

SENSYS[®]

Magnetometers & Survey Solutions

The framework of UXO clearance

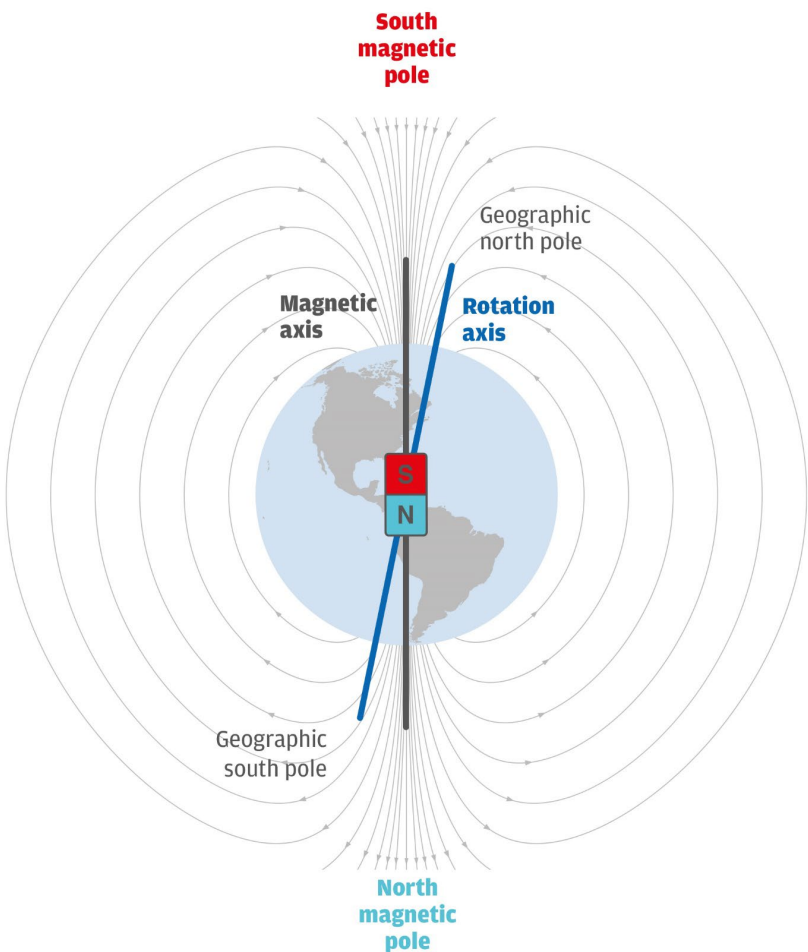
In Germany

Wolfgang Süß, MD @ SENSYS

SENSYS GmbH
Rabenfelde 5
15526 Bad Saarow
GERMANY

+49 33631 59650
info@sensys.de
www.sensys.de

SENSYS in a nut shell



” The Fluxgate Magnetometer is our core sensor to be used in most of our survey solutions. Our products measure magnetic fields, which are either the Earth’s Magnetic Field or local fields. ”



Founded 1990.



East of Berlin.



Focused!



Stable growth.



UXO Survey



ARChaeology



GEOphysics



OFFshore



SPEcial



SENSors



SOFTWARE

” We serve sensitive and challenging niche markets with single sensors, devices and complex solutions. ”

SENSYS in a nut shell



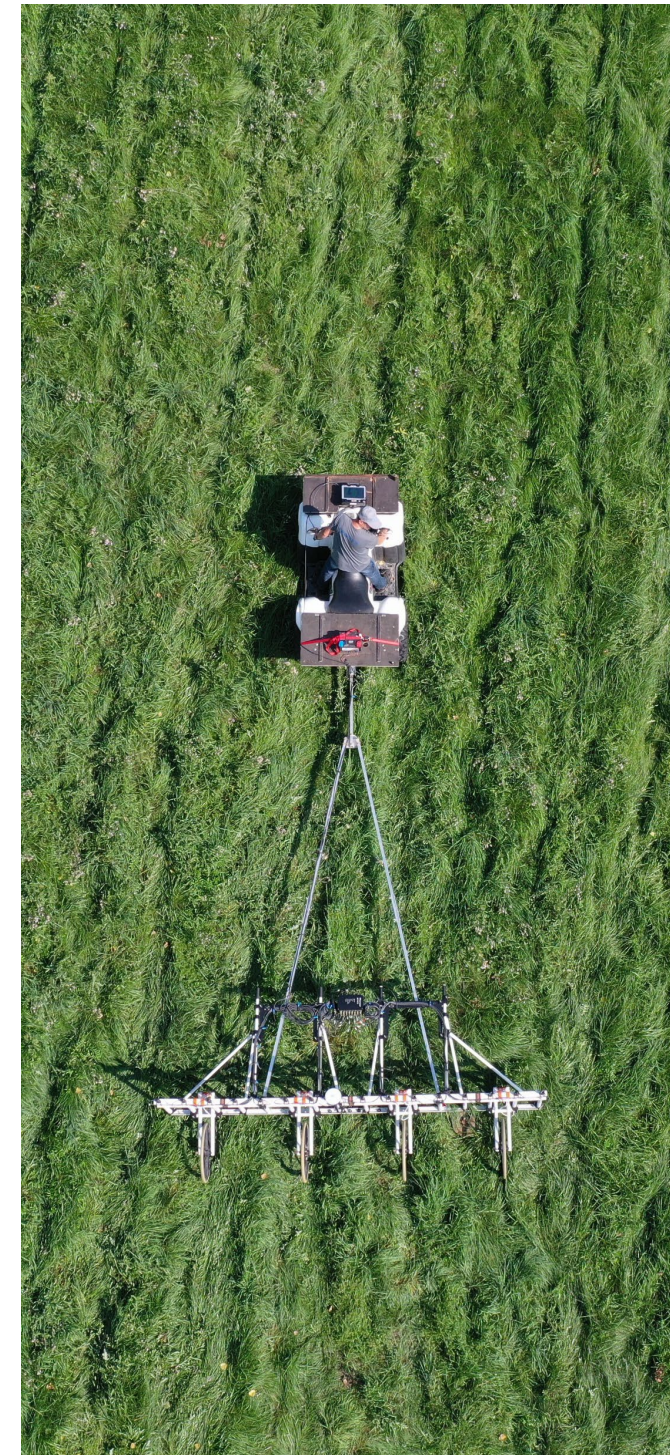
Aerial solutions



Direct-push systems



Handheld devices



Vehicle-towed systems



Submersible systems

The root cause of contamination

Bombing, combat, training during WWII



USAAF - National Museum of the U.S. Air Force photo 050606-F-1234P-042;



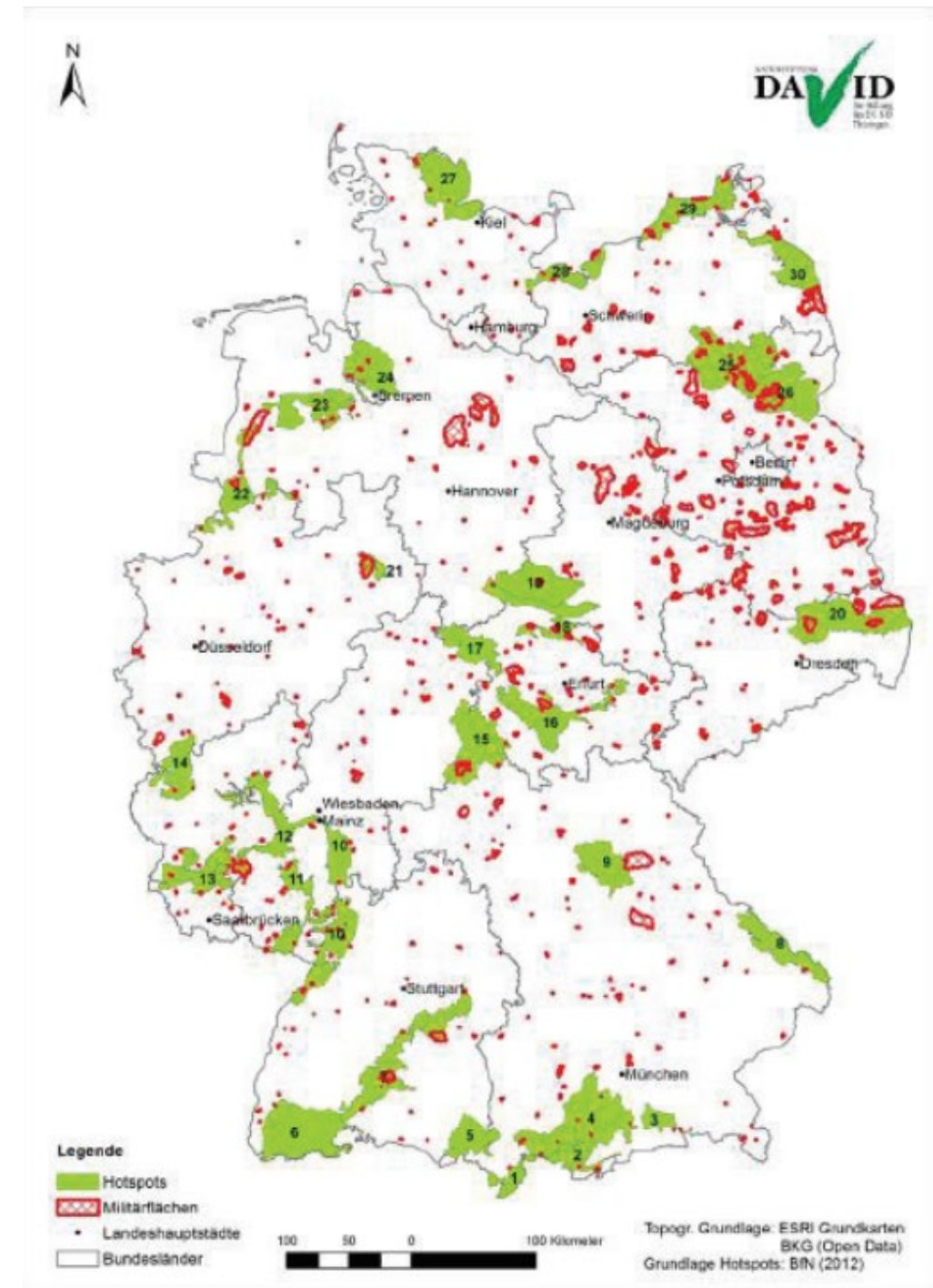
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<https://www.fairchild.af.mil/News/Photos/igphoto/2000994527/>

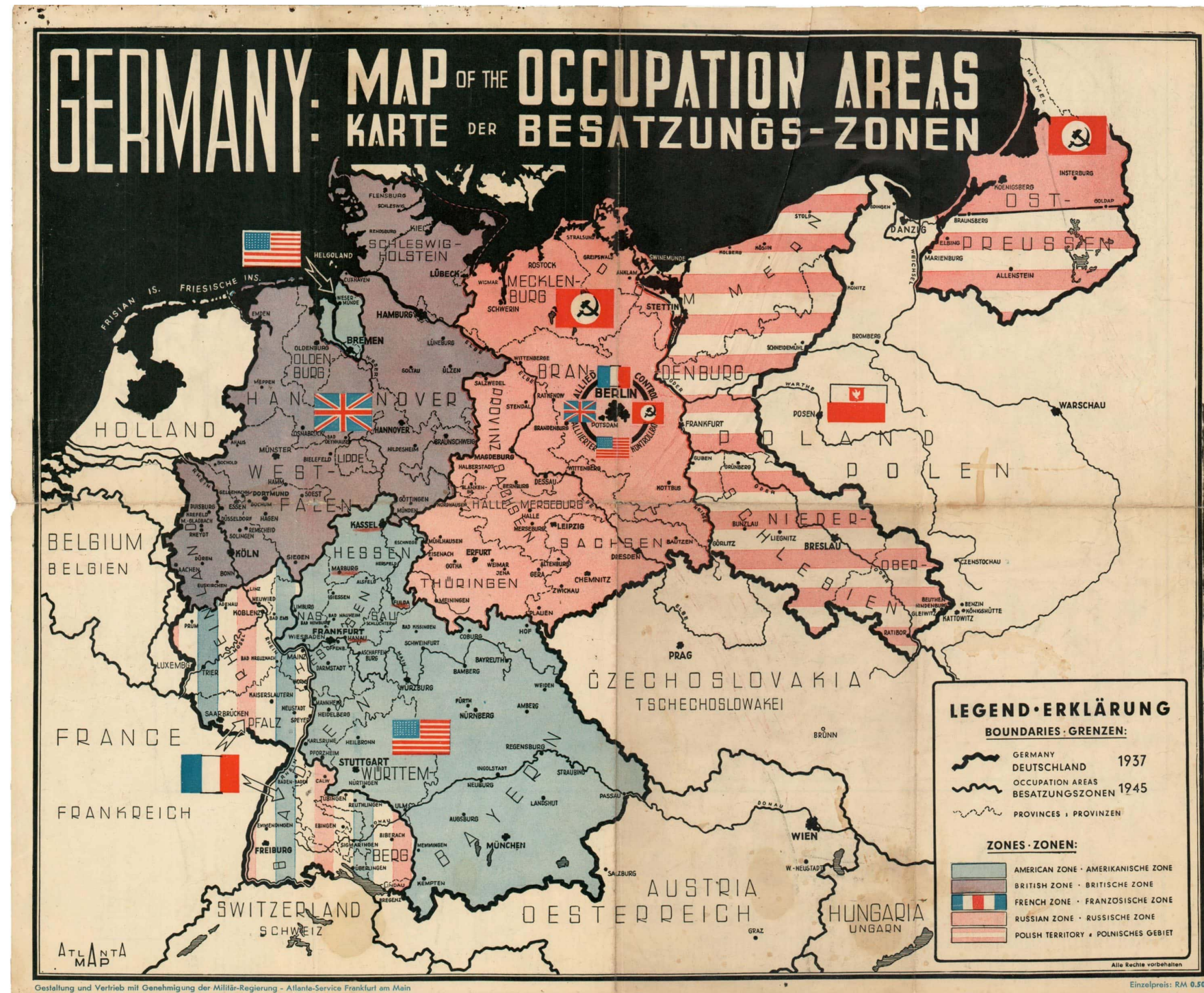


<https://germanhistorydocs.org/en/nazi-germany-1933-1945/members-of-the-hamburg-jungvolk-training-with-carbine-rifles-at-a-hitler-youth-camp-on-the-baltic-sea-1938>



https://digibib.hs-nb.de/file/dbhsnb_derivate_0000002228/Bachelorarbeit-Rechlin-2016.pdf

The end of WWII



<https://bostonraremaps.com/inventory/occupied-germany-necessity-paper-1945/>

The end of WWII



<https://www.youtube.com/watch?v=cSXtsqhRN5A>

The left over from WWII

- Around **100,000 to 300,000 tons** of UXO on land
- Around **1,200,000 tons** of dumped munition in the North Sea
- Around **300.000 to 600.000 tons** of dumped munition in the Baltic Sea
- Around **5,000 tons** of munitions gets defused and deflagrated per year
- Chemicals and explosives are detected in **almost all fish stocks** in the North and Baltic Sea

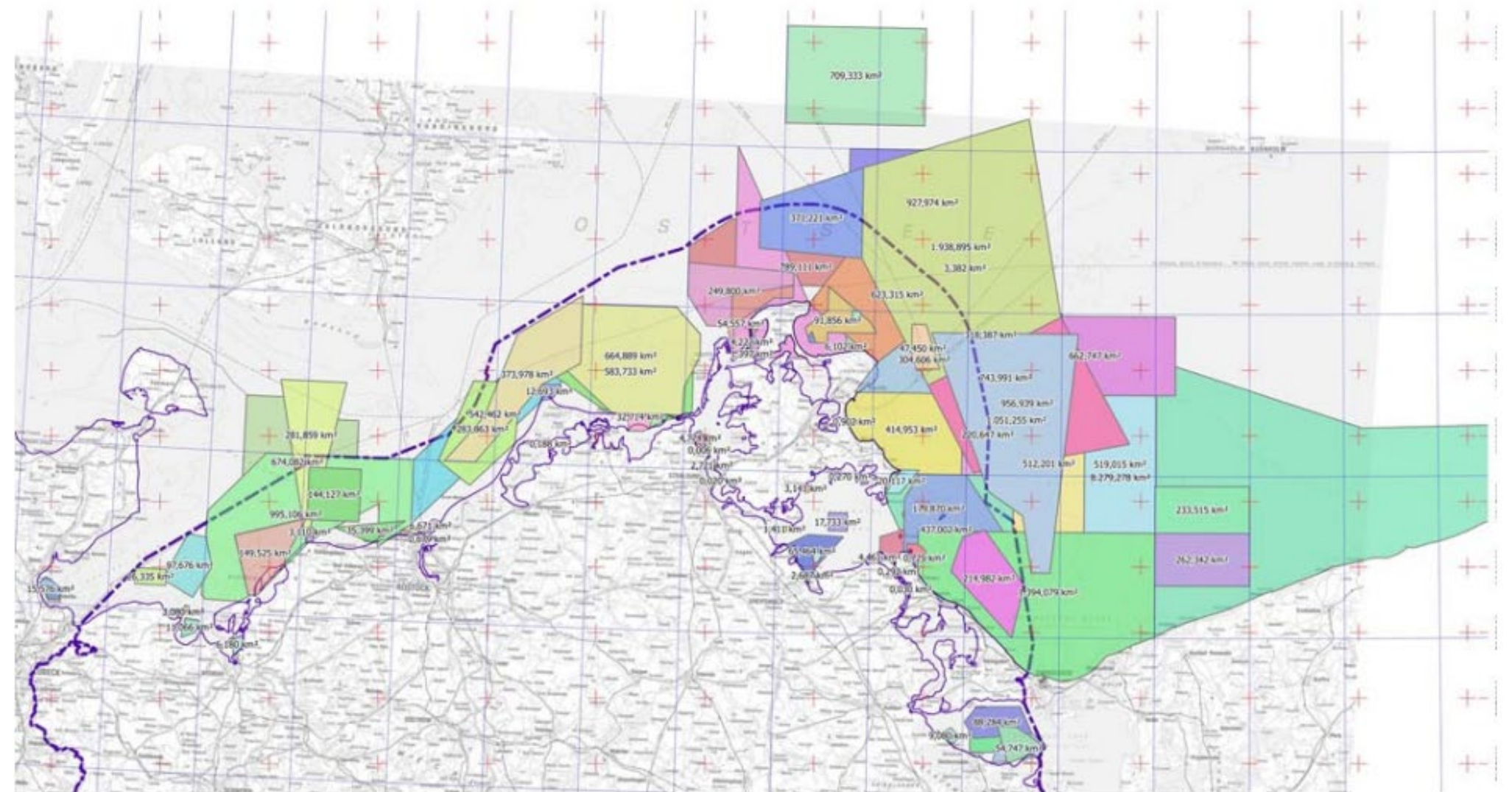
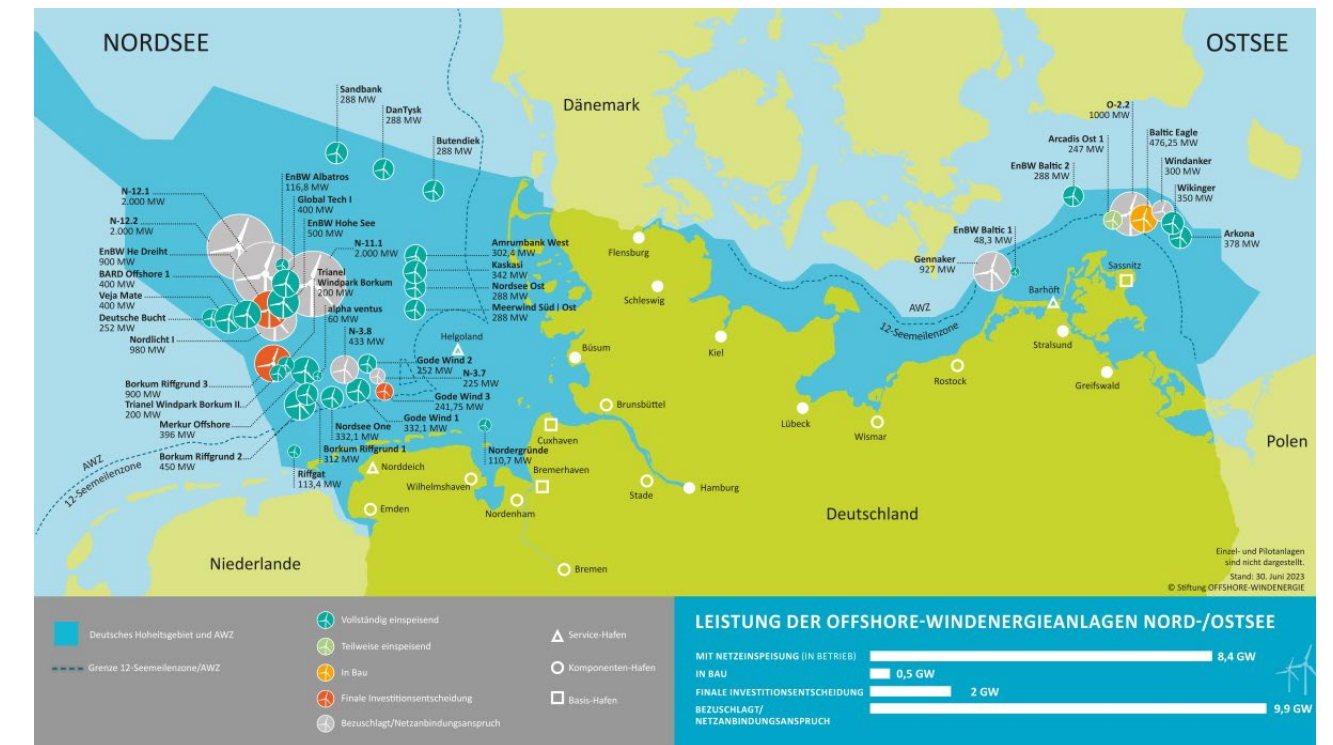


Illustration indicating areas of contamination off the cost of German State Schleswig-Holstein.

Germany a federal approach

- Explosive ordnance clearance coordination is a **federal state matter**
- UXO search is within **commercial EOD services**
- German's responsibilities in the water end with the EEZ (Exclusive Economic Zone) with an area of **8.2 million acres** (85% in the North Sea and 15% in the Baltic Sea)
- The largest land owner is the **BImA** (Federal Agency of Real Estate) with 20,000 properties, 38,000 apartments covering **1.2 million acres**, built up a reserve of around **€2.5 billion Euro** for UXO clearance
- DB Bahn with **34,000 km** of track and **50,000 acres** of adjacent forest
- Education is organized via various associations and **EOD schools**



Pilot

Immediate Programme Munition in the Sea covered with **100 Million Euro** governmental funding to concept the

- Detection & classification
- Wet storage
- Salvage
- Mobile annihilation at sea

UXO a federal approach



UXO clearance a commercial task

Education



Organisations



Güteschutzgemeinschaft
Kampfmittelräumung
Deutschland e.V.



Seals of quality



Directives



BFR KMR



Offshore



54145 1/2

UXO clearance companies

Pre-requisites

- **§7 SprengG** (German Explosives Law) for any (also foreign) company that intends to deal with Explosives
- **§20 SprengG** Senior Technical Supervisor in the ERW clearance (german: Fachtechnisches Aufsichtspersonal, FTA) asite on every clearance site
- **Annually** checked and maintained detection equipment (by manufacturer or qualified test lab)

UXO clearance as part of a huge process

The **BImA** released an own guideline for their properties (regardless which state):

BFR KMR (construction guideline for the clearance of explosive ordnance)

organized in phases:

Phase A	Historical investigation (aerial photo analysis, archives, questioning, ...)	Determine explosive ordnance contamination
Phase B	Technical investigation	Determine hazard
Phase C1	Concept, tendering, awarding	Planning of clearance project
Phase C2	Detection, clearance, acceptance, documentation	Removal

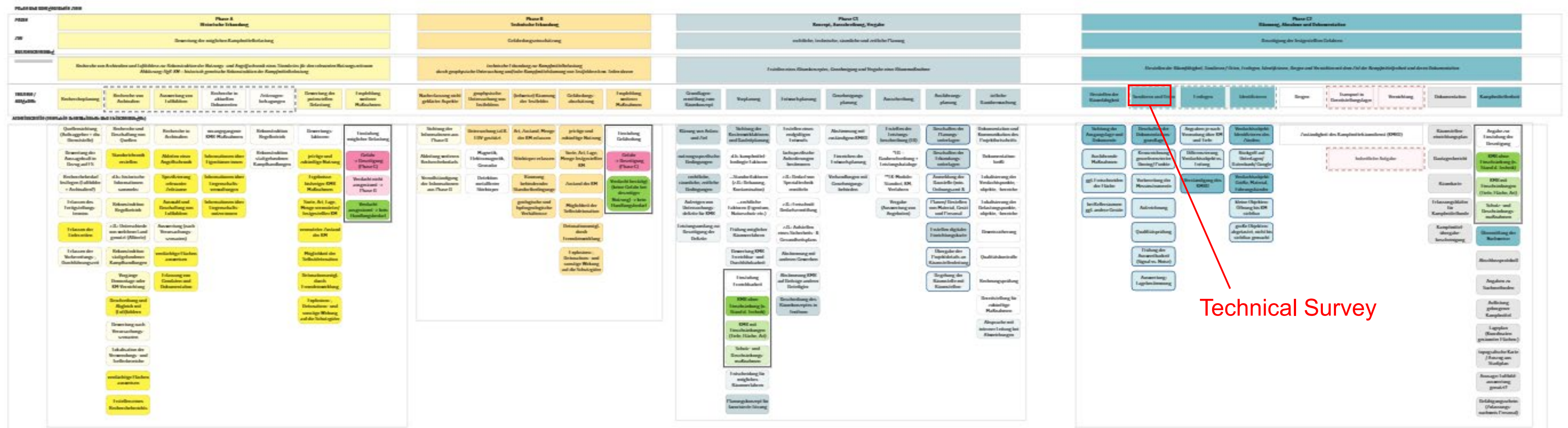
UXO clearance as part of a huge process

Phase A

Phase B

Phase C1

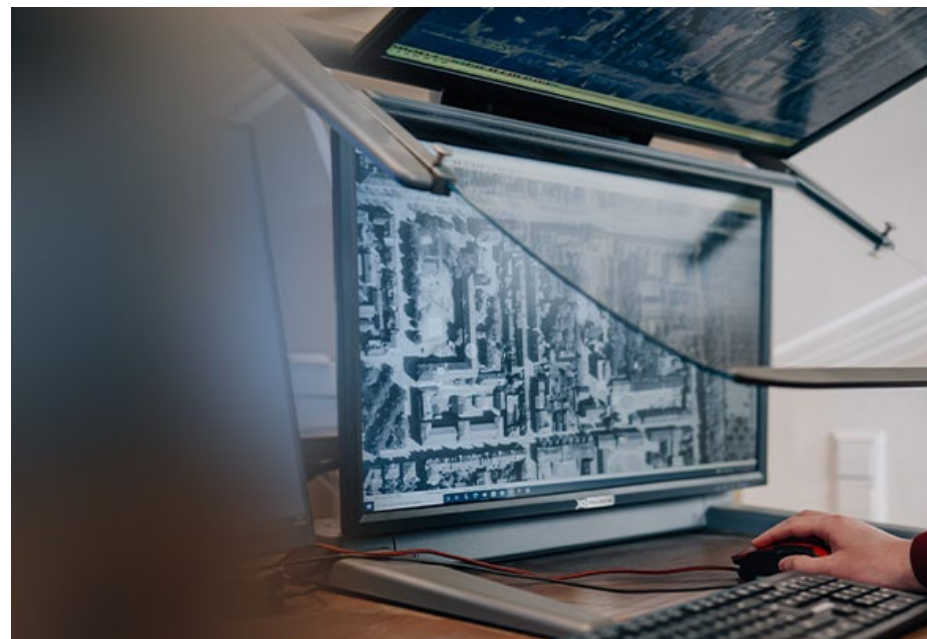
Phase C2



Phase A determine the contamination



Dr. Carls Luftbilddatenbank



LBA Luftbildauswertung

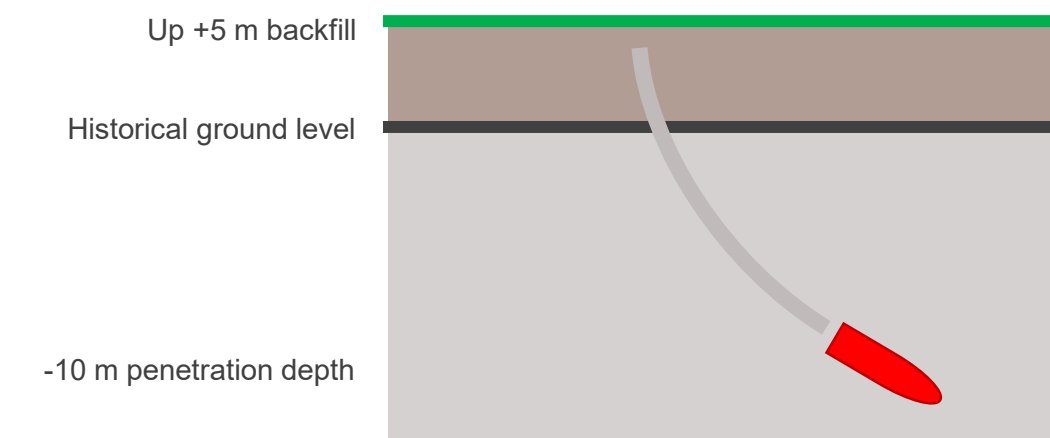
- **Historical non-technical survey** based on old military documents and contemporary witnesses
- **Aerial image analysis** became an important part of the pre-survey after the Allied Forces released millions of photographs of their WWII aerial bombings at the end of the 1990s

Phase B determine the hazard

- **What kind** of munition/threat is to be expected?
- **How** was explosive ordnance contamination caused?
 - Bombing, combat, destruction, military training, storage
- **Depth** of suspected munition
 - Most of UXOs is buried within 10 meters below (historical!) ground level (*up to +5 meters for todays ground level*)
- **Surrounding** and **backfill** of suspected munition
- **Infrastructure** and **geological** assessment
 - Most of UXOs are not defused at site anymore, but blasted
- **Assessment/requirements** for geophysical survey methods
- **Sample test areas** and concept of **methodical approaches**

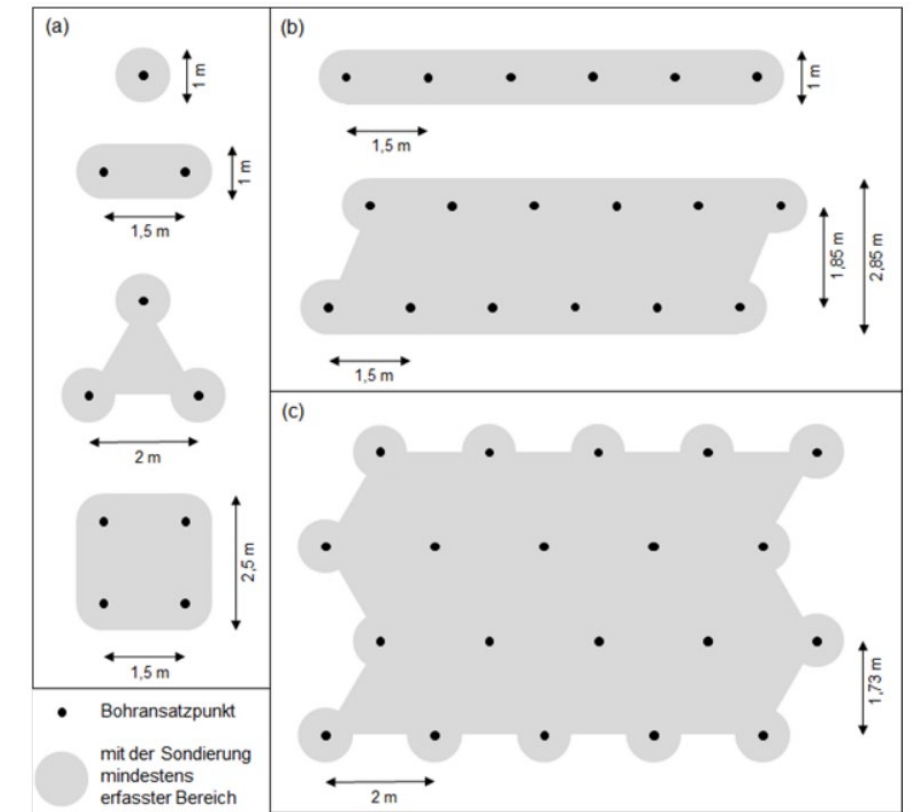


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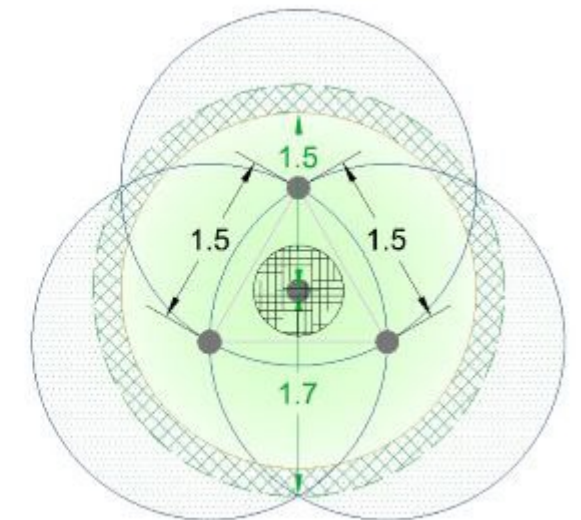
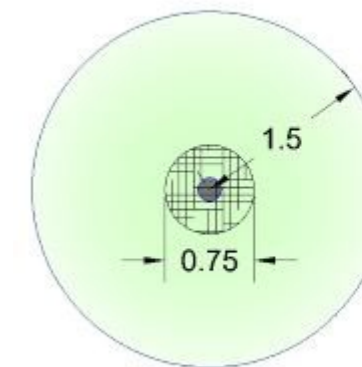
Phase C1 tendering and contracting

- **Tender with lots** to define scope of work
 - i.e. clearance of ground from 0 to x meters
 - i.e. clearance of munition greater than x kg
- Detailing the required geophysical methods
 - **GPR** - Ground penetration radar / borehole radar
 - **MAG** - Magnetometry (borehole/direct push or top surface survey)
 - **EM** – Electromagnetic
- Detailing the application of **geophysical methods**, i.e.
 - Borehole grids
 - Sensor spacing, data point density
 - EM: number of time gates
 - GPR: antenna frequencies
 - GPS accuracy
 - documentation



Guideline of the explosive ordnance disposal service in North Rhine-Westphalia (excerpt of borehole grid planning)

$$d = \sqrt{3} \times 0,6 \times \sqrt[3]{\frac{V_{Bombe}}{R_{Umgebung}}}$$



BFR KMR: Borehole distance calculation according Wegner and Fleischmann (1954)

Phase C2 survey and clearance - downhole



https://geomer-kampfmittel.com/wp-content/uploads/2020/07/20190827_070527-Kopie-768x1024.jpg

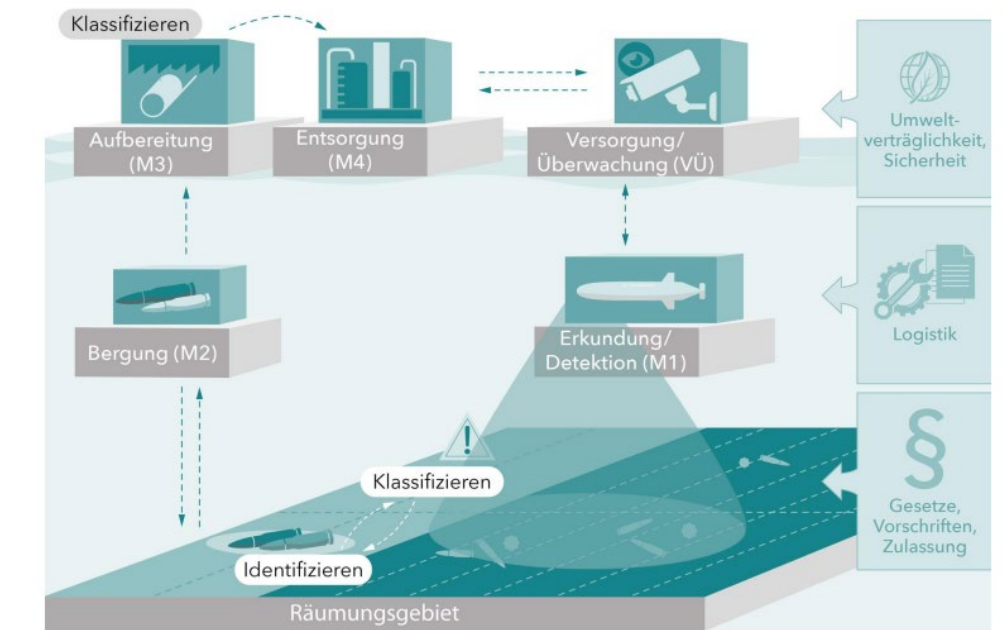


https://rp-online.de/nrw/staedte/emmerich/rees-an-der-bahnstrecke-in-millingen-wird-kraeftig-gebohrt_aid-67391329

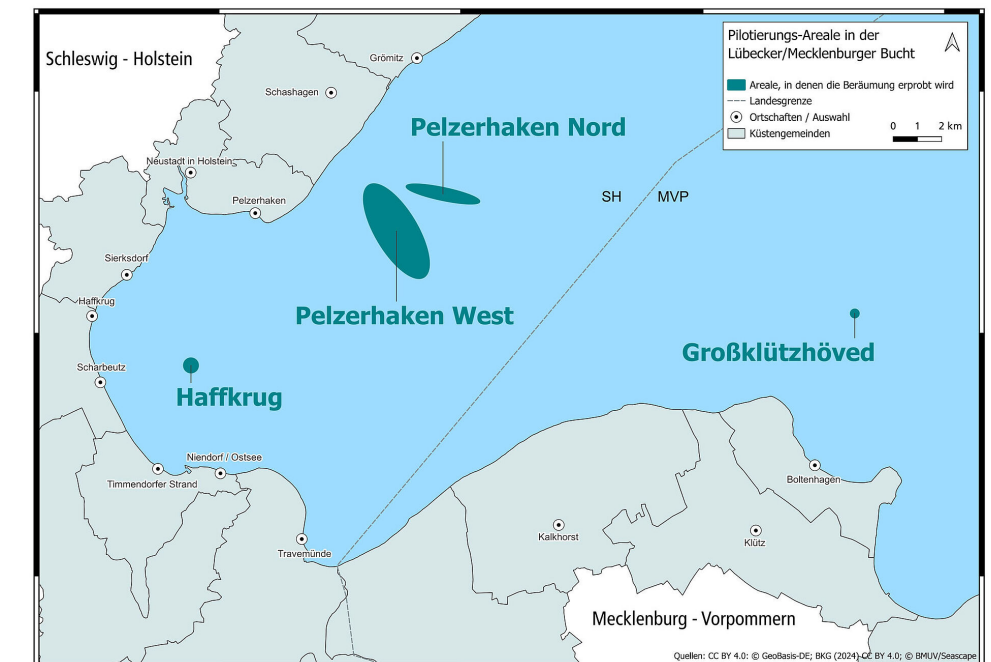
Phase C2 survey and clearance - offshore



https://www.ndr.de/nachrichten/schleswig-holstein/munitionsbergung154_v-fullhd.jpg



SEASCAPE



GEOMAR

Phase C2 survey and clearance (blasting/defusing)



https://rp-online.de/nrw/staedte/moenchengladbach/bohttps://ant-ag.com/eod-ieddmbenenentschaerfung-moenchengladbach-12500-menschen-von-evakuierung-betroffen_aid-35004153



<https://ant-ag.com/eod-iedd>

SumUp Intensive (endless) clearance

1. Clearance organization is a **federal state matter**
2. Clearance work is a **commercial task**
3. **BImA** and **DB Bahn** have huge budgets to spent
4. **200,000 – 300,000 air dropped bombs** still buried on land
5. **1,6 Million tons** of dumped munition in the sea is approached with an initial governmental programme with “only” 100 Million € budget
6. Technical survey methods are mainly GPR, Magnetics and EM
7. Requirements for documentation and regular maintenance of survey equipment is raising
8. A common database of findings (i.e. to train AI, help statistics) is not yet existing



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Magnetometers & Survey Solutions

Measure.

Detect.

Protect.

SENSYS GmbH
Rabenfelde 5
15526 Bad Saarow
GERMANY

+49 33631 59650
info@sensys.de
www.sensys.de



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www.tuv.com
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