Food and Agriculture
Organization of the
United Nations

Rapid Environmental Assessment (REA) investigator handbook

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Acronyms

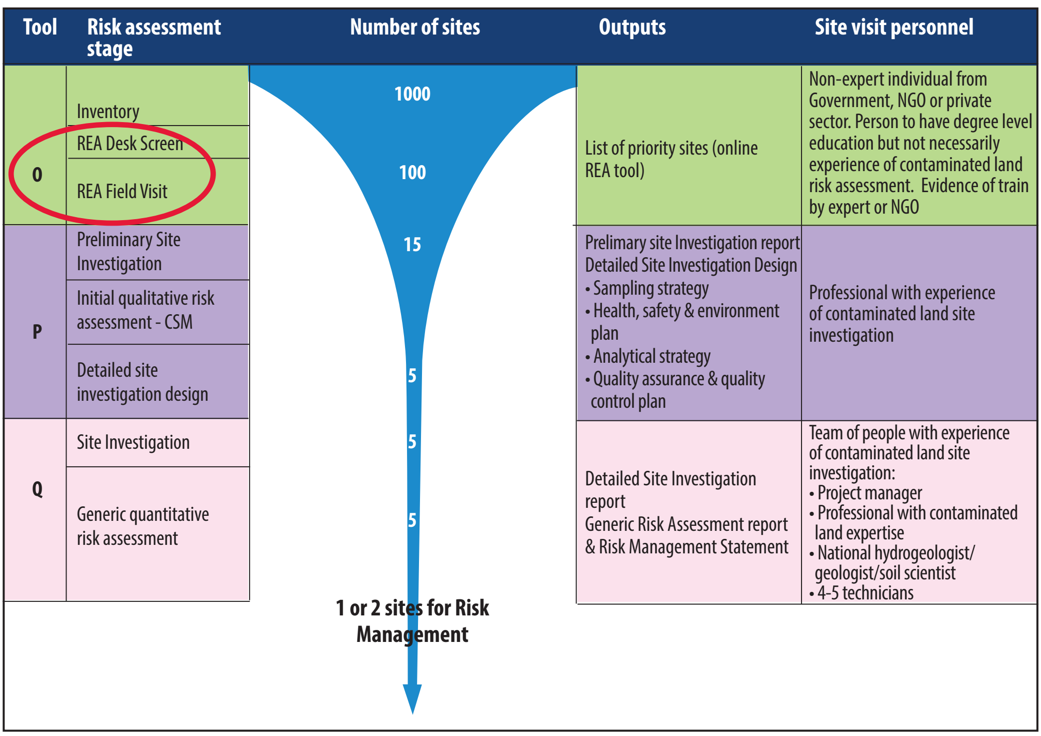
CSM	Conceptual site model
DDT	Dichlorodiphenyltrichloroethane
EU	European union
FAO	Food and agricultural organization of the united nations
GEF	Global environment facility
GIS	Geographic information systems
ISS	Initial site screening
IPM	Integrated pest management
NGO	Non-Governmental organization
POPs	Persistent organic pollutants
REA	Rapid environmental assessment

Background

Purpose of the investigator handbook

This handbook is intended to supplement Volume 5 of the FAO Environmental Management Toolkit for Obsolete Pesticides (EMTK) series. EMTK 5 aims to develop a detailed Risk Assessment of contaminated sites and accompanying statement on whether risk management is needed. The REA is the main component of Tool O in the EMTK Volume 5 process–Site identification and prioritization (Fig. 1). Prior to undertaking the REA process, an inventory is conducted following the guidance in EMTK 5. Once a complete inventory of all potentially contaminated sites is available, the REA process is used to give a first indication of possible prioritization. This will inform the deployment of further resources in a further, progressively more detailed assessments (Tools P and Q), and selecting priority sites for action (final output of EMTK 5). Under the following Volume 6 of the EMTK series, guidance is provided for the development and implementation of an Environmental Management Plan for those sites.

Figure 1
Full process as laid out in EMTK 5 for development of a detailed Risk Assessment with Tool O and the REA process circled



The handbook is intended to complement training provided by FAO, and will help to guide trained investigators through the process of successfully completing a Rapid Environmental Assessment (REA) of locations thought to be contaminated with pesticides. It is not intended to be a substitute for attending a training event and as a standalone document is insufficient to fully introduce the REA protocol.

The Rapid Environmental Assessment (REA)

The Rapid Environmental Assessment (REA) is a tool developed by FAO to prioritize pesticide contaminated sites for further intervention. The tool has been developed based on field trials on pesticide contamination sites in Vietnam and in five countries of the Former Soviet Union.

The resulting tool is comprised of two distinct phases. The first phase is a "Desk Screen", that utilizes limited site information and pre-existing GIS layers to prioritize sites for visits. Information on the soil type, nearby populations, the slope of the area, pesticide type and quantity (when available) and other information are used in an algorithm to determine visit priority.[1]

The desk screen is necessary because government or other agencies generally will not have the funds or resources to do site visits and assessments at all sites, so need a way to focus their limited resources on the sites most likely to present significant risks.

The second phase, the REA Field Visit, is comprised of a site visit and a site-specific sampling and assessment protocol. During a visit of typically 1-2 days, interviews are conducted with people knowledgeable of the site, and then samples are collected, photographs are taken, and a series of objective technical questions are answered in a uniform format. Completed REAs are uploaded into a secure online database. The database uses three separate algorithms to calculate relative risks; specifically risks related to Source, Pathway, and Receptor. These concepts are further defined later in this document.

1 Keith, John, et al. (2013) "Rapid Assessment of POPs Pesticide Contamination Sites – A Simplified Method and Innovative Data Management System Developed for Vietnam" *Proceedings of the International Conference on Contaminated Sites, Bratislava, Slovakia*

Assessing risk: an introduction to the REA approach

Hazard vs. risk

In Risk Assessment, a hazard represents a potential danger. Hazards can be either physical, biological, safety, ergonomic, or chemical in nature, but do not necessarily present a *risk* to humans. Risk is fundamentally the probability of harm-essentially the probability that a hazard will cause injury multiplied by the severity of injury. Regarding toxic chemical hazards from materials such as pesticides risk is most often a function of the toxicity of the chemical, severity of dose, length of exposure, type of exposure, and several other important criteria. A common error of Investigators in our field is to inaccurately characterize a hazard as a risk. The presence of a pesticide or other toxic chemicals presents a hazard, but it is a risk only if someone (a 'receptor') is exposed to the pesticide at a dose and for a time length that their health is impacted.

Hazardous chemicals can present risks due to properties other than their toxicity, such as risks of fire, explosion, from acid or caustic burns, from flammable, explosive or corrosive chemicals respectively. These risks may also be of concern, particularly at obsolete pesticides stores, and need to be assessed if relevant. However, most often at pesticide contamination sites, the critical concern is the health impact due to the toxicity of pesticides. Also, it should be noted that toxicity concerns can be acute or chronic in nature. That it health impacts that show up quickly, usually related to high dose exposures, or alternatively they may that take time to manifest, typically resulting from prolonged exposure at lower levels.

Risk screening model: source-pathway-receptor

Central to the REA approach is the model of Source-Pathway-Receptor as the basis for understanding and assessing risks at a site. This model is consistent with risk screening approaches used internationally (by USEPA, WHO and others) but is simplified in this program for conducting rapid risk screenings.

The REA is focused on people's health. In simple terms, the health impact of a toxic compound on an individual is a function of its toxicity and the dose received by people. The dose is a function of the concentration of the toxic compound, the time that people are exposed, and the pathway into the body. There are three basic routes of exposure: inhalation – entry into the body through breathing; ingestion – entry through eating or drinking; and dermal – entry through skin contact and absorption.

The existence of a public health risk at a site depends on three components:

i. source - there must be a source of pollution with a severe enough toxicity

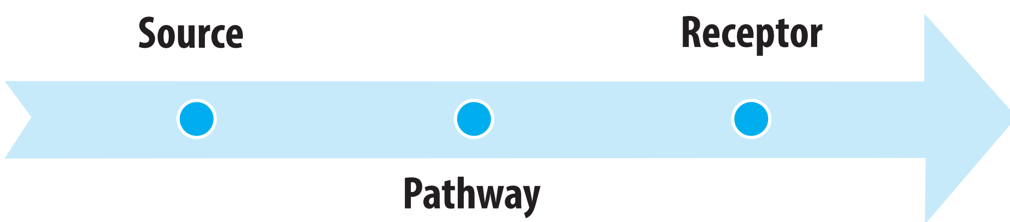
and a high enough level or concentration to be hazardous (e.g. 20 ppm of Aldrin in soil from leaking containers);

ii. pathway – the route of both migration of pollutants from the source to where receptors are (e.g. wind, storm runoff, groundwater, people carrying contaminated materials off-site) and how people encounter the pollutant (e.g. drinking contaminated groundwater, playing in contaminated soil, eating food animal that ingested the pollutants);

iii. receptor – people coming into contact with one of the exposure pathways.

The REA is the process by which these components are identified and assessed at a site. Importantly, all three must be present for a *risk* to exist. A contaminated site near a population, for instance, may present a *hazard*, but without a human exposure pathway, does not present a *risk*. Similarly, actively leaking drums into surface water, may present a serious *hazard* though if the site is in a remote area away from humans, it may not necessarily present a *risk*.

Figure 2
Source, pathway, receptor. All three must be present for a risk to exist



Source

The source, for the purposes of an REA, refers to the location where pesticides were released into the environment – soil or water – because of spills, poor storage or handling practices, deliberate burial of wastes, incidental dumping of pesticide contaminated material or gross over-application of pesticides at a use area. The resulting contamination serves as the location from which pesticides can migrate to receptors and may present direct exposure risks to people working or living at the source area. The key objective in evaluating a source area is to determine how much pesticide has been released to the environment (soil or water) – i.e. has escaped its containers or containment systems. In determining "how much" pesticide has been released at a source, the type of pesticide (specific chemical entity), quantity released, form (solid or liquid) and concentration are

all important to know. Historical information on the date of leakage/burial may also be important to know over what time period the leakage has occurred, in order to be able to assess how far contamination may have reached.

There are many substances that are hazardous to peoples' health. The form and characteristics of the pollutant are important. The amount of the pollutant is also critical. Investigators try to estimate the total area affected by a hazardous material and the level of contamination. One of the key factors here is the concentration of specific pesticides, which is measured by sampling and subsequent analysis. The critical parameter is the "over-standard" – the factor by which the concentrations of the pollutant exceed relevant international standards. For most common pesticides (and many other chemicals), scientific studies have been done to determine levels in soil or water below which health impacts are unlikely to occur, regardless of exposure pathways or the time length of exposure. These levels are termed "screening" levels, as contamination below these levels is deemed not to be of significant concern. The extent to which concentrations of pesticides in soils or water at a site exceed these screening levels provides a quantitative indicator of the potential hazard posed by the site.

Pathway

For our purposes, "pathway" refers to both the migration route and the exposure route into the body.

Migration Routes refers to how pesticides might move from a "source" to where receptors – people, farm animals or crops – are located. The following are the common migration routes:

- airborne emission of dust or vapors from a specific source during processing, handling or application of pesticides;
- spread of dust by wind from waste piles or contaminated areas;
- spread of dust or contaminated waste or soil by direct transport, such as by trucks carrying waste or people carrying contaminated mud on their boots;
- spread of dust or contaminated soil by water, such as in storm runoff, and then deposition in an area used by people;
- transport of soluble toxics or very fine particles in surface or ground water, to places where the water is used as a drinking water source (such as a well, pond or stream) either for people, farm animals or waterfowl;
- uptake of toxic contaminants into plants or animals, most often from contaminated water, which then enter the food chain of people.

Exposure routes are the physical ways that contaminants can enter the body. Substances can be toxic through:

- ingestion – basically swallowing. Pesticides can be ingested by:
- being taken up into food plants from contaminated fields; or

- being eaten by and incorporated into edible parts of livestock (cattle, pigs, etc.), chickens, waterfowl or fish;
- being present in drinking water; or
- incidental swallowing of contaminated soil, such as may be done by children playing in the soil, or because of poor hygiene (i.e. not washing hands) and eating after hands have become dirty with contaminated soil; or
- breathing in of contaminated dust which is caught in nasal passages or throat and lungs and is subsequently coughed up and swallowed.

Note incidental swallowing is often the most important exposure route, particularly for small children, whose small body mass makes it easier for them to get high dosage exposures.

- inhalation of dust or vapor, and then entry into the blood stream across lung membranes. Note that most dust, unless of a very small size (less than 2.5 microns) actually enters the body through ingestion;
- dermal exposure, through direct contact with contaminated soils or concentrated pesticides. The most common concerns are workers in contaminated areas, particularly if personal protection equipment (uniforms, gloves) are not worn while handling or using pesticides, and children playing in contaminated soils.

Receptor

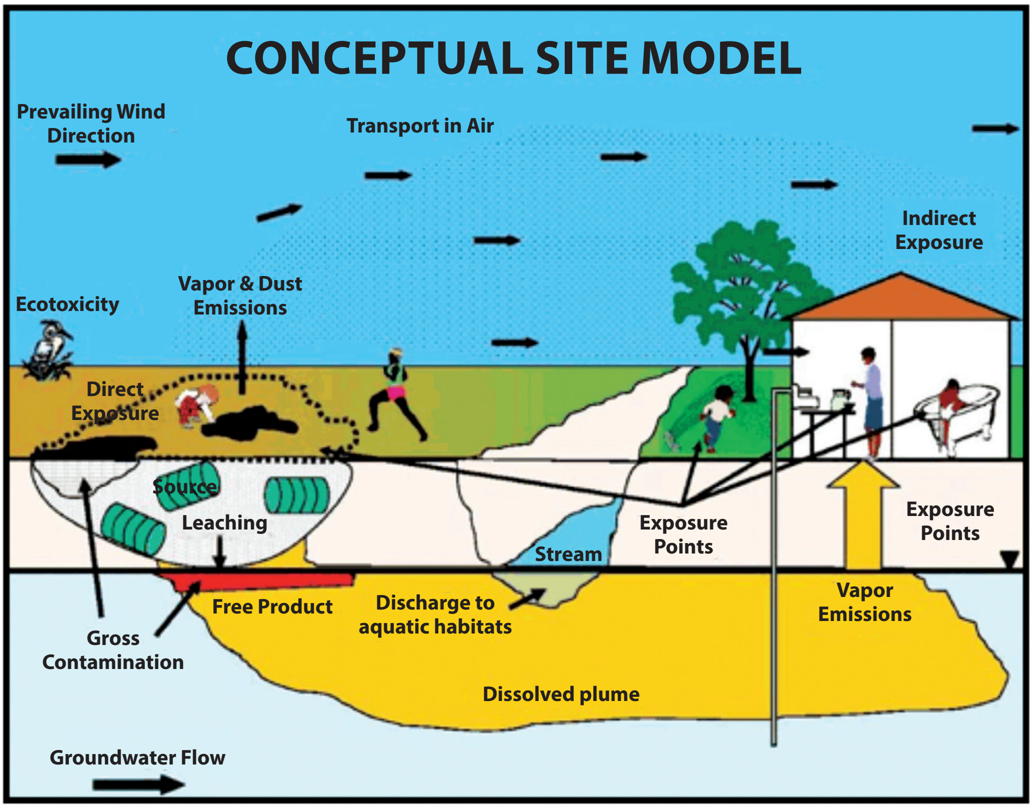
A hazard becomes a risk when a population is actually exposed to or impacted by the pollution at a dose high enough to potentially cause health impacts. A challenge for the Investigator is to identify the relevant population that can be exposed as determined by the levels of contamination, substance toxicity, migration routes and pathways that exist. The first step is to identify all the population groups within the probable area of influence of the polluted site, starting with populations immediately adjacent to the site, as well as those downstream and downwind from the site. This is best done using a local map and local information, by identifying nearby villages and urban areas (with estimated populations). Not all of these people will be at risk: that depends on the pollutant, migration route and pathways.

Conceptual Site Model (CSM)

The Conceptual Site Model (CSM) is a useful tool for understanding the risks posed by a given site and communicating these risks to others. Essentially it is a graphical representation of the relationship between the source, pathways, and receptors at a site. Investigators often find it useful to sketch out such a diagram while visiting a site. Consider how the receptors might come into contact with the unknown chemical hazard in Fig. 3 below.

Figure 3

Conceptual Site Model (CSM). The CSM can be a useful tool for better understanding the risks posed by a site. Consider how the receptors in this diagram may come into contact with the unknown physical hazard[2]



The overall result of going through this logic is to be able to identify the populations that are potentially affected though the Source-Pathway-Receptor connection. These people are the population at risk.

However, many health impacts from pollution are chronic or have multiple contributing causes and are difficult to attribute directly to one source. Also, sometimes health impacts do not appear until long after exposures to hazardous chemicals. Public health risk is easier to demonstrate when the migration routes are direct, the pathways are clear and the data on contamination is good. However, the objective of the REA is not to conclusively prove or quantify a specific health impact. It is to identify if there is a credible and significant risk to a population. Most often this credible risk is determined by estimating the exposure of

2 Interstate Technology Regulatory Council. Pictorial CSM. Retrieved from URL http://www.itrcweb.org/ism-1/3_1_2_Conceptual_Site_Models.html on 17 April 2014

people to a pesticide, and comparing this exposure to known information about exposure levels that cause health impacts. However, local health statistics or anecdotal information about health problems in a community can also provide supporting data about risks and impacts from a contaminated site. Further studies are generally necessary to evaluate and quantify the risks and health impacts, which then hopefully lead to interventions to reduce the risks and impacts. Note that interventions can be focused on any or all of the components creating a toxic contamination problem; elimination of the source (such as waste removal or elimination of use of a toxic substance in a process); control of migration routes (such as installation of pollution control equipment or covering waste piles); elimination of exposure routes (such as covering or paving contaminated areas or providing clean drinking water sources); or reducing the people in contaminated areas (such as by fencing off disposal sites).

Pesticides

Pesticides are a broad category of substances intended for preventing, destroying or controlling pests, such as disease vectors or unwanted plants or animals. These include defoliants, herbicides rodenticides and many others. Pesticides are typically composed of both active ingredients (the pure pesticide) and other ingredients such as the solvent and the adjuvant. Solvents carry a pesticide and can be either a solid or a liquid. Adjuvants are intended to make pesticides more effective. One type of adjuvant, a surfactant, is designed to make pesticides bond to a leaf.

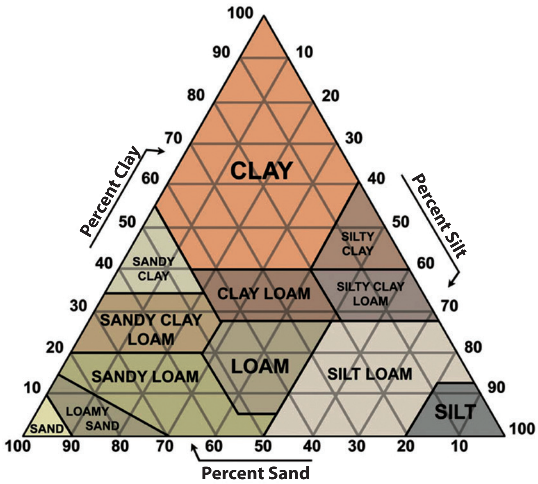
The focus of the EMTK series including the REA in on Obsolete Pesticides. These are pesticides that have either been banned from production and use due to concerns about their health or environmental impacts during or after use. Obsolete pesticides are also pesticides that have expired, are stored improperly and degrading, or are no longer suitable for controlling a pest for any other reasons.

The mode of action of pesticides is variable within the human body. Therefore, health effects from exposure to pesticides are also variable and can include neurological disorders, cancer, weakening of the immune system and respiratory infections, among other effects.

Fate and transport of pesticides

Fate and transport refers to the distribution, transport and transformation of contaminants from hazardous waste sites. Each pesticide is meant for targeting a different organism, and can be structurally very different from others. Solubility, volatility, and half-life (a measure of the rate of degradation in the environment) vary significantly between pesticides. Some pesticides, for instance, may degrade in a matter of days, while others may persist in the environment and not degrade for hundreds of years. Persistent pesticides (POPS) also tend to bioaccumulate in the fat tissue of animals or birds, which increases exposure to people who eat their meat, eggs or milk and also causes ecological damage; this is a key reason that POPS have been banned. These unique chemical characteristics affect how we assess risk at a given site.

Figure 4
Soil texture triangle. The relative percentages of clay, silt and sand can be important factors in understanding how pesticides migrate through soil



Pesticides can migrate through air, water, soil, and through organisms. In air, pesticides can be moved directly by wind, by binding with material that is moved by wind, or by volatizing and moving as vapors. They can be carried long distances before being deposited elsewhere. In water, pesticides can either deposit in sediment, float above the surface, or can diffuse and be carried with the current. Importantly, the velocity of moving water can relate to its ability to move larger sized particles.

In soil, texture is key parameter. Sandier soils will usually be more conducive to migration because pesticides usually adsorb less on sand particles and water moves through sand relatively quickly. Soils with a high percentage of clay and silt will likely slow the movement of pesticides, both because they are less permeable to water and because of greater binding (adsorption) of pesticides on to clay particles. Organic material also tends to adsorb pesticides, and may host organisms that can metabolize the pesticide. Contaminated soils within the root zone of plants are a source for uptake of pesticides into plants, with rich agricultural soils (loams with good organic content) presenting greater plant uptake risks. Similarly exposure to sunlight can increase the rate of photodegradation. A useful visual aid for conceptualizing soil texture is a textual triangle, seen here in Fig. 4.[3]

3 SoilSensor.com. Soil textural triangle retrieved from: https://www.nrcs.usda.gov/Internet/FSE_MEDIA/nrcs142p2_050242.jpg

Conducting an REA

General overview

All Investigators should go through a two-day training course. The purpose of the course is to familiarize Investigators with the REA protocol and overall management structure. After the training, Investigators will work with Supervisors to determine a site visit plan. The identities of sites to be visited will be confirmed by Supervisors and preliminary site information shared with Investigators. After investigators visit a site, they quickly enter site characteristics into the database, completing the online REA. Samples should be submitted for laboratory analysis.

Before your visit

Step 1: Coordinate the REA with your supervisor to make sure your plans are consistent with the regional priorities, budget, and timeline. Discuss any potential health and safety issues at the site.

Step 2: Research the site. Look for existing sampling data from other research projects. Try to identify the types of pesticides at the site and how the pesticides might have migrated. Examine available maps, such as from Google Maps, Google Earth or government sources, to learn about the area and key features such as the locations of roads, residential areas, industrial areas and water bodies.

Step 3: Identify a local contact or guide. Call local people to schedule interviews. Try to meet with:

i. local authorities (mayor, environmental agency, health agency);
ii. local organizations and community groups;
iii. local health professionals;
iv. local residents affected by the problem.

Step 4: Prepare your equipment. You will need:

i. **a camera.** Please check your batteries and set your camera to take large, high-resolution photos;
ii. **program summary.** Bring information about the Program to share with local officials and residents;
iii. **a notepad and pen.** Please take detailed notes;
iv. **a map** of the site (try printing from Google Earth or obtaining a local map);
v. **GPS** device and compass;

vi. **personal protective equipment (PPE).** It is recommended that investigators wear a minimum level of PPE to include eye protection, safety shoes or boots, nitrile gloves and dust proof coveralls. The use of additional protective equipment may be necessary depending on the level and type or risk. It is necessary that investigators are trained in risk assessment and the use and selection of PPE. Please see the section on HSE for further details;

vii. **sampling equipment** (see below).

Step 5: Prepare sampling equipment**.**

The equipment will depend on the pollutant and the type of sampling anticipated (soil, water). Follow the laboratory instructions (provided by your supervisor). Generally, you will need:

i. something to collect samples (shovel, spoon, bottle);
ii. a permanent pen to label sample containers;
iii. storage containers for samples (bags or glass bottles for soil, brown glass bottles for water);
iv. cleaning equipment:
   a. organic contaminants – an organic solvent such as methanol or acetone;
   b. metal contaminants – deionized water;
   c. paper wipes;
   d. detergent – phosphate free, if available;
   e. hand soap;
v. trash bags.

See the Protocol Guidance for further information.

During your visit

Please take lots of notes and pictures, and keep all receipts for expenses.

Step 1: Meet with local people that understand the site and may be aware of health impacts from the site or community health problems. Ask them about the source, the migration routes, the points where people are exposed and the pathways into the body (inhalation, ingestion, skin contact). Your local contact could be a Mayor, government employees from health or other departments that keep records about sites, employees of environmental organizations, a local doctor or nurse, the owner of the site, local school officials or local residents.

Ask these local people if they have any reports, studies, maps, or other information about the site and can make them available. If they have these, make copies there. Upload these documents to the online database when you return.

Step 2: Put on the necessary personal protective equipment and walk around site to understand the source, the pollutant, the migration routes, the pathways and the impacts. Take a lot of pictures (at least 10) of the pollution source, migration routes, contaminated areas. Include pictures of any nearby water bodies (such as streams or ponds) storm runoff channels, waste piles on or near the site, and places where humans might contact the pollutant (such as nearby residential areas, schools or playgrounds.) If there are people in or near the impacted area, please take pictures to show that potential for contact between the pollution and people – but always ask permission before photographing people. Define the areas that might be impacted by the pollution and which should be considered part of the "site" for our purpose. It is advantageous to be accompanied by a local person that can point areas of concern if possible.

Step 3: Prepare a site map. On your map, mark the location of the pollution sources, migration routes, sampling points, and the local neighborhoods that are affected. Also include notable buildings, water bodies, roads, rail lines, and the slope of the area.

Step 4: Record GPS coordinates for:

i. the pollution source, store or dumpsite;

ii. locations of samples;

iii. the possible exposure points (if different from sampling locations).

Step 5: Take samples following the Sampling Guide in this handbook. Make sure to record all necessary information for each individual sample.

Step 6: Explore the community to try to understand how many people could possibly be affected. If the impacted area is a residential area, estimate the number of dwellings and estimate the number of people per dwelling, using available maps, information from governments or community leaders and your own observation. If schools are present, ask about the number of students. If a contaminated water source (wells or surface water) is suspected, ask about and estimate the number of people using this water source. At the end of the REA you will enter the "estimated population at risk" for each sample location based on the number of people that could possibly be exposed to the contamination levels at that location.

> Remember to keep all of your receipts as this will be important for expense claims to return any monies spent on subsistence or additional materials and equipment required. Details of allowable expenses and how to claim will be given during the training sessions.

After your visit

Step 1: Enter your notes and data into the online database as soon as possible once you return. It is best to enter your REA into the database on the same day you return.

Step 2: Upload your photos, notes from interviews, maps, reports, and any other documents into the online database.

Step 3: Contact the laboratory and inform them of the number of samples collected and the contaminants for which the samples are to be analyzed. Bring or ship the samples to the laboratory according to their instructions. Make a detailed record of the type and identity of each sample using the sample identification form or chain of custody provided by the laboratory. Confirm the cost for the analysis and how long it will take to get results. Be clear and specific as to whom the results should be sent and how (such as a specific name and email address). Follow up with the laboratory if results are not received when expected.

Step 4: Once your REA is entered into the online database, inform your supervisor that your REA is complete and ready for review.

REA sampling protocol

Rapid environmental assessment sampling guidance for suspected pesticide contamination sites

The purpose of this document is to provide guidance on how to sample suspected pesticide contamination sites during a Rapid Environmental Assessment (REA). The process for conducting sampling is shown on the attached Sampling Process Flow Sheet.

The objectives of sampling during an REA are to:

i. characterize the type and magnitude of contamination at the primary source site - the area where pesticides were stored, spilled or processed, and the major release of pesticide to the environment is believed to have occurred;

ii. determine the potential for impacts to receptors at and around the site – people, farm animals, and to some extent crops and the natural environment;

iii. estimate the extent to which the contamination has spread from the primary source area to surrounding land, groundwater and nearby surface water.

Due to the brief, preliminary nature of an REA, the intent is to gain enough information to form an initial but scientifically based understanding of the site contamination and risks (i.e. an initial conceptual site model). The findings of the REA should be sufficient to prioritize the need for further action and provide a framework to develop a work scope for additional evaluation. A REA generally should be completed within one or two days, and the site sampling is typically performed in one day or less.

Step I – Historical review and site visit

If available, assessors should conduct a review of the pertinent site history and records. A tour of the site should be completed before deciding on sampling needs and strategies. To the extent possible, interview people with knowledge of the site to identify historical pesticide use at the site (including types of pesticides), handling and use practices, and places where pesticides were stored, spilled or spread. Note site features and map land use, ground surface materials (concrete, asphalt, and gravel) and topography in the area; nearby inhabited or human use areas; key structures and their use on or near the site; roads; rain runoff drainage routes; nearby water bodies and wells; if possible, information about groundwater depth, flow direction and geology; and visual or olfactory evidence of contamination or storage of obsolete pesticides. Based on this, several scenarios may present themselves relative to sampling needs:

- potential areas of significant contamination are clearly evident based on site history and observations, such as at or near pesticide storage or spill locations;
- inhabited or frequently used areas (e.g., homes, schools, parks, etc.) are in close proximity to the site creating risk of direct exposure to people due to pesticides in surface soils at the contamination site or spread from the site by people or wind;
- areas near the site are used for agricultural or raising food animals, creating the risk of contaminated foods;
- water drainage routes such as channels, ditches, or washes exist that may have been a route for rain run-off to carry pesticides off the site, creating a risk of contaminated soil or sediments and further spreading by water;
- water bodies down-gradient of the contamination area which pesticides may have been carried to by surface water runoff or water used at the site. There is particular concern if the down gradient water body is a pond, lake or slow moving stream where pesticides can accumulate, and/or the water body is used as a potable water source for washing, irrigation or as a source for food for animals or wildlife (e.g., fish, ducks, etc.);
- ground water is used in the apparent down-gradient direction, such as wells or springs. There is particular concern if the water use is for potable water, although washing and irrigation use may also be cause for concern.

Pesticide contamination sites vary significantly in size (area and extent of contamination), geographic setting, age (when pesticides were used, spilled or stored), and types of pesticides involved. All of these factors are important in determining the best sampling strategy. In general, very large sites have been known for some time and often have been investigated to varying degrees in the past. For such sites, the previous work done should be obtained and reviewed before deciding on the sampling needs and strategies. Due to the potential complexity of sampling needs, sampling strategies for a REA at large sites should be reviewed with environmental assessment experts prior to establishing sampling plans, with past evaluation results taken into consideration.

The guidance herein is intended primarily for medium and small contamination sites, generally with the primary source area under 1 hectare. Of course, any past investigation of such sites should also be obtained if possible and the results evaluated for these sites as part of establishing sampling plans.

Step II – Determine pesticides causing the contamination

Determine as best as possible the specific pesticides causing the contamination, based on historical records, past sampling and evaluation, discussion with people familiar with the site history, labels on any containers still present, etc. Also, determine when the pesticide releases occurred and ended (if they have ended.) Regarding sampling, the type of pesticide and time period of the potential release are important to know so that:

- analytical methods can target the right pesticides;

- sampling plans can factor in solubility and soil sorption; and
- sampling plans can factor in pesticide half-life and likely degradation in the environment.

If the specific pesticides cannot be determined, hopefully at least the type of pesticide can be determined:

i. organochlorine pesticides (OCPs)–examples are DDT, chlordane, lindane, dieldrin, heptachlor, aldrin, endosulfan;
ii. organophosphate pesticides (OPPs)–examples are malathion, parathion, chlorpyrifos;
iii. carbamates–examples are carbaryl (Sevin), carbofuran (Furadan), aldicarb (Temik);
iv. triazine herbicides–the key compound of concern is atrazine;
v. pyrethroids–examples are permethrin, allethrin, deltamethrin, cypermethrin and the natural pyrethrum;
vi. other herbicides and fungicides–examples are glyphosphate (Roundup), 2,4-D, fluometruon (used primarily on cotton) and paraquat, metalaxyl fungicide (for potatoes, vegetables);
vii. metallic based pesticides–examples are MSMA (monosodium methylarsenate herbicide and fungicide), copper oxychloride fungicides, mercury **and** arsenic containing wood preservatives;
viii. rodenticides–examples are coumarin (Warfarin), arsenic, strychnine, zinc phosphides.

Step III – Choose sampling strategies and the number of samples

Choose sampling strategies and determine the number of samples to be collected, referencing the list of example cases below. Note that more than one case may apply to a site, so it is possible, even likely, that the sampling strategy will include sampling following recommendations from several cases.

Due to practical considerations during the REA, such as time available at a site, access to areas outside the site, availability of equipment and sampling supplies, weather and the cost of sample analysis, it is necessary to limit the number of samples collected. The number of samples collected for a small or medium sized site for off-site laboratory analysis is typically between 6 and 12 samples. For example, 11 samples might be collected for a medium size (~3/4 hectare) former pesticide storage site where persistent organochlorine pesticides were stored and spilled, located adjacent to a small village and in an agricultural area as follows:

- 2 composite samples from the site, as per Case 1;
- 1 "hot spot" sample from a known spill area, as per Case 1;

- 3 receptor sector samples as per Case 2-in a nearby housing area, in a garden adjacent to the site, and along a dirt road frequently used by villagers;
- 1 sequential radial sample along a down-wind line towards agricultural land as per Case 3;
- 2 sample of drainage ditch soil as per Case 4; and
- 1 water sample from a village water supply well as per Case 5;
- 1 sample from a farm pond 50 m from the site as per Case 5.

For each sample collected, the following information is to be noted in the field sampling log:

- unique sample number;
- date and time sampled;
- quantity of material collected (grams or liters);
- sample type–soil, sediment, water. For soil or sediment samples, record whether they are moist or dry as well as soil type (e.g., sand, clay, silt);
- location–GPS coordinates to at least 5 decimal places (3 m). The project will provide investigators with hand held GPS instruments, if needed;
- for soil or sediment samples, record the depth interval over which they were collected (typically from 0–15 cm for surface soil samples);
- note the approximate location of the sample on the field map of the site prepared as part of the REA process. The map is to include information about slope, altitude and general features of the site and area–see separate instruction on this; and
- general weather conditions–temperature, raining or not.

Generally, surface soil samples will be collected from a depth interval of 0–15 cm. In cases were the land has been disturbed or historical records indicate deeper impacts, deeper samples should be collected (See Case 1 below). Samples should be free of rocks and organic matter such as roots and leaves.

Composite samples are a mixture of two or more discrete soil samples. The same volumes are used from each discrete sample, and they are homogenized prior to and after compositing.

Case 1 - Contamination at a defined contamination site

This case applies when contamination is believed to be present in a reasonably well-defined area where a release has occurred or is suspected. Often this will be a former storage area or the yard outside a former storage area, often defined by fences or other boundaries. It is expected that this case will apply to almost all sites. The purpose of sampling for this case is to roughly determine the type and level of contamination at the site, both on average and at apparent "hot spots".

Sampling regimen:

i. collect a composite sample of surface soils (generally 0 to 15 cm) in the defined contaminated area. This involves laying out a grid, with each grid section being no more than 4 m x 4 m, and less when possible. Collect samples from each grid section, with equal volumes for each sample, and then all grid samples should be composited into a single area sample. Collect at least 6 samples for each composite, which may mean that grid sections may need to be smaller than 4 m x 4 m for small contamination sites;

ii. for sites larger than 400 m^2, divide the area into several sub-areas, based on the most logical apparent division of the site, and two (or more) composite samples should be collected. Also divide the area into several sub-areas and collect separate composite samples if it appears that there is different types or levels of contamination in different areas of the site;

iii. collect specific "hot spot" samples where there is evidence of spills or concentrated contamination, such as a discolored/stained area, areas with a mound or other evidence of concentrated spills, or where records show spills or poor storage occurred. Note the areal extent of such hot spot. If the hot spot is fairly large, such as >10 m^2, then collect a composite sample from the hot spot;

iv. Collect sub-surface soil (at depths >15 cm) samples when:

   - there are reports that areas of contamination have been covered over by clean soil;
   - near-surface soil sampling indicates worse conditions at depth based on observations;
   - there are areas at the site where subsurface soil disturbance are likely, such as for gardening, agriculture or construction;
   - there are areas where spills of liquid pesticides are known or suspected to have occurred.

   In general, sub-surface sampling should be kept to a minimum and should be done only when necessary, due to the additional time and difficulty of collecting subsurface samples and the challenges of collecting good quality, representative samples. The key reason for collecting sub-surface samples is to determine if contamination is present at depth at locations where this is likely, as opposed to characterizing the extent of subsurface contamination;

v. for sub-surface soils, use a hand auger (if available) or dig a hole, and then collect a sample of the soil at depth as carefully as possible to avoid mixing of the sub-surface soil with surface soils (such from caving-in from

the hole sides to the hole bottom.) Take sub-surface soil samples at a depth of between 15 cm to 1 m, based on information known or visible evidence about the likely depth of contamination. (Note: Contamination at less than 15 cm should adequately be reflected in surface soil samples, while sampling at a depth greater than 1 m is not appropriate for the REA process due to equipment and time limitations.) Again, collect composite samples for suspected sub-surface contaminated areas (as opposed to hot spots), which means augering or digging a number of holes. As this process can take considerable time, judgment should be used to limit the amount and area of sub-surface sampling;

vi. do NOT collect samples of concentrated pesticides, such as from containers of pesticides or from piles known to be highly concentrated spills. It is not necessary to know the specific concentration of such materials, as it is sufficient to simply know that this material is concentrated pesticide waste. However, estimate the volume of such concentrated materials based on the container size and numbers or the size of concentrated spill piles.

Case 2 – Receptors in areas close to the contamination site

This case applies when receptor areas are close to the suspected contaminated area, typically within 100 m of the site. Receptor areas include:

- places where people live or frequently gather, such as residential areas, markets, schools, parks, etc.;
- agricultural fields, orchards or woodlands in active use;
- areas where food animals such as cattle, goats, pigs, chickens, etc. are kept or graze.

The purpose of sampling for this case is to estimate the level of potential exposure to people, either through direct exposure to pesticides in soils at the receptor area or through ingestion of contaminated water, crops or animals.

Divide receptor areas into sectors based on type of land use, and then collect composite samples for each sector, following the procedure described in Case 1 above. Sectors where people gather should typically not be larger than 400 m^2, however, agricultural and grazing areas can be larger and the grid division larger than 4 m x 4 m. Do not sample areas more than about 100 m from the site, as experience shows that pesticide contamination spread by wind or physical means (other than by water, which is covered in Cases 4 and 5 below) attenuates very rapidly with distance from a release site. Typically, if a contamination site is adjacent to inhabited areas, the surrounding possible receptors areas would be divided into 3 to 5 sectors for collection of composite samples, based on direction from the site. See example sheets.

Case 3 – Determining the extent of contamination around a site when receptors areas are not adjacent to or near the site

The purpose of sampling in this case is to determine how far from a site pesticide contamination has been spread by wind or physical spreading of pesticides or contaminated soils (other than by water.) In this case, radial sequential sampling is to be completed. Establish lines from the site in the direction that contamination may have been spread. Then, collect composite samples along each line, typically one composite for every 50 m, with individual samples taken every 5 m, for a total of 10 individual samples composited into 1 composite sample. Where possible, conduct field tests (see Step IV below) for the composite sample, to determine if pesticides are present. If the field tests show that pesticides are present in the first 50 m for the site, then collect another composite sample along the same line for the next 50 m, and so on until pesticide contamination is not detected or until 200 m is reached (which would indicate widespread contamination; going further is not recommended due to REA time limitations.) If field tests are not possible, then collect samples for 100 m from the site (i.e. 2 composite samples), and up to 200 m if the site has extensive surface spills or releases or there is reason to believe (from the background review and interviews) that pesticides were spread further.

Choosing the lines from the site needs to be done with care. At a site in the open with no notable features in the area, one would choose four lines in the cardinal directions – north, east, west and south. However, other factors need to be taken into consideration when choosing the number and direction of lines:

- a village or other inhabited area nearby (beyond 100 m away), in which case a line toward that village is desirable to know how close the contamination comes to the village. (Note: water bodies are discussed in Cases 4 and 5 below);
- prevailing wind directions. In areas where wind-spread dust is a concern, such as drier areas or areas with extensive bare ground, a line (or several) in the prevailing down-wind direction is desirable;
- topography. It is generally more likely that contamination has spread from a site in down-hill directions as opposed to up hill, so lines in notable down-hill directions are desirable, while lines in significant up-hill directions, particularly if no down-wind) generally are not useful unless the up-hill direction is also in the prevailing wind direction or there is reason to believe the pesticides were physically spread in that direction;
- large agricultural or grazing fields adjacent to the site. If there are fields too large for efficient sector sampling as described in Case 2, i.e. larger than about 0.5 hectare, then a sequential line sample out across the fields is a better method to determine the extent that the fields have been contaminated.

No more than 4 sample lines should be done at a site during the REA process due to time and sampling resource limitations.

Case 4 – Drainage ditches or pathways from a site

Many sites have drainage ditches, erosion gullies, ephemeral streams or other pathways where storm water runoff may have carried pesticides off of a site. Water-borne pesticide particles or contaminated soil are a prevalent way that pesticides are carried off-site. Due to the low solubility and/or high soil sorption of many pesticides, accumulation of pesticides in the sediments in rain runoff channels is a particular concern. The purpose of this case is to determine pesticide levels carried off by water and present in drainage pathway sediments.

Similar to the sampling process described in Case 3 above, collect sequential samples following the drainage pathway downhill, with individual samples collected every 5 m, and then composited every 50 m. Follow the twists and bends of the drainage pathway, as opposed to taking samples along a straight line. Collected samples from the deepest point in the drainage ditch, where water most often runs and contaminated sediments are most likely to accumulate. Finer-grained soil/sediments should be sampled, as opposed to course sand or pebbles.

Collect samples in dry weather if possible – i.e., not when water is flowing down the drainage pathway. If field tests are possible, then conduct field testing after the first 50 m sample is collected to determine if pesticides are present and the need for sampling further down stream. Repeat this process after the 100 m and so on until pesticides are no longer found or until practical limitations (access, time, presence of permanent water, etc.) preclude further testing. If field testing is not possible, then collect two composite samples along the drainage pathway, one from 0 m to 50 m from the site, and one from 50 m to 100 m from the site. Further sampling should not be done unless there is a clear reason to do so, due to REA time and sampling analysis cost limitations.

Case 5 – Surface and groundwater sampling

Contamination of surface and ground water is a common question and frequently a key concern around pesticide contamination sites, particularly if the water is used as a potable water source, but also if the water is used for bathing, fishing, raising ducks or geese, or irrigation. The purpose of this sampling is to determine the potential risks associated with pesticide-impacted water or pond/stream sediments.

Test surface or ground water if:

- in-use wells exist at or adjacent to the site;
- ponds or small streams exist at or adjacent to the site;
- wells or springs are present in the down-gradient direction within 250 m;
- farm ponds, small natural ponds, or slow-moving streams are present in the down-gradient direction with 250 m if these ponds or streams appear to receive rain run-off from the site.

Collect one water sample at each of the above types of water sources. If there is more than one choice of water body to be sampled, then sample the well, pond or stream closest to the site and the sources most likely to present exposure risk, with potable water source(s) being the highest priority. Selection can be guided by field testing, if possible.

Samples from in-use potable wells should be collected using existing infrastructure that mimics well usage (e.g., using existing well pumps) or alternatively using utilizing disposable bailers or dippers. If existing pumps are used, operate the pump for several minutes before sampling to assure that the sample is from the current ground water (as opposed to water that has been held in the piping.) Samples from surface water bodies such as small streams, ponds, or springs should be collected by hand or other suitable sampling device (e.g., bailer, dipper) directly into the sampling container There is no need to collect water samples in a number of situations:

- the water source is not used for potable purposes and the pesticides of concern are extremely insoluble such that they would not be present except as absorbed to suspended particles. This applies to some insoluble organochlorine pesticides;
- the water source has a high turn-over rate, such as a flowing stream or pond with significant flow in and out; and there have been years since the last release; and the pesticide of concern is highly soluble such that any pesticides have long since been flushed from the water body. This typically applies to highly soluble herbicides such as glyphosphate, and some organophosphates such as dimethoate (highly soluble) or malathion (very short half-life).

Sediment sampling from the bottom of water bodies or wells is sometimes a concern regarding potential sorption of pesticides onto sediments. However, for the REA, do NOT collect sediment samples. In other sections, sediment samples are mentioned, this should be checked for consistency. This will be done, if necessary, in future phases of investigation. Sediment samples are not to be collected due to practical considerations, such as access, equipment (which generally depends on knowing in advance that such samples may be needed and the depth to be sampled), and the challenge of handling and analyzing very wet sediments.

Step IV - Choose analytes – the pesticides to be tested and test methods

In general, specify analysis of samples using methods that will detect the four or five most common persistent pesticides believed to be at the site, based on data gathered in Step I. Often an analytical method will detect multiple pesticides; in this case, order analysis for all pesticides that the method can detect, but identify in the instructions to the laboratory the specific pesticides of most concern. Tables 1 below lists analytical methods (based on US EPA approved methods) for common pesticides of concern, and Table 2 provides further description of the methods. Focus particularly on organochlorine pesticides, as they tend to be the most persistent in the environment

– soils and sediments. However, if pesticides from several different classes are believed to be present in significant quantities, such as organochlorines, organophosphates and carbamates, then test for each class of pesticides, which may mean specifying several analytical methods. In general laboratory selection and choice of analytical methods will be left to the manager of projects that the investigators are involved with. The training program will provide further details about this.

A few examples to illustrate how analytes and test methods could be specified, referring to Table 1:

- if DDT, HCH (Lindane), chlorpyrifos, malathion and atrazine are identified as pesticides of most concern at a site, then, from Table I, method SW846-8085 can be specified, as this method can measure all of these pesticides of concern. The laboratory should be informed of the pesticides of concern, but analysis should be done for all pesticides that this method can detect;
- if the pesticides of most concern are DDT, HCH, malathion and carbaryl, then method SW846-8270 can be specified. Again, notify the laboratory, in the analytical instruction, of the pesticides of most concern, but have the analysis done for all pesticides the method can detect, as there is generally no additional cost for this;
- if the pesticides of most concern are HCH, endosulfan, profenfos, carbaryl and mancozeb and fluometuron, then several analytical methods need to be specified, such as SW846-8085 for the organochlorine and organophosphorus pesticides, and SW846-8321 for the carbamates and fluometuron;
- in general, if only organochlorines are of concern, specify method SW846-8081, and if only organophosphates are of concern, specify method SW846-8141, as these methods are generally less expensive than methods SW846-8085 or 8270.

Note that which test method to specify also depends on the specific laboratory capabilities and costs for the laboratories to be used in each country. Further information regarding this will be provided during country training programs.

If there is insufficient information to know which specific pesticides are present at the site, then specify that a qualitative analysis be done on the composite source samples from Case 1 for a general suite of pesticides, again based on classes of pesticides believed to be present. Analyze these samples first, before analyzing the other samples from Cases 2, 3, 4 or 5. The results from the source area composite sample qualitative analysis will identify the specific pesticides of most concern. Once the pesticides of most concern are known, then order quantitative analysis of all samples for four or five most prevalent pesticides, as per the guidance above. This two-step analytical process allows more effective use of funds for sample analysis and greater precision in determining the most important pesticides for which to test. However, the two-step process will add time, typically 4 weeks.

The suites of pesticides were developed based on analysis of existing contaminated site information which indicates the pesticides most likely present. These general suites to be analyzed for are:

- organochlorines: DDT, heptachlor, hexachlorocyclohexane (HCH, including lindane), dieldrin/endrin, 2,4-D, endosulfan–Method SW846-8081 or 8085;
- organophosphates: chlorpyrifos, malathion, parathion, fenitrothion, profenophos, dimethoate–Method SW846-8141 or 8085;
- carbamates: carbaryl (Sevin), mancozeb–Method SW846-8318;
- pyrethroids: cypermethrin, deltamethrin–Method SW846-8141;
- triazines: atrazine–field test kit or Method SW846-8141;
- other herbicides and fungicides: glyphosate (Round-up), fluometuron (in cotton production areas), diuron–Method SW846-8321;
- metal-based: arsenic (which includes MSMA), copper, mercury–inorganic methods for metals.

If nothing at all is known about pesticides present at a site, then order a qualitative analysis for the Case 1 source composite samples for all of the above compounds, a total of 24 compounds, (excluding glyphosate because of its high solubility and rapid degradation time.)

Field testing with confirmation testing performed in the laboratory is desirable to minimize the number and cost of laboratory analytes. However, ability to do field testing depends on knowing the pesticides at the site; having field test methods commercially available for those pesticides; and advance preparation to acquire and bring the field testing kits to the site.

Sample containers, preservation, and holding times

Soil samples are to be collected in plastic bags or preferably glass jars (minimum mass is 20 grams), and preserved with ice (4 °C). Generally, the samples should be extracted within 14 days, and analyzed within 40 days.

Water samples are to be collected in amber glass jars (minimum sample volume is 1 liter). For organochlorine and organophosphorus pesticides, Sodium thiosulfate ($Na_2S_2O_3$) is typically used as a preservative. Generally, the samples should be extracted within 7 days, and analyzed within 40 days.

Laboratory analysis

Laboratories used for sample analysis shall be high quality facilities, pre-approved by supervisors, and capable of performing the analyses using recognized and approved methods. The project will provide the information about laboratories to be used in each country and their analytical capabilities, along with information about sample shipping. A detailed discussion of laboratory analytical strategies and methods is available in EMTK5.

Table 1
Pesticides and analytical methods

Category	Pesticides	CAS#	US EPA SW-846 analytical methods
Organochlorines	DDT	50-29-3	8085, 8270, 8081, 8321
	HCH (BHC)	608-73-1	8085, 8270, 8081, 8121
	Endosulfan	115-29-7	8085, 8270, 8081
Organophosphates	Chlorpyrifos	2921-88-2	8085, 8141
	Dimethoate	60-51-5	8325, 8270
	Malathion	121-75-5	8085, 8270, 8141
	Parathion	56-38-2	8085, 8270, 8141, 8321
	Fenitrothion	122-14-5	8085, 8141
	Profenfos	41198-08-7	8085, 8141
	Glyphosate (Roundup)	1071-83-6	LC/MS/MS; GC/MS
Carbamates	Carbaryl	63-25-2	8318, 8270, 8321, 8325
	Mancozeb	8018-01-7	8318, 8270, 8321, 8325
Triazines	Atrazine	1912-24-9	8085, 8041, 8141
Pyrethoids	Cypermethrin	52315-07-8	GC with EC; GC/MS
	Deltamethrin	52918-63-5	GC with EC; GC/MS
Phenolic or phenoxy	2,4-D	94-75-7	8085, 8151, 8321
	Fluometuron	2164-17-2	8321
Inorganic/other	Metalaxyl	57837-19-1	8085
	Copper oxychloride	1332-40-7	Inorganic analytical methods

Table 2
Summary of US EPA SW-846 pesticide analysis methods

US EPA SW-846 method number	Description	Application
8085	GC/AED Compound-Independent Elemental Quantitation of Pesticides by Gas Chromatography with Atomic Emission Detection	Semi-volatile organohalide, organophosphorus, organonitrogen, and organosulfur pesticides
8270D	GC/MS Semi-volatile organic compounds by gas chromatography/mass spectrometry	Semi-volatile organic compounds extracted from environmental matrices
8141B	GC/FPD or GC/NPD Organophosphorus compounds by gas chromatography with flame photometric or nitrogen-phosphorous detector	Specific to organophosphorus compounds
8081B	GC/ECD or GC/ELCD Organochlorine pesticides by gas chromatography with electron capture or electrolytic conductivity detectors	Specific to organochlorine compounds
8325	HPLC/PB/MS Solvent extractable nonvolatile compounds by high performance liquid chromatography/particle beam/mass spectrometry	To determine benzidines and nitrogen-containing pesticides
8121	GC/capillary column Chlorinated hydrocarbons by gas chromatography, capillary column technique	Performed on extracts of chlorinated hydrocarbons from environmental matrices
8151A	GC/capillary column Chlorinated herbicides by GC using methylation of pentafluorobenzylation derivitization	Capillary GC method for chlorinated herbicides
8318A	HPLC N-methyl-carbamates by high performance liquid chromatography	Applicable to methyl-carbamates such as carbaryl in environmental matrices
8321B	HPLC/TS/MS Solvent-extractable nonvolatile compounds by high performance liquid chromatography/thermospray/mass spectrometry or ultraviolet detection	Detects pesticides such as fluometuron and other nonvolatile compounds

REA questions and rationale

Desk screen

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS1	Site Name	User Entered –Text Field	Enter name of site followed by administrative divisions in order of size. (e.g. Smith farm, Brookside Village, Essex Prefecture).	Use local names that will be recognizable to residents and officials.
DS2	Country	Pull Down Menu	SELECT BELOW from countries worldwide	Allows for specificity and consistency in country names. Editable for future changes.
DS3	Province	Pull Down Menu	Country Dependent	Allows for specificity and consistency in names. Editable for future changes.
DS4	Latitude	User Entered –Numerical Field	Enter as Decimal Degrees to at least 4 decimal points. i.e. 21.9876	Google Earth and other online mapping tools can be used to narrow coordinates.
DS5	Longitude	User Entered –Numerical Field	Enter as Decimal Degrees to at least 4 decimal points. i.e. 105.8765	Google Earth and other online mapping tools can be used to narrow coordinates.
DS6	Suspected Primary Pesticide	Pull Down Menu	Specify Below: Alachlor • Aldrin • Atrazine • Bromacil • Carbamates not otherwise specified • Carbaryl • Carbofurna • Chlordane • Confidor • Cyanazine • DDT • Dieldrin • Dimethoate • Dioxins • Endosulfan • Endrin • Fenitrothion • Fipronil • Glyphosate • Heptachlor • Hexachlorobenzene • Lindane (Hexachlorohexane all forms) • Malathion • Mancozeb • Methyl Bromide • Methylparathion • Metolachlor • Mirex • Organochlorine not otherwise specified • Organophosphate not otherwise specified • Parathion • Pesticides (Total) • Polychlorinated Biphenyls (PCBs) • Simazine • Toxaphene • Triclorfon • Other	Critical information used throughout algorithm

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS7	Sample Sector 1 Sample Type	Pull Down Menu	Select Sample Type • targeted • composite • unknown	Targeted sampling, also known as maximal risk sampling, is used to estimate health risk but this may overestimate the overall population at risk. Composite sampling seeks to take an average reading over a larger area.
DS8	Sample Sector 1 Sample Media	Pull Down Menu	Select Sampling Media • Water–Drinking (ug/l or ppb) • Water–Fishing (ug/l or ppb) • Water–Irrigation/Bathing/ Washing (ug/l or ppb) • Air–Outside (ug/m3) • Air–Workplace (8 hrs) (ug/m3) • Air–Residential (ug/m3) • Soil–Residential (mg/kg or ppm) • Soil–Agricultural (mg/kg or ppm) • Soil–Industrial (mg/kg or ppm) • Urine (ug/l) • Blood ug/dl • Hair (ppm) • Food (varies)	Necessary information to characterize the human health risk associated with pesticide exposure
DS9	Sample Sector 1 Population	User Entered –Text Field	Enter population numbers for exposure to a particular media	The number of people likely to be exposed from each exposure pathway. Data collected from initial site investigation.
DS10	Sample Sector 1 Test Result	User Entered –Text Field	Enter data from investigator sampling	Care must be taken to ensure the units match up with recommended levels (DS8)

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS11	Sample Sector 2 Sample Type	Pull Down Menu	Select Sample Type • targeted • composite • unknown	Targeted sampling, also known as maximal risk sampling, is used to estimate health risk but this may overestimate the overall population at risk. Composite sampling seeks to take an average reading over a larger area.
DS12	Sample Sector 2 Sample Media	Pull Down Menu	Select Sampling Media • Water–Drinking (ug/l or ppb) • Water–Fishing (ug/l or ppb) • Water–Irrigation/Bathing/ Washing (ug/l or ppb) • Air–Outside (ug/m3) • Air–Workplace (8 hrs) (ug/m3) • Air–Residential (ug/m3) • Soil–Residential (mg/kg or ppm) • Soil–Agricultural (mg/kg or ppm) • Soil–Industrial (mg/kg or ppm) • Urine (ug/l) • Blood ug/dl • Hair (ppm) • Food (varies)	Necessary information to characterize the human health risk associated with pesticide exposure
DS13	Sample Sector 2 Population	User Entered –Text Field	Enter population numbers for exposure to a particular media	The number of people likely to be exposed from each exposure pathway. Data collected from initial site investigation.
DS14	Sample Sector 2 Test Result	User Entered –Text Field	Enter data from investigator sampling	Care must be taken to ensure the units match up with recommended levels (DS12)

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS15	Sample Sector 3 Sample Type	Pull Down Menu	Select Sample Type • targeted • composite • unknown	Targeted sampling, also known as maximal risk sampling, is used to estimate health risk but this may overestimate the overall population at risk. Composite sampling seeks to take an average reading over a larger area.
DS16	Sample Sector 3 Sample Media	Pull Down Menu	Select Sampling Media • Water–Drinking (ug/l or ppb) • Water–Fishing (ug/l or ppb) • Water–Irrigation/Bathing/ Washing (ug/l or ppb) • Air–Outside (ug/m3) • Air–Workplace (8 hrs) (ug/m3) • Air–Residential (ug/m3) • Soil–Residential (mg/kg or ppm) • Soil–Agricultural (mg/kg or ppm) • Soil–Industrial (mg/kg or ppm) • Urine (ug/l) • Blood ug/dl • Hair (ppm) • Food (varies)	Necessary information to characterize the human health risk associated with pesticide exposure
DS17	Sample Sector 3 Population	User Entered –Text Field	Enter population numbers for exposure to a particular media	The number of people likely to be exposed from each exposure pathway. Data collected from initial site investigation.
DS18	Sample Sector 3 Test Result	User Entered –Text Field	Enter data from investigator sampling	Care must be taken to ensure the units match up with recommended levels (DS16)

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS19	Sample Sector 4 Sample Type	Pull Down Menu	Select Sample Type • targeted • composite • unknown	Targeted sampling, also known as maximal risk sampling, is used to estimate health risk but this may overestimate the overall population at risk. Composite sampling seeks to take an average reading over a larger area.
DS20	Sample Sector 4 Sample Media	Pull Down Menu	Select Sampling Media • Water–Drinking (ug/l or ppb) • Water–Fishing (ug/l or ppb) • Water–Irrigation/Bathing/ Washing (ug/l or ppb) • Air–Outside (ug/m3) • Air–Workplace (8 hrs) (ug/m3) • Air–Residential (ug/m3) • Soil–Residential (mg/kg or ppm) • Soil–Agricultural (mg/kg or ppm) • Soil–Industrial (mg/kg or ppm) • Urine (ug/l) • Blood ug/dl • Hair (ppm) • Food (varies)	Necessary information to characterize the human health risk associated with pesticide exposure
DS21	Sample Sector 4 Population	User Entered –Text Field	Enter population numbers for exposure to a particular media	The number of people likely to be exposed from each exposure pathway. Data collected from initial site investigation.
DS22	Sample Sector 4 Test Result	User Entered –Text Field	Enter data from investigator sampling	Care must be taken to ensure the units match up with recommended levels (DS20)

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS23	Sample Sector 5 Sample Type	Pull Down Menu	Select Sample Type • targeted • composite • unknown	Targeted sampling, also known as maximal risk sampling, is used to estimate health risk but this may overestimate the overall population at risk. Composite sampling seeks to take an average reading over a larger area.
DS24	Sample Sector 5 Sample Media	Pull Down Menu	Select Sampling Media • Water–Drinking (ug/l or ppb) • Water–Fishing (ug/l or ppb) • Water–Irrigation/Bathing/ Washing (ug/l or ppb) • Air–Outside (ug/m3) • Air–Workplace (8 hrs) (ug/m3) • Air–Residential (ug/m3) • Soil–Residential (mg/kg or ppm) • Soil–Agricultural (mg/kg or ppm) • Soil–Industrial (mg/kg or ppm) • Urine (ug/l) • Blood ug/dl • Hair (ppm) • Food (varies)	Necessary information to characterize the human health risk associated with pesticide exposure
DS25	Sample Sector 5 Population	User Entered –Text Field	Enter population numbers for exposure to a particular media	The number of people likely to be exposed from each exposure pathway. Data collected from initial site investigation.
DS26	Sample Sector 5 Test Result	User Entered –Text Field	Enter data from investigator sampling	Care must be taken to ensure the units match up with recommended levels (D24)

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/Justification
DS27	Estimated Additional Population at Risk	User Entered –Text Field	Enter population value	This variable gives the investigator the ability to add additional population at risk numbers that are not included above
DS28	Last Time Pesticides Were Used	Pull Down Menu	• Within 30 Days • Within 1 year • 1-2 years • 2-5 years • 5-10 years • More than 10 years	Determines how recent contamination has occurred at the site
DS29	Frequency of Pesticide Use	Pull Down Menu	• Only once • Occasional use • Frequent use • The site was/is used for storage of pesticides	Frequency of use indicates the likely presence of the contaminant in the environment. Sites where pesticides were used only once would likely present less of a risk than an area where pesticides were stored.

General background

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
GB1	Name of Investigator	User Entered–Text Field	Enter name of individual that performed the investigation. Surname followed by Family name	Necessary to track individual should issues arise from assessment.
GB2	Number of REAs completed by investigator	User Entered–Text Field	Enter decimal value of number of investigations completed by Site Investigator. (1,2… 99)	Used for tracking purposes and workload assessment.
GB3	Investigation Date (DD/MM/YYYY)	User Entered–Text Field	Enter date as day, month and year (dd/mm/yr) that investigator first visited the site	This is the date of the initial visit and is used for tracking purposes.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
GB4	Why is the site believed to be contaminated?	Pull Down Menu	• Location of Pesticide Spillage • Agricultural Production • The land has been used as a pesticide storage site • The land has been used as a pesticide formulation site • The land has been used as a pesticide burial site	Necessary information that will be used to improve future pesticide management and minimize releases
GB5	Site Owner	User Entered– Text Field	Enter name of individual or company that presently owns the site	This is key information necessary in the event of future work.
GB6	Site Owner Contact Information	User Entered– Text Field	Enter contact information for variable DS7. Include full address, postal code, telephone numbers and email where possible	This is key information necessary in the event of future work.
GB7	Nearest Hospital / Health Clinic	User Entered– Text Field	Enter name and village of nearest medical facility to the Site	This is key information should residents or workers be seriously exposed to pesticides which warrants emergency medical treatment.
GB8	Is the REA complete?	Pull Down Menu	• No • Yes	Necessary in helping to determine the completeness of REAs and finalize sites
GB9	Has anyone conducted repackaging, remediation or other cleanup work at the site?	Pull Down Menu	• No • Yes	The response to this question factors into final risk algorithm. Where work has started, the site receives a lower Type and Quantity Risk score.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
GB10	Physical Description/ Additional Information	User Entered– Text Field	Text box that allows the investigator to add additional characteristics or information about the site. Include a description of any work done as per question GB9 here.	The REA captures some of the more relevant pieces of information about a contaminated site. It is not however intended to be a comprehensive assessment. This text box gives the investigator the opportunity to tell the story of the site.

Type and quantity

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
TQ1	Score-Priority	Automatic	Automatically populated field that is dependent on formula	Based on information from REA formula that will be pulled from various other fields such as contaminant, population at risk, and test result
TQ2	Source of Information	User Entered –Text Field	Enter text box that identifies where data originated.	Enter as much detailed information as possible. Including journal listing, government and other reports.
TQ3	Other Contaminants	User Entered –Text Field	User entered text field for listing other contaminants found at site	Enter each contaminant (in order of prevalence) separated by a comma. If you have sampling data for this contaminant, then enter it under “Second Contaminant Information”.
TQ4	Water Solubility	Automatic	Automatically populated field that is dependent on Contaminant. Reported in units of mg/dl	Important variable that determines environmental (water) mobility of pesticide

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
TQ5	Sorption (soil) Coefficient	Automatic	Automatically populated field that is dependent on Contaminant	Important variable that determines environmental (soil) mobility of pesticide
TQ6	Soil Half-Life	Automatic	Automatically populated field dependent on "Contaminant". Values are reported in days. Source: National Pesticide Information Center at http://npic.orst.edu/ingred/ppdmove.htm	Important variable that describes the environmental persistence of pesticides. The higher this number, the more persistent the pesticide. The relationship between the date of contaminant continues to pose a risk.
TQ7	Are Pesticides Still Used?	Pull Down Menu	• No • Yes	Active use may continue to present a health risk.
TQ8	Quantity of pesticide use	Pull Down Menu	• Small • Medium • Large • Very large	An answer can be helpful to set an upper limit on the amounts of pollutants that could potentially enter the environment.
TQ9	Extent of Staining on the site	Pull Down Menu	• No sign of staining • Surface slightly discolored/ stained • Surface completely discolored due to pesticide • Surface saturated with pesticide (visibly moist)	An answer can assist in identifying where pesticides were used, stored or released, to the environment.
TQ10	Approx. Surface area being Contaminated?	User Entered –Numerical Field	Enter value in square meters. Round up to whole integer.	This can assist with understanding the size of the release of pesticides, which can also infer the magnitude of the risk.
TQ11	Estimated depth of contamination	User Entered –Numerical Field	Enter value in meters	This can assist in understanding the likelihood that releases of pesticides can endanger groundwater.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
TQ12	Was a test pit dug to determine depth of contamination?	Pull Down Menu	• No • Yes	This response can help authenticate ground based spills and better understand and predict the impact on groundwater.
TQ13	Has the contaminant spread into another media?	Pull Down Menu	• No • Yes	An answer of "YES" would increase the risk of human exposure and possible health effects
TQ14	Is there a strong smell associated with the site attributed to contamination?	Pull Down Menu	• No • Yes	A positive response indicates possible airborne release and subsequent inhalation exposure to residents. This can also be used to ascertain the "freshness" of a spill.

Pathway risk

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR1	Mean Annual Rainfall	User Entered –Numerical Field	Enter data in millimeters of rain per year.	An answer assists in understanding the likely risk to nearby water bodies, both surface and groundwater supplies. Wet and warm climates also may speed up half-life of pesticides.
RR2	Mean Annual Wind Speed	Pull Down Menu	• Low <4.5 m per sec • Medium 4.5-7.5 m per sec • High >7.5 m per sec	Increased wind speed help to distribute contaminants downstream and potentially expose other populations.
RR3	Mean Summer Temperature	User Entered –Numerical Field	Enter value in degrees Celsius during peak summer months	Elevated temperatures increase vapor pressure and increase the inhalation risk

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR4	Mean Winter Temperature	User Entered – Numerical Field	Enter value in degrees Celsius during peak winter months	Elevated temperatures increase vapor pressure and increase the inhalation risk
RR5	Permanent Surface Water On-Site?	Pull Down Menu	• No • Yes	A positive response may indicate an increased human health risk.
RR6	What is the Permanent Surface Water used for?	Pull Down Menu	• Other • Unknown • Irrigation • Fishing • Bathing/ Washing • Drinking	Responses help to identify the particular human exposure pathway and appropriate intervention strategies.
RR7	Is there evidence of a high water table or ground water?	Pull Down Menu	• No • Yes	A high water table will increase environmental mobility of ground based spills and therefore increase the potential health risk due to ingestion or dermal exposure.
RR8	Depth to Top of Water Table?	User Entered –Numerical Field	Enter value in meters from surface to capillary layer of water table.	The lower this value, the more likely pesticide can contaminate groundwater supplies. Also, during periods of flooding, the contaminant may be further mobilized and present an increased health threat.
RR9	Is the site in a Flood Plain?	Pull Down Menu	• No • Yes	An answer assists in determining the likelihood that the groundwater and /or surface waters could be impacted by a pesticide release at the surface, and which is later inundated by flooding.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR10	Location of closest river or water body	Pull Down Menu	• No water source in vicinity • Within 500 m of contamination • Within 100 m of contamination • Within 50 m of contamination • Running through the contaminated site Need question on nearby water body type–pond, small stream, lake, river, wetland as per previous comment	An answer assists in determining the likelihood that the water body could be impacted (thereby increasing the potential for human exposure) by surface runoff from a pesticide release at the surface.
RR11	Location of closest well	Pull Down Menu	• No well in vicinity • Within 500 m of contamination • Within 100 m of contamination • Within 50 m of contamination	An answer assists in determining the likelihood that water used for human consumption could be impacted by surface runoff or contaminated groundwater from a pesticide release at the surface.
RR12	Direction of closet well?	Pull Down Menu	• North • Northeast • East • Southeast • South • Southwest • West • Northwest	Useful variable that orients population at risk to the location of contamination

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR13	Groundwater known to flow towards receptors?	Pull Down Menu	• Do Not Know • No • Yes	An answer assists in determining the likelihood that water used for human consumption (drinking or agriculture) could be impacted by/from a pesticide release at the surface.
RR14	Soil Type?	Pull Down Menu	• Lateritic • Clay • Volcanic • Loam • Sandy • Gravel	Each soil category has different permeability's and porosity's that strongly influence environmental mobilization of pesticides.
RR15	Depth of Soil to Strata?	Pull Down Menu	• 1 m • 3 m • 5 m • 10 m • >10 m	An answer assists in predicting the likelihood of contamination infiltrating into the subsurface including impacting groundwater supplies.
RR16	Bedrock type	Pull Down Menu	• Sedimentary rock • Metamorphic rock • Igneous rock	An answer assists in predicting the likelihood of contamination infiltrating into the subsurface including impacting groundwater supplies. Depending on the composition of the strata, a confining layer could be produced which will create an aquifer.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR17	Position of the contaminant relative to the slope of land?	Pull Down Menu	• Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is intermediate • Contaminants at or below ground level and slope is intermediate • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat • Do Not Know	Each answer helps to further predict the runoff potential of pesticides and impact on human exposure and health.
RR18	Has the ground surface been disturbed?	Pull Down Menu	• No • Yes	Past excavations such as water lines, drainage ditch or cable installations, may exacerbate pesticide mobilization and contribute to increase risk.
RR19	Have there been any significant releases?	Pull Down Menu	• No • Yes	Significant releases such as accidents will generate a large acute health risk
RR20	How were the pesticides applied?	Pull Down Menu	• By Hand • Mechanically, specify machine	This variable helps to judge the scope of previous activities. Mechanical application generally means larger volumes, which may impact site contamination and exposure.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR21	Prevailing Wind Direction	Pull Down Menu	• North • Northeast • East • Southeast • South • Southwest • West • Northwest	Useful variable that orients population at risk to the location of contamination and possible inhalation risks.
RR22	Contaminant	Automatic	Value (contaminant name) automatically carried over from previous "Type And Quantity" page	Helps to reemphasize the key contaminant
RR23	Number of Containers	User Entered –Numerical Field	Enter data (if applicable). Enter integer	Variable helps to determine the overall scope of contamination risk
RR24	If no containers, select	Pull Down Menu	• Uncontained piles • Residue or spills only • Not Applicable (Containers)	This information help to clarify the absence of pesticide containers. Residue and spills only present more serious risks that material in sealed containers.
RR25	If uncontained piles, estimate quantity	User Entered –Numerical Field	Enter data in cubic meters. Round up to whole number (integer)	Useful variable in determining remediation efforts and scope of environmental contamination.
RR26	Size of Containers	User Entered –Numerical Field	Enter the size of containers under variable RR 23 in liters.	Important variable in determining overall contamination and scope of environmental remediation.
RR27	Type of Container?	Pull Down Menu	• Steel or metal drum • Metal can or pail • Plastic drum • Plastic pail • Paper container Other	Metal containers may be subject to corrosion and release of contents. Plastic containers are generally more durable but are often used by residents for other purposes.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR28	Container Age?	Pull Down Menu	• 1-5 years • 5-10 years • 10-20 years • >20 years	Useful variable in determining the age of the materials and length of exposure period.
RR29	Container Condition?	Pull Down Menu	• Excellent • Good • Moderate • Poor • Very Poor	Container integrity is critical to predicting spillage and environmental contamination.
RR30	Formulation	Pull Down Menu	• Solidified • Powder • Liquid	Variable helps determine the state of the pesticide
RR31	If liquid, identify dilutant	Pull Down Menu	• Water • Oils • Volatile Solvents	This variable helps to verify the dilutant for pesticides found in liquid form
RR32	Specify concentration of pesticide if known	User Entered –Numerical Field	Enter the concentration of pesticide if known (ppb)	Higher concentrations will likely require more immediate dilution or other action
RR33	(Container) Identification Method	Pull Down Menu	• Good, legible labels • Inventory or written records • Unreliable labels Verbal or informal records	This variable helps to verify the contents of the container and perhaps negate the need for environmental sampling. Labels also provide important safety information.
RR34	Location (of containers)	Pull Down Menu	• Inside building with good roof • Inside building with poor roof • Outdoors • Below ground	Critical variable that strongly impacts the potential for environmental contamination and mobilization.
RR35	If containers in building, select	Pull Down Menu	• Good Walls • Incomplete or poor walls • Not applicable (Outside)	Poor storage building construction may increase the potential for environmental contamination.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RR36	If containers covered, select	Pull Down Menu	• Not applicable (Indoors with good roof) • Tarpaulin or plastic in good condition • Other or poor cover • No cover	Poor or damaged tarpaulin or plastic sheets will increase the risk of environmental release and contamination

Receptor risk

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RC1	What is the land use for the foreseeable future?	Pull Down Menu	• Remote wilderness • Industrial (inc. for continued use of pesticides) • No use by people, such as scrub land, desert • Light Industrial/ Commercial • Agricultural or animal grazing • Parkland • Housing/residential • Critically Sensitive Receptors (Schools, Hospitals, etc)	Future land use in an important factor in deciding whether the contaminated area will pose a public health threat in the future and to what levels eventual remediation work needs to be undertaken. Future land use also helps to identify the population at risk and set appropriate cleanup goals.
RC2-13	List number of people in these categories	User Entered –Numerical Field	Enter population data into a 4 x 3 table (4 categories of location and 3 categories of activity)	This data helps to quantify the exposed population that live, work or visit in and around the site.
RC14	Site accessible to animals that are consumed?	Pull Down Menu	• Food animals/fish on site • Food animals/fish within 100 m • Accessible to occasional food animals	Food animals (whether meat or milk products) can biomagnify pesticides and pose a significant health risk.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RC15	Distance to sensitive marine or freshwater ecological area?	Pull Down Menu	• > 5 km • 1 km to 5 km • 300 m to 1 km • 0 m to 300 m	This response assists in predicting the likelihood of impacts to sensitive receptors.
RC16	Proximity to source of potentially contaminated drinking or bathing water	Pull Down Menu	• > 5 km • 1 km to 5 km • 300 m to 1 km • 0 m to 300 m	The distance of water to a contaminated site is critical in estimating health risks.
RC17	In which direction?	Pull Down Menu	• North • Northeast • East • Southeast • South • Southwest • West • Northwest	This variable helps to orient the water source to the contaminated site.
RC18	What is it used for?	Pull Down Menu	• Other • Unknown • Irrigation • Fishing • Bathing/Washing • Drinking	The use of the water source will determine exposure pathways and help to define remediation strategies.
RC19	Ingestion of contaminated soils possible?	Pull Down Menu	• No • Yes	A positive response indicates an additional and significant exposure pathway
RC20	Grazing pattern around the contaminated area	Pull Down Menu	• No animals graze within 100m of the area • Animals graze/feed within 100m of the area • Animals graze/feed within 10m of the area • Animals graze/feed in the contaminated area	Grazing animals can ingest contaminated grass, fruits, vegetables as well as soil and biomagnify pesticides. A significant health risk is possible.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RC21	Describe how far crops are produced from contaminated area	Pull Down Menu	• No crops are produced within 100 m • Crops are produced within 100 m of the contaminated area • Crops are produced within 10 m of the contaminated area • Crops are produced in the contaminated area	Crops grown in and around contaminated sites can pose several risk pathways. Some crops can absorb contaminants and incorporate them into their tissue. However, the dominant exposure pathway is the dry deposition of pesticide contaminated soil onto the food and subsequent ingestion
RC22	Alternative water supply for drinking and bathing readily available?	Pull Down Menu	• Water not suspected of being contaminated • No • Yes	If water is contamination is confirmed, having a readily accessible alternate drinking or bathing water source would greatly reduce exposure. This variable helps to establish some intervention strategies.
RC23	Is dermal contact …. anticipated?	Pull Down Menu	• No • Yes	Agricultural pesticides and their solvents are occasionally dermal irritants and can be absorb by the skin. This is most significant for full body water contact but is also true for dust.
RC24	How far are crops, animals or humans downwind of site?	Pull Down Menu	• No crops are produced within 100 m • Crops are produced within 100 m of the contaminated area • Crops are produced within 10 m of the contaminated area • Crops are produced in the contaminated area	If crops and/or animals are produced or harvested near a contaminated site, the possibility of absorption is greatly increased.

ID	Variable name	Data entry form	Data details/Pull down menu choices	Description/ Justification
RC25	Describe access to the contaminated area	Pull Down Menu	• Controlled access; entry difficult • Remote locations; less accessible • Moderate access; entry more difficult • Easy access; few barriers to entry	If people come in contact with a contaminated site, the possibility of absorption (ingestion, inhalation or dermal) is greatly increased.
RC26	Strength of reliance of local people on natural resources for survival	Pull Down Menu	• People use resources from within 200 m of the site • People use resources from within 50 m of the site • People use resources from within 20 m of the site • People use resources from the site	If people come in contact with a contaminated site, the possibility of absorption (ingestion, inhalation or dermal) is greatly increased. The strength of reliance of this land for survival is high, then intervention strategies may be prove challenging.
RC27	Describe ground cover over contaminated area	Pull Down Menu	• The site is covered by a concrete slab or other type of engineering • There is complete grass cover and other vegetation • There is sparse grass cover • The contaminated area is bare	Bare soil offers the highest risk to residents given the entrainment of contaminated dust into air with subsequent inhalation. Covered contaminated greatly reduces the risk and may also slow down groundwater infiltration.

Health and safety

Introduction

Investigations must be conducted in a safe manner. This document provides an overview of the health and safety guidelines investigators should follow before, during and after REA visits.

Before each REA, investigators must:

- evaluate potential health and safety hazards; and
- identify appropriate controls and precautions to eliminate or reduce risks;
- brief other parties coming to the site on general and any specific health and safety requirements.

Responsibilities:

Investigators are responsible for their own safety. Investigators must avoid situations where their lives and well-being are endangered.

FAO Supervisors should ensure that investigators have been informed of general health and safety requirements and will support investigators in obtaining any data or measurements needed to address risks posed by specific site investigations.

Before the REA visit

1. Perform a risk assessment

Before conducting a site screening, investigators must identify the potential hazards that they may encounter at the site, including:

Type of hazard	Examples	Notes
Chemical hazard	• Chemical pollutants present in the area • Particulate pollutant • Chemical vapor or gas	Review previous studies or publications related the area, identify potential sources, etc.
Physical hazard	• Radiation • Noise • Excessive cold or hot weather • Slips, trips, falls	Take into account the layout and state of the site, particularly any shafts, excavations, buildings etc. Attention should be paid to expected local weather and of other factors such as quality of the access. For radiation hazards see "Radiation safety" below

Type of hazard	Examples	Notes
Biological hazard	• Bacteria, viruses, parasites • Animal bites	For extended periods in the field participants will be expected to undergo a pre- and post- work medical. During the medical blood and urine tests may be conducted, see "Bio-safety" below.

Once hazards have been identified, the investigator must estimate the likelihood that the expected extent of exposure to the identified hazards will put the investigation team at significant risk. The principal pathways of exposure at contaminated sites are normally ingestion, inhalation, and direct contact but other possible exposures should be considered. Estimating the potential risk should consider the activities the investigator will carry on during the site investigation and the amount of time that the investigator is planning on staying at the site.

Next, the investigator must determine what measures he/she must take to reduce the probability that the exposure to these hazards will cause injury or endanger his/her wellbeing (such as wearing personal protective equipment, etc.). The investigator must communicate these conclusions to all those invited to the visit including government officials.

Attention should be paid to planning for sites where there is a possibility of radiation exposures. In such cases, a detailed safety plan must be prepared, including the use of appropriate radiation monitoring devices. No investigator should plan to enter a site with possible radiation hazards without specific advice and approval from his or her supervisor, who will obtain specialist advice as needed.

Additionally, the investigator should evaluate any security concerns (such as risks posed by violence, crime, etc.) and take appropriate measurements to address those as well.

Assessors should complete a Task Based Risk Assessment (TBRA), an example of which is set out below. The TBRA provides a format for setting out foreseen risks and appropriate mitigation measures. More detailed guidance regarding HSE is given in the EMTK5 document.

Task based risk assessment for rapid environmental assessment

LOCATION: Country X
SITE NUMBER:
SITE NAME: Various sites

PESTICIDES PRESENT (Give quantity, and indicate if material is leaking): Soils contaminated with Trifluralin, DDT, DDE, Endosulfan I& II, Endrin, Isodrin, Dicofol, As, Cu, Lambdacylohalothrin, Metalochlor, Prometryn, Methoprene.
OTHER CHEMICALS AND MATERIALS (TOOLS ETC) PRESENT: Soil Auger Kit, Hexane, Acetone

PERSONNEL INVOLVED:

TASK	ZONE	FREQUENCY	DURATION	EXPOSURE ROUTE	WHO CLASS	S_P	LIKELIHOOD OF CONTACT	OTHER RISKS	REDUCE RISK OF EXPOSURE/MITIGATION MEASURE	PPE
Travel between sites	1	8	2 hrs	None	n/a	n/a	None	Car accident	FAO drivers and cars only	
Travel in Malaria area	1	1	3 wks		n/a	n/a	High	Infection	Malarial prophylactics as prescribed	Mosquito nets
Use of equipment including soil auger	2	16	30 mins ea. 8 hrs total	Dermal oral inhalation	n/a	n/a	High	Mechanical	Training in use of equipment, follow SOP	Wellington boots with steel mid-sole and toe-cap, half-face vapour mask, type 5-6 coveralls
Equipment decontamination	2	10	20	Dermal oral	n/a	n/a	Medium	Acetone/ Hexane, High Flammability	PPE, collect washings	Nitrile gloves (thick)
Water sampling	2	50	10	Dermal	n/a		High	Mechanical hazards	Follow SOP	Nitrile gloves/Cotton overalls work boots
Soil sampling with suspected high POP concentration	1	50	10 min	Dermal oral inhalation						Wellington boots with steel mid-sole and toecap, Half-face vapour mask, type 5-6 coveralls

COMMENTS:

Completed By:	**Date:**
Approved By:	**Date:**

Reproductive hazards:

Women who are pregnant or who are planning on becoming pregnant should evaluate potential contaminants that could be found at a site to specifically determine potential reproductive hazards. If there are potential reproductive hazards, they should discuss with their physician about the potential risks of performing these site evaluations and appropriate ways to address them.

2. Get personal protective equipment (PPE) ready

The investigator must have access to essential personal protective equipment and must identify and use the appropriate PPE the during site visits. Basic equipment includes:

- non lace up boots with steel toe caps;
- disposable coverall;
- respiratory protection.

  As per the risk assessment, respiratory protection should be used according to the hazard expected:

  - masks with dust protection (particulate mask) or vapour protection must be worn whenever there is potential exposure to these hazards, as determined by the risk assessment.

  Note that masks may not be necessary if there is no reason to believe there is dust exposure or vapour risks present. Respirators must be used according to the manufacturer's instructions, training by the supervisor will be given prior to the team going out onto site.
- Goggles or safety glasses: must be worn whenever there is the presence of particles in the air that may damage the eyes (for example, flying debris or significant amounts of dust) or when there is the risk of splash or splatter of contaminated substances.
- Gloves: Assessors should wear thin nitrile gloves when attending site to prevent contamination while touching or picking up contaminated items. The use of more durable gloves may be necessary where

Other PPE may be identified by the risk assessment as relevant to a specific site. If the investigator believes that such PPE is required and is not easily available or is expensive, then, his or her supervisor should be contacted.

PPE should be inspected before every site visit and it should be cleaned, repaired or replaced if needed.

During the visit

1. Traveling to and from the site:

- vehicles used to travel to and from the site must comply with local regulations (up to date inspections if required, etc.);

- the number of occupants must not exceed the number of people that can be seated;
- seat belts, if available, must be used by those riding in the front of the vehicle or in all seats if required by local regulations;
- drivers must adhere to speed limits, signs and all other traffic norms;
- vehicles must never be driven by anyone under the influence of alcohol.

2. During the REA:

During the REA, the investigator must:

- wear appropriate PPE (see above);
- wash hands before eating anything (even if gloves are worn during the REA);
- must NOT – under ANY circumstance – enter confined areas. These are areas large enough for a person to enter but with limited ventilation and/or limited or restricted means of entry or exit (for example wells, tanks, pits, vessels, sewer systems, pipelines, etc.);
- be cautious in areas that may be slippery due to water, mud, steep slopes, etc.;
- be cautious if using ladders or stairways that may be unsafe;
- be cautious in exposed elevated areas;
- be aware that hazardous material and toxic contamination may look innocuous –take precautions anyway. Do not assume that because people (e.g. local community members) are living in the area without any protection or without presenting any obvious adverse health symptoms that there is no hazard.

Bio-safety

Biological agents such as bacteria, viruses, parasites can be present in human and animal fluids and waste such as blood, faeces and urine. Touching or any contact with human and animal fluids and waste, or dead animals, should be avoided during investigations.

Collection of human fluid samples, such as urine or blood samples, should only be done by persons with specific responsibility and training for such sample collection, and must be done following protective protocols. FAO investigators do NOT take human samples but may be present when authorized persons (normally local medical staff) do so. Good practice in such situations includes:

- wearing <u>disposable</u> gloves and safety glasses at all times;
- good handling and disposal practices for needles, vials, tubes or other materials used in the sampling process;

- protective clothes, such as a lab coat or uniform must be worn during sample collection and should be removed before entering in contact with other people, especially children and pregnant women.

Radiation safety

Ionizing radiation is composed of particles with enough energy to produce tissue damage. These can be found in wastes from uranium and other similar processing facilities, and in defunct nuclear weapons production or storage facilities, among others. If investigations are going to be carried out in or near sources where radiation may be present, a detailed safety plan must be designed by the investigator with the support and approval of his or her supervisor.

After the visit

After the site visit the investigator must:

- wash hands and face before eating anything;
- change from working clothes and shoes. Take showers before entering into close contact with other people, particularly pregnant women and/or children;
- clean shoes to remove any mud or soil on them, wearing gloves during the cleaning and making sure that the removed soil is collected and disposed of properly or is left at the site. Soiled material or scraping from shoes must not be left on floors, in cars or around door entrances or other places where people gather;
- wash clothing before wearing again;
- if any safety related incidents occurred during the visit, these must be communicated to the relevant supervisor;
- if there are any lessons learned during the visit that can be shared with other investigators to prevent future incidents, these also should be communicated to the relevant supervisor so that they can be shared with other investigators.

Further health and safety information can be found at:

- US Center for Disease Control and Prevention–workplace safety and health topics http://www.cdc.gov/niosh/topics/chemical.html

US OSHA administration–Health and safety topics

http://www.osha.gov/SLTC/

Further information on toxic pollutants can be found at:

- Agency for toxic substances and disease registry–case studies in environmental medicine: http://www.atsdr.cdc.gov/csem/csem.html

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