Comparative sampling methodologies for detecting and quantifying 2,4,6 trinitrotoluene post-blast traces in water

Experimental set up

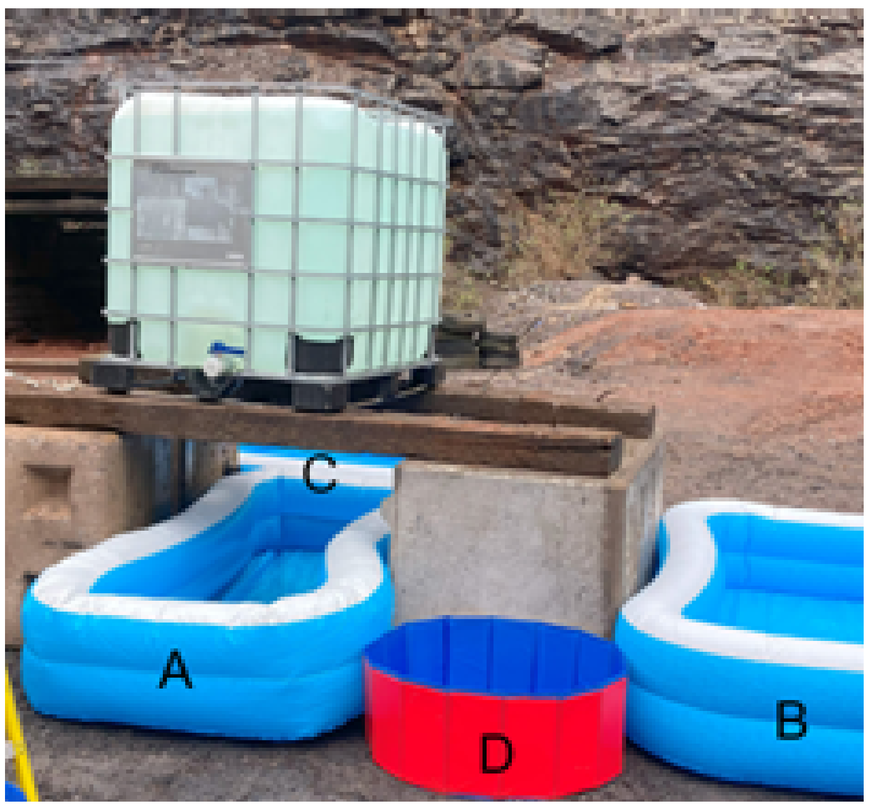

Figure 1: Experimental set up at Alfords range showing all four paddling pools A, B, C and D as well as the IBC filled with 1000l of water suspended on top of two solid wood beams.

Figure 2: Pipe bomb rigged for high order detonation with PENO donor charge visible.

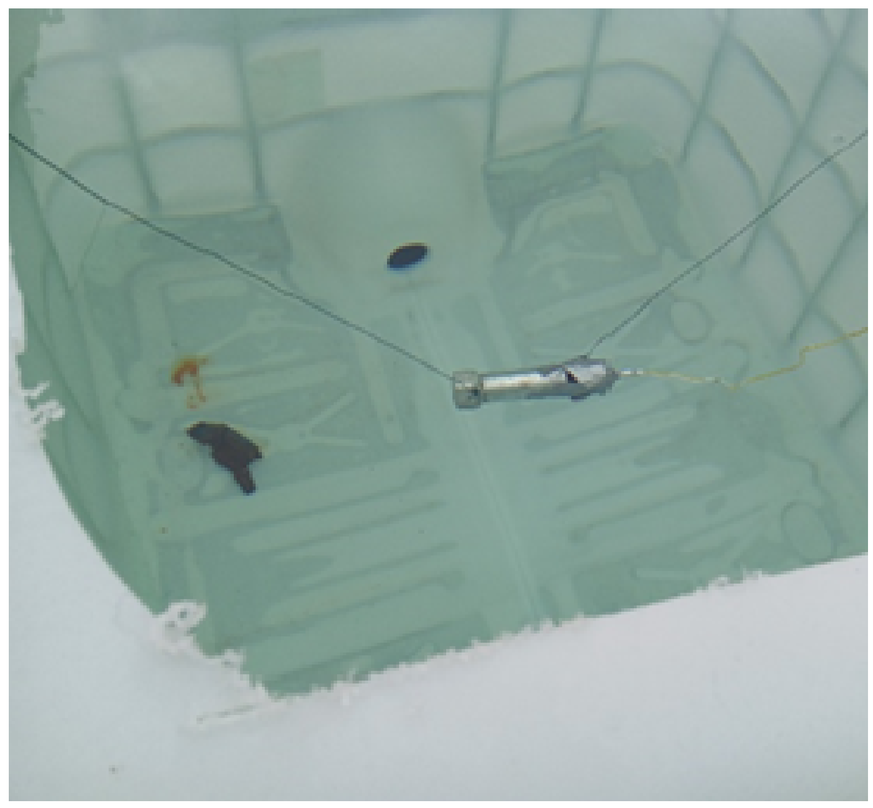

Figure 3: Suspended pipe bomb in IBC tank for high order detonation with detonator attached.

Methods

Grab and composite sampling

- Grab sampling: collecting a lump of material from a lot in a single operation
- Composite sampling: pooling of grab samples into one bulk sample
- Grab samples were split into two portions: one retained as an individual grab sample and the other used to create a composite sample
- Random selection of the grab samples was determined by the sampler
- Duplicates were taken resulting in 20 grab samples and two composite samples, each composed of 10 subsamples
- Six of these samples were collected from the surface of the IBC and one sample was taken each from the four paddling pools

Low order	High order
The Vulcan method, used by the British military, was used	One cap of each pipe bomb was removed and 20 g of PENO was placed directly in contact with the TNT
The pipe bomb with attached Vulcan, was suspended centrally within the IBC	Detonator was then directly placed into the PENO
UXO is not detonated, shell is pierced, thus causing less environmental damage	Any live explosive material within the UXO is detonated with the donor charge

3-D Multi-Increment Sampling

- Considered the most representative method
- Systematic sampling and pooling several primary increments into one overall sample
- Sampling area is divided into a grid, and a single grab sample is taken from approximately the same location within each square to compile the bulk sample
- To be representative of a body of water must incorporate a spatial aspect and be conducted three-dimensionally
- Employed by sectioning the lot within the metal cage surrounding the IBC into 12 sub-lots across two layers
- Each sub-lot was sampled from approximately the same positions
- 12 subsamples, six from layer one and six from layer two, were collected

Results

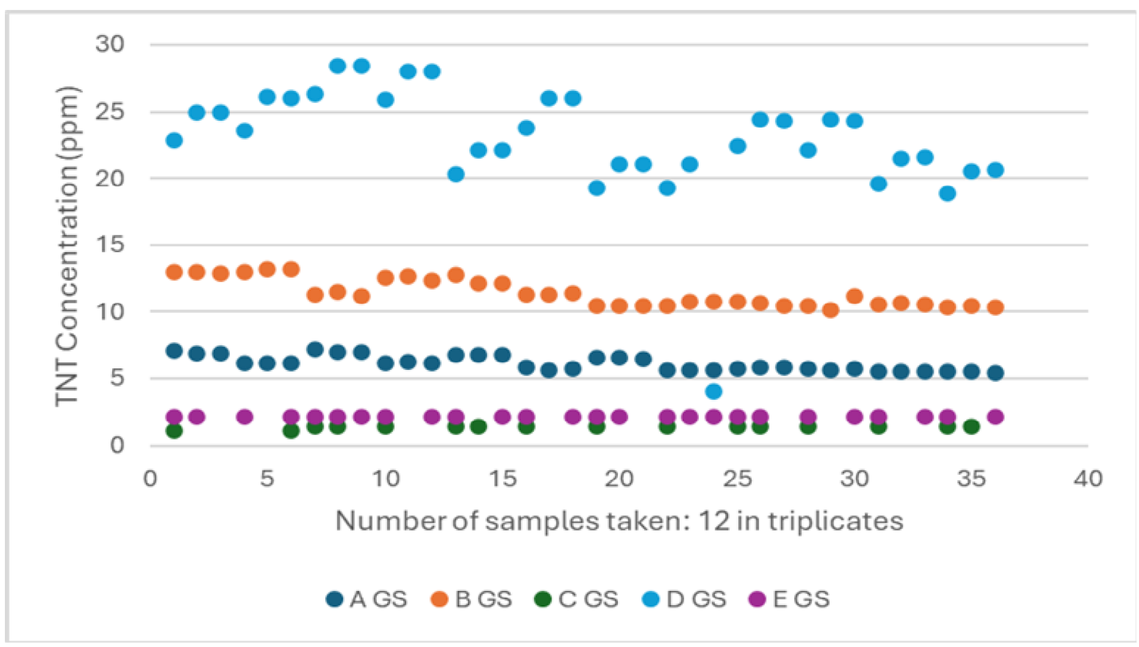

Figure 4: Visual comparison of all grab samples (GS) within the intermediate bulk container (IBC) where concentrations could be calculated by use of HPLC.

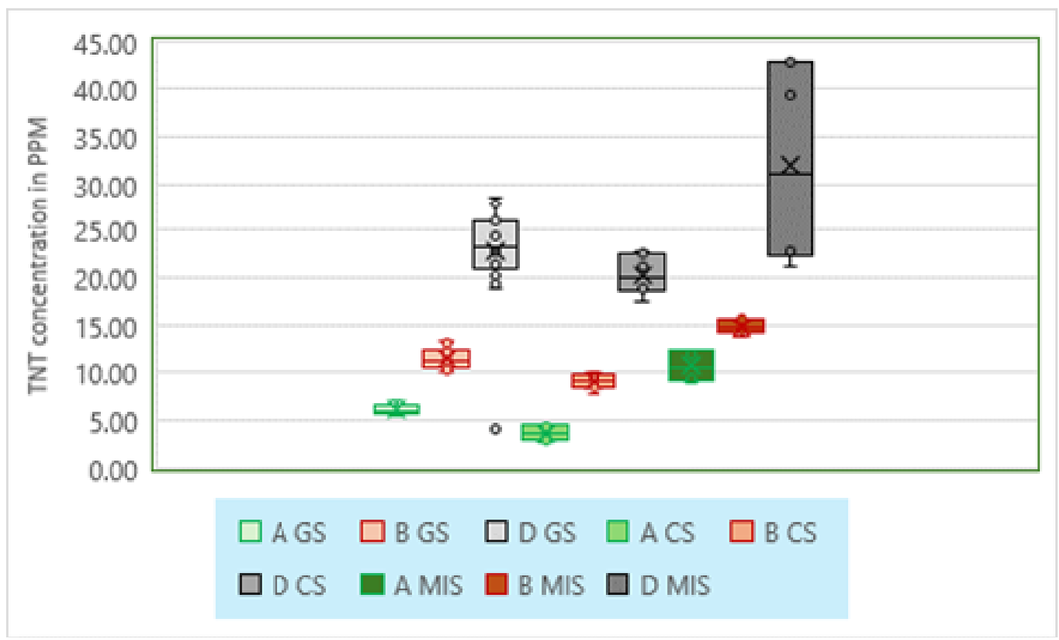

Figure 5: Statistical comparison of grab (GS), composite (CS) and multi-increment sampling (MIS) for low order (LO) deflagration 'A, B and D'.

Current assumptions of homogeneity in sampling may not hold true, as evidenced by results from multi-increment, composite, and grab sampling methods. 3D-MIS generally showed the highest recovery of TNT suggesting heterogeneous dispersion of post-blast materials within the IBC. Composite sampling significantly reduces the time taken for analysis, while requiring meticulous planning and coordination. To obtain a comprehensive understanding of the environment hazard mapping through grab sampling is essential, but is prone to high variation, necessitating analysis in triplicate at minimum to mitigate false negatives. Sampling for HO, proved more difficult as instrumentation sensitivity was a hinderance.

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