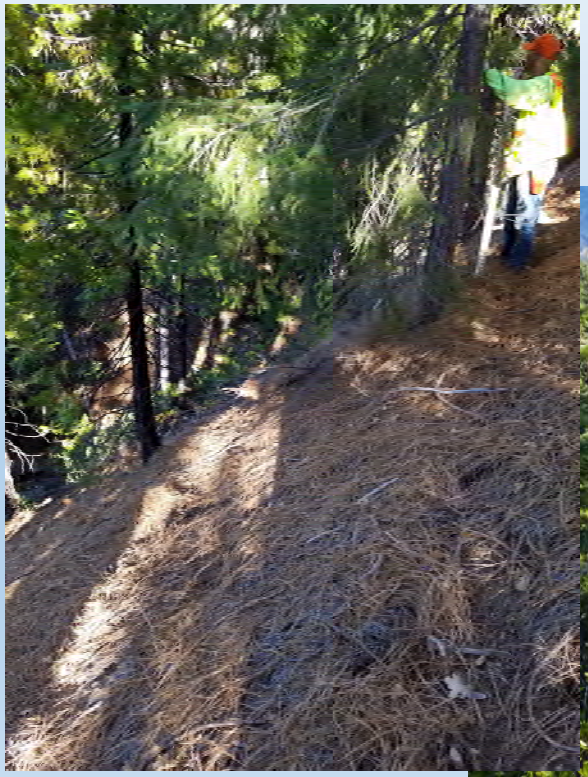
- Final construction
  - Vault Ring
  - 2 Radials
  - Tower Ring
  - 2 UFERs (one at utility entrance and one at ice bridge entrance)
- Future (if needed)
  - Down to tree line

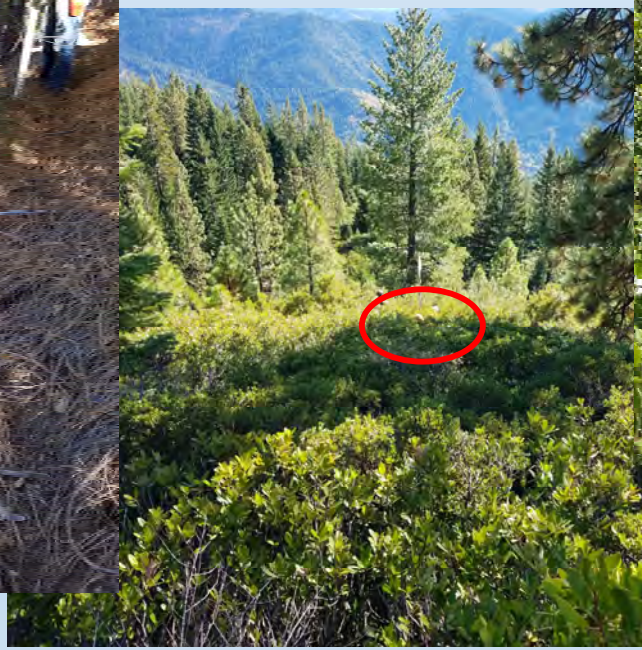


Design

ITS Field Element Network Communications Special Design

- Coordinate with Power Utility (Pacific Power)
- Overhead vs buried service
- Caltrans had to hike and stake the path prior to estimator coming out





Design

ITS Field Element Network Communications Special Design

- Coordinate with Power Utility (Pacific Power)
- Overhead vs buried service
- Caltrans had to hike and stake the path prior to estimator coming out
- Recent fires – change to utilities process and materials

Image curtesy of California fires over 10 years: See 170-plus areas where blazes repeatedly ignited (sfchronicle.com)

Design

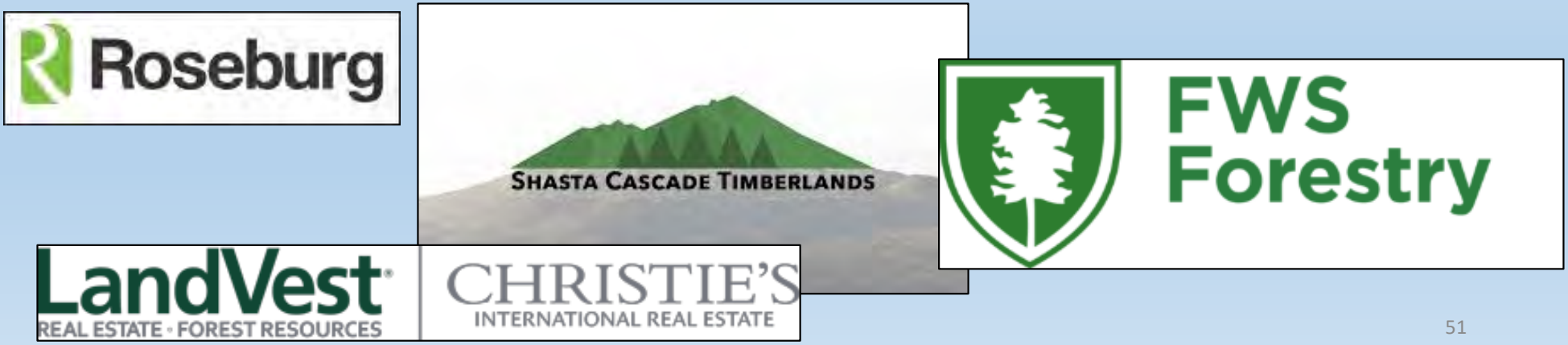
ITS Field Element Network Communications Special Design

- Coordinate with Power Utility (Pacific Power)
- Overhead vs buried service
- Caltrans had to hike and stake the path prior to estimator coming out
- Recent fires – change to utilities process and materials
- Not a typical design for estimator
  - Not willing to provide an estimate
  - Had to push request up the chain of command
  - Received after RTL – placed 3x expected in project estimate

Design

ITS Field Element Network Communications Special Design

- Coordinate with Private Landowners
- Roseburg/Shasta-Cascades Timberland
- Require easement for access and utility
- Roseburg bought out by international company
- Initial contact retired and pertinent information was not passed along to the new contact
- Company contact name changes
  - Roseburg – Original landowner
  - Shasta-Cascades Timberland – New landowner
  - Land Vest – New property management
  - FWS Forestry Services – Final property management



Design

ITS Field Element Network Communications Special Design

- Coordinate with Dunsmuir High School
- Careful about checking in when students are on campus
- Adult Education Forestry course provided opportunity for student logging and management

Design

ITS Field Element Network Communications Special Design

- Coordinate with Site Owner
- United States Forestry Services (USFS)
- Historic fire lookout built in 1933 must be preserved
- Careful not to restrict viewshed from the lookout
- Color requirement to blend in with natural environment (no white)

Image curtesy of Mt. Bradley Ridge Fire Lookout - Shasta National Forest - Dunsmuir CA - Living New Deal

Design

ITS Field Element Network Communications Special Design

- Coordinate with Previous Mountain Top Site Owner (Sugarloaf)
- California Highway Patrol (CHP)
- Agreements for tower and rack usage and routing of waveguide

Design

ITS Field Element Network Communications Special Design

- Coordinate with California State Fire Marshal (SFM)
- Actually a “simple” process
- Classified as a Communications Vault – Occupancy Class U – Utility and Miscellaneous Group
- Fill out the forms (marshal filled out)
- Prepare drawings for SFM approval
- Provide SFM stamp for bid documents
- Inspection of vault after construction – minor changes

DEPARTMENT OF FORESTRY AND FIRE PROTECTION
OFFICE OF THE STATE FIRE MARSHAL
Fire and Life Safety Division - North
2251 Harvard Street, Suite 130, Sacramento, CA 95815
(916) 566-2962

PERMIT APPLICATION
This is not a Permit for Construction

Application #: 19-N-1124-C-AC
Alternate Application #:
Permit Type: Construction (C)

Application Information
PROJECT DESCRIPTION: North Canyon TMS Improvements

Project Location
LOCATION NAME: MT Bradley
ADDRESS: MT Bradley Road, Dunsmuir, CA, 96025
COUNTY: Siskiyou
FACILITY CLASSIFICATION: State-Owned facilities (miss office buildings, etc.)
LOT #:
SUITE: FLOOR #: FACILITY #: New BUILDING #: New
PRIMARY OCCUPANCY DESCRIPTION: 91 OCCUPANCY GROUP: U

Applicant Information
BUSINESS NAME: Department of Transportation
OWNER/APPLICANT: Lonnie Hobbs
ADDRESS: 1657 RIVERSIDE DRIVE, REDDING, CA 96001
PHONE #: (530) 225-2809 EXT: FAX #: EXT:
CELL #: EMAIL: lonnie.hobbs@dot.ca.gov

Agency Information
AGENCY NAME: Department of Transportation PROJECT#:
ADDRESS: 1657 RIVERSIDE DRIVE, REDDING, CA 96001
CONTACT NAME: Lonnie Hobbs PHONE #: (530) 225-2809 EXT:
EMAIL: lonnie.hobbs@dot.ca.gov CELL #: FAX #: EXT:

Building Contractor
COMPANY NAME: LICENSE #:
CONTRACTOR NAME: PHONE #:
ADDRESS: EMAIL:

Sq. Ft./Cost Details
TOTAL SQ. FT.: 405 PROJECT SQ. FT.: 0 CONSTRUCTION COST FOR REMODEL: 0.0000
CONSTRUCTION COST: 0.0000 OCCUPANCY LOAD: 2
CONSTRUCTION TYPE: Wood Frame, no ceiling TYPE OF FRAME: Masonry
TYPE OF HEATING: TYPE OF COOLING:
SPRINKLER REQUIRED: No SPRINKLER TYPE:

Comments
COMMENTS:

DEPARTMENT OF FORESTRY AND FIRE PROTECTION
OFFICE OF THE STATE FIRE MARSHAL
Fire and Life Safety Division - North
2251 Harvard Street, Suite 130, Sacramento, CA 95815
(916) 568-2962

PERMIT

Application #: 19-N-1124-C-PI
Alternate Application #:
Permit Type: Construction (C)

HOW TO SCHEDULE AN INSPECTION
Call the Permit Office at (916) 568-2962 or visit calfire.govmotus.org

PERMIT #: 19-N-1124-C-PI DATE ISSUED: 03/26/2019
MASTER PERMIT #:
APPLICANT: Lonnie Hobbs TYPE: Construction (C)
AGENCY: Department of Transportation
CONTRACTOR:
PROJECT ADDRESS: MT Bradley Road, Dunsmuir, CA 96025

PERMIT NOTICE
THIS CARD MUST BE POSTED ON SITE, WEATHER PROTECTED AND VISIBLE FROM THE SREET. REQUESTED INSPECTIONS WILL NOT BE CONDUCTED IF THIS BUILDING PERMIT CARD IS NOT POSTED
PERMIT ISSUED BY:

Shane Wilson, Building Official

INSPECTION REQUIREMENTS

Nr	INSPECTION TYPE	STATUS	SCHEDULE DATE	INSPECTOR
1	Fuel Storage Tank			

EXPIRATION:
This Permit is valid from the date of issuance shown above and will be voided if the work described does not begin within 1 year of issuance of this Permit. If work on the above project ceases for longer than 1 year, this Permit is void and the applicant/owner will have to re-apply for a second permit.
All construction work on the project and any previous inspections may be re-inspected at any given time by the inspector to verify construction items stay in compliance after the original inspection and that damage has not occurred to any portion of the work previously inspected.
Permits for a Special Event are valid for the duration of the event, subject to a field inspection at the discretion of the Office of the State Fire Marshal. The State Fire Marshal reserves the right to change or cancel the event due to any unforeseen conditions.

Design

ITS Field Element Network Communications Special Design

- No Coordination required with Americans with Disability Act (ADA)
- 2016 ADA Standards Chapter 11B Section 203.5
- ...shall not be required to comply with these requirements...
- ...electrical or communication equipment rooms...

203.5 Machinery Spaces. Spaces frequented only by service personnel for maintenance, repair, or occasional monitoring of equipment shall not be required to comply with these requirements or to be on an accessible route. Machinery spaces include, but are not limited to, elevator pits or elevator penthouses; mechanical, electrical or communications equipment rooms; piping or equipment catwalks; water or sewage treatment pump rooms and stations; electric substations and transformer vaults; and highway and tunnel utility facilities.

Image curtesy of 203 General Exceptions - ADA Compliance - ADA Compliance (ada-compliance.com)

Construction

Advertising and Prospective Bidders

- Met prospective bidders at the bottom and drove to site
- Mandatory meeting for prime to place a bid
- Liability waiver for site visit
- Two different days provided for flexibility
- Caltrans representative was provided a list of talking points and was not to have knowledge of the project to limit giving different information to the two groups

Construction

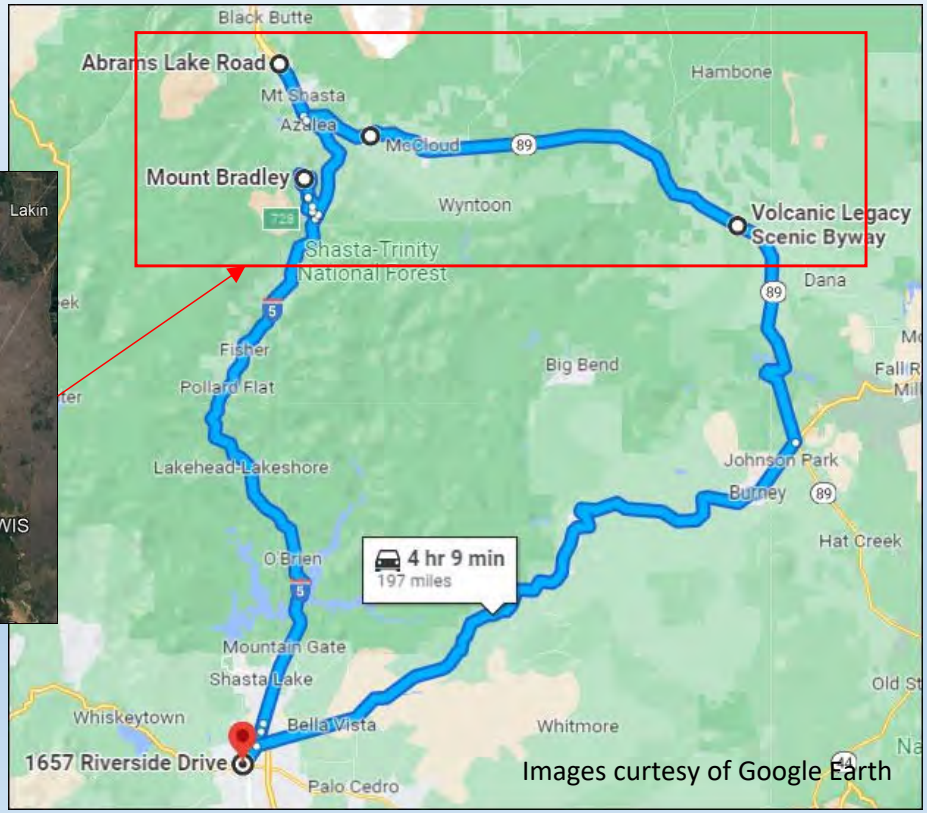
Advertising and Prospective Bidders

- Low Bidder Requirement
- Only one bidder – needed to get special approval to accept
- Local company that worked on a previous vault and tower project so you might expect minor issues (wrong)

Construction

Construction Issues

- Multiple Locations to Inspect
- Five active construction sites
  - Multiple foremen, workers getting conflicting information
  - Mt Bradley was not the priority, often just one person working
- 61 miles (2+ driving hours) between sites
- 197 miles (4+ driving hours) round trip from office

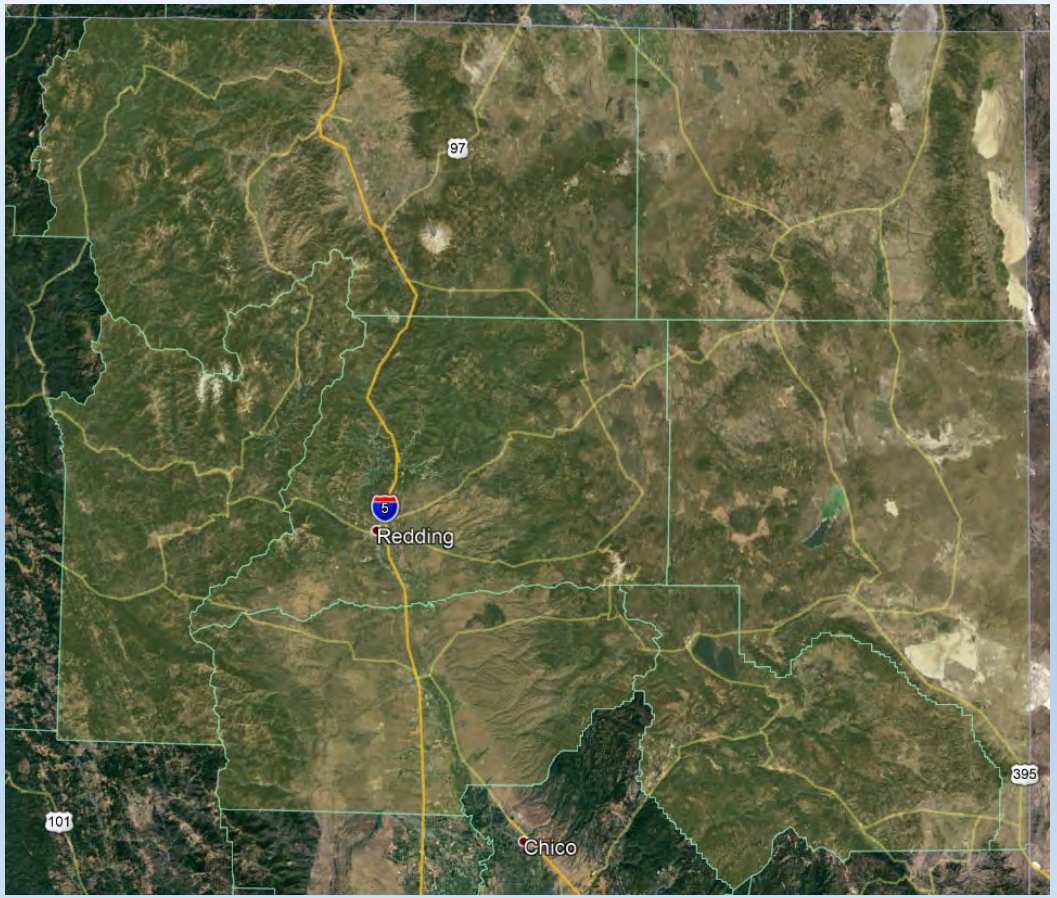


Images curtesy of Google Earth

Construction

Construction Issues

- ITS Project with Civil Construction
- Not typical for Caltrans construction to manage/inspect ITS projects
- 1 or 2 electrical inspectors cover all electrical projects in the entire D2 area
- Had to contract inspection with a private company – TDR (which is a civil firm)



Construction

Construction Issues

- Winter Weather
- Strong winds and cold
- Winter suspension
- Road plowed to finish construction
- Delay to getting power to the site

Construction

Construction Startup and Testing

- Coordinate with Cummins for the generator and ATS
- No power from Pacific Power – had to use portable generator to test components and power transfer

Startup

Commissioning

- Tower work in high winds and cold
- Long lead time on Department Furnished Materials
- Severe winter weather

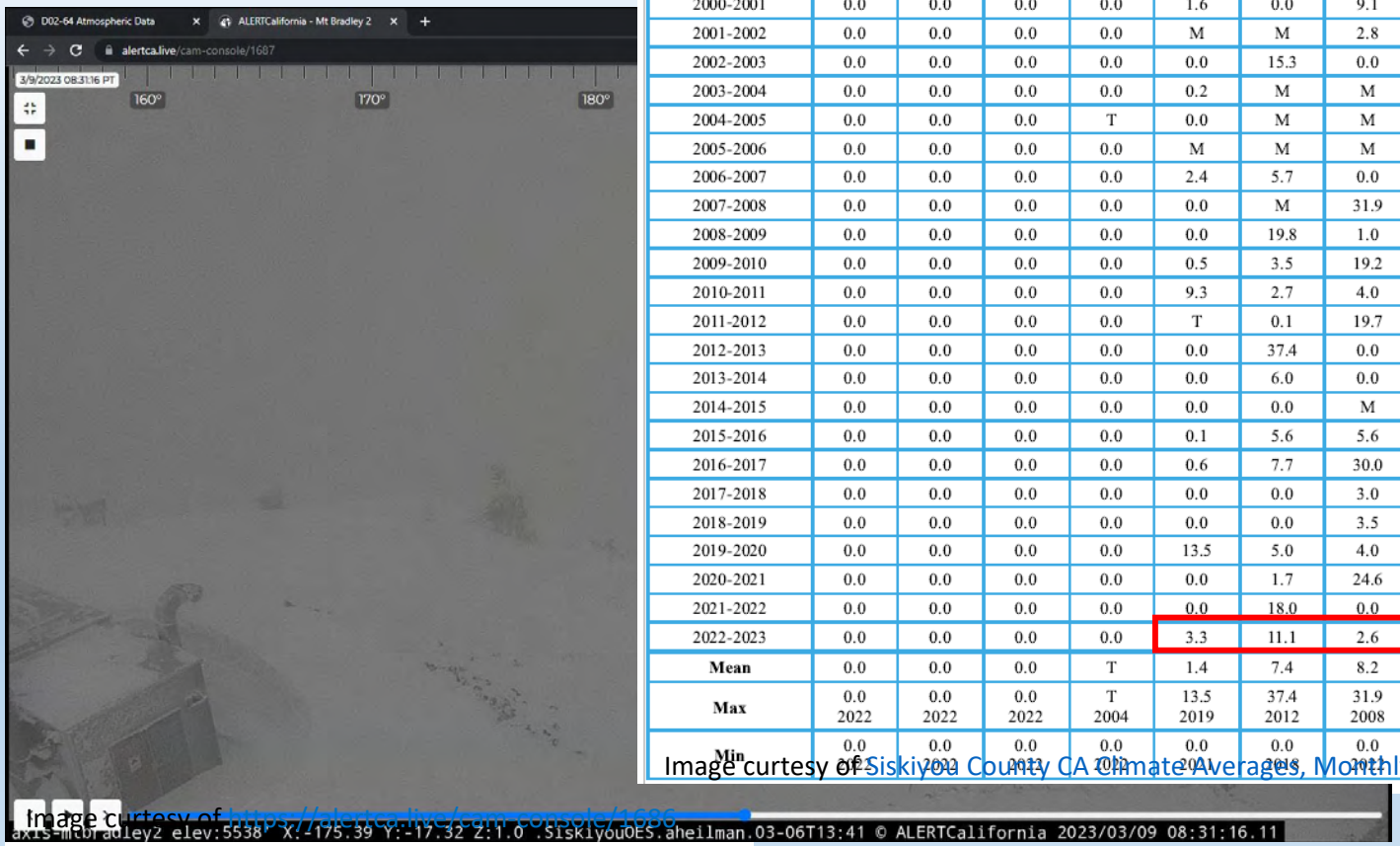


Image curtesy of https://alertca.live/cam-console/1686

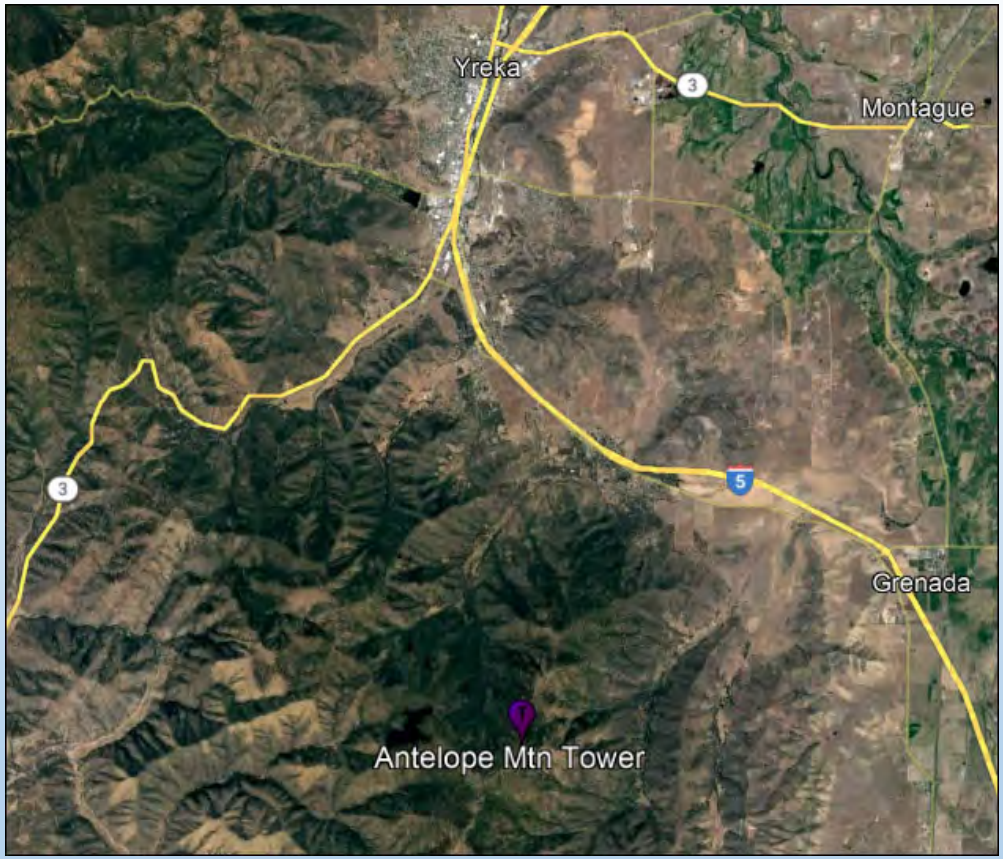
Monthly Total Snowfall for DUNSMUIR TREATMENT PL, CA

Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
1999-2000	0.0	0.0	0.0	0.0	0.0	1.2	2.7	4.9	4.7	0.0	0.0	0.0	13.5
2000-2001	0.0	0.0	0.0	0.0	1.6	0.0	9.1	36.0	M	0.0	0.0	0.0	M
2001-2002	0.0	0.0	0.0	0.0	M	M	2.8	0.0	2.3	0.0	0.0	0.0	M
2002-2003	0.0	0.0	0.0	0.0	0.0	15.3	0.0	0.0	0.0	M	0.0	0.0	M
2003-2004	0.0	0.0	0.0	0.0	0.2	M	M	M	0.0	0.0	0.0	0.0	M
2004-2005	0.0	0.0	0.0	T	0.0	M	M	0.0	1.0	1.2	0.0	0.0	M
2005-2006	0.0	0.0	0.0	0.0	M	M	M	M	M	1.0	0.0	0.0	M
2006-2007	0.0	0.0	0.0	0.0	2.4	5.7	0.0	8.5	0.0	0.4	0.0	0.0	M
2007-2008	0.0	0.0	0.0	0.0	0.0	M	31.9	17.0	0.0	0.0	0.0	0.0	M
2008-2009	0.0	0.0	0.0	0.0	0.0	19.8	1.0	24.4	3.0	0.0	0.0	0.0	48.2
2009-2010	0.0	0.0	0.0	0.0	0.5	3.5	19.2	3.5	4.0	5.5	0.0	0.0	36.2
2010-2011	0.0	0.0	0.0	0.0	9.3	2.7	4.0	12.0	12.2	0.0	0.0	0.0	40.2
2011-2012	0.0	0.0	0.0	0.0	T	0.1	19.7	2.3	3.5	0.0	0.0	0.0	25.6
2012-2013	0.0	0.0	0.0	0.0	0.0	37.4	0.0	0.0	3.8	0.0	0.0	0.0	41.2
2013-2014	0.0	0.0	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
2014-2015	0.0	0.0	0.0	0.0	0.0	0.0	M	0.0	0.0	1.5	0.0	0.0	M
2015-2016	0.0	0.0	0.0	0.0	0.1	5.6	5.6	2.0	0.0	0.0	0.0	0.0	13.3
2016-2017	0.0	0.0	0.0	0.0	0.6	7.7	30.0	0.0	2.0	0.0	0.0	0.0	40.3
2017-2018	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	4.5	0.0	0.0	0.0	7.5
2018-2019	0.0	0.0	0.0	0.0	0.0	0.0	3.5	11.7	0.2	0.0	0.0	0.0	15.4
2019-2020	0.0	0.0	0.0	0.0	13.5	5.0	4.0	0.0	4.5	0.0	0.0	0.0	27.0
2020-2021	0.0	0.0	0.0	0.0	0.0	1.7	24.6	0.5	3.0	0.0	0.0	0.0	29.8
2021-2022	0.0	0.0	0.0	0.0	0.0	18.0	0.0	0.0	0.0	1.0	0.0	0.0	19.0
2022-2023	0.0	0.0	0.0	0.0	3.3	11.1	2.6	50.0	36.1	M	M	M	103.1
Mean	0.0	0.0	0.0	T	1.4	7.4	8.2	7.9	3.9	0.5	0.0	0.0	25.9
Max	0.0 2022	0.0 2022	0.0 2022	T 2004	13.5 2019	37.4 2012	31.9 2008	50.0 2023	36.1 2023	5.5 2010	0.0 2022	0.0 2022	48.2 2009
Min	0.0 2022	0.0 2022	0.0 2022	0.0 2022	0.0 2022	0.0 2018	0.0 2022	0.0 2022	0.0 2022	0.0 2022	0.0 2022	0.0 2022	6.0 2014

Image curtesy of Siskiyou County CA Climate Averages, Monthly Weather Conditions (weatherwx.com)

Future Plan

District Office (DO) → Bass Mtn → Sugarloaf → Mt Bradley → Antelope



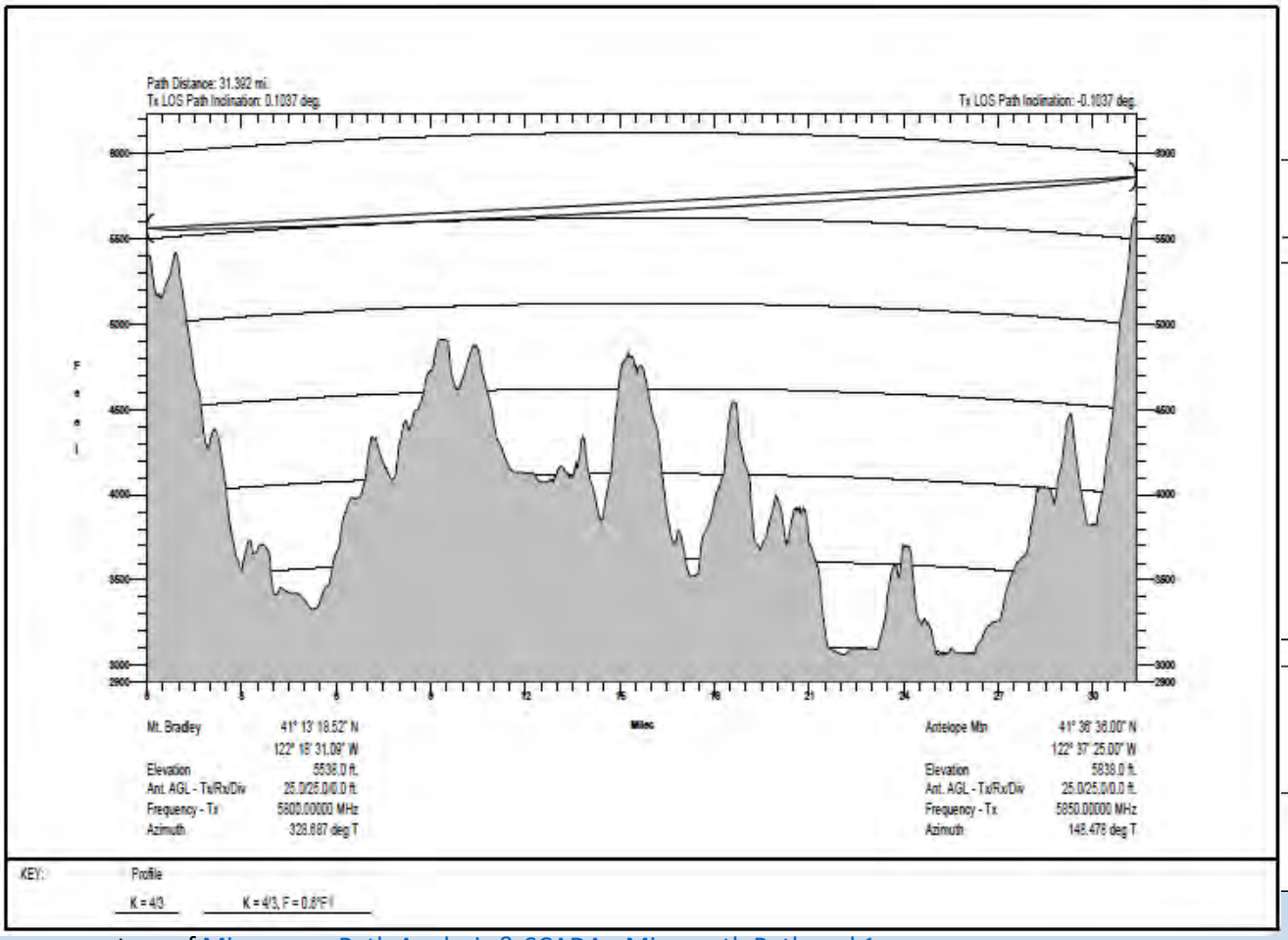
- CalFire owned vault and tower
- Existing radio tower and vault are adequate
- Overlooks Siskiyou area (moderate elevation ~5,870ft)
- Close to I-5; 4-mile maintained dirt road

Images curtesy of Google Earth

Future Plan

District Office (DO) → Bass Mtn → Sugarloaf → Mt Bradley → Antelope

- LOS verified by software
- 31.39 Miles
- Five nines calculated



Microwave Link Analysis

		Site A	Site B
Site Name		Mt. Bradley	Antelope Mtn
Location		Siskiyou County	Siskiyou County
Call Sign			
Latitude		41° 13' 18.52" N	41° 36' 36.00" N
Longitude		122° 18' 31.09" W	122° 37' 25.00" W
Elevation	ft/m:	5538.0 / 1688.0	5838.0 / 1779.4
Azimuth	deg:	328.6866	148.4783
Distance	mi/km:	31.392 / 50.5	31.392 / 50.5
Frequency	MHz:	5800.00000	5850.00000
Equipment			
Tx Antenna Height	ft:	25.00	25.00
	ft:	8 / V	8 / V
	ft:	0.00	0.00
	ft:	25.00	25.00
	ft:	8 / V	8 / V
	ft:	0.00	0.00
	dBm:	57.24	57.32

	Site A to B	Site B to A
	dBi: 40.82	40.90
	dBi: 40.82	40.90
	dBm: 24.00	24.00
	dB: 105.64	105.80

	Site A to B	Site B to A
	dB: 141.785	141.86
	dB: 0.00	0.00
	dB: 0.42	0.42
	dB: 0.00	0.00
	dB: 1.00	1.00
	dB: 0.00	0.00
	dB: 0.58	0.59
	dB: 5.00	5.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 1.00	1.00
	dB: 0.58	0.59
	dB: 5.00	5.00
	dB: 1.00	1.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 0.00	0.00
	dB: 1.00	1.00
	dB: 157.37	157.45

	Site A to B	Site B to A
	dBm: -51.73	-51.65
	dBm: -90.00	-90.00
	dB: 38.27	38.35
	sec/year: 168.92	167.53
	sec/year: 0.00	0.00
	%: 99.99946435	99.99946877

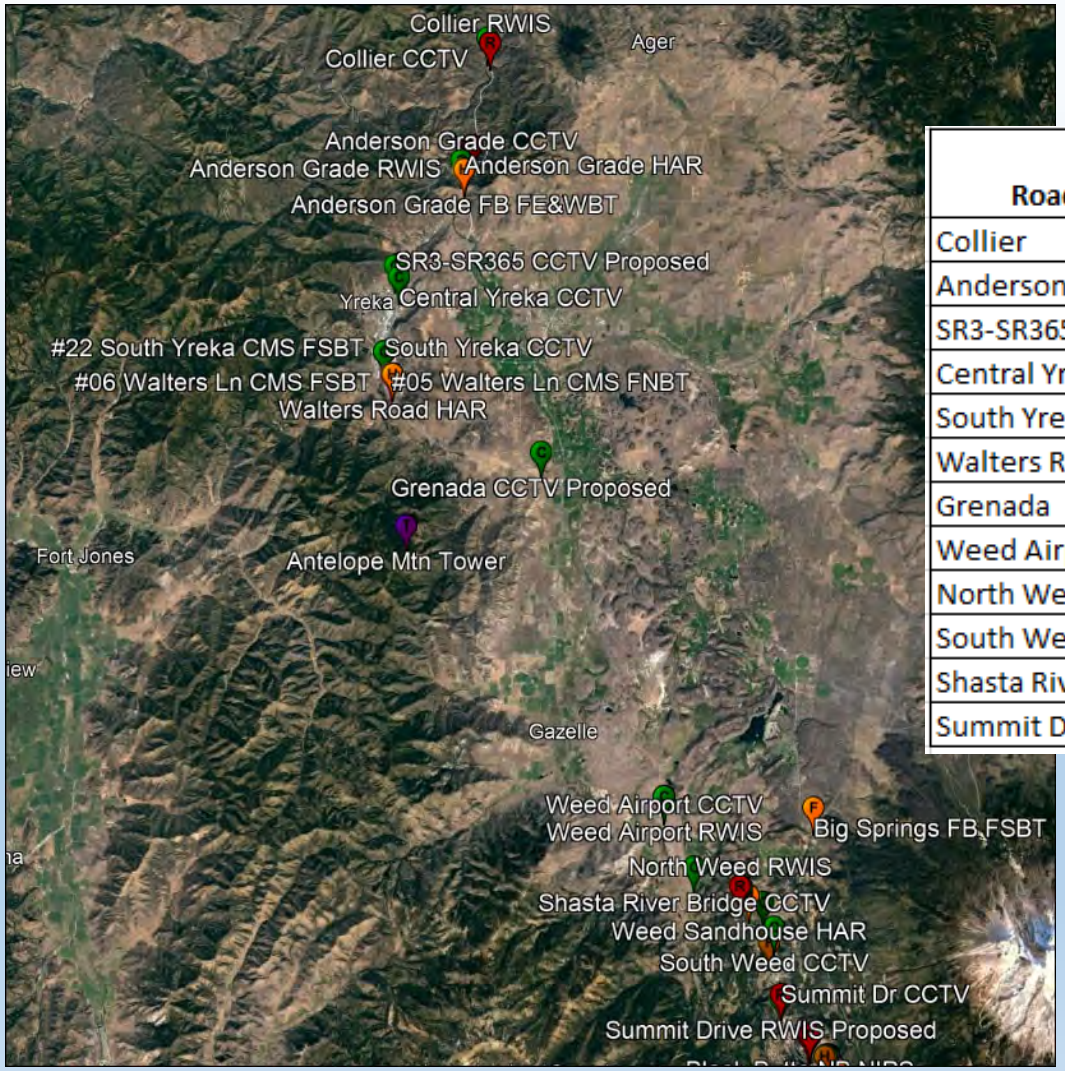
Terrain Factor (w)	140.0	Average Temperature	15.56°C / 60.0°F
DFM	0.000	TFM	38.346
AIFM	0.000	EIFM	0.000

Images curtesy of Microwave Path Analysis & SCADA - Micropath Pathanal 1

Future Plan

District Office (DO) → Bass Mtn → Sugarloaf → Mt Bradley → Antelope

- Antelope LOS to 10 possible Roadside links, total of 20 elements connected



Roadside Links	LOS	Distance (Miles)
Collier	No	17.5
Anderson Grade	Yes	13
SR3-SR365	Yes	9.2
Central Yreka	Yes	8.81
South Yreka	Yes	6.23
Walters Rd	Yes	5.43
Grenada	Yes	5.46
Weed Airport	Yes	13.1
North Weed	Yes	17.3
South Weed	Yes	19
Shasta River Bridge	Yes	15.6
Summit Dr	No	21.1

Lessons Learned

???

Design:

- Request a larger TCE from R/W than expected
- Get utility agreements in writing, follow up discussions with emails
- Escalate issues up the chain before it gets down to the wire

Construction:

- Request additional inspection resources for communications projects
- Request help with inspections, new set of eyes on the project
- Don’t assume construction inspectors know your office’s specific requirements
- Reconsider when helping relocate other users' equipment

Maintenance:

- Access during snow conditions

Questions