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Work-Based Group Project Presentation
Bomb Run Team
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1 Introduction

Post WWII the Swiss military have been dumping munitions in various lakes across Switzerland as they believed this was a safe method of disposal [1]. Most munitions were dumped in four lakes in the Alpes: Lake Neuchatel, Thun, Brienz and Lucerne [1][2]. The Swiss Government offered a 50,000 francs reward for solutions to remove the munitions in a safe and environmentally considerate way, split three ways between the top solutions [1].

This report focuses on the Bomb Run Team that were tasked with the shallow water recovery of three identified munitions. The assignment brief used British munitions for ease of research for the students which would not be found within the lakes. These were the BL-755 Cluster Bomb, 1000lb Bomb and a 3kg Practice Bomb. Lake Neuchatel was the lake the students focused on primarily due to the depths of the munitions being 6 to 7 metres [1].

2 Team Collaboration

To work efficiently each of the 4 Team members was given a role as a focal point for the project. The student's primary input to this presentation was the environmental considerations and impacts that this activity could/would cause. They were identified by the team as the Environmental Specialist.

In order to aid research and keep communication open, an email chain between all members of the team was established and used frequently to discuss solutions and share reference material. Additionally, a WhatsApp group was also created for organising meeting times when on University Campus. Both allowed for consistent communication between team members and for members to reach out from their designated role to assist others with issues. It also meant that all team members knew of the entire devised process and worked collaboratively to finalise it.

3 Munitions Research

3.1 BL-755 Cluster Bomb

The BL-755 Cluster Bomb is an airborne munition which discharges 147 'bomblets' once the distance to target has reached the desired meterage [3][4]. The submunitions are ejected from as much as 18 metres from the target to allow for a widespread before impact [4]. The bomblets are very universal as they are High-Explosive-Dual-Purpose (HEDP), Anti-Vehicle (AV) and Anti-Personnel (AP) which made the BL-755 a potent weapon for the British arsenal [4]. The submunitions function on impact using a piezo-electric fuse which initiates the shaped charge within, producing an Explosively-Formed-Jet (EFJ) and 2000 pieces of fragmentation for a secondary AP effect [4].

Due to the munition being submerged in water for ~80 years, damage sustained from water ingress must be considered. For the BL-755 the main concern is the damage to the piezo-electric fuse within the submunitions as this can cause short circuits which leads to malfunction of the fuse [5]. This factor contributes to the uncertainty of the condition of this munition and its explosive sensitivity due to a potentially compromised fuse. The other consideration is corrosion due to water. The BL-755 contains ferrous metals within the casings of both the main body and the submunitions, specifically cast iron in the Mk 1 and cast steel in the Mk 2 [4][6]. Corrosion in the outer casings increases the risk of the submunitions being deployed either in situ or when moved.

These damage considerations led the Environmental Specialist to decide that high ordering the munition where it stands in the lake is the best disposal solution as moving the BL-755 poses too many unknown risks to the persons completing the activity. When this information was presented to the other team members, they agreed that the Environmental Specialists' approach was the safest and most efficient.

3.2 1000lb Bomb

The 1000lb bomb has two main variations, the Medium-Capacity (MC) and the General-Purpose (GP) with the MC replacing the GP in 1942 [7]. The MC variant is a High-Explosive Blast aircraft bomb which contains a Torpex liquid biscuit fill, as per the assignment specification [7]. They are nose fused with either an impact or timed delay fuse fitted which initiates the main fill [7].

Sediment coverage of the nose fuse is the primary consideration when deciding on disposal and/or removal techniques to employ. The Environmental Specialist researched using a sub-bottom profiler to provide an image of the munition underwater to highlight the amount of sediment the fuse is under [8]. However, due to this equipment's limited application, a magnetometer would first be used to identify the locations of the munitions under the lakes. A magnetometer detects the ferrous metals in the casings of the munitions and provides a pin map for their locations [8]. The sediment coverage influences the disposal process of this munition as the fuse would need to be disrupted prior to removal. If it is buried in sediment, this will not be possible to do safely, therefore, it would be high ordered in situ. If disruption is possible, lift bags will then be used to rise the munition to the water surface, with pontoons then being inflated to maintain its stability before towing it to the shore [9]. On the shore, a cut and burn technique will be employed using a flexible linear cutting charge (FLCC) to expose the explosive fill before burning it out [10].

3.3 3kg Practice Bomb

The 3kg Practice Bomb is a training munition that produces a flash and smoke signal to simulate a rocket plume and help pilots locate where it lands [11]. The munition contains SR800 as the booster and magnesium as the main fill to produce the desired effect [11]. Although this munition does not contain any high explosives, it still poses significant hazards to personnel and must be handled with care. Using the lift bag technique method mentioned in section 2.2, this munition would be recovered to shore and then allowed to function as designed rather than using a UXO disposal technique.

4 Environmental Considerations

4.1 Water Pollution

Lake Neuchatel is inhabited by many animals and is an attraction for both tourists and locals. Therefore, the water pollution must be controlled. This includes toxins leaking from exposed explosive material due to casing corrosion and the products from high ordering munitions in situ [12].

By completing a water survey both pre and post activity the levels of toxic material in the water can be calculated and mitigations put in place to prevent further damage to the ecosystem.

The Environmental Specialist proposed that water samples are taken and send off to a laboratory prior to anyone entering the water in case there is a risk of carcinogenic material. The samples would be taken at various locations on the lake, with some taken where clusters of munitions are located and some from the furthest point away from the munitions, to identify if the levels are consistent for the entire body of water or if they are increased in certain locations [13].

This process is regarding safety of the EOD divers that will be deployed to visually inspect the munitions to report their condition.

Post activity, the water sample will indicate if the high order detonation products have polluted the water. Some products will be insoluble solids that can be collected but others will be gases and soluble products. If the levels pose risk to people entering the area, the lake will be quarantined and treated accordingly to reduce the hazard.

The Environmental Specialist also highlighted that the fragmentation in the water and the casings on the shore must be cleared from the area, so the area is returned to a better condition than before the activity began. Otherwise, people swimming in the lake or the animals could be injured by sharp metal waste.

4.2 Animal Inhabitants

There are around 3200 different species of animal that inhabit Lake Neuchatel, 144 of which are Swiss Red List and 18 further are protected at a European level. This includes fish, birds that migrate to the area, mammals and invertebrates [14][15].

The Environmental Specialist suggested that the mammals and birds be scared away from the area by human disturbance and small explosive charges being set off to reduce the risk of damage to their populations [15]. The other members of the team had not considered proceeding with the protected animals stopping the work from occurring. However, the Environmental Specialist was able to convince them that by scaring the mammals away and capturing a sample of each species to reintroduce to the environment post activity that the threat to the species would be minimal.

The Environmental Specialist also researched ways to reduce harm to the fish; however, this would not be cost effective or guaranteed to be possible. From the EOD divers entering the water and general disturbance around the munitions before high ordering them, the fish would avoid the area and so the risk of harm is reduced. The Environmental Specialist noted that this is not the most effective method yet is the most practical for the situation.

5 Systems Thinking Approach

5.1 Visual Inspection Decision

The Bomb Run Team generated many ideas on how to inspect the munitions to analyse their individual conditions. This would be done after the sub-bottom profiler has generated the sediment coverage report. By applying a systems thinking approach, the ideas were narrowed down to two which were to send a robot down with a camera to inspect or to send an EOD diver down with a camera [16]. Further discussion and research led the team to decide that an EOD diver would be the safest option. Despite this increasing the amount of people at risk from 0 to 1, the unpredictability of the munitions along with the chance that there may be munitions disturbed by the robot rolling over the sediment, it would mean that there is less interference with the munitions themselves during this process. By equipping the diver with a radio for communication back to the shore, it allows for better manipulation and imaging of the munitions themselves. Additionally, by using a trained EOD diver, they are fully competent to complete this activity, and the cost of deployment is significantly less than a robot.

5.2 Disposal Decision

Disposal decisions were critical to this process with many viable and proven methods being suggested by all members of the team. The team decided that low ordering as many munitions as possible would be the safest way to dispose of them but realised that this would not be possible for all that are found. As the 3kg practice bomb is designed to deflagrate, the decision was made to function it as designed rather than cut and burn to reduce the risk of accidental ignition. By applying a systems thinking approach, the team decided that cut and burn would be only effective for the disrupted 1000lb bombs and that the BL-755 would have to be high ordered as it was too dangerous to disturb and remove [16].

The other suggestion for disposal was to melt the explosives out of the munitions and burn separately. However, this method was decided against due to the unknown sensitivity and conditions of the high explosive material within the munition main fills. Also due to water ingress, the temperature required to melt the explosive compounds would be unknown and therefore would have to be figured out true testing methods that would increase the timeframe for the activity and thus the overall cost. As the munitions would be disturbed during the removal process, the team decided that disposing of the munitions as quickly as possible once on the shore would keep the activity ALARP.

6 Presentation Skills

The Bomb Run Team were assessed and given both team and individual feedback on presenting their proposed disposal plan. The Environmental Specialist's individual feedback was very positive, with their presentation delivery skills being highlighted as professional and confident.

“Confident delivery with good interaction with the audience. Good pace and volume. Minimal reading from slides, clear evidence of preparation. Open body language throughout.”

J. Steen – feedback on ES presentation skills

Overall, the feedback was constructive with the improvements being addressed for inclusion of more content rather than the skills of presenting the team's solution.

7 Conclusion

This report on the presentation of shallow water disposal and recovery of dumped munitions in Swiss lakes highlights the Bom Run Team and their solution and research with a focus on the Environmental Specialist's influence and contribution to the overall devised solution.

The research on the Environmental Specialist's subjects was thorough with additional assistance given to other members of the team. Their influence was critical in the decision-making processes for each section as the team worked systematically and collaboratively to generate ideas and the final result.

The Environmental Specialist focused on the Health and Safety and environmental challenges that the activity would have to address, with these aspects being considered throughout all decisions on processes involved.

To progress this solution further, a total costing and time frame draft should be considered to review the practicability of the stages within although both factors were taken into consideration throughout.

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