Technical Proposal
Rapid Technical Surveys using the Wide Area Detection and
Explosive Scent Tracing
By R. Hess

1 Objectives

1.1 Develop a cost-effective system that can be quickly deployed to a Landmine and UXO affected country that will rapidly identify potential high threat and/or confirm low threat areas. The system must be able to:

- Perform rapid, objective-based site sampling against all potential threat munitions to a minimum depth of minus one meter.

- Accurately record and map the sampling zones in a manner that can be quickly entered into the Mine Action GIS Data-base.

- Able to work in tropical, arid, and moderate-cool environments

- Have the ability to mount on the various prime movers commonly found in developing countries.

- Remove the potential for human-error to the maximum amount possible.

- Multi-lingual capable

2 Background

2.1 Identifying and separating potentially hazardous from non-hazardous areas is one of the most difficult tasks a Mine Action Manager is faced with. The most common methodology employed for an Impact survey involves roving teams using a questionnaire based system. While considerable amounts of socio-economic information is gathered, areas that are "Surveyed-out" as low threat are based on a subjective assessments rather then objective sampling. The potential margin for error for an impact survey is very high and areas are often incorrectly assessed.

2.2 Even with highly successful impact surveys, such as the Canadian-funded Level-1 in Cambodia, there is still a very wide margin of error potential in data gathering process. The human factor is both the strongest asset and the weakest link of any project; the data gathered is only as good as the people who do it. If a person is not in good health, misunderstands the answers given, or asks the wrong type of question, critical information is lost or never collected.

2.3 Contrary to the previously beliefs, threat munitions are often located far deeper then what the normal search methodologies could detect. The Mine Action community as a whole has reconsidered its previous stance of 10-20cm clearance and are now classifying areas in accordance with the end land use (ELU). Cluster munitions, artillery, mortars, gravity bombs, and deep-buried landmines have been located in areas that were technically "cleared".

3 Concept

3.1 Incorporate commercial, off the shelf (COTS) Ion Scanning Explosive Detection systems into the sampling process

The commercial homeland defense industries have made in substantial improvements in explosive trace detection. Airport security, customs departments and forensics laboratories across the world were in need of a reliable system that could quickly identify the presence of explosives and as a result, Ion Scanning systems can now reliably detect explosive traces down to the Picogram level (*one-trillionth of a gram*), **the new Fido system can detect even lower.**

This is equal to or better then many well-trained biosensor system, however the machine are not affected by altitude changes, background traces (stinging plants, oil, etc), long working days, or low humidity/high heat conditions

These systems are man-portable, contain no hazardous components, and can be flown to any site on commercial flights as excess baggage.

3.2 Construct the sampling system utilizing commonly available components.

This type of trace sensing process only requires small amounts explosive particles to be trapped on a Fiberglas filter for analysis. Filters in various sizes and shapes designed for air sampling are commonly available from VWR Scientific and are rated at temperatures of up to 140o f. The filter itself can be removed from the holder and tested though the Ion Scanning device in the same manner as the filters supplied by the manufacturer.

Gas powered lawn vacuums are also commercially available, inexpensive, can draw up to 400cfm of air through the hose. The engine and vacuum assembly is simply dismounted from the standard chassis and mounted either directly to the prime mover or on a pallet assembly that can be carried in a scoop bucket.

PVC pipe and flexible, ribbed radiator hoses are used to connect the vacuum unit to the sampling nozzles on whatever prime mover is used.

3.3 Incorporate a flexible, accurate digital geophysical map of the area sampled.

Recently, various wide area detection systems have proven to be effective against metallic mines in actual clearance operations. This system shown below is currently in use and has proven itself as a highly versatile and extremely cost effective means of assessing the potential deep-buried Landmine and UXO contamination.

This is a modular system that incorporates commercial, off-the-shelf (COTS) technologies from the industrial sectors to produce a fast and cost-effective search and survey tool. This system incorporates the recent improvements in high precision satellite positioning systems, ground conductivity sensors, laptop computing, and Geographic Information System (GIS) technology into a portable, rapid data collection and analysis platform with "follow-the bullet" navigational software to ensure the correct course is maintained and recorded.
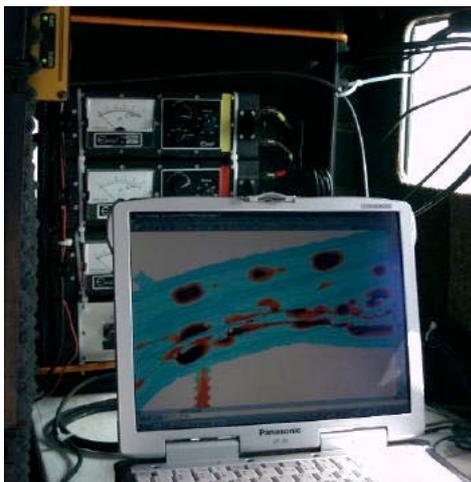
The system records the data directly into a commercial laptop at 20 times per second, which allows a faster recording over conventional data-logging systems and less chance of human error. The data is stored directly into an Access database file for projection into standard GIS systems.

As it is a modular system, it can be mounted on a variety of prime movers. These include Mine Resistant Vehicles (MRV, as shown above), small All-Terrain Vehicles, or commercial construction and agricultural equipment.

The system can use either active or passive detection systems to accommodate the terrain, threat, and specific needs.

3.4 Accurately track and map the route and areas being surveyed and sampled

The Geo-Physical Survey System (GeoSvy) provides three interoperable and interchangeable phases of field operations, survey planning, real-time operations, and post-collection analysis of results. The Graphic vector-based display shows current maps of the survey area. This display is used as the basis for a highly interactive survey planning capability. The job planner establishes a survey area and alignment lines at a specified resolution.

Wide area DGPS satellite tracking system (Omni-star) allows the KIMS to rapidly move along roadways with +/- one-meter accuracy without relocating and recalibrating a transmitter every 3-4 km. This ensures mobility along long stretches of road and provides accurate tracking of the system moving back and forth across large open areas.

- Real-time positioning data for
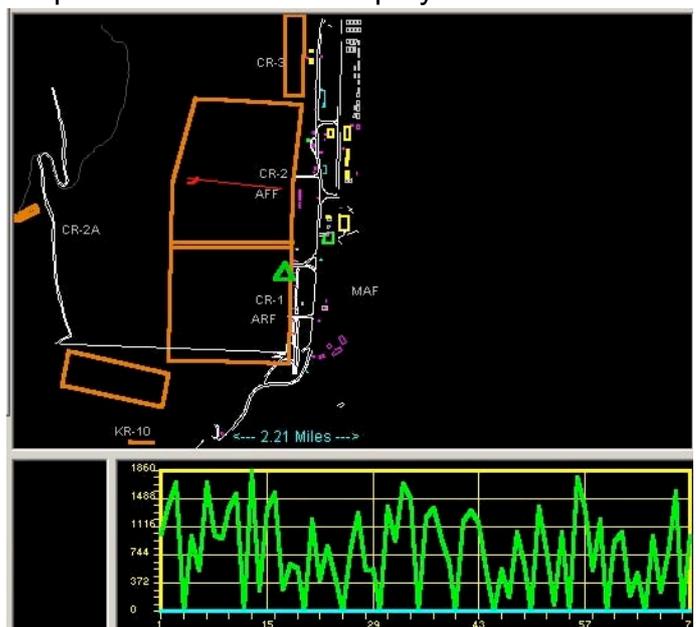
large open areas is provided by a centimeter-level accuracy Z-surveyor. This utilizes a base station at a known surveyed position and connected via radio link to the roving survey vehicle. Position information is passed from the GPS receiver to the computer using a NMEA standard GPGGA serial message. The laptop computer receives serial messages from the towed sensors through PCMCIA interfaces.

- The GPS data is received at a rate of once per second and the sensor data at 8 times per second. The position associated with a particular sensor reading is interpolated between sequential GPS readings.

- As data is collected, the vehicle operator is guided along the preplanned alignment lines by a graphic display showing the alignment center-line, a representation of the vehicle's position relative to the center-line, and a direction arrow showing the direction to turn to get back on-line. This display is also color-coded by alignment offset to allow for at-a-glance vehicle operation. While on-line all of the alignment view graphics are shown in green. As the alignment offset increases all of the graphics turn yellow and then to red for larger offsets.

3.5 Employ the correct prime mover for the environment

To be effective, the combined system cannot be vehicle-specific and must be mountable to various prime movers. Each country has its own logistical challenges and unique vehicles require special considerations for maintenance and spare parts. The system must be flexible enough to be mounted on the vehicles that are most commonly available in the host nation.

4 Proposed Test Locations

4.1 Cambodia.

The US has Funded 12 month project with CMAC in the Pailin region. Very few clearance activities have been conducted in this area and the landmine and UXO contamination is extremely high.

4.2 Eritrea/Ethiopia Temporary Security Zone

The UN has a contract to conduct a rapid road verification project in this region. The current equipment list includes four Mine Resistant Vehicle, an Armored 5.5 ton Excavator, a fully operational wide-area detection system, a Manual Clearance Team, and an MDDT.

5 Cambodia Equipment

5.1   DTW Tempest Mini-Flail

Tempest side view

The vehicle is remotely guided only through line-of-sight with the use of a simple hand-held control panel. All gauges and power indicators are located on the rear of the vehicle. The vehicle can effectively cut through heavy grass and bushes and is very useful as a vegetation and tripwire reduction tool.

Example of Vegetation Conditions

Employing the Tempest in a wide-area EST role will involve a two-stage process. The only modifications required is building a platform to replace the flail, which would hold the EST filters and Vacuum assembly. This can be transported as part of the Tempest package to the field.

5.2   Mine Resistant Vehicles:

The preferred MRV's be two of the WMF WerWolf systems from Namibia or South African Casspirs. This range of vehicles is extremely mobile, has good power-weight ratios, and is extremely survivable against AT Mine blasts.

The alternate choice would be the Mine Protected Range of South African Samil vehicles. These are used vehicles however they can be purchased in a fully recondition/reconditioned configuration. While not as powerful as the Werwolf, they are extremely durable vehicles and cost approximately _ of the price.

Due to the harsh road conditions in Cambodia, heavier MRV's will have mobility problems. Both the Werwolf and the Samil 20 & 50 series vehicles are small enough to cross the bridges and still able to maneuver through the local conditions.

## 5.3   Configurations: Werwolf

5.3.1   Command vehicle & KIMS/EST Vehicle for roadways

A standard troop carrier configuration would be employed as a command and control platform for the Tempest and as the prime mover for the KIMS/EST is used in a road survey capacity. The troop cab is more then sufficient to configure all of the required equipment to operate both systems.

5.3.2   Recovery and Tow Vehicle

The second vehicle will have a recovery platform installed in place of Troop carrier pallet and a winch, it can serve as both the Cargo and recovery vehicle. The other would retain the armored troop carrier pallet and work as a Command & Control vehicle for the Tempest while it's searching and can also be used as a REST sampling platform itself along roadways and improved trails that are wide enough.


Extension on the Bed to carry the Tempest
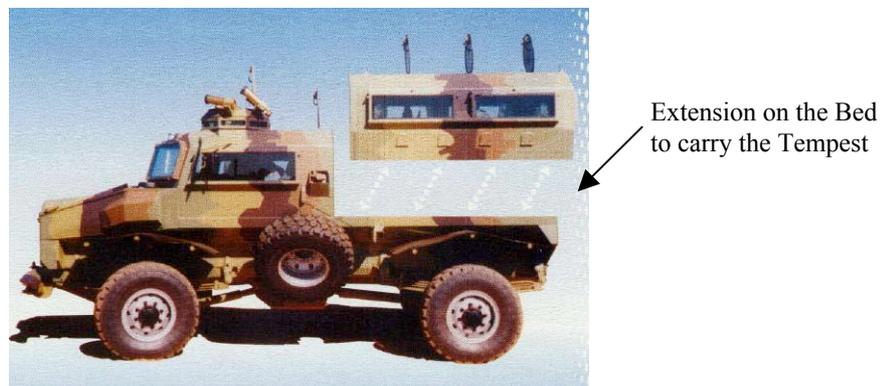
The actual tracking and mapping of the operation would also be a two-phase operation. One would be a simple working map of the area and the other would be through the 'Missing Link" system developed by GeoSpatial and used by the Forest Industry in Canada.

The Missing link system accurately records and tracks the progress of skidders moving the logs being harvested and can be downloaded into a GIS. This would allow accurate tracking of where the REST samples were taken and be able to record them into the Level-1 database, therefore assisting in the land management effort during and after the clearance efforts.

 The working map is a simple drawing of site and used as a planning tool and for command and control. This will also be used to compare the results of the REST samples once they are tested.

The first step will be to cut U-shaped lanes evenly spaced at 10 to 15 meters apart across the area to be sampled. If we're working a grid system, then the grids can be 50x50 or 100x100 meters.

Tempest in Area Preparation

|	MRV/Transport and Recovery Vehicle	MRV/Command Vehicle
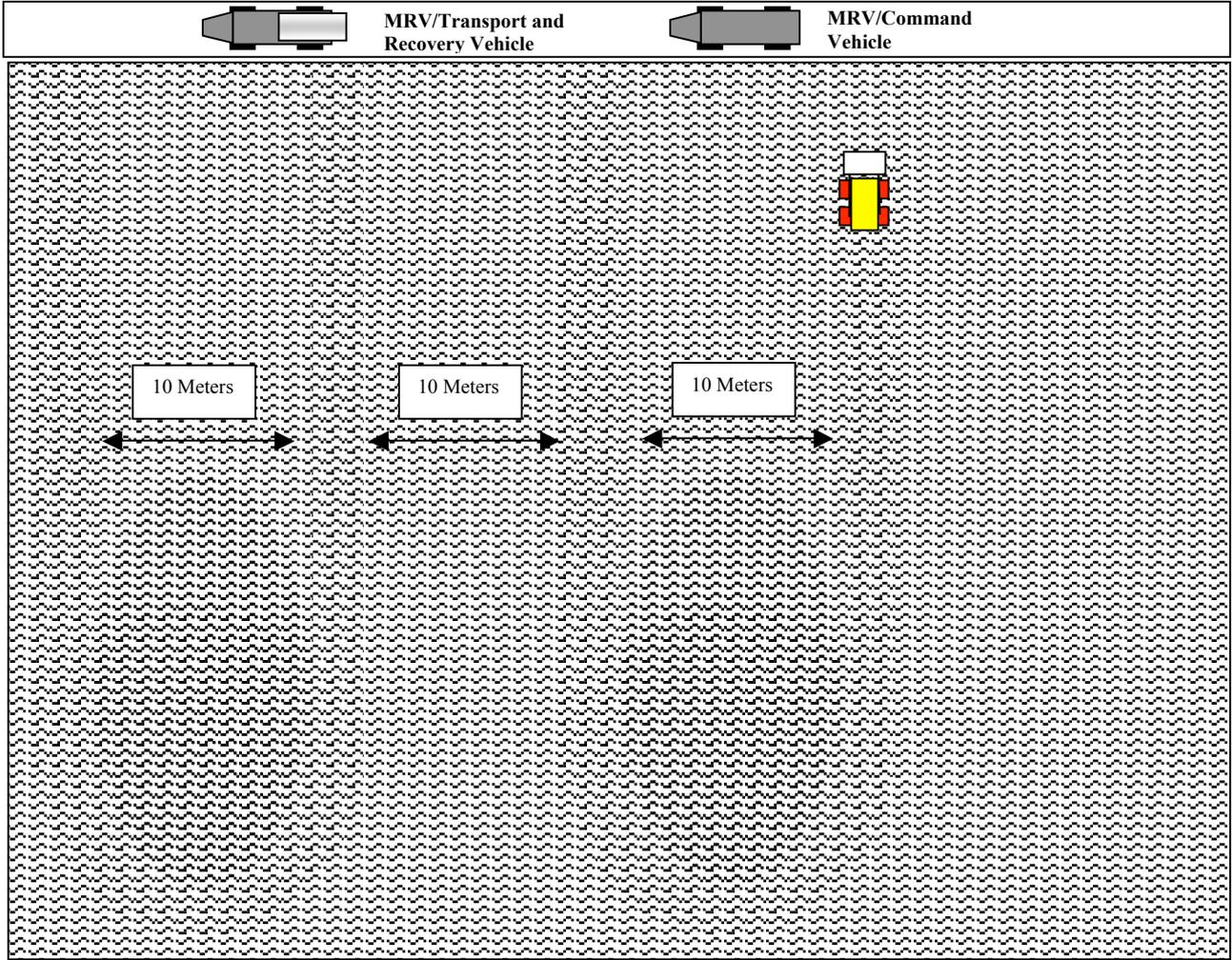
Should no detonation occur during the area prep process, enough time will be allowed for any fumes to clear and the REST Pallet would be attached in place of the Flail Device. The lanes would be number sequentially and marked on the working map.

Once the area is ready, the REST pallet is installed on the Tempest in place of the flail. The Vacuum assembly can be as simple as the motor from one of the back-pack MEDDS linking in two sets of filters mounted on each side of the pallet.

Each time the Tempest returns to the road, the filters are changed and marked accordingly.

Tempest in REST Sampling role.
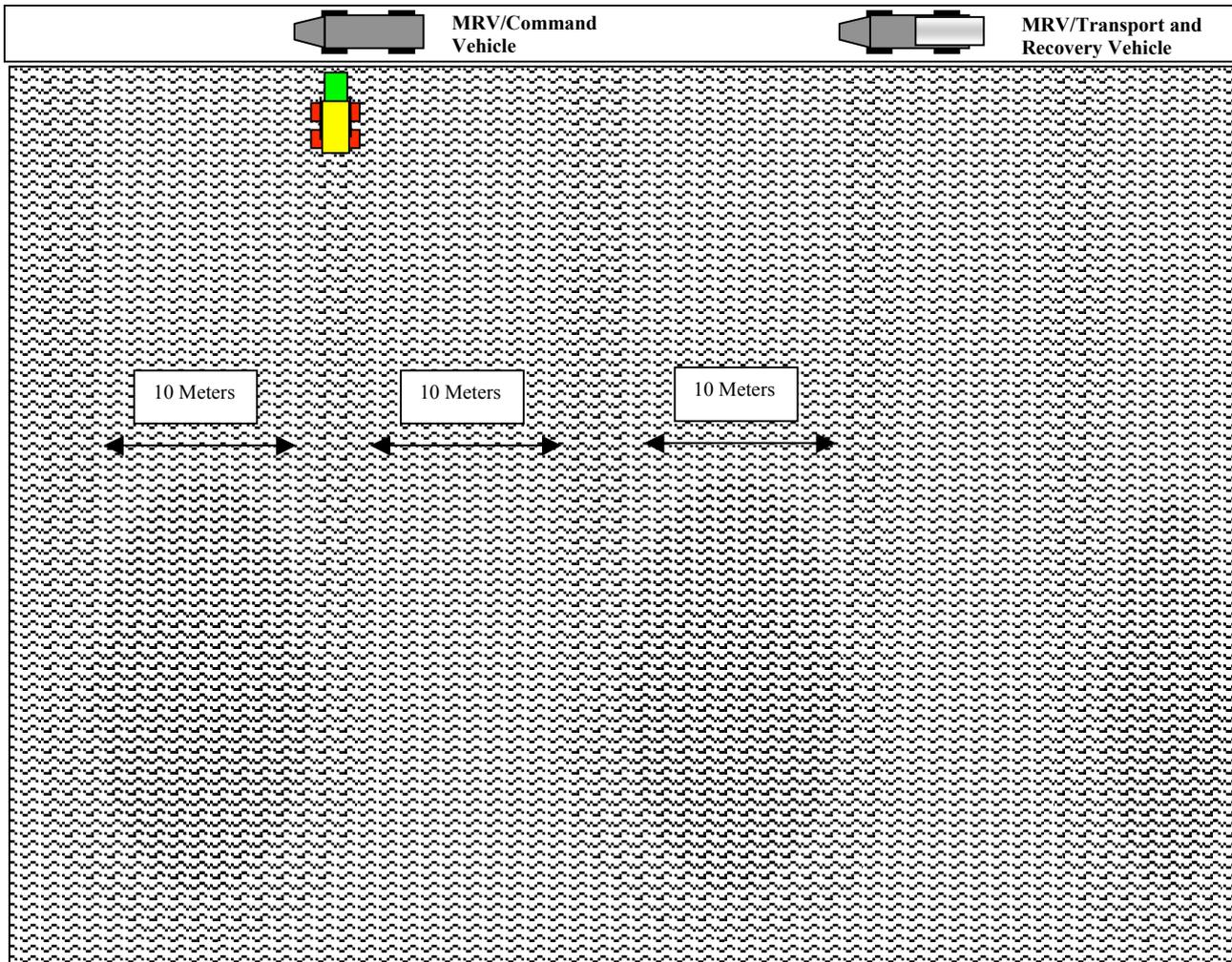
If the Tempest breaks down in the lane or has a disabling Mine-strike, the Recovery WerWolf can safely drive directly down the lane and attach a chain or tow bar to the rear or front and drag it out.

  If an oversized, strong eyebolt is attached to the front and rear of the Tempest for these situations, then a long metal bar with a spring-loaded snatch hook can be used to hook it up to the Werwolf. The operators would never need to dismount from the vehicle during the entire recovery operation.

By incorporating the Missing Link technology, the system should be able to link the data into the GIS system. If a good aerial photograph system is already in place with the GIS, then we'll be able to produce maps that will look like the two below.

This technology has already been used in US clearance programs (hence the maps below) and during talks with GeoSpatial, this will be easy enough to do in macro to micro level to support mine action programs in developing countries

The Overview can be broken down into larger grids, which would be highlighted when the REST filters indicate a presence of explosives. The individual 50x50 or 100x100 sub-grids can then be identified through the higher resolution settings. Anything obviously noticeable would also be entered on the map, so a living system is developed
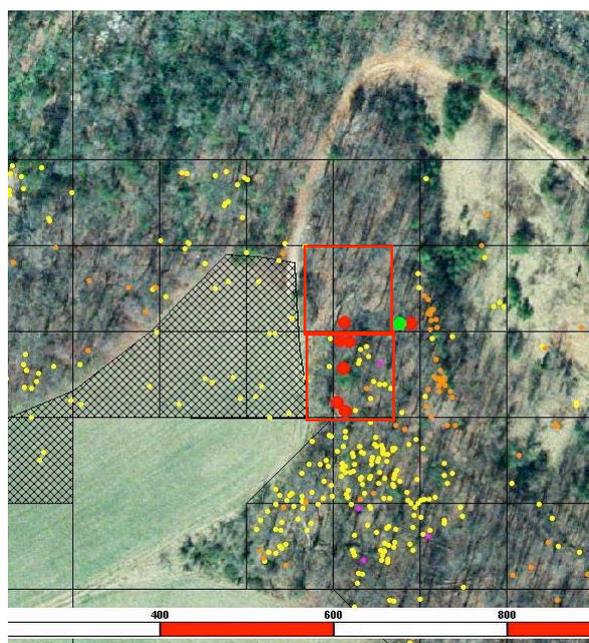
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