BESS as a Wildfire Ignition Source

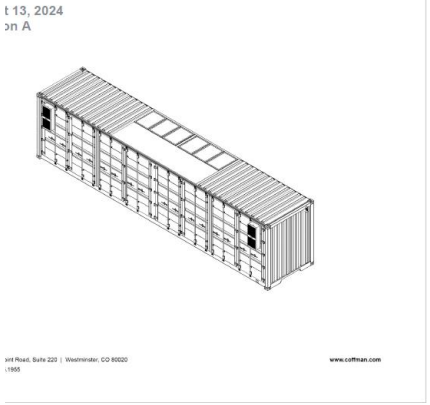
(k) Continued Thermal Runaway
04:35:51

(d) Ignition
[00:42:30]

(c) Ignition flame observed
[00:40:15]

COFFMAN ENGINEERS

Draft Preliminary HMA Report
Rancho Viejo Solar Utility BESS

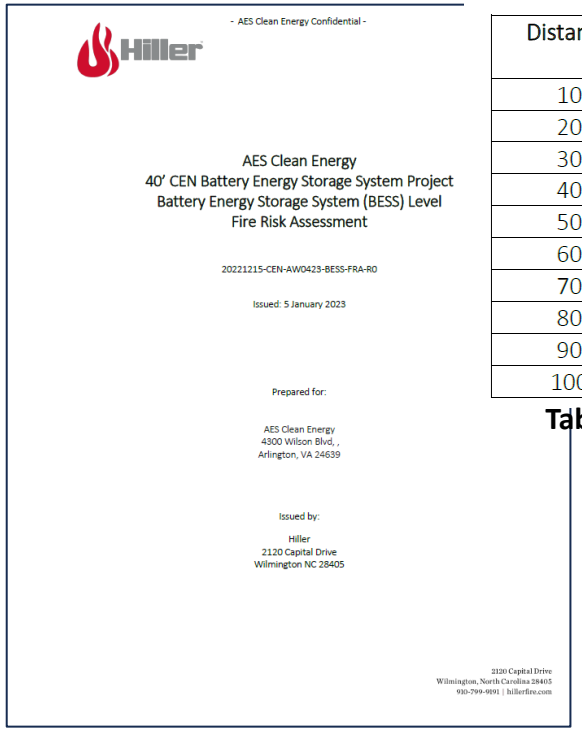


4.1 UL9540A TESTING

The CEN BESS system has been subject to testing utilizing the methods of UL 9540A at the cell, module, unit and installation levels. The UL 9540A test results are summarized below. Refer to the UL 9540A Cell, Module and Unit level test reports for detailed information. Full UL 9540A test reports are provided for review in Appendix F.

- **Cell Level Testing** – Cell level testing indicates that 423 L of gas may be released per cell when thermal runaway occurs. Testing indicates that the gas is primarily composed of hydrogen (32.7%), carbon monoxide (40.9%), methane (15.43%) and carbon dioxide (9.2%) with a LFL of 8.04% at ambient temperature. Refer to the *UL 9540A Cell Level Report* for detailed gas composition data. The average cell surface temperature at thermal runaway was 178°C. The cell vent gas fundamental burning velocity, S_u, was determined to be 88.40 cm/s with a maximum pressure, P_{max}, of 105.3 psig.
- **Module Level Testing** – Module level testing demonstrated that thermal runaway initiation of a single cell is capable of propagation throughout a majority of the cells within the module. The testing resulted in flaming combustion, flying debris, explosive discharge of gas and sparks or electrical arcs. A peak heat release rate (HRR) of 3935 kW was achieved during testing.
- **Unit Level Testing** – Unit level testing did not result in propagation of a thermal runaway event from the failure of a single cell. External flaming combustion was observed with a peak HRR of 426.1 kW. Release of flammable gas with an associated explosion was not observed. The maximum enclosure wall surface temperature observed was 169°C.
- **Installation Level Testing** – The installation level test is intended to collect information regarding the performance of the ESS's fire protection features. The installation level test included the operation of the direct injection clean agent cooling system. The installation level test did not result in propagation of a thermal runaway event from the failure of a single cell. No flaming or flying debris was observed outside of the enclosure. The maximum enclosure wall surface temperature observed was 670°C.

Response to a BESS Fire by Local Fire Fighters



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AES Clean Energy
40' CEN Battery Energy Storage System Project
Battery Energy Storage System (BESS) Level
Fire Risk Assessment

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Table 2: Theoretical Momentary Heat Flux as a Function of Distance

Distance	Momentary Maximum Theoretical Heat Flux (kW/m²)
10'	939
20'	589
30'	348
40'	235
50'	170
60'	127
70'	98
80'	77
90'	62
100'	51

Table 2: Heat Flux over Distance, pg. 34

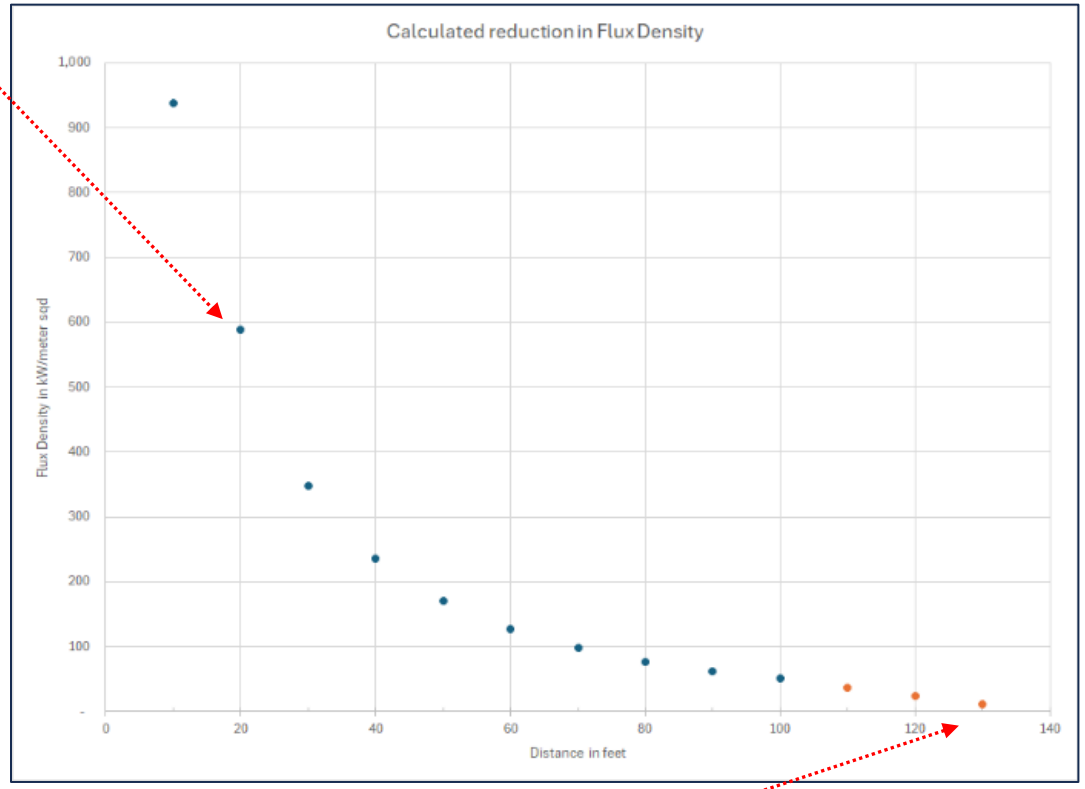


Table 5: Physiological Effects of Thermal Radiation [82]

Time for Physiological Effects (on bare skin) to Occur Following Exposure to Specific Thermal Radiation Levels		
Radiation Intensity (kW/m2)	Time for Severe Pain (seconds)	Time for 2nd Degree Burn (seconds)
1	115	663
2	45	187
3	27	92
4	18	57
5	13	40
6	11	30
8	7	20
10	5	14
12	4	11

Table 5: Heat Flux Effects on People, pg. 39

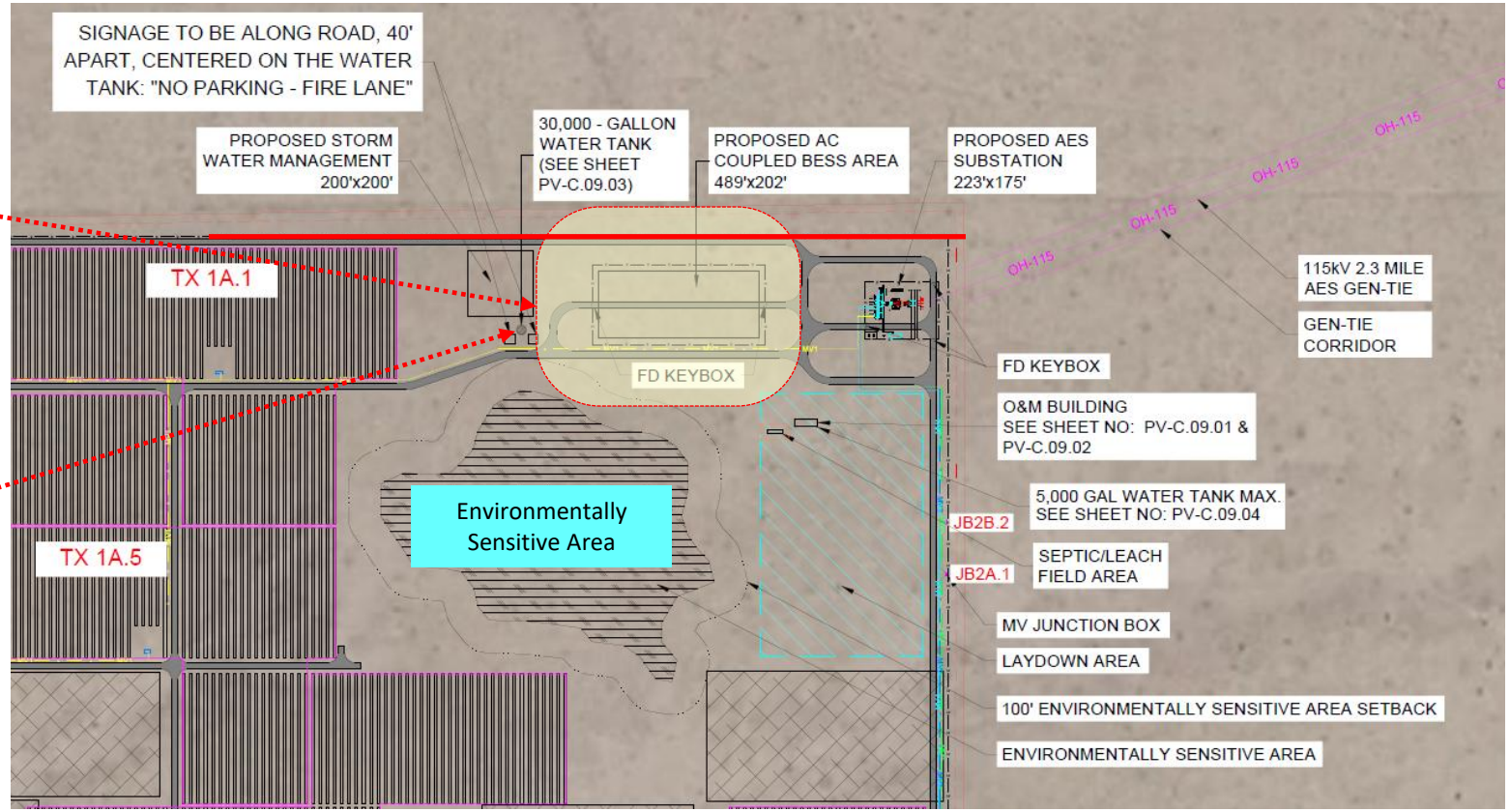
Radiant heat flux above 10 kW/m² in the presence of a spark could cause ignition in dry grass. Grasses at ~130 feet would experience a heat flux sufficient for ignition. Within ~130 ' of a burning enclosure, First Responders without significant protective gear would have difficulty performing.

150’ Stand-off Area - Zone of Dangerous Heat from Radiant Thermal Flux

A stand-off of ~ 150 feet is shown surrounding the BESS units.

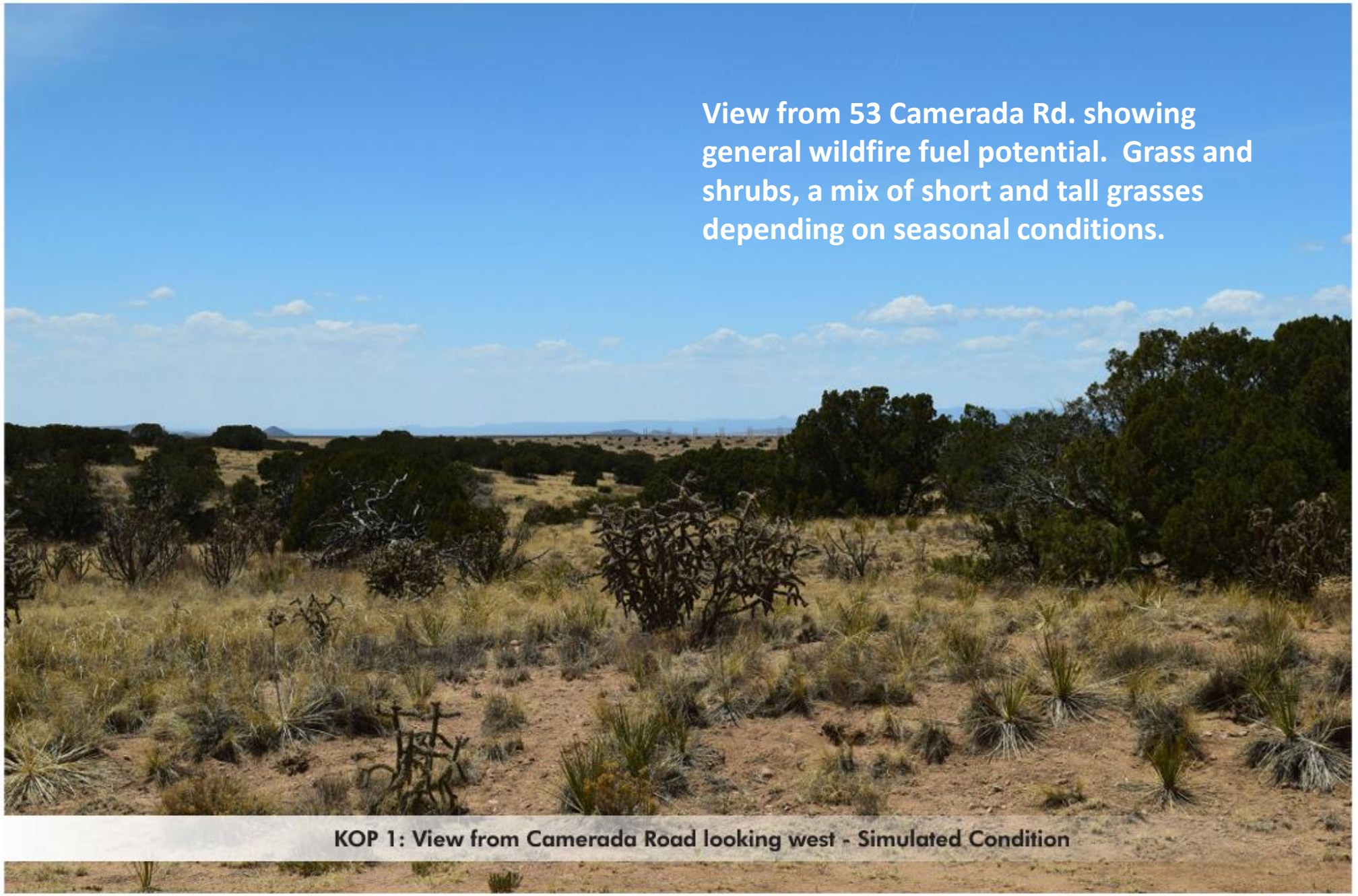
The stand-off area extends beyond the proposed fence line.

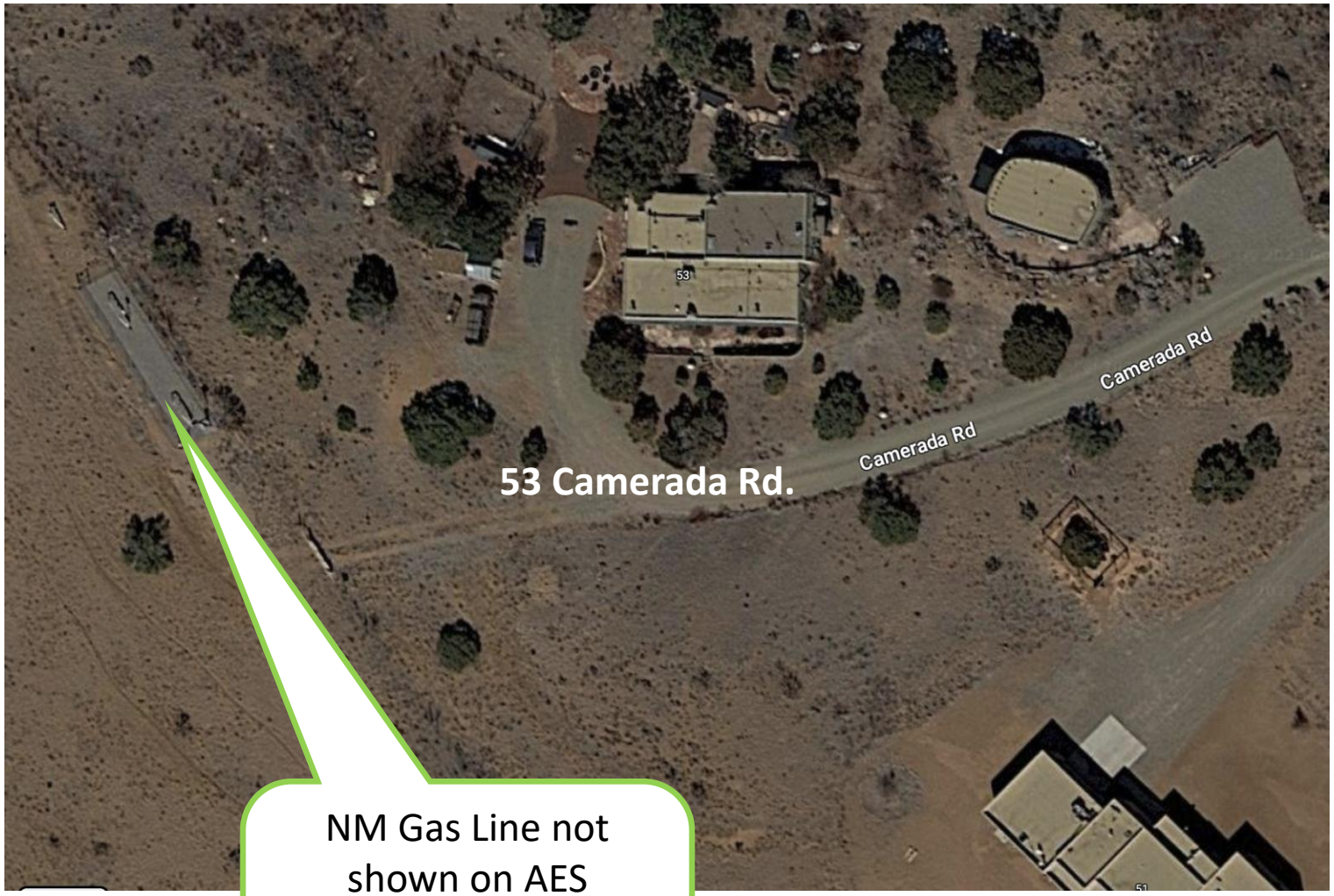
30,000 water source is local just beyond the stand-off area



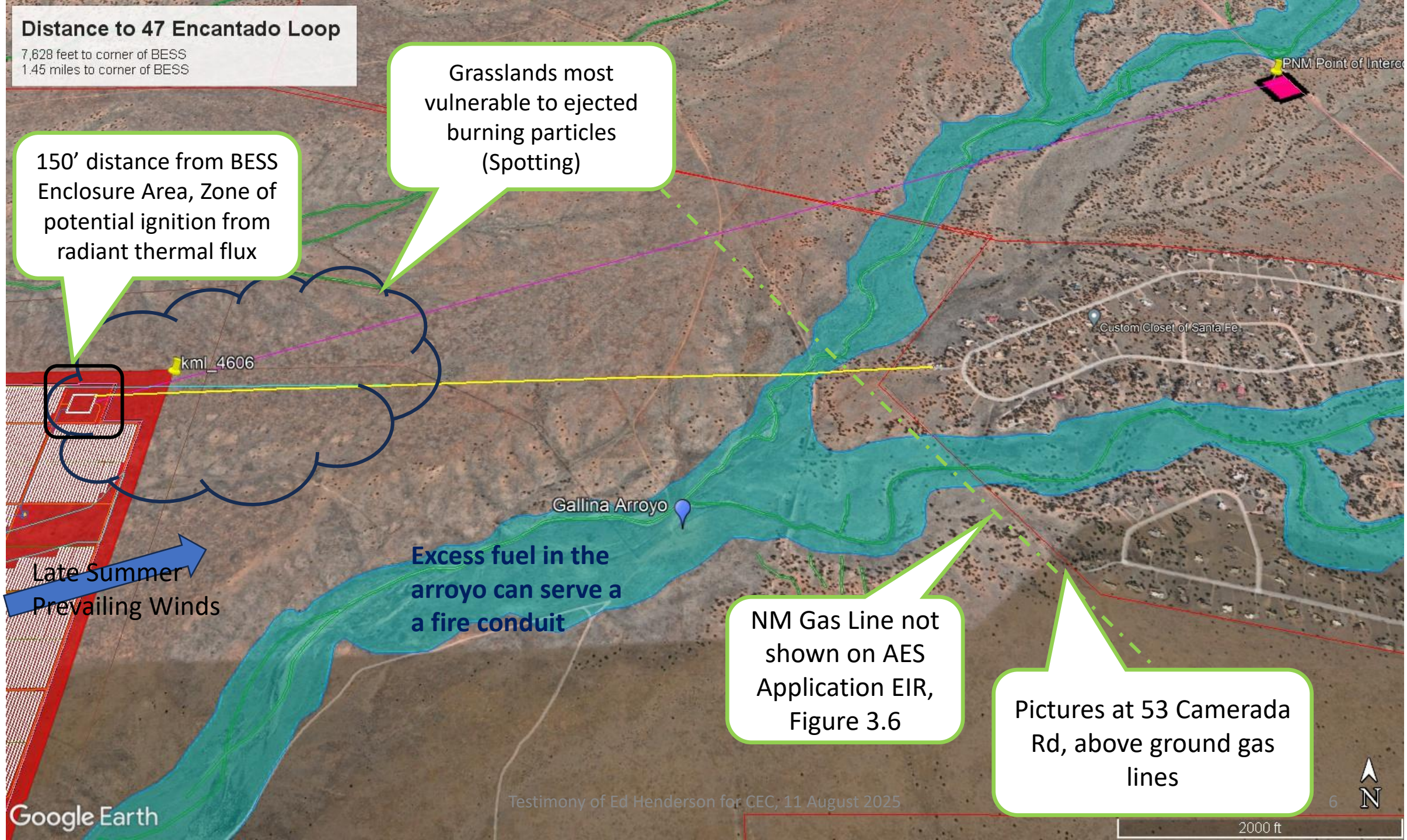
It has already been determined that 30,000 gallons of water is marginally effective. The stand-off area demonstrates that in a fire event, not just adjacent containers, but all the containers and grounds within the area will require cooling spray.

Anything within the Stand-off area is subject to a heat flux greater than 10 kW/m^2.
Not only grasses, but responders, vehicles, all the BESS containers and their support systems (chillers, BMS, sensers, inverters and switch gear).


View from 53 Camerada Rd. showing general wildfire fuel potential. Grass and shrubs, a mix of short and tall grasses depending on seasonal conditions.
KOP 1: View from Camerada Road looking west - Simulated Condition



NM Gas Line not shown on AES Application Environmental Impact Report, Figure 3.6


Distance to 47 Encantado Loop
7,628 feet to corner of BESS
1.45 miles to corner of BESS
Grasslands most vulnerable to ejected burning particles (Spotting)
150’ distance from BESS Enclosure Area, Zone of potential ignition from radiant thermal flux
kml_4606
Gallina Arroyo
Custom Closet of Santa Fe
PNM Point of Interc
Late Summer Prevailing Winds
Excess fuel in the arroyo can serve a a fire conduit
NM Gas Line not shown on AES Application EIR, Figure 3.6
Pictures at 53 Camerada Rd, above ground gas lines
Google Earth
2000 ft
N