



Line of Sight (LoS)



Evaluation and Validation

General

The presence, or absence, of Line of Sight (LoS) is an important aspect of combat and combat training and, therefore, critical in the design of a live fire training range. Long distances, topography of the natural terrain, structures, plus firing positions and targets can all combine to block the view downrange. The designer must perform a graphical and/or numerical line-of-sight analysis during the design process to ensure that all firing positions, targets, limit markers, lane markers, etc. are properly sited and visible from the required location(s). LoS analysis may also be required from control and camera towers to targets, firing positions, maneuver areas, etc. This computer-based analysis must be based on an accurate terrain model. Topographic surveys for the design of a range require sufficient accuracy to produce 1/2-m (1ft) contour intervals. The individual range sections in the RDG contain specific information on the LoS requirements for each particular range. In addition, on mounted maneuver ranges, the designer must coordinate with the range training and functional support personnel at the installation, ACOM, and TCM Ranges to determine the required training engagements and develop the target engagement capability matrix and subsequent LoS requirements.

The RTLTP MCX at the Huntsville Center reviews the required LoS as part of the design review process. For the larger maneuver ranges, the MCX uses a computer tool to analyze the LoS at designated milestones during the design; generally, the 35% and 95% design stages. The designer must provide fully modeled data, to include survey data, proposed trails, proposed target berms, proposed downrange power centers, target engagement capability matrix, and proposed firing and target positions in the format defined below for the evaluation. The MCX processes the data through the LOS analysis tool to determine/verify that the proposed range meets training table requirements. For small arms qualification ranges, the MCX may only verify that the designer has performed the required LoS analysis. The designer must provide profiles showing the required LoS. The stakeholders will evaluate and validate that the range provides the required LoS. None of these reviews absolves the designer from the responsibility of providing required line-of-sight when designing the range.

The angle of fire (AoF) is an important piece of information that the LoS calculates. The AoF affects the berms design and its protection of the target equipment. Refer to the individual targetry emplacement sections in the RDG for detailed requirements/limits for angle of fire.

The other element of target visibility, (i.e. the target lifters ability to present 100% of the target silhouette above the berm), is beyond the scope of the RDG and not addressed in this section.

Line of Sight tools also perform beaten zone analyses. The beaten zone is the areas behind targets where rounds regularly hit. The repeated impact of rounds in the same small area can cause severe damage to range infrastructure and terrain features. Beaten zone analysis is especially critical on heavily used stationary firing position to stationary target combinations; like tank zeroing and small arms qualification ranges. The designer is responsible for minimizing the risk of damage to critical downrange features or structures.

Line of Sight Philosophy

It is critical during the range design process to provide maximum target visibility for the shooter. With very few exceptions, design the ranges to provide 100% visibility of all required targets. This is critical for qualification ranges in order to maintain qualification standards; extremely little variance is allowed. On some tactical and maneuver ranges, the intent is sometimes to provide more realistic battlefield conditions and in some cases, 100% target visibility may not always be required; some allowances may be possible with the approval of the installation, the MCX, and TCM Ranges. Coordinate with the stakeholders and refer to the individual ranges for specific information on the LoS requirements for each particular range.

Note that there are two different sets of criteria used for ranges, one during the design and construction process and another for training purposes. Design and construct ranges for 100% target visibility with very few exceptions; TCM Ranges, RTLP MCX and the installation, must all be aware of and approve any exceptions. During training, the target is 'available' with 90% target visibility.

It is the designer's responsibility to provide the required LoS. The designer must provide sufficient analysis and/or calculations to prove that the proposed design provides all required visibility.

Use the following generally acceptable criteria as a starting point for LoS analysis; coordinate with the stakeholders for each particular range.

Firing Points

The firing point is the point where LoS is required 'From'. The control tower, camera locations, etc. can also be 'firing points' in a LoS analysis. The designer is responsible for ensuring visibility from every 'probable' point within a firing position, both horizontal and vertical. However, the sheer number can make it impractical to analyze all possibilities. As a practical minimum, designers perform LoS analysis from the worst-case horizontal and vertical limits and at discrete points within the firing area. The spacing of the discrete points depends on the type of firing position, the terrain, and the range type.

The following criteria are the minimum typically used.

Vertical

- Six Inches (6") above foxhole or prone firing area on small arms qualification ranges
- Lowest barrel or weapon/commander sight heights for all vehicles trained

Note: For ranges where vertical angle of fire is critical or may be an issue, LoS analysis may be required from multiple vertical elevations.

Horizontal

- Center front on single foxholes and prone firing positions
- Four corners and center point on Sniper firing positions
- Start, End, and 50' intervals along the centerline of firing box trail
- Center of the pad in both Hull Down and Turret Down positions

Camera

LoS for cameras is typically from a point 1' above the height of the camera mounting plate.

Control Tower

For visibility from the control tower, assume a seated position behind the counter, (i.e. 3' AFF and 3' back from the window). Include any obstructions from the tower itself in the analysis, (e.g. the wall below the window, walkways around the front of the tower, any railings, etc.) as well as any buildings/terrain around the tower that might block visibility.

Target Point

The Target point is where LoS is required 'To'. The intent, as stated above, is to provide 100% visibility of the target silhouette. In most cases, a significant portion of the target berm is visible from the firing point, especially on many small arms ranges. On ranges where significant amounts of cut and fill is required to achieve LoS or on ranges that have long distance requirements, visibility is only economically achievable to the very top of the berm. Because computerized LoS tools would show LoS failure from the berm itself, the MCX developed the following Target LoS points used in the LoS tool for design/construction and availability based on the standard emplacement configuration. (On the standard SIT/MIT, the berm is even with the timber, which is 1 inch above the concrete wall. On a SAT/MAT, the berm is 3 inches above the concrete wall.)

Small Arms Qualification Ranges

Small arms qualification ranges do not differentiate between design and availability.

Design Criteria

- LoS point on a SIT or MIT is 0.2 Inches (0.2") above the berm or one tenth of a foot (0.1') above the top of the concrete front wall.
- LoS point on a SAT or MAT is 0.6 inches (0.6") above the berm or three tenths of a foot (0.3') above the top of the concrete.

Maneuver Ranges

Design Criteria,

The design criteria are the same as that used for small arms qualification ranges.

- LoS point on a SIT or MIT is 0.2 Inches (0.2”) above the berm or one tenth of a foot (0.1’) above the top of the concrete front wall.
- LoS point on a SAT or MAT is 0.6 inches (0.6”) above the berm or three tenths of a foot (0.3’) above the top of the concrete.

Availability Analysis Criteria

A target is ‘available’ when at least 90% of the target is visible. Use the following criteria based on the standard silhouettes.

- LoS point on a SIT or MIT is 5 Inches (5”) above the berm/timber or one-half of a foot (0.5’) above the top of the concrete front wall.
- LoS point on a SAT or MAT is 9 inches (9”) above the berm or one foot (1.0’) above the top of the wall.

Horizontal

Use the following criteria to ensure that the entire width of the target is visible, and visible along the entire track for moving targets.

- SIT – both sides of the target wall
- SAT – both sides and the center point of the target point
- MIT – both ends and a minimum of 5-meter intervals along the target wall
- MAT – Start and end point of track and a minimum of 50-meter intervals along the target wall.

Ground Clearance

Terrain and vegetation between the firing point and the target are significant issues affecting LoS. Design the range so that the vegetation, when kept at the typical heights at the particular location, does not interfere with LoS. Include a consideration of the fact that shrinking maintenance budgets often means increased mowing intervals and higher vegetation. Consider standard construction tolerances and the thickness of added topsoil in the design. At a minimum, design the range so that LoS clears intermediate ground by the typical, maintained vegetation heights (use six inches as a minimum). That means a required overcut for LoS of at least 6 inches.

Target Engagement Capability Matrix.

For Mounted Maneuver Ranges, the Project Development Team (PDT), [the designer, the stakeholders (functional range training support personnel at the installation, ACOM, TCM Ranges), and the RTLP MCX] develop the project’s Target Engagement Capability Matrix (capability matrix) based on training standards and the installation’s training requirements at the beginning of the design process. The capability matrix contains the critical engagements that the range must provide in order for the project to meet Army training standards and the MCX uses it to analyze and validate LoS requirements. The matrix starts with a list of required engagements for the range. During the design process, the PDT adds the specific firing point/target combinations that meet those training engagements. The designer must include the capability

matrix in each design submittal for validation. Designers should consider hiring their own functional range training support personnel to aid in the design process. The final design product also includes an availability report. The availability report is a spreadsheet for each firing point showing which targets are visible from that point with the corresponding distance, azimuth, and angle of fire.

AS OF: 26 Jun 12		HBCT Gunnery 3 Sep 09										
Trail #	ABRAMS TABLE VI DEFENSIVE ENGAGEMENT POSSIBILITIES	Target Specifics of Engagements										
TT VI ENG	SIGHT AND CONDITIONS	CREW/MEMBERS	TARGET TYPE	TARGET POSTURE	BP 10	BP 11	HBP X03	HBP 12	BP 13	BP 14	BP 15	
60	OPCH Fall	TC	KE	Moving	1 Moving Tank, <800m or >2000m or <800m-2000m	M01 or M04 or M42403	M- or M06/M06 or M02/M03/M04	N02 or M- or M03/M04/M05/M06	M- or M- or M02/M03/M04/M05	M04 or M- or M05/M06	M04 or M- or M05/M06	
61	Machine Gun Pure	Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
62	Machine Gun Pure	Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
63	Main Gun Pure	Gunner	KE	Moving	1 Moving Tank, <800m or >2000m or <800m-2000m	M01 or M04 or M42403	M- or M06/M06 or M02/M03/M04	N02 or M- or M03/M04/M05/M06	M- or M- or M02/M03/M04/M05	M04 or M- or M05/M06	M04 or M- or M05/M06	
64	Main Gun Pure	Gunner	CE	Stationary	1 Stationary Truck, Butler or PC, <900m-1000m or APC or Busier, <800m or <800m-1000m	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04
			CE	Stationary	1 Stationary Truck, Butler or PC, <900m-1000m or APC or Busier, <800m or <800m-1000m	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04
			KE, detm	Moving	1 Moving Tank, <800m or >2000m or <800m-2000m	M01 or M04 or M42403	M- or M06/M06 or M02/M03/M04	N02 or M- or M03/M04/M05/M06	M- or M- or M02/M03/M04/M05	M04 or M- or M05/M06	M04 or M- or M05/M06	M04 or M- or M05/M06
65	Change of Weapon System	Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
			KE	Stationary	1 Stationary Tank, <800m or >2000m or <800m-2000m	M01 or M04 or M42403	M- or M06/M06 or M02/M03/M04	N02 or M- or M03/M04/M05/M06	M- or M- or M02/M03/M04/M05	M04 or M- or M05/M06	M04 or M- or M05/M06	M04 or M- or M05/M06
66	Change of Weapon System	Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Sniper (Fapad) or Technical Truck, <800m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
			CE	Stationary	1 Stationary Truck, Butler or PC, <900m-1000m or APC or Busier, <800m or <800m-1000m	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04
67	Degraded	Gunner	CE	Stationary	1 Stationary Truck, Butler or PC, <900m-1000m or APC or Busier, <800m or <800m-1000m	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04
			CE	Stationary	1 Stationary Truck, Butler or PC, <900m-1000m or APC or Busier, <800m or <800m-1000m	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04	V03/V04 or V07/V08 or V09/V10/V11/V12/V13/V14	V0P / M02/M03/V01/V02/V03/V04 or V05 or V06/M02/M03/V01/V02/V03/V04
68	Degraded	Gunner	KE	Moving	1 Moving Tank, <800m or >2000m or <800m-2000m	M01 or M04 or M42403	M- or M06/M06 or M02/M03/M04	N02 or M- or M03/M04/M05/M06	M- or M- or M02/M03/M04/M05	M04 or M- or M05/M06	M04 or M- or M05/M06	
69	Simultaneous	Leader	M200	Stationary - Flare	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
		TC	Call 50	Stationary	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	
		Gunner	Coast	Area gr Point	1 Set of Troops, RPG Tn, Moving Inf, Sniper (Fapad) or Technical Truck, <300m or 300m-400m	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C03 / M01 / F141 / V03 or C10/C07 / M03 / F142/F101 / F02/M05/M06	C01 / M01 / F-1 V01 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C07 / M03 / F-1 V03 or C02/C03/C04/C05 / F01 / M02 / F01 / M03 / M04 / M05 / M06	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	C10 / M- / F041 / V- or C10/C11 / M- / F041 / V- or C10/C12 / M- / F041 / V-	

Legend	Target Listings	All targets listed are those that meet the conditions (type & distance) for the specific task. All targets are listed in the order shown in "Target Specifics of Engagements". There are five spaces between each target listing.
VR	Indicates a SAT emplacement	
BP	Indicates a BIA emplacement	
CP	Indicates a 4-BIT cluster emplacement	
IBP	Indicates a 40m MIT emplacement	
F041 or F042	Indicates a Facade FA411-14-story / FA02-2-story	
StnD	For Offensive engagements, indicates the location (Stationing Point) on the trail where the engagement starts.	
Black Font	Indicates that we have LOS to the target from the specified firing point.	
Plum Font	Indicates that we have full LOS to the target from Full Down but not from Turned Down. It may be probable that a portion of the target is viewable from the Turned-Down position, but the LOS software only counts full LOS.	
Red Font	Indicates that we do not have LOS for that target from the specified firing point.	
V01-V08 or V09-V13 or V15-V16	Engagement conditions met and at least one MP is available.	
H041 or H02, H04, H05	Engagement conditions met but no MP is available.	
V02-V02 / V03-V03 / V04-V04	All engagement conditions met but at least one target condition is not viewable from turned-down, so it is not a complete engagement.	
NTA	At least one target condition for the task is not available from the specified firing point.	

SAMPLE TARGET ENGAGEMENT CAPABILITY MATRIX

The designer should coordinate with the Government about whether or not to include field verification of LoS in the construction contract. The field verification occurs as early as possible in the construction process. The contractor informs the Government if any of the engagements included in the availability report are not visible. The Government investigates the cause, (survey bust, construction or design error, etc.), and determines if or how to correct the issue.

LOS Data Submittal Requirements

The designer is required to provide the following information to the RTLP MCX for LoS analysis and validation on Mounted Maneuver Ranges:

Layer/Level Standards Document

The designer will provide the layer/level standards document used for range design. This document should include the following:

- a. Layer names/number and description of type of data contained
- b. Drawing naming convention
- c. Drawing units (English or metric)
- d. Target and firing point naming convention
- e. Firing/Target type designation
- f. Inventory of files contained within the submittal and a description of the data contained

Existing Digital Model

The designer will provide an existing surface digital terrain model using one of the following formats:

- a. Preferred – dtm formatted Bentley InRoads version 8.4 surface
- b. Land XML Format
- c. Electronic **comma or space** delimited ASCII formatted files containing digital surface information. Each type of data should be in a separate file. The file formats are as follows:
 - a. Random Points should have the following format: ID*, Northing, Easting, Elevation, Feature*
 - b. Breakline Information:
 - i. ID*, Northing, Easting Elevation, Feature*, Pencode
 - ii. Pencode - This field defines for each linear feature a zero (0) or one (1). A one identifies the first point of a linear component followed other points within the line having zero. The next new line will start with a one.
 - c. For electronic **comma or space** delimited ASCII formatted files containing triangle point information (TIN), the file format is as follows:
 - i. Random Points should have the following format.
 - ii. ID*, Northing, Easting, Elevation, Feature*

(NOTE: * = Optional parameters)

Trail / Moving Target Emplacement Locations

- a. Electronic file containing 3D graphic alignments shown at zero elevation at the centerline of trails and moving target emplacements
- b. Profile of existing and proposed alignments and associated profile report in text format.

Stationary Target Emplacement

Electronic comma or space delimited

ASCII formatted file with the following information: Name-Type, Northing, Easting, and Elevation

Start / End Trail Firing Positions

In an electronic CAD file, the designer must locate and label starting and ending firing positions along the trails.

Proposed Range Digital Terrain

The designer must provide a proposed digital terrain model including all trails, firing positions, target locations, and any other site grading required on the project. Use one of the following formats:

- a. Preferred – dtm formatted Bentley InRoads version 8.4 surface
- b. Land XML Format
- c. 3D Electronic drawing containing 3D data defining proposed range: breakline features are preferred, but contours can be submitted