APPENDIX D

Validation Report

Fort Ord

OE Risk Assessment Protocol

Validation Report – Sensitivity Analysis & Beta Test

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For the
Presidio of Monterey
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1.0 INTRODUCTION

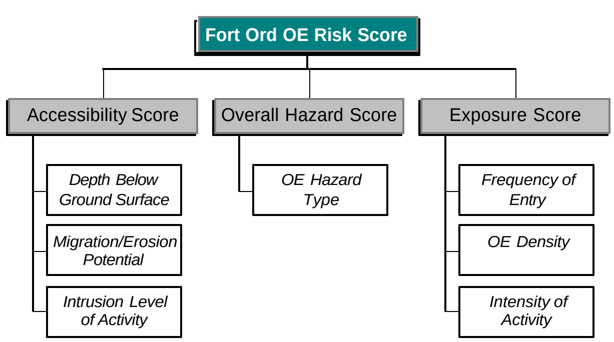
1.1 BACKGROUND

The Fort Ord OE Risk Assessment Project Team has created a Protocol for conducting the ordnance and explosive (OE) risk assessment based on existing tools, which have been modified for site-specific needs. Key to the development of the Fort Ord OE Risk Assessment Approach is the creation of an approach that logically combines the elements of OE risk – Accessibility, Overall Hazard, and Exposure. Prior to implementing the risk assessment Protocol, the Project Team conducted a sensitivity analysis and beta test to determine whether the input factors and the process algorithms produce an overall OE risk score that will fulfill the objectives previously defined for the risk assessment approach.

At the time of the validation exercises, the Protocol was in Preliminary Draft format and was assumed to be complete and cover applicable aspects of OE risk in a qualitative and straightforward manner. The testing and results of the validation of the Protocol is outlined in this report.

The input factors are separated into three categories – Accessibility, Overall Hazard, and Exposure. In each category the input factors are combined to determine a ranking for the category. The rankings of the three categories are then combined to determine an overall qualitative risk score as developed by the Project Team, using best professional judgment. Below is a graphical depiction of each of the factors and how they role up into these three categories for the Fort Ord OE Risk Assessment Approach. For more information, please see the Fort Ord OE Risk Assessment Approach Protocol (March 2002).

Figure 1-1. Fort Ord Risk Assessment Approach



1.2 PURPOSE

The Beta Test on the Protocol was implemented to test the following objectives, goals, and concepts:

- **Estimation of baseline and residual risk**
- **Decision of remedial action and risk management selection** – In the RI/FS process, risk assessment is used to evaluate remedial actions in the Threshold Criteria of the National Contingency Plan's 9 Criteria used to evaluate remedial alternatives – Overall Protection of Human Health and the Environment.
- **Communication of OE risk** – The Protocol should clearly outline how site information is being used to determine the OE risk.
- **Compliance with CERCLA** – The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation and Feasibility Study (RI/FS) process was established to identify the nature and extent of risks at a site and to determine the applicability of various cleanup methods. This Fort Ord OE Risk Assessment Protocol is proposed to encompass the three goals of the RI/FS human health evaluation, as established by CERCLA, to:
    - Establish baseline risk assessment,
    - Refine preliminary action objectives, and
    - Evaluate remedial alternatives affect on risk.
- **Defensibility and Flexibility** – This goal relates to communication of the Protocol as well as the Protocol's ability to be applied to a variety of site conditions. To be defensible, the Protocol should be based on sound technical principles. The Protocol should show resolution between remedial action alternatives on a single site.
- **Straightforwardness** – Again, the Protocol should show a logical and defensible step-wise process used to determine the OE risk score.

As the decisions made in the RI/FS process are not based solely on the risk assessment, the Fort Ord OE Risk Assessment Protocol will be only one input used to determine the response action for the site. The Protocol was developed to assess the baseline and residual risk at the site. The residual risk will change depending on the effect that alternative response actions have on the factors driving the risk at the site. In order to select a response action several other factors should be considered, as outlined in the NCP.

1.3 DOCUMENT LAYOUT

The report details the validation of the Fort Ord OE Risk Assessment Protocol in the following six sections:

Section 1.0 – Introduction: This section introduces the concepts related to the partnered development of the Protocol.

Section 2.0 – Process: This section describes the techniques used to analyze the logic of the Protocol.

Section 3.0 – Sensitivity Analysis Results: This section explains each of the methods and assumptions used to analyze the sensitivity of the risk assessment results to the seven input factors and presents the results of this analysis.

Section 4.0 – Beta Test Analysis Results: This section explains the methods and assumptions used to test the Protocol using site data, and presents the results of the tests.

Section 5.0 – Questionnaire: This section presents the beta test participants' thoughts and recommendations regarding the Protocol as captured in a questionnaire.

Section 6.0 – Summary and Recommendations: This final section combines the information from Sections 1.0 to 5.0 and provides options for resolution of necessary changes to the Protocol.

This report will be finalized after the April 2002 meeting of the Project Team pending resolution of changes to the Protocol.

2.0 PROCESS

Two validation techniques were used to analyze the logic of the Fort Ord OE Risk Assessment Protocol – Sensitivity Analysis and Beta Testing. The Sensitivity Analysis was conducted to determine which input factors significantly affect the OE risk score and which have relatively minor impact. The Beta Test was conducted to determine the functionality of the Protocol and compare the application to the objectives and goals of the OE risk assessment. In addition, a questionnaire on the usefulness of the Protocol was given to the assessment teams as part of the Beta Test. This section discusses the process used to conduct the Sensitivity Analysis and Beta Test, as well as the questionnaire.

2.1 SENSITIVITY ANALYSIS

Sensitivity analysis is the computation of the effect of changes to input variables on the results. For quantitative models, sensitivity analysis evaluates mathematical equations used to combine multiple input variables into results. In the Fort Ord OE Risk Assessment Protocol, the model is qualitative. In place of equations, the matrices are used to combine the input variables into qualitative results. Thus, the sensitivity analysis evaluates changes from “A” through “E” for each input variable and their effect on the results.

2.2 BETA TEST

Malcolm Pirnie prepared a concept paper for the team to review. The Beta Test Concept Paper identified the steps for the implementation of the beta test as follows:

Step 1 Establish independent assessment teams

Step 2 Choose data sets in coordination with the Project Team

Step 3 Compile data sets for use in the risk assessment. Information to include:

- Site description (terrain, erosion potential, vegetation)
- Historical information
- OE Type
- Density of OE
- Depth of OE
- Sampling confidence relative to DQOs
- Proximity to populations
- Current use scenarios
- Reuse scenarios

Step 4 Formulate problem statements to include baseline conditions, response actions, and intended receptors.

Step 5 Independent teams run the risk assessment approach Protocol on each site as defined in the problem statement.

Step 6 Compile results and recommendations

Step 7 Prepare summary report

Three independent assessment teams (Team A, Team B, and Team C) were tasked with running the Protocol on the two data sets. Two problem statements were developed based on information from Fort Ord sites. The independent teams used the Protocol to determine OE risk for baseline conditions and remedial action alternatives, which included baseline, no action, institutional controls, surface clearance, and clearance to depth. The problem statements presented two intended receptors based on the proposed reuse for the property as identified in the data set package.

2.3 QUESTIONNAIRE

A questionnaire was developed to capture the strengths and weaknesses of the Protocol, as well as any additional recommendations from the independent assessment teams. The questionnaire contained eight open-ended questions developed to guide the reviewers to provide recommendations for change. Each member of the independent assessment teams was asked to complete the questionnaire

3.0 SENSITIVITY ANALYSIS RESULTS

3.1 METHODS AND ASSUMPTIONS

Two techniques were used to conduct sensitivity analyses – deterministic and probabilistic. Deterministic analyses were used to determine all theoretically possible results for each tool (i.e., how many times that scores of "A" through "E" would theoretically occur). Probabilistic analysis was conducted to determine the dependence of each input variable relative to the result. In other words, it shows us how much an Overall OE Risk result would change for a proportional change to an input factor.

In the initial development of the Fort Ord OE Risk Assessment Protocol, the Project Team discussed their thoughts and goals for the sensitivity of each input factor. For Accessibility, the Project Team thought that OE Depth should be a primary driver to the Protocol, Level of Intrusion should be a secondary driver, and Migration/Erosion should be a modifier to the overall score. For Exposure, the Project Team reasoned that OE Density should be a primary driver to the Protocol, and Frequency of Entry and Intensity of Contact with Soil should be secondary drivers to the overall score.

Because of the large number of input variables and process algorithms, Microsoft Excel® was used to systematically change each input variable one-at-a-time while holding all others constant. The program cycled through the range of possible scores for input variables ("1" through "9" for depth), stored the results ("A" through "E"), and counted the number of occurrences of each result. The total number of possible results and the number of possible results for each score on the scale were recorded and are presented below.

Malcolm Pirnie used Decisioneering Inc.'s Crystal Ball® 2000, a commercially available add-in to Microsoft Excel®, to conduct the probabilistic analyses. Crystal Ball® was designed primarily to conduct Monte Carlo analysis with an option built into the software that was used to conduct the probabilistic sensitivity analyses. Frequency distributions were assumed to be uniform for the input factors; that is, each score of the input factors was assumed to be equally likely to occur.

The software randomly chooses from the frequency distribution for each input factor, determines the OE risk score, and stores the results. The input factors' values are then compared to the OE risk scores and correlated. The resulting output is a correlation coefficient ranging from -1 to +1. The further this coefficient is from zero, the stronger the correlation. A positive correlation coefficient indicates a direct relationship between the input factor and the OE risk score and a negative correlation coefficient indicates an indirect relationship.

The sensitivity analyses were used to evaluate situations where a hazard would be found on the site. That is, the results given below do not consider the sites with no OE found or with inert OE.

Both the deterministic and probabilistic analyses are limited by assumptions for the input factors. For the probabilistic analysis, all scores for each input factor were assumed to be equally likely. For example, there was a 25% chance that the OE Type score would be 0, 1, 2, or 3; whereas in applying the Protocol to the sectors at Fort Ord, the OE Type will depend on the past use of the site. In addition, for both the probabilistic and deterministic analyses, all of the input factors were assumed to be independent. This is a simplification of the factors; for example, OE Density will depend on the Level of Intrusion and may be linked to OE Hazard Type as well. It is important to note that although some of the input factors may be linked, it does not appear that any of the factors are mutually exclusive. These simplifications were made to provide the Team with a cursory analysis of the Protocol application.

3.2 RESULTS

This section presents the results of the deterministic and probabilistic sensitivity analyses on the Protocol.

3.2.1 Deterministic Sensitivity Analysis

A deterministic analysis was performed on the Fort Ord OE Risk Assessment Protocol to determine the distribution of all theoretically possible results. In other words, the deterministic analysis determines how many times scores of “A” through “E” would theoretically occur.

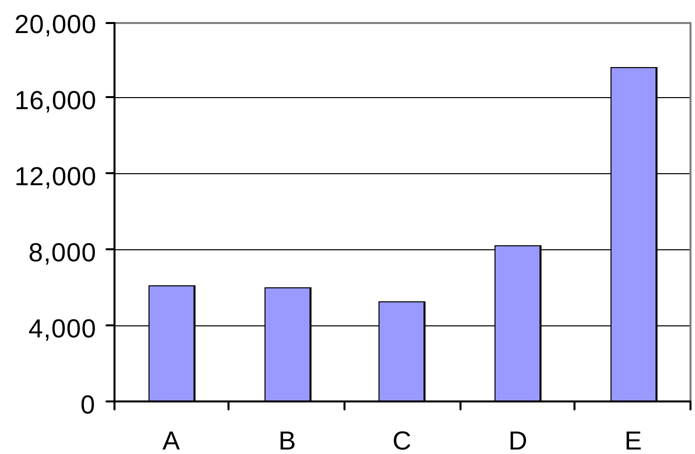


Figure 3-1. Deterministic Sensitivity Analysis Results

Figure 3-1 shows that situations exist for arriving at all of the scores “A” through “E.” Given all possible situations, the Protocol gives the highest possibility of a site being scored as “E” (i.e., highest risk). This analysis does not show the Fort Ord anticipated outcomes of the Protocol because the variables were not weighted for site-specific input factors. The analysis indicates for all given input factor situations, a score of "A-D" will be less likely than the situations where the input factor scores give a score of "E" because certain input factors drive the score to a higher risk (e.g., surface OE). However, considering the possible combinations of input factors at Fort Ord, this analysis indicates that all Overall OE Risk scores are possible and that certain factors are likely to cause a higher score.

3.2.2 Probabilistic Sensitivity Analysis

The illustration below shows each of the seven input variables included in the analysis conducted for the Fort Ord OE Risk Assessment Protocol. They are displayed from top-to-bottom in order of highest rank relative to its dependence on the result. The values provided for the correlation coefficients indicate the relative strength of the dependence between the input variable and result (i.e., coefficients closer to zero indicate weaker dependencies).

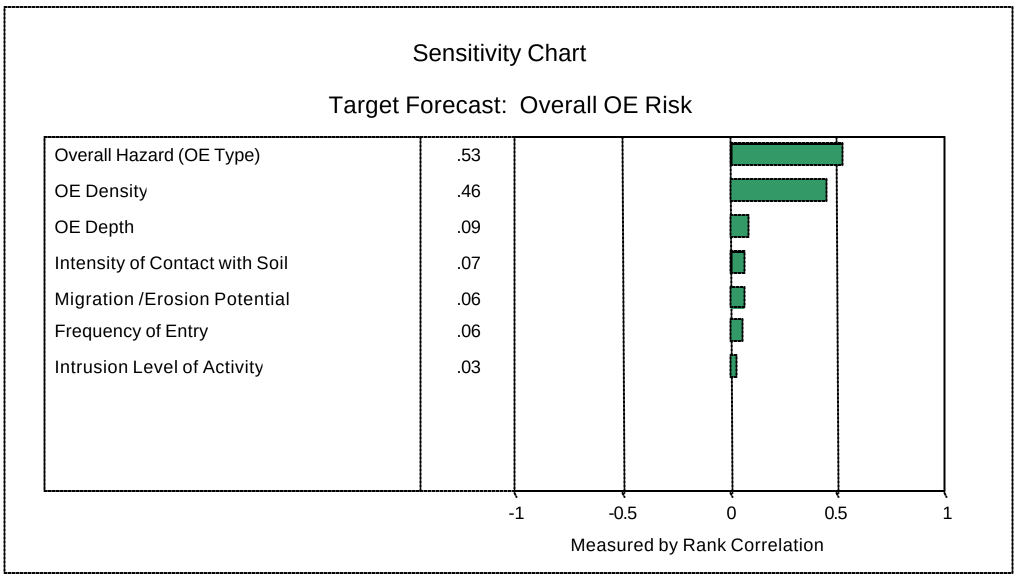


Figure 3-2. Probabilistic Sensitivity Analysis Results

Figure 3-2 shows the relative dependence of each input variable to the Overall OE Risk results. Overall Hazard (OE Type) has the highest relative rank dependence on the Overall OE Risk score. This indicates that as the OE Type score increases; the Overall OE Risk score will increase and that the Overall OE Risk score is most highly reliant on this factor. The next highest dependence factor is the OE Density. Therefore, if either OE Type is more likely to cause an injury or there is a high density of OE items, the Overall OE Risk score is higher. The other input factors – OE Depth, Intensity of Contact with Soil, Migration/Erosion Potential, Frequency of Entry, and Intrusion Level of Activity – have less impact on the Overall OE Risk score. Thus, a change in any of these factors must be significant for the Overall OE Risk score to change.

3.3 EVALUATION OF RESULTS

The sensitivity analysis results varied from the initial assumptions made by the Project Team, as seen below:

Table 3-1. Assumed vs. Actual Sensitivity Results

Input Factor	Initial Assumptions	Result of the Sensitivity Analysis
OE Hazard Type	Primary Driver	0.53 (Primary)
OE Density	Primary Driver	0.46 (Primary)
OE Depth	Primary Driver	0.09 (Secondary)
Intensity of Contact with Soil	Secondary Driver	0.07
Migration/Erosion	Modifier	0.06
Frequency of Entry	Secondary Driver	0.06
Intrusion Level of Activity	Secondary Driver	0.03

The two primary drivers are OE Hazard Type and OE Density, but OE Depth can only be considered a secondary driver. Migration/Erosion was assumed to be a modifier; however, the Overall OE Risk score is just as dependent on Migration/Erosion as it is on Frequency of Entry and only slightly less dependent on Intensity of Contact with Soil.

The Project Team spent a significant amount of time discussing the result of the sensitivity analysis versus the logic used to create the matrices. Concern was expressed on Depth not being a primary driver and on the overwhelming weight/influence of the OE Hazard Type and Density versus the other factors. OE Hazard Type was of specific concern because it is difficult to change the OE Hazard Type during a given response. The influence of OE Density was also a concern because, although the Project Team thought that the number of hazards should affect the risk, the lack of an acceptable standard and the inefficiencies inherent to the detection equipment concerned the Team. In general, the Team felt that the logic of the matrix tables was valid and met their logic about how sites should be evaluated based on the variables included in the risk analysis, but that this analysis may need to be reevaluated after the results of the beta test are available.

4.0 BETA TEST RESULTS

4.1 METHODS AND ASSUMPTIONS

The Beta Test was conducted to determine whether or not the Protocol would help the BCT make decisions on remedial action alternatives in the Feasibility Study. The following questions are answered in this summary report to assist in determining the Protocol's function:

- Are the results from the independent teams comparable?
- Is there appropriate resolution between remedial actions?
- Can the Protocol perform under varying site conditions?
- Can the results be clearly explained?
- Are there changes from the Beta Test that can improve the Protocol?

Three independent assessment teams (Team A, Team B, and Team C) applied the provided data to the Protocol to determine the reproducibility of the Protocol results given the same conditions. Huntsville Corps of Engineers (COE) provided members of Team A, Harding ESE, Inc., provided members of Team B, and Malcolm Pirnie, Inc. provided the members of Team C. Each independent assessment team included at least one individual not directly involved in the Protocol development to provide an outside perspective on the Protocol. Support persons with knowledge of the Protocol development aided the independent teams in applying the Protocol to the data sets.

The independent assessment teams were tasked with running the Protocol on the two data sets. The data sets were provided to the teams in the form similar to a word problem. The teams were not tasked with compilation of the data or deciding remedial action alternatives.

The data used for the Beta Test was obtained from two different sites that have already undergone study or actions (from geophysical survey to removal action). The COE recommended the sites to the team for the Beta Test based on data availability and variation in site conditions.

The data set was inclusive of information from all documents and data available for the selected sites, including information from geophysical investigation and removal actions, historical records, number, type and density of UXO found during investigation, technology application, planned site reuse, and proximity to communities. Some data (site access, erosion, etc.) was assumed for the sites[6]. All data received remained unaltered, although site-identifying information was obscured to protect anonymity.

[6] Because the Risk Assessment Protocol was developed after the activities in these areas were begun, some of the specific information was not collected or processed suitably to efficiently run the risk assessment.

Two problem statements were developed for the independent teams based on the data sets. Each team was tasked with using the Protocol to determine the overall OE risk scores for baseline conditions and residual risk subsequent to remedial action alternatives, which included no action, institutional controls, surface clearance, and clearance to depth. Each problem statement presented one current and two future intended receptors based on the proposed reuse for the property as identified in the data set package.

Neal Navarro (COE) served as the point of contact for all questions arising from the teams during the Beta Testing. Minor questions were clarified regarding typographical errors in the package. The main question arose from Team B finding of four OE items not included in the Appendix C table "Fort Ord Ordnance Hazard Classification: FOR USE BY UXO-TRAINED PERSONNEL ONLY." These items classified by a discussion between the teams. An additional email was sent to the three teams to provide an equation to calculate residual density. The following equation was provided to the teams:

$$(Residual\ Density) \cong \frac{1}{P_D}\frac{(1-P_D)(total\ number\ of\ OE\ items\ found)}{(percent\ of\ coverage)(total\ site\ acres)}$$

4.1.1 Limitations to Beta Test

The Beta Test presents an invented scenario and removes the negotiations and compromises on specific features of a site (e.g., patterns of use, type of receptor) that would be common to determining a site's OE risk. To the best of its ability the Project Team attempted to make the Beta Test as accurate and straightforward as possible. The Protocol was developed after the data was collected for these sites, thus on Fort Ord OE sites, data may or may not contain all of the information needed to determine the OE risk. The data used for this testing was accurate and not modified in any way; only some of the site conditions were modified and augmented in an attempt to normalize the problem statements in absence of this data.

Essential assumptions were made for rainfall, planned reuse, and detector efficiency, which, in some cases, were not representative of actual data. The independent assessment teams were not allowed to collect additional information on the site and were required to make assumptions when the problem statement did not distinctly illustrate the conditions at the site. Had the teams been able to seek additional information on the sites, the number of assumptions required would have decreased. Clearly, the methods must be adaptable when the data are less than ideal; however, the Project Team will need to recognize and evaluate the impact of data assumptions to the outcome of the testing.

4.1.2 Problem Statement #1

Problem Statement #1 related to the assessment of OE risk at Site PFX. The following information was included in the problem statement:

Table 4-1. Site PFX Data Summary Table

Size	50 acres
Actions to Date	– Archive Search Report – Four-foot removal in 111 grids (100'x100' grids) with 100% of items found in those grids removed
Former Use	Training for rifle grenades and shoulder-launched projectiles for 20 years
Planned Reuse	Residential Neighborhood
Vegetation	Maritime chaparral
Soil Type	Sand
Precipitation	Equal to average for area
Detection Equipment Efficiency (P_D)	92%*
Notes	Remedial alternatives requiring removal assumed to meet the Data Quality Objectives and Remedial Action Objectives set out in the Remedial Designs and the ROD for density and depth.

*This number is in no way meant to represent the actual field P_D of any particular instrument but was included for illustration purposes.

Problem Statement #1 required the teams to determine the baseline OE risk for the site and the OE risk for both a construction worker and a resident assuming the following remedial alternatives:

- No Action
- Institutional Controls
  - Construction Worker = The Army will provide construction support for construction activities. This will include checking the building plan for site-specific findings and providing a minimum of a two-person UXO team standing by.
  - Resident = The Army will provide written documentation to all new homeowners notifying them of the potential ordnance presence. The landowner will require a permit to dig below twelve inches.
- Surface Removal, and
- Subsurface Removal

4.1.3 Problem Statement #2

Problem Statement #2 related to the assessment of OE risk at Site DROX. The following information was included in the problem statement:

Table 4-2. Site DROX Data Summary Table

Size	53 acres
Actions to Date	– Archive Search Report – Land Disposal Site Plan – 100% grid sampling
Former Use	Training for small arms, automatic riles, 40 mm projectiles, and antitank 35 mm sub-caliber weapons for sixty years
Planned Reuse	Recreational area
Vegetation	Maritime chaparral
Soil Type	Sand
Precipitation	Equal to average for area
Detection Equipment Efficiency (P_D)	92%* 34%* 30%*
Notes	Remedial alternatives requiring removal assumed to meet the Data Quality Objectives and Remedial Action Objectives set out in the Remedial Designs and the ROD for density and depth.

*These numbers are in no way meant to represent the actual field P_D of any particular instrument but were included for illustration purposes.

Given site-specific information, Problem Statement #2 required the teams to determine the baseline OE risk for the site, and the OE risk for both a hiker and an outdoor maintenance worker, assuming the following remedial alternatives:

- No Action
- Institutional Controls
  - Hiker = The Army will provide ordnance awareness training and prohibit camping on the site. Signs will be posted at all entryways indicating that digging is not allowed.
  - Outdoor Maintenance Worker = The Army will provide ordnance awareness training. A permit will be required to dig below six inches.
- Surface Removal, and
- Subsurface Removal

4.2 RESULTS

This section summarizes the OE risk scores applied to the problem statements by each team. All of the teams considered the potential for different assumptions to impact the Overall OE Risk score; however, not all of these variations are presented below. Please see Attachment A for each team's scores.

4.2.1 Problem Statement #1

The following tables present the results from the teams for a construction worker and a residential receptor in Problem Statement #1.

Table 4-3. Beta Test Results for Construction Worker on Site PFX

Remedial Alternative	Team A	Team B	Team C	Assumptions/Comments**
Baseline	**E** (5,3,3)*	**E** (5,4,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared, if consider area cleared, score would be B Team B – considered intrusion depth to be from surface to 12" below ground surface (bgs) Team C – assumes kid, 12-18 years, may dig below surface
No Action	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared, if consider area cleared, score would be B. Team B – one item found on surface, all within intrusion depth Team C – digging for basement/utility services (>4 ft)
Institutional Controls	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – Assumes UXO-expert is standing by, if the footprint were cleared, the score would be B. Team B – institutional controls do not impact score Team C – institutional controls would only change the narrative as awareness of OE should be increased
Surface	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared. Team B – one item removed from surface Team C – no significant change in density due to few items on surface
Subsurface	**B** (2,2,3)	**B** (2,2,3)	**B** (2,2,3)	Team A – applies to 50% area not cleared. Team B – assumes 100% of detected OE removed to depth, if residual density is used, score is E. Team C – DQO's met, if not score is E

*(Accessibility, Exposure, Overall OE Hazard), underlined numbers vary from other two teams.
**Indicates significant comments or assumptions made by each team

The scores are similar for the teams, with all but subsurface removal scoring an "E." Team A considered only the area not cleared during previous field activities, whereas, Teams B and C considered the entire 50 acres of property. This assumption gave comparable scores for all three teams. The teams felt limited by not having enough information to evaluate the effectiveness of the institutional controls alternative. The institutional controls would limit the depth of intrusion, but is not a complete control of the activities. Team A considered two scenarios – the UXO-expert is standing by during excavation or the area of excavation is cleared by the UXO-expert. Team C considered that a higher Intensity of Activity score (e.g., if the construction worker worked overtime) would not impact the overall score.

Table 4-4. Beta Test Results for Resident on Site PFX

Remedial Alternative	Team A	Team B	Team C	Assumptions/Comments**
Baseline	**E** (5,3,3)*	**E** (5,4,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared, if consider area cleared, score would be B. Team B – considered surface to 12" bgs. Team C – assumes kid, 12-18 years, may dig below surface
No Action	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared, if consider area cleared, score would be B. Team B – one item found on surface, all within intrusion depth Team C – digging for fence post or garden
Institutional Controls	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – Assumes UXO-expert is standing by, if the footprint were cleared, the score would be B. Team B – institutional controls do not impact score Team C – institutional controls would only change the narrative as awareness of OE should be increased
Surface	**E** (5,5,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – applies to 50% area not cleared. Team B – one item removed from surface Team C – no significant change in density due to few items on surface
Subsurface	**B** (2,2,3)	**B** (2,2,3)	**B** (2,2,3)	Team A – applies to 50% area not cleared. Team B – assumes 100% of detected OE removed to depth, if residual density is used, score is E. Team C – DQO's met, if not score is D

*(Accessibility, Exposure, Overall OE Hazard), underlined numbers vary from other two teams.
**Indicates significant comments or assumptions made by each team

The overall OE risk scores are similar for the teams, with all but subsurface removal scoring an "E." Team A considered only the area not cleared during previous field activities, whereas, Teams B and C considered the entire 50 acres of property. Team B used Appendix E of the Protocol to consider child vs. adult receptors. Team C considered how a change in intensity of activity (e.g., weekend gardening vs. a garden party) would affect the overall score. Team C commented that in reality to get a house on the property, there is not likely to be ordnance on the surface to a depth of at least one foot because of grading, therefore, the OE risk scores should be lower for resident.

4.2.2 Problem Statement #2

The following tables present the results from the teams for a hiker and an outdoor maintenance worker for Problem Statement #2.

Table 4-5. Beta Test Results for Hiker on Site DROX

Remedial Alternative	Team A	Team B	Team C	Assumptions/Comments**
Baseline	B (1,2,3)*	E (5,3,3)	E (5,5,3)	Team A – 100% sampling equals 100% removal. Team B – surface only intruder could encounter all OE within 12” bgs Team C – assumed firebreak could increase erosion and frequency of entry
No Action	B (1,2,3)	E (5,4,3)	E (5,5,3)	Team A – 100% sampling equals 100% removal Team B – surface items of Haz. class 1 or 2 Team C – assumes only trail use and no digging
Institutional Controls	B (1,2,3)	E (5,4,3)	E (5,5,3)	Team A – 100% sampling equals 100% removal Team B – digging and camping bans do not affect hiker, awareness cannot be evaluated in input factors Team C – institutional controls would only change the narrative as awareness of OE should be increased
Surface	B (1,2,3)	E (4,4,3)	E (5,5,3)	Team A – 100% sampling equals 100% removal Team B – significant risk for shallow OE Team C – majority of items are below surface, thus surface removal does not affect
Subsurface	B (1,2,3)	B (1,2,3)	B (2,2,3)	Team A – 100% sampling equals 100% removal Team B – if calculated residual density, score would be a C Team C – DQO’s met, if not score is D

*(Accessibility, Exposure, Overall OE Hazard), underlined numbers vary from other two teams.
**Indicates significant comments or assumptions made by each team

Team A considered only the area was cleared during previous field activities, whereas, Teams B and C considered the residual risk for the 53 acres of property. Team A’s assumption that 100% removal occurred on the site affects the comparison of the scores. This assumption would need to be verified by site data for it to be considered valid. Team B felt more information was needed to assess the input factors for the baseline condition. Team B indicates that a ban on digging and camping should not impact the actions of a hiker and that OE awareness training cannot be evaluated using the input factors available for the Protocol. Team B considered only OE from the surface to 12 inches below ground surface as potentially impacting the receptor and Team C considered all items (0 to 48 inches). Team C indicated that it would likely split the site and consider the firebreak separately but assumed all the same site for this evaluation. Team C felt that the qualitative narrative would change for the institutional controls option, as the hiker should be more aware of the risk.

Table 4-6. Beta Test Results for Outdoor Maintenance Worker on Site DROX

Remedial Alternative	Team A	Team B	Team C	Assumptions/Comments**
Baseline	**B** (1,2,3)*	**E** (5,3,3)	**E** (5,3,3)	Team A – 100% sampling equals 100% removal Team B – surface only intruder could encounter all OE within 12" bgs Team C – assumed firebreak could increase erosion and frequency of entry
No Action	**B** **(2,2,3)**	**E** (5,5,3)	**E** (5,5,3)	Team A – 100% sampling equals 100% removal Team B – worker potentially exposed to all OE on site Team C – assumed golf course, could plant trees
Institutional Controls	**B** (2,2,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – 100% sampling equals 100% removal Team B – intrusion depth limited by permit requirement, does not prevent intrusion Team C – with items on the surface, prohibitions on digging would not be protective
Surface	**B** (2,2,3)	**E** (5,5,3)	**E** (5,5,3)	Team A – 100% sampling equals 100% removal Team B – density reduced, but significant OE remains Team C – majority of items are below surface, thus surface removal does not affect
Subsurface	**B** (2,2,3)	**B** (1,2,3)	**B** (2,2,3)	Team A – 100% sampling equals 100% removal Team B – if calculated density, score would be E Team C – DQO's met, if not score is D

*(Accessibility, Exposure, Overall OE Hazard), underlined numbers vary from other two teams.
**Indicates significant comments or assumptions made by each team

Team A's assumption that 100% removal occurred on the site effects the comparison of the scores. This assumption would need to be verified by site data for it to be considered valid. Team B considered a "lawn maintenance worker" and Team C considered a "golf course worker." As with a residential community, Team C commented that a recreational area (e.g., golf course or baseball diamond) would require some clearance for grading, therefore, the risk scores would likely be lower than seen above.

4.3 EVALUATION OF RESULTS

The following table presents the evaluation of the beta test results to the goals set out in the Beta Test Concept Paper.

Table 4-7. Evaluation of Beta Test Results

Beta Test Objective or Goal	Evaluation of Results	Limitation of Beta Test and/or Protocol?
Estimation of baseline and residual risk	Although some assumptions were made, the Protocol allowed for the estimation of baseline and residual risk in the Beta Test	Neither
Decision of remedial action and risk management selection	The Protocol allows for a comparison between remedial alternatives; however, resolution of this comparison may be limited. Specifically, for institutional controls and surface removal if a majority of items are below the surface.	Protocol
Communication of OE risk	Communication may be limited due to the required assumptions for the Beta Test. In general, the OE risk cannot be explained without detailed explanation of the Protocol. Reasoning for scoring of OE Density will be most difficult to communicate.	Beta Test
Compliance with CERCLA	The Beta Test shows that the Protocol would help to evaluate remedial alternatives and establish a baseline risk for the sites.	Neither
Defensibility and Flexibility	Due to multiple assumptions, the Beta Test results seem to not be defensible; however, the Protocol was highly flexible in allowing the assumptions to be made. Even with the lack of data for making the assumptions, the Beta Test teams made similar assumptions and the resulting scores were reproducible. Shows the need for clear decisions to be made prior to implementing the risk assessment for receptors, OE data, and exposure scenarios. A clear conceptual site model, or the like, will be needed to run the risk assessment.	Beta Test
Straightforwardness	Again, due to the multiple assumptions required by the teams, the Beta Test results show the Protocol to be limited by the data required. The teams did not have difficulty in using the Protocol or coming to a solution for the limited data.	Beta Test and Protocol

The following recommendations are from the Teams.

- More explanation needed to calculate density – homogeneity of site, efficiency of detection equipment, when to use a score of “2” vs. “3-7.”
- Better compilation of data will be required from Remedial Investigation results. Need to work closely with the sampling and analysis group to ensure the results meet the needs of the risk assessment.
- OE risk results vary depending on assumptions made. Clear discussions of the assumptions are needed early in the implementation of the risk assessment.

5.0 QUESTIONNAIRE

This section provides a summary of the questionnaire responses. The participant's questionnaires are provided in Attachment B.

5.1 QUESTIONS AND RESPONSES

The table below summarizes the answers to six of the eight questions asked to each member of the independent assessment teams following completion of the beta test.

Table 5-1. Questionnaire Responses

Question	Yes	No	Comments
Did the Protocol clearly explain how the tool was developed and how to apply the tool?	7	1	• More explanation for interpretation of depth and density data needed (2)* • Does the baseline include previous activities? (2)
Would you recommend areas for additional directions or to be rewritten?	7	1	• Algorithms confusing, "illogical" • More explanation for interpretation of depth (2) and density (6) data needed • Discussion of how a change in OE type is possible • Further explanation of Appendix E and how to use
Based upon your experience, do you think the Protocol facilitates evaluation of all of the variables of OE risk at a site?	2	5	• Evaluation of future land use and institutional controls not feasible with this Protocol • Weighted too heavily to OE factors • Evaluation of OE scrap not included • Appendix E needs further explanation and discussion of potential receptors • Only one piece of decision making process • Can't tell with the sample problems
Did you get stuck on any point in running the risk assessment? If so, where and how?	4	4	• Density calculation • How to assess previous activities • Further explanation of Appendix E and how to use (2) • Need more information to evaluate migration factors • Further explanation of institutional controls
Were there any areas of strong disagreement between your team?	0	8	• No strong disagreements in any of the teams, some resolution of assumptions required
Did personal experience and knowledge factor into your scoring of each factor?	5	3	• Experience in chemical risk assessment influenced some participants • Experience with all of factors except intrusion level of activity, intensity of contact with soil, and frequency of entry (2)

*Number in parenthesis indicates number of respondents giving this comment. If no parenthesis, only one respondent made this comment.

Responses to the remaining two questions are described below:

Question: Please identify missing elements, limitations, or improvements:
Summary of Responses:

- Missing elements:
  - Add potential penetrations of the OE item into calculation of residual density;
  - Add a way to use scrap information to determine presence of OE
- Limitations:
  - Assumptions required for running beta test limited the confidence in the final score,
  - The Protocol does not consider OE scrap,
  - The Protocol does not consider items deeper than detectable,
  - The density score was irrelevant,
  - The algorithms were confusing,
  - There is no change in risk if institutional controls are used,
  - Appendix E useful but did not always agree with the best professional judgment.
- Improvements:
  - Change density to four categories as shown below:

Table 5-2. Proposed OE Density Scores

Score	Description
1	No evidence of OE
2	OE potential but detection not likely
3	OE confirmed on surface
4	OE confirmed subsurface

Question: Do you have any other recommendations to improve the Protocol?
Summary of Responses:

- Add a discussion on methods used to calculate density
- Add guidance on evaluation of uncertainty and sensitivity of score. For example, if you choose a higher score for a certain input factor, it may or may not change the OE risk score. Therefore, should the user choose the higher score?
- Explain how the ranges used to score density were developed
- Review Table 5-10 – not sure why some scenarios remain C, D, and E when there is not likely to be exposure or least potential for accessibility.
- Add an example of how to use the Protocol.
- Discuss affect of institutional controls on the risk.
- Find references for Appendix E and rely less on best professional judgment.

5.2 Additional Comments or Discussion

This section provides any additional comments received from the independent assessment teams.

5.2.1 Team A

– Influence of Input Factors: Results are driven too much by OE factors (type, density) with minimal influence from accessibility and exposure (or lack thereof).

– Remedial Alternatives: Nothing but clearance to depth alternative appeared to reduce risk.

– Evaluation of Data: Why are we evaluating cleared areas?

– Remedial Alternatives: Alternatives should include combination of clearance with Institutional Controls.

– Detector Efficiency vs. Depth: Detector efficiency will vary with depth (may be 99% efficient at 0-1 foot and only 85% efficient at 1-2 feet, on average would be 92% efficient.)

5.2.2 Team B

- Influence of Institutional Controls on Risk: can't evaluate institutional controls effectiveness since outcome of action cannot be tied to one of the seven evaluation parameters. Particularly applies to construction support. In other cases institutional control provided in problem statement did not appear restrictive enough to prevent encounter. Consequently calculated scores reflect the failure of institutional controls to affect risk.

- OE Density: Should be defined over homogeneous sector and for particular receptor. No useful guidance in RA Protocol to resolve issue. Insufficient data available to make use of data provided in Table 12.

- Residual Risk – When to Score Density as "2" or "3-7": Residual risk after removal to depth could be defined two ways. 1) Use score of 2 for OE density and depth. 2) Use actual residual density and depth assuming 100% of surface OE removed. In both cases assume Haz type was highest of OE found. Group decided it best to calculate both ways.

- Risk to Surface Only Receptors: If a receptor intrusion depth was below surface, RA Protocol assumes a buffer. For surface only receptor (trespasser, hiker) doesn't appear a buffer is considered. Group decided that for surface only receptors would evaluate two ways: 1) only encounter surface OE. 2) encounter all surface OE and all OE to 12". Part of this discussion resulted from issues on how to treat risk to hiker from surface only OE removal and removal to depth. If we considered hiker only exposed to surface OE, then the result of the surface removal (table 4DROX) and removal to depth (table 5DROX) should be same. But, according to density and depth scores, can only assign a score of 2 if removal to depth occurs. Therefore surface removal and removal to depth would not be scored the same. But for a surface only receptor, if surface OE removed, then risk from surface only removal and removal to depth should be the same.

- Role of OE Scrap in Risk Assessment: OE scrap items such as fragments and expended items are not considered in the risk assessment. There may be cases where fragments are found at a site indicating that an impact area may be present. In some cases the fragment may be from an item that could penetrate to a depth deeper than the detection depth of the geophysical instrument used in the survey. This information will be discussed in the RI portion of the RI/FS. Will this information be discussed in the risk assessment, maybe as an uncertainty in the analysis or in the data evaluation section? This information could affect the recommendations for remedial alternatives and long-term risk management decisions.

5.2.3 Team C

– Sensitivity of Input Factors: Team considered different options for input factors (e.g., higher intensity of activity, higher frequency of activity, etc.) where assumptions were made to determine the effect on the overall OE risk. Change noticed in only extreme cases.

– Remedial Alternative Selection: The institutional controls would limit intrusion but intrusions would still be possible. Considered that it would be a "hopeful assumption" that the controls would be effective in reducing risk.

– Remedial Alternative Selection: If teams could evaluate different alternatives, could see variety in scores. For example, if you perform a one-foot clearance on the site, the density would decrease and your OE risk would decrease. Team realized that in reality the EOD would dig until they do not find items.

– OE Hazard Type: The Protocol does not identify a way to go from an OE Type of 3 to an OE Type of 1 or 2, therefore, if you start with an OE Type of 3 there is little chance to reduce risk. If surface OE is OE Type 3 and subsurface OE is OE Type 1 or 2, a surface removal could change the OE Type from 3 to 2 or even 1. More discussion needed.

– Sectorization: How to create more homogeneous sectors for running the risk assessment. In several cases in the Beta Test, we would have used separate sectors for different uses (e.g., firebreak vs. dense vegetation).

– Appendix E Assumptions: Intrusion Level, Frequency of Entry, and Intensity of Activity are all subject to discussion. Appendix E should be further refined and assumptions should be discussed with regulators and Installation prior to implementing the risk assessment. Appendix E is clear, but additional discussion on the values in the table and its role in the risk assessment are warranted.

– OE Density: Density should be evaluated spatially and looked at in more detail than allowed in the Beta Test.

– Migration/Erosion Potential: Need to indicate that the Universal Soil Loss Equation was used to calculate the average for migration/erosion and that it should be used for comparison.

– Seismic and Other Natural Events: Need to add a discussion of sensitivity of OE items to seismic activity – how "stable" are the different OE types? What about natural events affecting the OE?

5.3 EVALUATION OF RESULTS

Overall, the team members thought that the Protocol was a useful tool but some changes and modifications will be required as discussed above. These are further outlined in the next section.

6.0 SUMMARY AND RECOMMENDATIONS

The purpose of this section is to summarize the validation and present recommendations for changes. This validation report is intended to present the results, so that the Project Team can review proposed recommendations for changes and propose additional recommendations for change to the Fort Ord OE Risk Assessment Protocol.

6.1 SUMMARY OF PROTOCOL VALIDATION

As established in this report, the Protocol is

- Capable of producing baseline and residual OE risk scores that are reproducible when assumptions are clearly outlined,
- Capable of showing OE risk reduction only due to subsurface clearance, and
- Capable of performing under varying site conditions and levels of data collected.

In general, the independent assessment teams found the Protocol to be understandable and agreed that the Protocol clearly explains how the Fort Ord was developed and how to apply it to OE sites. As presented in the previous section, the teams felt that some further evaluation and explanation of some of the input factors is warranted, including OE density determination and remedial alternative definitions and selections.

6.2 SUMMARY OF RECOMMENDATIONS AND COMMENTS

General comments on the Beta Test problem statements are provided below:

- Data provided in the Problem Statements required the teams to make several assumptions regarding the migration/erosion.
- Detector efficiencies given were unrelated to the actual field efficiencies of the equipment indicated. If calculating residual densities using the wrong detector efficiency, the resulting residual density would be erroneous.
- Institutional controls should be combined with all of the remedial alternatives.

From the teams' comments and the results of the sensitivity analysis, the following list provides the recommended areas for further investigation by the Project Team:

1. Evaluate OE density explanation and calculation, considering Table 5-2.
2. Review algorithms for reducing risk with institutional controls or surface clearance.
3. Review Appendix E for completeness and accuracy. Clearly agree to the assumptions with the Project Team prior to implementing the Protocol.
4. Review the Sampling and Analysis Plan to determine how information will be collected and what information may require further investigation for application of the OE risk assessment.
5. Evaluate how to consider a residential receptor after construction of the house is complete (e.g., after grading).

Resolving these topics was the focus of the Project Team's April 2002 meeting. Project Team members discussed and reached agreement on modifications to the Protocol. The revised matrices and decisions on the OE Depth and OE Density input factors are provided in the Draft Protocol. The sensitivity analysis on the revise matrices is given below.

6.3 REVISED SENSITIVITY ANALYSIS RESULTS

6.3.1 Deterministic Sensitivity Analysis

A deterministic analysis was performed on the revised Protocol to determine the distribution of all theoretically possible results.

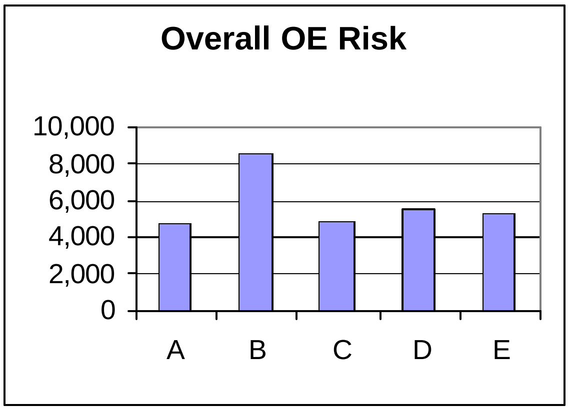


Figure 6-1. Deterministic Analysis of Revised Matrices

Figure 6-1 shows that situations exist for getting all of the scores "A" through "E." Given all possible situations, the Protocol gives the highest possibility of getting a score of "B" (i.e., low risk). This analysis does not show the anticipated outcomes of the Protocol at the former Fort Ord because of the site-specific input factors considered. The analysis does indicate that the situations where the input factor scores give a score of "A," "C," "D," or "E" will be less likely than the situations where the input factor scores give a score of "B."

6.3.2 Probabilistic Sensitivity Analysis

The illustration below shows each of the seven input factors included in the analysis conducted for the revised Protocol. They are displayed from top-to-bottom in order of highest rank relative to its dependence on the result. The values provided for the correlation coefficients indicate the relative strength of the dependence between the input variable and result (i.e., coefficients closer to zero indicate weaker dependencies).

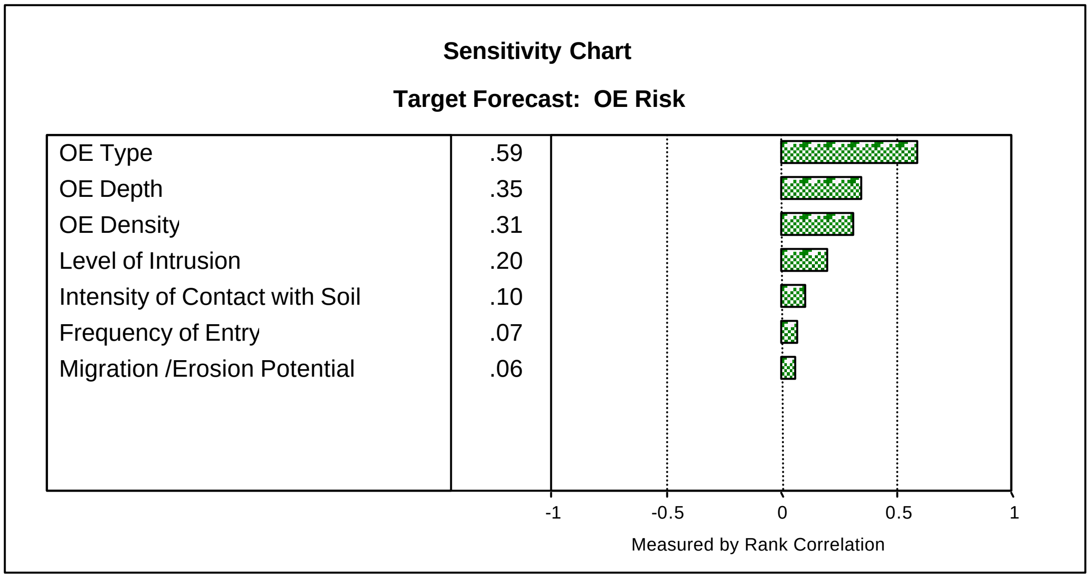


Figure 6-2. Probabilistic Sensitivity Analysis Results

Figure 6-2 shows the relative dependence of each input variable to the Overall OE Risk results. Overall Hazard (OE Type) has the highest relative rank dependence on the Overall OE Risk score. This indicates that as the OE Type score increases; the Overall OE Risk score will increase. The next highest dependence factor is the OE Depth. Migration/Erosion Potential is a modifier to the Overall OE Risk, as is Frequency of Entry.

Again, it is important to note that both the deterministic and probabilistic analyses are limited by assumptions for the input factors. For the probabilistic analysis, all scores for each input factor were assumed to be equally likely. For example, there was a 25% chance that the OE Type score would be 0, 1, 2, or 3; whereas in applying the Protocol to the sectors at Fort Ord, the OE Type will depend on the past use of the site. In addition, for both the probabilistic and deterministic analyses, all of the input factors were assumed to be independent. This is a simplification of the factors; for example, OE Density will depend on the Level of Intrusion and may be linked to OE Hazard Type as well. It is important to note that although some of the input factors may be linked, it does not appear that any of the factors are mutually exclusive. These simplifications were made to provide the Team with a cursory analysis of the Protocol application.

The Project Team determined the revised matrices provided a better representation of the expected situations at the former Fort Ord.