

## **APPENDIX O: COMPUTER MODEL STUDY 10:**

### **A 40 ft. Deep Extension Added to the Range Structure and a Rear Berm was 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 10 was conducted with a 20 ft. and 30 ft. tall berm added on the down range and rear sides of the range in addition to the side and rear walls added to the range structure so the firing positions were open only in the direction of fire; the 40 ft. deep extension added to the roof/ceiling of the range structure with the underside of the roof lined with a sound absorbent panel mounted on plywood; and the side and rear walls covered with the sound absorbent facing used in Computer Model Studies 7, 8 and 9; and the sound absorbent material on the inside face of the partitions dividing the individual lanes and the other interior surfaces of the range building described in Computer Model Studies 7, 8 and 9 were also included in this scenario. The models were run 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.

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 40 ft. deep extension was added to the range structure. The underside of the extension was lined with a sound absorbent material installed over plywood as in Computer Model Study 9.
6. A 20 ft. and 30 ft. tall U-shaped berm described in Computer Model Study 6 was also included.
7. The side walls and rear wall of the range structure were also included in this model so that the range was only open in the direction of fire. Wood frame walls were built between each firing lane with plywood covering. Sound absorbent panels were installed on the sides and ceiling of each lane as well as on the side and rear walls of the entire range structure as in Computer Model Studies 7 and 8.
8. 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.
9. The berm height of 20 ft. was used in the reference model.
10. The sound levels shown on the noise contour maps are LAeq in dBA.

In Experiment 10, the down range berm height is raised to 20 ft. and 30 ft. tall and a 20 ft. and 30 ft. tall U-shaped berm is added at the rear of the range in addition to the 40 ft. deep roof lined with sound absorbent material that was constructed on the downrange side of the range building in Experiment 9 and the addition of the solid side walls and rear wall added to the range building in Experiment 8 and the solid dividers are installed between each lane in the Site 1: County Road Commission oriented to the north and to the north-northwest and Site 2: Sands West oriented to the north, northwest, and southwest. A sound absorbent lining panel is added to the rear wall, side walls, interior lane dividing

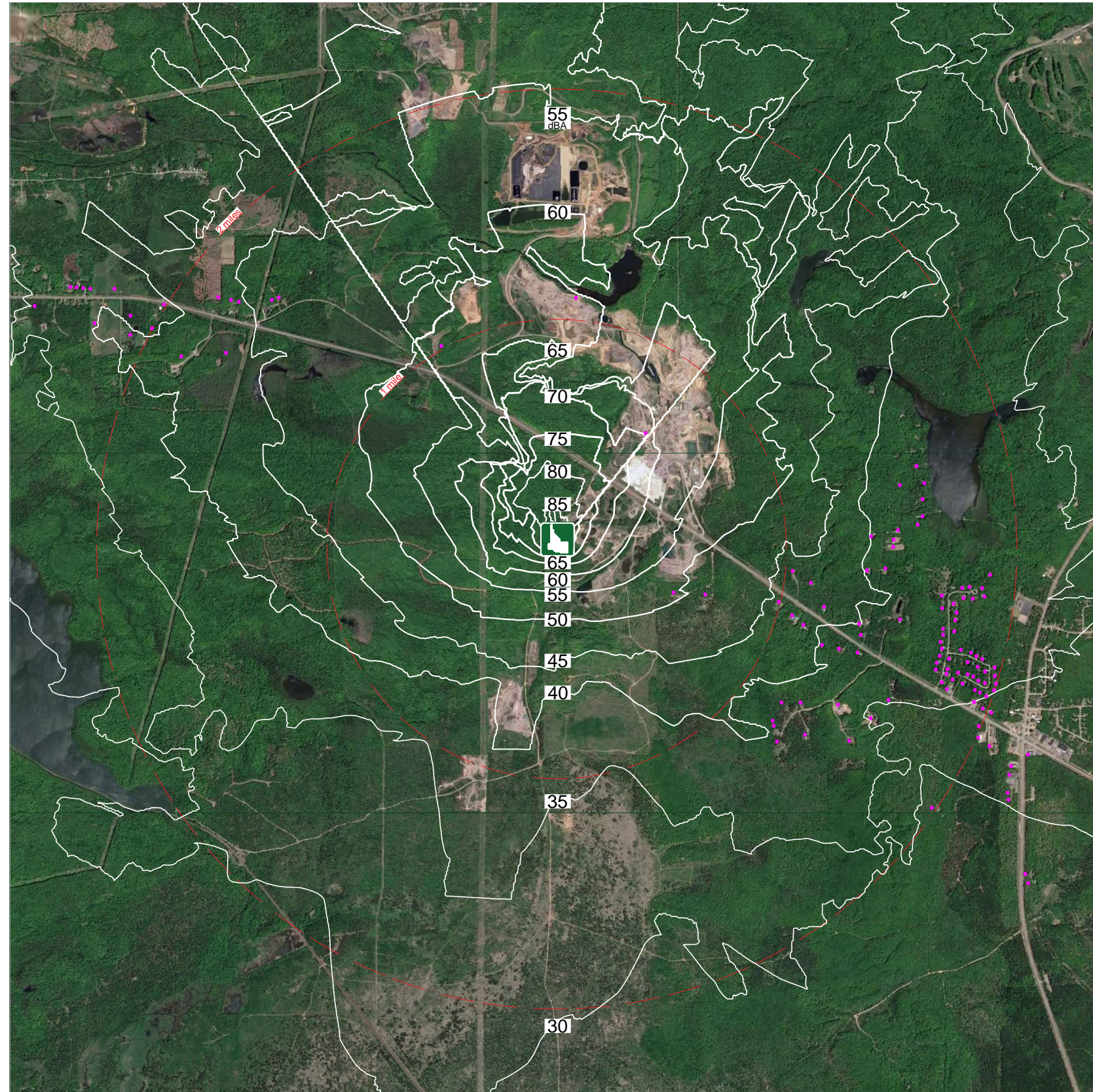
walls and the ceiling of each lane in the range building. This locates each shooter in a sound absorbent enclosure on 3 sides with a 40 ft. deep roof structure that reduces sound propagating out of the range building.

The linear pressure score is reduced by approximately 97% for the Site 2: Sands West oriented to the northwest with the 30 ft. tall berms and also by 97% for the Site 2: Sands West oriented to the northwest with the 20 ft. tall berms. The rough order of magnitude cost for installing the 40 ft. extension of the roof, the side walls, rear wall, solid dividers in each of the lanes and lining the ceiling and walls of each lane with a weather-resistant sound absorbing panel such as Troy Board manufactured by Troy Acoustics and increasing the height of the berms to 30 ft. tall is \$1,600,700 and \$785,800 with the range building and a berm height of 20 feet tall.

It is worthwhile to note that Site 2: Sands West oriented to the northwest has the lowest linear pressure score for this mitigation scheme.

**Table O-1. Summary table of rating points for each scenario tested in Experiment 10.**

<b>BUSY DAY 6 SHOOTERS   30 FT BERM FRONT AND REAR AND 40FT EXTENDED ROOF</b>					
<b>Site</b>	<b>DOF</b>	<b>Berm Height</b>	<b>Lin Press</b>	<b>dB</b>	<b>PTS</b>
SITE 2: Sands	NW	30 FT. U-Shape Berm	66	68	457
SITE 2: Sands	NW	20 FT. U-Shape Berm	86	69	515
SITE 1: MCRC	NNW	30 FT. U-Shape Berm	103	70	286
SITE 1: MCRC	NNW	20 FT. U-Shape Berm	104	70	294
SITE 2: Sands	N	30 FT. U-Shape Berm	198	73	600
SITE 1: MCRC	N	30 FT. U-Shape Berm	219	73	302
SITE 2: Sands	N	20 FT. U-Shape Berm	234	74	660
SITE 1: MCRC	N	20 FT. U-Shape Berm	273	74	326
SITE 2: Sands	SW	30 FT. U-Shape Berm	605	78	672
SITE 1: MCRC   Reference	N	20 FT. Tall Berm	850	79	298
SITE 2: Sands	SW	20 FT. U-Shape Berm	895	80	733
SITE 2: Sands   Reference	N	20 FT. Tall Berm	2,415	84	1149
<b>TYPICAL DAY 3 SHOOTERS   20 FT BERM FRONT AND REAR AND 40FT EXTENDED ROOF</b>					
<b>Site</b>	<b>DOF</b>	<b>Berm Height</b>	<b>Lin Press</b>	<b>dB</b>	<b>PTS</b>
SITE 2: Sands	NW	30 FT. U-Shape Berm	29	65	531
SITE 1: MCRC	NNW	30 FT. U-Shape Berm	33	65	208
SITE 1: MCRC	NNW	20 FT. U-Shape Berm	35	65	231
SITE 2: Sands	NW	20 FT. U-Shape Berm	39	66	580
SITE 1: MCRC	N	30 FT. U-Shape Berm	88	69	233
SITE 2: Sands	SW	30 FT. U-Shape Berm	90	70	517
SITE 1: MCRC	N	20 FT. U-Shape Berm	102	70	256
SITE 2: Sands	SW	20 FT. U-Shape Berm	106	70	540
SITE 2: Sands	N	30 FT. U-Shape Berm	109	70	734
SITE 2: Sands	N	20 FT. U-Shape Berm	230	74	659
SITE 1: MCRC   Reference	N	20 FT. Tall Berm	359	76	354
SITE 2: Sands   Reference	N	20 FT. Tall Berm	989	80	992



**MARQUETTE CRC**  
**MODEL O-1**

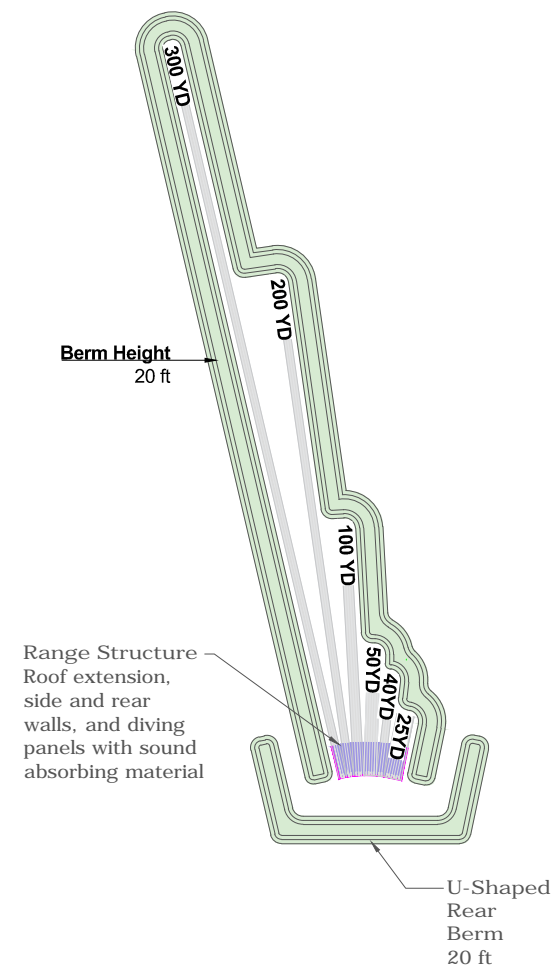
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

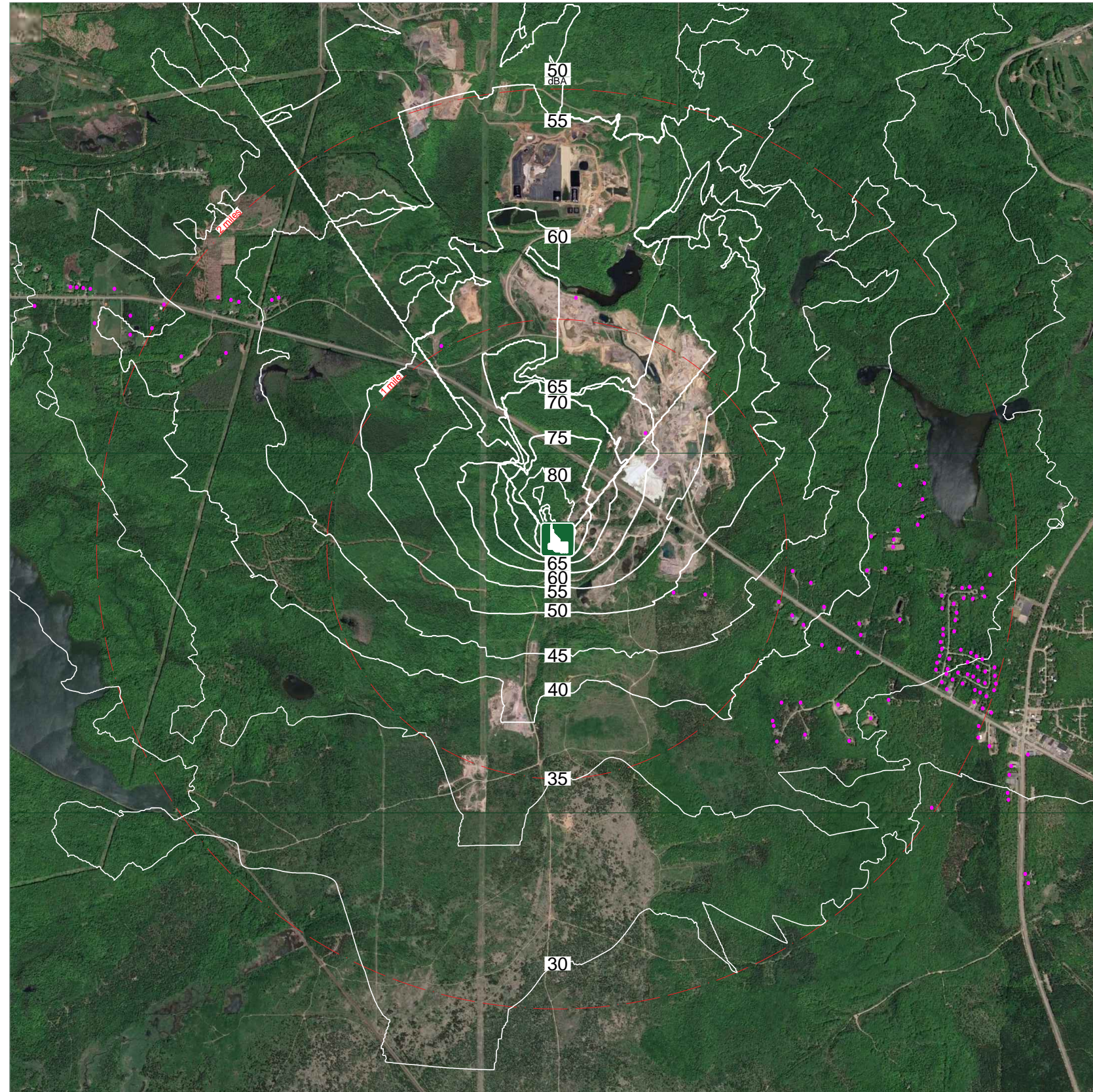
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**MARQUETTE CRC**  
**MODEL O-2**

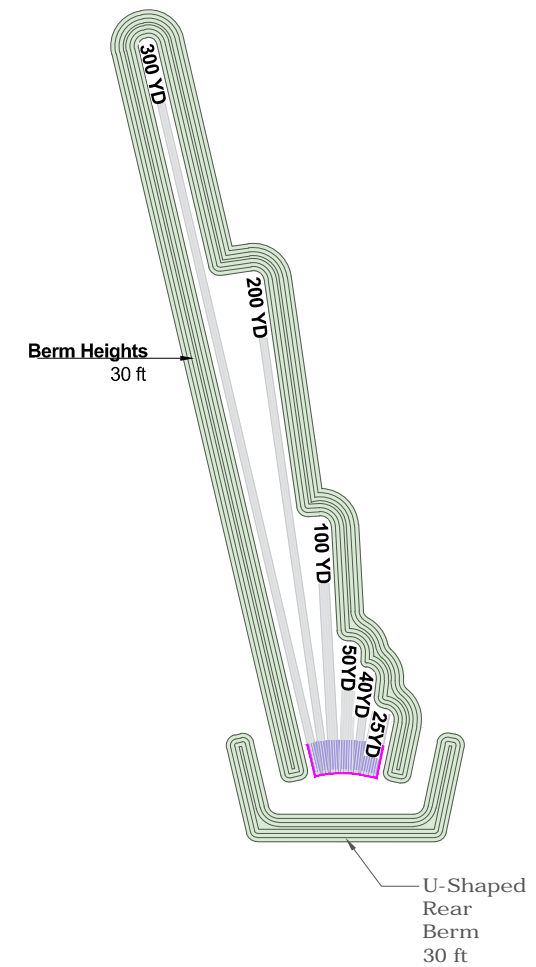
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

**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 O-3**

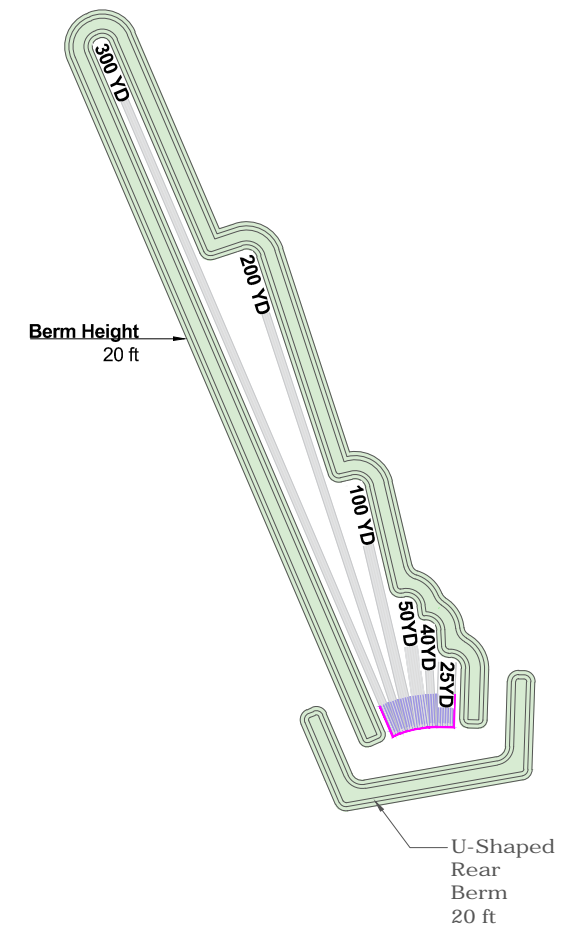
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

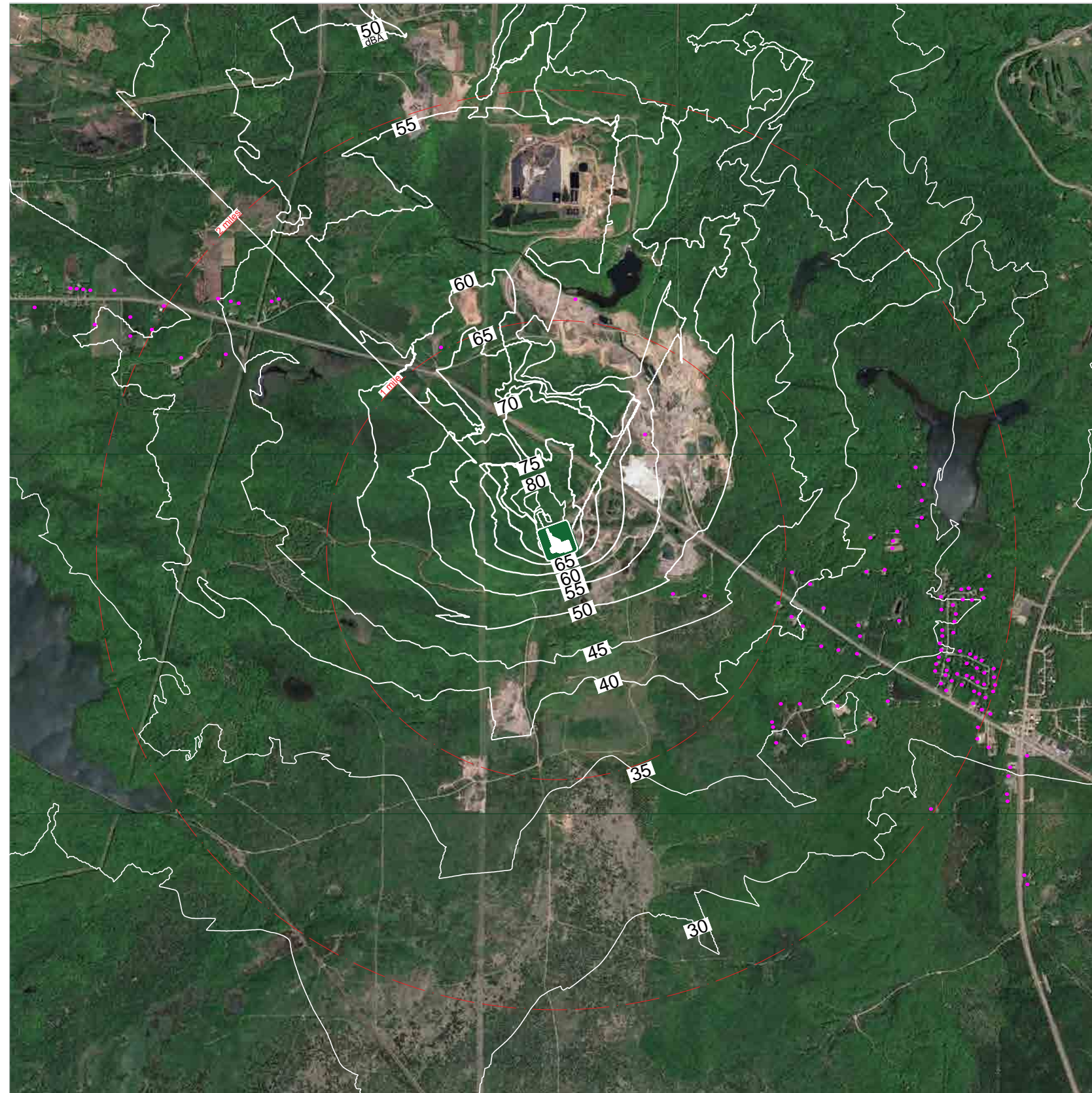
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. NNW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**MARQUETTE CRC**  
**MODEL O-4**

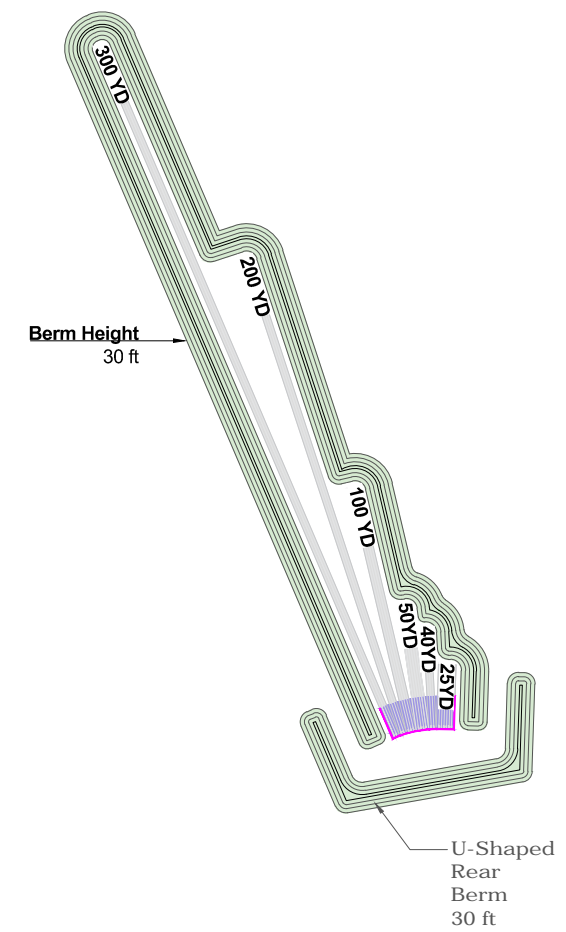
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

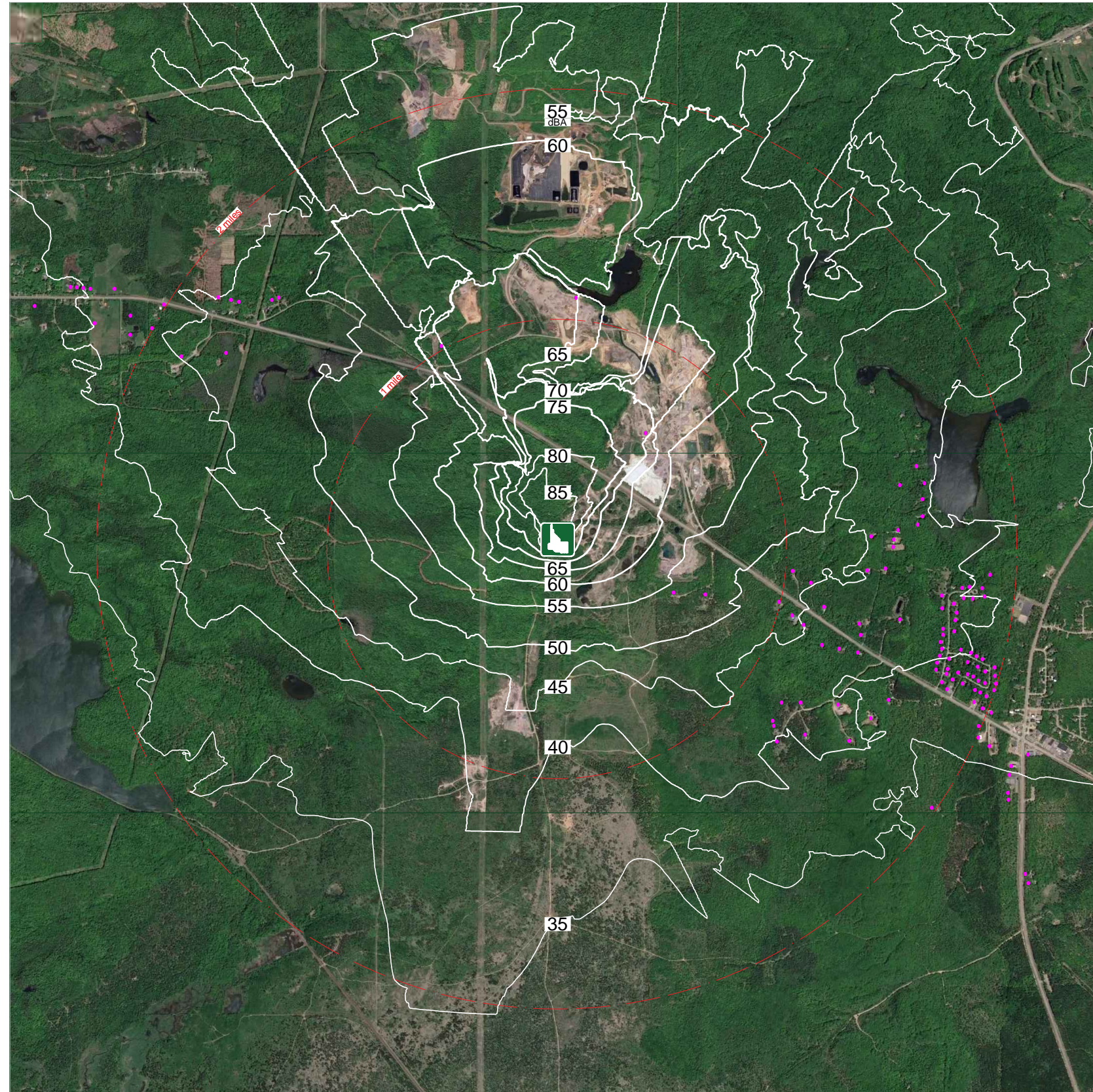
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. NNW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**MARQUETTE CRC**  
**MODEL O-5**

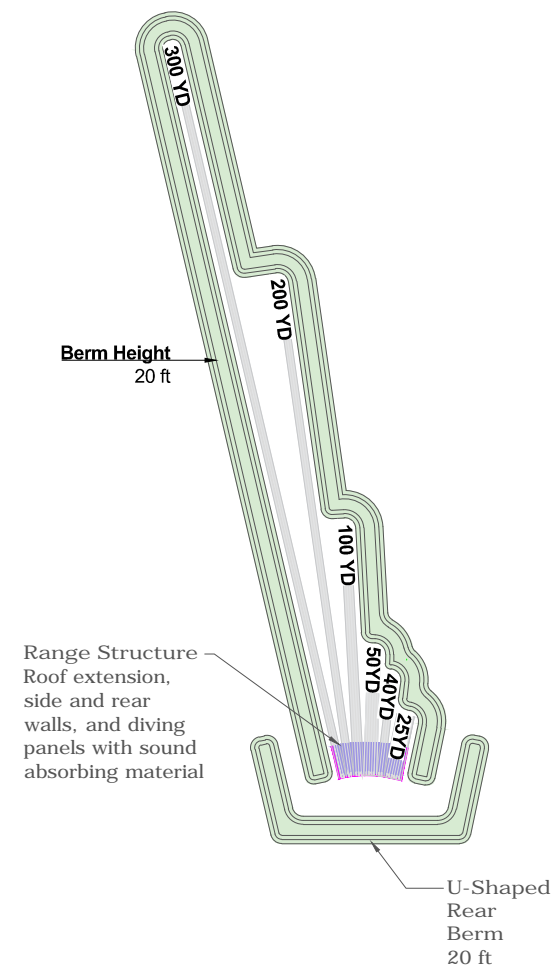
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

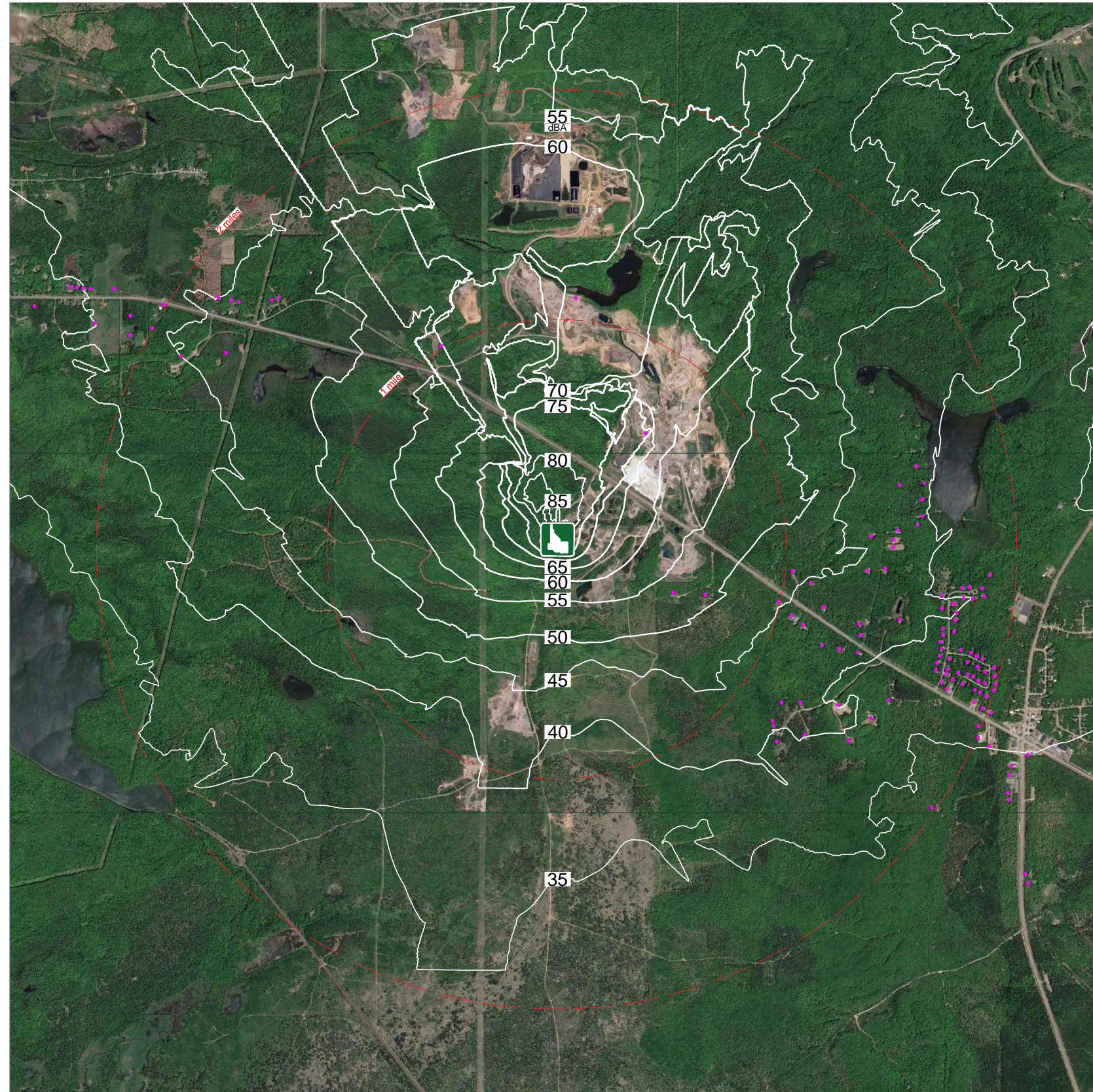
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**MARQUETTE CRC**  
**MODEL O-6**

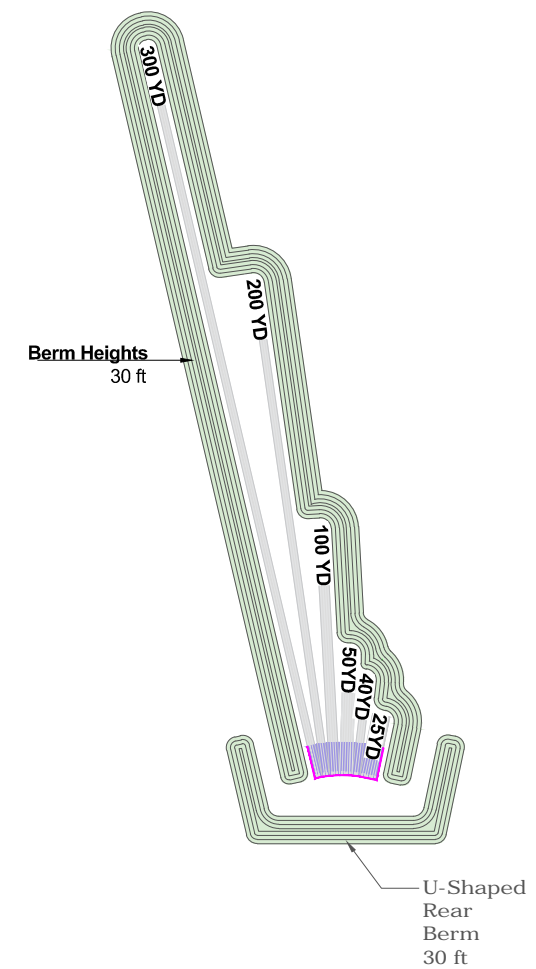
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

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

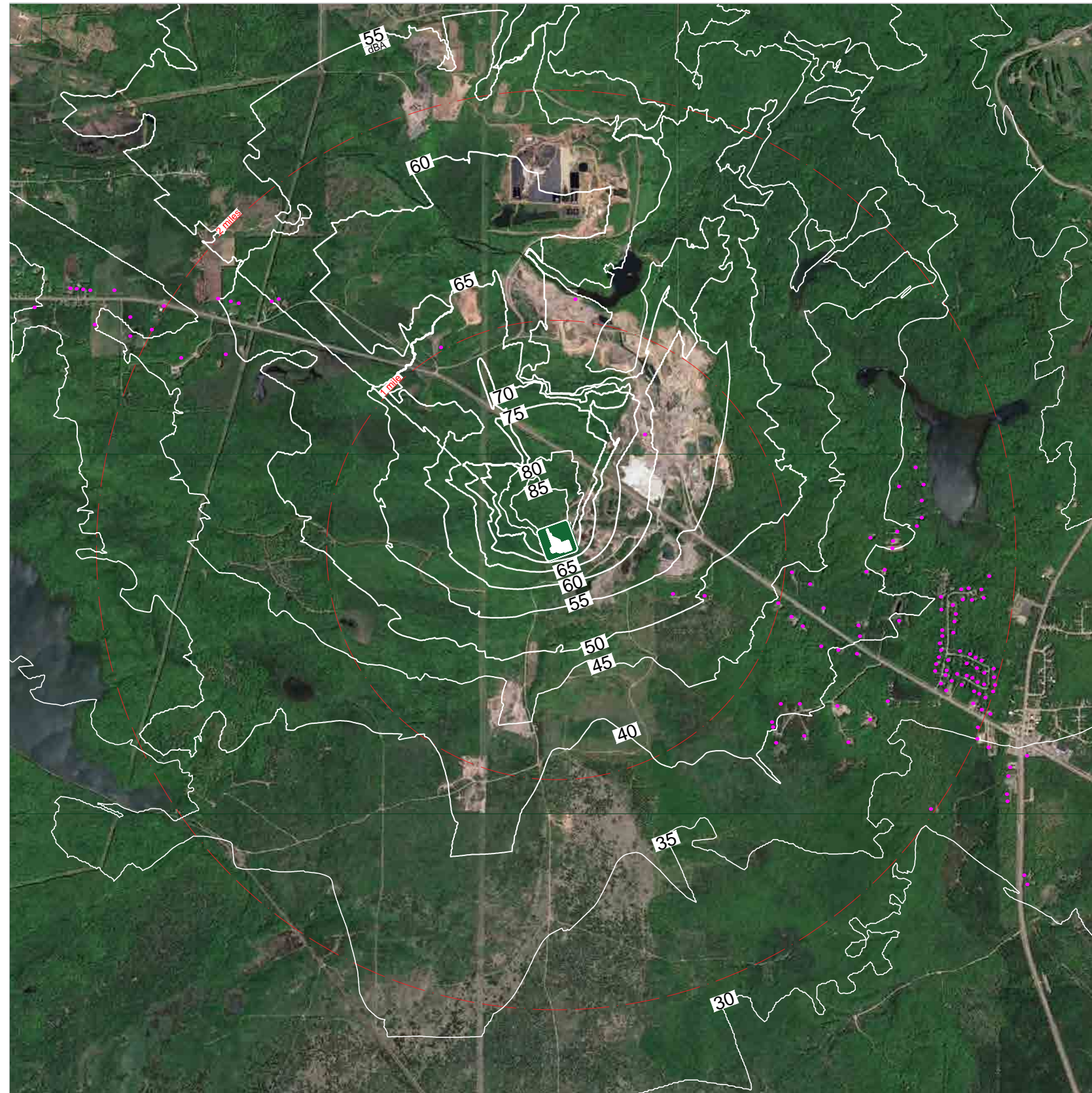
**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.







**MARQUETTE CRC**  
**MODEL O-7**

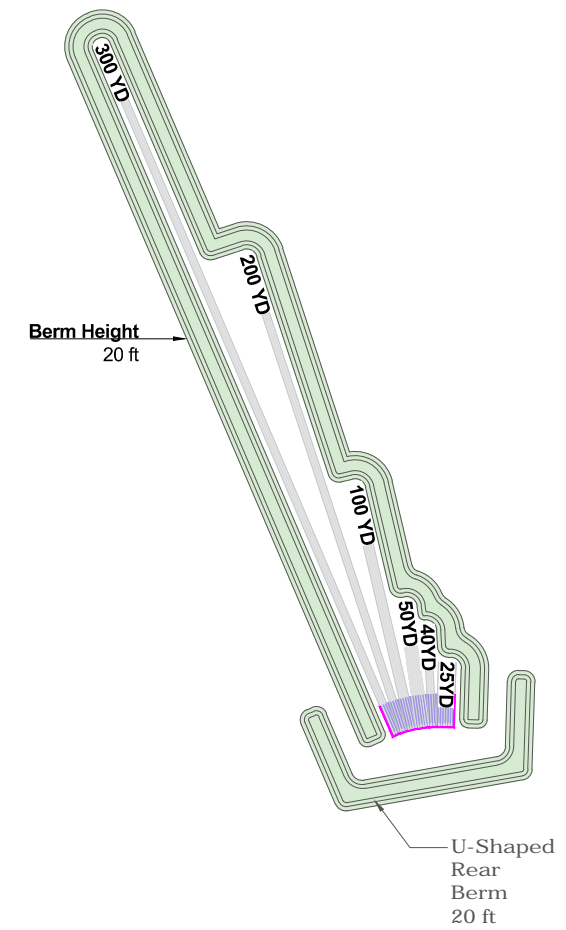
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

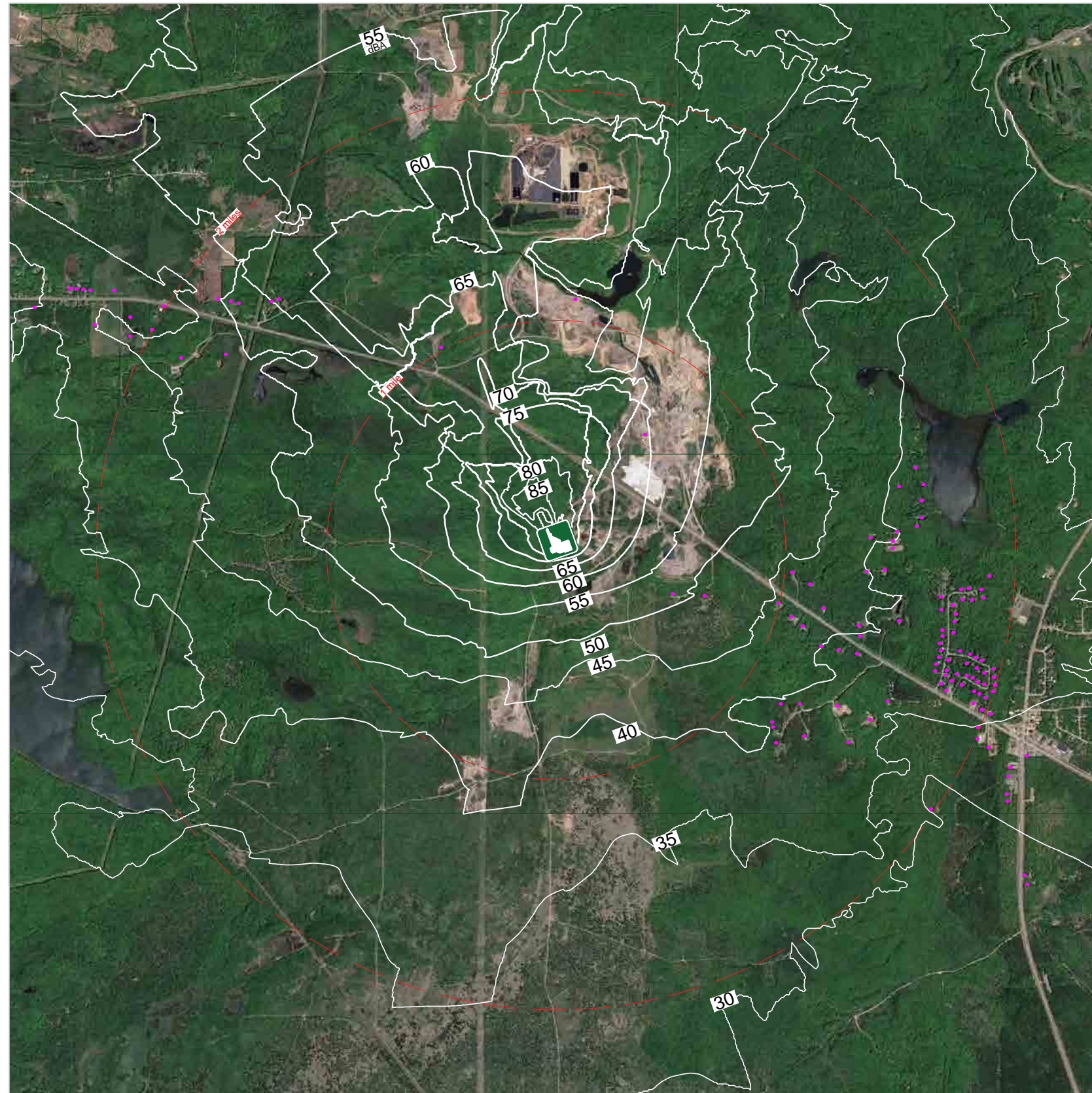
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. NNW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**MARQUETTE CRC**  
**MODEL O-8**

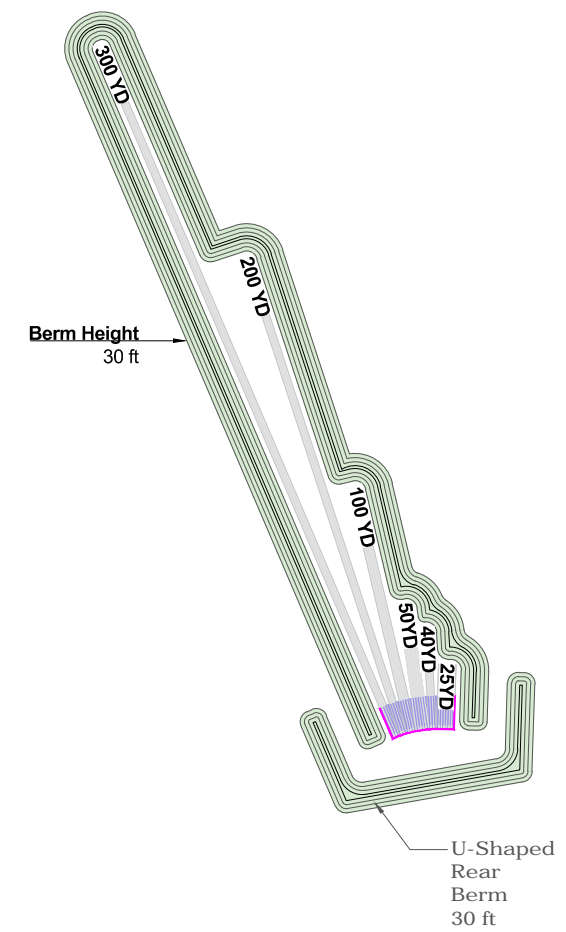
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

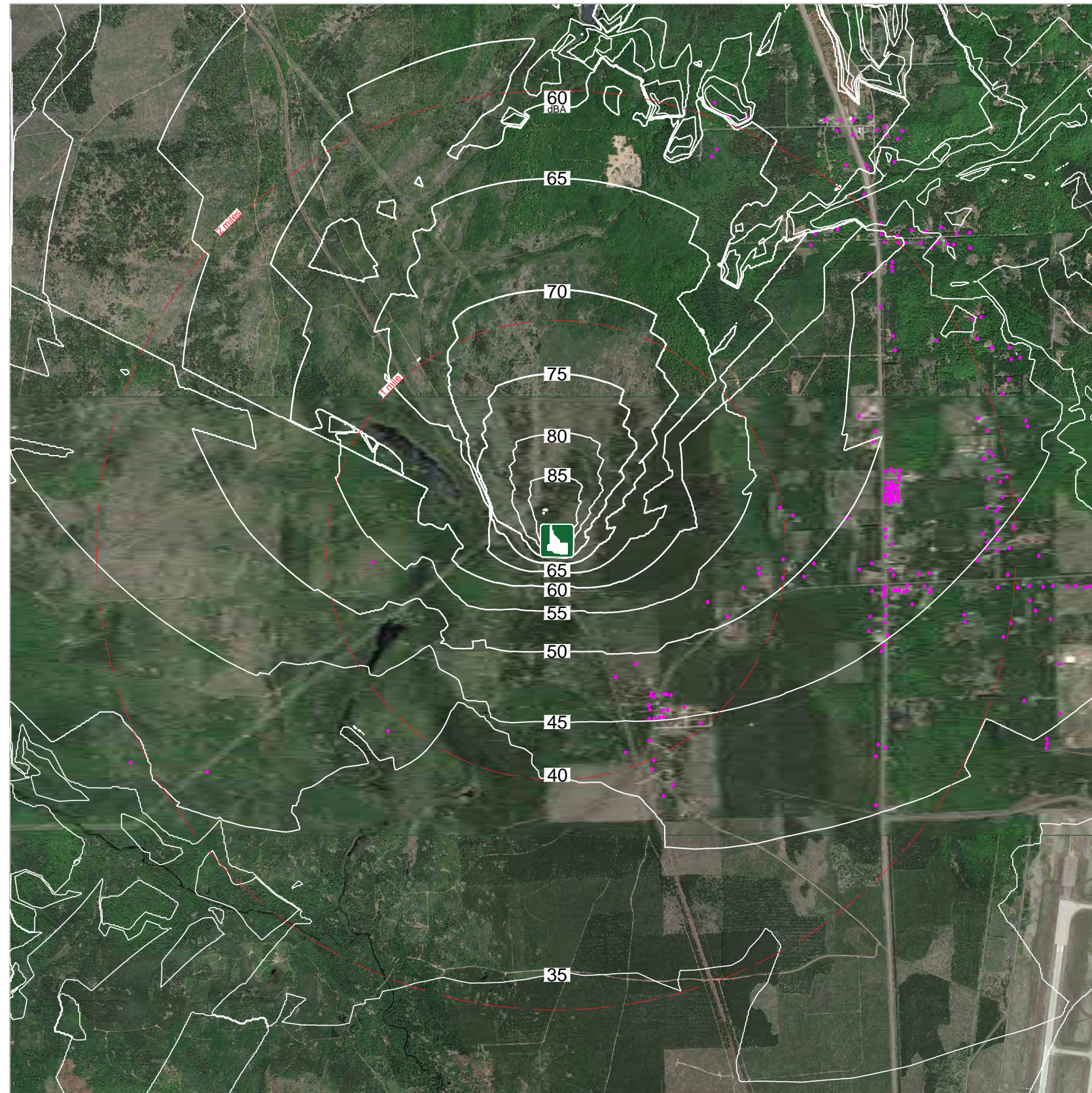
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. NNW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-9**

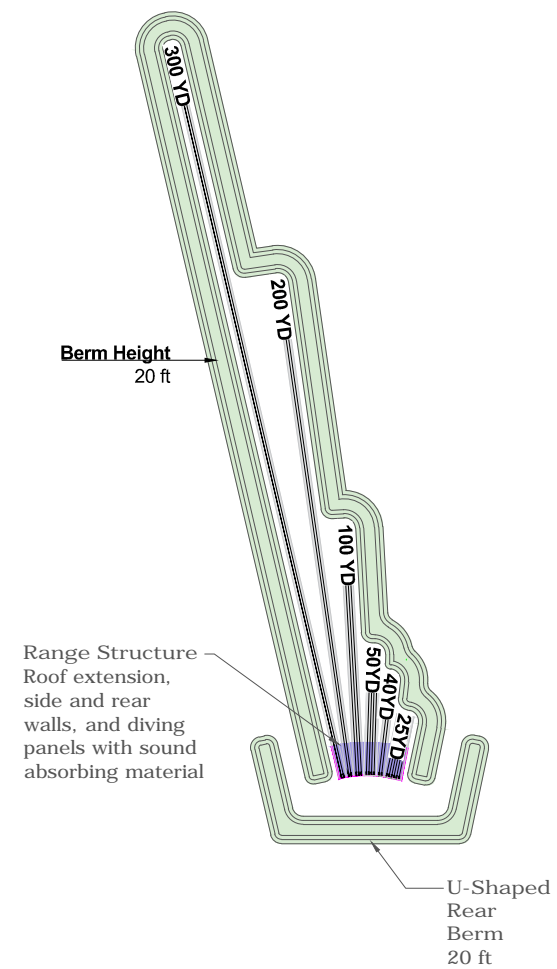
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

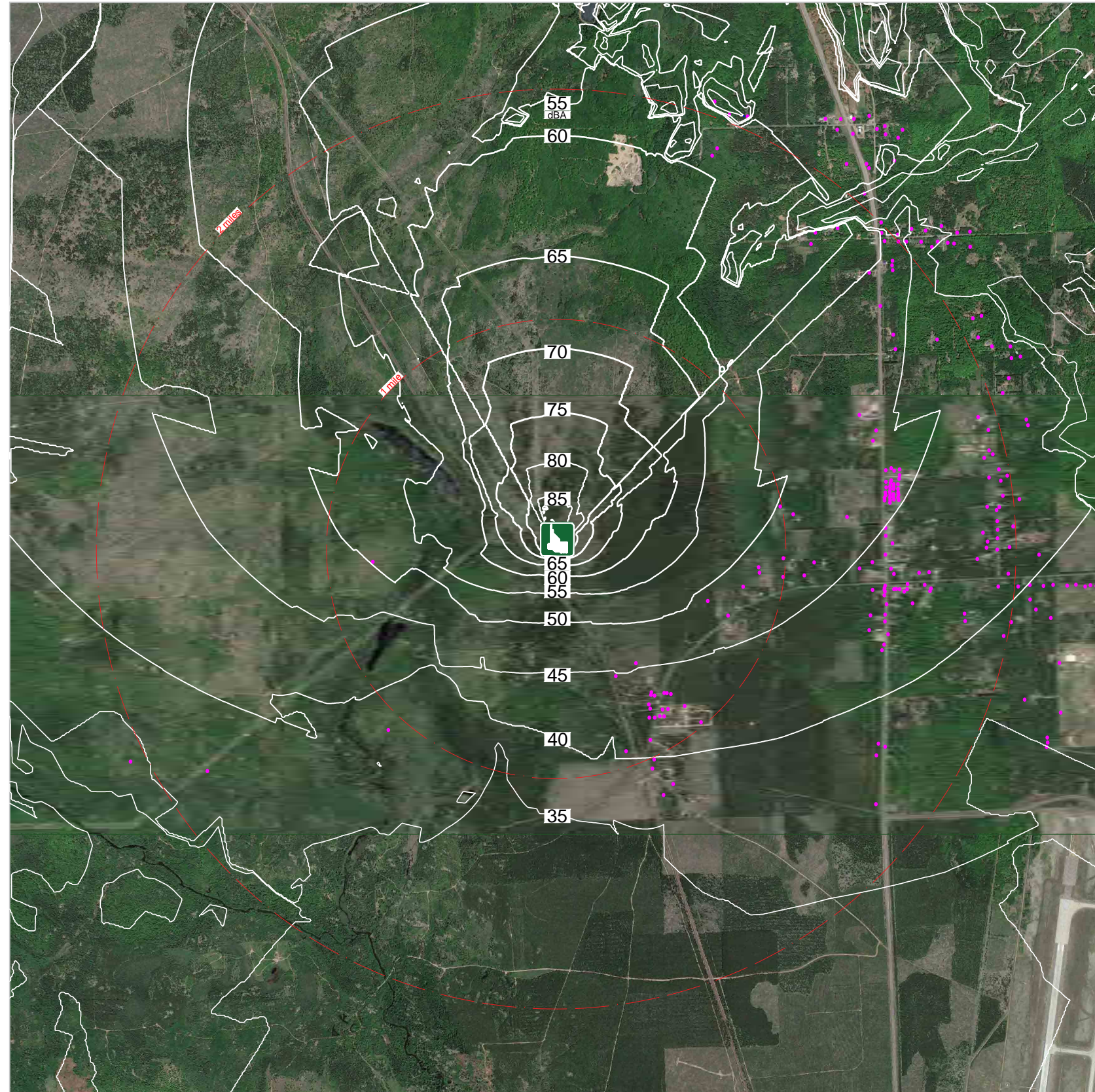
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-10**

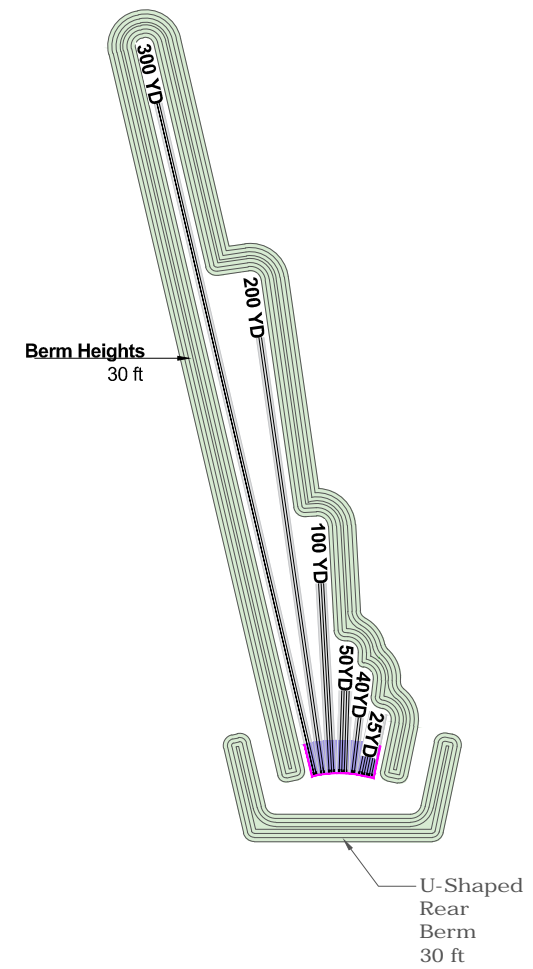
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

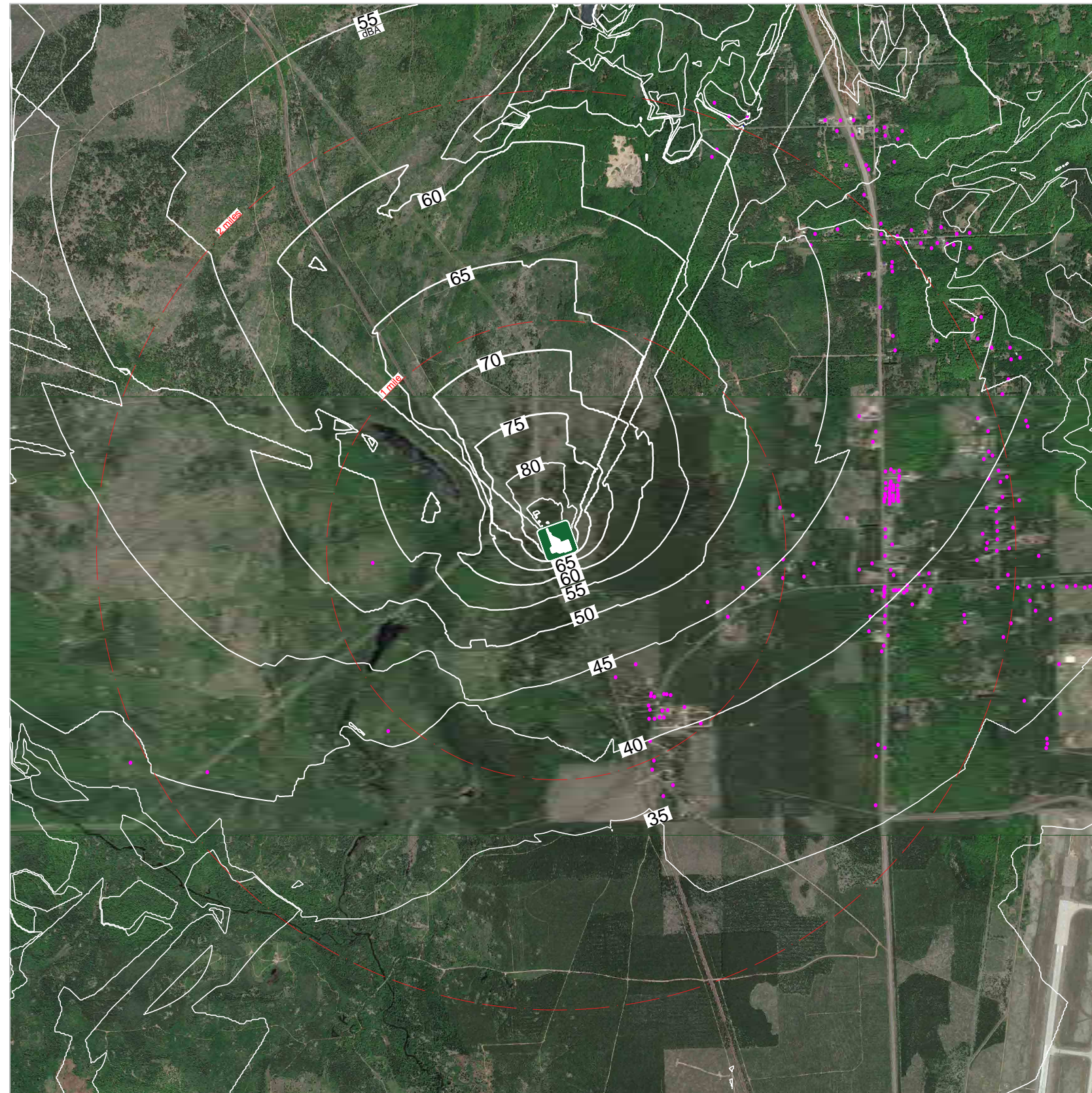
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





### SANDS MODEL O-11

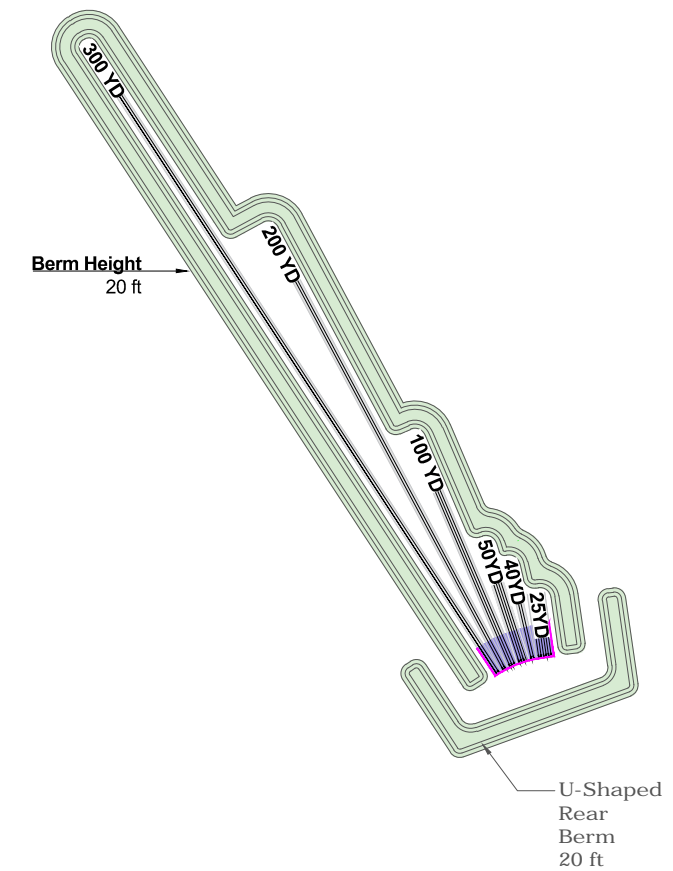
20 ft. Tall Side and U-Shaped Rear Berms  
40 ft. Extended Roof  
Sound absorbing canopy and dividers  
Structure with rear and side walls

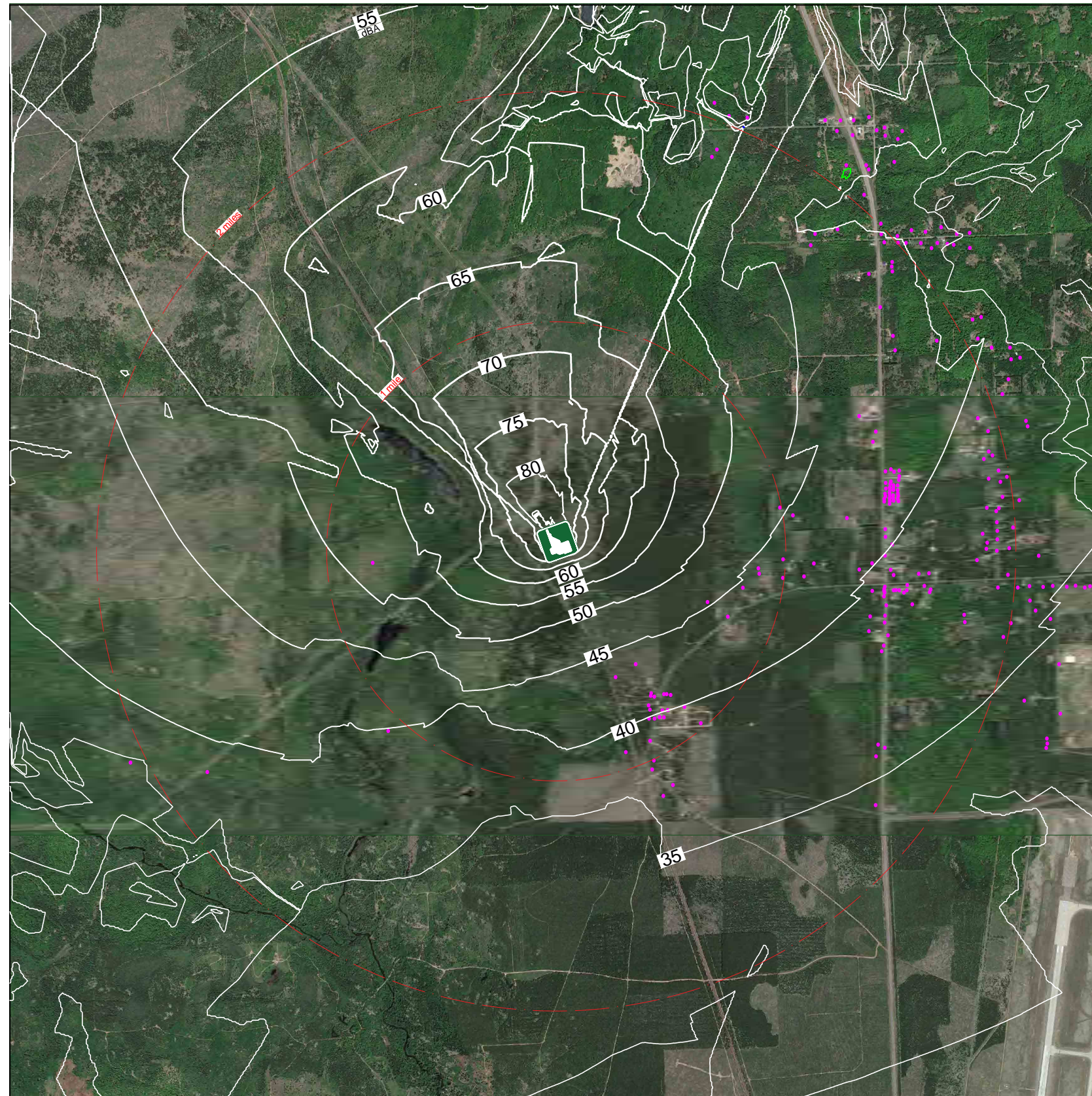
**Typical Day:**  
Shooters within 1 second:  
1 Rifle  
1 Shotgun  
1 Handgun

#### D.O.F. NW

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-12**

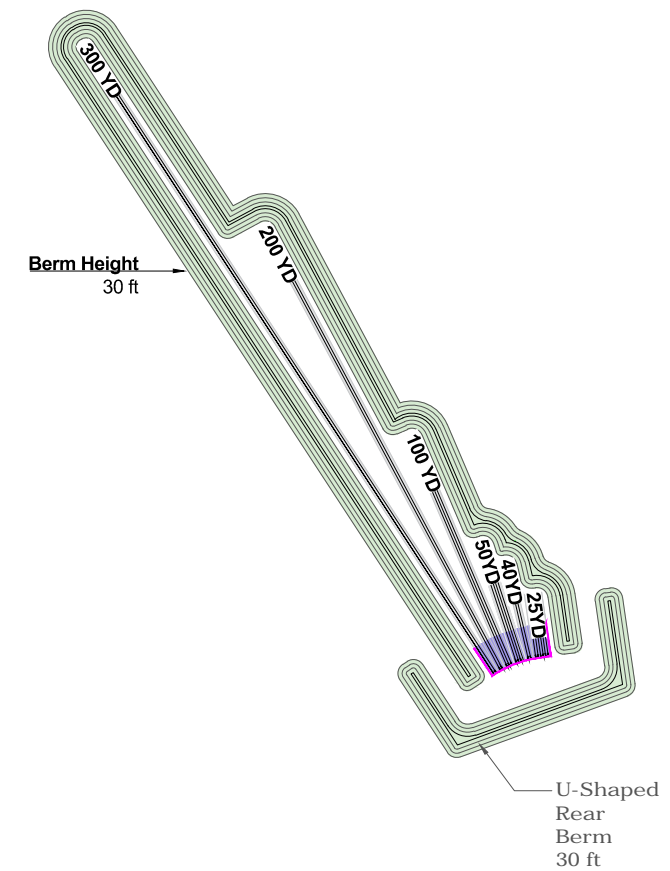
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

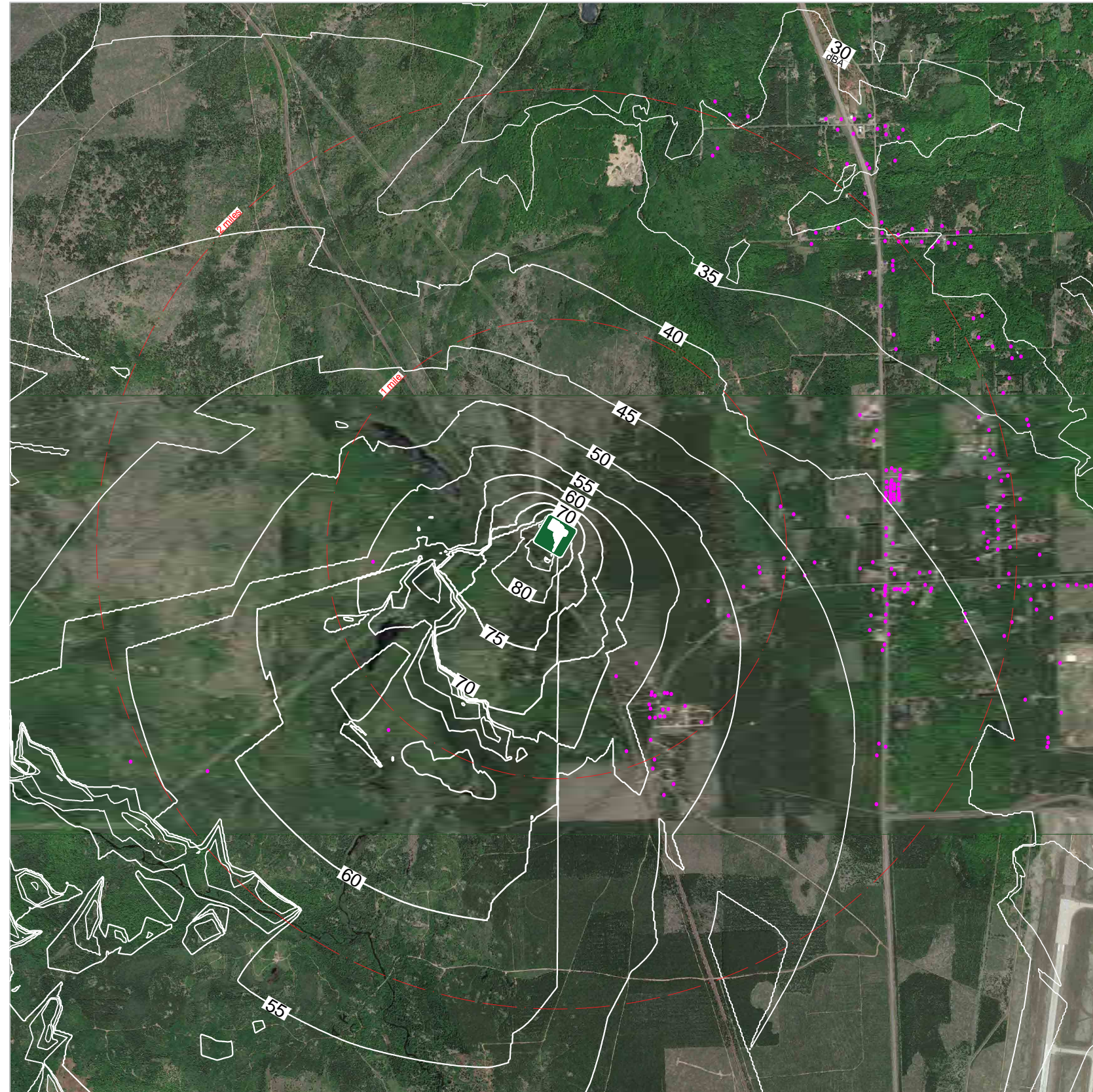
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. NW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-13**

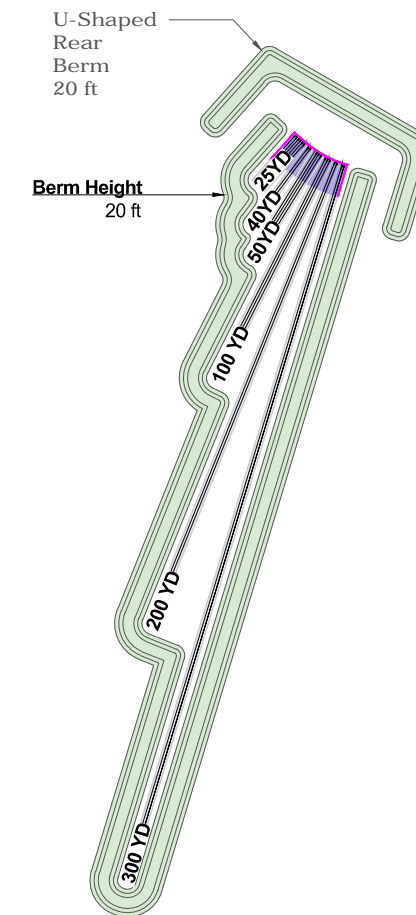
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

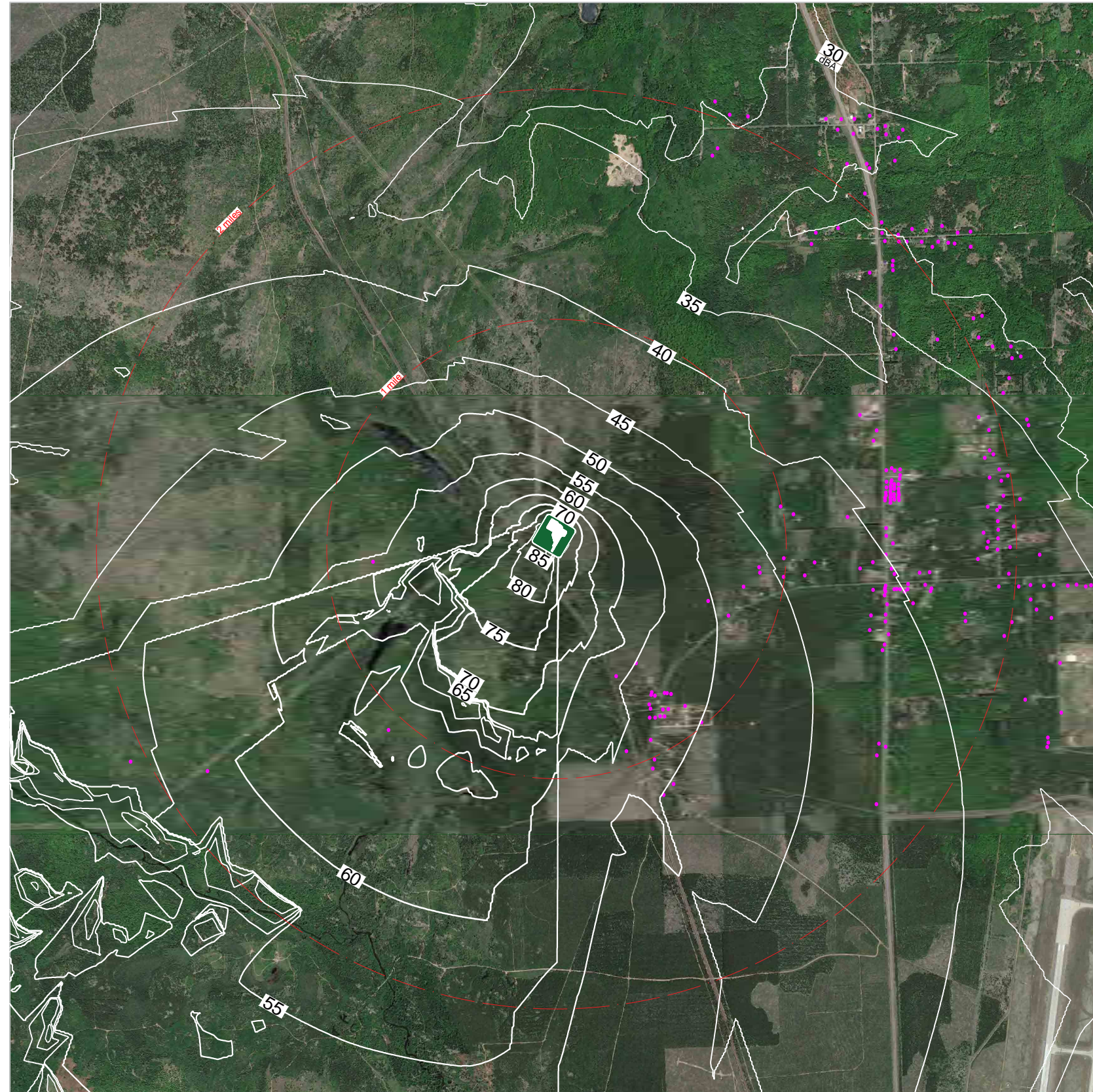
**Typical Day:**  
 Shooters within 1 second:  
 1 Rifle  
 1 Shotgun  
 1 Handgun

**D.O.F. SW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-14**

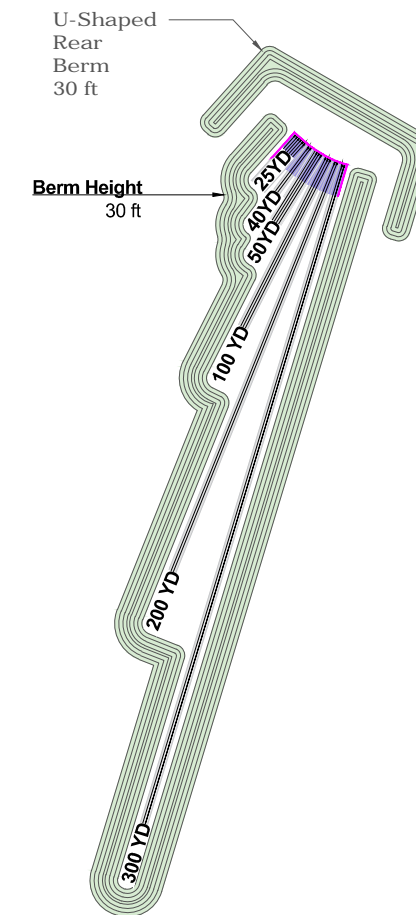
- 30 ft. Tall Side and U-Shaped Rear Berms
- 40 ft. Extended Roof
- Sound absorbing canopy and dividers
- Structure with rear and side walls

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

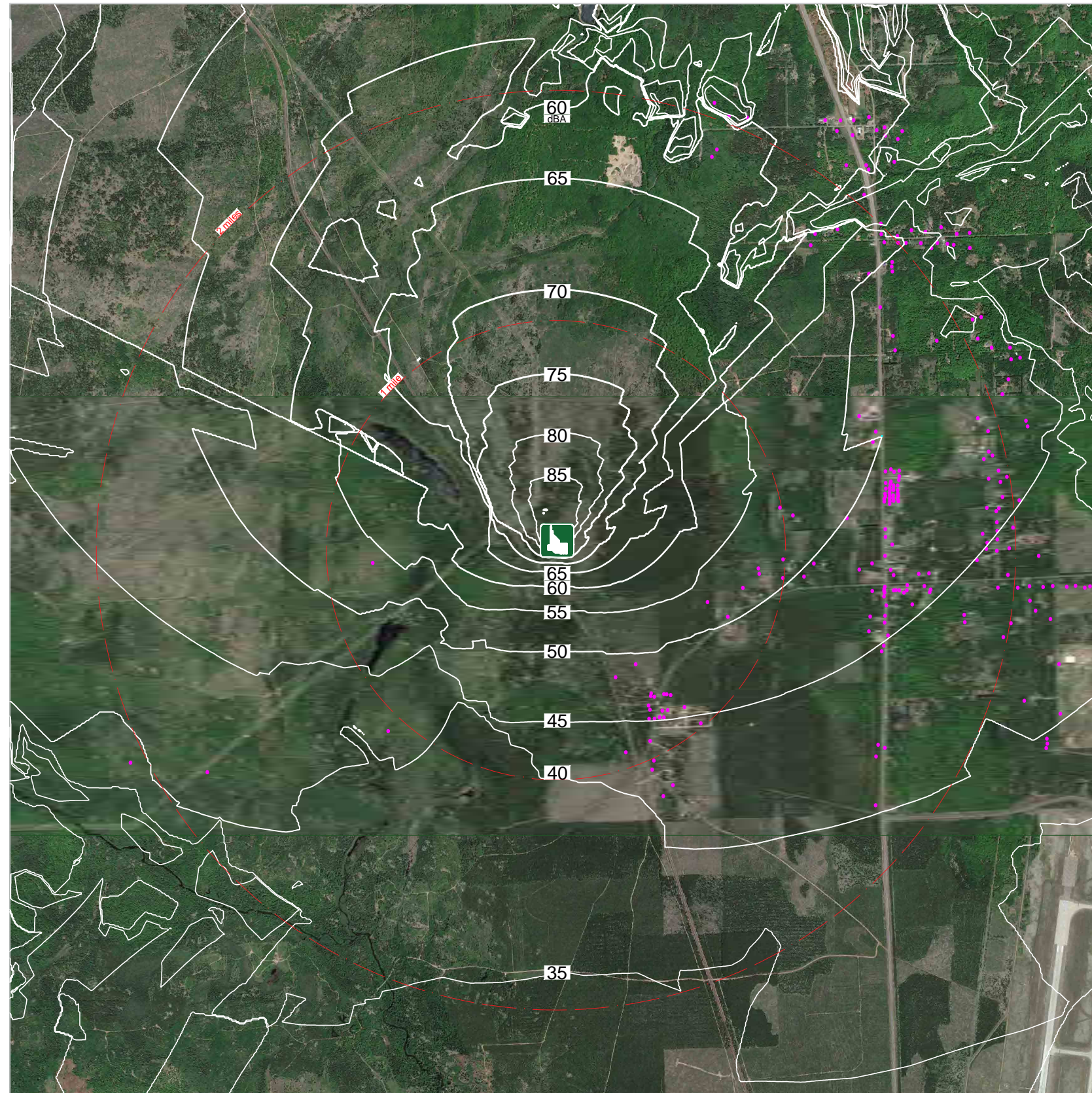
**D.O.F. SW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.







**SANDS**  
**MODEL O-15**

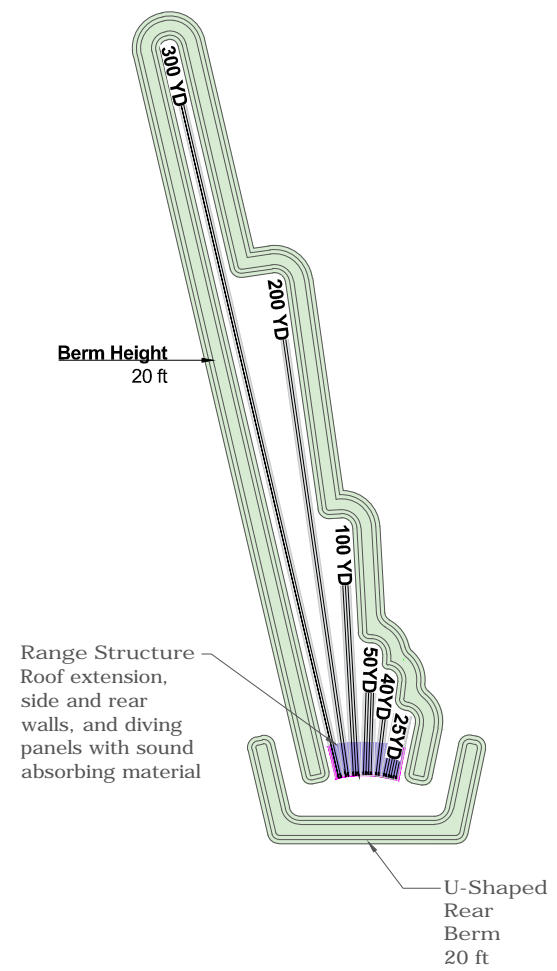
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

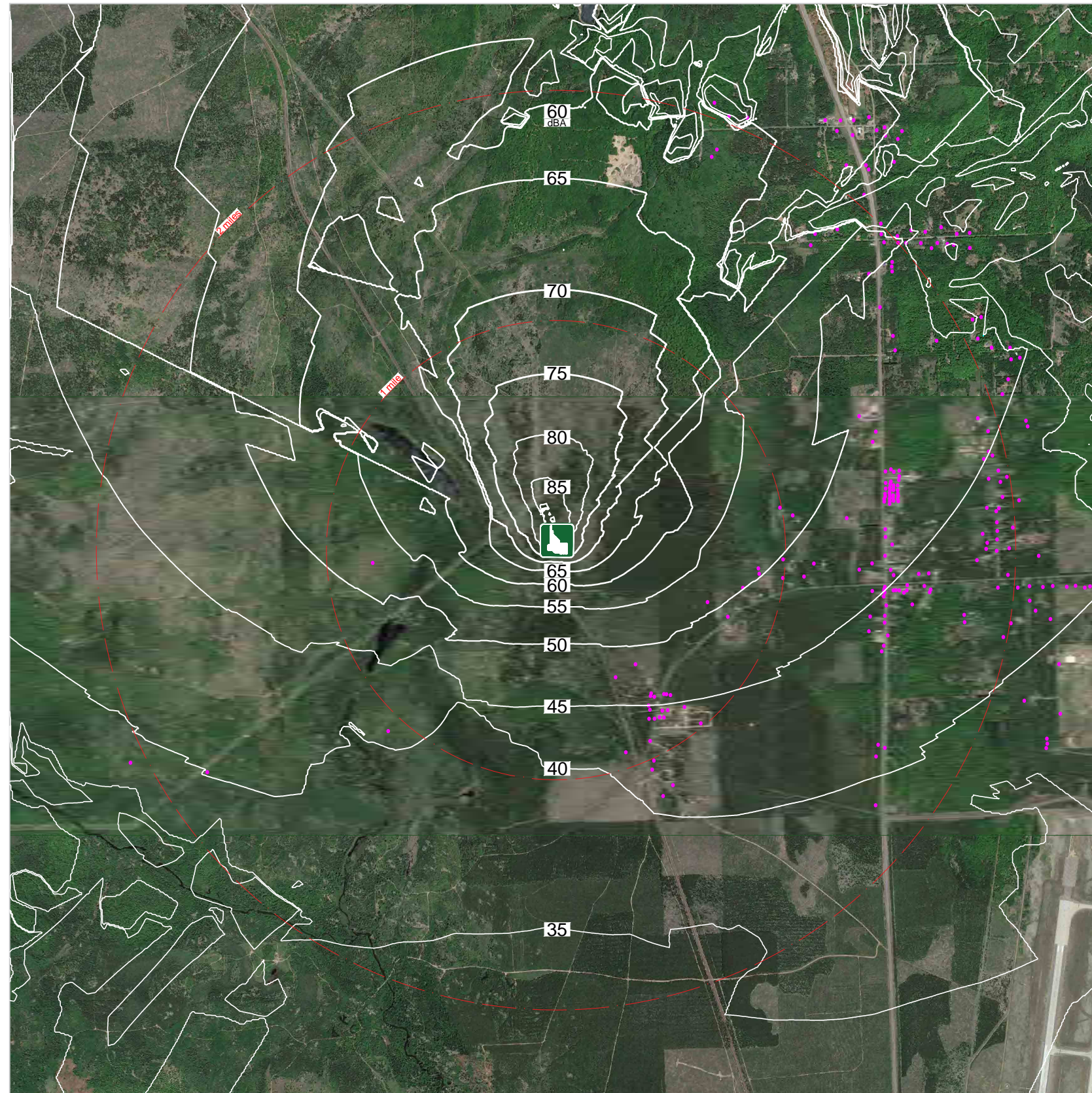
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-16**

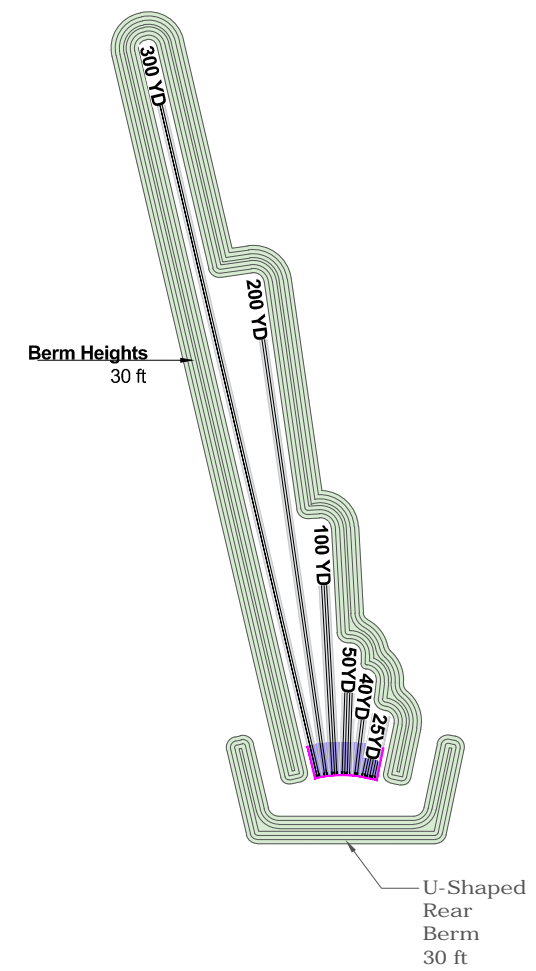
30 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

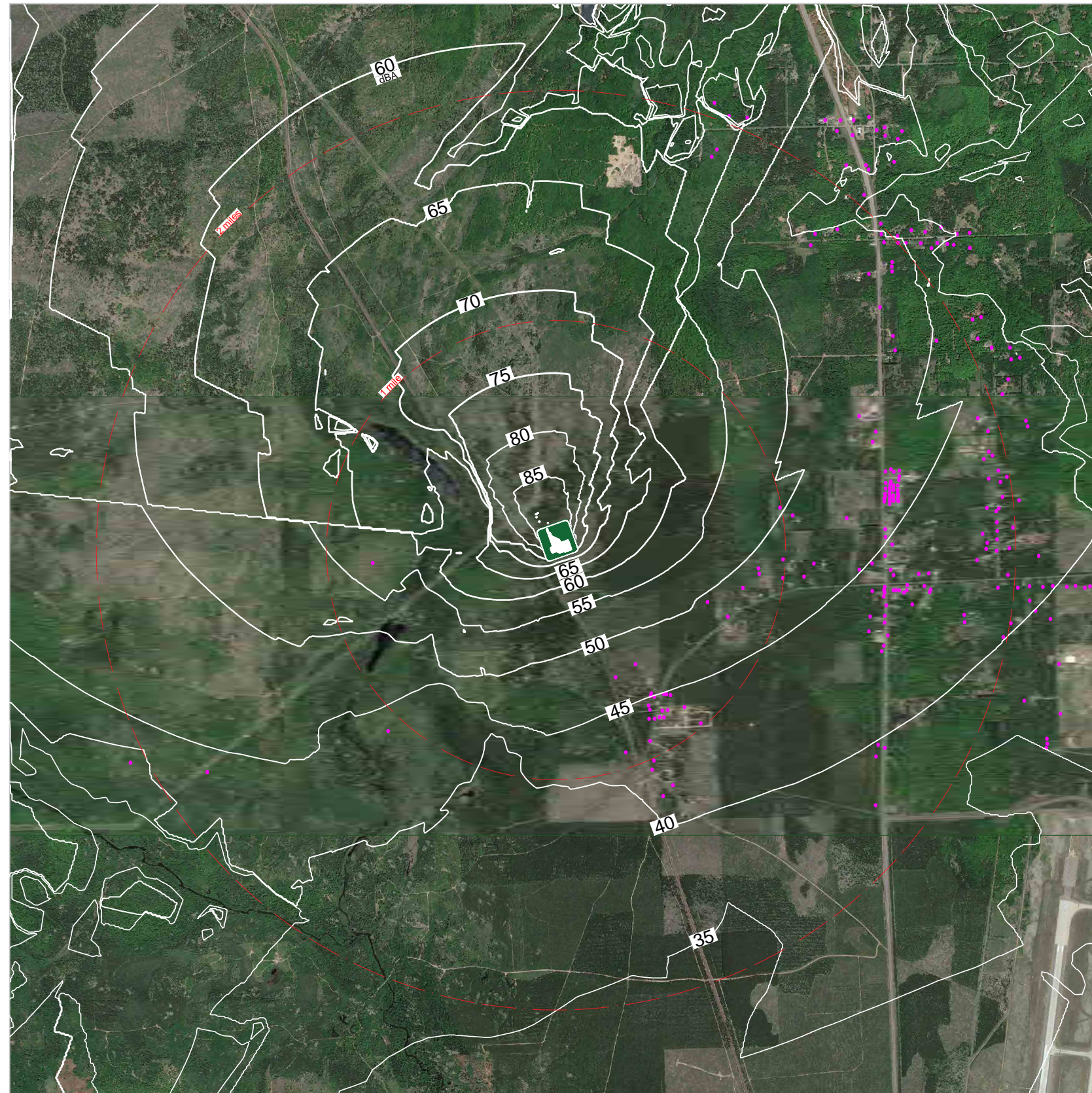
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. N**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-17**

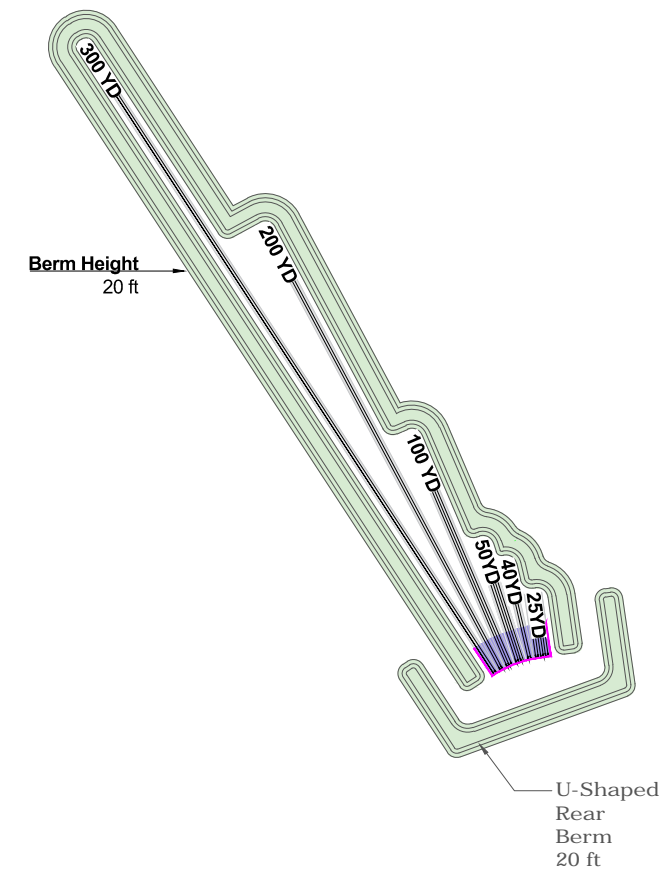
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

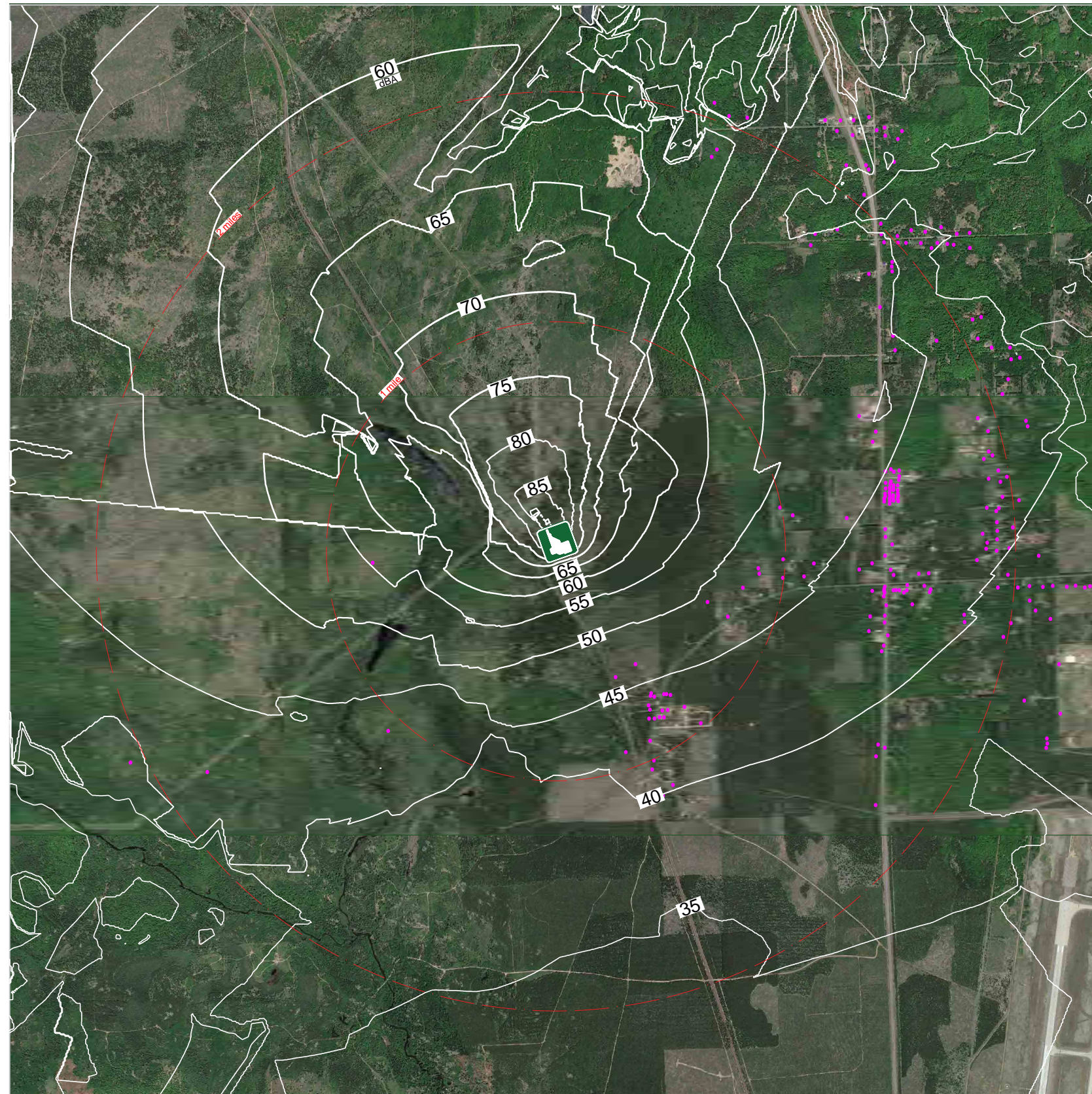
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. NW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





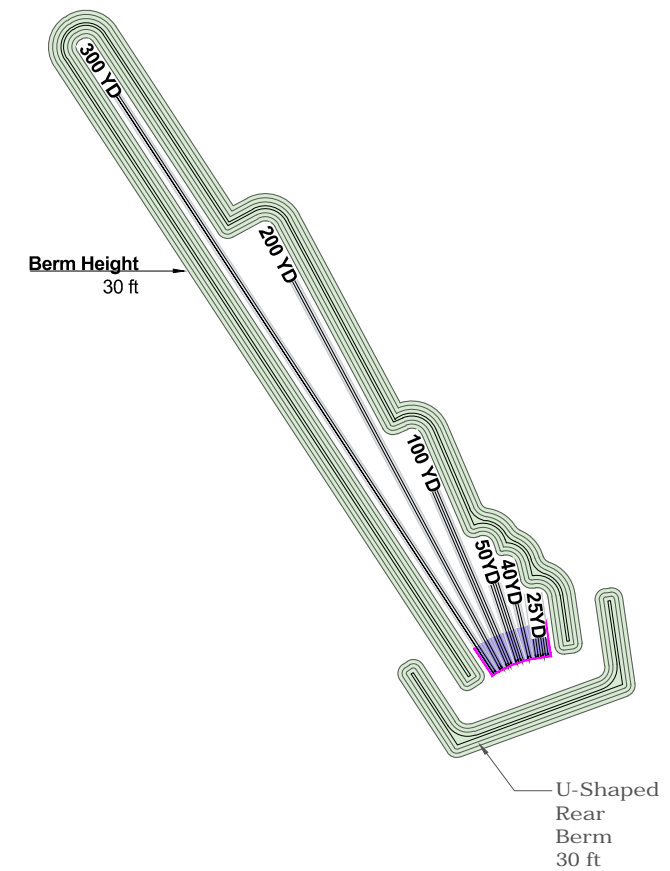
**SANDS**  
**MODEL O-18**

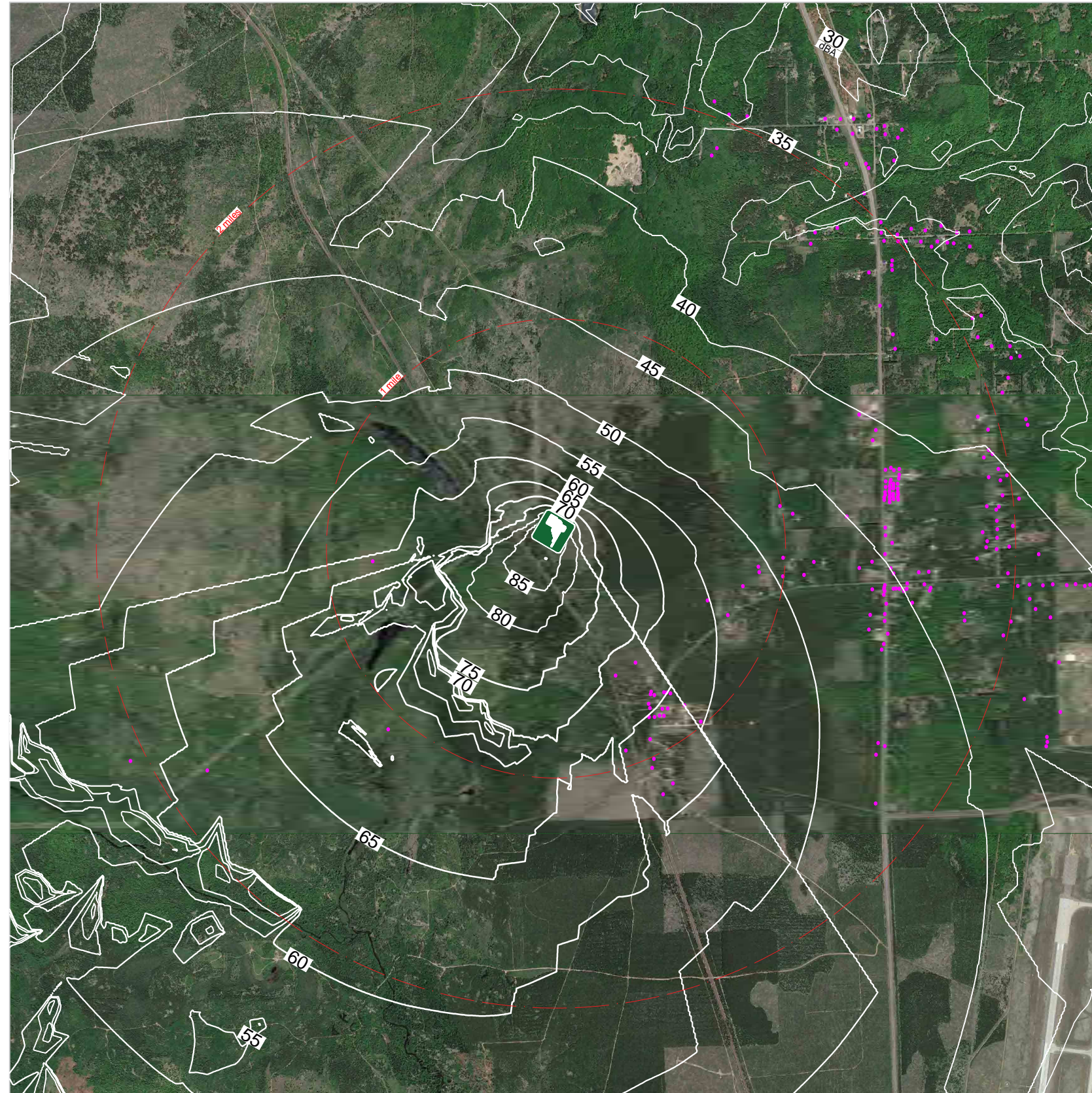
- 30 ft. Tall Side and U-Shaped Rear Berms
- 40 ft. Extended Roof
- Sound absorbing canopy and dividers
- Structure with rear and side walls

**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 O-19**

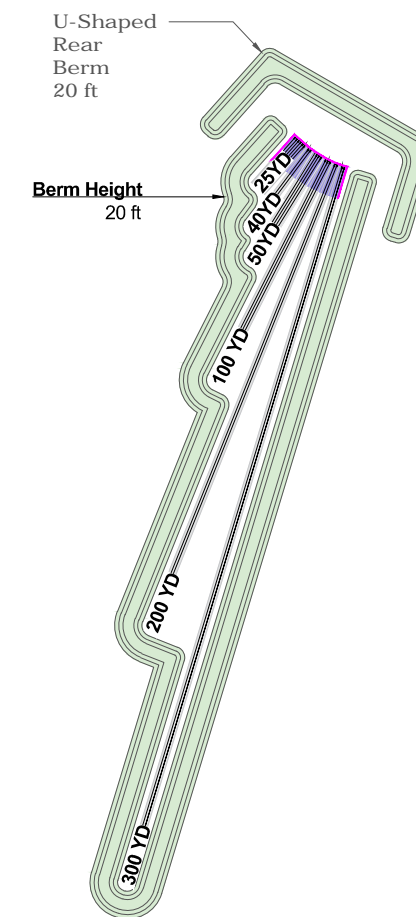
20 ft. Tall Side and U-Shaped Rear Berms  
 40 ft. Extended Roof  
 Sound absorbing canopy and dividers  
 Structure with rear and side walls

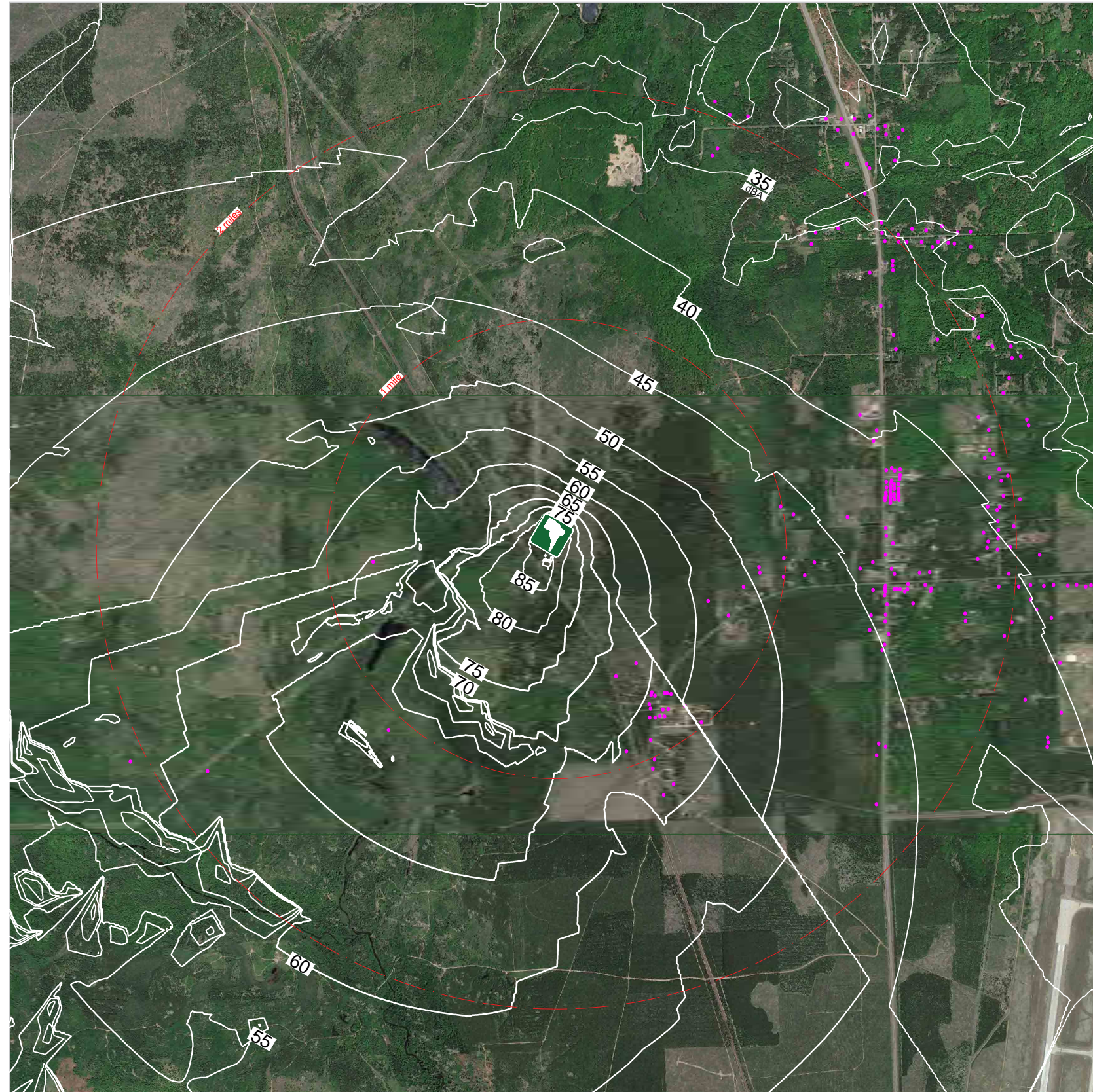
**Busy Day:**  
 Shooters within 1 second:  
 3 Rifles  
 1 Shotgun  
 2 Handguns

**D.O.F. SW**

Wind: 1 to 11 mph downward

50°F and 80% R.H.





**SANDS**  
**MODEL O-20**

- 30 ft. Tall Side and U-Shaped Rear Berms
- 40 ft. Extended Roof
- Sound absorbing canopy and dividers
- Structure with rear and side walls

- 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.

