

**APPENDIX K: COMPUTER MODEL STUDY 6:
U-Shaped Berm at the Rear of the Range Added
Sites 1 and 2 with Base and Alternate Range Orientations
Typical and Busy Day Scenarios
20 ft. and 30 ft. tall berms**

Computer model study 6 was conducted with a U-shaped berm at the rear of the range added on Site 1: County Road Commission with the direction of fire to the north and to the north-northwest for the busy day scenario and Site 2: Sands West with the direction of fire to the north, northwest, and southwest with the busy day scenario. The relative ranking of the sites remained similar for the typical day scenario.

1. The “busy day” scenario has 1 shooter on the 50 yard range, 200 yard range and on the 300 yard range firing a .223 rifle, one shooter on the 40 yard range firing a 12 gauge shotgun and 2 shooters on the 25 yard range firing 0.40 caliber handguns.
2. The “typical day” scenario has one shooter on the 300 yard range firing a .223 rifle; one shooter on the 40 yard range firing a 12 gauge shotgun and one shooter on the 25 yard range firing a 0.40 caliber handgun in the same one second time period.
3. The wind condition in the base model was modeled as downwind with 1 to 11 mph wind as the other in Computer model studies 1 and 2.
4. The 50°F and 80% relative humidity condition was used in the models.
5. A U-shaped berm was added at the rear of the range with a slot between the rear berm and the front berm to allow people to access the range.
6. The direction of fire was to the north and to the north-northwest for Site 1; and to the north, northwest and southwest for Site 2.
7. The berm height of 20 ft. was used in the reference model.
8. The U-shaped berm was modeled at 10 ft. tall, 20 ft. tall and 30 ft. tall at Site 1 and Site 2.
9. The sound levels shown on the noise contour maps are LA eq in dBA.

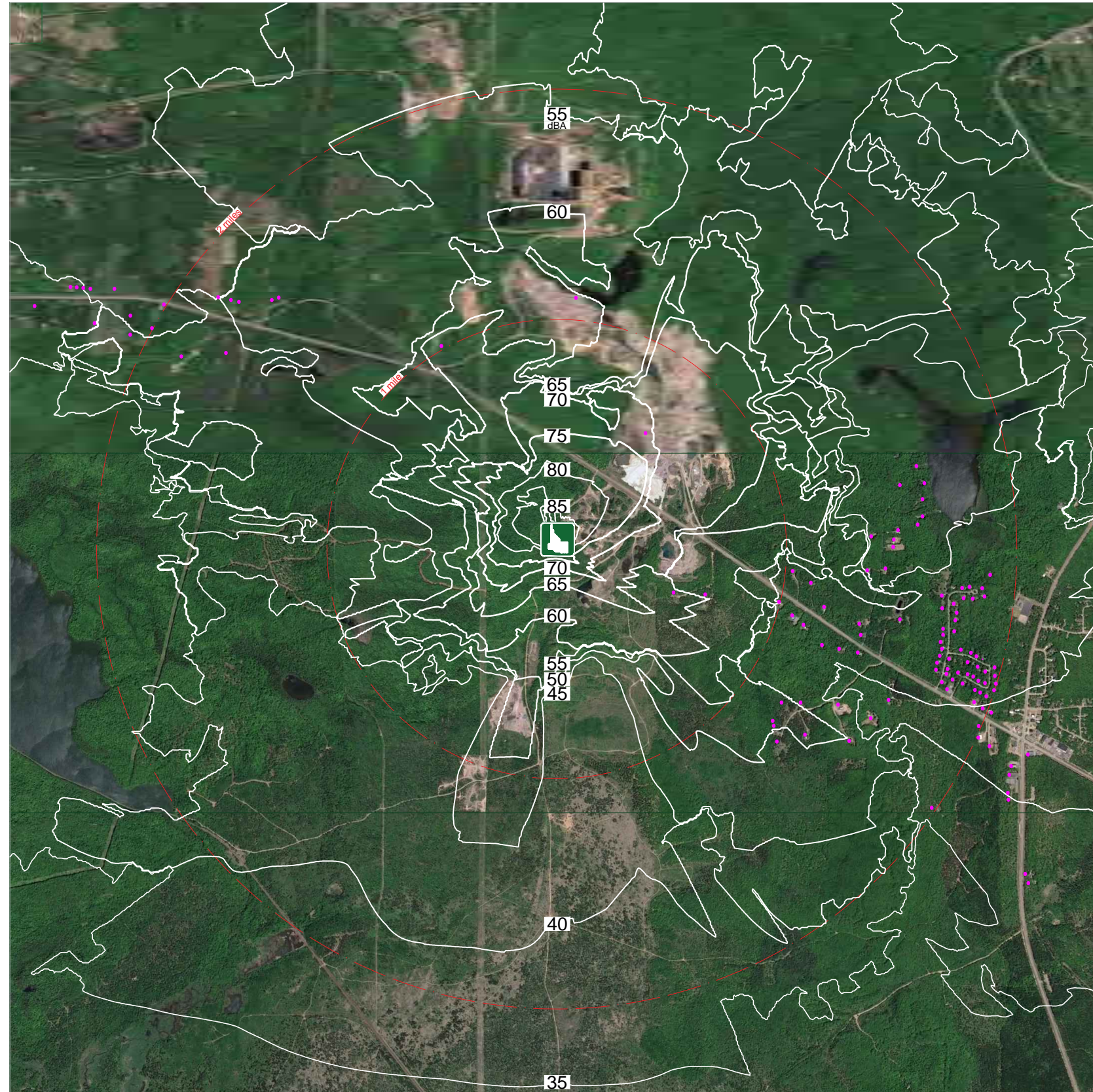
Increasing the height of the berms to 20 ft. tall and 30 ft. tall respectively and including a berm of similar height in a U-shape around the rear of the range significantly reduces the linear pressure and dB scores for the ranges at Site 1: County Road Commission. The linear pressure score is decreased by 30% to 60% with the addition of the 20 ft. tall berm and the U-shaped berm at the rear of the range and by almost 70% when the down range berm and rear berms are increased to 30 ft. tall for the base and alternate range orientation at Site 1.

The linear pressure score is decreased by 47% with the addition of the 20 ft. tall berm and the U-shaped berm at the rear of the range and by an additional almost 60% when the down range berm and rear berms are increased to 30 ft. tall for the northwest range orientation at Site 2. The linear pressure score is reduced by 6% with the addition of the 20 ft. tall side and rear berms and by 22% with the addition of the 20 ft. tall side and rear berms for the base range orientation to the north. Changing the range orientation to the southwest resulted in an increase in the linear pressure score in Site 2: Sands West when compared to the base range orientation to the north. This was due to the cluster of structures located in the direction of fire within 1 mile to the southeast of the center of the range.

The rough order of magnitude cost increase for extending the berm height from 10 ft. tall to 20 ft. tall and including the U-shaped berm at the rear of the range is approximately \$345,200. The rough order of magnitude cost increase for extending the berm height from 10 ft. tall to 30 ft. tall and including the U-shaped berm at the rear of the range is approximately \$1,160,100. The additional cost for adding the 10 ft. tall U-shaped berm to the 10 ft. tall downrange berm is approximately \$32,600.

Table K-1. Summary table of rating points for each scenario tested in Experiment 6.

BUSY DAY 6 SHOOTERS U-SHAPED BERM AT REAR OF RANGE					
Site	DOF	Berm Height	Lin Press	dB	PTS
SITE 1: MCRC	N	30 FT. U-Shape Berm	367	76	374
SITE 1: MCRC	NNW	30 FT. U-Shape Berm	388	76	364
SITE 1: MCRC	NNW	20 FT. U-Shape Berm	465	77	395
SITE 1: MCRC	N	20 FT. U-Shape Berm	849	79	412
SITE 1: MCRC Reference	N	20 FT. Tall Berm	850	79	298
SITE 2: Sands	NW	30 FT. U-Shape Berm	1,000	80	762
SITE 2: Sands	NW	20 FT. U-Shape Berm	1,333	81	801
SITE 2: Sands	N	30 FT. U-Shape Berm	1,964	83	900
SITE 2: Sands	N	20 FT. U-Shape Berm	2,367	84	924
SITE 2: Sands Reference	N	20 FT. Tall Berm	2,415	84	1149
SITE 2: Sands	SW	30 FT. U-Shape Berm	3,084	85	1145
SITE 2: Sands	SW	20 FT. U-Shape Berm	4,367	86	939
TYPICAL DAY 3 SHOOTERS U-SHAPED BERM AT REAR OF RANGE					
Site	DOF	Berm Height	Lin Press	dB	PTS
SITE 1: MCRC	N	30 FT. U-Shape Berm	272	74	416
SITE 1: MCRC	NNW	30 FT. U-Shape Berm	345	75	440
SITE 1: MCRC	NNW	20 FT. U-Shape Berm	352	75	444
SITE 1: MCRC	N	20 FT. U-Shape Berm	355	76	348
SITE 1: MCRC Reference	N	20 FT. Tall Berm	359	76	354
SITE 2: Sands	NW	30 FT. U-Shape Berm	431	76	834
SITE 2: Sands	N	30 FT. U-Shape Berm	764	79	933
SITE 2: Sands	NW	20 FT. U-Shape Berm	824	79	934
SITE 2: Sands	N	20 FT. U-Shape Berm	972	80	982
SITE 2: Sands Reference	N	20 FT. Tall Berm	989	80	992
SITE 2: Sands	SW	30 FT. U-Shape Berm	1,567	82	1005
SITE 2: Sands	SW	20 FT. U-Shape Berm	1,983	83	1025



MARQUETTE CRC
MODEL K-1

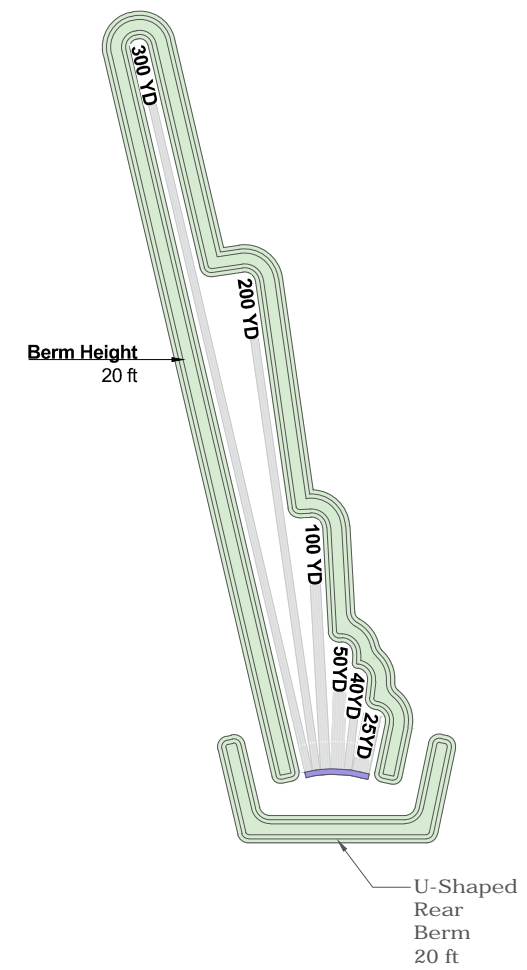
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

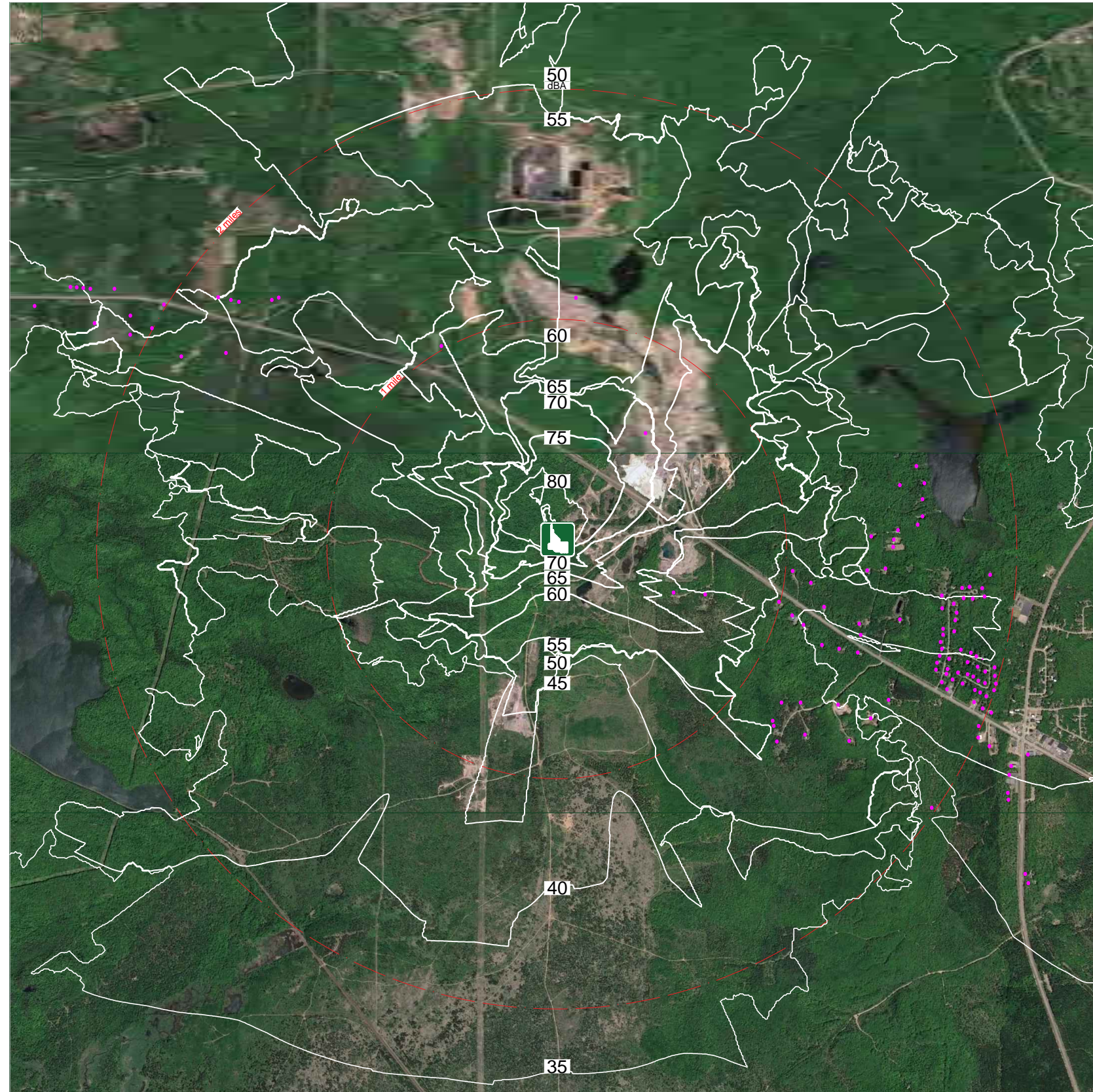
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-2

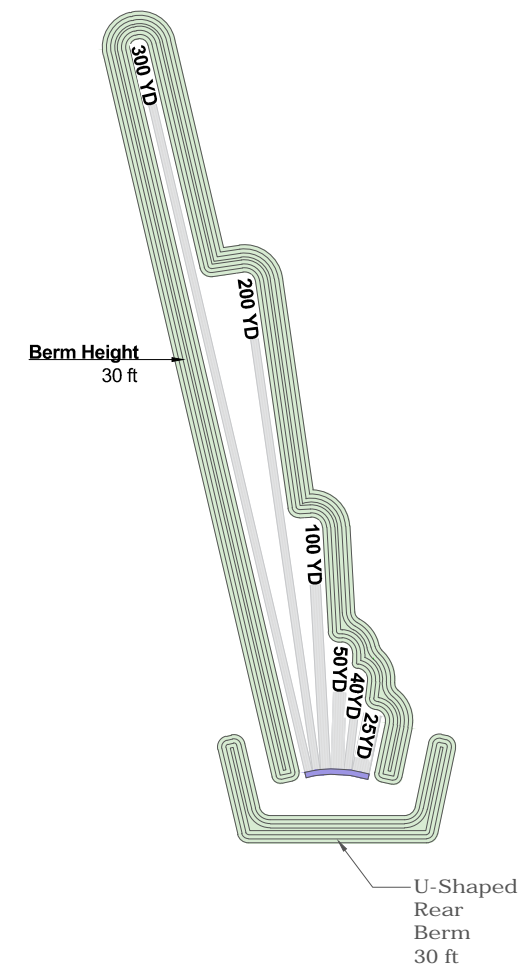
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

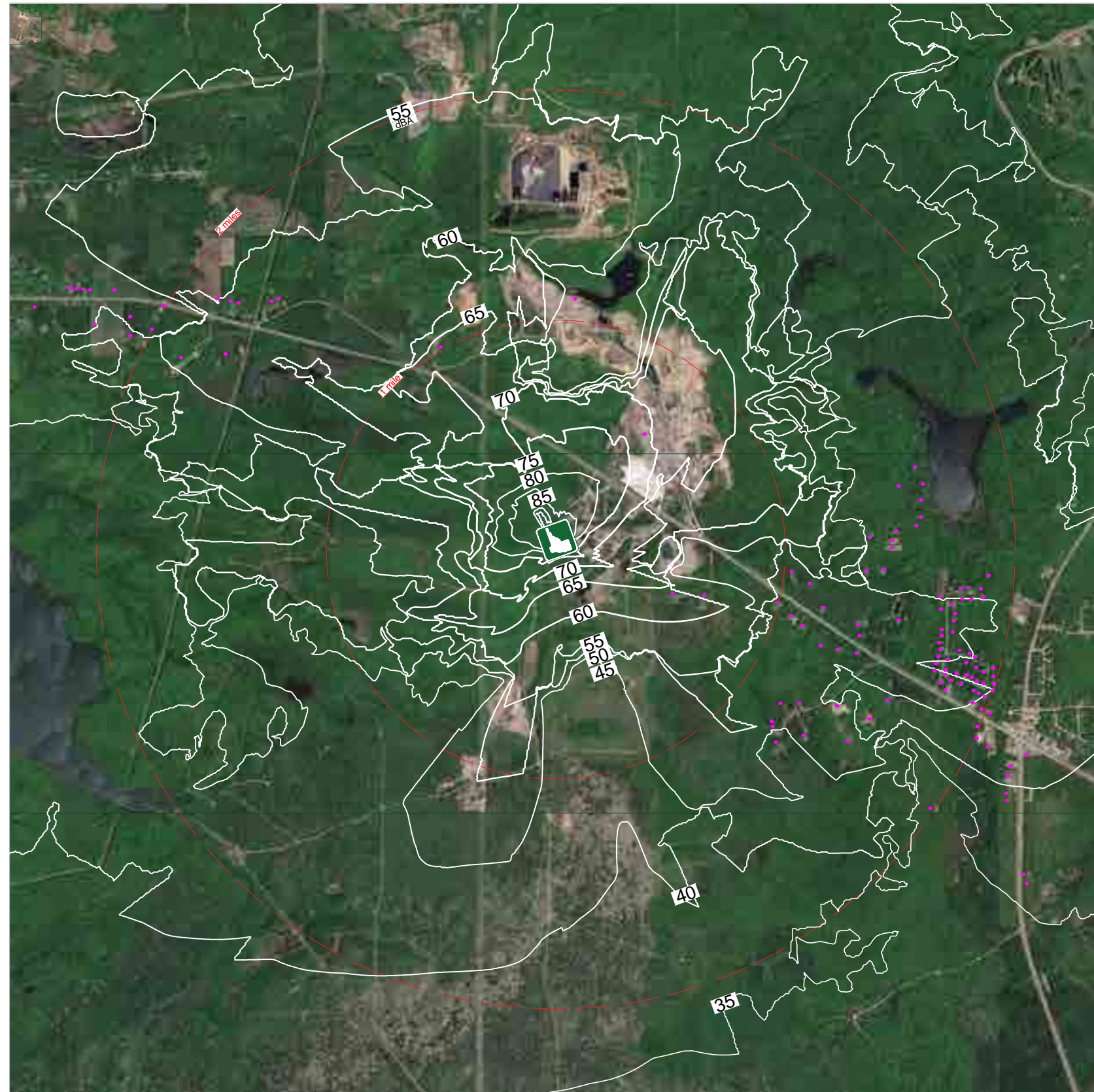
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-3

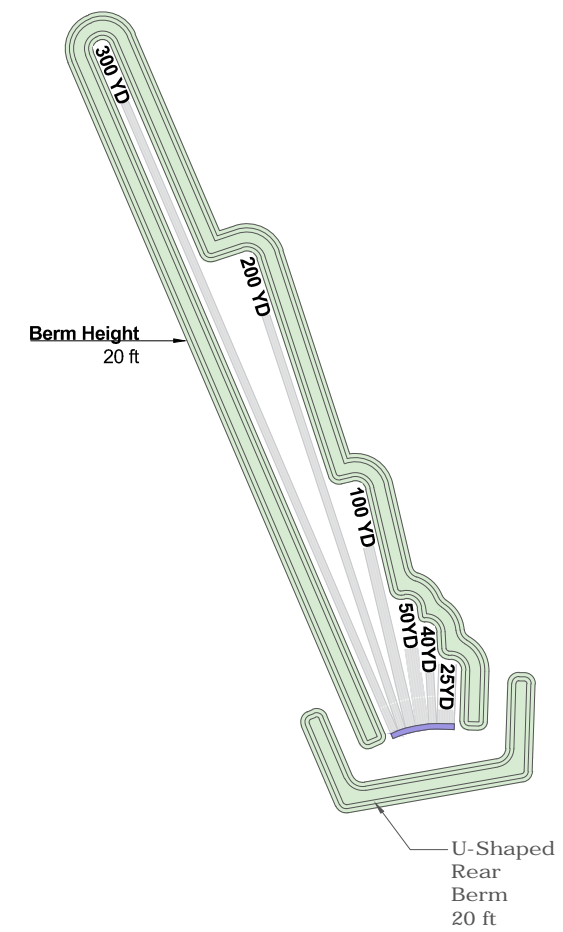
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. NNW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC MODEL K-4

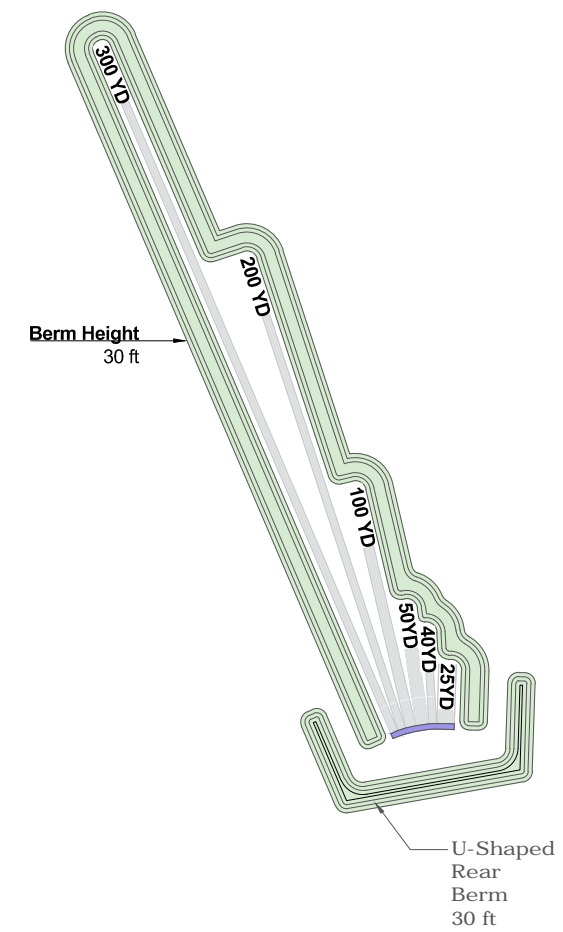
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

Typical Day:
Shooters within 1 second:
1 Rifle
1 Shotgun
1 Handgun

D.O.F. NNW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-5

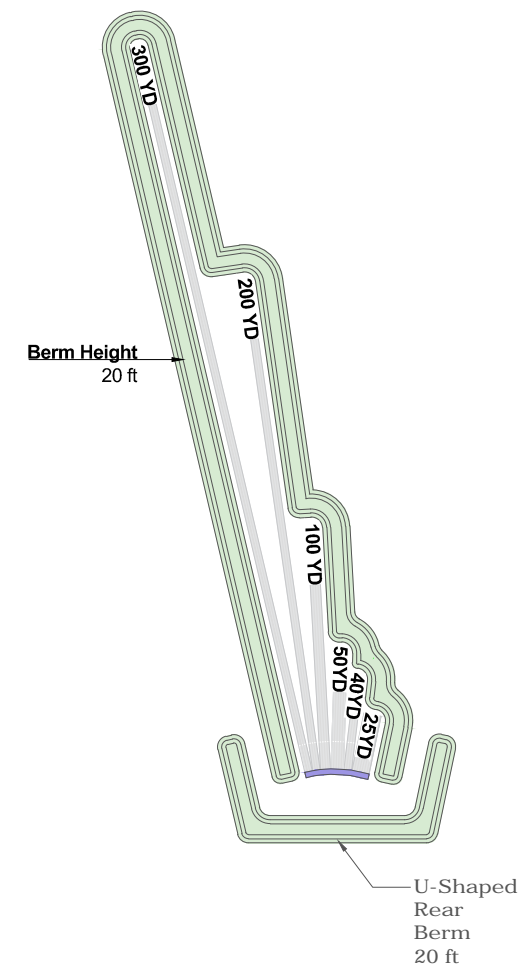
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

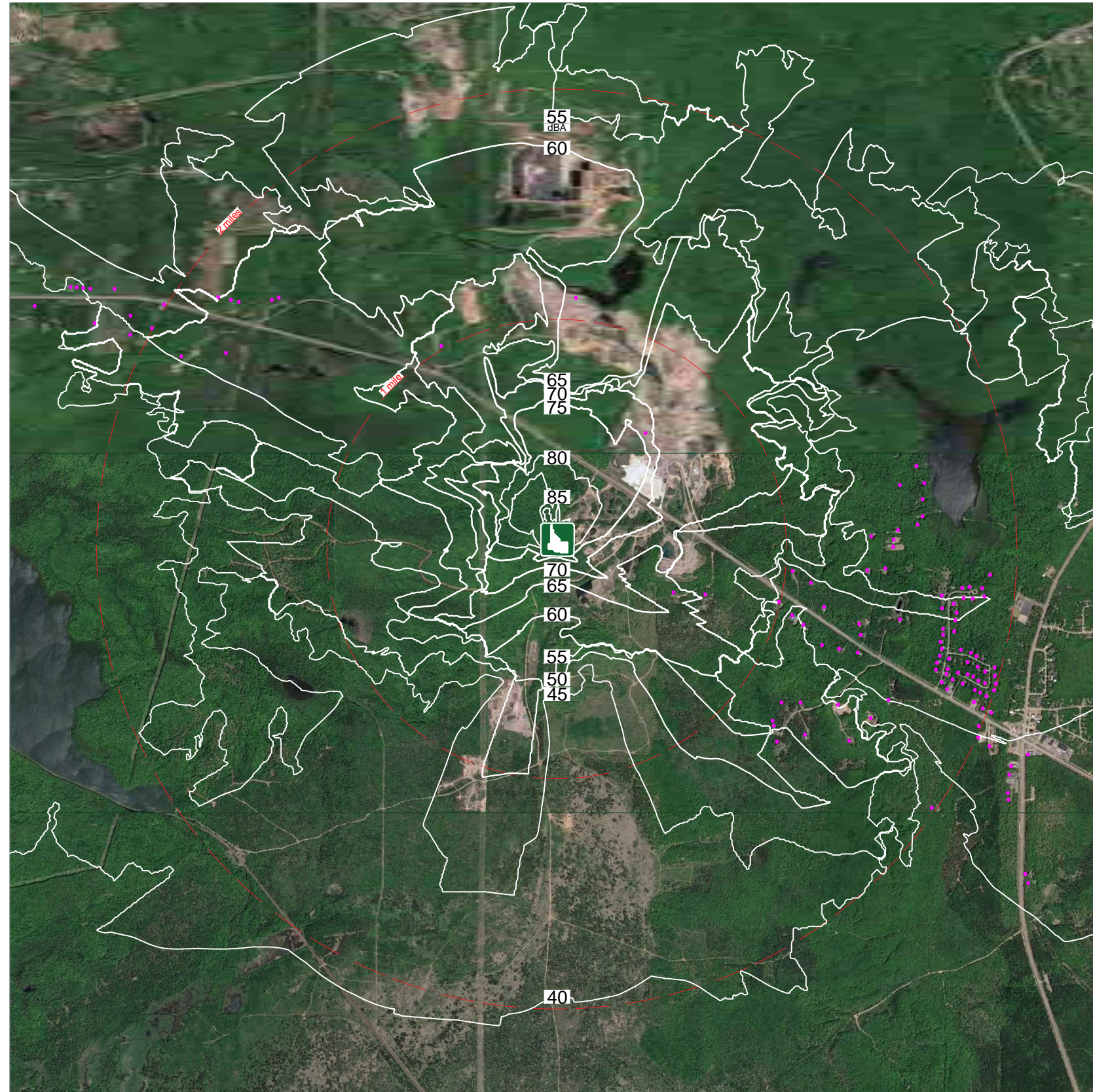
Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-6

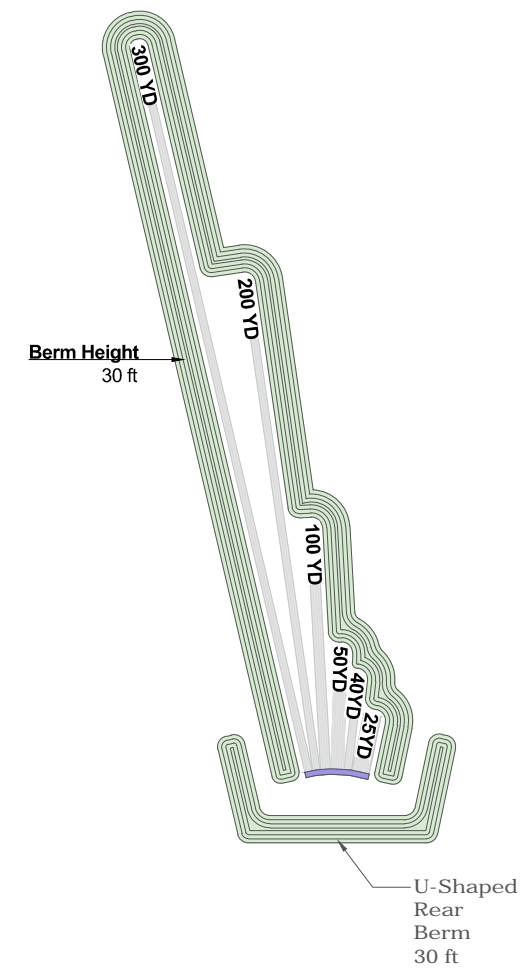
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-7

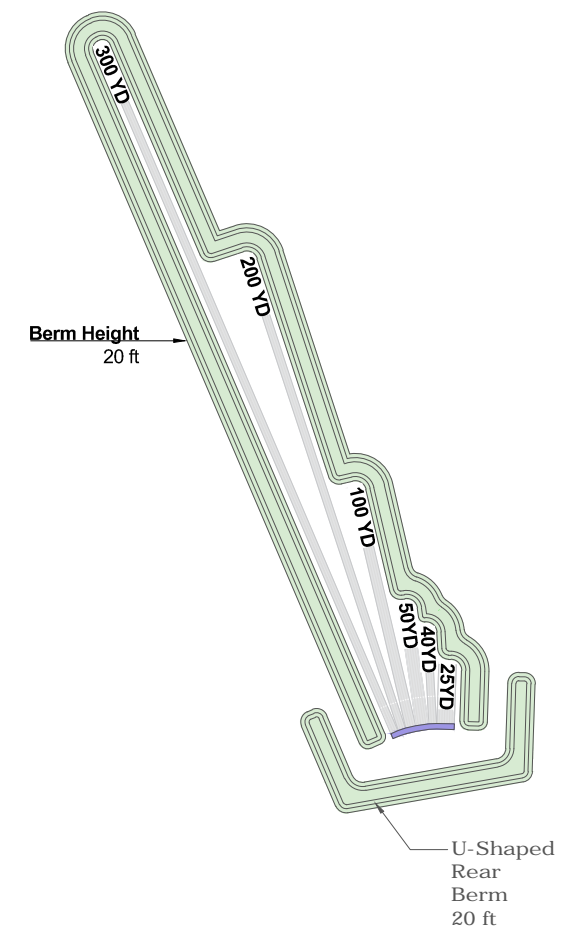
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. NNW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





MARQUETTE CRC
MODEL K-8

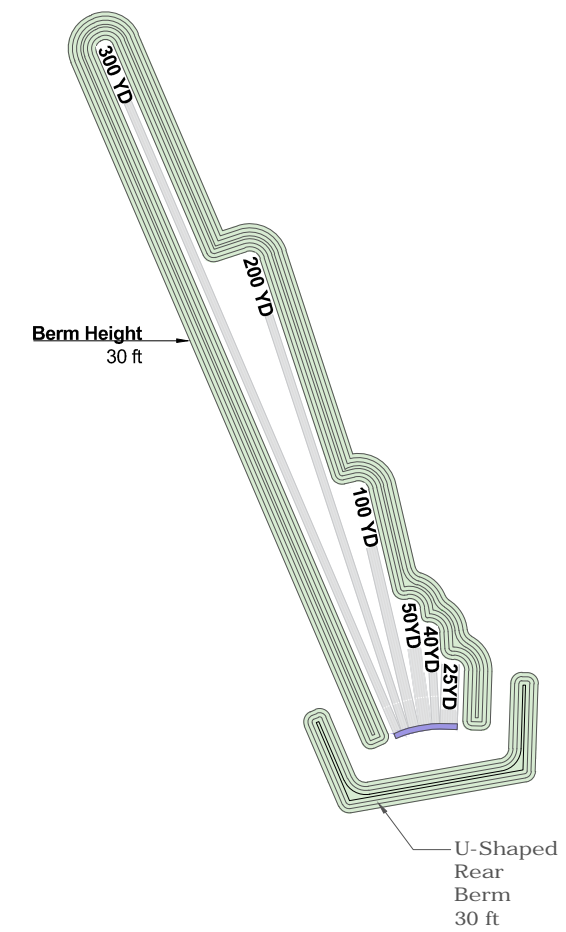
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

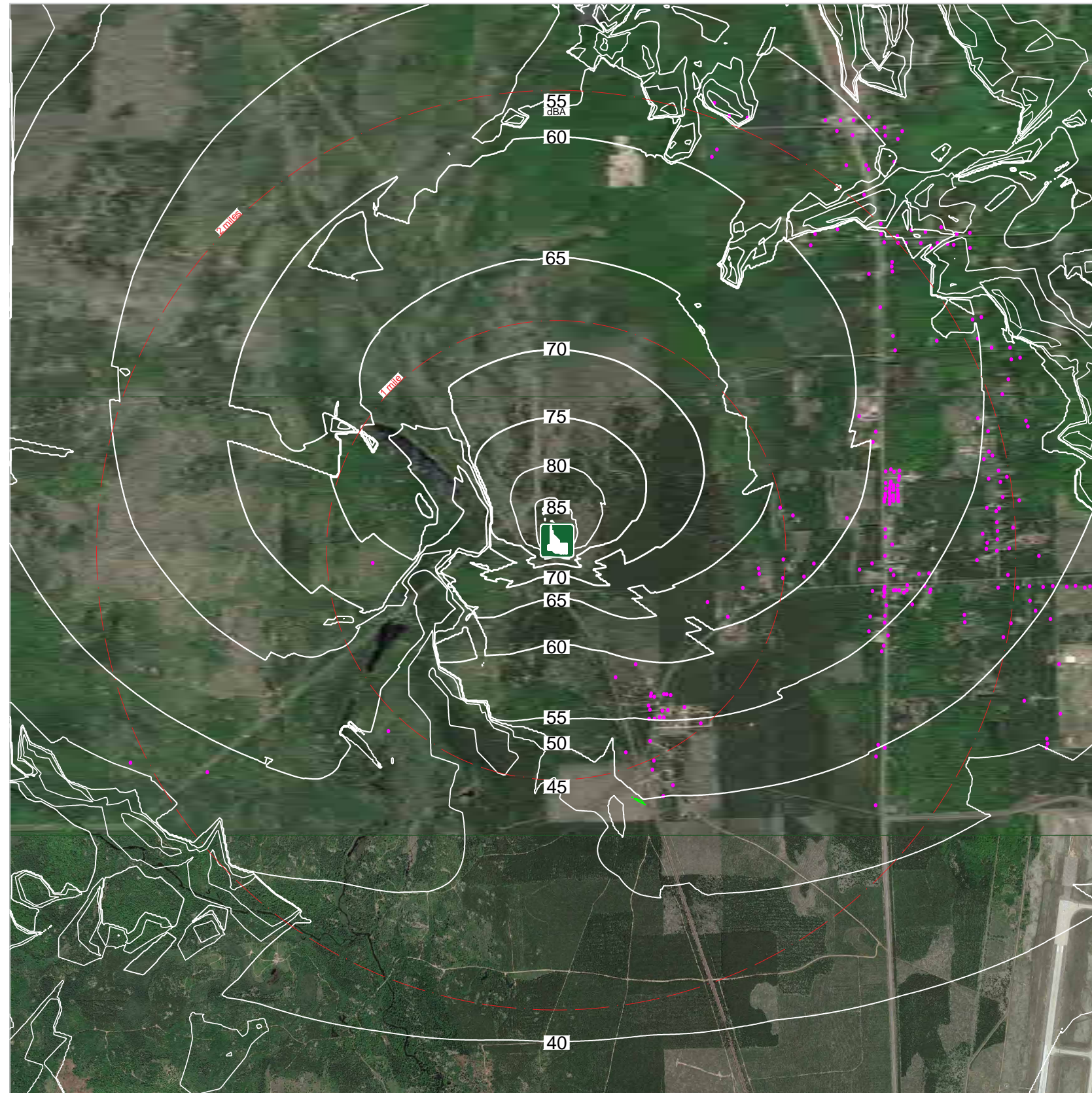
Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. NNW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-9

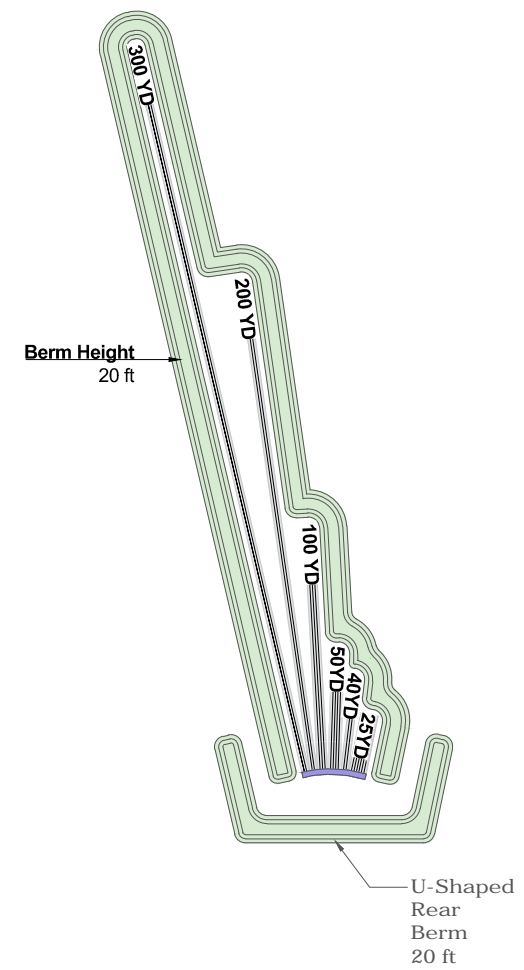
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

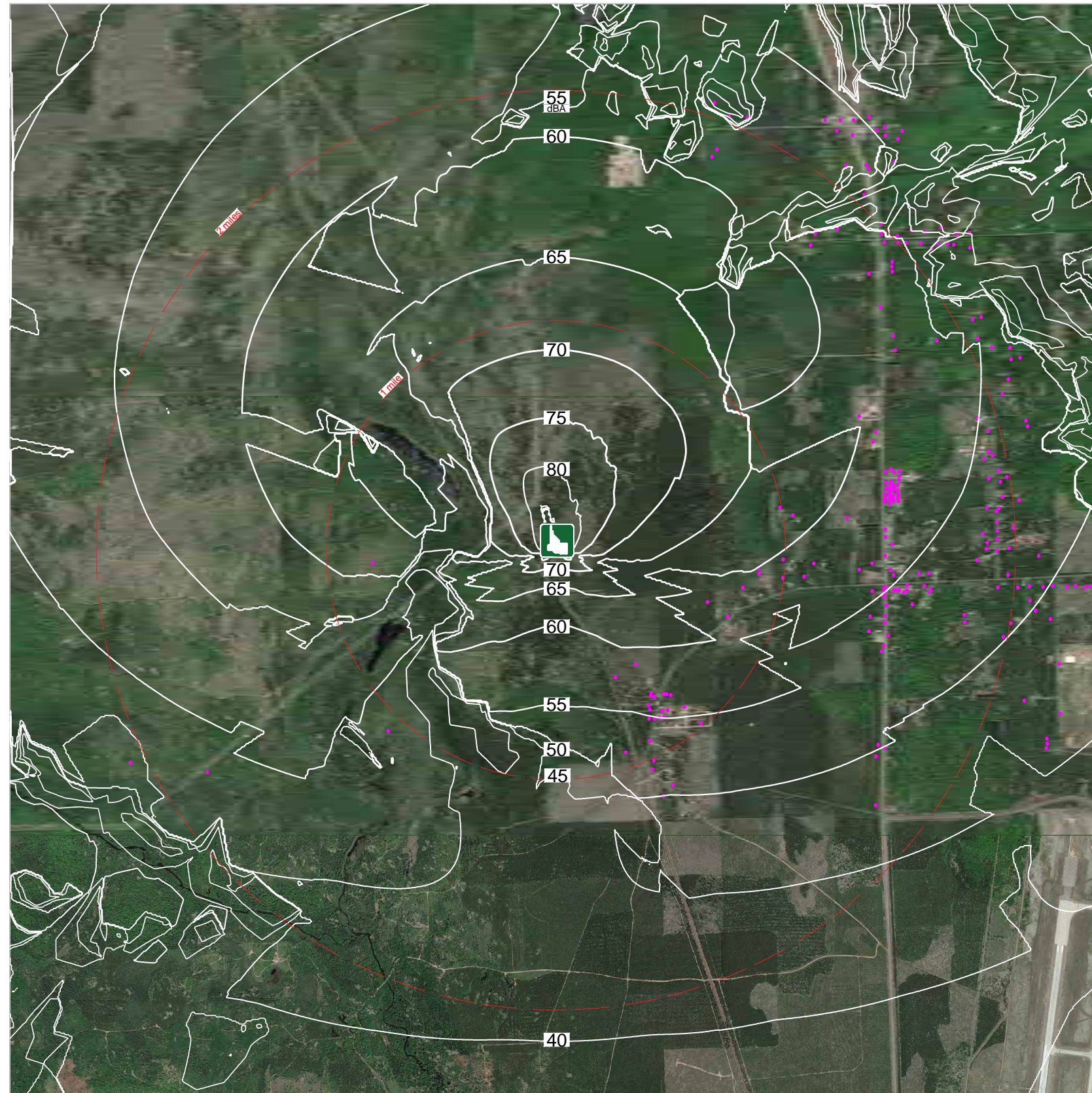
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-10

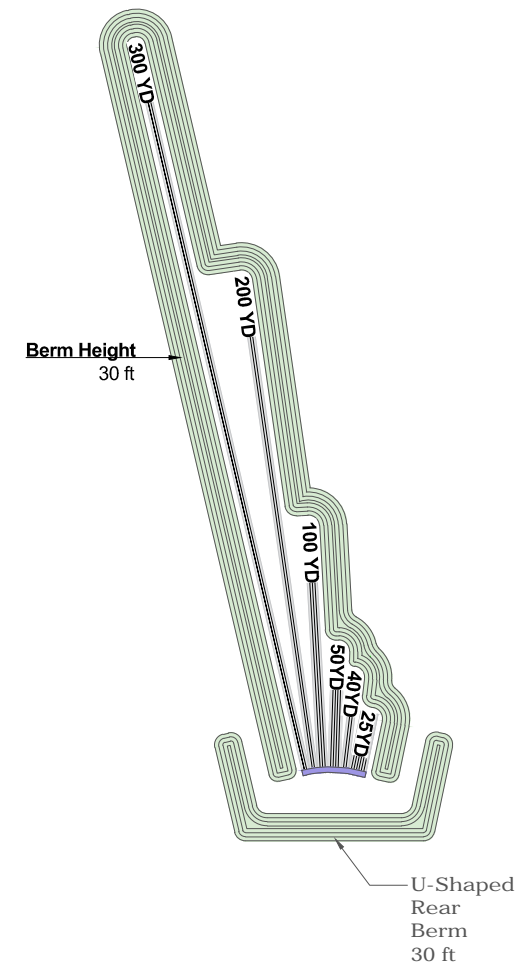
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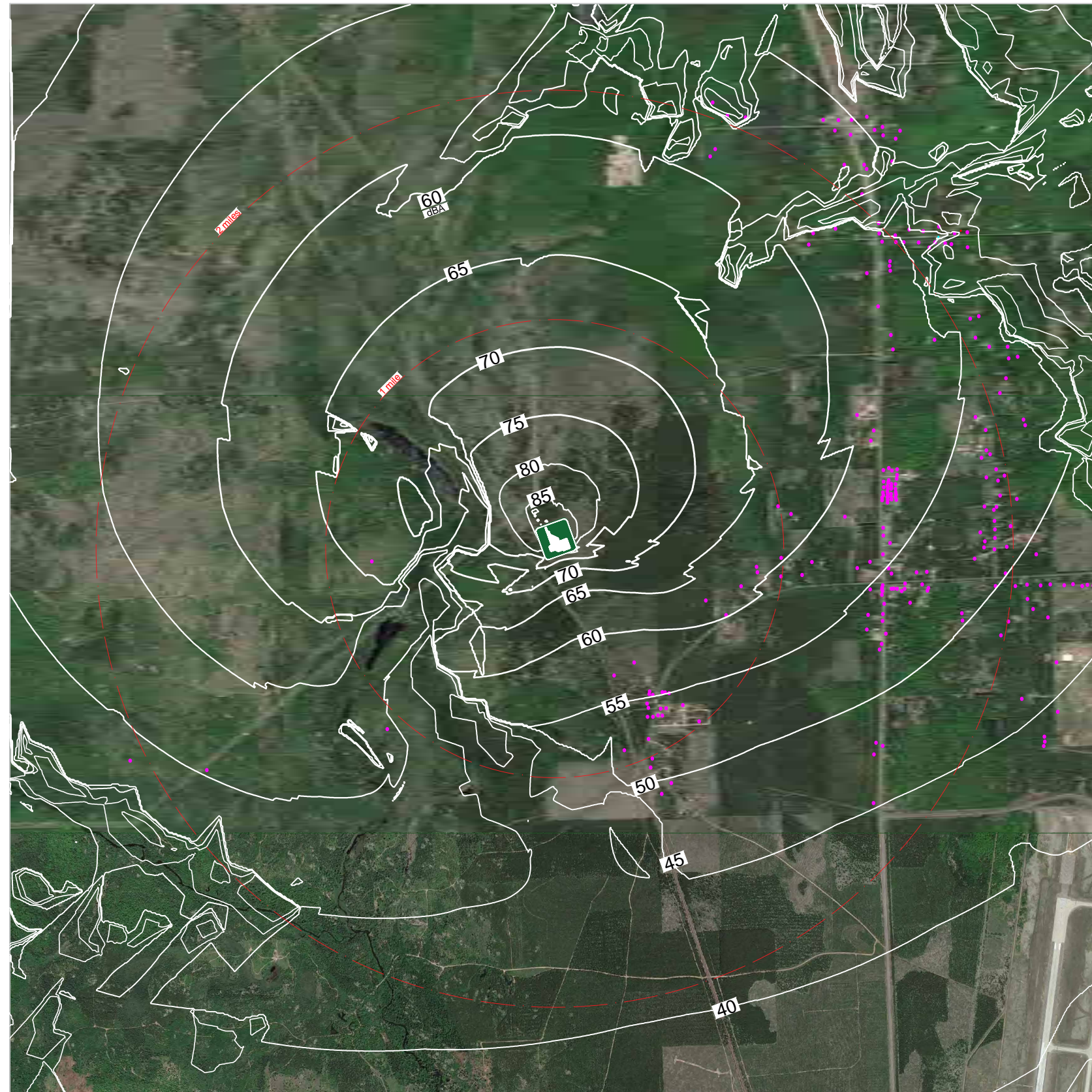
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-11

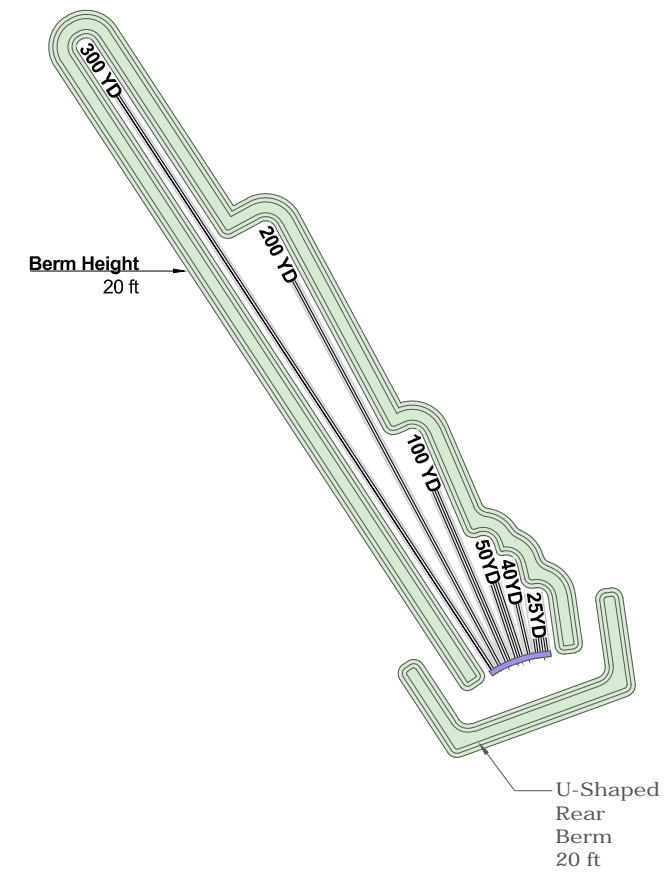
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

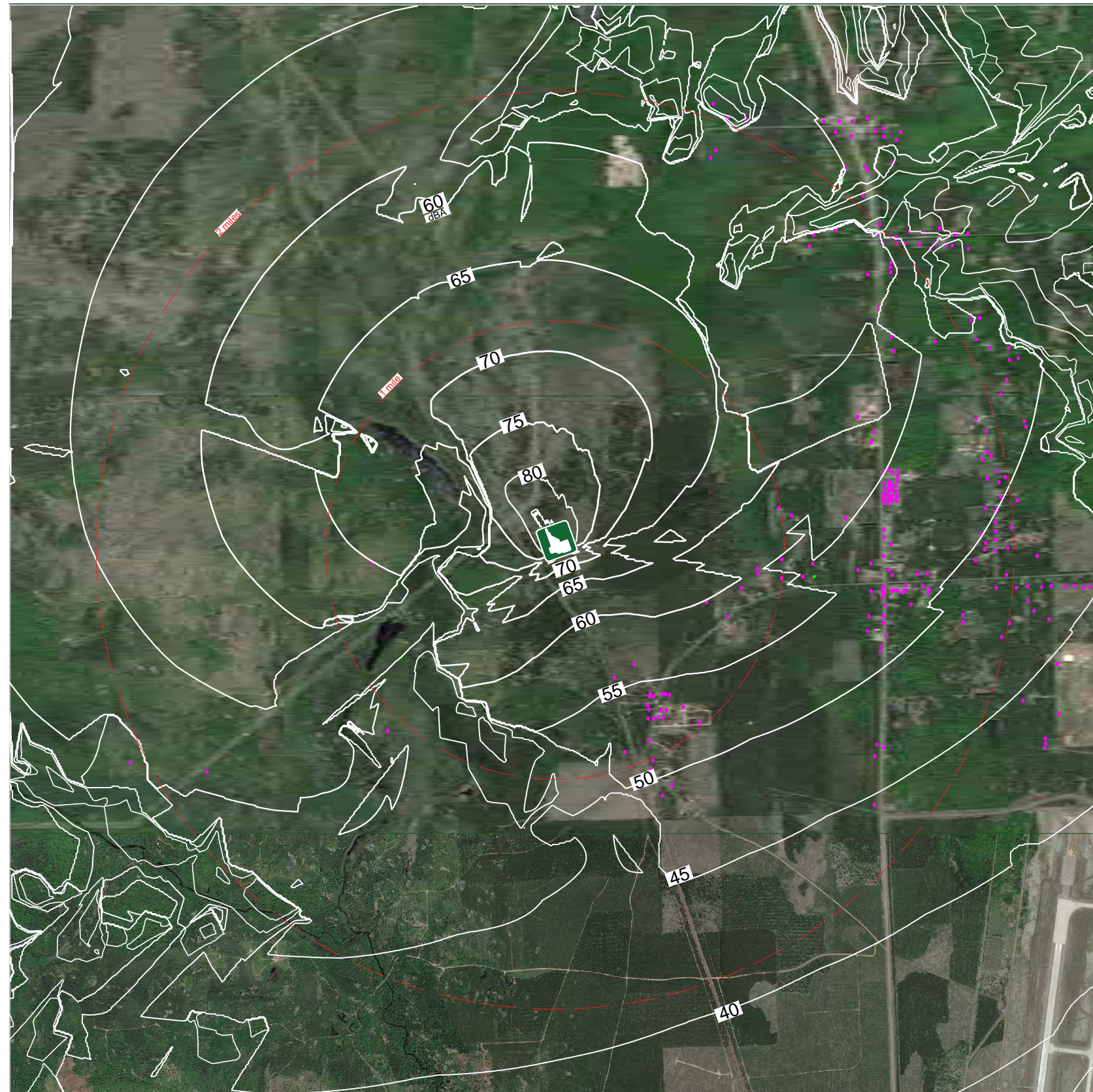
Typical Day:
Shooters within 1 second:
1 Rifle
1 Shotgun
1 Handgun

D.O.F. NW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-12

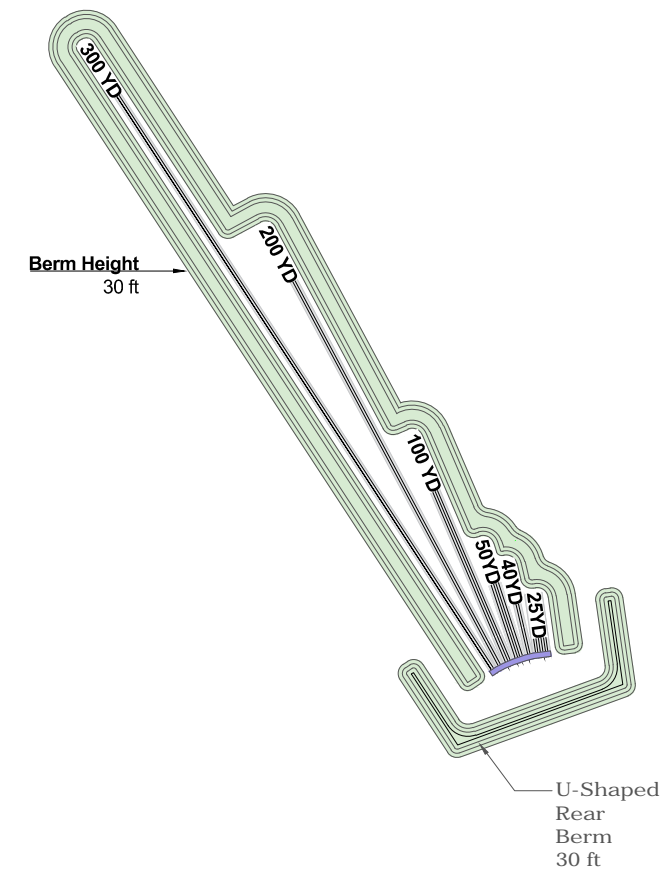
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

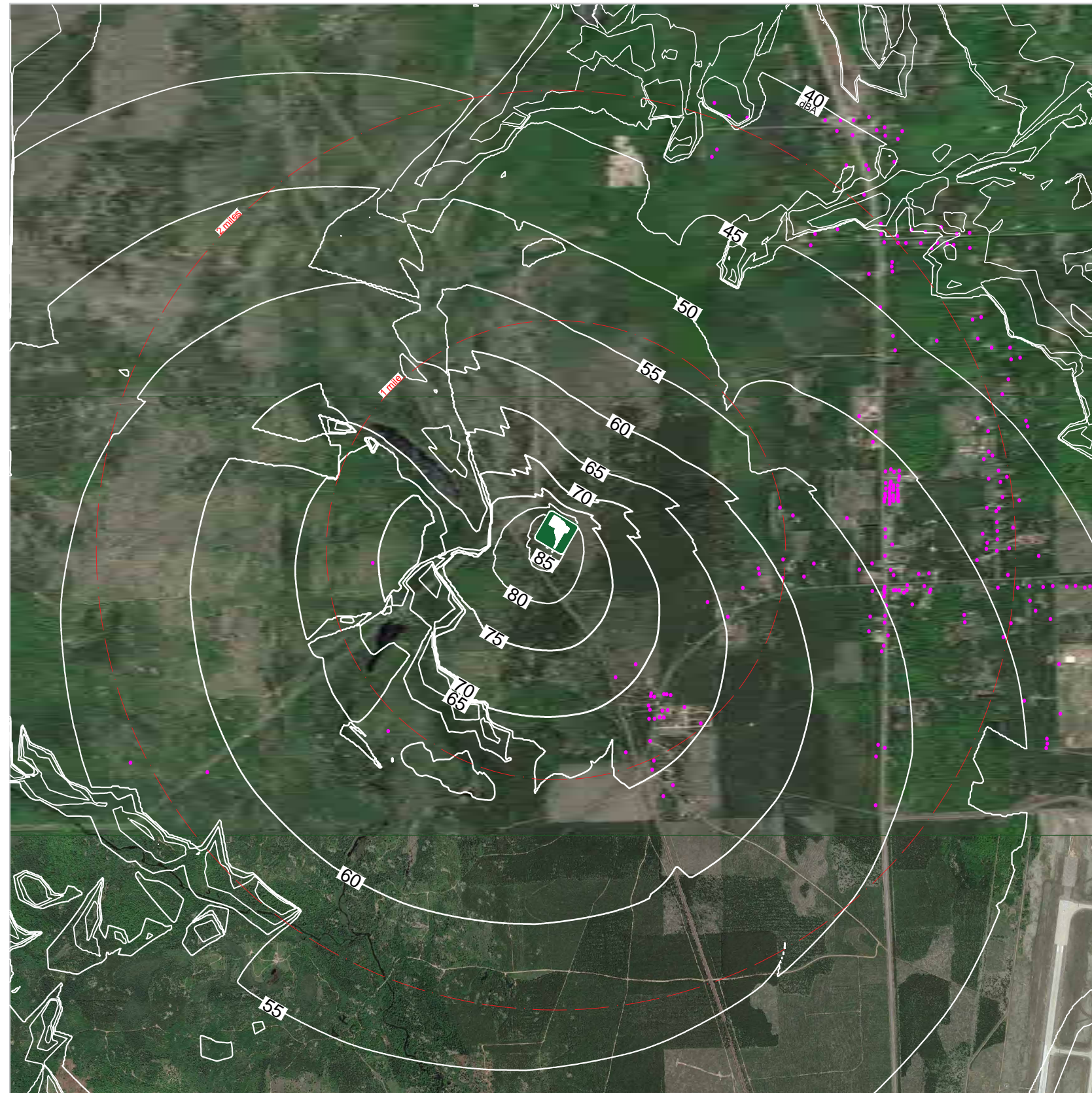
Typical Day:
Shooters within 1 second:
1 Rifle
1 Shotgun
1 Handgun

D.O.F. NW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-13

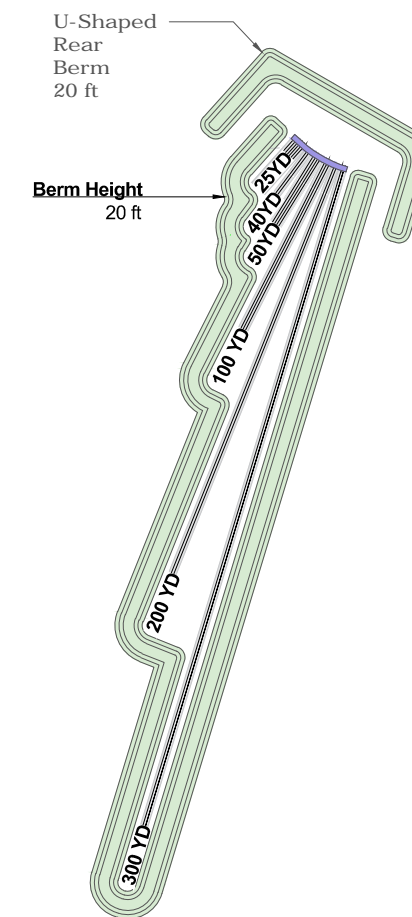
20 ft. Tall Side Berms with 20 ft. Tall Rear U-Shaped Berm

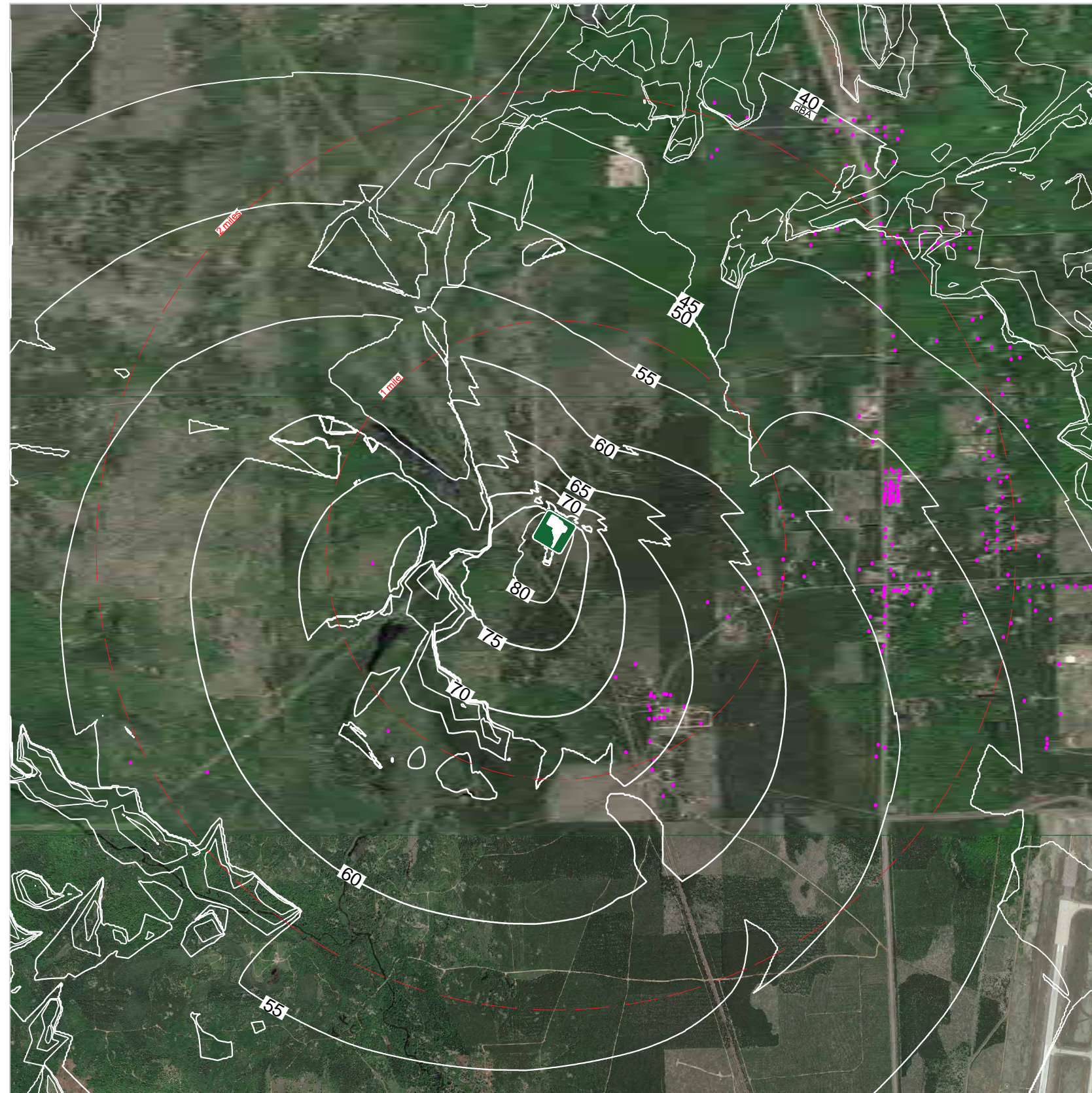
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. SW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-14

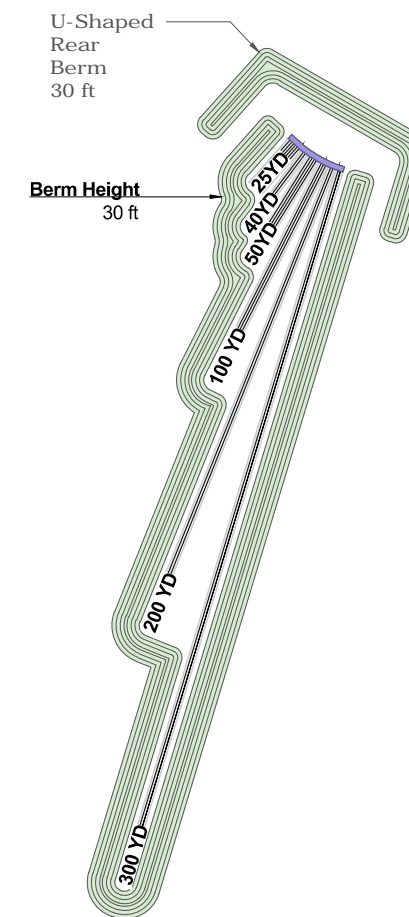
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

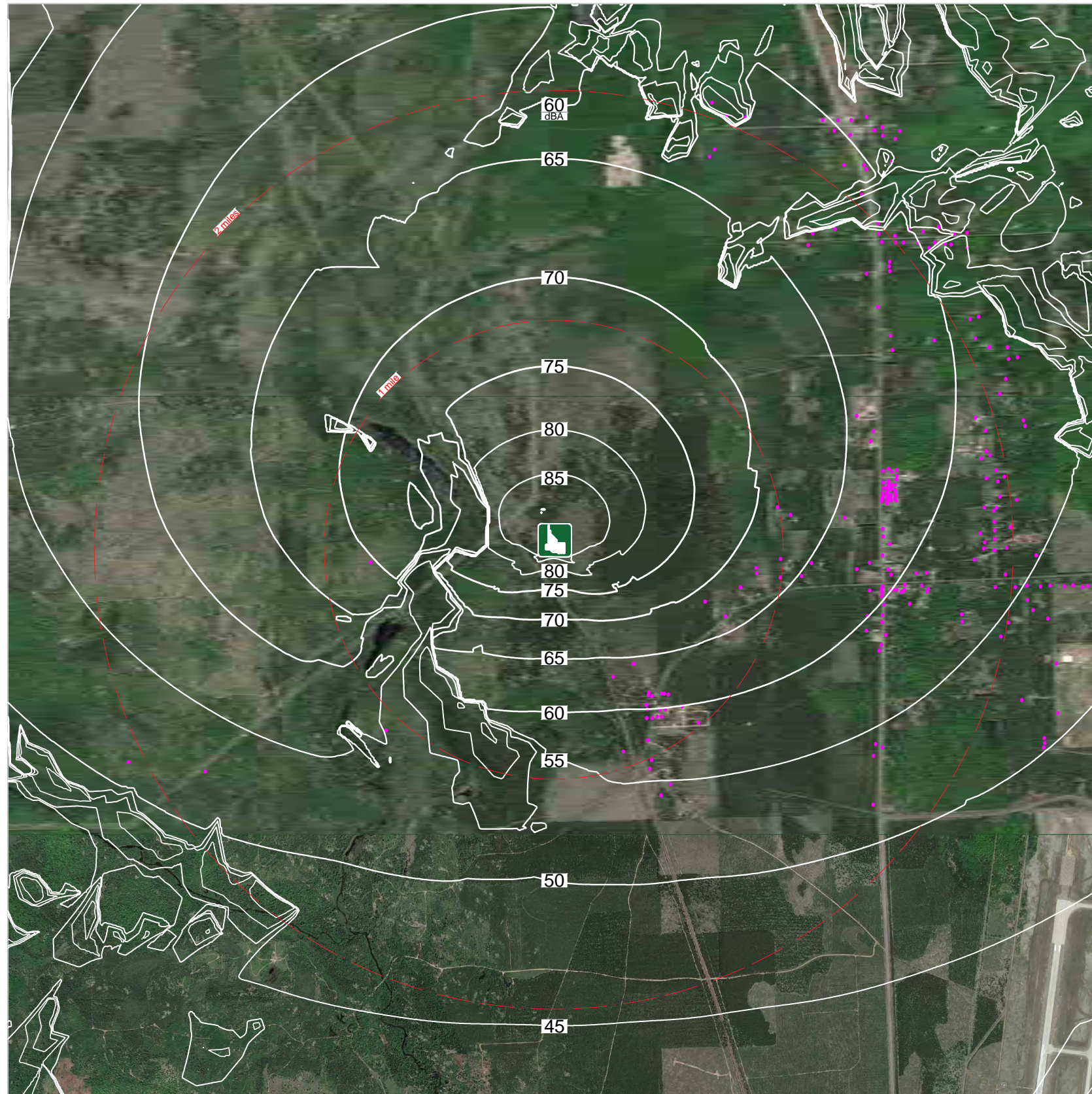
Typical Day:
 Shooters within 1 second:
 1 Rifle
 1 Shotgun
 1 Handgun

D.O.F. SW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-15

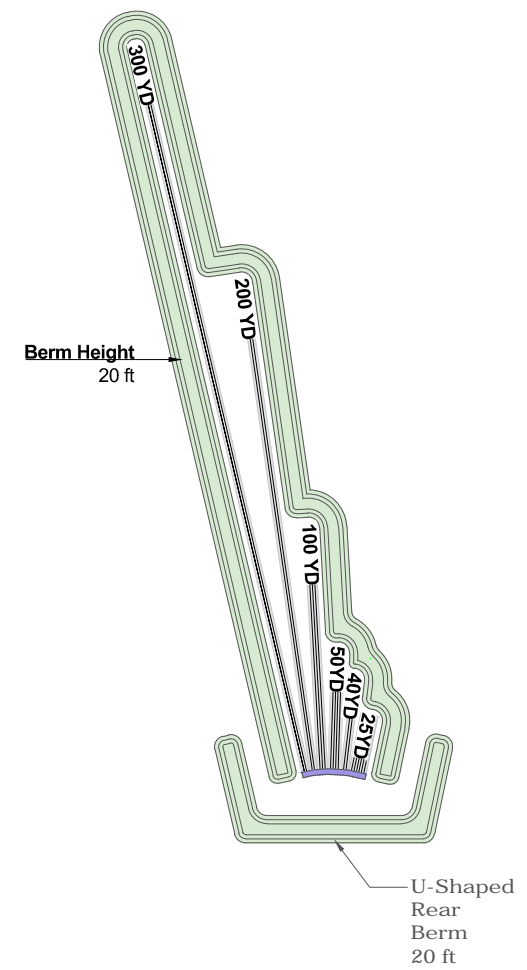
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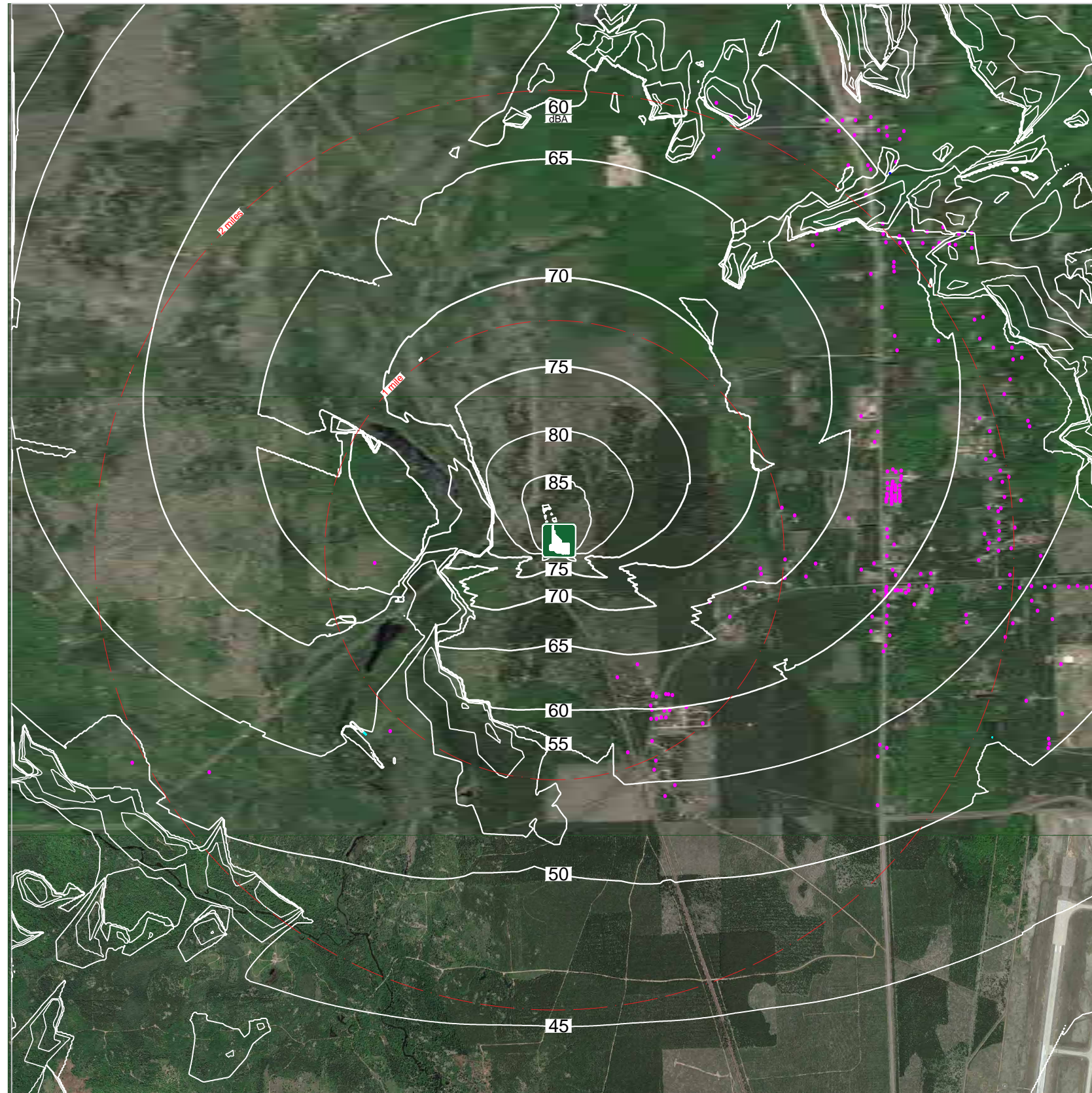
Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-16

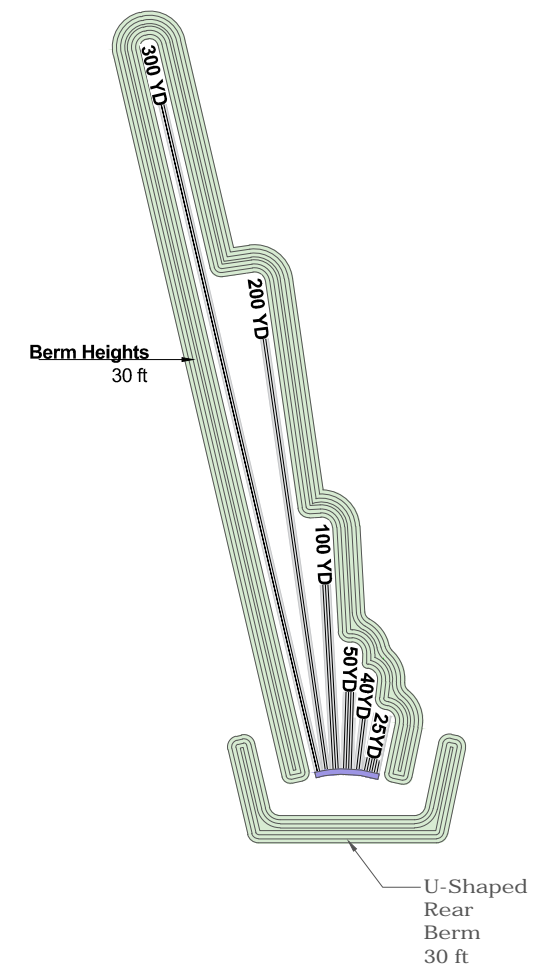
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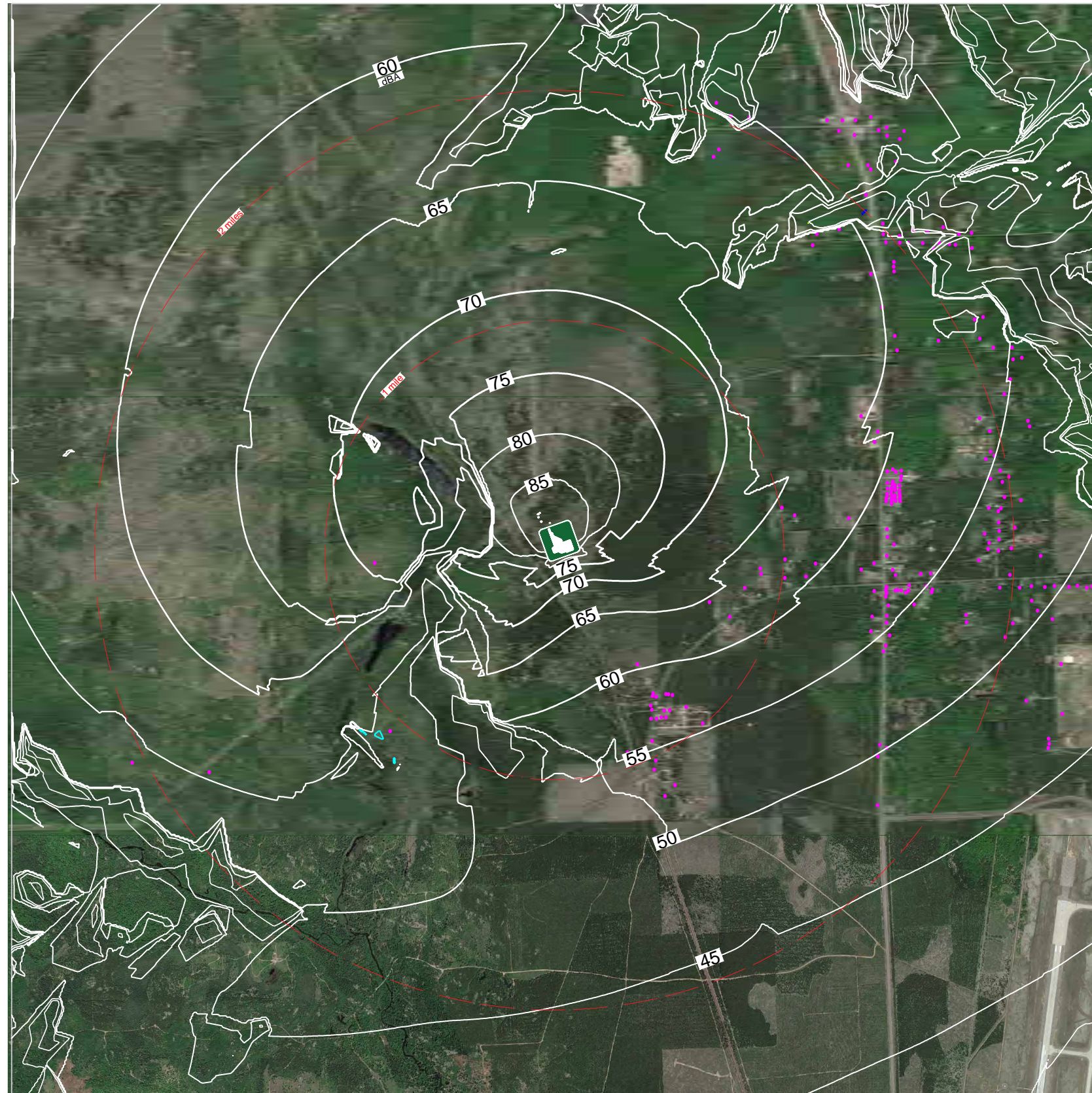
Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. N

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-17

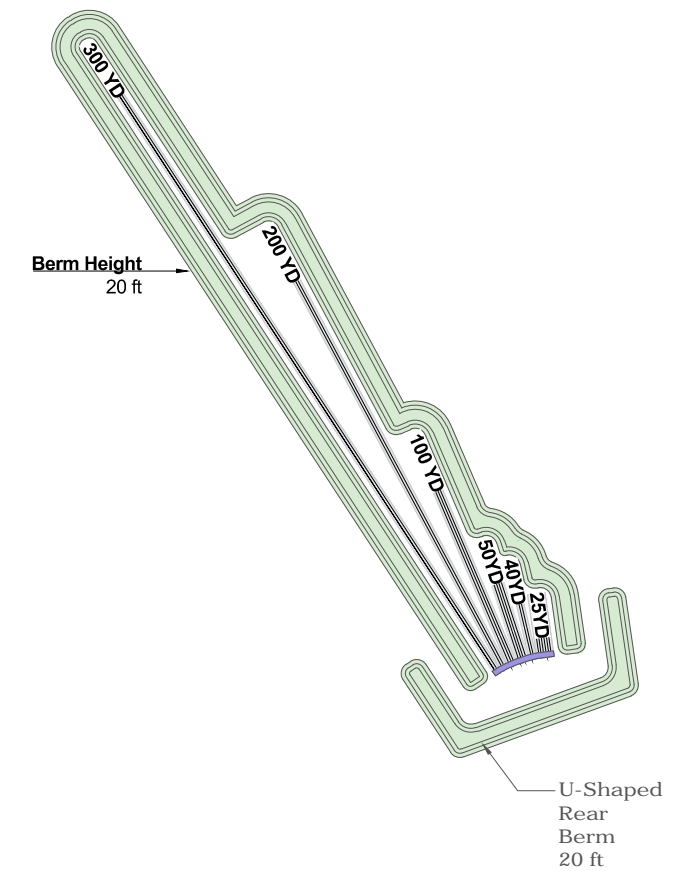
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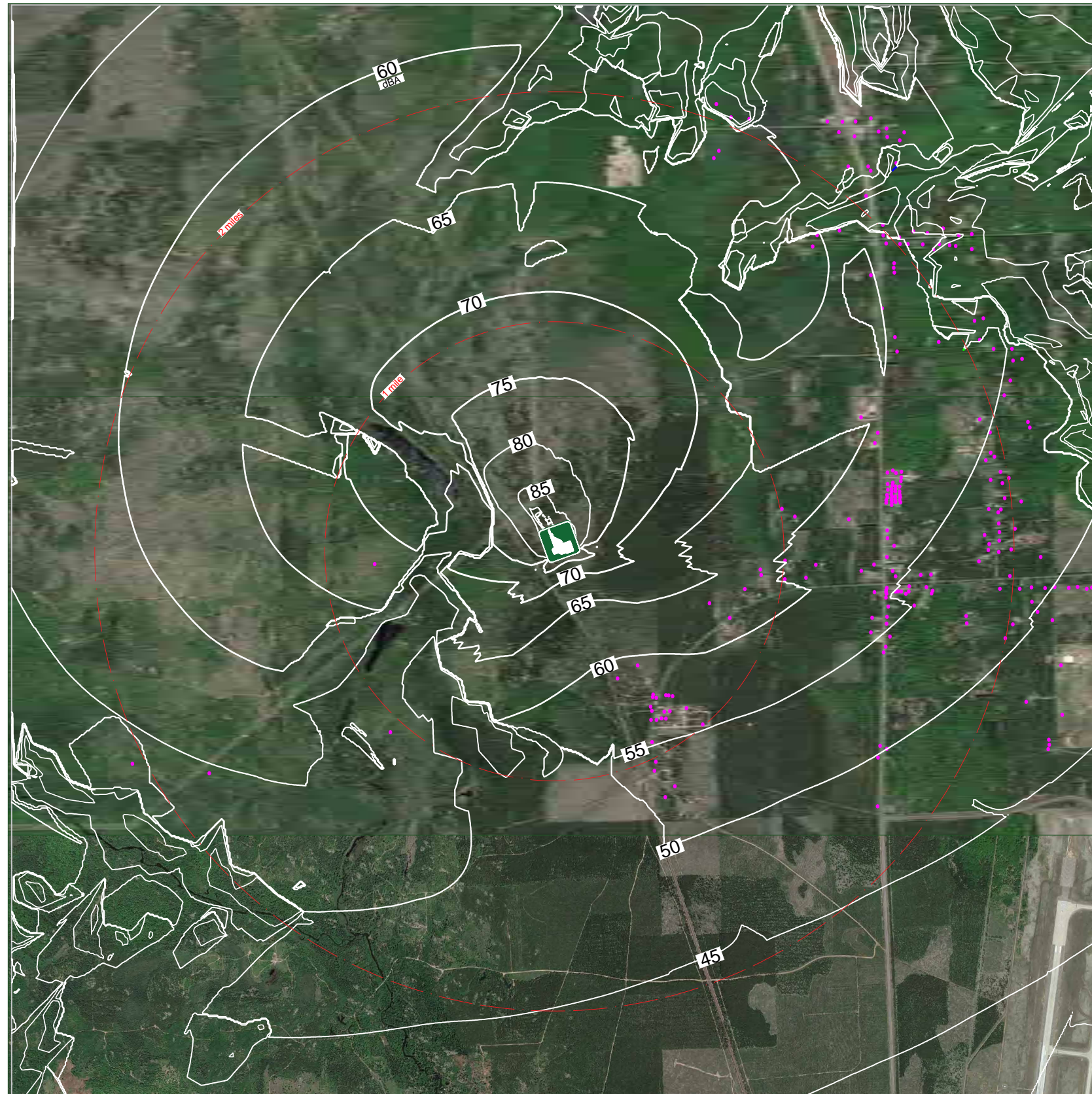
Busy Day:
Shooters within 1 second:
3 Rifles
1 Shotgun
2 Handguns

D.O.F. NW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-18

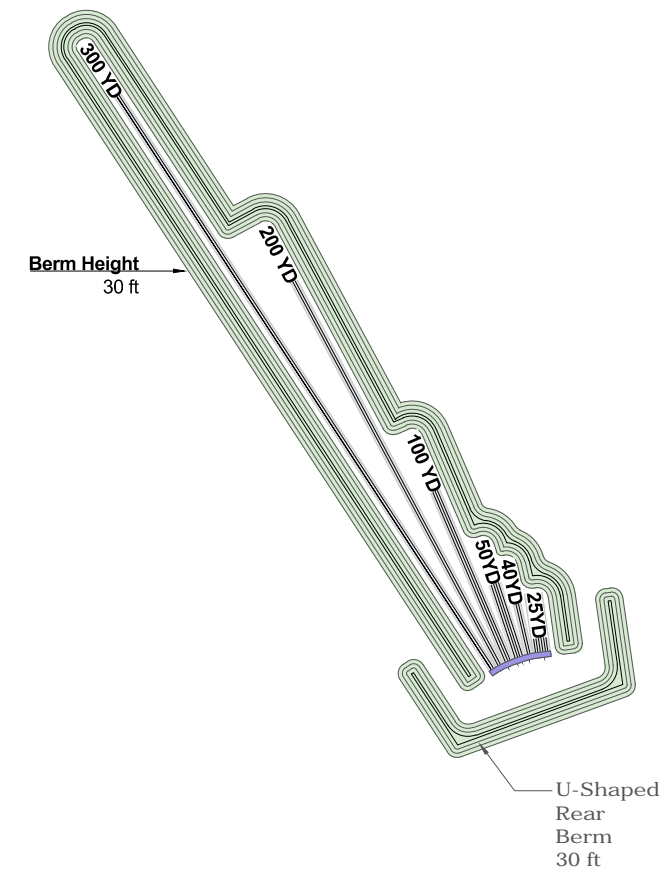
30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

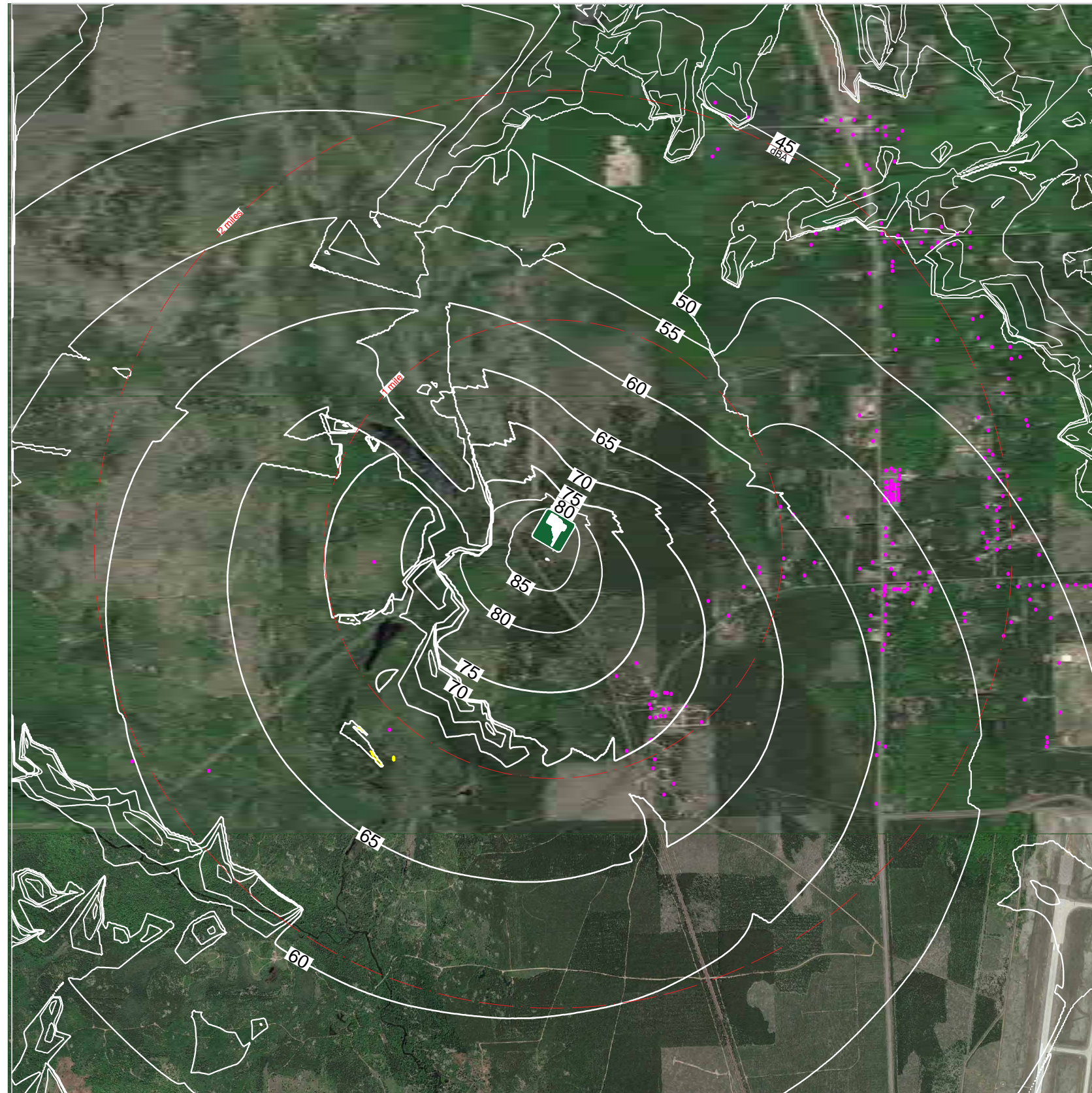
Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. NW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-19

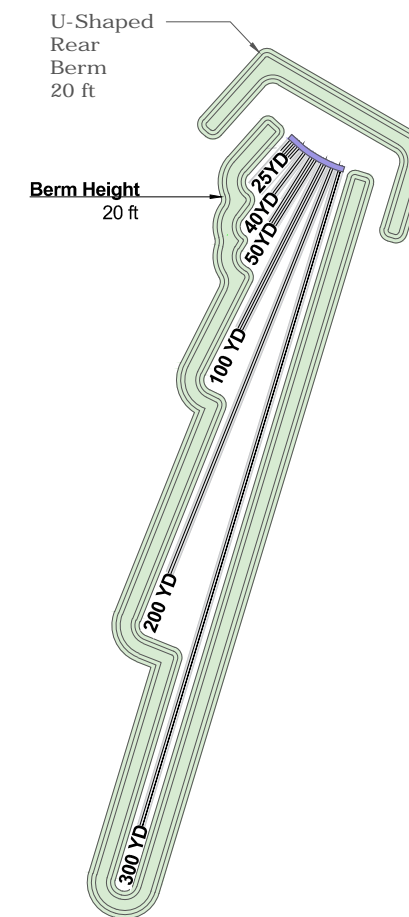
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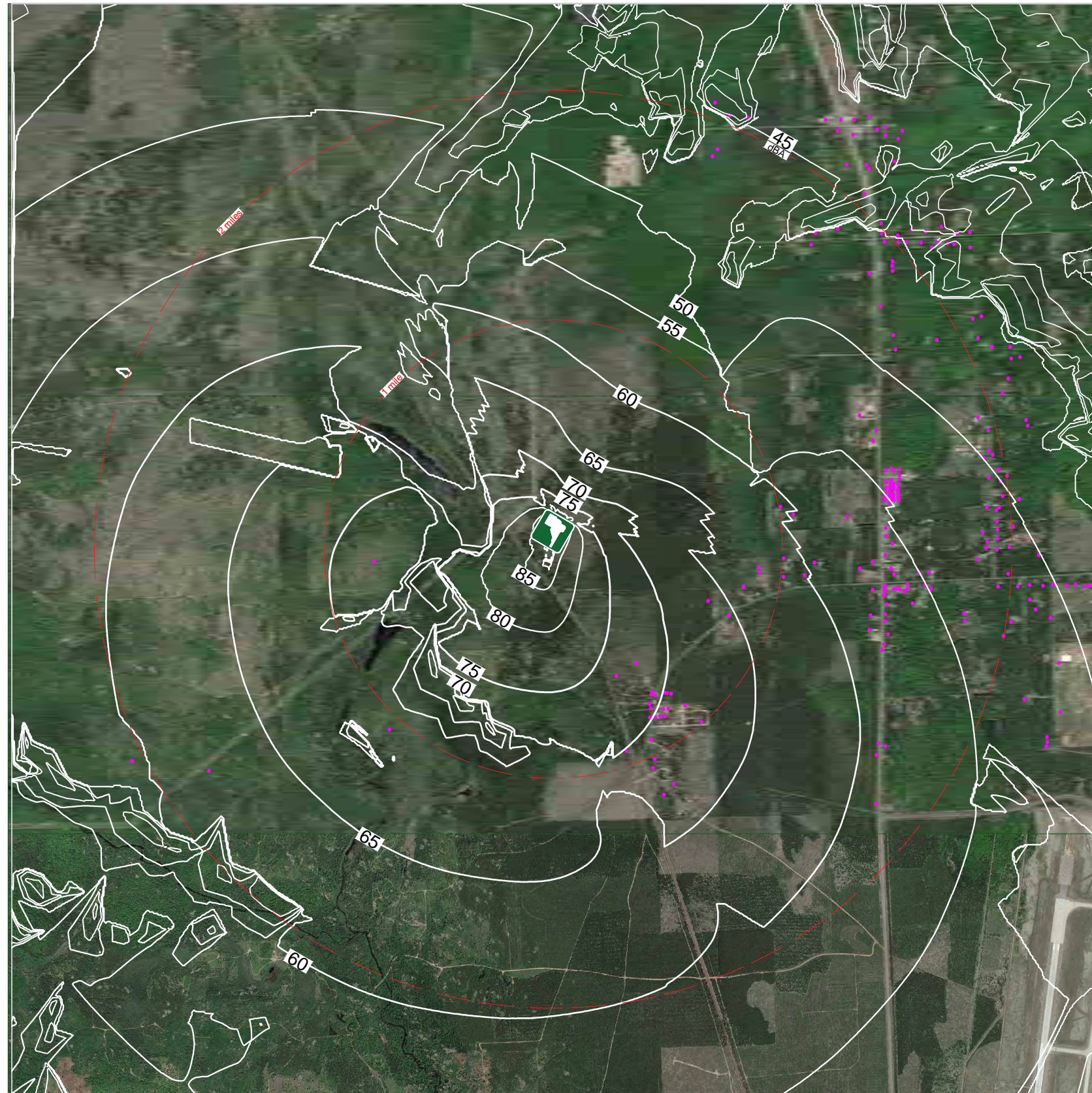
Busy:
Shooters within 1 second:
3 Rifles
1 Shotgun
2 Handguns

D.O.F. SW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





SANDS
MODEL K-20

30 ft. Tall Side Berms with 30 ft. Tall Rear U-Shaped Berm

Busy Day:
 Shooters within 1 second:
 3 Rifles
 1 Shotgun
 2 Handguns

D.O.F. SW

Wind: 1 to 11 mph downward

50°F and 80% R.H.

