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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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M60050.001168
MCAS EL TORO
SSIC # 5090.3

21 June 1994

Mr. Bret Raines
BRAC Environmental Coordinator
Code 1811
Southwest Division
Naval Facilities Engineering Command
1220 Pacific Highway
San Diego, California 92132-5181

Dear Mr. Raines:

Enclosed is an assessment of (1) the Cost Estimate for Field Screening Techniques for Phase II Remedial Investigation; (2) Evaluation of the El Toro Homogeneous Hypothesis; and (3) Statistical Review of El Toro Homogeneous Hypothesis prepared by EPA's ARCS contractor. The purpose of these reviews is to provide the Base Closure Team (BCT) with a summary of the critical issues regarding the MCAS El Toro RI/FS which remain to be resolved in the Phase II Workplan for OUs 2 and 3. They are also meant to assist in highlighting the main issues during the transition from CLEAN I to CLEAN 2.

If you have any questions concerning this matter, please do not hesitate to contact me.

Sincerely,

John Hamill

John Hamill
Remedial Project Manager

Attachment
cc: Commanding General, USMC El Toro
Joe Zarnoch, DTSC
John Broderick, RWQCB
John Dolegowski, CH2MHILL
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Draft Cost Estimate for Field Screening Techniques
Phase II Remedial Investigation
MCAS El Toro

Background

This memorandum provides a rough draft cost estimate for performing a Phase II Remedial Investigation (RI) using field screening techniques at the Marine Corps Air Station (MCAS) El Toro. This cost estimate was prepared at EPA's request.

The Phase I RI at MCAS El Toro was largely a site inspection level effort for site characterization. The originally proposed Phase II Work Plan (by CH2M HILL) was insufficient to characterize the nature and extent of contamination. The sampling strategy used in the Phase I RI and the originally proposed Phase II RI work plan was based on an unsubstantiated assumption of equal probability of finding contaminants at any point within each stratum. As a result, very few samples were taken in each stratum in the Phase I RI and only a few additional samples were proposed for the Phase II RI. Consequently, the uncertainty in the type, distribution and concentrations of chemicals of concern (COCs) is believed to be high due to the limited data from each stratum. The Phase I RI did not adequately characterize the spatial variability of contaminants within each stratum to provide enough information for subsequent decision making. To overcome the high degree of uncertainty, field screening techniques, which involve collecting a massive number of samples for field screening and a much smaller number of field quantitative analyses, are proposed for MCAS El Toro. Field screening techniques can provide information which streamlines data collection efforts by optimizing the use of soil sampling techniques and minimizes the number of samples sent to off-site fixed laboratories for confirmation analyses.

Although field screening analyses are typically used to gather preliminary information to reduce errors associated with spatial heterogeneity, in many cases, field analyses can provide useful data for risk assessment. The analyses provide semi-quantitative results, often free of significant matrix interference, that can be used quantitatively if confirmed by a quantitative analysis from fixed laboratories (See Guidance for Data Usability in Risk Assessment, Part A, Final, EPA, 1992). The precision and accuracy of individual measurements may be lower in the field than at fixed laboratories, but the quicker turnaround time, the ability to provide the project team with real-time data for field decision making, and the possibility of analyzing a massive number of samples compensate for this factor. In addition, field analysis of volatile organic compounds (VOCs) prevents losses of VOCs during shipment and storage. Finally, utilizing this

approach results in a large cost savings over collecting and analyzing the same number of samples using conventional investigation technology.

The use of field screening and field quantitation analyses with a mobile field laboratory can expedite field investigations and enable field managers to obtain real-time data to guide field investigations. The approach can result in additional savings from a reduction in the number of samples sent off-site for Contract Laboratory Program (CLP) level IV analyses, which typically result in a large number of non-detect results. Most importantly, for those strata that are classified for no further investigation, less questions will be raised because the entire stratum has been thoroughly investigated, the QA/QC is known, and the results have been confirmed.

Purpose

The purpose of this document is to provide a preliminary estimate for the cost for collecting a massive number of soil gas and soil matrix samples in strata within the CERCLA Areas of Concern (CAOCs) and to analyze these samples in the field using rapid screening and field quantitative analyses. Field screening techniques can produce data close to laboratory techniques in accuracy and precision in near real-time. The overall objective is to conduct a complete RI in a single phase in approximately six months.

General Assumptions

For the purpose of this cost estimate, the following general assumptions have been made. **Based on discussions with the MCAS El Toro Team, which included representatives of the Navy, CH2M Hill, DTSC, RWQCB, EPA and Bechtel, (April 28, 1994) various strata have been excluded from this estimate.** This meeting also refined the sampling strategy to be used. For the purpose of this cost estimate, Bechtel has assumed that, among the 34 strata in the remaining CAOCs that will be investigated at MCAS El Toro, 11 strata will be found to be clean, 11 will be found to be uniformly contaminated, and 12 will be found to be contaminated with an average of three hot spots per stratum. In general, it is assumed that soil gas samples will be collected from 5, 10, and 20 ft depths, and soil matrix samples will be collected from 1, 5, and 10 ft depths at each sampling location. These intervals may be modified dependent upon a more detailed evaluation of site specific information.

For landfill strata, soil samples will not likely be collected. At CAOCs 3 and 5, soil gas samples will only be collected around the perimeters to investigate the possibility of landfill gas migration. Two locations will be sampled at three depths. At CAOCs 2 and 17, soil gas samples will be collected at 3 depths around the perimeters to investigate landfill gas migration and within the

landfills at 1 depth to locate potential hot spots of VOC sources for ground water contamination.

Specific assumptions regarding sampling and analysis are stated in the following relevant sections.

Field Work

Survey

A survey crew will lay out the grid systems for sampling locations and survey them to within plus or minus 0.1 foot. The spacing between each sample has been determined based on CAOC and stratum history. It is assumed that the survey work will be subcontracted.

Geophysics

Prior to drilling and sampling, utility clearance will be conducted by geophysical methods and by a non-destructive intrusive technique such as hand auguring or air knife drilling. Estimating the costs for these activities was beyond the scope of this assignment. Therefore, it was assumed that CH2M HILL's assumption of 13 locations cleared per day per person was accurate. This leads to a need for 4 Geophysicists for two months.

2000 holes / 13 holes/person/day = 154 people days / 4 people = 38 days

Heath and Safety

Health and safety personnel will oversee all field work to insure work place safety. They will identify and mark exclusion zones, and conduct health monitoring as appropriate. It was assumed that two Health and Safety officers will be required for the field work.

Drilling and Sampling

Direct push technologies such as cone penetrometer (CPT) or Geoprobe will be used to rapidly collect soil and soil gas samples. Several assumptions are made regarding drilling and sampling. Based on preliminary information from several drilling contractors, it is assumed that about 1.5 holes can be drilled and sampled per hour. This rate includes setting up the drilling rig, drilling, sampling, moving the drilling rig to the next sampling location, and decontaminating the sampling equipment. These rates assume that the drilling subcontractor will provide the following crew for the rigs:

- two drillers/samplers per rig,
- two people for decon, and
- one supervisor.

It is also assumed that the prime contractor will supply one geologist for each rig to log the hole and to provide supervision and, two additional geologists, who will help out as needed.

Based on the assumed drilling and sampling rate, about 12 holes can be drilled and sampled per rig per day. The rate is estimated as:

1.5 holes/hour/rig x 8 hours of production/day = 12 holes/day/rig

Assuming that two rigs will be employed to drill and sample soil gas and two rigs will be employed to collect soil matrix samples (four rigs total), about 72 soil gas and 72 soil matrix samples can be collected daily. The rate is estimated as:

3 samples/hole x 12 holes/day/rig x 2 rigs = 72 samples/day

This rate is considered to somewhat conservative because it is derived based on an assumption of 8 working hours per day. In the field, it is common (weather and daylight permitting) to work 10 hours per day.

The costs for the drill rigs are shown in Appendix A.

Phase 1 Sampling and Analysis

Field Sampling

Phase 1 involves collecting massive quantities of soil and soil gas samples from a grid system in each stratum. Three soil matrix samples will be collected ranging from 1 to 10 ft depths at each grid location. Soil gas samples will be collected ranging from 5 to 20 ft depths at each grid location.

For landfill strata, soil samples will not likely be collected. Only soil gas samples will be collected from within the landfill and/or along the perimeters. Table 1 lists the strata, grid spacing, number of sampling locations per stratum, and the number of soil and soil gas samples. A smaller grid size will be used to collect the soil samples as compared to soil gas samples at some strata, based on the individual strata history. Based on information presented on Table 1, approximately 5,870 soil gas and 4,810 soil matrix samples will be collected during the Phase 1 field screening sampling.

During the field screening, if contaminants are detected, the data will be used to locate the "hot spots" and the areal extent of contamination within the stratum and perhaps beyond the stratum boundary will be determined.

The cost for analytical equipment can be found in Appendix A.

Field Screening Analysis

Instruments for field screening analysis (FSA) analyses will be installed in trailers near the field operation. For soil gas samples, it is assumed that two approaches involving GC/FID/ECD and direct MS, respectively, may be used to analyze the samples. Approach 1 involves the use of GC/FID/ECD to analyze the majority of the soil gas samples and GC/MS to analyze about 10% of the samples to validate the GC/FID/ECD results because the GC/MS can provide unambiguous results. The soil gas samples will be extracted from the soil into a steel canister. From there, it will be bled into a glass vial and sent to a mobile field laboratory for analysis. It is estimated that three GC/FID/ECD and one GC/MS will be needed to analyze the soil gas samples. The GC/FID/ECD can analyze about 40 samples per day, and the GC/MS can analyze about 50 samples per day. The sample throughput for soil gas sample analysis is shown on Table 2.

Approach 2 involves the direct use of an MS to analyze soil gas samples. During the first shift, an MS mounted on a pickup truck will follow one of the direct push rig to analyze soil gas directly introduced into the MS in a "continuous" mode right at the sampling locations. During a second shift, the MS will return to a field mobile laboratory and analyze the soil gas samples that have been collected earlier in the day by other rig. About 10% of the soil gas samples will be analyzed by GC/MS to validate the MS results. Also, in the beginning of the project, a GC/FID/ECD will be available to confirm the MS results. An average of up to 100 soil gas samples per day can be analyzed by a MS, assuming that it will be run two shifts per day, and that, for part of the second shift, it will be run in GC/MS mode. The sample throughput for soil gas sample analysis is shown on Table 2. It is estimated that using this approach will add about $100,000 to the overall cost of the project. However, Bechtel has not included this cost in Appendix A.

The soil matrix samples will be analyzed for VOCs, non-volatile organics (e.g semivolatile organics, pesticides, PCB and other classes, such as herbicides, explosives, etc., that may be required for a specific CAOC), and metals. It is proposed that TDGC/MS be used for rapid screening and semi-quantitative analyses. During the two shift days assumed for these instruments, about 100 VOC or 64 non-volatile organic analyses per machine can be analyzed in the rapid screening mode using TDGC/MS. A GC with an ECD detector also will be available for non-volatile organic analyses. X-ray fluorescence (XRF) or ICP will be used for metal analysis. During the two shift days assumed for these

instruments, about 70 metals analyses per machine can be analyzed. The sample throughput for soil matrix sample analysis is shown on Table 2.

In addition, the use of immunoassay techniques should be evaluated for the analysis of non-volatile organics in soil samples because it may provide timely, cost effective screening level information.

If no contamination is found, the stratum will be placed into the "clean" category. Additional soil samples from the clean strata will be collected for field quantitative analyses (Phase 2) and CLP level IV equivalent confirmation analyses (Phase 3).

Data on sample locations, sample type, contaminant identity and concentration will be entered into a data management database on a daily basis. The FSA soil sub-contractors will supply operators for daily input of data into the 3-D system (these personnel are included in the daily costs shown in Appendix A). In addition, the prime contractor will supply a Senior Data Manager and 4 data specialists to plan and implement the data management procedures for the project. Contaminant profiles in each stratum will be displayed using 3-D visualization software/hardware for real-time decision making. This provides the project team with an ability to direct the sampling plan and make decisions from the field to achieve an overall reduction in project time and cost.

Phase 2 Sampling and Analysis

Phase 2 involves collecting a moderate number of soil samples for on-site, field quantitative (FQ) analyses, equivalent to CLP quality. The purpose for Phase 2 samples are to verify "clean" areas, verify the non-detect boundaries for the contaminated areas and to verify the MCAS El Toro Chemicals of Concern (COCs) and their levels within the contaminated areas.

Clean Strata (Assume 11 Strata)

To verify clean strata, it is estimated that three samples from each of three random locations in each stratum will be collected for field quantitative analyses. The number of samples is estimated as:

3 samples/location x 3 locations/stratum x 11 strata = 99 samples

To account for unforeseen situations, it is estimated that a total of about 110 samples will be analyzed.

Uniformly Contaminated Strata **(Assume 11 Strata)**

To verify the non-detect results at the stratum boundary for the 11 uniformly contaminated strata, it is estimated that samples from 3 depths at 4 locations from outside of the contaminated zone will be needed. The number of samples is estimated as:

3 samples/location x 4 locations/stratum x 11 strata = 132 samples

To account for unforeseen situations, it is estimated that a total of about 160 samples will be analyzed to verify the non-detect results.

To verify the levels of contamination within the 11 uniformly contaminated stratum, samples from three depths at three random locations will be collected for field quantitative analyses. The number of samples is estimated as:

3 samples/location x 3 locations/stratum x 11 strata = 99 samples

To account for unforeseen situations, it is estimated that a total of about 110 samples will be analyzed to verify the levels of contamination.

The total for these strata should be about 270 samples.

Strata with Hot Spots **(Assume 12 Strata)**

It is assumed that the average number of hot spots per strata will be three. For the strata with hot spots, it is estimated that samples from three depths from three random locations in each of the 12 stratum will be needed to verify the non-detect areas. The number of samples is estimated as:

3 samples/location x 3 locations/stratum x 12 strata = 108 samples

To account for unforeseen situations, it is estimated that a total of about 120 samples will be analyzed to verify the levels of contamination.

To verify the levels of contamination within the hot spots, samples from three depths at one random location within each of the three hot spots will be collected for field quantitative analyses. The number of samples is estimated as:

3 samples/location x 3 locations/stratum x 12 strata = 108 samples

Therefore, it is estimated that about 120 samples will be needed to verify the levels of contamination for the 12 strata with hot spots.

The total for these strata should be about 240 samples.

Total Phase 2 Samples

Overall, a total of about 620 samples will be collected for the Phase 2 analysis. It is assumed that a GC/MS will be used for VOC analysis; a TDGC/MS will be used for non-volatile organic analyses; and an XRF or ICP will be used for metal analysis.

Phase 3 Sampling and Analysis

Phase 3 involves sending a minimal number of samples to off-site laboratories for confirmation analyses for the full list of the El Toro COCs using analytical methods equivalent to CLP Level IV protocols. The purpose for this step is to confirm the results obtained from field screening and field quantitation analyses.

For the 11 clean strata, one split sample from each stratum will be sent to an off-site laboratory for confirmation analyses. A total of 11 samples will be analyzed for the full list of El Toro COCs using CLP Level IV equivalent analytical protocols.

For the 11 uniformly contaminated strata, three samples per stratum selected from the most contaminated locations or intervals will be sent to off site laboratories for analyses. For the assumed 11 uniformly contaminated strata, a total of about 33 samples will be analyzed.

For the 12 strata with hot spots, three samples per stratum selected from the most contaminated locations or intervals within the hot spots will be sent to off site laboratories for analyses. For the assumed 12 strata with hot spots, a total of about 36 samples will be analyzed.

Overall, for Phase 3, a total of about 100 samples will be analyzed for the full list of El Toro COCs using CLP Level IV equivalent analytical protocols to confirm clean strata or to quantitatively determine the contaminant levels in the contaminated strata. The analytical cost for CLP level IV is shown in Appendix A.

QA/QC Procedures

Field analytical methods can produce legally defensible data if appropriate QC measures are implemented and if documentation is adequate (EPA, 1992). Generally, QC samples are taken at a minimum of 1 for every 20 environmental samples. However, this frequency may be modified based on site conditions (EPA, 1992). If the natural variability of the chemicals of potential concern is relatively large, the major planning effort will be to collect more samples from the contaminated areas, rather than collecting more QC samples (EPA, 1992).

Field duplicate samples are collected to assist in determining the precision of the sampling collection and handling practices. The duplicate sample is collected from the same location as an investigative sample and is submitted to the laboratory blind.

The field QC procedures are designed to verify that sample collection and handling practices are not introducing variables that could render the validity of the samples questionable. Field duplicates are the major field QC samples of importance to the precision of measurement error. Precision is achieved when it can be demonstrated that the sample collection and handling practices are reproducible.

Results from all of the QC samples will be examined as early as possible in the sampling operation to ascertain if presumed sampling characteristics are accurate and discover areas where the sampling strategy requires modification.

Soil Gas Analysis

For soil gas analysis, a field equipment blank will be collected at the beginning and end of the day. The number of field equipment blanks is:

2 samples/day/rig x 2 rigs x 130 days = 520 samples

A field duplicate (FDup) sample will be collected at a frequency of one for every 20 samples. The number of field duplicates is:

1 FDup x (1/20) x 5,866 = 293 FDup samples

These field blanks and duplicates are submitted to the laboratory blind.

Field mobile laboratory QC samples are used by the laboratory to monitor laboratory practices. The field mobile laboratory will perform a duplicate analysis on every 10th sample, and a laboratory blank analysis after every 10th sample. The numbers of laboratory QC samples are:

1 duplicate sample x (1/20) x 5,866 = 293 duplicates

1 blank sample x (1/20) x 5,866 = 293 blank samples

The estimated total number of soil gas QC samples is about 1,399 samples.

Soil Matrix Analysis

For the collection and analysis of soil samples, duplicates will be collected at a rate of one day. These duplicate samples will provide a measurement of precision for both field procedures and laboratory analysis. The number of field duplicates is:

1 duplicate/day x 130 days = 130 duplicates

To measure accuracy of laboratory analysis, matrix spike (MS) analyses will be performed at a frequency of one sample per day. The number of MS samples is:

1 MS/day x 130 days = 130 samples

In addition, performance evaluation samples (PES) consisting of soil that has been spiked with a known quantity of various chemicals of potential concern will evaluate the accuracy of the analytical methods. One performance evaluation sample will be analyzed per day. The number of PES is:

1 PES/day x 130 days = 130 PES

Blank samples will be collected to evaluate whether the laboratory or field procedures represent a possible source of contamination of the environmental samples. Rinsate blanks will be collected to verify that adequate decontamination procedures are being observed in the field. At the start of the job (i.e., the first week), one rinsate blank will be collected per rig per day. Thereafter, one sample will be collected per rig per week for the remainder of the job. The number of field blanks is:

1 sample/rig/day x 2 rigs x 5 days = 10 samples for the first week

1 sample/rig/week x 2 rigs x 25 weeks = 50 samples for the remainder of the job

Laboratory blanks are used to determine if contaminants have been introduced into the analysis via contaminated laboratory solvents, reagents, glassware, and other sample processing materials. One laboratory blank may be run each day. This frequency, however, may be increased if significant contamination is encountered. The number of laboratory QC samples is:

1 lab blank/day x 130 days = 130 lab blanks

130 lab blanks x 20% = 26 additional blanks to account for high hits

The estimated total number of soil matrix QC samples are about 606 samples.

Total Number of Samples

Because of the massive number of samples for field screening and field quantitation analyses and the similarity in samples collected, the frequencies of different QC samples required to achieve the Data Quality Objectives (DQO) may not have to be high. However, for the purpose of this estimate, the assumed frequencies for the QC samples, as shown above, are used to calculate the number of QC samples. The final number of QC samples needed to achieve the project DQO will have to be determined by the project team.

The total number of soil gas samples is estimated as:

5,866 samples + 1,399 QC samples = 7,265 samples

The number of soil gas QC samples is about 24% of the total soil gas samples.

The total number of soil matrix samples is estimated as:

4,806 FSA samples + 620 FQ samples + 606 QC samples = 6,032 samples

The number of soil matrix QC samples is about 11% of the total soil matrix samples.

Ground Water Investigation

In the original Phase II RI work plan, the Navy and their contractor (CH2M HILL) proposed to install a total of about 37 new ground-water monitoring wells. For the purpose of this cost estimate and to allow a direct comparison with the estimate prepared by the Navy's contractor, it is assumed that the same number of wells will be installed during the field screening effort. These wells will be installed by traditional rigs (i.e., reverse circulation air rotary). Given the level of effort to perform this cost estimate, the assumptions and rationales for the installation of these wells were not evaluated by Bechtel. Including this portion of the estimate does not imply that Bechtel concurs with the approach proposed in the original Phase II RI work plan.

For the purpose of this estimate, Bechtel assumed that each well would average 212 feet in depth, for a total of about 7800 feet of wells installed. It was also assumed that each well would have 30 feet of screen and would take two days to install in addition to the drilling time. It was further assumed that the drilling rate would average 13 feet per hour. Therefore:

7800 ft / 13 ft/hr = 600 hours

which is equivalent to 75 working days, assuming 8 working hours per day.

It is assumed that drilling the wells will take about 75 days Well development will take 37 days and well installation will take about 74 days. Also, a 10% contingency has been added to cover downtime and other unforeseen problems. Finally it is assumed that each well will be sampled after development, and that 37 samples will be sent off-site for CLP level IV analysis.

Deep Soil Borings

As with the wells, the Navy's estimate of 8 deep soil borings and then collecting 35 soil samples, from the Phase II work plan, has been retained. Bechtel has assumed that the borings will average 182 ft deep, for a total of about 1120 feet of boring drilled, and that the drilling rates will be the same as for the wells. Therefore,

1120 feet / 13 ft/hr = 86 hours

which is equivalent to 10.8 working days, assuming 8 working hours per day.

It is assumed that drilling and sampling the borings will take about 11 days. Also, a 10% contingency has been added to cover downtime and other unforeseen problems.

Aquifer Testing

After installation of the well some of them will be tested to determine aquifer properties. Estimating the costs for these activities was beyond the scope of this assignment. Therefore, it was assumed that CH2M HILL's cost was accurate and their number was used.

RI Report

At the conclusion on the field work, the prime contractor will prepare a RI report documenting the results of the field investigation. The RI report will clearly show which strata and CAOCs are contaminated, and which can be removed from the RI/FS program and labeled for no further action (i.e., "clean'). In addition the report will provide sufficient information to allow the El Toro team to determine what remedial action need to be taken to remediate the remaining strata and CAOCs.

Costs

The actual costs are presented in Appendix A.

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
1. EOD Range	1. EOD Range	Ordnance Burial Site	35	1.524×10^6				No further investigation for now.
2. Magazine Road Landfill	1. Landfill	Landfill	27	1.176×10^6	100 (Soil Gas) 0 (Soil)	174 (Soil Gas) 0 (Soil)	286 (Soil Gas) 0 (Soil)	118 in landfill sampled at a depth of 5' 56 around edge of landfill sampled at 3 depths.
	2. Stained Area	Landfill (?)	4	175,000	50 50	70 70	210 280	
3/4. Original Landfill	1. Landfill	Landfill	25	1.069×10^6	75 0	2 x 128 0	768 0	Estimated perimeter length is about 9,600 ft. Assumes 2 locations at 20 ft spacing and 3 sample depths.
(Site 4 Excluded)	2. Drainage Ditch	Shop, Hangars	0.01	440				Removal.
	3. SWMU 194	Incinerator	0.01	560	10 10	6 6	18 18	Small spacing due to small study area.

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
5. Perimeter Road Landfill	1. Landfill	Landfill	1.4	61,700	75 0	2 x 33 0	198 0	Estimated perimeter length is about 2,450 ft. Assumes 2 locations at 20 ft spacing and 3 sample depths.
6. Drop Tank Drainage Area No. 1	1. Concrete Apron Edge	Airfield Flight Line	0.03	1,300				No further investigation.
	2. Drainage	Airfield Flight Line	0.8	35,400	25 25	57 57	171 171	
	3. Storage Area	Drum Storage Area	1.48	64,400	25 25	103 103	309 309	
7. Drop Tank Drainage Area No. 2	1. North Pavement Edge	Airfield	0.39	16,900				"Linear" Stratum. Removal.
	2. Old East Pavement Edge	Airfield	0.90	39,400				"Linear" Stratum. Removal.
	3. New East Pavement Edge	Airfield	2.03	88,500	75 x 20 75 x 20	59 95	177 177	New bounberies includ Stratum 4 North of Stratum 5.
	4 Drainage Ditch	Airfield	0.86	37,600				Investigated as pert of Stratum 3
	5. Open Dirt Area	Airfield	2.07	90,000	50 50	36 36	108 108	Grid spacing due to smaller size.

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
8. DRMO Storage Yard (Part of Site 24)	1. East Storage Yard	Drum Storage	1.31	57,000	25 25	68 68	204 204	Reduced by 25% due to Site 24 sampling.
	2. West Storage Yard	Drum Storage	2.63	114,700	25 25	138 138	414 414	Reduced by 25% due to Site 24 sampling.
	3. Refuse Pile	Not Applicable	0.08	3,600				Removal.
	4. PCB Spill Area	Not applicable	0.05	2,000	10 10	15 15	45 45	Reduced by 25% due to Site 24 sampling.
	5. Old Salvage Yard	Drum Storage	2.4	103,900	25 25	166 166	498 498	Reduced by 25% due to Site 24 sampling.
9. Crash Crew Pit No. 1 (part of Site 24)	1. Pit Areas	Fire Training	0.5	20,000	0 20	0 50	0 150	Grid spacing due to small size.
10. Petroleum Disposal Area (Part of Site 24)	1. Aircraft Matting Area	Air Field	12.3	538,000	50 50	161 161	483 483	Reduced by 25% due to Site 24 sampling.
	2. Concrete Apron Area	Air Field	9.6	419,000	50 50	126 126	378 378	Reduced by 25% due to Site 24 sampling.

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
11. Transformer Storage Area (Part of Site 24)	1. Concrete pad, and 2. Drainage Ditch (excluded)	Drum Storage	0.2	8,000				Removal
	3. Yard Area	Drum Storage	0.93	40,000	25 25	65 65	195 195	
12. Sludge Drying Beds	1. West Sludge Drying Beds	(Similar to lagoon)	1.4	63,000	50 35	25 51	75 153	Assume contaminants similar to lagoons.
	2. East Sludge Drying Beds	(Similar to lagoon)	0.7	30,000	50 35	12 25	36 75	Stratum 3 is a linear stratum. Grid spacing assumes 1 across, 14 intervals at 100-ft spacing along the ditch.
	3. Drainage Ditch	(Similar to lagoon)	0.3	14,000	1 x 100 1 x 100	14 14	42 42	
	4. SWMU 90	(Similar to lagoon)	1.9	81,000	50 35	32 66	96 198	
	5. Former IWTP	(Similar to lagoon)	0.61	26,500	50 35	11 22	33 66	

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
13. Oil Change Area	1. Area Southeast of Tank Farm	Tank Farm	0.4	17,300	50 50	7 7	21 21	
	2. Area Southwest of Tank Farm	Tank Farm	0.4	17,500	50 50	7 7	21 21	
14. Battery Acid Disposal Area (Excluded)	(entire area)	Shop	0.16	7,150				Removal.
15. Suspended Fuel Tanks	1. Stained Area	Not Applicable	0.06	2,500	20 15	6 11	18 33	Grid spacing due to small size of site.
16. Crash Crew Pit No. 2	1. Disturbed Ground Area	Fire Training	1.2	53,000	50 35	21 43	63 129	
	2. Main Firefighting Pit	Fire Training	0.04	1,700	10 10	17 17	51 51	Small grid spacing due to small stratum size and contamination observed in Phase I.
	3. Drainage Channel	Fire Training	0.22	9,750				No further investigation

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
17. Communi-cation Station Landfill	1. Landfill	Landfill	10.3	450,000	100 0	120 0	219 0	45 in landfill sampled at 5'. 75 around edge of landfill sampled at 3 depths.
	2. Stained Area	Landfill	0.09	3,800				Investigated as part of Stratum 1.
19. ACER Site	1. Northeast Stained Area	Air Field	0.7	30,000	75 75	12 12	36 36	
	2. Excavated Area	Air Field	0.5	23,100				Removal.
	3. Stained Area around Excavation	Air Field	3.3	141,900	100 100	14 14	42 42	
20. Hobby Shop	1. East Drainage Ditch	Shop	0.03	1,200				Linear stratum. No further investigation.
	2. South Drainage Ditch	Shop	0.04	1,900				Removal
	3.Stained Area (west of building)	Shop	0.06	2,500				Removal

Table 1
Phase I Screening Level Samples
MCAS El Toro

Site	Stratum	CAOC Category	Estimated Size (Acres)	Estimated Size (Ft^2)	Spacing (Ft)	Estimated Number of Grid Locations	Estimated Number of Samples (Step 1)[1]	Comments
20. Hobby Shop (cont.)	4. Courtyard and Front Slope (considered together)	Shop	0.5	19,400	50 35	8 16	24 48	
21. Materials Manage-ment Group	1. Storage Area	Drum Storage	0.3	13,800	25 25	22 22	66 66	
22. Tactical Air Fuel Dispensing System (Part of Site 24)	1. Western Area	Air Field	0.75	32,500	50 50	10 10	30 30	Reduced by 25% due to Site 24 sampling.
	2. Eastern Area	Air Field	1.24	54,000	50 50	17 17	51 51	Reduced by 25% due to Site 24 sampling.

Total Soil Gas:	5,333	Estimated total soil gas samples w/10% contingency:	5,866
Total Soil :	4,369	Est. total soil samples w/10% contingency:	4,806
Total Phase I Samples:	9,702	Est. total samples w/10% contingency:	10,672

1. Upper row at each stratum on this table represents soil gas samples, while the lower row represents soil samples. Includes samples collected from three depths at each grid location.

Table 2
Daily Subcontractor Throughput Rates Conduct Field Investigation for Shallow Soil at MCAS El Toro

Analyses	Instruments Required[1]	Sample Throughput	Rigs
Phase 1			
5,866 and 587 soil gas analyzed by GC/FID/ECDs and GC/MS, respectively or 5,866 and 587 soil gas analyzed by MS and GC/MS, respectively[2]	2 laboratory GC/FID/ECDs 1 field GC/MS 1 field direct GC/MS	40 Samples/ machine/day 50 Samples/ machine/day 100 Samples/ machine/day	2 rigs
4,806 soils analyzed by GC/MS and XRF or ICP for full EPA target compound list organics and metals[2]	1 GC/MS for VOCs 3 GC/MS non-volatiles 1 XRFs or ICPs	100 Samples/ machine/day[4] 64 Analyses/ machine/day[4] 70 Samples/ machine/day[4]	2 rigs
Phase 2			
110 soil samples to verify non-detects for clean sites; 280 soil samples to verify non-detects for contaminated sites, and 230 samples to verify the TARGET list inside the contaminated area analyzed by quantitative GC/MS and XRF or ICP.[1,2]	1 GC/MS for VOCs 1 GC/MS for non-volatiles 1 XRF or ICP	15 Samples/ machine/day 8 Samples/ machine/day 10 Samples/ machine/day	Included in Phase 1

1. Minimun menber of instruments required to analyze all samples in 130 working days.
2. Does not include QA/QC samples.
3. Assumes that 11 strata will be "clean", 11 will be uniformly contaminated, and 12 will have an average of three hot spots each.
4. Assumes the the machines will be run for two shifts per day.

Appendix A

SAMPLING COST ESTIMATE

20376-022
ARCS Project
MCAS El Toro

Project Data

Client:	U.S.E.P.A. San Francisco, CA
Project Location:	Marine Corps Air Station (MCAS), El Toro, CA
Project Scope:	Project Management, project controls and procurement of subcontracts for the Field Screening Sampling on a 100-acre site.

Total number of sampling required for are;

		Samples, ea
-	Soil Gas Sampling	5,870
-	Soil Sampling	4,810
	Total	10,680

Type of Estimate:	Engineer's Estimate.
Pricing Level:	Second quarter, 1994 price and wage level. The future escalation and contingency are excluded from the estimate.
Purpose of Estimate:	To provide the client with an approximate Field Screening Sampling Cost.
Construction Schedule:	Project target schedule is as follows:

- Start Engineering — September 1994
- Start Sampling — December 1994
- Complete Sampling — May 1995
- Complete Project — August 1995

1.0 ESTIMATE BASIS

1.1 Contractor's Cost

- Jobhours and grade levels were estimated by the project team to reflect the scope included in the technical approach.

- Jobhours were extended by the current composite wage rates provided by other similar project.

- Contractor's labor costs including payroll additives and indirect costs were estimated using composite multiplier used for other similar project.

- The estimate is based on 12 month project schedule.

1.2 Subcontract Cost

- Majority of subcontract cost has been estimated based on subcontractor's informal phone quotations or written quotations. The major subcontractors who provided cost information are;

Subcontractor Items	Subcontractors
• Drilling	Target, Huntington Beach, CA
• Soil Gas Sampling	Target, Huntington Beach, CA
• Soil Sampling	Target, Huntington Beach, CA
• Deep Sampling	Boyles Brother Drilling Salt Lake City, UT
• Off Site Clip Samples	Sequoia Lab., San Francisco, CA
• Soil Analysis	Site Works, Medford, MA
• Computer System	Intergraph, San Francisco, CA

1.3 Contractor's Fee, Contingency and Escalation

- Contractor's fee has been included in the estimate based on summation of 10% on contractor's cost and 5% on subcontractor's cost.

- Contingency and escalation have been excluded from the estimate.

2.0 ESTIMATE RESULT

Table 1 Cost Estimate Summary

DATE: 06-MAY-94
PROJECT: 20376-022
FILE: ELTORO-1

TABLE A-1

COST ESTIMATE SUMMARY

NO.	COST ITEMS	TOAL COST ESTIMATED IN $ 1,000	FOR DETAIL SEE TABLE
1.0	CONTRACTOR'S COST		
1.1	PROJECT OFFICE	1,576	NO. 2
1.2	SAMPLING SITE	1,115	NO. 2
1.3	FIELD OFFICE OTHER DIRECT COST	508	NO. 3
	SUBTOTAL 1.0	3,199	
2.0	SUBCONTRACT COST		
2.1	SAMPLING	1,886	NO. 4
2.2	LABORATORY ANALYSIS	3,331	NO. 5
2.3	OTHER SUBCONTRACT COST	357	NO. 5
	SUBTOTAL 2.0	5,574	
	SUBTOTAL, 1.0 + 2.0	8,773	
	- FEE AT 10% ON CONTRACTOR'S COST	320	
	- FEE AT 5% ON SUBCONTRACTOR'S COST	279	
	TOAL COST ESTIMATED(2Q, 94)	9,372	

DATE: 06-MAY-94
PROJECT: 20376-022
FILE: ELTORO-2

TABLE A-2

ESTIMATED LABOR COST

BASED ON

12 MONTHS SCHEDULE INCLUDING 6 MONTH SAMPLING

NO	LABOR CATEGORY	GR	-3	-2	-1	1	2	3	4	5	6	1	2	3	TTL M-M	TTL MH*	$/MH	TOTAL $
			MONTHS															
1.0	CONTRACTOR'S LABOR																	
1.1	PROJECT OFFICE(SAN DIEGO OFFICE)																	
1.1.1	WAGES;																	
	PROJECT MANAGER	29	0.5	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.8	0.5	10.6	1,781		
	PROJECT ENGINEER	28		0.3	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.3	8.6	1,445		
	LEAD GEOLOGIST	27		0.3	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	9.3	1,562		
	HEALTH & SAFETY MGR	28			0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.5			7.0	1,176		
	PROJECT CONTROLS	27	0.3	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.3	8.6	1,445		
	PROCUREMENT	27	2.0	2.0	2.0	2.0	2.0	0.5	0.5						11.0	1,848		
	SECRETARY	21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	12.0	2,016		
	SUPPORT(ACCTN'G)	21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	12.0	2,016		
	DATA VALIDATOR	27				1.0	1.0	1.0	1.0	1.0	1.0				6.0	1,008		
	SR. DATA MANAGER	27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	12.0	2,016		
	MISC. TECH SUPPORT	26							2.0	2.0	2.0	2.0	2.0	2.0	12.0	2,016		
	GEOLOGIST	26										3.0	3.0	3.0	9.0	1,512		
	COMPUTER SPECIALIST	26										2.0	2.0	2.0	6.0	1,008		
	SUBTOTAL 1.1.1(INCLD MULTIPLIER)														124.1	20,849		1,423,676
1.1.2	ODC'S;																	
	COMMUNICATION															20,849		
	MATERIALS & SUPPLIES															20,849		
	REPRODUCTION															20,849		
	COMPUTER COST															20,849		
	SUBTOTAL 1.1.2																	152,613
	TOTAL PROJECT OFFICE, 1.1																	1,576,289
1.2	SAMPLING SITE(EL TORO)																	
1.2.1	WAGES;																	
	FIELD MANAGER	27				1	1	1	1	1	1				6.0	1,302		
	HEALTH & SAFETY	25				2	2	2	2	2	2				12.0	2,604		
	FIELD GEOLOGIST	25				6	6	6	6	6	6				36.0	7,812		
	GEOPHYSICIST	25			4	4									8.0	1,736		
	COMPUTER SPECIALIST	26				4	4	4	4	4	4				24.0	5,208		
	SUBTOTAL 1.2.1(INCLD MULTIPLIER)														86.0	18,662		1,064,446
1.2.2	ODC'S																	
	COMMUNICATION															18,662		
	MATERIALS & SUPPLIES															18,662		
	REPRODUCTION															18,662		
	STANDARD AUTOMATION															18,662		
	SUBTOTAL 1.2.2																	50,387
	TOTAL 1.2																	1,114,833

* BASED ON 40 MH/WK FOR 1.1, 50 MH/WK FOR 1.2

DATE: 06-MAY-94
PROJECT: 20376-022
FILE: ELTORO-3

TABLE A-3

OTHER ODC'S ESTIMATE

NO.	COST ITEMS	QNT'Y	UNIT	UNIT COST	TOTAL COST
1.3	OTHER ODC'S (FIELD)				
	PROJECT EXCUTION OFFICE (4 TRAILERS FOR 12 PEOPLE, 6 MONTHS)	24	MO-EA	350	8,400
	REPORT PRINTING AND DISTRIBUTION (20 DRAFT + 20 FINAL)	40	EA	250	10,000
	HEALTH & SAFETY EQUIPMENT, ALLOW (12 EA X $ 50/EA-DAY, $ 15,000/MO)	6	MO	12,000	72,000
	FIELD VEHICLES/TRUCKS RENTAL (10 EA X 6 MO)	60	MO-EA	550	33,000
	OTHER MATERIAL & SUPPLIES, ALLOW	12	MO	2,500	30,000
	COMPUTER (4 EA)	48	MO-EA	250	12,000
	COMPUTER (INTERGRAPH WORK STATION)	2	EA	80,000	160,000
	TRAVEL - 10 PEOPLE X 1 TRIP/MO X 12 MOS (LA - SF), ALLOW $ 450/TRIP	120	EA	450	54,000
	TEMP ASSIGNMENT - 13 PEOPLE X 6 MO + 4 PEOPLE X 2 MO	86	M-M	1,500	129,000
	TOTAL OTHER ODC'S, 3.0				508,400

DATE: 06-MAY-94
PROJECT: 20376-022
FILE: ELTORO-4

TABLE A-4

SUBCONTRACT COSTS

SOILGAS	5,870
SOIL	4,810
TOTAL	~11,000

NO.	COST ITEMS		QNTY	UNIT	UNIT COST	TOTAL COST	S/T
2.0	SUBCONTRACT COST						
		BASIS:					
2.1	SAMPLING						
		– SAY 11,000 SAMPLES, 3 SAMPLES/HOLE					
		– 3,700 HOLES					
2.1.1	DRILLING FOR FIELD SCREENING	– (1.5 HOLE/HR) X 8 HR = 12 HOLES/DAY-RIG					
	$/DAY	– 3,700 HOLES/12 = 310 DAY-RIGS					
		– 180 DAYS = 6 MONTHS = 26 WEEKS = 130 DAYS					
	2 RIGS, SOILGAS (2/EA) 4,500	– 310/130 = 2.4 RIGS, SAY 3 RIGS + 1 ADDITIONAL					
	2 RIGS, SOIL (3/EA) 5,200	– COST INFORMATION FROM TARGET, 4/22/94					
		– $ 10,350/DAY IS FOR LEVEL D					
	1 SUPERVISOR 650	– $ 14,350/DAY FOR LEVEL C($ 100/HR-RIG)					
	TOTAL (4 RIGS+11EA) 10,350						
	VOL. DISC @ 20% 8,280						
	– DRILLING 3,700 HOLES		130	DAY	8,280	1,076,400	
	– MOB/DEMOB FOR RIGS AND PEOPLE		1	LT	27,000	27,000	
	SUBTOTAL 2.1.1					1,103,400	1,103,400
2.1.2	DRILLING FOR WELLS						
	– 2 RIGS FOR 37 DEEP HOLES (AVG 210LF/EA)						
	FOR LEVEL D – 80 % OF TIME AT 1.0 COST FACTOR		164	DAY	2,400	393,600	
	FOR LEVEL C – 20 % OF TIME AT 1.2 COST FACTOR		41	DAY	2,880	118,080	
	– MOB/DEMOB		2	RIG	5,200	10,400	
	– MARERIAL COST FOR WELLS (37 EA)		37	EA	3,500	129,500	
	SUBTOTAL 2.1.2					651,580	651,580
2.1.3	DRILLING FOR DEEP 8 BORINGS (AVG 180 FT/EA)						
	– REQUIRE 1 RIG FOR 12 DAYS						
	FOR LEVEL D – 80 % OF TIME AT 1.0 COST FACTOR		9	DAY	2,400	21,600	
	FOR LEVEL C – 20 % OF TIME AT 1.2 COST FACTOR		3	DAY	2,880	8,640	
	– MOB/DEMOB (WITH 2.1.2)		1	LT	INCL'D	0	
	SUBTOTAL 2.1.3					30,240	30,240
2.1.4	AQUIFER TESTING (PER CH2M HILL)		1	LT	101,000	101,000	101,000
	TOTAL FOR SAMPLING, 2.1						1,886,220

DATE: 06-MAY-94
PROJECT: 20376-022
FILE; ELTORO-5

TABLE A-5

SUBCONTRACT COSTS

SOILGAS	5,870
SOIL	4,810
TOTAL	~11,000

NO.	COST ITEMS	QNTY	UNIT	UNIT COST	TOTAL COST	S/T
2.0	SUBCONTRACT COST(CONTINUOUS FROM PREVIOUS PAGE)					
2.2	LAB ANALYSIS COST(PER TARGET/SITE WORK)					
2.2.1	SOILGAS ANALYSIS COST					
	EACH					
	BASIC 6,000					
	24% QC 1,400					
	TOTAL 7,400					
	BASIS: USE GC/FID AT 40 SOILGAS ANALYSIS/DAY-EA; 7,400/40 X 130 DAYS = 1.4 OR 2 UNITS REQ'D; USE 2 UNITS + 1 SPARE; COST INFO PER TARGET; 2 UNITS + 2 PERSON = $ 2,100/DAY; 3 UNITS + 2 PERSON = $ 2,400/DAY; - POWER HOOKUP EXCLUDED; - 1 LAB TRAILER INCLUDED; - MOB/DEMOB = $ 4,000; - GAS CONTAINER INCLUDED					
	SOILGAS ANALYSIS	130	DAY	2400	312,000	
	MOB/DEMOB	1	LT	4000	4,000	
	SUBTOTAL 2.2.1				316,000	316,000
2.2.2	SOIL ANALYSIS COST(PER SITE WORK)					
	SAMPLE					
	BASIC 5,000					
	PHASE II 620					
	QC 610					
	TOTAL 6,230					
	BASIS: - 6,230 SAMPLES; - 6 TESTS/SAMPLE OR 37,380 TESTS; - A CREW OF 27; - 11 GC/MS + 4 OTHER INSTRUMENTATIONS					
	- INSTRUMENT, SUPPLIES, TRAILORS(11 GC/MS)	1	LT	1E+06	1,058,000	
	- LABOR(CHEMICALS, DATA BASE ANALYSIS)	1	LT	804000	804,000	
	- PER DIEM	1	LT	522200	522,200	
	- TRAVEL	1	LT	280000	280,000	
	- MOB/DEMOB	1	LT	350000	350,400	
	SUBTOTLA 2.2.2				3,014,600	3,014,600
	TOTAL, 2.2					3,330,600
2.3	OTHER S/C COSTS					
	- EXTERNAL LAB SAMPLES(INCLD'G SHIPPING)	185	EA	1,200	222,000	
	- SAMPLES DISPOSAL AFTER ANALYSIS (2"X6"LX3X 6,230EA)	240	CF	250	60,000	
	- SURVEY 100 ACRE SITE AND MARK HOLES	1	LT	25000	25,000	
	- U/G UTILITY CLEARANCE(2,000 SPOTS)	1	LT	50000	50,000	
	- ACCESSIBILITY TO THE SITE ASSUMED GOOD	1	LT	0	0	
	TOTAL, 2.3				357,000	357,000

Attachment 1.

MCAS El Toro Homogeneous Hypothesis

In the Phase I RI/FS, MCAS El Toro has posed a hypothesis. That is, there exists an equal probability of detecting any Chemical of Concern (COC) at any location within the volume of soil defined for each stratum. This means, in other words, by most definitions, the potential contamination within the soil is homogeneous. A number of assumptions are implied in this hypothesis.

1. The chemical constituents of each wastestream or release were well defined.

2. Each waste stream released had a homogeneous composition and was repeatedly released over time (10-50 years). That is, there must have been numerous occasions of releases. If the wastestreams were not homogeneous, then heterogeneous wastes must have been released randomly and often so that the hypothesis would still be valid.

3. Within each stratum, each waste stream was released randomly or evenly over the stratum area (volume).

4. All physical parameters within each stratum are homogeneous: geology, stratigraphy, topography, rainfall, drainage, wind speed, exposure to sunlight, use, traffic, etc.

4. The environmental fate and transport characteristics of each chemical released are similar (half-life, K_{oc}, Henry's Law Constant, reactivity, K_{ow}, solubility, etc.).

EPA continually requested evidence to support these assumptions, to no avail. Instead, MCAS El Toro has provided macroscopic descriptions of activities, waste streams, record searches, etc. For

example, MCAS El Toro has stated that records were searched and interviews conducted during various previous investigations. How did these records lead to justification for the hypothesis, specifically at each stratum. Who was interviewed? What was the position(s) held (experience) by each interviewee? Simply to state that x number of interviews were conducted or to macroscopically summarize records does not support the hypothesis. Note that plans are now being made to conduct interviews with past and present employees, some with over 40 years of experience at MCAS El Toro. Why weren't these employees sought out 4 years ago?

According to the Draft MCAS El Toro Base Closure Plan, (March 1994) two sources appear to have been used, initially, to acquire historical aerial photographs (HAPs): CALTRANS and Whittier College. HAPs for only the years 1964, 1985, and 1989 were acquired from CALTRANS. The approach used to obtain HAPs was to seek one HAP for each calendar year, rather than to obtain as many as possible. Given the high degree of uncertainty inherent in scoping 40-50 years of potential releases, more reliance should have been placed on obtaining the maximum number of HAPs possible. In fact, EPA submitted to MCAS El Toro it's own limited report on acquisition and interpretation of MCAS El Toro HAPs after MCAS El Toro stated that their effort (stated to involve hundreds of HAPs) did not radically change the planned field investigation. The EPA HAP report, submitted in January, 1992, required significant revisions to the Phase I RI/FS FSP. (Note that due to this embarrassing turn of events, MCAS El Toro hired another contractor to conduct an extensive HAP survey. The subsequent report was issued in October, 1993, long after the Phase I field work was completed.) Unfortunately, the funding had been allocated to perform the RI Phase I field work at a fixed level and could not be increased at that late date. Thus, MCAS El Toro attempted to cover the many new strata uncovered by the EPA HAP report by <u>declaring strata to be homogeneous</u> based on their interpretation of the EPA HAP report and their scoping information. Some additional sampling was proposed by eliminating some planned field work such as not installing some planned monitoring wells, and, instead, using that funding for adding soil boring locations within newly discovered strata and for subsequent sampling/analyses. This declaration of homogeneity was based upon alleged "similar release mechanisms". However, despite repeated written requests, MCAS El Toro has failed to provide EPA with documentation of the rationale and specific criteria used to justify the sampling approach.

How are the environmental fate and transport characteristics of all chemicals in each waste stream potentially released within each stratum similar? If not, chemicals would tend to move, react,

partition, etc. differently within each stratum. Subsequent investigations would find chemicals distributed preferentially in certain locations, giving rise to "hot spots". However, the hypothesis assumes that "hot spots" do not exist.

MCAS El Toro must provide evidence to support the above assumptions. What evidence shows: repeated, numerous releases of wastestreams (COCs)?; random releases?; releases which were evenly spread throughout the stratum? For example, assume a waste stream (e.g., chlorinated solvents) was released only on two occasions, once in 1942 and once in 1992, in a given stratum. Assume further that these two releases occurred in two substantially separate areas of the stratum. Given the five assumptions supporting the hypothesis, can one reasonably assume expect that an analysis of soil taken today from the "1942" spill area would be representative of the true condition in that stratum? The Agencies think not. With the MCAS El Toro sampling approach, it is likely that the "1992 hot spot" would not be sampled. Since no direct evidence pointing to these "hot spots" has been found, MCAS El Toro assumes that sufficiently large numbers of releases of wastes (COCs) have occurred in a random fashion within each strata such that a random sampling event with a few sampling locations (e.g., n=5) would detect any contamination. That is, each sampling point (horizontal and vertical) has an equal probability of detecting any contamination within the stratum and that the result is representative of the true condition at that stratum. However, what if in reality only a few, random releases occurred in a stratum? It is unlikely that the MCAS El Toro sampling approach would detect contamination in such a scenario unless, coincidentally, a sample point was located in one of these hot spots.

How thoroughly does MCAS El Toro understand the chemical composition of the wastes released? Have sufficient, appropriate analytical methods been employed in Phase I to assure the public that all hazardous substances (COCs) potentially released in significant amounts at MCAS El Toro would be detected in this RI? What degree of uncertainty remains? If MCAS El Toro chooses (for economic, political, or other reasons) not to do more investigations, MCAS El Toro should state that fact. For example, if MCAS El Toro feels that this approach is similar to those employed in others RIs, that should be stated rather than claiming that their approach is based on some scientifically defensible rationale.

Thus, the hypothesis is based on assumptions that cannot be evaluated properly without additional strata-specific information.

However, regardless of whether or not strata-specific information supporting the hypothesis has been submitted, any hypothesis must be tested. That is, scientifically sound measurements must be taken, data evaluated, and used to confirm or reject the hypothesis. Otherwise, science is not being used to support decisions. Certainly, other factors can be used to make decisions (e.g., political, economic, etc.,). For example, regulatory agencies can agree that a stratum does not need to be thoroughly investigated for releases of hazardous substances, pollutants, or contaminants, due to cost, future land use, etc. However, these other factors have not been proposed in this RI/FS. Therefore, EPA has expected all along that MCAS El Toro would evaluate the data collected during the RI Phase I and test their hypothesis.

The problem now is that the statistical approach proposed is not normally used to evaluate environmental data. EPA has not seen this approach employed at other federal facilities within Region IX. Furthermore, attempting to use summary statistics to evaluate the power, confidence level, etc., of the data will likely fail due to the small sample size. That is, large numbers of Non-detects (Nds) may result. EPA, however, does have methods (see Draft Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, EPA, July, 1992) of evaluating data with large numbers of ND. Note that the MCAS El Toro hypothesis was the same at each stratum, regardless of its size (area/volume).

The Phase I RI at MCAS El Toro did not adequately characterize the spatial variability of contaminants within each stratum to provide enough information for subsequent decision making. Uncertainty in the scoping effort compounded by uncertainty caused by sampling can yield meaningless data. The uncertainties in the Phase I RI data should have been presented and well understood before these data were used to draw conclusions. The relationship between the number of samples and measures of statistical performance depends on the variability of the COCs, which is measured by the coefficient (Cv) (see Guidance for Data Usability in Risk Assessment, Part A, Final, EPA, 1992). If indeed the distribution of contaminants within each stratum is homogeneous, then the resulting Cv values from the Phase I data should be very low, indicating that the effect of spatial variation on contaminant concentrations is minimal. Unfortunately, as stated above, the summary statistics from the Phase I results cannot be generated due to the small sample size.

The concern of EPA is that MCAS El Toro cannot state what the probability is (at each stratum) that the stratum is "dirty" when the data suggests that it is "clean." Is it quantitative or qualitative? This difficulty arises at facilities with large expanses of land at which releases have potentially occurred over longtime periods. In order to decide with a reasonable degree of certainty that such areas are "clean" and classified for No Further Investigation (NFI), a large amount of sample points are needed to arrive at defensible positions. In the past, such large sampling efforts have been costly, even prohibitive. Now, however, newly developed field analytical methodologies allow collection of massive numbers of samples, real time analysis, and rapid decision-making at a greatly reduced cost. Unfortunately, MCAS El Toro has been resistant to using this approach.

Attachment 2.

MCAS El Toro Homogeneous Hypothesis
Statistical Review

These comments are based on review of sections of the Installation Restoration Program Draft Final Sampling and Analysis Plan, February 1991, the Draft Final Sampling and Analysis Plan (SAP) Amendment, August 26 1992, and the Phase II Work Plan, November 1993, and are focused on *statistical soil sampling*. Attached is a summary of the major comments on the Phase I sampling approach, its impact on Phase II, and on the Phase II work plan.

Installation Restoration Program Draft Final Sampling and Analysis Plan, February 1991

The February 1991 Installation Restoration Program Draft Final Sampling and Analysis Plan describes the objective of the Phase I Sampling activities at the 22 sites within the boundaries of the El Toro MCAS as *"designed to test source areas to determine whether contamination exists and at what general levels and extent"* . The Plan also proposes *"random sampling within statistical strata to help eliminate potential biases.* ***The number of the samples within strata varies according to the size of the strata*** *and the sample medium"*. Statistical strata are defined as: *"homogeneous areas of potential contamination (based on available information). For example, in sites with visible contaminated areas, the statistical strata is the area of visible contamination. For sites with no prior information about contaminant location, the statistical strata are the areas with similar uses or activities. Within a statistical strata there is no information available leading to a preference for sampling one area rather than any other."*

Although the document describes methods of randomly locating the data collection stations, **it does not describe the actual statistical methodology of selecting the number of samples within each stratum, and does not state the level of confidence and power that the selected number of samples will provide to the decision makers.**

These statements lead to the conclusion that 1) the size of a stratum will influence the number of samples within each stratum and 2) since the strata will be defined on a case by case basis, a description of the criteria for selecting the boundaries of each stratum will be provided in the Phase I RI documents.

Draft Final Sampling and Analysis Plan (SAP) Amendment, August 26 1992.

The August 26 1992 Draft Final Sampling and Analysis Plan (SAP) Amendment, describes changes to the general sampling approach since the original SAP. Section 3 of this document describes the methodology for the Statistically Based Sampling. This document is the first effort to provide a statistical rationale for the number of samples selected within each homogeneous stratum. The objectives of the Phase I sampling effort stated in the document include:

- Estimation of constituent concentrations at potential source areas for preliminary risk assessment, and

- Refinement of the list of constituents of concern for the Phase II investigation.

"A statistical sampling strategy will be used to develop the number and locations of samples for surface and subsurface soil samples.....The key decisions to be made at the end of Phase I include the number and allocation of samples needed for Phase II sampling and the list of constituents for which the samples should be analyzed."

In addition to the above key decisions, Phase I results lead to the selection of the strata for which no further action is recommended. The decision of declaring a stratum as contaminated or not by a specific contaminant, or a group of contaminants, is central to the decision of no further action.

The document states that *"because little is known about the statistical distribution of constituent concentrations"*, a *"largest of N"* (although this is not a standard statistical term, it is widely used in most of the El Toro documents) sample strategy is proposed for estimating *"reasonable maximum exposures (RME's) to the constituent of concern. Simple probability is used to show that the confidence (probability of being correct) that the largest constituent concentration in N samples is greater than P percent (as a fraction) of all potential sample concentrations is* $C = 1-P^N$ *"* (see pages 3-5 in the SAP Amendment).

When statistics are used the goal is to collect enough information to reduce the uncertainty associated with decisions regarding alternative actions for the site. The fact that little is

known about the statistical distribution of constituent concentrations is a significant source of uncertainty. One of the objectives of the Phase I sampling effort was to collect enough samples providing information to reduce this uncertainty, and provide a better approximation of the true distribution of each constituent.

Use of a simple binomial approach for sample selection implies that the assumption about the statistical distribution of the data is, in essence, being postponed for the next round of data collection Phase II.

The formula used to estimate the number of samples indicates that if P is chosen to be 0.5 (the median), as in Phase I, then C represents the probability that the largest observed constituent concentration level from N samples is greater than the concentrations of 50% of all potential concentrations within the sampling area (i.e. C is the probability that the largest observed concentration is above the median).

For example, according to this method, if we select only one sample, there is a 50% probability that 50% of all potential concentration levels of a given constituent in the soil will be less than the observed concentration. With two samples the probability of the largest of the observed concentrations being larger than 50% of all potential chemical concentrations within the sampling area is 75%. With three samples this probability is 87.5%, and so on.

This approach makes no assumption about expected concentrations, the detectability of the constituents of concern, and the variability of the distribution of a constituent within the site. The variability of a constituent should be known if a formal statistical approach (hypothesis testing in support to decision making) will be used for Phase II.

No explanation is given on how this approach is related to the decision making (probability of declaring a site clean when in reality is dirty or, declaring a site dirty when in reality is clean).

It is customary when a statistical approach if used, to make decisions regarding remedial action alternatives by testing a hypothesis concerning the data. It is extremely important that the statistical methodology used leads to the selection of a number of samples in a manner that minimizes the uncertainty in the interpretation of the data. There are several statistical

methodologies which, if used correctly, lead to the selection of the number of samples required to make decisions ***with a specified levels of confidence and power***

An omission in the SAP Amendment is the lack of discussion of the influence of the size of a stratum on the selection of the number of samples.

The statistical method described in the SAP Amendment seems to be appropriate for simple, well defined systems with a reasonably small areal extent. If a methodology is used without any regard for the size or complexity of the system under investigation, it may lead to erroneous conclusions. The application of statistical methods is valid if the samples are representative of the statistical population under investigation. In soil investigations the statistical population is the total number of possible soil samples to be selected from a given area (i.e. the total volume of soil within a stratum divided by the volume of each sample). For example, if the same number of equal size samples is used to characterize two different size sites, then the fraction of the total population sampled in the larger site is smaller than the fraction of the population sampled in the smaller site. Only in cases where it has been proven that each area is homogeneous within its boundaries, can the same number of samples be justified for two different size areas. In environmental studies, because of the complexity of the systems under characterization, the smaller the size of a stratum, the lower the probability for statistical error.

Using the correct stratification assumptions is critical for the success or failure of the implementation of a stratified sampling scheme.

The SAP Amendment states that the two criteria used for the lateral stratification of the areas of concern were similarity of activities and patterns of contamination. Both are valid criteria for declaring an area as homogeneous, as long as additional factors that may affect site homogeneity are examined. Such factors are the physical characteristics of the site, weathering and run-off processes, the expected variability of concentration levels, and the characteristics of the constituents of potential concern. The assumption of homogeneity should be made only for areas where most likely hot spots are not present, and low variability of the chemicals of concern is also expected. Only under these conditions the sampling methodology followed in Phase I is statistically valid.

Phase II Work Plan, November 1993.

The Phase II Work Plan should discuss the following elements of the statistical approach:

How the investigation results of Phase I support the Phase II approach. Specifically, uncertainties in the Phase I data should be presented and well understood before the data are used to draw any conclusions about their theoretical distributions, real means and standard deviations (and consequently CV's). Summary statistics for the Phase I data should be presented and discussed by stratum or groups of strata. The presentation should include the number of samples, mean, error estimates, and variability estimates for the COPC's.

The Work Plan (page 4-104) states that *"because the number of samples collected from a stratum is relatively small, there is uncertainty associated with this estimate. In fact an alternate population distribution of values could have yielded a similar set of sample values"*. There is uncertainty associated with both large and small samples. The point here is that the Phase I sample sizes within strata are so small that the uncertainty in the data is very large. The similarities of the distributions should be discussed here. The discussion should explain in what ways are the distributions similar.

More background information is needed on the construction of the hypothesized and alternative distributions in Figures 4-6, 4-7, and 4-8. If these distributions were taken from another source, then a reference to this source should be provided. Are these hypothetical cases based on hypothetical data given here just to clarify the concepts, or are they based on actual site data? Are Figures 4-6, 4-7, and 4-8 based on the same data set? It appears that there are inconsistencies between the figures. The Y axes of these Figures should be labeled. The discussion of the method is based on the assumption of lognormal distributions of risk. It is not made clear whether the analytical results from Phase I data support the assumption of lognormality or not. Were there normality and lognormality tests conducted for the different COPCs?

It should be clearly stated in the text where the discussion is referring to the sample mean population mean and where to the mean of the logarithms. Also, it should be clarified where the text is referring to the risk distribution and where to the distributions of the COPC concentration data, or their logarithms.

The discussion of the analysis of the Phase I estimated risks is not very clear. In particular, it is not clear how the sample-specific risks were calculated. Clarification is needed on what contaminants are represented and what are their concentrations. Further discussion is needed about Figure 4-10 and Table 4-14. At least five different populations are present in Figure 4-9. An explanation of this should be given in terms of real concentrations for the COPCs, not just in terms of risk. Analysis of variance is an excellent approach for assessing variability. However, additional discussion of the implementation of the analysis of variance approach for this study should be provided. The discussion should explain what strata and what COPCs were used for this analysis.

It is not clear what criteria were used to select the MDRD of 4.8 and 7.4. What does this translate to in terms of the MDRD of the actual mean of the concentration values of particular COPCs? What is the percent of MDRD for a specific COPC?

It is not clear what degrees of freedom, and why, were used to select $t_{a(1)}$ and $t_{b(1)}$. The values of these parameters, and consequently the number of samples, can vary considerably for the same probability depending on the degrees of freedom used to select these parameters. The degrees of freedom used and the actual values of $t_{a(1)}$ and $t_{b(1)}$ should be given.

Recommendations for Phase II

Before finalizing the Phase II sampling plan, the results of the Phase I investigation and the validity of the assumptions that lead to the selection of the number of samples for a particular stratum should be reexamined. This is especially important in cases where no further action or the removal of a COC from the COC list is recommended. Statistics is not an exact science. Since the information obtained from statistical analysis will always be incomplete (it is impossible to sample the entire site inch by inch), there will always be uncertainty in the collected data. When very little is known about a site, assumptions are made in good faith to help the investigation process. As more information is gathered, these assumptions should be revisited and tested.

Although considerable effort has been devoted to the identification of homogeneous strata in the sampling strategy design of Phase I, the sampling results could indicate otherwise. Actions for Phase II should be based on a thorough examination of the assumptions and criteria of homogeneity used for the selection of individual strata in Phase I, as well as on the results of the Phase I investigation. If during the review of the results of the Phase I investigations there are doubts about the homogeneity of some strata, these doubts should be clarified before the implementation of Phase II. In this case the stratification scheme of Phase II should be modified, and if appropriate, additional samples should be collected.

The stratification process is a judgmental process. A list of all criteria to be used for the definition of the strata at each site should be well documented. A suggested, non-exhaustive list of criteria for the lateral stratification of the areas of concern could be:

- Similarity of past activities
- Patterns of contamination
- Physical characteristics of the site
- Weathering and run-off processes
- Expected variability of concentration levels
- Characteristics of the constituents of potential concern
- Expected hot spots
- Geology, etc.

Because of the small size samples used in certain strata, a conservative approach should be followed for eliminating COPC's from the COPC list. The most conservative approach in screening out chemicals is to keep on the critical list all the chemicals that were detected at least once within a stratum. This is critical especially in cases where random sample locations do not give a good coverage of the stratum and the homogeneity of the site is in doubt. A less conservative approach is to keep on the COPC list all the constituents whose maximum observed concentration within each stratum exceeds the cleanup level. The maximum observed value should always be used in risk assessment calculations requiring the observed median concentration or mean concentration.

It is impossible to fully characterize a site using a strictly statistical sampling approach. It is impossible to reduce the uncertainty to zero. There are cases where professional judgment about the sampling location could provide greater confidence (although non-quantifiable) in the data than any statistical approach. In cases where a statistical approach suggests a large number of data which could affect the cost of a project disproportionally to the benefit of acquiring unbiased information, the decision of using a statistical approach should be reevaluated. Some times it is more beneficial to a project to use professional judgment for selecting the number and locations of samples, rather than a completely random approach. This could lead to a more effective allocation of the limited project rescouses. **A judgmental approach for selecting the number and location of samples proposed by an interdisciplinary group of experts could lead to a better site characterization than a non-suitable statistical approach.**