# Open Source Assessment of Cluster Munition Use in the City of Kharkiv during Spring 2022



JUSTICE & ACCOUNTABILITY UNIT

Bellingcat
Global Legal Action Network

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# About Us

The Justice & Accountability Unit (J&A Unit[1]) is a unique partnership between open source investigators from Bellingcat and lawyers from Global Legal Action Network.

The J&A Unit's investigators receive legal training to guide their research and follow a rigorous, co-designed methodology which we have developed to meet criminal evidentiary standards.

The J&A Unit is a self-contained entity which is separated ('firewalled') from the rest of Bellingcat, ensuring that journalistic work and accountability work is conducted independently, preventing possible bias.

Using Bellingcat's pioneering investigative techniques and GLAN's legal expertise, the J&A Unit works to enhance legal accountability processes such that when victims and witnesses legitimately record the commission of atrocity crimes or their aftermath, that evidence can be relied on in court.

# Thanks

This report would not have been possible without input from a large number of groups and individuals.

The biggest thanks goes to all the members of J&A Unit who contributed to this report and investigations of individual incidents.

We would also like to extend our thanks to all other contributors from GLAN and Bellingcat; members of the Global Authentication Project volunteer community; Mnemonic; Atlos.org; Huridocs.org.

This work would not have been possible without satellite data from Planet Labs and Maxar Technologies.

Special thanks to Petro Pyatakov Col (ret), an expert on Soviet bloc rocket artillery systems and the senior ex-military satellite imagery expert whom we consulted for this report.

[1] https://j-and-a.glanlaw.org/

# Glossary

## Abbreviations

**AoI** - Area of Interest

**API** - Application Programming Interface

**FCS** - Fire Control System

**GAP** - Global Authentication Project

**GLAN** - Global Legal Action Network

**GLONASS** - Global Navigation Satellite System (Russia's satellite navigation system)

**HE-Frag** - High-Explosive Fragmentation

**IHL** - International Humanitarian Law

**IVO** - 'in the vicinity of'

**J&A Unit** - The Justice & Accountability Unit

**MLRS** - Multiple Launch Rocket System

**MoD** - Ministry of Defence

**OOSI** - Online Open Source Information

**OSI** - Open Source Information

**REABAT** - Rocket Artillery Battery

**REABR** - Rocket Artillery Brigade

**READN** - Rocket Artillery Division

**SAR** - Synthetic Aperture Radar

**SGBV** - Sexual and Gender-Based Violence

**UGC** - User Generated Content

**WACZ** - Web Archive Collection Zipped

## Other Useful Terms

**Firing point** - a place where one Multiple Launch Rocket System has fired from.

**Launch position** - a place where several Multiple Launch Rocket Systems have fired from.

**Launch area** - a grouping of several launch positions.

## A Note on Coordinates:

The number of decimal points in a set of coordinates is used in this report to give an idea of resolution.[2] The standard for a point location within this report is four decimal coordinates (for example: xx.xxxx, xx.xxxx), which is accurate to 11 $m^2$. Lower numbers of decimal coordinates indicate wider areas and therefore less accuracy, so three decimal coordinates would indicate an accuracy of 111 m, two coordinates 1.11 km etc.

[2] https://support.garmin.com/en-US/?faq=hRMBoCTy5a7HqVkxukhHd8

# Executive Summary

This report presents an open-source investigation into the use of cluster munitions in Kharkiv during the first months of the full-scale Russian invasion of Ukraine, in 2022. The research was conducted by Bellingcat and the Global Legal Action Network (GLAN) using open source investigation, geospatial analysis and expert input.

The report identifies 32 incidents involving the use of Uragan and Smerch/Tornado-S, 24 of which were identified as the latter. Cluster munitions fired by Smerch/Tornado-S were used in populated areas of Kharkiv, leading to civilian casualties and significant damage to infrastructure.

The investigation relied on open-source investigative methods, including geolocation, chronolocation, and satellite imagery analysis to examine photos, videos and other open source material related to cluster munition attacks. Analysis of images of munition remnants allowed to link the attacks from Smerch/Tornado-S to an area in Belgorod Oblast where these Multiple Launch Rocket Systems (MLRS) were identified to be operating from.

Examination of open source material related to trade shows, military parades, news reports and the build up to the full-scale invasion could be compared with media published by the Russian Ministry of Defence (MoD) to identify that the 79th Brigade of the Western Military District was present in this launch area.

Open source investigation also demonstrates that the commander of the 79th brigade Brigade during this period was Colonel Evgeny Yurievich Gerashchenko, who would have received orders from Colonel General Alexander Zhuravlev of the Western Military District.

The use of cluster munitions in civilian areas raises serious questions regarding violations of International Humanitarian Law (IHL). This report, and the 32 incident reports of attacks in Kharkiv, provides information for potential legal accountability in any future investigation.

# I. Background

In the hours after the beginning of the full-scale invasion of Ukraine by the Russian Federation on 24/02/2022, Bellingcat researchers began identifying and collecting images showing the conflict as it developed. Many of these images were captured by residents of the growing number of areas affected by the fighting. Within a few days of the start of the invasion, Bellingcat staff noticed that many of these images shared a common theme: they showed harm to civilians or to civilian infrastructure, including schools, churches, and hospitals. In early March 2022, Bellingcat decided to begin plotting this open source evidence of civilian harm onto a mapping platform. This platform, which became known as the Bellingcat Ukraine 'Civilian Harm Map'[3], is fed by a growing database of pictures and videos from social media. A fuller explanation of this map and its methodology can be found in Annex IV.

Within this dataset, one theme emerged with more clarity than any other - the widespread use of ground-launched cluster munitions, including in residential urban areas. This was particularly pronounced in the cities of Mykolaiv and Kharkiv, where footage of cluster munition attacks impacting hospitals[4], humanitarian aid lines[5] and residential areas[6] were common-place during the early stage of the war.

Whilst neither Ukraine nor Russia are signatories to the Cluster Munitions Convention, the use of these weapons are still governed by IHL, meaning they must be used in accordance with the principles of humanity, distinction, precautions, proportionality and military necessity. The repeated use of cluster munitions in residential urban areas of Kharkiv and Mykolaiv present within the Civilian Harm Map indicated that these principles may have been breached.

Consequently, the J&A Unit decided to focus on Kharkiv, due to the higher number of incidents involving cluster munitions recorded there at that time. Potential incidents and the associated URLs (Seed Data) associated with them were identified within the Civilian Harm Map. These incidents were then investigated using the GLAN & Bellingcat Online Open Source Methodology[7] (the Methodology). For each of the incidents, the Seed Data was examined and verified by placing it in space and time, identifying and examining further material associated with the incident and assessing the context of that information. Ultimately this resulted in 32 incidents which were investigated using the Methodology.

Each of these incidents was investigated using the Methodology, resulting in a set of 32 standardised open source reports. The data from these reports was then input into UWAZI, an evidentiary review platform. This data is available on request from GLAN[8]. This overarching

[3] https://ukraine.bellingcat.com/
[4] https://www.bellingcat.com/news/2023/01/27/anatomy-of-a-shelling-how-russian-rocket-artillery-struck-mykolaiv/
[5] https://t.co/halebktg7j
[6] https://www.bbc.co.uk/news/60591017
[7] https://www.glanlaw.org/online-open-source-methodology
[8] https://www.glanlaw.org/

report is an additional analytical product based on the information identified in the 32 individual incident reports.

In the course of their widespread use in Ukraine, the type of cluster munitions used in this theater, primarily 9M55K and 9M27K rockets, left distinctive remnants. Due to the design and method of employment of these munitions, it was assessed that examining the orientation of these remnants could indicate the direction from which they originated.

This kind of open source investigation is not able to offer a comprehensive view of the damage resulting from the use of cluster munitions in the city of Kharkiv. They are much better considered as a supplement to medical records and witness statements. However, the J&A Unit believed it was possible that open source information, paired with expert opinion, could be used to set out the fundamentals of the incidents that have been captured by open source content, and further to link these incidents in Kharkiv to a specific unit and possibly specific commanders responsible for these attacks.

# Scope

## Open Source Information

The mission of the J&A Unit is to demonstrate the viability of Online Open Source Information (OOSI) as evidence. This helped to define the type of information we collected and used to inform our analysis.

With the exception of expert comments, all information within this report consists of OOSI. Within the Methodology[9] we draw a distinction in OOSI between Examinable Content and Descriptive Content:

- **Examinable Content:** granular items of online content (such as individual videos, photographs, Tweets, Telegram posts, Wikimapia entries etc.) which an open source analyst can apply their expertise to in order to draw further conclusions. This content can be examined and interrogated for its veracity and/or significance in cross-authenticating other items of content.

- **Descriptive Content:** any content published online, usually written, in which events are described, but which cannot be examined using open source investigative techniques. For example, if a reliable NGO publishes witness statements, these are descriptive content, and so is a media article describing the occurrence of an event. Such content is not necessarily more or less reliable than Examinable Content, but it is not the subject matter to which OOSI analysts are applying their skills and it is therefore differentiated from Examinable Content.

[9] https://www.glanlaw.org/online-open-source-methodology

Examinable Content forms the core of what was analysed within the incident reports. Each incident report collected and analysed Examinable Content related to each incident. This content was analysed using chronolocation and geolocation, placing it in space and time. Other sources, consisting of both Examinable and Descriptive Content, were sought in order to cross reference the available open source information and identify any inconsistencies or gaps. Contextual analysis was also used to assess this content, using knowledge of the open source information environment, the wider context of the war, and the specific context of the battle of Kharkiv.

### Expert Comments

Experts were consulted at various points throughout this process. In the early stages of investigations the artillery expert Petro Pyatakov Col (ret) was consulted[10], in order to understand what conclusions could and could not be drawn from munition remnants. During the completion of the final report, further expert comments from Petro Pyatakov Col (ret) and a senior ex-military satellite imagery expert were also sought in order to test and validate analytical findings.

### Interviews

A decision was made that interviews with witnesses, survivors and perpetrators would not be carried out by Bellingcat. This was done for several reasons, including:

- To prevent witness contamination - a risk of a witness being interviewed by multiple investigators, which may weaken their testimony at a later date.
- To prevent retraumatization of witnesses.
- To remain within the expertise of Bellingcat, which is the verification of OOSI, rather than examination of witness testimony.

The authors of this report therefore acknowledge that there will be gaps within the information presented. Hence, it is important that this report is read within the context of other evidence, and, where possible, combined with witness testimony and physical evidence.

## Scope of Incidents

The date range chosen for the examination of cluster munition use in Kharkiv is from 24/02/2022, the day of Russia's full-scale invasion of Ukraine, until 15/04/2022. In early April 2022, it appears that the intensity of cluster munition attacks reduced, although they continued past this date. This may have been a result of redeployment[11] of the Russian Federation's forces due to their failure to achieve their initial objectives.

The initial list contained all incidents between 24/02/2022 and 15/04/2022 within Bellingcat's Civilian Harm Database that were assessed as being related to cluster munition use in Kharkiv

[10] Interview with the artillery expert Petro Pyatakov Col (ret) on 26/08/2022.
[11] https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf

Oblast. However, ultimately some incidents within this initial list were not investigated due to the limited analysis capacity. Priority was given to the investigation of incidents which were more likely to indicate a direction of origin of munitions, i.e., they contained imagery or footage of rocket cargo sections or motors.

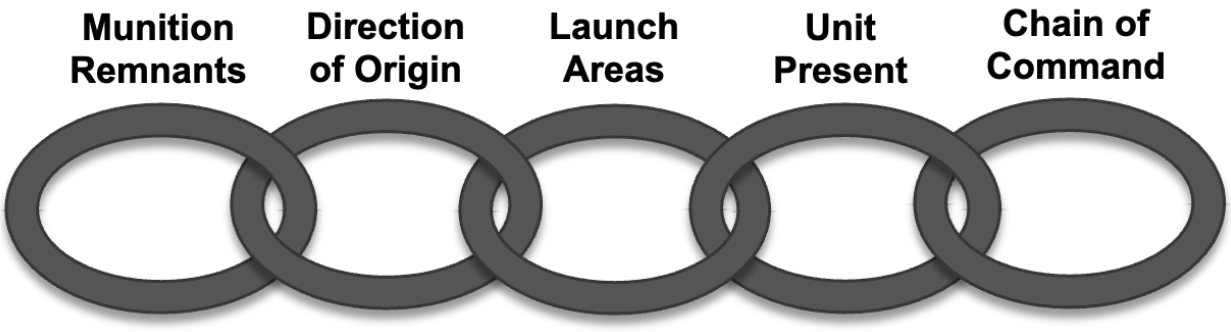
As a result, 32 incidents from the Civilian Harm Database were analysed by the J&A Unit. Of these 32 incidents:

- Two were identified as being a result of BM-21 Grad fire;
- Five were identified as being the result of attacks using BM-27 Uragan;
- 24 were identified as being the result of attacks using BM-30 Smerch or Tornado-S;
- One incident remains undetermined.

The identification of the weapon remnants in question represented a significant linkage opportunity. ‘Linkage’ is the term commonly used to link an attack to its perpetrator, whether at the level of an individual, unit or party to the conflict. The more specific linkage can be, the higher utility for criminal prosecutions. The two incidents of BM-21 Grad use would be unlikely to provide any useful linkage information, due to the large number of units, both Russian and Ukrainian, using these systems. The five incidents of 9M27K use could provide some information in relation to their use during the battle of Kharkiv, but did not represent a particularly large dataset.

As such, a decision was made to focus on the analysis on the 24 incidents in which Smerch/Tornado-S were used. The relatively large number of incidents, as well as the small number of military units able to use this system, meant that analysis of Smerch/Tornado-S attacks was much more likely to yield useful information, such as the identification of the unit responsible for each attack.

This analysis focused on building a chain, linking munition remnants in the attacks to the areas from which they were launched, to the unit which was in that area, to the people ultimately in command of that unit.



# II. Context of the Kharkiv Axis

The city of Kharkiv is the second largest city in Ukraine with a pre-full scale invasion population of almost 1.5 million. It is located in the north-east of Ukraine, about 30 km from the border with Russia. Together with its outskirt districts and nearby towns, it forms the Kharkiv agglomeration with a population (prior to Russia's full-scale invasion) of over two million people[12]. The city is a large industrial, scientific and cultural centre, and was the second largest military production complex after Kyiv.

Russia's full-scale invasion began[13] with dozens of missile strikes on cities all over Ukraine, including Kharkiv, before dawn on 24/02/2022. Simultaneously, Russian forces that amassed under the pretext of military exercises along the Ukrainian border in Belgorod Oblast launched a ground attack on Kharkiv Oblast. These forces included[14] the 1st Guards Tank Army, 6th Combined Arms Army and 20th Guards Combined Arms Army from the Western Military District[15], and elements of the 41st Combined Arms Army[16] from the Central Military District. In total, they were reported[17] to have around 20,000 men with hundreds of tanks and armoured vehicles that were supported by rocket and conventional artillery.

[12] https://web.archive.org/web/20220406120543/http://database.ukrcensus.gov.ua/PXWEB2007/ukr/publ_new1/2021/zb_chuselnist%202021.pdf
[13] https://www.bbc.com/news/world-europe-60506682
[14] https://www.understandingwar.org/backgrounder/russia-ukraine-warning-update-initial-russian-offensive-campaign-assessment
[15] https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-march-5
[16] https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-april-1
[17] https://www.pravda.com.ua/eng/articles/2023/10/19/7424751/

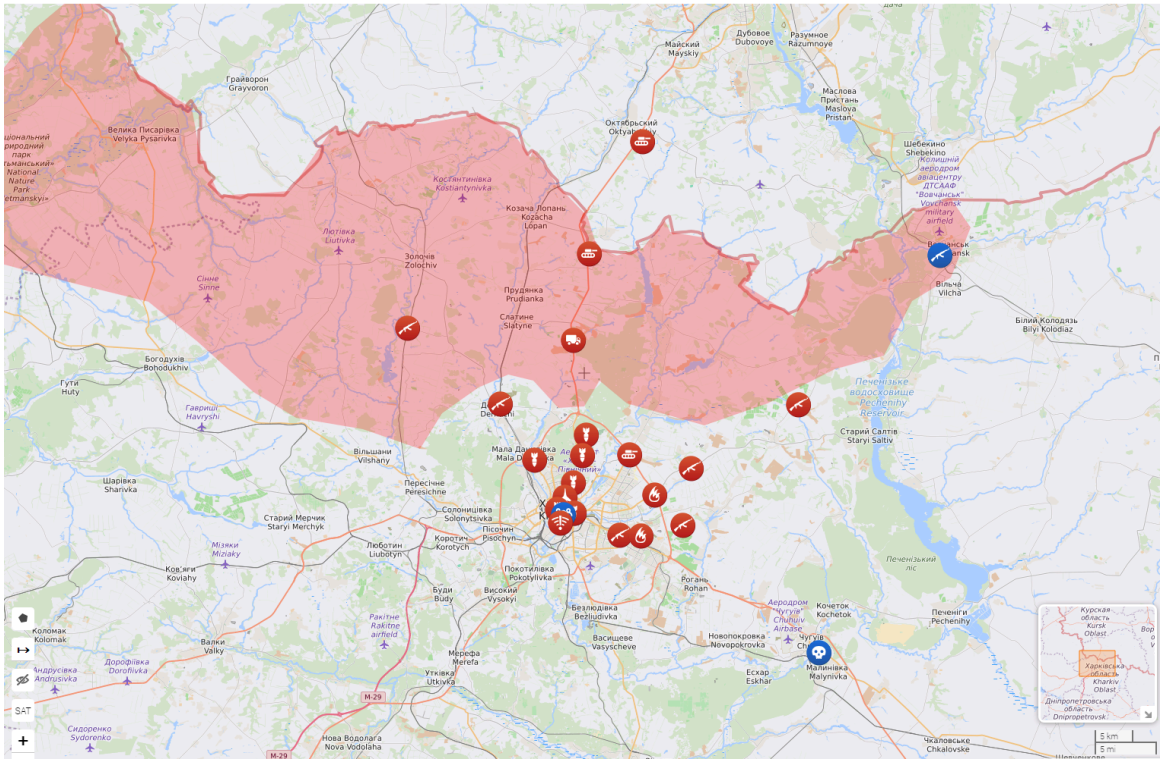



*Image 1: Liveuamap[18] as of 24/02/2022 showing the areas under control of Russian troops (marked in red) as well as particular locations of shelling impacts and clashes (marked with red and blue circles).*

On 24/02/2022, the governor of Kharkiv Oblast reported[19] that Russian forces had attacked both the oblast and the city of Kharkiv from the directions of Sumy, Derhachi, Vovchansk and Kupyansk, but had been repelled by Ukrainian forces.

Later, on 25/02/2022, after regrouping and conducting a substantial artillery and air bombardment of the outskirts of the city, Russian troops tried to break through Pyatihatky,[20] through which there is a direct route to the centre of Kharkiv. This Russian convoy[21] was attacked and successfully stopped by the Ukrainian forces within the village.

27/02/2022 was a turning point in the city's defence. A Russian column of "Tigr" armoured vehicles and several KAMAZ trucks entered Kharkiv via Oleksiivka and advanced to the central part of the city. Residents of Kharkiv posted videos[22] of the Russian military's movements on social networks. This convoy was stopped and, after a battle, destroyed[23] by Ukrainian forces.[24]

[18] https://liveuamap.com/en/time/23.02.2022
[19] https://www.facebook.com/100044020894667/videos/4244792838956867/
[20] https://www.radiosvoboda.org/a/kharkiv-viyna-lyutyy-2022/32284813.html
[21] https://www.youtube.com/watch?v=1XuwcRQqdPY
[22] https://www.youtube.com/watch?v=S3kvkyF8Kqc
[23] https://www.newsflare.com/video/480880/ukrainian-troops-examine-destroyed-russian-convoy-in-kharkiv-on-day-4-of-war?origin=februarythe
[24] https://www.washingtonpost.com/world/2022/02/28/kharkiv-ukraine-russia-war-east/

A key to success[25] on the Ukrainian part was the society's mobilization and combat cooperation between all armed formations, both state and volunteer.

Having failed to enter the city directly by land, the Russian military intensified strikes on Kharkiv using cluster and incendiary munitions, as well as aviation. This combined artillery bombardment affected the civilian population, spreading fear and panic. Large numbers of buildings, including medical facilities, schools, universities, churches and administrative buildings were damaged and destroyed. Critical civilian infrastructure, such as gas mains and water pipelines, electricity lines and communication towers were severely damaged, and hundreds of civilians were wounded or killed. The city was on the verge of humanitarian catastrophe[26], and the majority of its population fled[27] during the first weeks of invasion.

By early April Russian troops had completely withdrawn[28] from Kyiv, Chernihiv and Sumy oblasts, but continued to maintain pressure on Kharkiv as one of its key objectives. On 19/04/2022, both the Ukrainian and Russian officials announced the start of a new phase[29] of Russian operations. This was characterised[30] by continued artillery and air bombardment, but limited offensive ground operations by Russian forces compared to initial phases in the fighting. Parts of the city remained[31] under heavy bombardment,[32] including use of cluster munitions,[33] until May 2022 when the Russian forces were pushed further away from the city's border. By 14/05/2022, Ukrainian forces had succeeded[34] in preventing the Russian military from encircling or seizing Kharkiv, and had forced their retreat[35] from the city.

The Ukrainian forces continued[36] to make steady, albeit slow[37] progress in areas around Kharkiv, and the frontline remained relatively unchanged until September 2022. On 02/09/2022, Ukrainian forces carried out a rapid and successful offensive[38] in Kharkiv Oblast, and liberated

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25 https://www.researchgate.net/publication/373620973_Stratagems_of_the_Ukrainian_and_Russian_troops_in_the_battles_for_Kharkiv_February_24_-_May_14_2022/fulltext/64f34749fa851147de0c3183/Stratagems-of-the-Ukrainian-and-Russian-troops-in-the-battles-for-Kharkiv-February-24-May-14-2022.pdf?origin=publication_detail&_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uRG93bmxvYWQiLCJwcmV2aW91c1BhZ2UiOiJwdWJsaWNhdGlvbiJ9fQ&__cf_chl_tk=kYltooesKC_UfqxdxQMEUI1GBHGnTIgjy1tLiRjmc.Q-1736413850-1.0.1.1-SLIJBojrqjQo.aGR5T05up8.V1ZZxQFkkbKnLXv.SB8

26 https://www.hrw.org/news/2022/03/07/under-shelling-kharkiv#:~:text=Most%20of%20its%20population%20of,people%20remain%20in%20the%20city.

27 https://www.nytimes.com/interactive/2022/05/19/magazine/kharkiv-siege.html

28 https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-april-1

29 https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-april-19

30 https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-may-1

31 https://www.amnesty.org/en/latest/research/2022/06/anyone-can-die-at-any-time-kharkiv/

32 https://www.amnesty.org/en/latest/news/2022/04/ukraine-russias-cruel-siege-warfare-tactics-unlawfully-killing-civilians-new-testimony-and-investigation/

33 https://www.hrw.org/news/2023/05/29/cluster-munition-use-russia-ukraine-war

34 https://www.understandingwar.org/backgrounder/russian-offensive-campaign-assessment-may-14

35 https://www.theguardian.com/world/2022/may/14/ukraine-has-won-the-battle-of-kharkiv-analysts-say-as-kyiv-warns-of-long-phase-of-war

36 https://www.britannica.com/place/Kharkiv-Ukraine

37 https://www.youtube.com/watch?v=_H8KF3i2iBU

38 https://www.britannica.com/event/2022-Russian-invasion-of-Ukraine/The-Ukrainian-counterattack

more than 8800 square km$^2$ within a week. Izyum, which had fallen to the Russians in April and served as a strategic supply hub, was recaptured on 10/09/2022, and by the time the Ukrainian advance slowed, almost the entirety of Kharkiv Oblast had been liberated.

## Use of Cluster Munitions on Kharkiv

In early March 2022, Amnesty International reported[39] on "*a broad pattern of unlawful indiscriminate attacks across populated areas in Kharkiv*", which included attacks with cluster munitions. The exact number of cluster munition attacks[40] during 2022-2023 in Ukraine as a whole is not known, but hundreds have been documented, reported, or credibly alleged, mostly in populated areas. Kharkiv Oblast was only one of the Ukrainian regions affected by such attacks. At least ten of the country's 24 oblasts were affected by the use of cluster munitions: Chernihiv, Dnipropetrovsk, Donetsk, Kharkiv, Kherson, Luhansk, Mykolaiv, Odesa, Sumy, and Zaporizhzhia.

In May 2023, Human Rights Watch reported[41] that the Russian military's use of cluster munitions had caused hundreds of civilian casualties, damaged civilian objects, including homes, hospitals and schools, and civilian infrastructure. "*Cluster munitions are weapons that can be delivered by rockets, missiles, and aircraft. They open in mid-air and disperse dozens and even hundreds of smaller submunitions, also called bomblets, over an area the size of a city block. Many submunitions fail to explode on initial impact, leaving duds that act like landmines, posing a threat to civilians for years and even decades*."

It is not possible to portray an exact picture of the damage and casualties resulting from cluster munitions solely using open sources. However, since the very early days of the war, organisations such as the United Nations, Amnesty International, Human Rights Watch and Airwars have examined the use of cluster munition in Ukraine, and in Kharkiv.

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[39] https://www.amnesty.org/en/latest/news/2022/04/ukraine-russias-cruel-siege-warfare-tactics-unlawfully-killing-civilians-new-testimony-and-investigation/

[40] https://www.hrw.org/sites/default/files/media_2023/05/UkraineCM_Briefing_May2023_final.pdf

[41] https://www.hrw.org/news/2023/05/29/cluster-munition-use-russia-ukraine-war



*Image 2: Uragan missiles used by the Russian army in Kharkiv, Ukraine displayed by Ukrainian military, 21/10/2022 (Credit: REUTERS/Clodagh Kilcoyne).*

For example, Airwars examined one incident on 25/02/2022 in which cluster munitions struck[42] Kharkiv Children's Hospital and a blood donation center, killing one person and injuring at least three others.

On 28/02/2022, three MLRS salvos, including 9N235 submunitions deployed using BM-30 Smerch, struck the northern part of the city killing at least nine civilians,[43] including children, and wounding at least another 18.

Kharkiv's Saltivka district was repeatedly targeted during the siege of the city. Over the first two weeks of the full scale war, Amnesty International's Crisis Evidence Lab verified[44] 22 incidents in this district alone, showing damage to civilian areas including schools, residential blocks, food markets, and a tram depot, between 27/02/2022 and 16/03/2022 February (see the Amnesty International map below). Photos from strikes depicted[45] remnants of Smerch rockets and cluster munitions across the area.

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[42] https://airwars.org/investigations/anatomy-of-a-russian-cluster-munition-strike-explainer/
[43] https://airwars.org/investigations/anatomy-of-a-russian-cluster-munition-strike-explainer/
[44] https://www.amnesty.org/en/latest/news/2022/04/ukraine-russias-cruel-siege-warfare-tactics-unlawfully-killing-civilians-new-testimony-and-investigation/
[45] https://airwars.org/investigations/anatomy-of-a-russian-cluster-munition-strike-explainer/

**Documentation of damage to residential areas of Saltivka, Kharkiv as verified by Amnesty International**




*Image 3.*

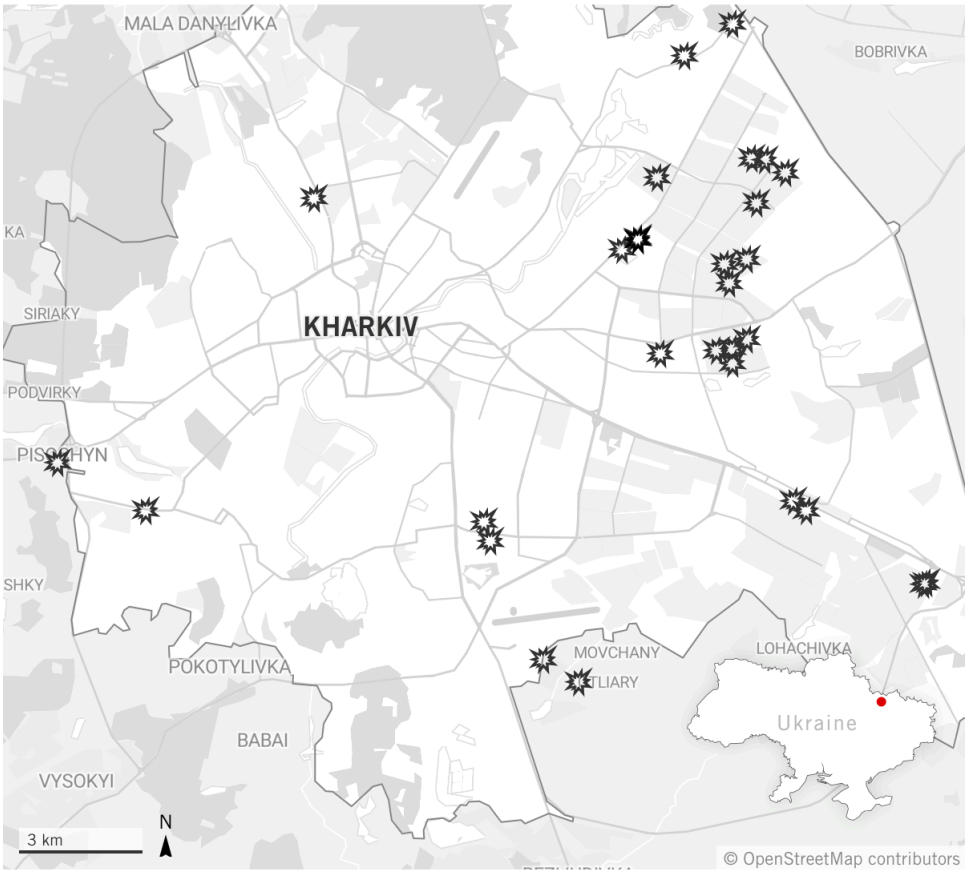
During April and May 2022, Amnesty International investigated[46] 41 strikes which killed at least 62 people and injured at least 196, and interviewed 160 people in Kharkiv, including survivors, relatives of victims, witnesses, and doctors (see the Amnesty International map below). These strikes included a widespread use of 9N210/9N235 cluster munitions and scatterable mines, as well as inaccurate systems such as Grad rockets.

46

https://www.amnesty.org/en/latest/news/2022/06/ukraine-hundreds-killed-in-relentless-russian-shelling-of-kharkiv-new-investigation/

## Strikes Which Killed And Injured Civilians In Kharkiv, Ukraine

The damage was verified by Amnesty International via site visits and open source investigations




Map: 13 June 2022 • Source: Amnesty International

*Image 4.*

The severity and widespread nature of these attacks using cluster munitions in urban areas suggested a pattern of use. As such the J&A Unit began collecting, verifying and analysing open source content related to cluster munition attacks in Kharkiv, with the intent to understand this campaign as fully as possible.

# III. Munition Remnants




The J&A Unit investigated 32 incidents which were identified within the Civilian Harm Database as being a result of cluster munitions within Kharkiv Oblast. After investigation, 24 were identified as likely being a result of missiles fired by Smerch or Tornado-S.

Each one of these incidents was investigated using the Methodology, resulting in a set of standardised open source incident reports. These reports placed the content depicting the incident in time and space, comparing the incidents against reference materials such as satellite imagery and other open sources, ultimately verifying this open source content to the point where it could be relied upon for analysis.

| No. | Incident Code | Reported Date | Launch System Identified |
|---|---|---|---|
| 1 | CIV0018 | 25/02/2022 | Smerch/Tornado-S |
| 2 | CIV0019 | 25/02/2022 | Smerch/Tornado-S |
| 3 | CIV0460 | 25/02/2022 | Smerch/Tornado-S |
| 4 | CIV0031 | 25/02/2022 | Smerch/Tornado-S |
| 5 | CIV0450 | 27/02/2022 | Smerch/Tornado-S |
| 6 | CIV0242 | 27/02/2022 | Smerch/Tornado-S |
| 7 | CIV0266 | 27/02/2022 | Smerch/Tornado-S |
| 8 | CIV0463 | 28/02/2022 | Smerch/Tornado-S |
| 9 | CIV0082 | 28/02/2022 | Smerch/Tornado-S |
| 10 | CIV0097 | 28/02/2022 | Smerch/Tornado-S |
| 11 | CIV0093 | 28/02/2022 | Smerch/Tornado-S |
| 12 | CIV0464 | 28/02/2022 | Smerch/Tornado-S |
| 13 | CIV0091 | 28/02/2022 | Smerch/Tornado-S |
| 14 | CIV0083 | 28/02/2022 | Smerch/Tornado-S |
| 15 | CIV0075 | 28/02/2022 | Smerch/Tornado-S |
| 16 | CIV1907 | 28/02/2022 | Smerch/Tornado-S |
| 17 | CIV0077 | 28/02/2022 | Smerch/Tornado-S |
| 18 | CIV1655 | 28/02/2022 | Smerch/Tornado-S |
| 19 | CIV0195 | 03/03/2022 | Smerch/Tornado-S |
| 20 | CIV0244 | 03/03/2022 | Smerch/Tornado-S |
| 21 | CIV0761 | 04/03/2022 | Uragan |
| 22 | CIV0213 | 06/03/2022 | Not Known |

| | | | |
|---|---|---|---|
| 23 | CIV0336 | 12/03/2022 | Smerch/Tornado-S |
| 24 | CIV0372 | 15/03/2022 | Uragan |
| 25 | CIV0465 | 20/03/2022 | Smerch/Tornado-S |
| 26 | CIV0497 | 22/03/2022 | Grad |
| 27 | CIV0522 | 22/03/2022 | Smerch/Tornado-S |
| 28 | CIV0533 | 24/03/2022 | Uragan |
| 29 | CIV0556 | 25/03/2022 | Uragan |
| 30 | CIV0656 | 01/04/2022 | Grad |
| 31 | CIV0862 | 05/04/2022 | Smerch/Tornado-S |
| 32 | CIV0798 | 15/04/2022 | Uragan |

In many of these incidents, munition remnants were identifiable as having been fired from Smerch, such as the 9M55K missile. The 9M55K missile consists of several different components. These include a rocket motor, a cargo section, and a cargo section which contains the sub-munitions.

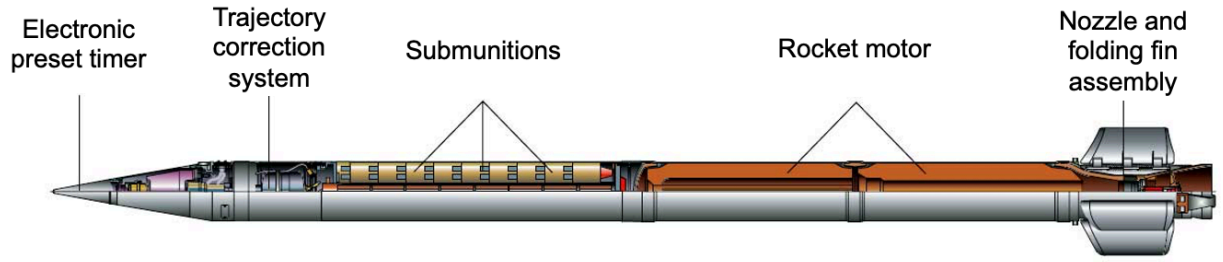



*Image 5: Cross section of a 9M55K (Credit: Missilery[47]).*

The standard version of the 9M55K carries 72 unguided fin-stabilised high-explosive fragmentation (HE-Frag) submunitions, which are highly effective against soft skin and lightly armoured targets. This 300 mm rocket has an overall length of 7.6 m and a launch weight of 800 kg and has a minimum range of 20 km and a maximum range of 70 km. The submunitions weigh 1.75 kg and are fitted with a self-destruct mechanism that operates after a period of 110–160 seconds.[48]

When a 9M55K rocket is fired, it reaches a pre-set altitude before the cargo section and the rocket motor separate. After this occurs, the two sections continue on their trajectories. Once the cargo section reaches a pre-set altitude it then releases its sub-munitions above the target area. The submunitions impact the ground in a rough oval shape. The cargo section and rocket motor continue and impact the ground past the sub-munitions, with the rocket motor usually going further due to its greater mass.[49]

[47] https://en.missilery.info/missile/smerch/9m55k
[48] Senior ex-military satellite imagery expert.
[49] Interview with the artillery expert Petro Pyatakov Col (ret) on 26/08/2022.

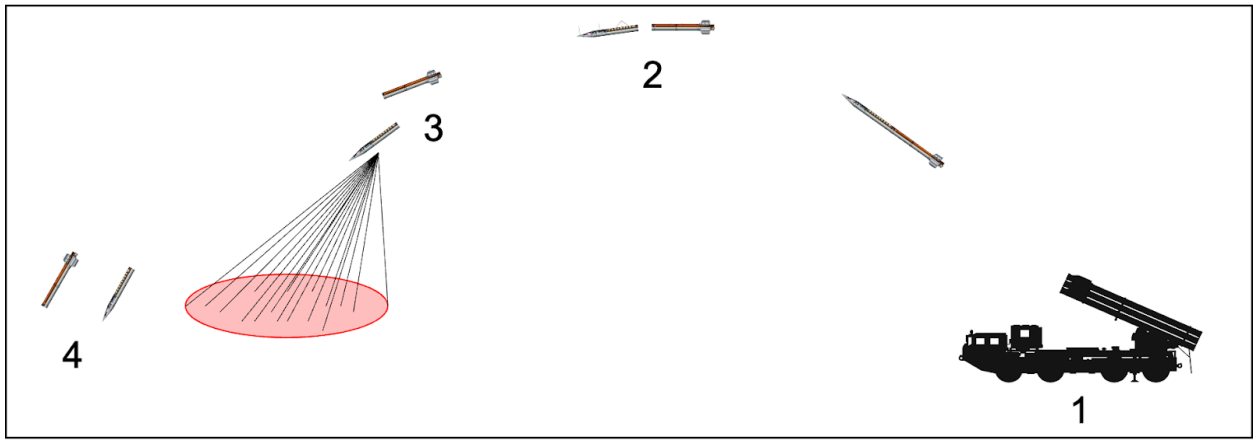



*Image 6: Graphic showing the launch (1), separation of cargo section and rocket motor (2), release of submunitions (3) and impact of cargo section and rocket motor (4).*

Advice from experts indicated that the orientation of the rocket motors and cargo sections after impact can indicate the direction from which the munition originated.




*Image 7: Two examples of rocket motors after impact in Kharkiv (Credit from left to right: Voynareal[50], Nexta[51]).*

[50] https://t.me/voynareal/10891
[51] https://t.me/nexta_live/17149

Due to the way a 9M55K missile operates, the direction from which it originated can be ascertained in several ways, which included:

1. Aligning[52,53] the rocket motor, cargo section and impact of submunitions.
2. Measuring the direction in which the rocket motor or cargo section are pointing.[54]

## Caveats

None of these methods are exact. For example, once the cargo section and rocket motor separate, they are no longer as aerodynamic as when they are connected. This means that they will not necessarily point back exactly towards their point of origin. Another complication is that sometimes the force of torque during impact would bend a rocket motor forward. While this adds complicating factors, it would result in a bend pointing roughly 180 degrees away from the direction it arrived from.

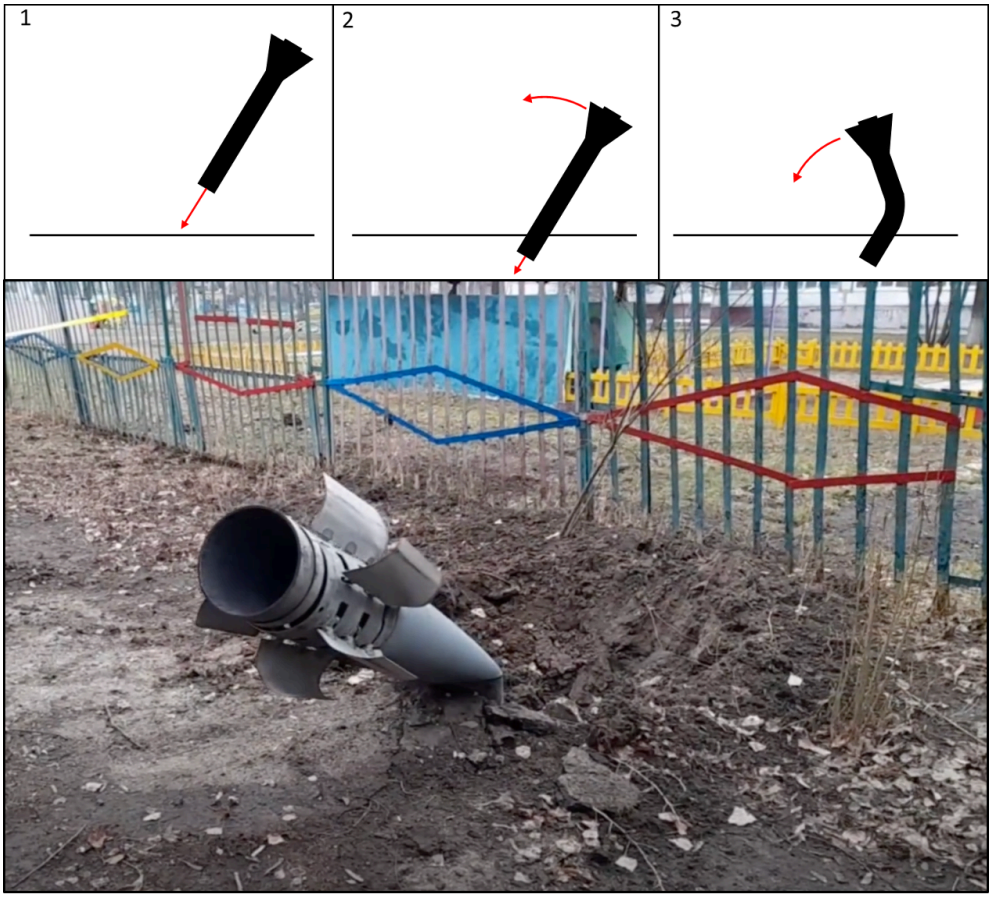



*Image 8: Top: A simplified graphic demonstrating how a rocket motor could bend on impact. Bottom: An example of such an impact in Kharkiv (Source: Redacted).*

[52] https://www.bellingcat.com/news/2023/01/27/anatomy-of-a-shelling-how-russian-rocket-artillery-struck-mykolaiv/
[53] Interview with the artillery expert Petro Pyatakov Col (ret) on 26/08/2022.
[54] Interview with the artillery expert Petro Pyatakov Col (ret) on 26/08/2022.

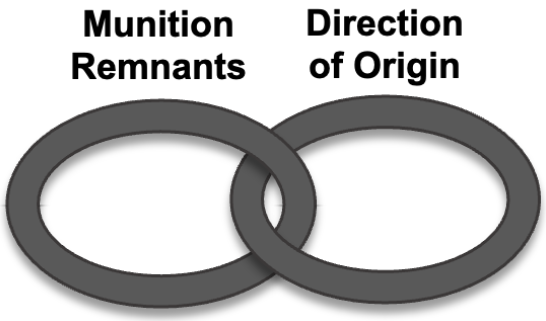
These factors can be mitigated to a certain extent if it is possible to take measurements from multiple motors or cargo sections, and the measurements used in aggregate. Within the 24 incidents investigated using the Methodology, we identified 22 munition remnants for which it was possible to ascertain a direction of origin. Not every remnant was associated with a separate incident; in some cases, only submunitions or their effects were observed, while in others, multiple remnants appeared close together.

Some groups of incidents were assessed as potentially comprising one cluster munition attack or barrage, for example where the submunition impacts and the rocket motor or cargo section were geolocated and chronolocated to the same trajectory and time frame. This is detailed below in Groupings.

However, even with confidence that the orientation of a rocket motor or cargo section is a material piece of information, a separate challenge remained: how accurate could an open source analyst be when assessing which direction a rocket motor or cargo section was pointing when using only open source images or videos? How could this uncertainty be expressed when presenting such an assessment?

In order to answer those questions, two experiments were conducted to measure the accuracy of analysts making such assessments, which are outlined below.

# IV. Direction of Origin




In order to assess the direction in which a cargo section or rocket motor pointed, it was first necessary to assess how accurate an open source analyst could be when judging the direction in which a rocket motor pointed, using only open source imagery, such as an image or a video. This question is not one of military knowledge, but rather of spatial intelligence: in order to assess the direction, the analyst must visualise the orientation of the rocket motor in reference to the space surrounding it. This requires the same skill set used for the task of geolocating, a task which the J&A Unit considers within its expertise.

To understand how accurate an open source analyst would be when conducting this type of assessment, two experiments were conducted. The first consisted of a proof of concept, establishing if the accuracy of this kind of assessment could be reliably predicted. The second consisted of a more robust experiment to test that proof of concept.

Both of these experiments consisted of presenting a group of open source analysts with imagery of a tubular object and asking them to make an assessment of the direction in which it pointed.

## Experiment 1: Proof of Concept

In order to test the accuracy of such assessments, investigators were given images and videos of tubes (simulating cargo sections and rocket motors) embedded in the ground and asked to assess the direction in which these objects pointed. The investigators made directional assessments by examining the images and videos, and then measuring this angle of this assessed direction using the line measuring tool in Google Earth Pro.



*Image 9: Example of one of the images used for the proof of concept assessment. Note the tube placed in the ground.*

The test involved six investigators from the J&A Unit and 25 examples, resulting in 150 data points. The data from this test was then gathered and collated on a graph where the x-axis is the difference between the assessed bearing and the actual bearing, and the y-axis is the relative probability of that answer. This resulted in a histogram that can be approximated by the normal distribution, i.e. a bell curve.

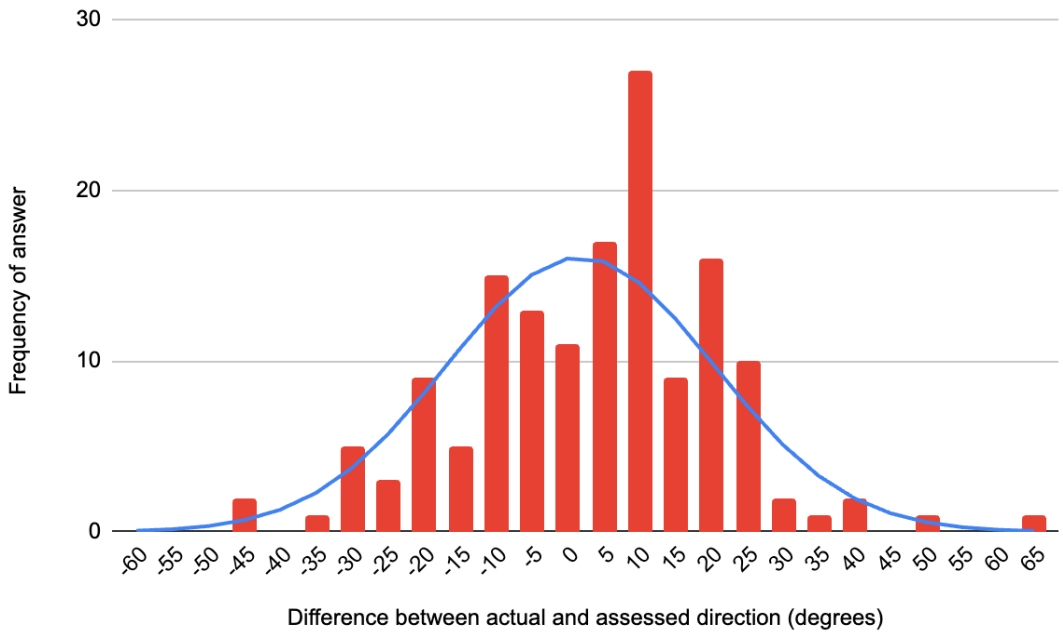



*Image 10.*

The data showed a mean difference of 1.8 degrees between the assessed and actual bearings, indicating little bias towards one direction or the other. The standard deviation was calculated to be 18.6 degrees. 95% of values drawn from a normal distribution will fall within two standard deviations of the mean, or 37.2 degrees from 0.

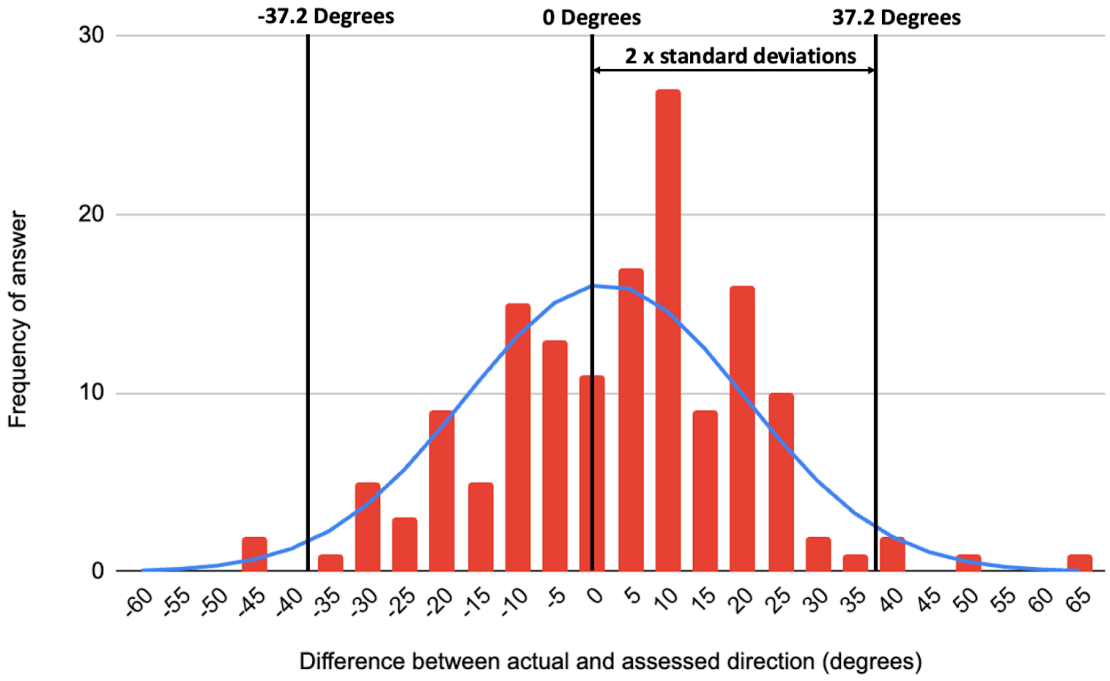



*Image 11.*

From this experiment, a standardized arc template for Smerch rockets was developed. This template helped investigators assess the direction of origin based on the geolocation and spatial indicators of the rocket remnant. The arc represents the possible area of origin, with the likelihood, and therefore the intensity of red shading, increasing towards the center. The angle of the template is 74.4 degrees and extends up to 70 km, with a 20 km minimum range, reflecting the stated minimum and maximum range[55] of Smerch.

This arc was applied by placing the “point of impact” over the location where the cargo section or rocket motor landed, and then aligning the “center of arc” with the assessed direction of origin.

[55] https://missilery.info/missile/smerch

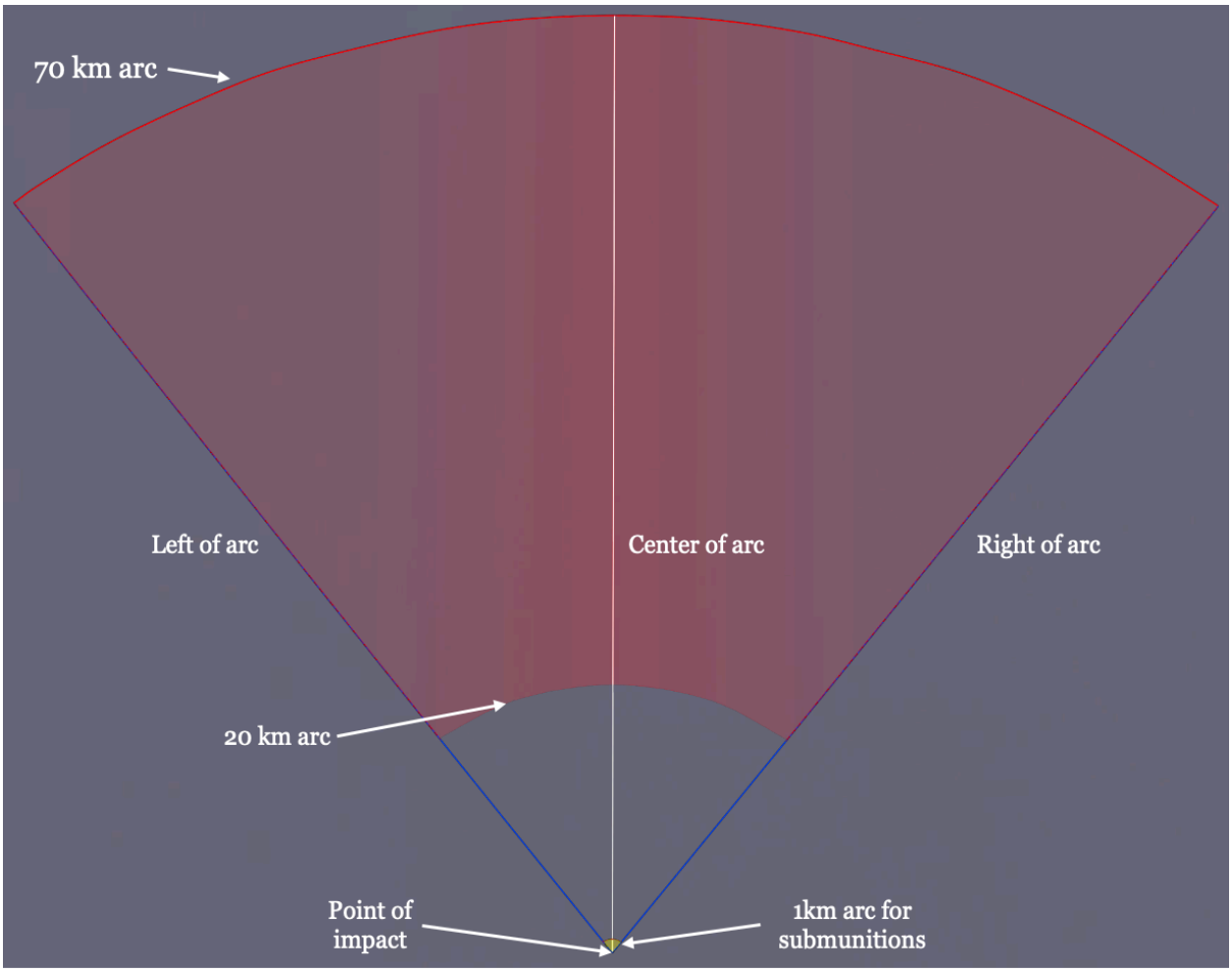



*Image 12: Area of origin arc developed as a result of the direction of origin proof of concept.*

It should be stressed that, while this arc has an angle of 74.4 degrees to include 95% of assessments made by the investigators, the experiment showed that investigators would only occasionally identify a bearing that was significantly inaccurate. The majority of the answers tended to point towards the actual direction the object was pointing at.

## Experiment 2: Confirmation of Concept

While the proof of concept was sufficient to demonstrate that this kind of assessment was feasible, it was decided to repeat this experiment with a more robust methodology and using an object that was closer to the dimensions of an actual 9M55K missile.

To that end, a model of a 9M55K rocket motor was constructed from a cylindrical metal duct with the same diameter of 300 mm. This duct came in three sections, allowing the length to be adjusted as required. On one of these sections six fins were added, reflecting those seen on a Smerch missile.



*Image 13: Left: Example of a 9M55K rocket motor from Kharkiv. Right: Model used for the confirmation of concept.*

This test involved seven investigators and 24 examples, resulting in 168 data points. The data from this test was then gathered and collated on a graph where the x-axis is the difference between the assessed bearing and the actual bearing, and the y-axis is the relative probability of that answer. As with the proof of concept, this resulted in a histogram that can be approximated by the normal distribution, i.e. a bell curve.

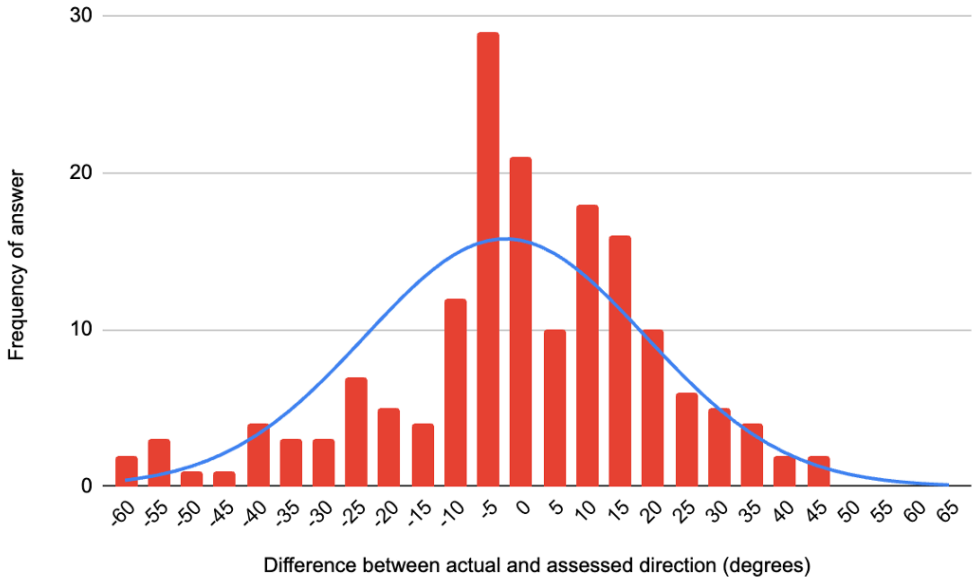



*Image 14.*

The mean of the dataset is -2.3095 degrees, indicating little bias towards one direction or the other. The standard deviation of this distribution is 21.2.

95% of values drawn from a normal distribution will fall within two standard deviations of the mean, or 42 degrees in either direction. This is slightly larger than the direction of origin proof of concept.

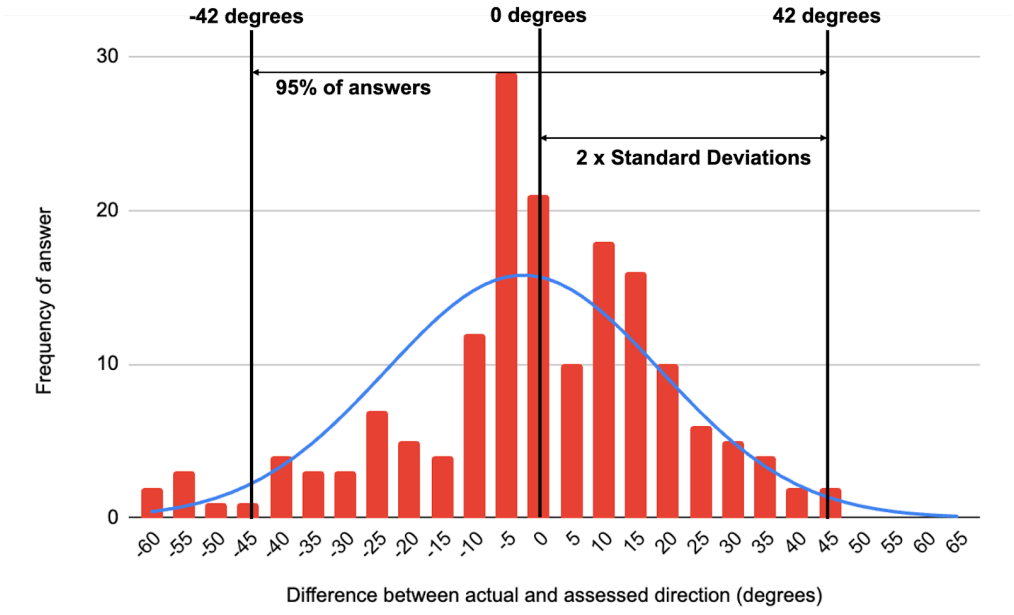



*Image 15: Histogram of results from the direction of origin confirmation of concept, displaying 2x standard deviations.*

While the results from the confirmation experiment differ slightly from the original direction of origin test, the difference was not so much as to invalidate the original direction of origin proof of concept. However, in order to be as thorough as possible, a second arc was developed on the basis of the direction of origin confirmation of concept and applied to all fragments identified in the 32 incident assessments.

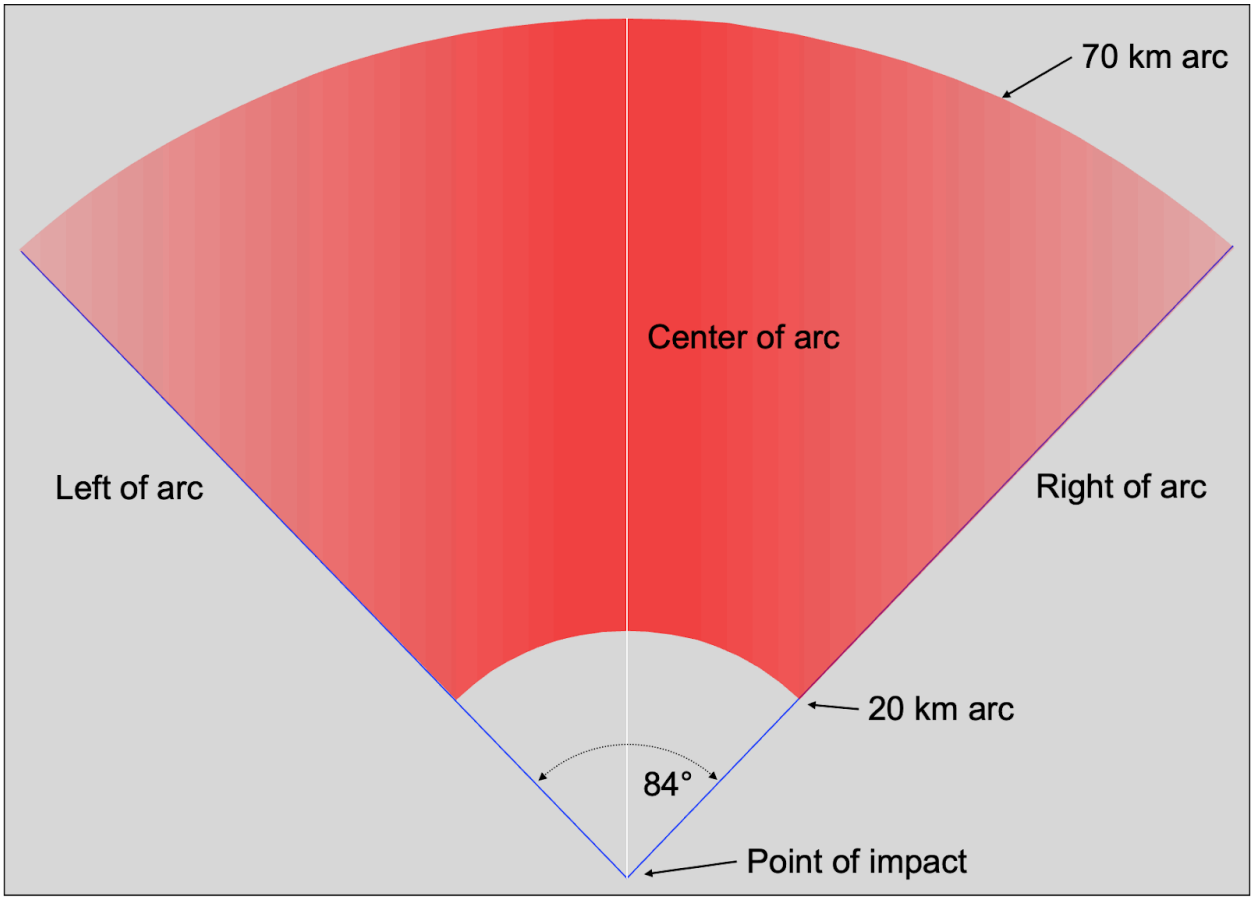



*Image 16: Area of origin arc developed as a result of the direction of origin confirmation of concept*

The full explanation of the confirmation experiment can be seen in Annex III.

The results of the application of this arc can be seen in Chapter V. Identifying Launch Areas.

## Groupings

Within the 32 incidents that were examined, there tended to be two distinct types: the impact of munition remnants, such as rocket motors and cargo sections, and the impact of submunitions. Sometimes several of these incidents occurred in Kharkiv on the same day. However, due to the intensity of shelling, it was not possible to immediately link incidents to each other without significant further analysis.

As the analysis of incidents continued, and the standardised template was applied to munitions remnants, groupings of incidents became identifiable. These groupings generally took the form of rocket motors, cargo sections, and submunitions impacting along a line which was consistent with the direction of origin indicated by the munition remnants.

The fact that these groupings were identified only after each incident had been independently analysed increased the confidence that they were related. In other words, investigators were not working to a “theory” that these incidents would be related, and as such, the J&A Unit mitigated cognitive biases such as confirmation bias in the analysis of the incidents.

**Grouping 1**
**Date:** 25/02/2022
**Incidents:** CIV0018, CIV0019, CIV0031, CIV0035

This grouping, from the day after the full scale invasion commenced, displays a clear relationship between incidents that were analysed independently of one another. In this grouping, submunitions and cargo sections from 9M55K missiles were identified impacting a residential area of Kharkiv.

Further to the south west, two rocket motors were identified which clearly indicated a direction of origin that aligned with the impact of submunitions and cargo sections.[56,57] A third rocket motor was identified as having impacted a building near these other incidents, but it was not possible to accurately identify its direction of origin.[58] The furthest rocket motor landed approximately 3.7 km past the area of impact of the submunitions.

[56] CIV0019
[57] CIV0018
[58] CIV0035

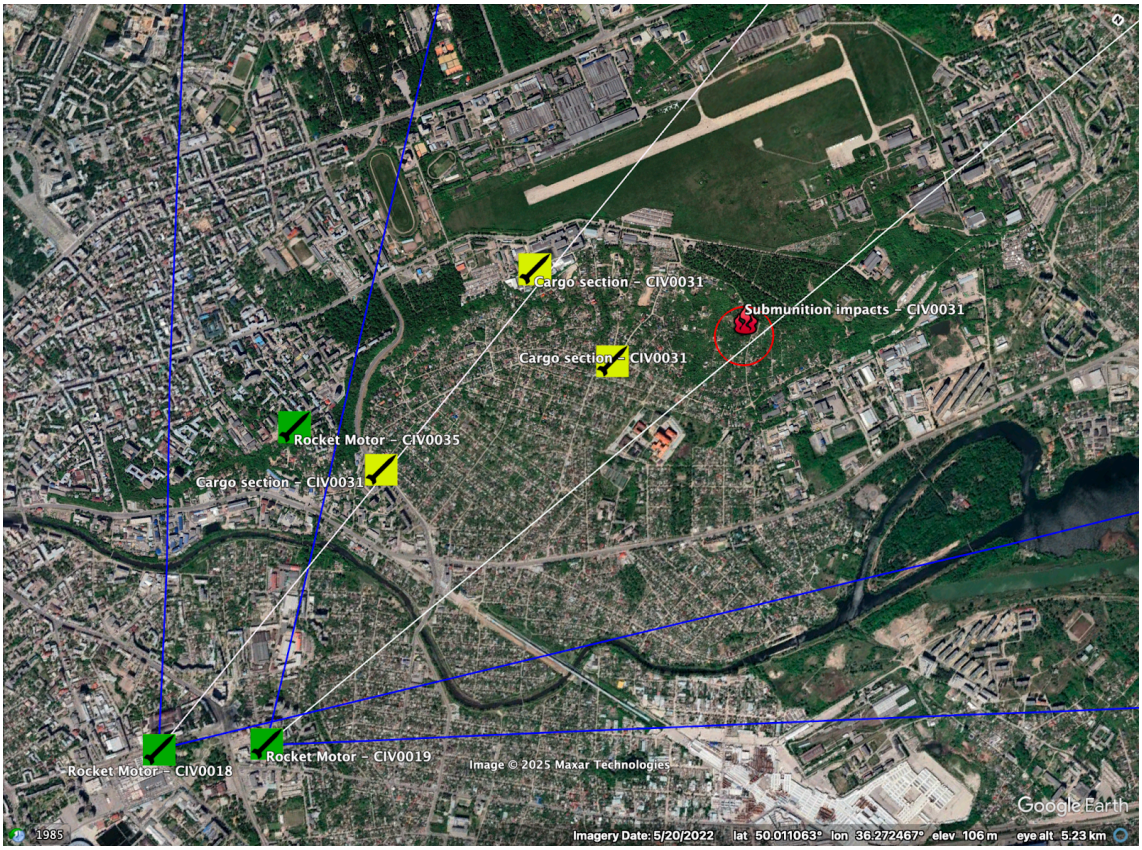



*Image 17: Map depicting the impact of submunitions, munition remnants and their assessed direction of origin in Grouping 1. White lines indicate the assessed directions of origins, while blue lines represent the left and right arcs of the standardised template (Credit: Google/Maxar Technologies).*

In this grouping it appears plausible that the target was the airfield immediately to the north of these incidents. Satellite imagery from 27/02/2022 (below) shows that this airfield displays a large number of small dark marks in the snow, which would be consistent with the impact of a large number of small explosives, such as cluster munitions.

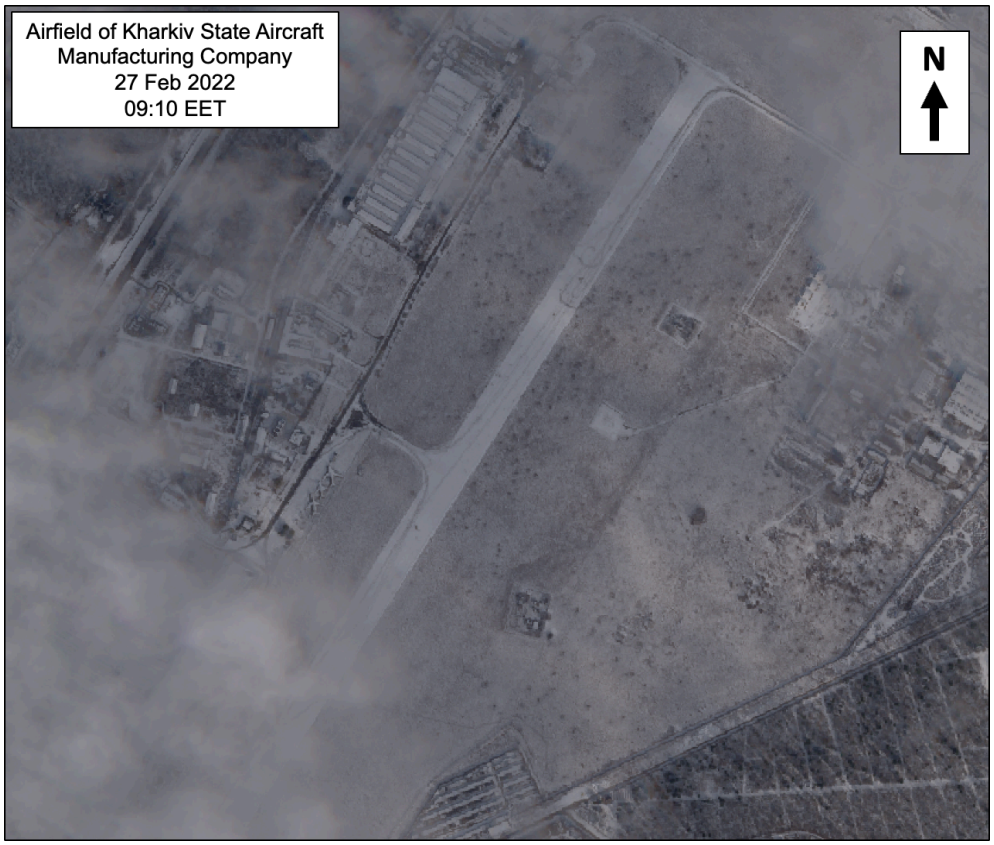



*Image 18: Satellite imagery from 27/02/2022 depicting the airfield (Credit: © 2023 Planet Labs PBC[59]).*

**Grouping 2**
**Date:** 27/02/2022
**Incidents:** CIV0242, CIV0450

In this grouping a partial match was made between two different incidents, one incident with two rocket motors and one with a single rocket motor. These rocket motors were identified within a 60 m radius. In CIV0242 a large fire and damage to a gas pipeline was identified approximately 2.7 km to the north, along the line of assessed directions of origin of two rocket motors, on the 26/02/2022 and 27/02/2022. The rocket motors were first captured on video on 27/02/2022.

While the analysis for CIV0242 initially identified the damage to the pipeline as being unlikely to have been linked to the rocket motors, this was on the basis that they were too distant. However, other groupings have shown that 2.7 km is well within the expected distance between the point of impact of rocket motors and their associated submunitions.

[59] Planet Labs Asset ID: 20220227_071004_ssc19_u0002

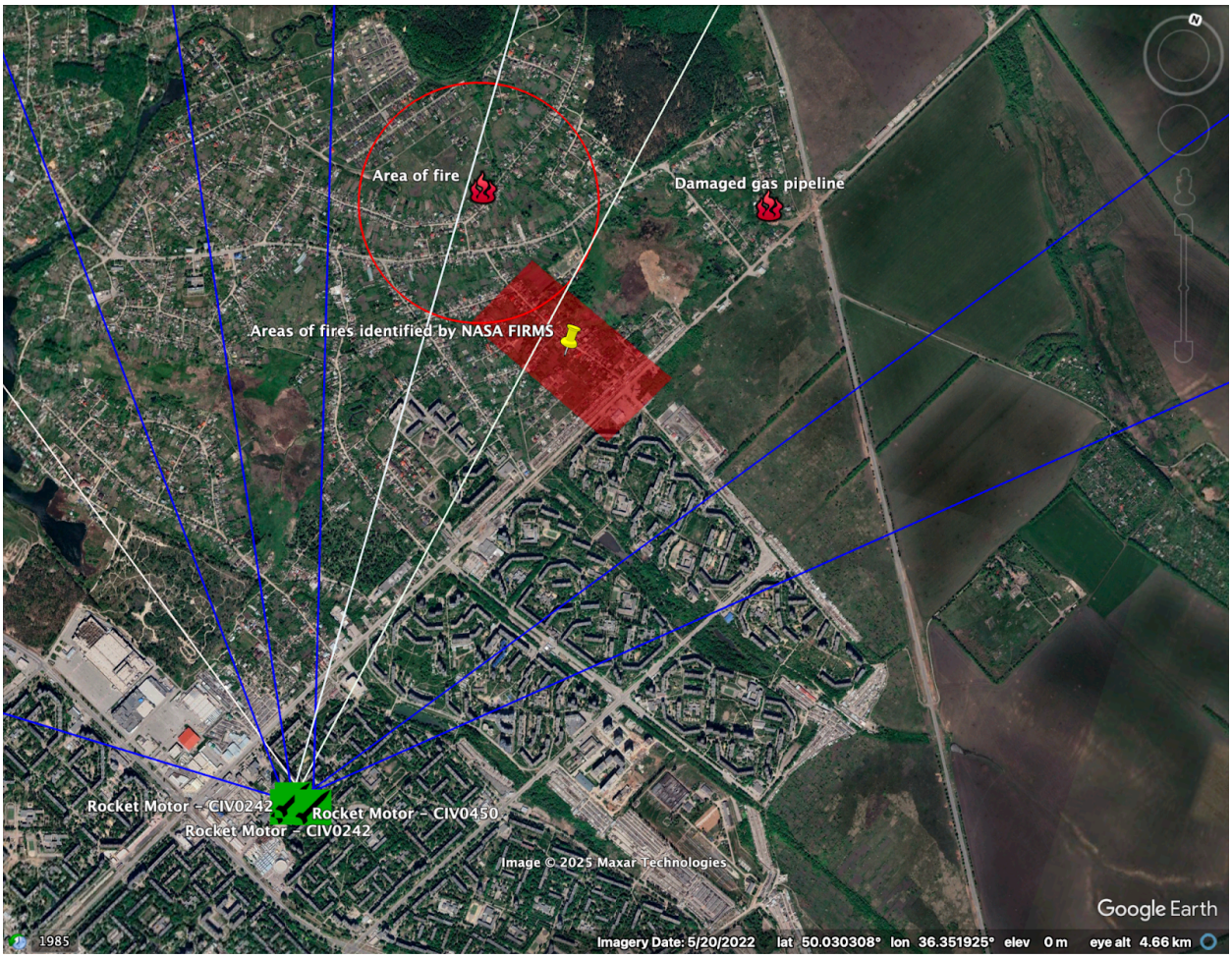



*Image 19: Map depicting the impact of submunitions, munition remnants and their assessed direction of origin in Grouping 2. White lines indicate the assessed directions of origins, while blue lines represent the left and right arcs of the standardised template (Credit: Google/Maxar Technologies).*

**Grouping 3**
**Date:** 28/02/2022
**Incidents:** CIV0082, CIV0083, CIV0463, CIV1907

In this grouping, three rocket motors, one cargo section and the impact of sub-munitions were identified as forming a group, although one of the rocket motors appears to have originated from a slightly different angle. This incident is particularly notable due to CIV0083, which reportedly resulted in the death[60] of four people who were seeking water.

[60] CIV0083

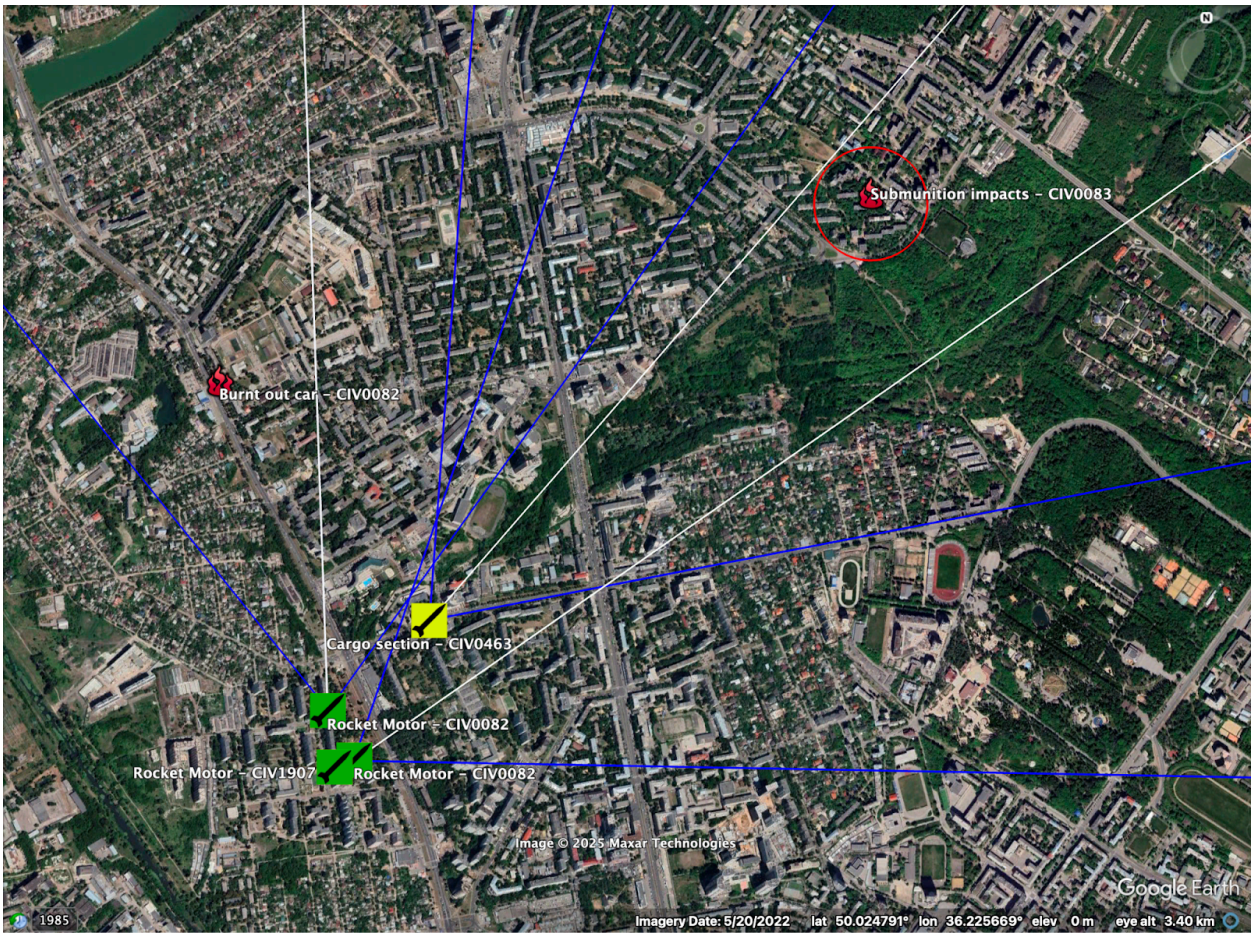



*Image 20: Map depicting the impact of submunitions, munition remnants and their assessed direction of origin in Grouping 3. White lines indicate the assessed directions of origins, while blue lines represent the left and right arcs of the standardised template (Credit: Google/Maxar Technologies).*

**Grouping 4**
**Date:** 28/02/2022
**Incidents:** CIV0075, CIV0077, CIV0093, CIV0464, CIV1655

This grouping resulted in a large number of images and videos depicting these events from multiple angles. Five rocket motors, three cargo sections and the impact of submunitions were caught on video. All the assessed directions of origin were consistent with one another, aligning over the areas where the cargo sections impacted and where the submunitions landed. Notably, the rocket motors landed about 3.5 km past the area the submunitions impacted.

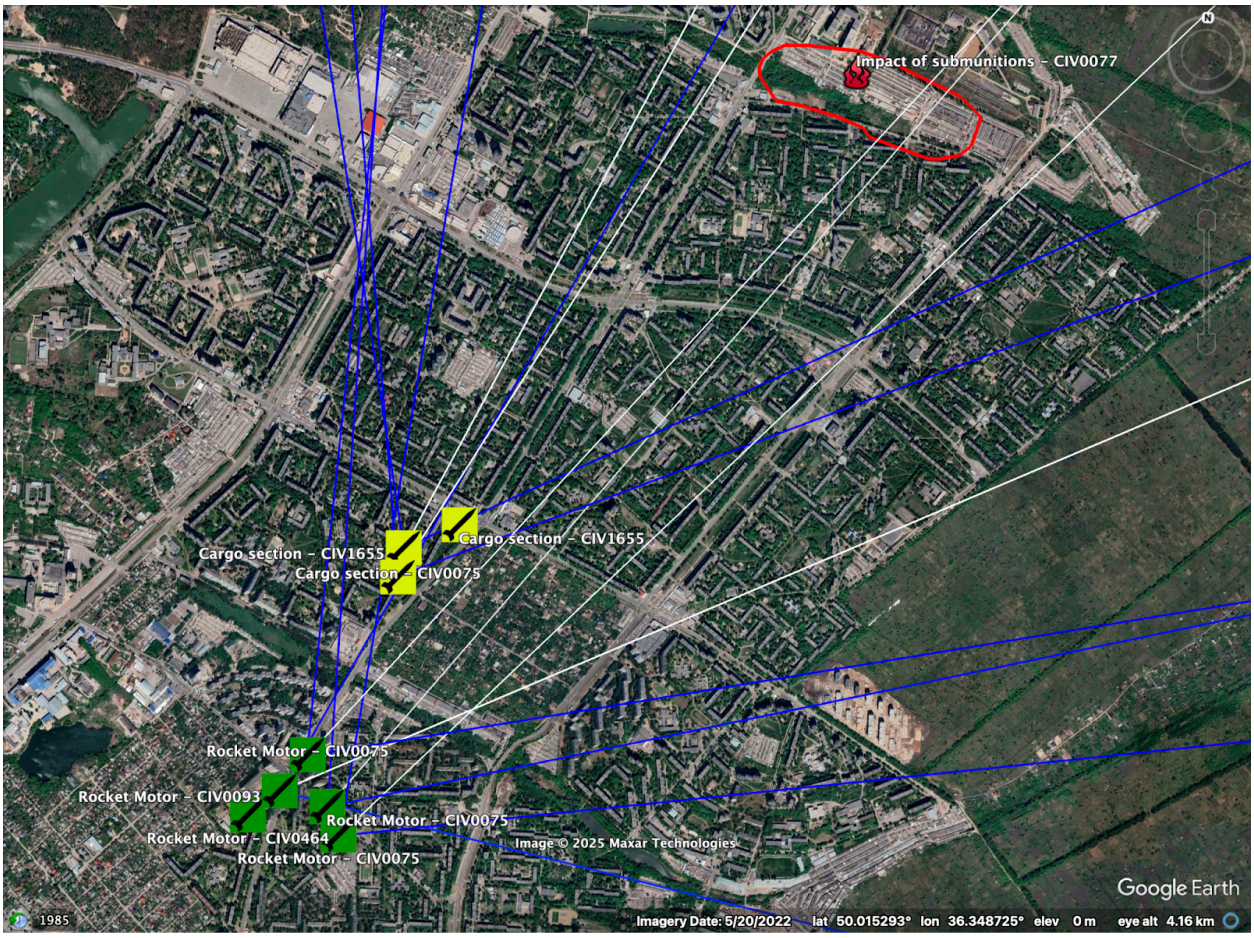



*Image 21: Map depicting the impact of submunitions, munition remnants and their assessed direction of origin in Grouping 4. White lines indicate the assessed directions of origins, while blue lines represent the left and right arcs of the standardised template (Credit: Google/Maxar Technologies).*

**Grouping 5**
**Date:** 03/03/2022
**Incidents:** CIV0244, CIV0195

In this grouping submunitions impacted a residential area. A single rocket motor whose direction of origin appears to align with the impact of these submunitions was identified to the southwest.

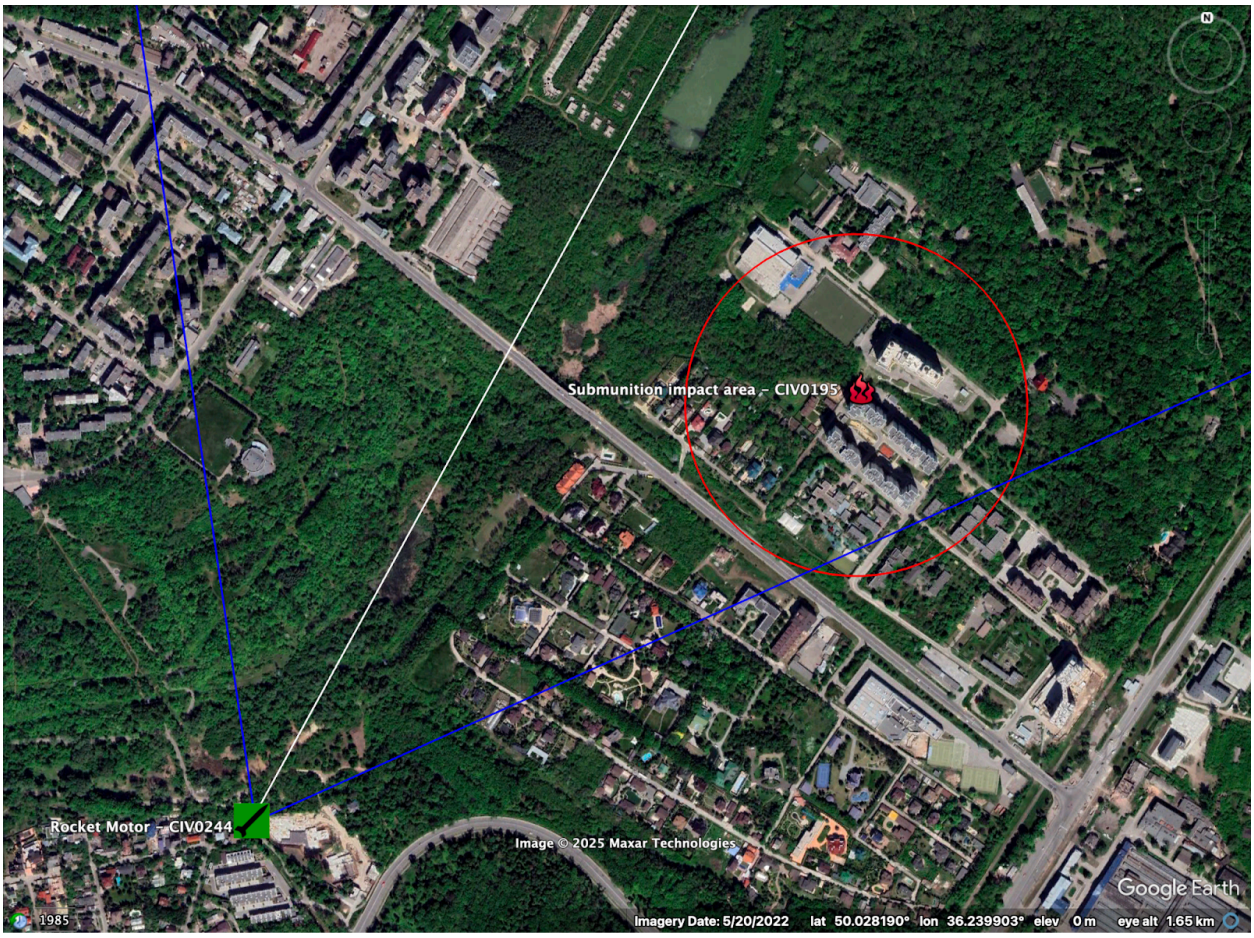
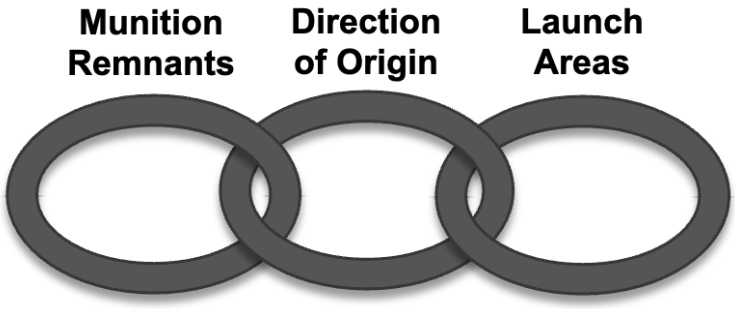



*Image 22: Map depicting the impact of submunitions, munition remnants and their assessed direction of origin in Grouping 5. The white line indicates the assessed directions of origin of the rocket motor, while the blue lines represent the left and right arcs of the standardised template (Credit: Google/Maxar Technologies).*

# V. Identifying Launch Areas




## Identification of Area of Interest

In order to identify responsibility for 9M55K attacks in Kharkiv, it was necessary to assess the location from which the attacks originated. For that purpose, the cumulative direction of origin templates generated by the incident reports were overlaid onto a map of Kharkiv Oblast.

As outlined by the section “Caveats” in the chapter “Munition Remnants”, while a single template may give a tentative indication of direction, it was the cumulative application of these templates that conclusively identified the area of interest (AoI) for possible launch positions. The results of this application can be seen below.

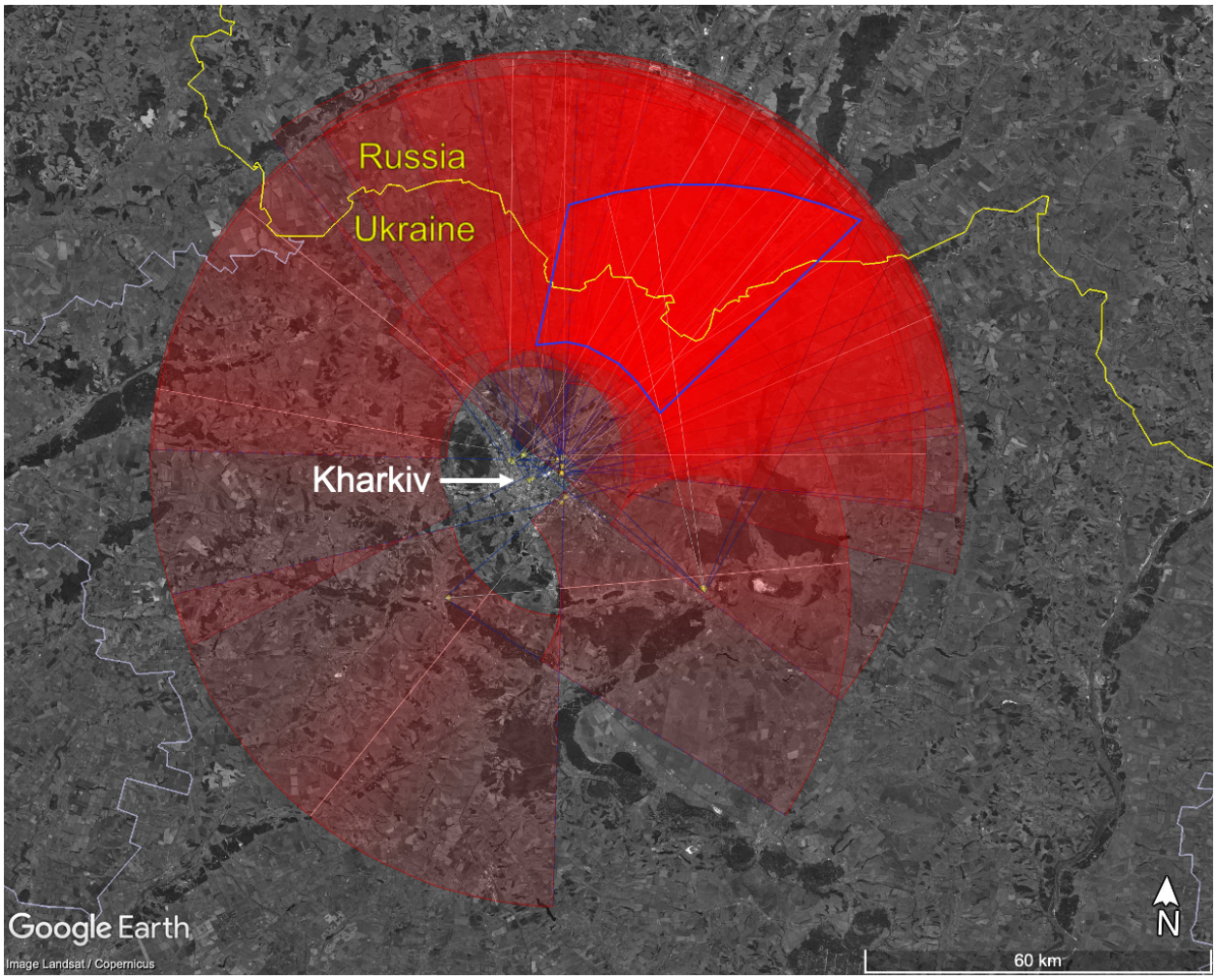



*Image 23: AoI resulting from cumulative overlay of 9M55K direction of origin proof of concept templates (Credit: Google/Ladsat/Copernicus).*

After the direction of origin confirmation of concept experiment was carried out, this application was repeated with the new, slightly wider arc. The result can be seen below. As can be seen, the slightly wider arc did not have a great effect upon the area of interest.

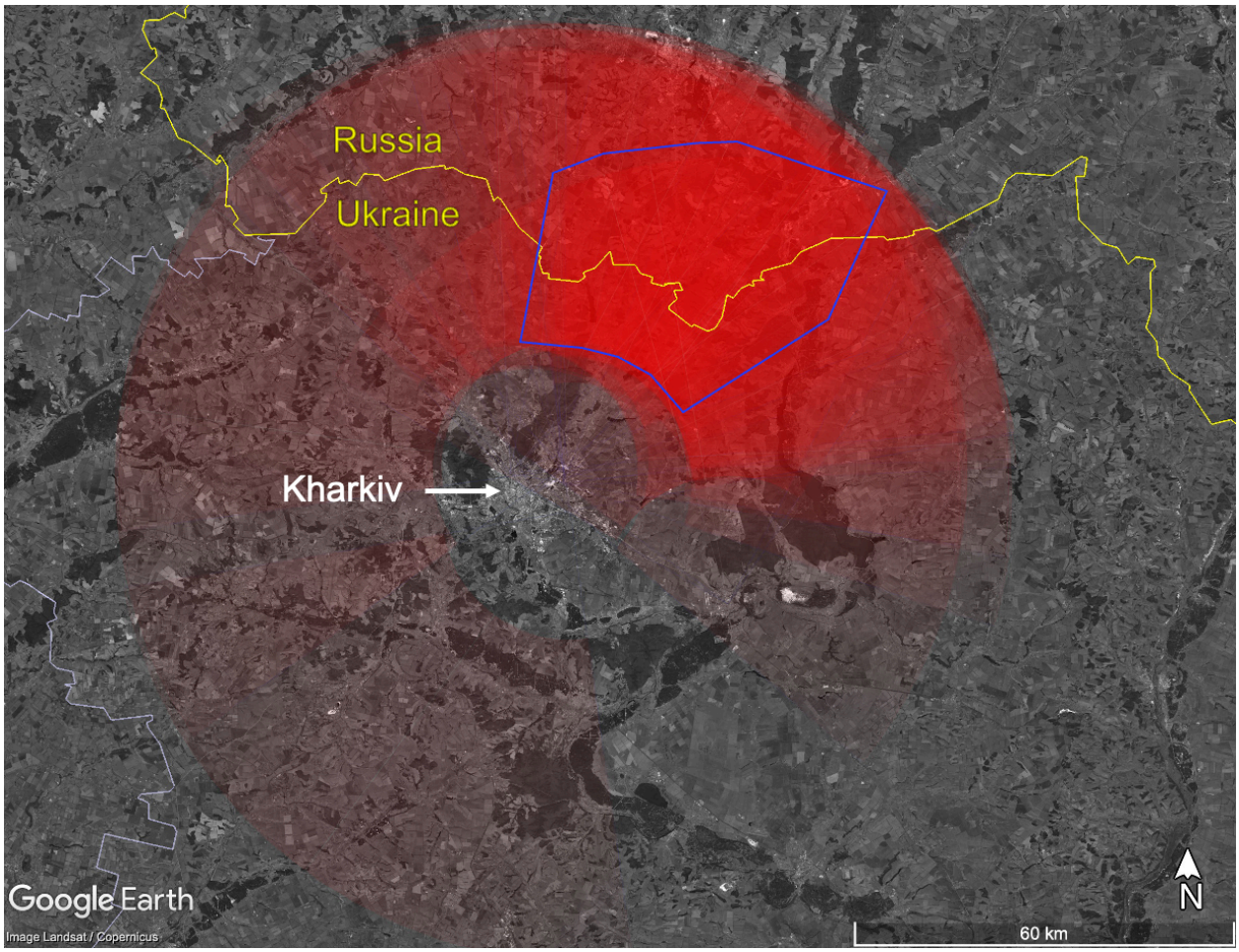



*Image 24: AoI resulting from cumulative overlay of 9M55k direction of origin confirmation of concept templates (Credit: Google/Ladsat/Copernicus).*

## Indications of Smerch

Once the AoI was identified, it was necessary to check this location for indications of BM-30 Smerch activity. A review of different types of open source material was carried out to identify indications of BM-30 activity, including user-generated content, satellite imagery and videos released by the Russian MoD. This resulted in a series of indicators which are listed below.

### Capabilities and Characteristics of BM-30 Smerch, 9M55K Rockets and 9N210/9N235 Submunitions

The BM-30 "Smerch"[61] is a MLRS capable of firing multiple types of 300 mm rockets, including the 9M55K cluster munition. The reported minimum and maximum range of a 9M55K is 20 km and 70 km respectively.

[61] https://missilery.info/missile/smerch

A 9M55K carries a payload of 9N210/9N235 submunitions, each one containing[62] an explosive charge and hundreds of pre-formed metal fragments.

The BM-30 system comprises not just the launch vehicles, but also transloaders, and vehicles with command post and fire control systems. The BM-30[63] system employs 1T12-2M vehicles for topographic survey and 1B44 radio direction-finding meteorological complexes to acquire data for planning and executing combat operations. Brigades employing BM-30 can use either "Vivariy" or "Slepok-1" for their command post or fire control systems.

While appearing visually similar, Tornado-S is essentially a deep upgrade[64] of Smerch, with a better targeting system and extended range.

There are conflicting reports about the precise structure of rocket artillery brigades operating Smerch. Some sources[65] claim that there are six launchers per battery. Other sources[66] state that each battalion (also referred to as a 'Division') consists of six launchers. One source,[67] which is aimed at informing conscripts about service in specific units, notes that the 79th Brigade has three battalions, each of which consists of two batteries, and each battery consists of two launchers and one transport and loading vehicle. Each one of these units include command posts and fire control systems, which are used to control its operations.

We consulted Col (ret) Petro Pyatakov, an expert on Soviet bloc rocket artillery systems. He stated that:

> "*In the Smerch rocket artillery brigade (REABR) there are three rocket artillery divisions [battalions] (READN) with three rocket artillery batteries (REABAT) with four BM30 or Tornado-S in each. That is, there are 4 installations in the REABAT, 12 in the READN, and 36 in the REABR*."

This is consistent with information provided by the senior ex-military satellite imagery expert, who noted that:

> "*At the brigade level, they comprise 3 battalions, each with 3 batteries. A battery comprises 4 launchers (2 fire platoons). This was probably the situation at the beginning of the conflict. To complicate it further, the Tornado-S (significant upgrade to Smerch, but almost identical launch vehicle), has been observed since the start of the Ukraine invasion, normally within a Rocket Artillery Brigade. The brigade comprises 2 - 3 battalions, each with 2 (occasionally 3) firing batteries, which in turn have 2 - 3 launchers each (vs 4 in a Smerch battery).*"

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[62] https://armamentresearch.com/soviet-9n210-submunitions-documented-in-ukraine-2022/
[63] https://missilery.info/missile/smerch; https://missilery.info/missile/uragan-0
[64] https://web.archive.org/web/20220319221356/https://www.janes.com/defence-news/news-detail/ukraine-conflict-russian-forces-employ-guided-rockets
[65] https://kranigruz.ru/rszo-smerch/, https://tvzvezda.ru/news/201707141731-zqcs.htm
[66] https://topwar.ru/195741-rszo-smerch-bezzhalostnoe-sovershenstvo.html
[67] https://web.archive.org/web/20180612142352/http://vojskovayachast.ru/zapadnyj-voennyj-okrug/

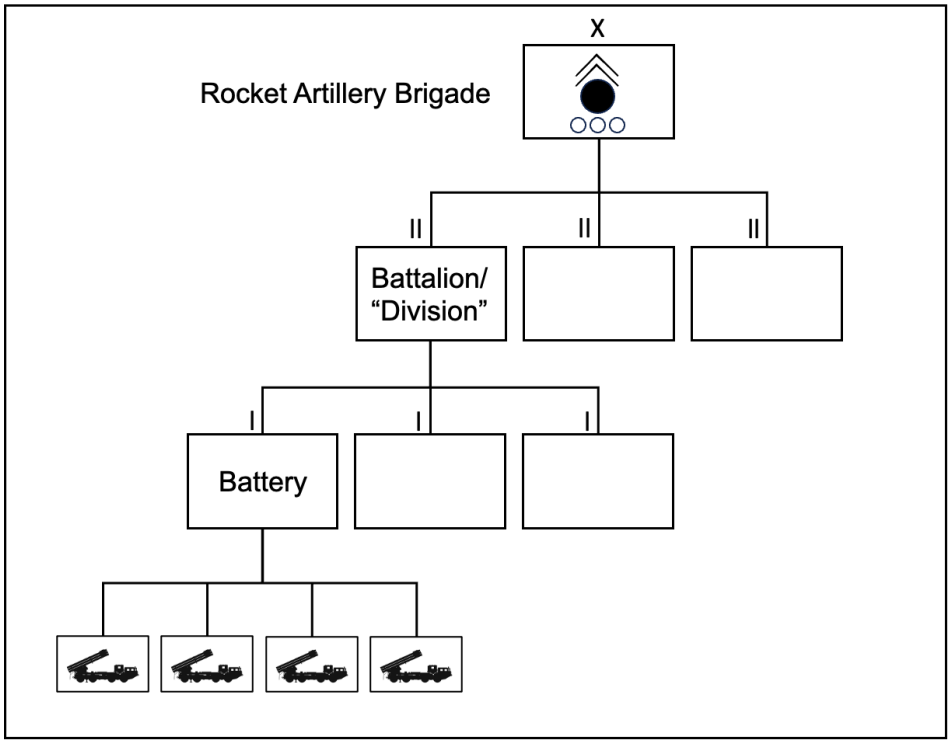



*Image 25: Simplified doctrinal Order of Battle of a BM-30 Rocket Artillery Brigade.*

The convoys seen in Kursk (See section: **BM-30 Systems In Kursk**) may be a useful guide as to the actual order of battle of a rocket artillery unit. The first convoy, which seems to have been filmed in its entirety, contained six launchers and six reloading vehicles. The second convoy, which does not appear to have been filmed in its entirety, consisted of at least four launchers and four reloading vehicles. Each of these convoys was assessed to be a battalion-sized element by the artillery expert.

It therefore appears that an operational, as opposed to a theoretical, Smerch rocket artillery brigade would possibly consist at the lower estimate of the sources examined above.

**Large Vehicles**

It was hypothesised, and confirmed by the imagery expert, that the vehicles of the BM-30 system may themselves be visible on commercial satellite imagery, if they were present in the AoI. Smerch and Tornado-S launch vehicles and transporter-loaders are distinctive. At 12 m in

length, these launch vehicles are comparable only with the Iskander[68] and S-300[69]/400[70] systems,[71] of which only the S-300 is used[72] by Ukraine.

In order to identify reference satellite imagery, locations of known BM-30 systems were checked. The best example of this was the Museum of Artillery[73] in Perm, Russia, which displays a BM-30 transporter-loader and a BM-30 launcher immediately next to each other. A BM-27 launcher is also next to these vehicles, providing a useful reference.




*Image 26: Google Maps Street View image[74] with annotations (Credit: Google).*

The BM-30 transporter-loader in particular has a distinctive visual signature. Its storage area contains two stacks of six rockets on each side of the vehicle, which are then loaded into the launcher using a ram in the center of the vehicle. These missiles are lighter in colour than the dark green of the transporter-loader itself and so are visible in satellite imagery.

[68] https://armyrecognition.com/military-products/army/missiles/ballistic-missiles/iskander-russia
[69] https://armyrecognition.com/military-products/army/air-defense-systems/air-defense-vehicles/s-300-pmu1-sa-20a-gargoyle
[70] https://armyrecognition.com/military-products/army/air-defense-systems/air-defense-vehicles/s-400-russia-uk
[71] https://missilery.info/missile/smerch
[72] https://www.forbes.com/sites/davidaxe/2023/07/24/the-ukrainians-have-their-own-surface-to-air-missile-system-what-they-dont-have-is-factories-to-make-them/
[73] https://maps.app.goo.gl/QHuGMjniMLZnPiae9
[74] https://maps.app.goo.gl/dARRBDFqwjnvn9DBA



*Image 27: Footage of the reloading process with one rocket on the centrally mounted ram. Note the colour of the rockets (Credit: Russian MoD[75]).*

[75] https://t.me/mod_russia/25521

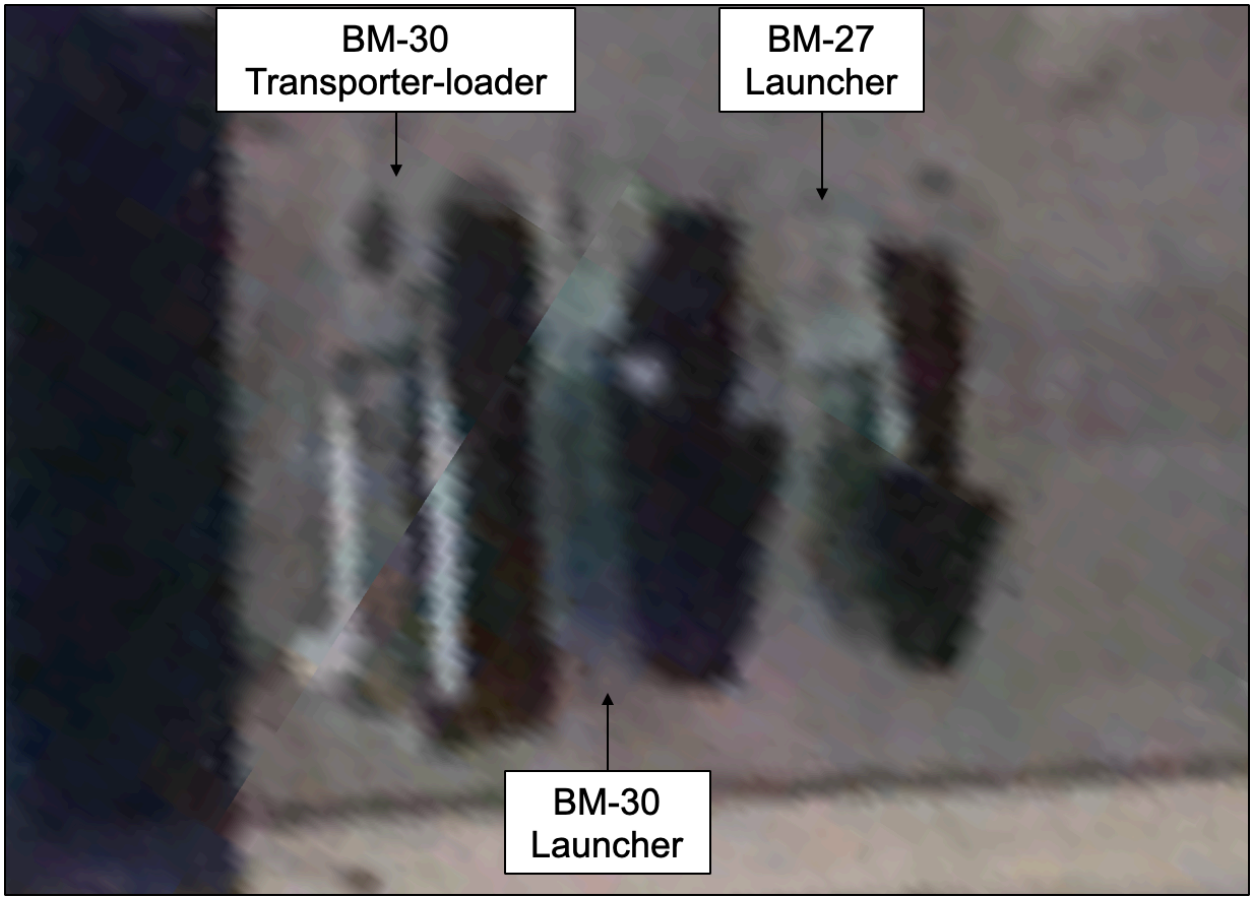



*Image 28: Vehicles in the Museum of Artillery in Perm. Note the double line on the back of the transporter-loader created by the two rockets, which would be thicker on a fully-loaded transporter-loader (Date of imagery: 13/07/2017. Credit: Google/Maxar Technologies).*

It should be noted that although the transporter-loader in Perm is loaded with only two rockets, one on each side, transporter-loaders usually carry a stack two rockets wide on each side as seen in the footage[76] above, released by the Russian MoD. As such, while the transporter-loader in Perm may be a useful reference image, the distinctive double line created by the presence of the double-stacked rockets would in fact be wider than that seen in the satellite image of the BM-30 transloader in Perm.

These vehicles, visible in Satellite imagery available in Google Earth Pro, were measured using Google Earth Pro's mensuration tool in order to gain a better understanding of their length. The launch vehicle came to a length 12.07 m, while the transporter-loader vehicle is a little longer, at 13.17 m. This is consistent with the reported lengths of these vehicles.

[76] https://t.me/mod_russia/25521

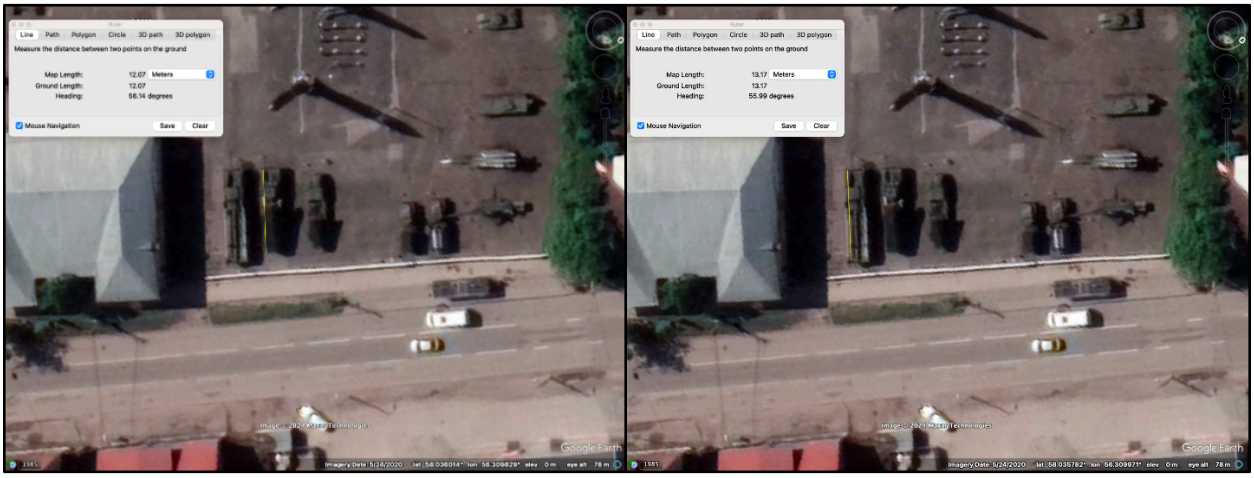



*Image 29: Left: Measurement of launch vehicle. Right: Measurement of transporter-loader vehicle (Credit: Google/Maxar Technologies).*

**Heavy Vehicle Tracks**

The Smerch system includes multiple heavy vehicles, including the launch vehicles, the transporter-loader vehicles, and the ammunition transport vehicles. These vehicles may leave significant ground signs when they move, including vehicle tracks, depending on the nature of the terrain. According to the imagery expert: "*Where the terrain is appropriate e.g. muddy fields, the tracks are a very strong indicator of MLRS activity and often lead to the launchers themselves. Evident turning circles are key (minimum turning circle of the launcher is 15 m), and can help to distinguish from [other heavy machinery, such as] tractors etc*."[77]

The official Russian MoD Telegram channel published a video[78] depicting the reloading process for a BM-30 system which includes all of these vehicles. In this video it is possible to identify the three types of vehicles mentioned above. Although it is not possible to identify an exact measurement, it is clear that the ammunition transport vehicle is several meters longer than the transporter-loader. Note also the ground sign left by these vehicles in the form of a large number of intercrossing tracks.

[77] Senior ex-military satellite imagery expert.
[78] https://t.me/mod_russia/14575

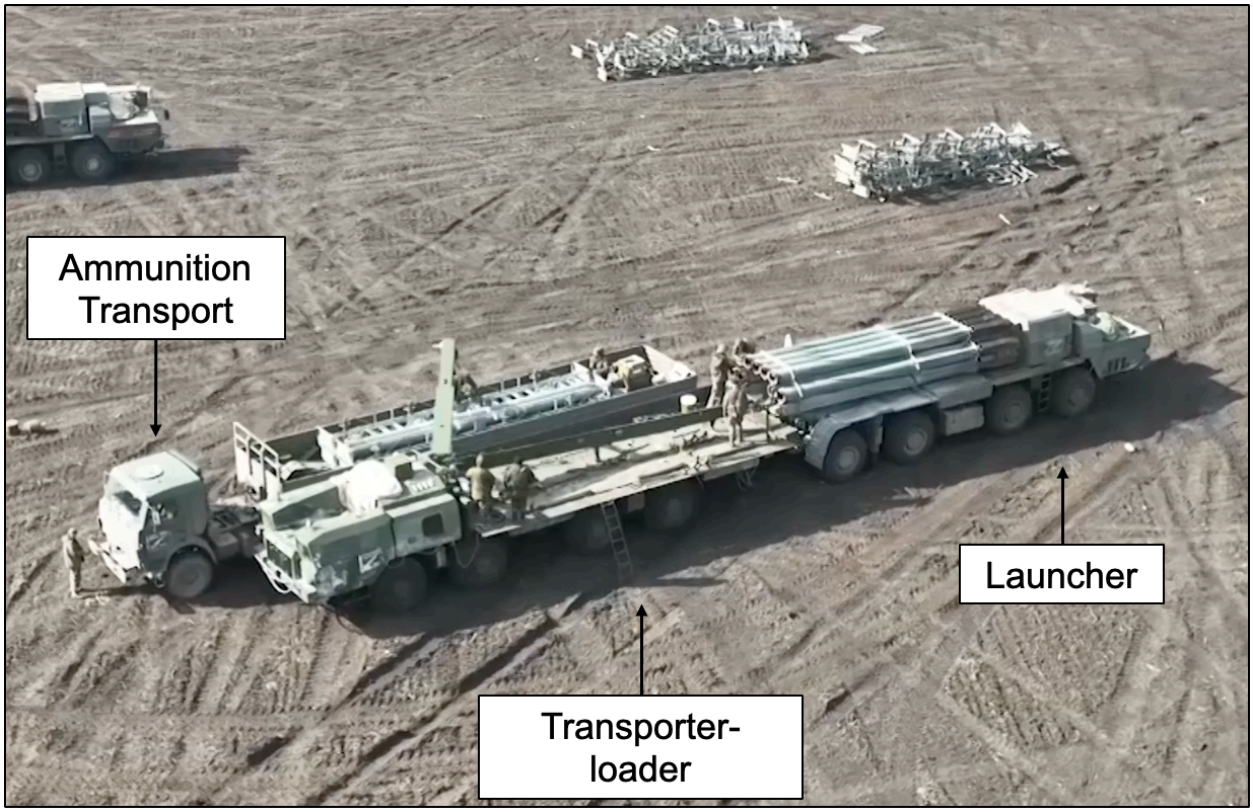



*Image 30: An example of a launcher, transporter-loader and ammunition transport (Credit: Russian MoD[79]).*

**Vehicles Hidden in Tree-Lines with Tracks Leading to Launch Positions**

If a BM-30 system remained in the same area in order to conduct launches, it may be necessary to hide these vehicles. Trees provide a quick and easy way to hide vehicles and activity. Videos released by the Russian MoD show activities like interviews[80] and reloading[81] of launch vehicles taking place in treelines. Conversely, the launchers themselves are depicted[82] as driving out into open areas before firing.

Therefore, vehicles hidden in tree lines, with tracks leading to vehicles at possible launch positions, could be regarded as an indication of BM-30 activity.

[79] https://t.me/mod_russia/14575
[80] https://t.me/mod_russia/20050
[81] https://t.me/mod_russia/25521
[82] https://t.me/mod_russia/17968




*Image 31: Example of vehicles hidden in treeline at [50.326, 36.328](#)[83] (Credit: Google/Maxar Technologies).*

**Command Centers**

When a BM-30 system deploys, it is not just the launcher and reloading vehicles that do so. Headquarters' vehicles, specialised vehicles, and tented accommodation may be required for longer operations. As such, concentrations of vehicles and tents were also considered as possible indicators.

[83] https://maps.app.goo.gl/8E3zRPYYFT3c4Xpr5

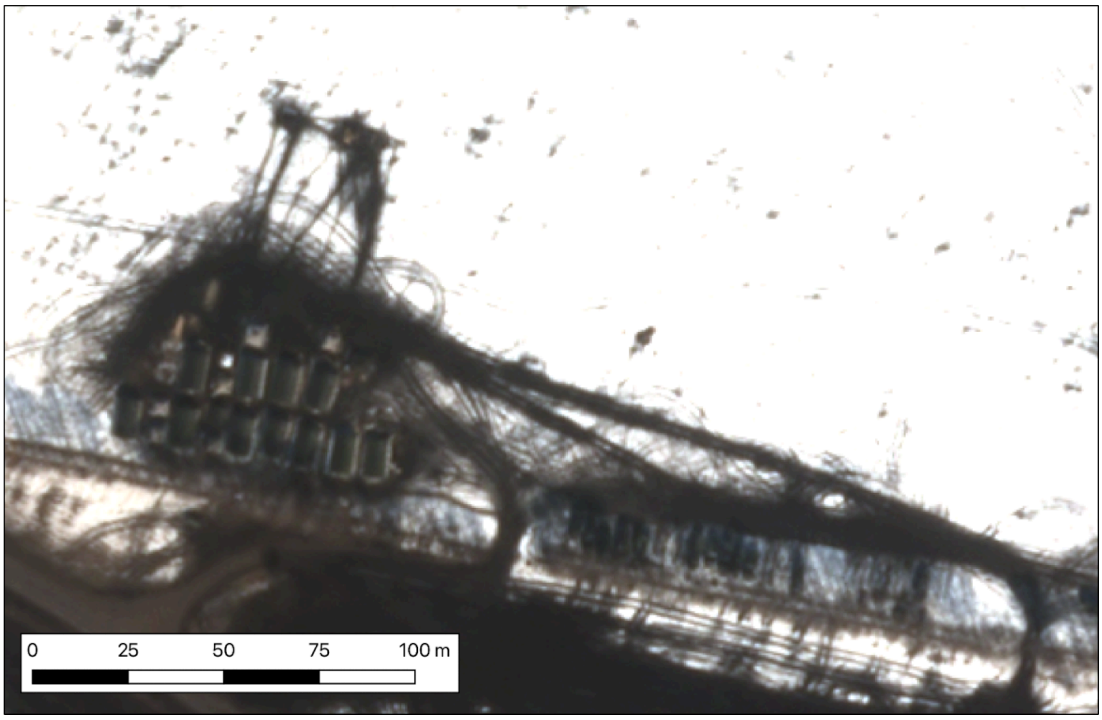



*Image 32: Example of a concentration of tents and vehicles, which may indicate an HQ.*

**Burn Marks**

When a MLRS fires a salvo of rockets, a significant amount of heat is generated by the rockets, which is expelled out the rear of the launch tubes as the rocket launches. This can create large burn marks.

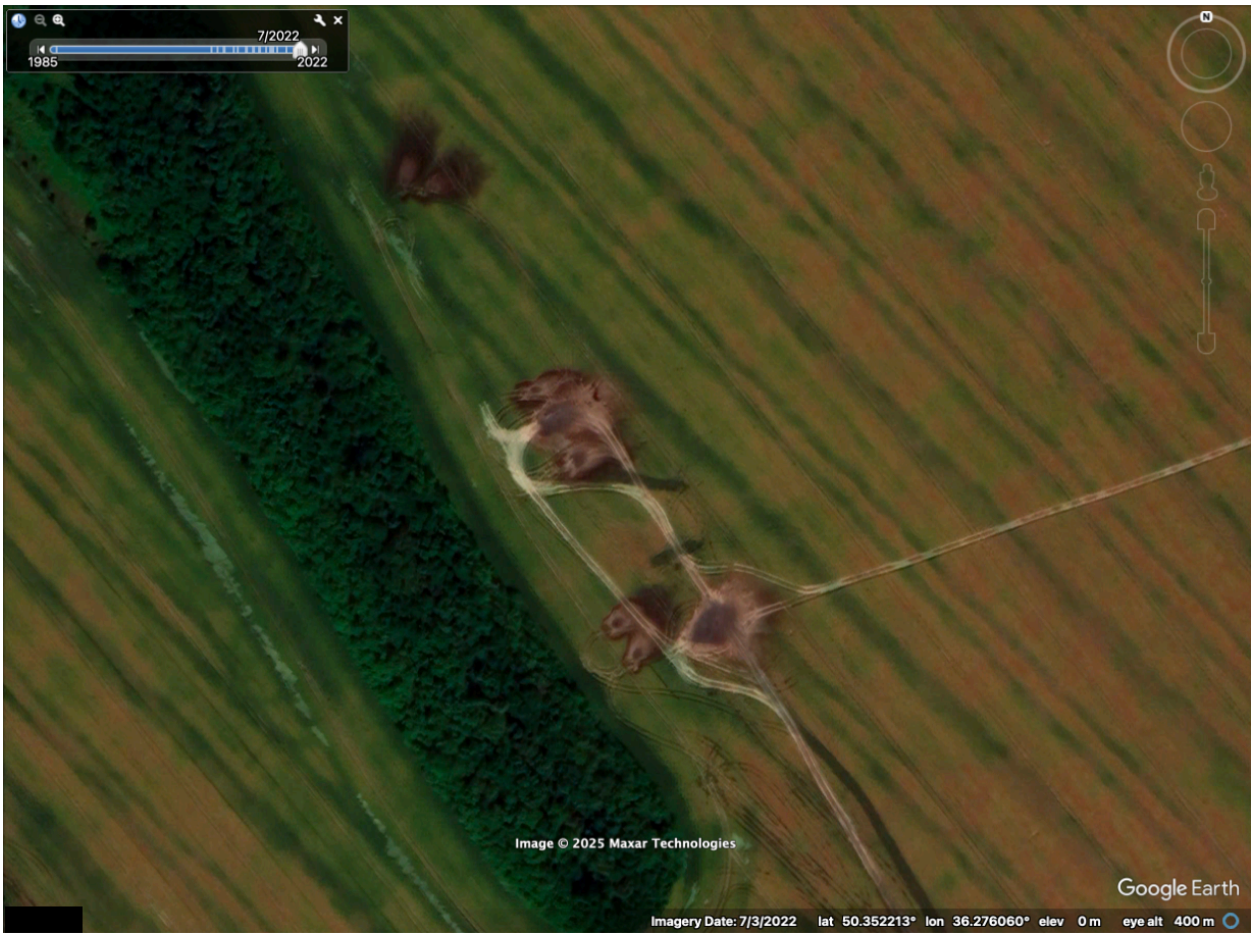



*Image 33: Examples of burn marks south-west of Belgorod at [50.3521, 36.2761](https://maps.app.goo.gl/uKbkf6Bg8vWaeZbJA)[84] (03/07/2022, Credit: Google/Maxar Technologies).*

## Craters

The forces resulting from a 300 mm rocket launch can create a significant crater in the ground when they are launched from a high angle. These craters will be visible on high resolution satellite imagery and are distinctive due to the combination of an ellipse, scorch marks and tracks leading to them. However, care must be taken that craters caused by counter-battery fire are not mistaken for those caused by launches.

Counter-battery fire is when an artillery group is discovered and enemy artillery target them. These craters tend to have an identifiable signature, namely multiple craters in a group, earth disturbed in an identifiable pattern (side spray, or base spray in the case of mortars), and a lack of an identifiable burn mark around the crater.[85]

[84] https://maps.app.goo.gl/uKbkf6Bg8vWaeZbJA
[85] US Army Field Artillery School, “Crater Analysis and Shell Reports”, Edition B, Nov 1992



*Image 34: Photo from a training exercise from Russia's 79th Brigade VK page[86].*

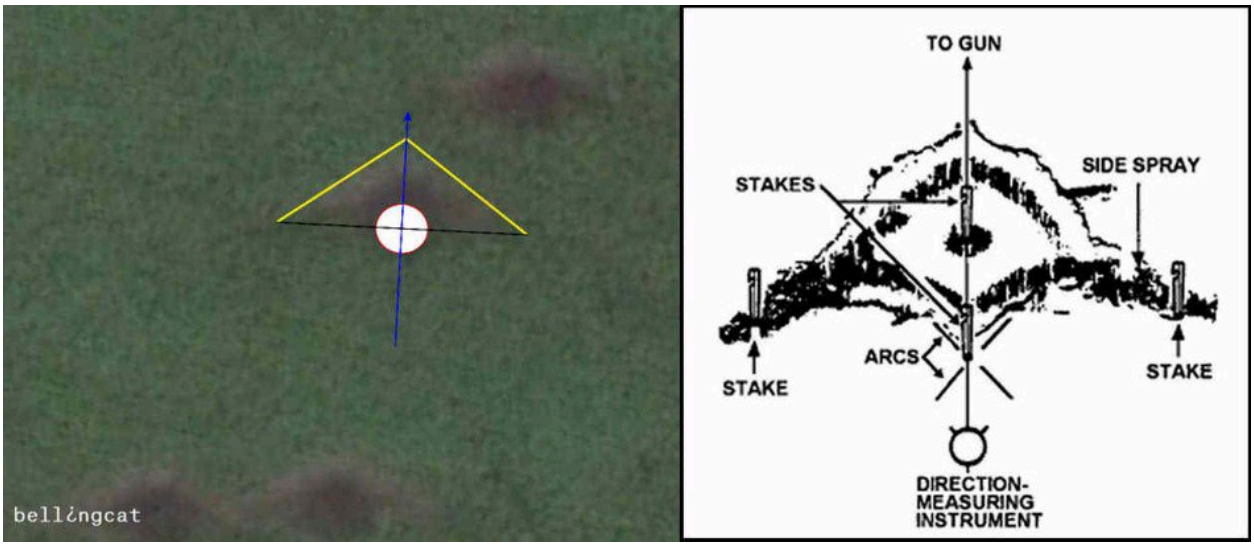



*Image 35: Example[87] of low-angle fuze quick craters (e.g. low-angle artillery or MLRS fire).*

[86] https://vk.com/video12150336_170800081
[87] https://www.bellingcat.com/news/uk-and-europe/2016/12/21/russian-artillery-strikes-against-ukraine/

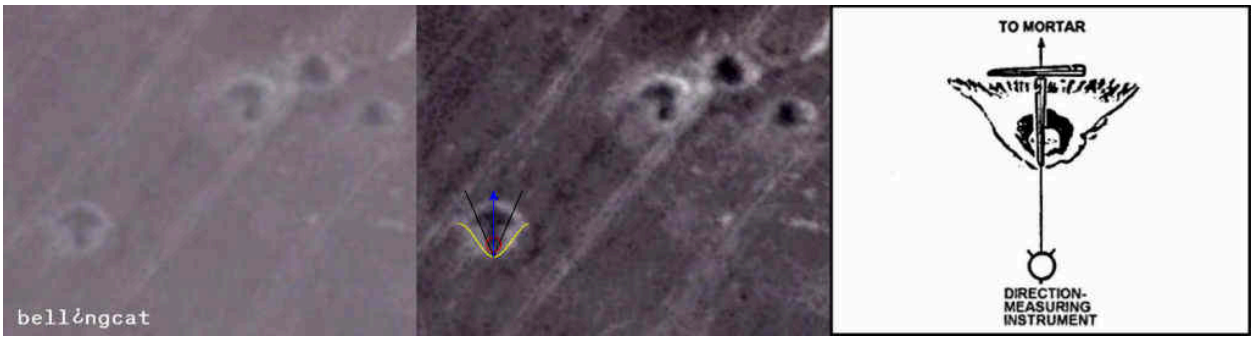



*Image 36: Example[88] of high-angle shell craters (e.g. mortars, high-angle MLRS fire).*

### Areas of Melted Snow in Otherwise Complete Snow Fields

When rocket launches occur in snow fields, they can create large areas which have been cleared of snow by the heat of the launch. Care must be taken to ensure these areas are not simply naturally occurring snowmelt or areas cleared of snow by the passage of vehicles. Confidence in this assessment rises if there are two to four areas of cleared snow in a row, indicating that the snow clearance is not natural melting. An example of a launch in a snowfield can be seen in this video,[89] which purportedly shows a BM-30 Smerch of the "Kharkiv Group" firing.

[88] https://www.bellingcat.com/news/uk-and-europe/2016/12/21/russian-artillery-strikes-against-ukraine/
[89] https://t.me/voenacher/12367

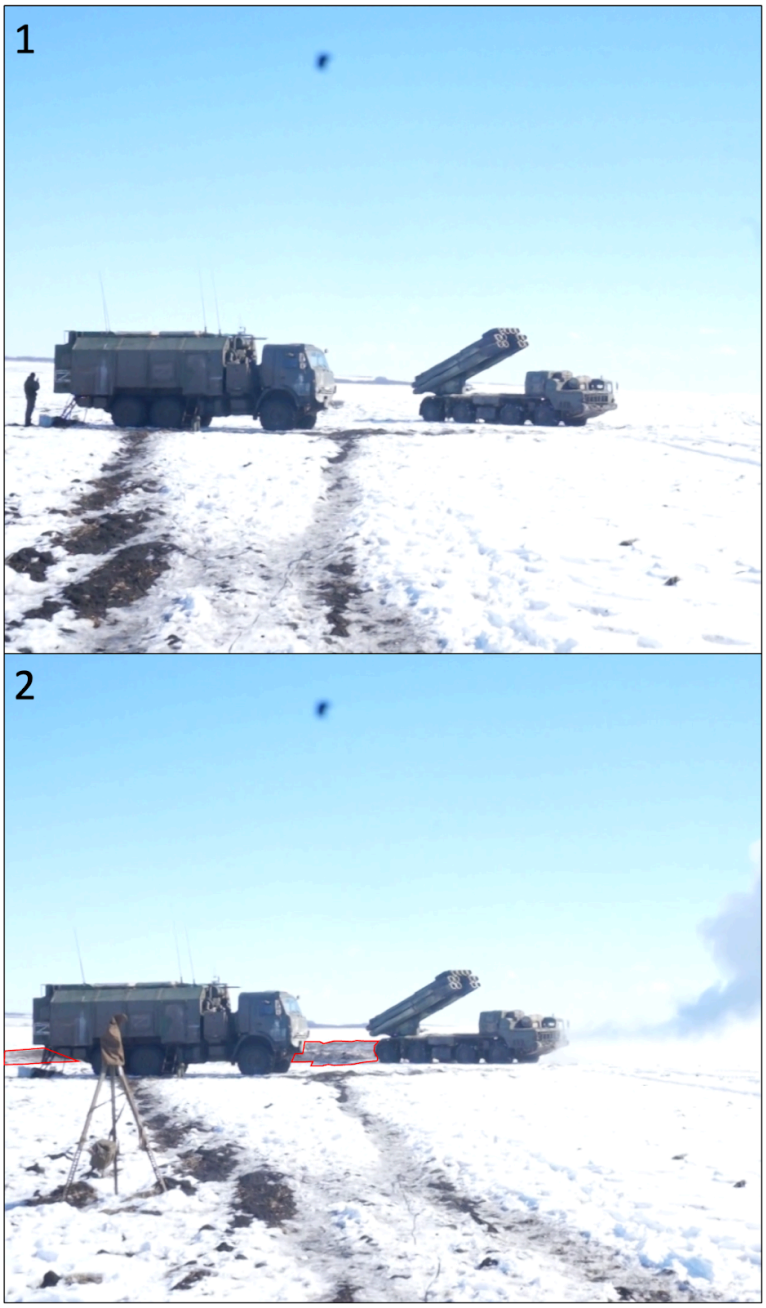



*Image 37: Before and immediately after a BM-30 launch. Note the area of cleared snow which extends behind the launcher (Credit: @voenacher[90]).*

## Piles of Scrap

Rockets for the BM-30 system appear to be delivered in metal frames which are then discarded after the rockets are loaded into the transporter-loader.

[90] https://t.me/voenacher/12367




*Image 38: Example of metal frames[91] (Credit: Missilery).*

A video[92] posted by the Russian MoD which depicted the reloading of a Smerch system revealed another type of ground sign, namely piles of this scrap metal, almost certainly the frames which house the rockets. These piles of scrap metal can be seen in the background, behind a Smerch launcher being reloaded. Rockets in their frames can be seen in the bed of the ammunition transport. These piles are large enough to be visible in high resolution satellite imagery.

[91] https://missilery.info/files/m/s.gurov/20/9/tornado-s_luga_191116_2_15.jpg
[92] https://t.me/mod_russia/14575

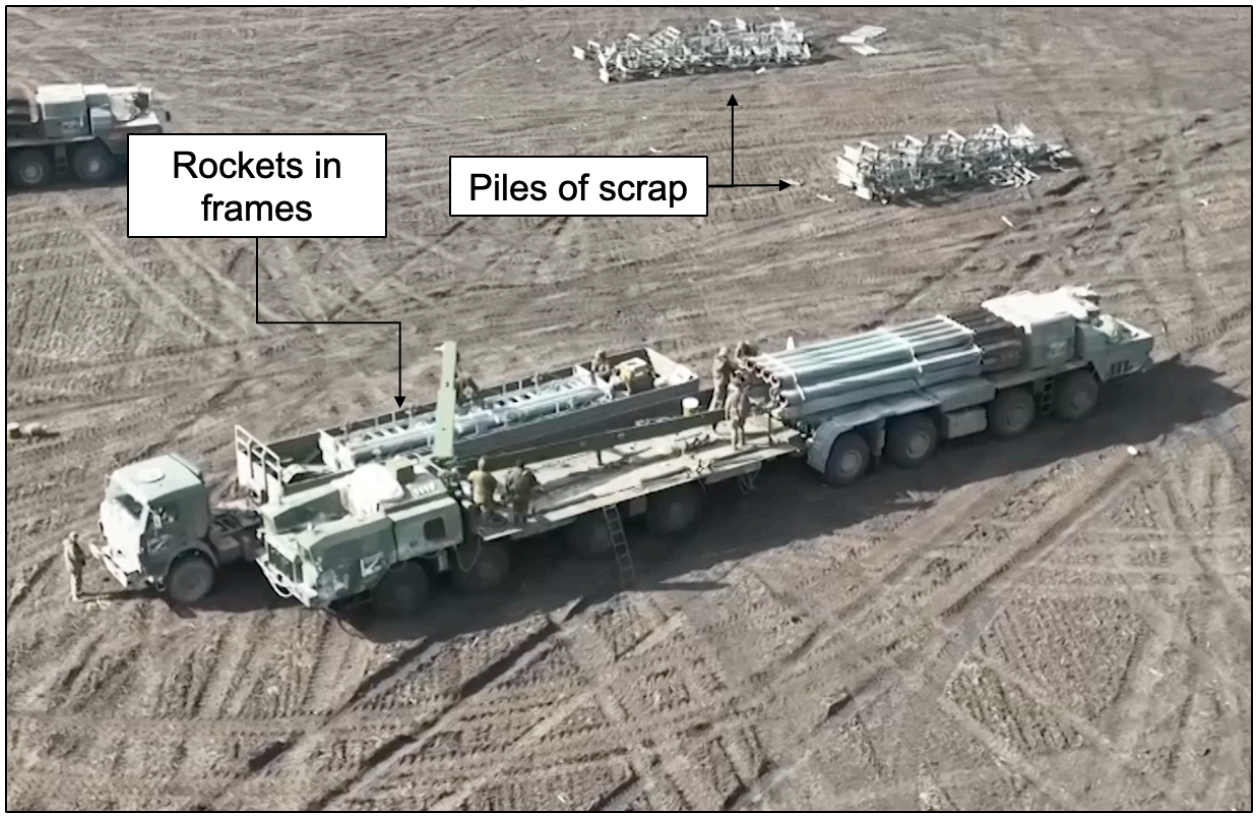



*Image 39: Photo showing the reloading of a Smerch system. Note the piles of scrap in the background (Credit: Russian MoD[93]).*

# Identification of Launch Areas

## Satellite Data

Once this list was completed, the AoI was then checked using commercial satellite imagery of the period in question, including high and mid resolution optical imagery from Planet Labs, high resolution imagery from Maxar Technologies and synthetic aperture radar (SAR) imagery from Sentinel 1.

Planet Labs PlanetScope provided medium resolution satellite imagery, where each pixel is approximately 3 m. While this resolution is not sufficient to clearly identify specific vehicles, it was sufficient to identify possible indicators of their presence, such as tracks. Large burn marks are also visible at this resolution, as are large patches of melted snow.

Once these indications were identified, further information was required to confirm the presence of military vehicles.

[93] https://t.me/mod_russia/14575

While the resolution of PlanetScope imagery limits the ability to identify vehicles, it has a high revisit period, meaning that usually there was PlanetScope imagery of a location every 24 hours, or sometimes even more often. The utility of this imagery increased if there was snow cover, when launch activity, such as large areas of cleared snow, could be clearly identified.

As an optical constellation, PlanetScope was still limited by bad weather, which was most notably apparent in the period between 28/02/2022 and 10/03/2022 during which there was significant cloud cover and therefore limited imagery. Despite this gap, PlanetScope was still extremely useful in identifying areas of operation of MLRS, and the period during which a particular area of operations was active.

Once an assessment of activity had been carried out using PlanetScope, high resolution imagery from Planet Labs and Maxar Technologies was obtained to conduct further analysis. This was used to confirm if the area was indeed being used by a BM-30 Smerch system, as well as how many vehicles of what types were present.

Other sources of satellite imagery were obtained, including SAR from Sentinel 1; however, these proved to be of limited use. The resolution of Sentinel 1 was generally too low to clearly identify BM-30 systems, and while it may provide indications of activity of large metal objects, the risk of false positives was considered relatively high and so this imagery was not relied upon for analysis.

## Identification of Activity and Launch Areas

The AOI was checked visually using Planet Labs PlanetScope imagery from 22/02/2022 until 30/04/2022. Locations which displayed potential indications of activity, such as burn marks or snow-melt areas, were geographically marked within Google Earth Pro, along with the date they first became evident. The area around these marks was then examined using high resolution imagery from Planet Labs SkySat, as well as Maxar Technologies imagery available on Google Earth Pro, from before, during and after the indication became evident, which resulted in the identification of smaller indications of activity, such as identifiable vehicles.

Most of these indications of activity appeared to be concentrated in certain areas and linked by vehicle tracks. In these cases, if there were indications specific to a MLRS, such as burn marks or identifiable vehicles, we classified the grouping as a “launch area”. Within each of these launch areas there may be multiple launch and reloading sites.

In some cases, areas of significant activity were identified as being unlinked to MLRS activity. For example, a large concentration of vehicle activity was identified south of Belgorod. It was examined using SkySat, imagery available on Google Earth Pro and a video taken from a nearby road and was identified as likely being a radar position.

The analysis identified six potential operating areas for BM-30 systems within the AoI. These areas were labelled **Red, Orange, Yellow, Blue, Violet** and **Green**. Five of these areas showed

visible evidence of BM-30 launcher or transporter-loading vehicles, confirming their presence. In one other launch area, Launch Area Orange, BM-30 vehicles couldn't be positively identified, however, burn marks and firing positions consistent with other BM-30 launch areas were observed, and a satellite image captured a launch which displayed characteristics which, whilst distinct from BM-27 Uragan or Grad launches, could be consistent with a BM-30 launch. These launch sites were not used continuously; each was active for days or weeks before activity shifted to new areas.

The analysis of the Launch Areas by the J&A Unit was reviewed by the artillery expert and the satellite imagery and targeting expert. A summary of these expert reviews has been included in each section.

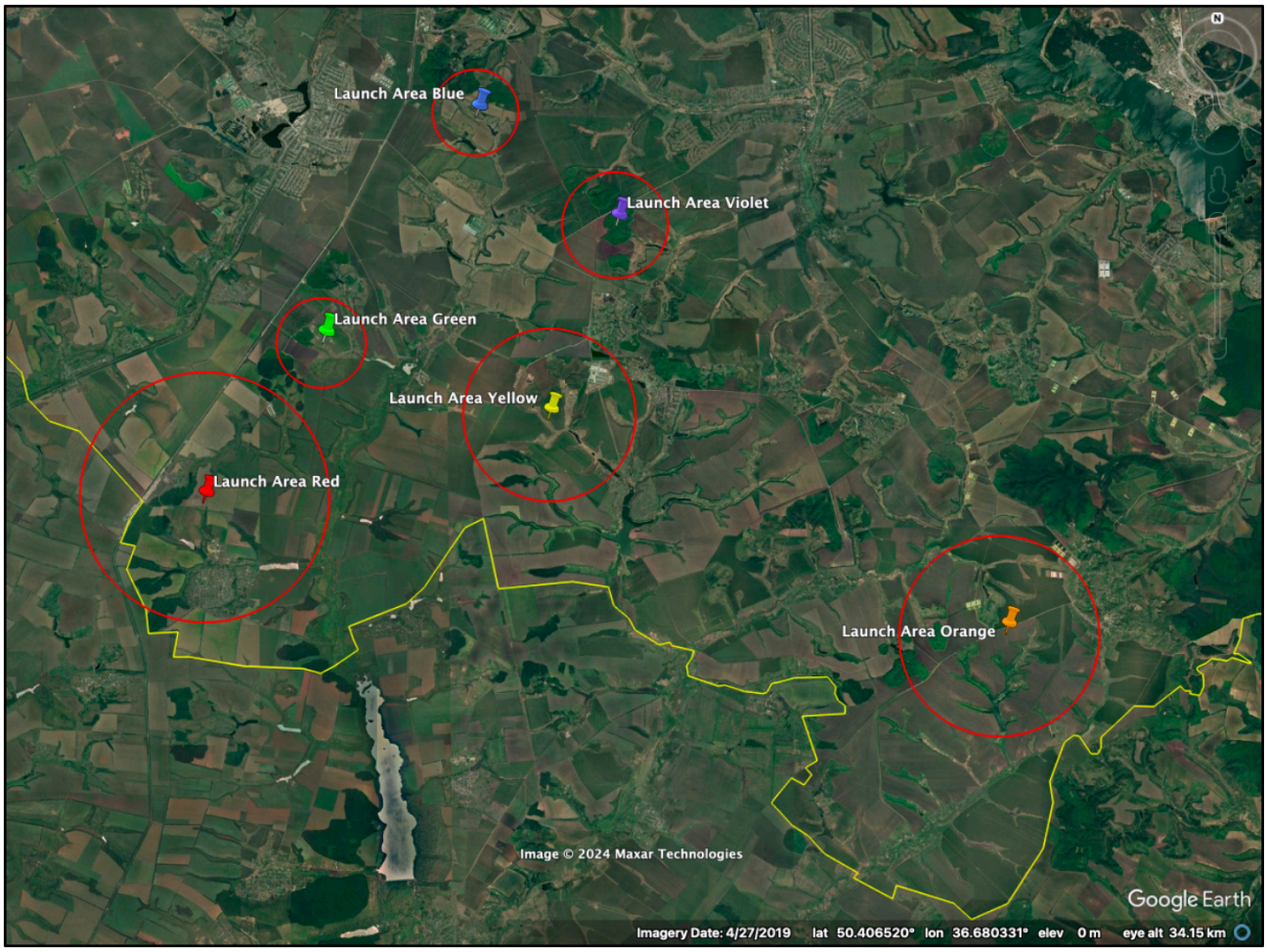



*Image 40: The six Launch Areas identified within the Area of Interest (Credit: Google/Maxar Technologies).*

## Launch Area Red

Launch Area Red was identified just to the north of the village of Zhuravlevka, inside the Russian Federation in the vicinity of (IVO) 50.33, 36.32[94]. It appears that Launch Area Red was used as a launch area for BM-30 Smerch systems during this period.

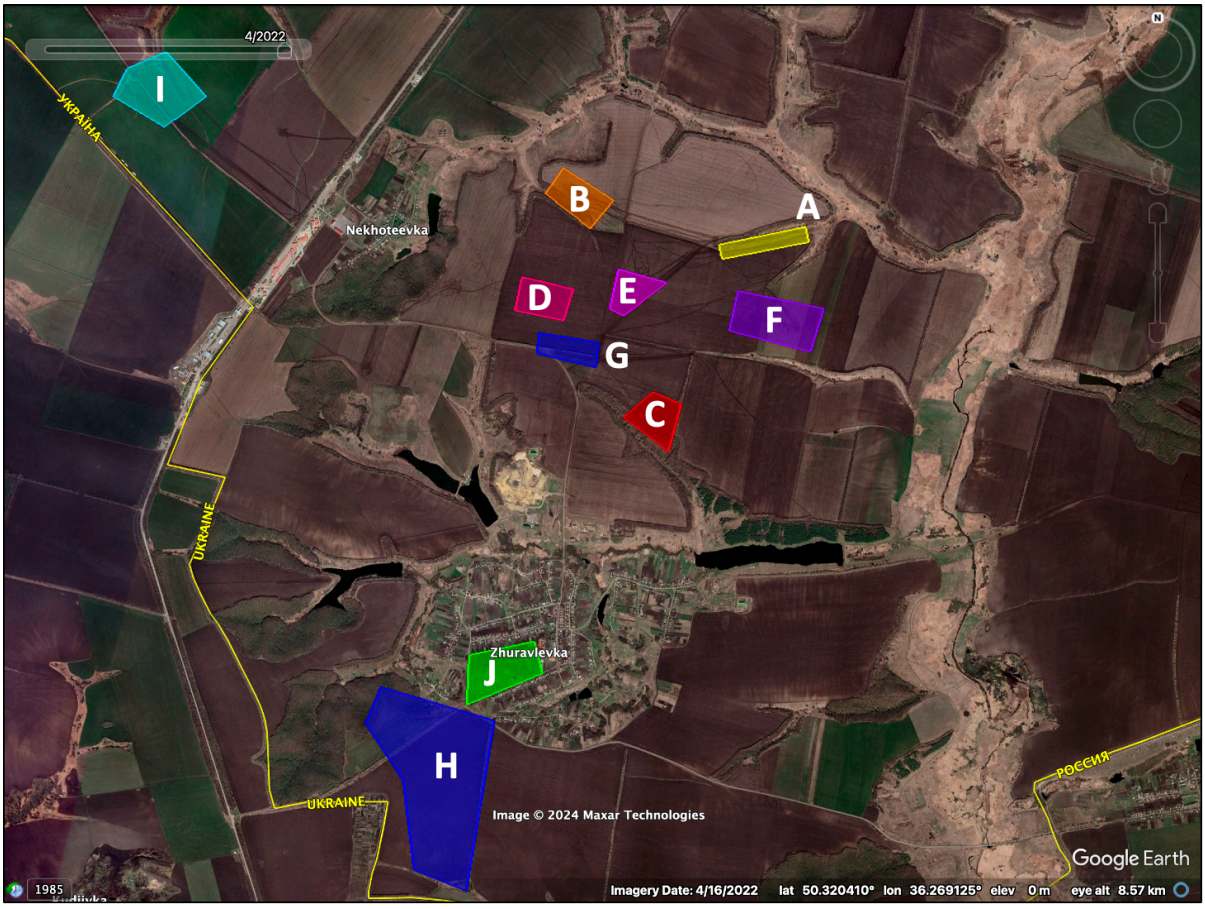



*Image 41: Summary of locations within Launch Area Red (Credit: Google/Maxar Technologies).*

Satellite imagery shows activity in this area from 27/02/2022 until 16/04/2022, although most activity appears to have lessened in late March, with no new launch activity visible after 23/03/2022. After this date almost all vehicles appear to leave, with only a few remaining, and none of them appear to be launch or transporter-loader vehicles. This location may have been in use earlier than 27/02/2022; however, poor weather conditions, including heavy clouds, did not allow us to obtain clear high-resolution optical satellite imagery until 27/02/2022.

[94] https://maps.app.goo.gl/84TiuAV98DTndnnd8

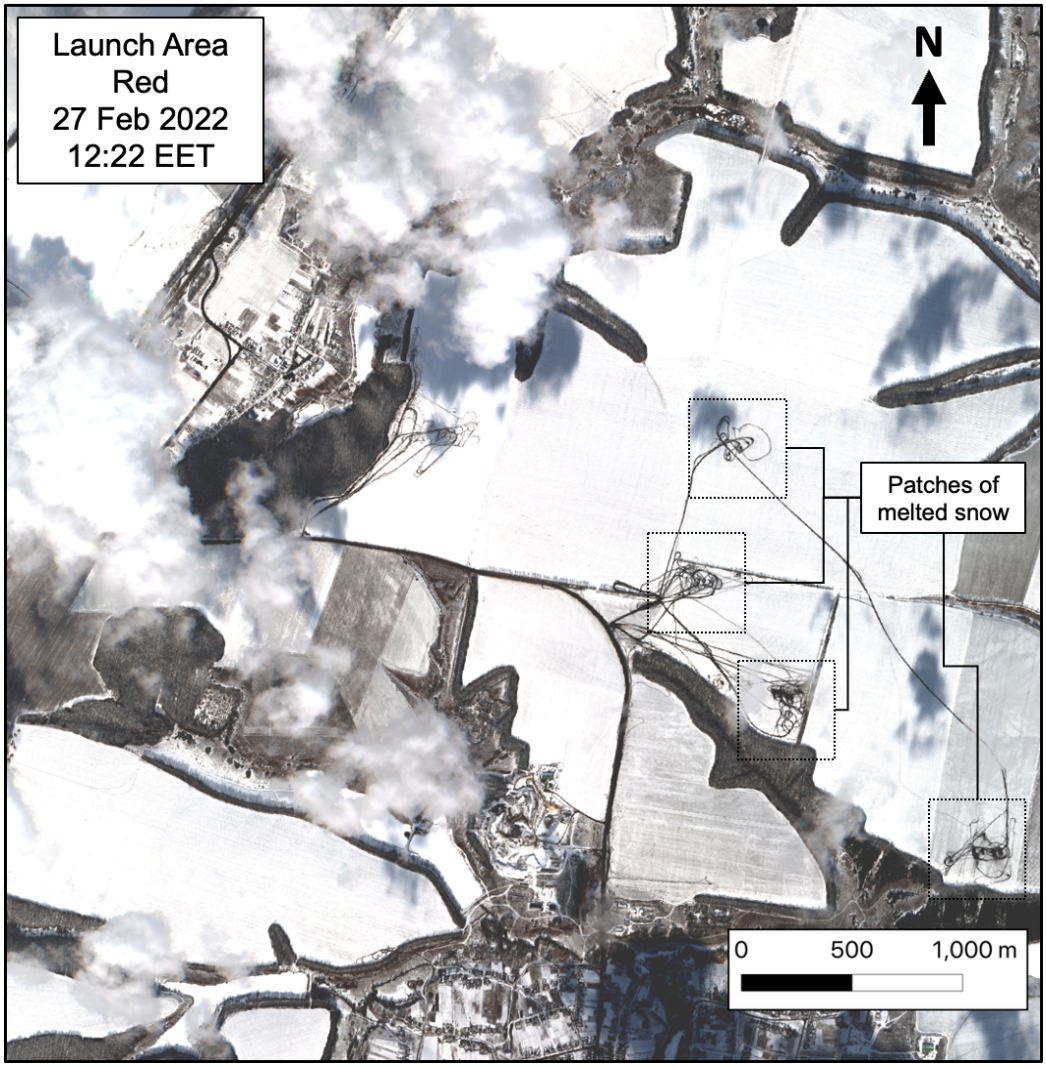



*Image 42: Satellite imagery from 27/02/2022 showing activity at the site of Launch Area Red (Credit: © 2023 Planet Labs PBC).*

Identifying the full extent of the activity at Launch Area Red is a challenge due to the limitations of weather conditions which affected the availability of clear optical satellite imagery. This is further complicated by limitations within satellite imagery itself. Depending on the conditions under which it was taken, satellite imagery may not show a particular vehicle clearly enough for it to be identified. Additionally, the unit which was based here appears to have taken steps to obscure its activity, for example by placing vehicles in treelines to hide them. The locations of interest have been identified below.

In satellite imagery from 15/03/2022 it is possible to clearly identify Smerch transporter-loaders with their distinctive double line at Launch Area Red. Additionally, slightly further away from the treelines, there are four objects which appear to be vehicles based on the tracks leading to them. These vehicles appear to be approximately 12 m in length, consistent with BM-30 vehicles. Two of the vehicles are aligned with large areas of cleared snow in a pattern that would be consistent with the vehicle being a launcher having just fired a salvo.

Based on the presence of these transporter-loaders and what appear to be launch vehicles, it appears that Launch Area Red was indeed being used as a launch area for BM-30 Smerch systems during this period.

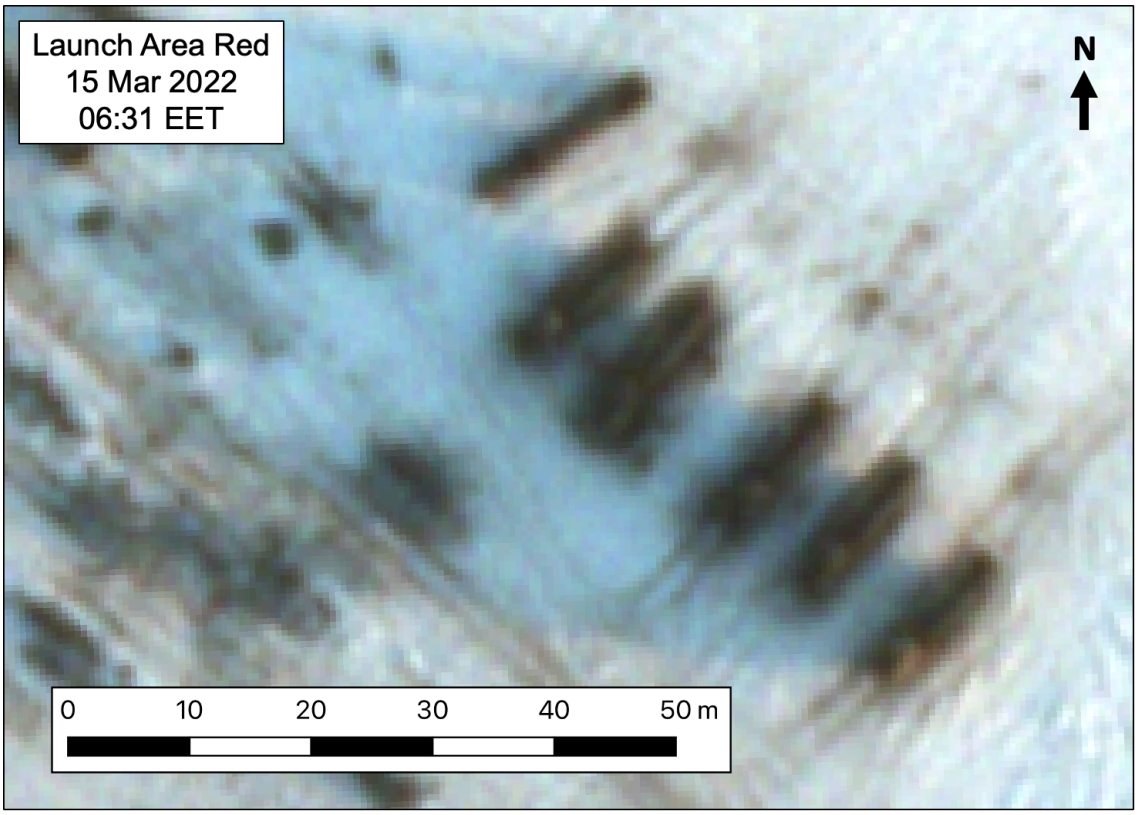



*Image 43: Five vehicles which match the size and distinctive double line of the BM-30 transporter loader (Credit: © 2023 Planet Labs PBC).*

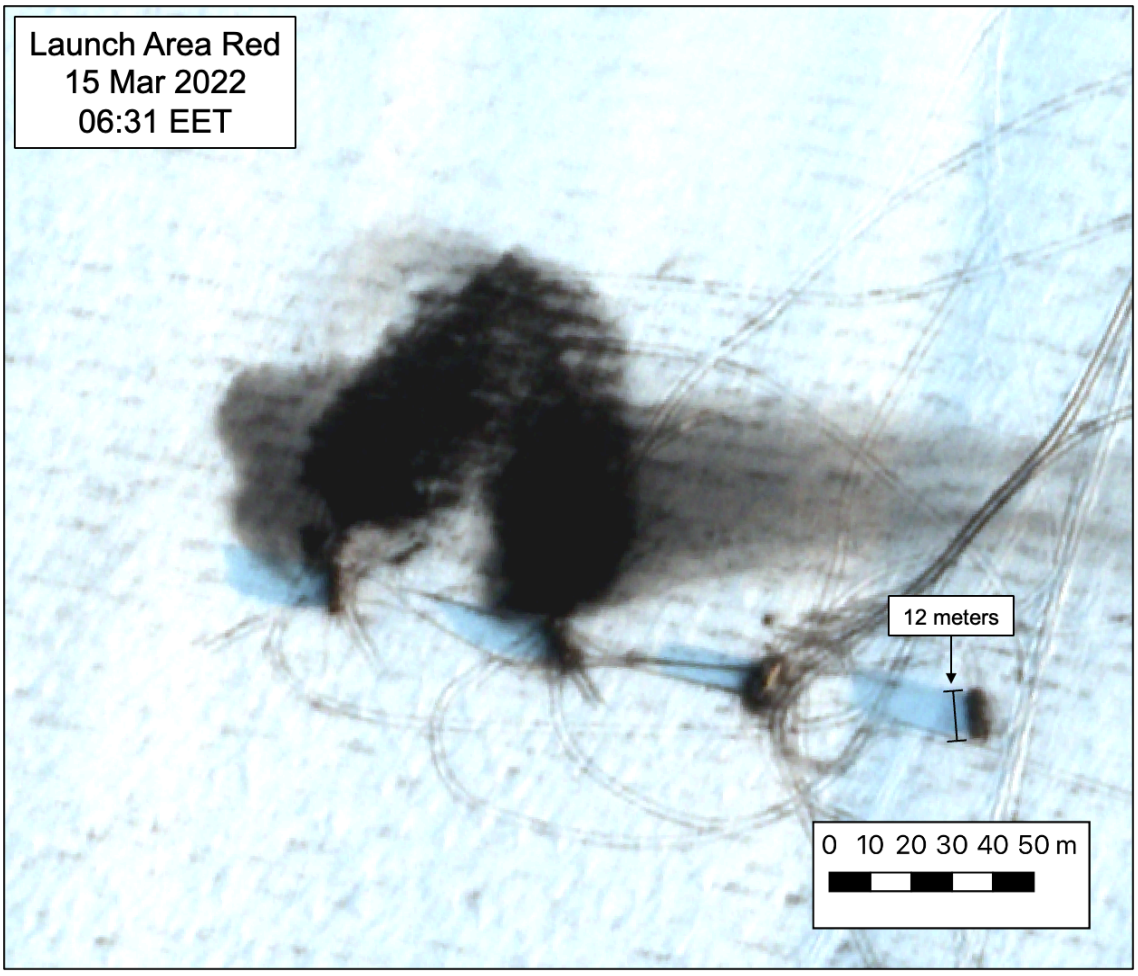



*Image 44: Four vehicles which appear to be launchers (Credit: © 2023 Planet Labs PBC).*

Assessing the level of activity across launch areas can be challenging. While examining this location over several satellite captures can provide information about how sites were used over that period, there is a risk that a single vehicle could be seen at multiple different locations, which could result in it being counted multiple times. As such, while an examination of all available satellite imagery can provide a useful overview of the launch area, counting the vehicles in a single capture may provide a more accurate picture of the number and types of vehicles operating in this launch area.

This is corroborated by both experts consulted in the course of this assessment. According to the imagery and targeting expert: "*The size of the deployment cannot be determined on imagery but is possibly at a Brigade level. While several probable MLRS launch sites have rightly been identified, some of them appear to be single launches and not all are spread out in a linear fashion. It is possible therefore that some may have either been training launches, launches against fleeting targets of opportunity, or as part of preparation surveys for future operations. In addition, care must be taken not to misidentify possible launch areas from other activity. This is*

*very easy to do where there is a limited amount of snow on the ground and the temperature is near melting point as appears to be the case in February and March 2022."*[95]

A high definition satellite image from 18/03/2022, which appears to have captured a large number of vehicles, was used for this purpose. In this image it was possible to identify several areas of activity in which vehicles were present at that moment. These have been labelled as Locations A-G below.

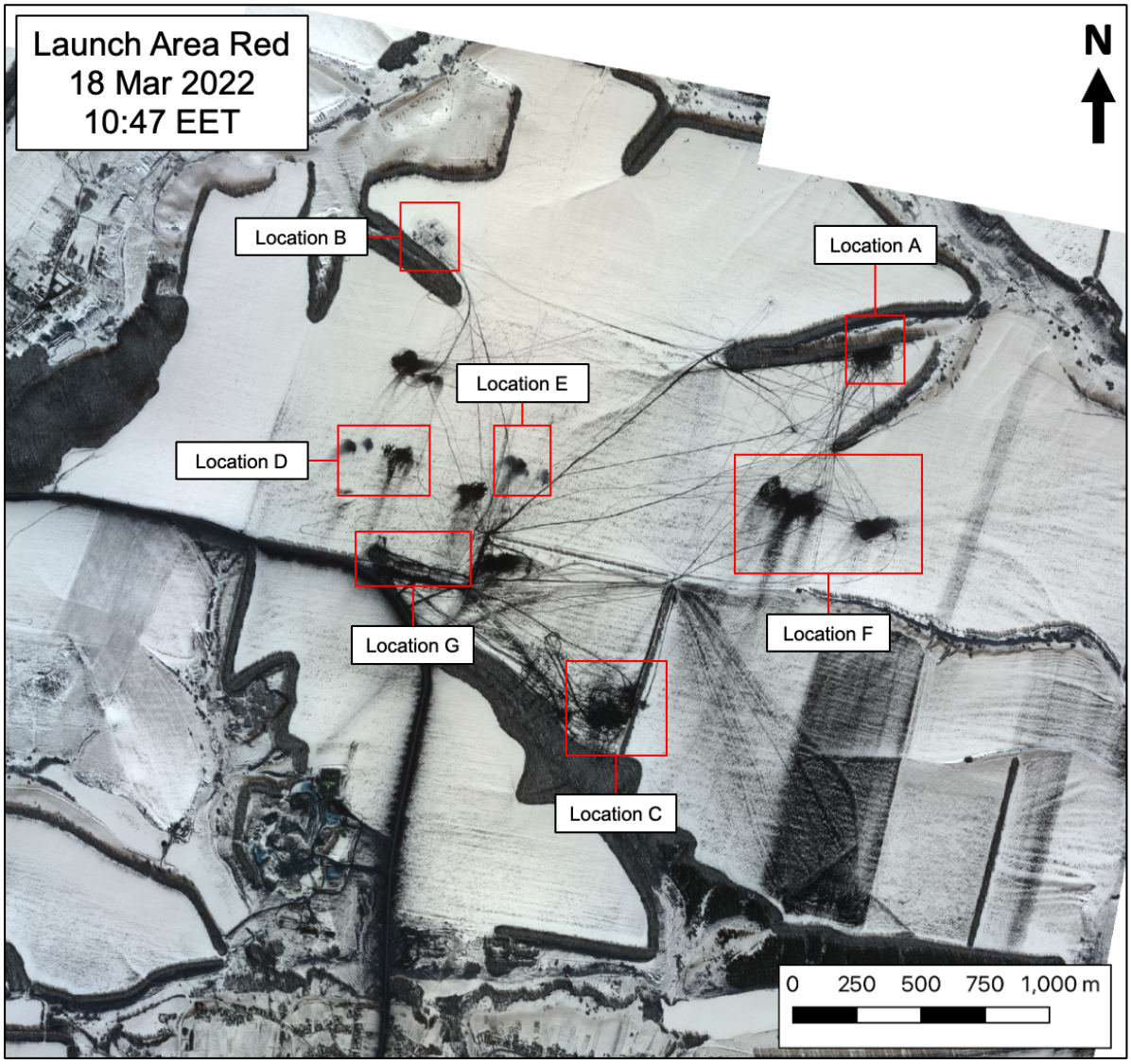



*Image 45: Satellite imagery from 18/03/2022 showing activity at the site of Launch Area Red (Credit: © 2023 Planet Labs PBC).*

[95] Senior ex-military satellite imagery expert.

**Location A:** IVO 50.339 36.341[96]

At Location A it is possible to identify four large vehicles and a large area in which snow was no longer present. This location was notable for several reasons, such as: the large numbers of vehicle tracks going to and from this location, including to locations which appear to be launch positions; the significant activity at the location itself, with tracks moving around the location rather than simply transiting through it; the presence of this location immediately next to a treeline.

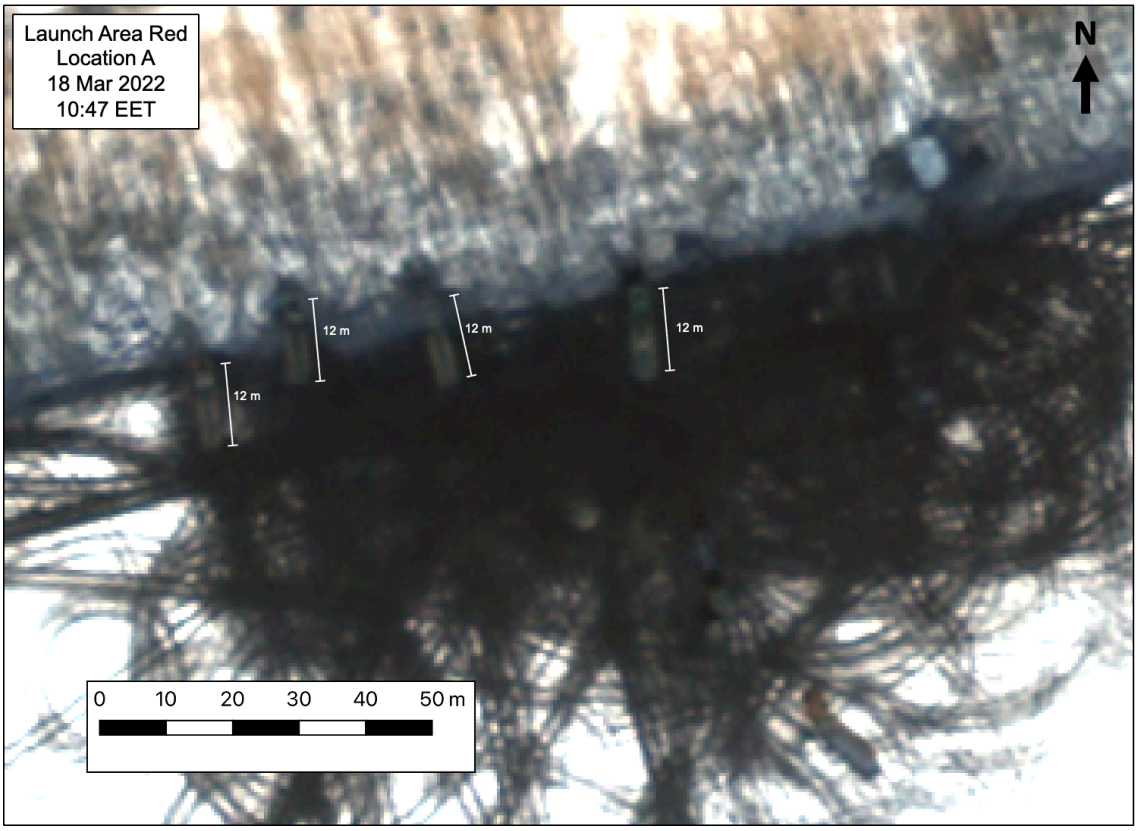



*Image 46: Location A, Launch Area Red in satellite imagery from 18/03/2022 (Credit: © 2023 Planet Labs PBC).*

Three of the four vehicles visible at this location appear to match the size and have the distinctive double lines of transporter-loaders for the BM-30 system. The fourth vehicle (on the right) does not match this distinctive feature, and appears to be slightly longer than 12 meters in length. It was not possible to identify this vehicle.

[96] https://maps.app.goo.gl/tnuV9FwCpbUPkrp7A



*Image 47: Left: Vehicles seen at Location A. Right: Suspected transporter-loader displaying distinctive double line from Location B on 15/03/2022 (Credit: © 2023 Planet Labs PBC).*

Satellite imagery of Location A displayed the presence of the transporter-loader vehicles, multiple intercrossing vehicle tracks and tracks leading to locations identified as launch positions and was immediately next to a treeline.

Together these factors indicate that Location A was a reloading site. This assumption was corroborated by the two experts. According to the targeting and imagery expert, the length and disposition of vehicles would strongly support the presence of launchers and transloaders respectively.[97] While, according to the artillery expert, presence of vegetation and a ravine suggest that it can be used as a shelter for personnel.[98]

**Location B:** IVO 50.343, 36.321[99]

Location B contained eight objects of note. Six of these objects were approximately 12 m in length, consistent in size with vehicles from the BM-30 system, and had tracks leading into their

[97] Senior ex-military satellite imagery expert.
[98] Artillery expert Petro Pyatakov Col (ret).
[99] https://maps.app.goo.gl/ZKnNgLh9rraUAwKC8

location, indicating they were indeed vehicles. Two other objects appear to be slightly longer, at approximately 15 m in length, consistent with ammunition transports.

This location also had the same characteristics as Location A, including: the large numbers of vehicle tracks going to and from this location, including to locations which appear to be launch positions; the significant activity at the location itself, with tracks moving around the location rather than simply transiting through it; The presence of this location immediately next to a treeline.

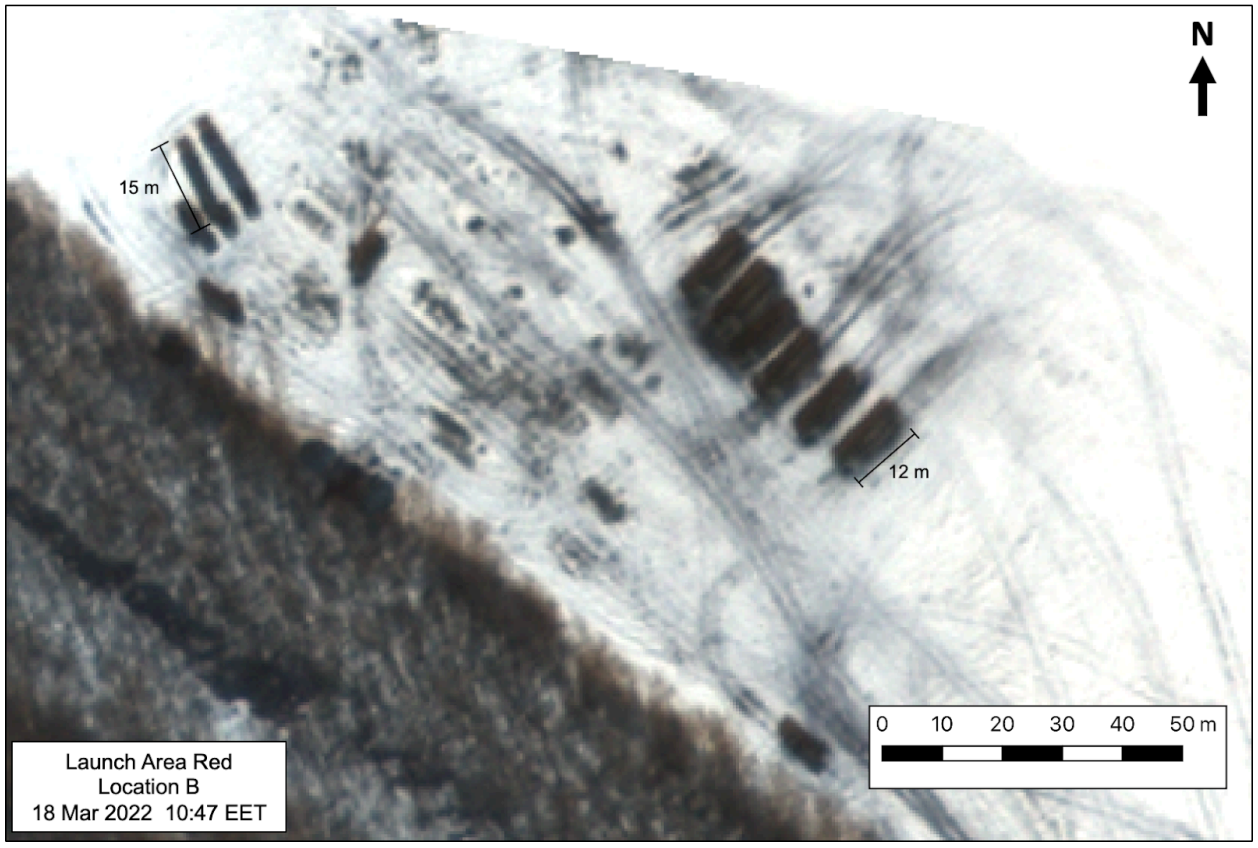



*Image 48: Location B, Launch Area Red in satellite imagery from 18/03/2022 (Credit: © 2023 Planet Labs PBC).*

The quality of the satellite imagery from this capture is sufficient to identify that there appear to be six vehicles of approximately 12 m in length present, and that they appear to display the distinctive double line of a BM-30 transporter loader.

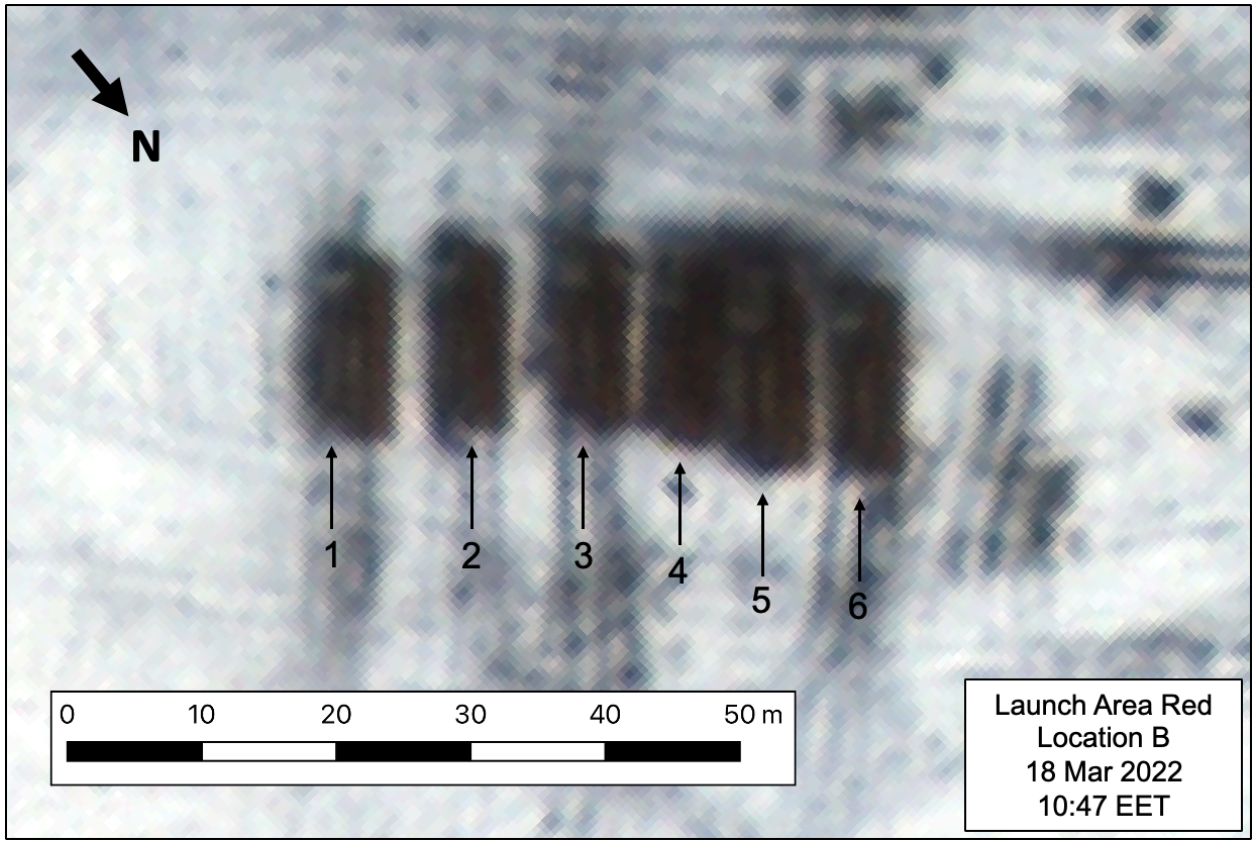



*Image 49: Possible transporter-loader vehicles at Location B, Launch Area Red in satellite imagery from 18/03/2022 (Credit: © 2023 Planet Labs PBC).*

Satellite imagery from the same location on 15/03/2022 shows five vehicles of the same length parked in the almost exactly the same location. It was therefore considered likely that they were the same vehicles. The vehicles present on 15/03/2022 certainly display the distinctive double line of a BM-30 transporter-loader. Taking this into account it is assessed that the vehicles seen at Location B on 18/03/2022 are indeed BM-30 transporter-loaders.

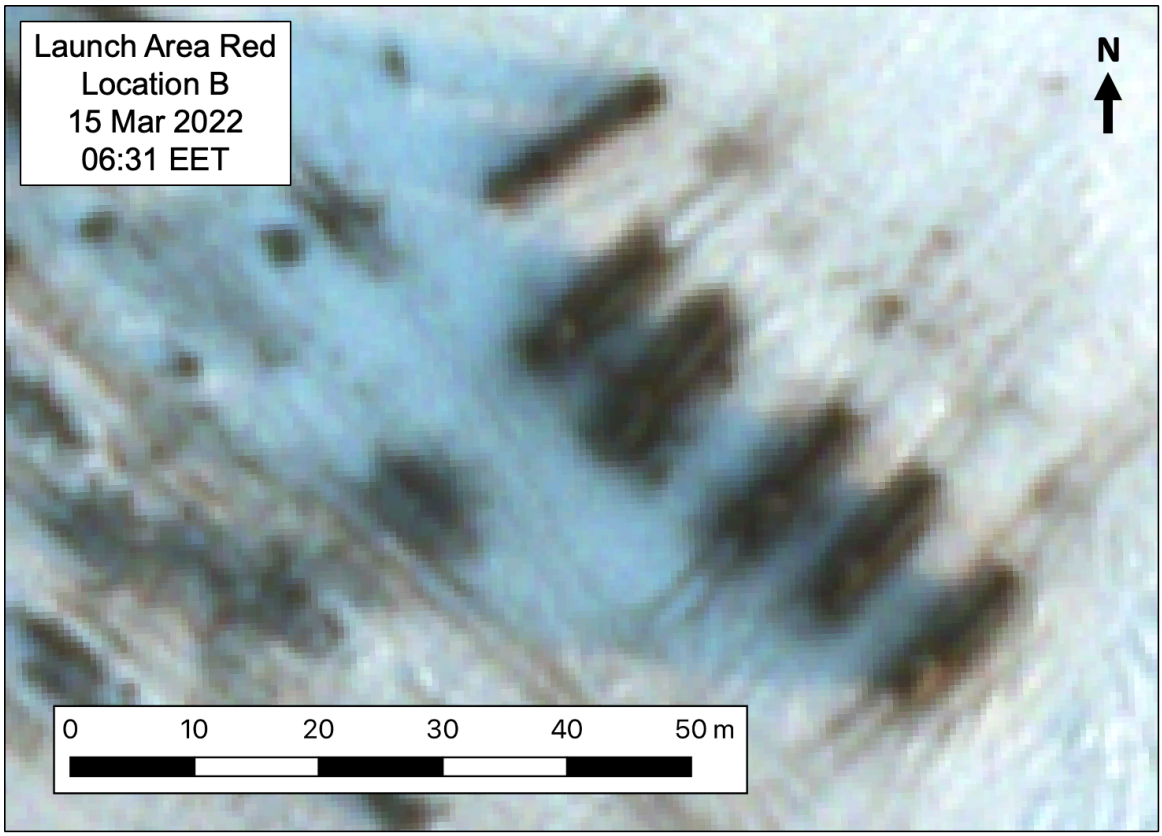



*Image 50: Vehicles at Location B, Launch Area Red in satellite imagery from 15/03/2022 (Credit: © 2023 Planet Labs PBC).*

Satellite imagery of Location B displayed the presence of BM-30 transporter-loader vehicles; the presence of long vehicles consistent with ammunition transports; multiple intercrossing vehicle tracks; tracks leading to locations identified as launch positions and was located immediately next to a treeline.

These factors indicate that Location B was a BM-30 reloading site. This was corroborated by both experts consulted for this report.

**Location C:** IVO 50.327 36.330[100]

At Location C, four objects which appear to be vehicles of approximately 8 m were identified in an area where there had been significant vehicle movement. Beside each object was a discoloured area of ground.

[100] https://maps.app.goo.gl/7YQ4do5eVhssW5PG8

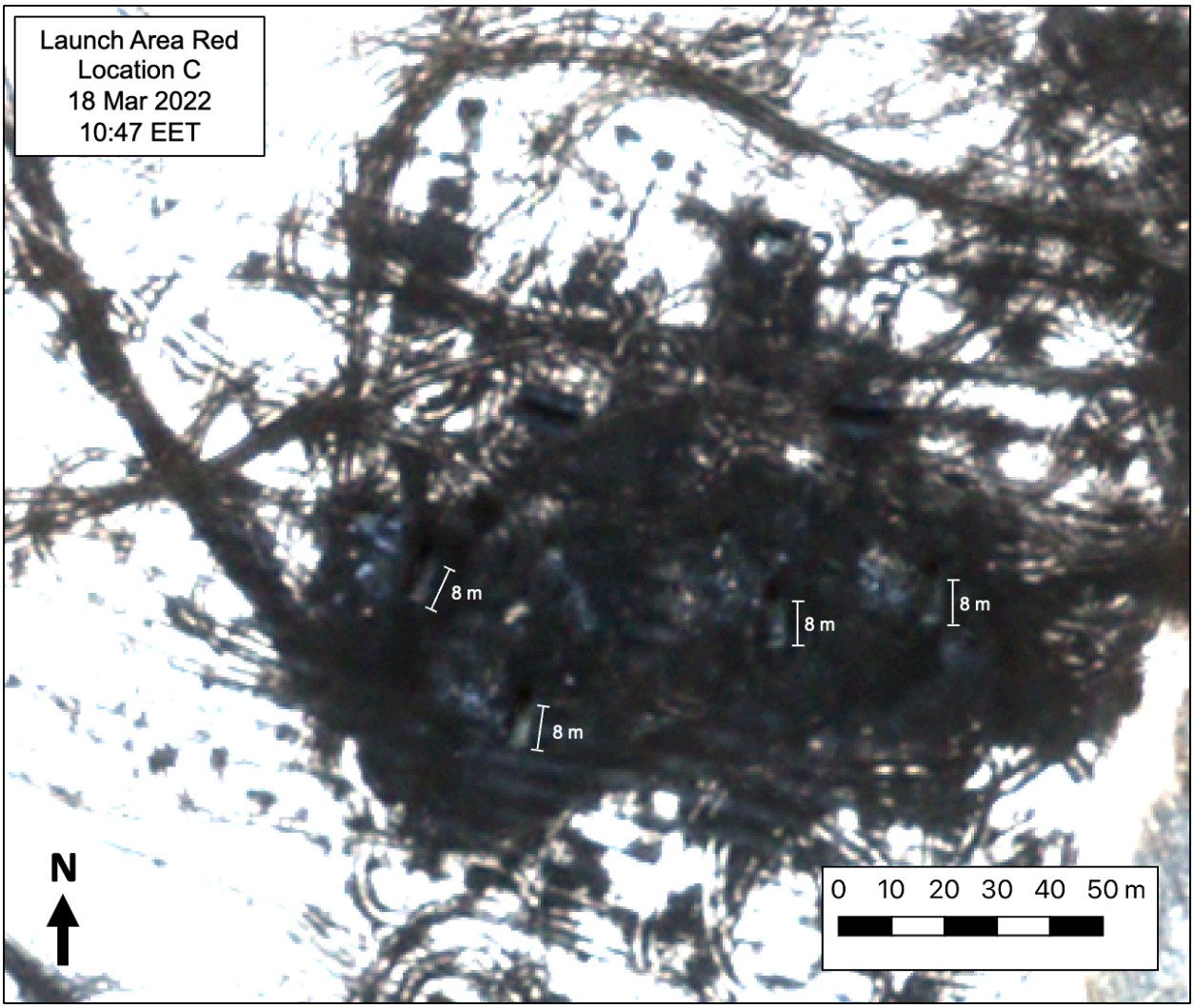



*Image 51: Location C, Launch Area Red in satellite imagery from 18/03/2022 depicting what appears to be four vehicles (Credit: © 2023 Planet Labs PBC).*

At approximately 8 m, the length of these vehicles indicate that they are not BM-30 transporter-loaders. Satellite imagery of Location C in mid-April from Maxar Technologies and available on Google Earth Pro may depict the same vehicles.

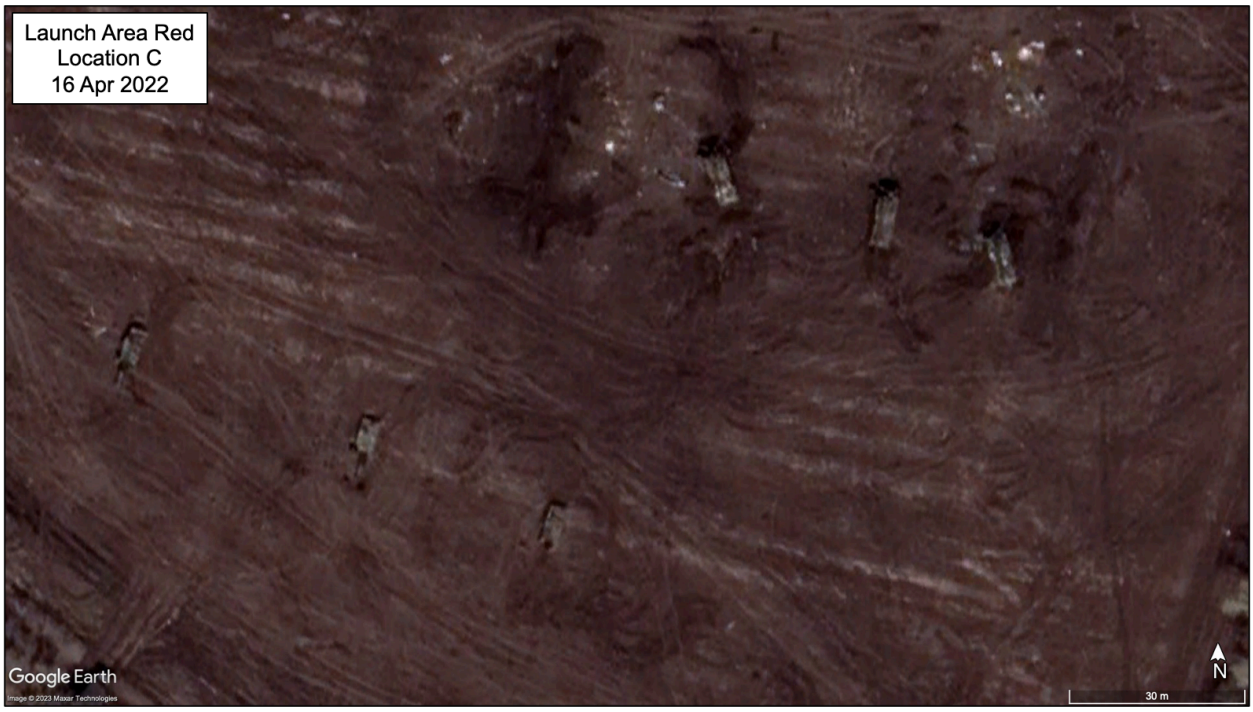



*Image 52: Location C, Launch Area Red in satellite imagery from 16/04/2022 depicting what appears to be six vehicles present at the site (Credit: Google/Maxar Technologies).*

The discoloured areas of ground next to these vehicles may be consistent with piles of crates used to transport 300 mm rockets, however this could not be established with high confidence. It is possible that these could be cranes used to load BM-30 missiles onto transporter-loaders, but the exact designation of these vehicles could not be established at the time of writing this report.

Satellite imagery of Location C displayed the following characteristics: a large numbers of vehicle tracks going to and from this location, including to locations which appear to be launch positions; significant activity at the location itself, with tracks moving around the location rather than simply transiting through it, and was located immediately next to a treeline.

As such it is considered a possibility that this is a reloading site of some kind, and that vehicles other than BM-30 transporter-loaders may have been used for loading. The artillery expert corroborates that this may be a reloading point due to the proximity of trees in the direction of launches, and presence of vegetation and a ravine that can be used as a shelter for personnel.[101] The imagery expert noted that, while there was a lot of activity at the Location C, there are no clear indications of MLRS launches or vehicles that can be identified as such and it is also possible the area was being used as a tactical field training area.[102]

[101] Artillery expert Petro Pyatakov Col (ret).
[102] Senior ex-military satellite imagery expert.

**Location D:** IVO 50.336, 36.317[103]

At Location D, three, possibly four, objects of approximately 12 m in length were identified. The tracks leading to and from their positions indicate that these are vehicles of some kind. Their apparent length is consistent with vehicles from the BM-30 system.

This location also included several areas cleared of snow or covered in a dark substance, such as earth or soot. Two of these discoloured areas appeared to be immediately next to two of the vehicles, indicating that they may be launchers and that the cleared area of snow is the result of a launch.

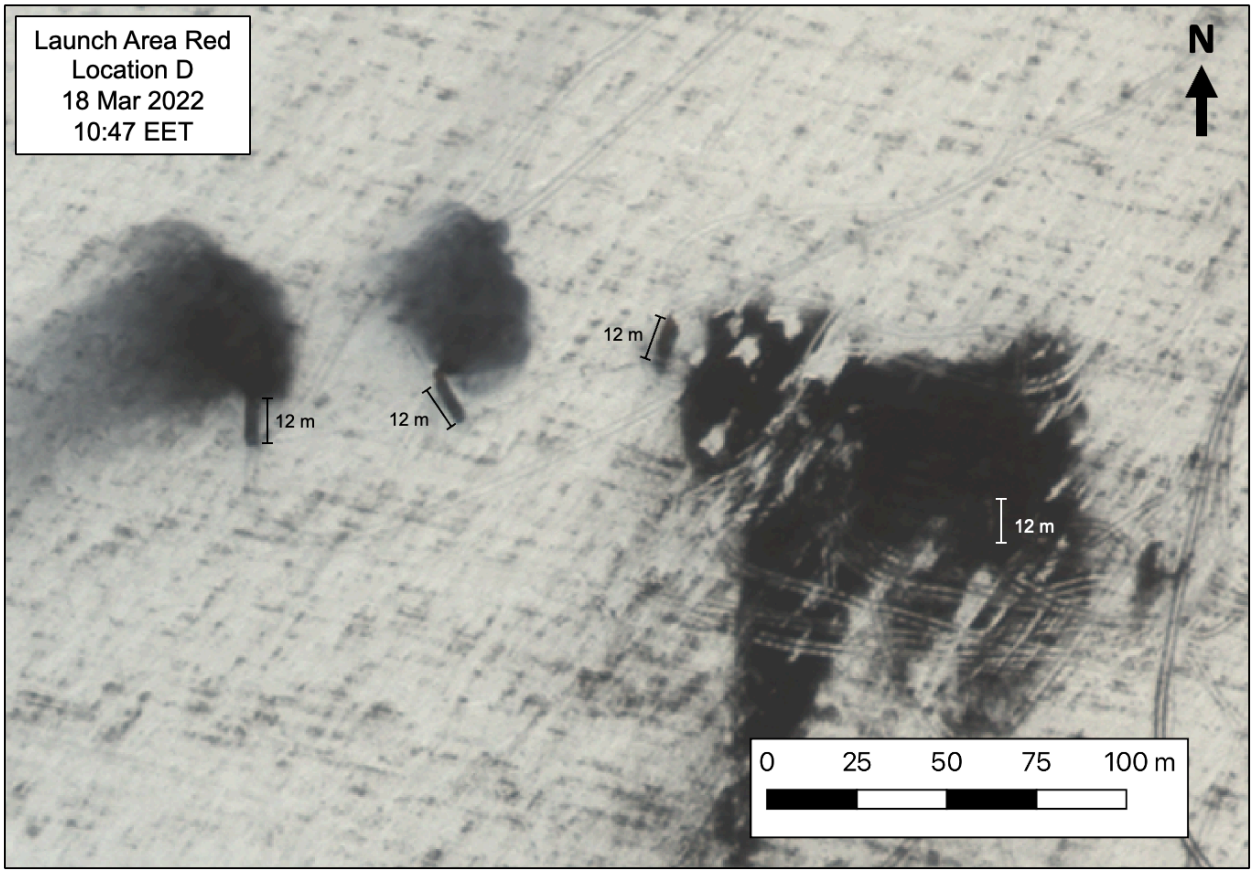



*Image 53: Location D, Launch Area Red in satellite imagery from 18/03/2022 depicting what appears to be four vehicles (Credit: © 2023 Planet Labs PBC).*

Satellite images of Location D displays the following characteristics: Located away from treelines; contains areas cleared of snow; has tracks leading to or from locations containing transporter-loaders; the presence of large vehicles of approximately 12 m.

These factors indicate that the vehicles present at Location D are launchers and that therefore this a launch position. This was corroborated by both experts consulted for this report.

[103] https://maps.app.goo.gl/qT8Boc9osHauTMmt7

**Location E:** IVO 50.337, 36.327[104]

At Location E, four objects of approximately 12 m in length were identified with tracks leading to them, indicating they are vehicles. As with Location D, next to these vehicles there appear to be areas where either the snow has been removed or which has been covered by a dark substance such as soot or dirt.

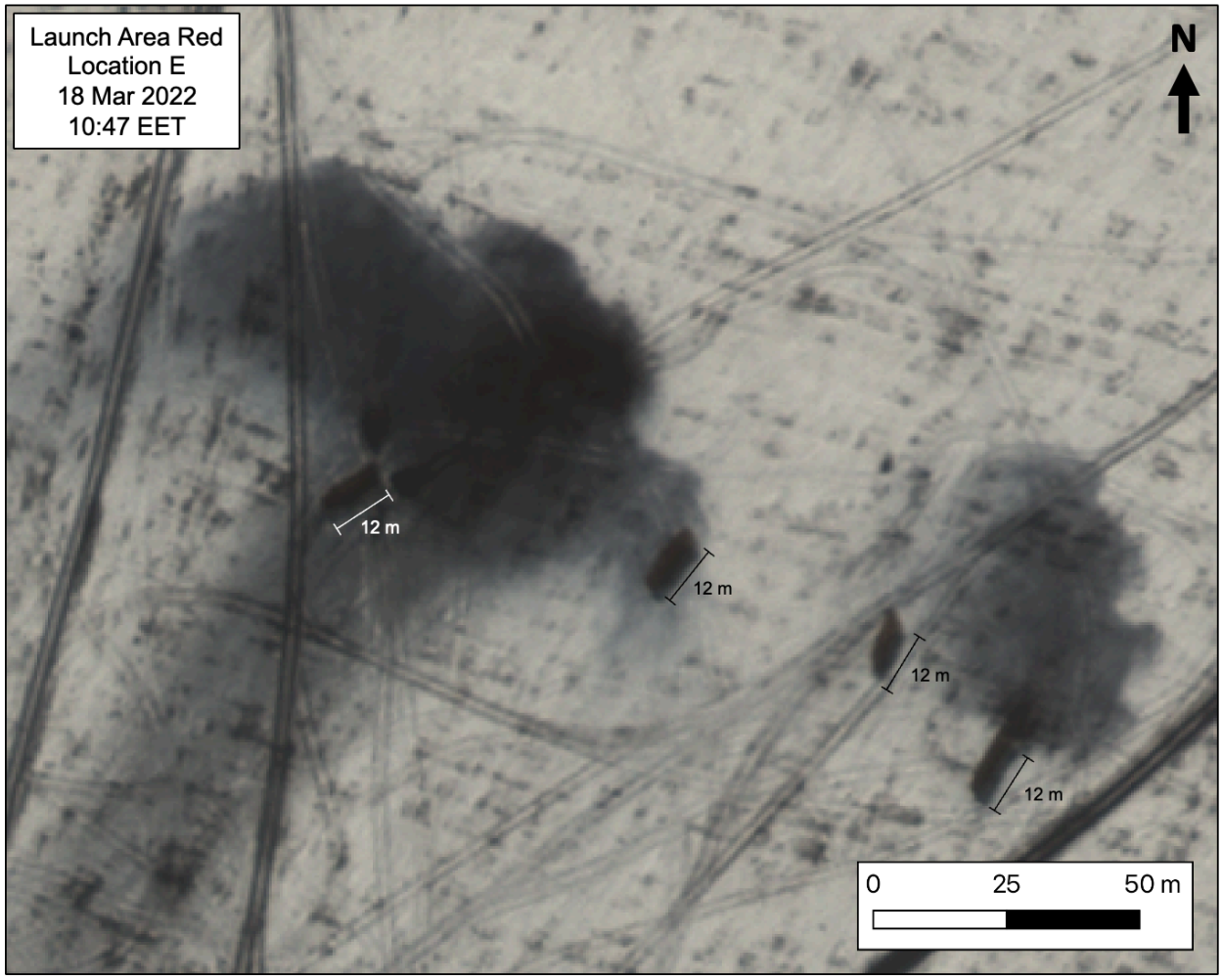



*Image 54: Location E, Launch Area Red in satellite imagery from 18/03/2022 depicting what appears to be four vehicles (Credit: © 2023 Planet Labs PBC).*

Satellite imagery of Location E displays the following characteristics: it is located away from treelines; contains areas cleared of snow; has tracks leading to or from locations containing transporter loaders. Has the presence of large vehicles of approximately 12 m.

These factors indicate that the vehicles present at Location E are launchers and that therefore this a launch position. This was corroborated by both experts consulted for this report.

[104] https://maps.app.goo.gl/8LK5bgmDmsbh5TwN9

**Location F:** IVO 50.334, 36.345[105]

At location F, three objects were identified which, based on the track marks, to and from their locations, appear to be vehicles of approximately 12 m in length. These vehicles are located in the center of areas which seem to have been cleared of snow.

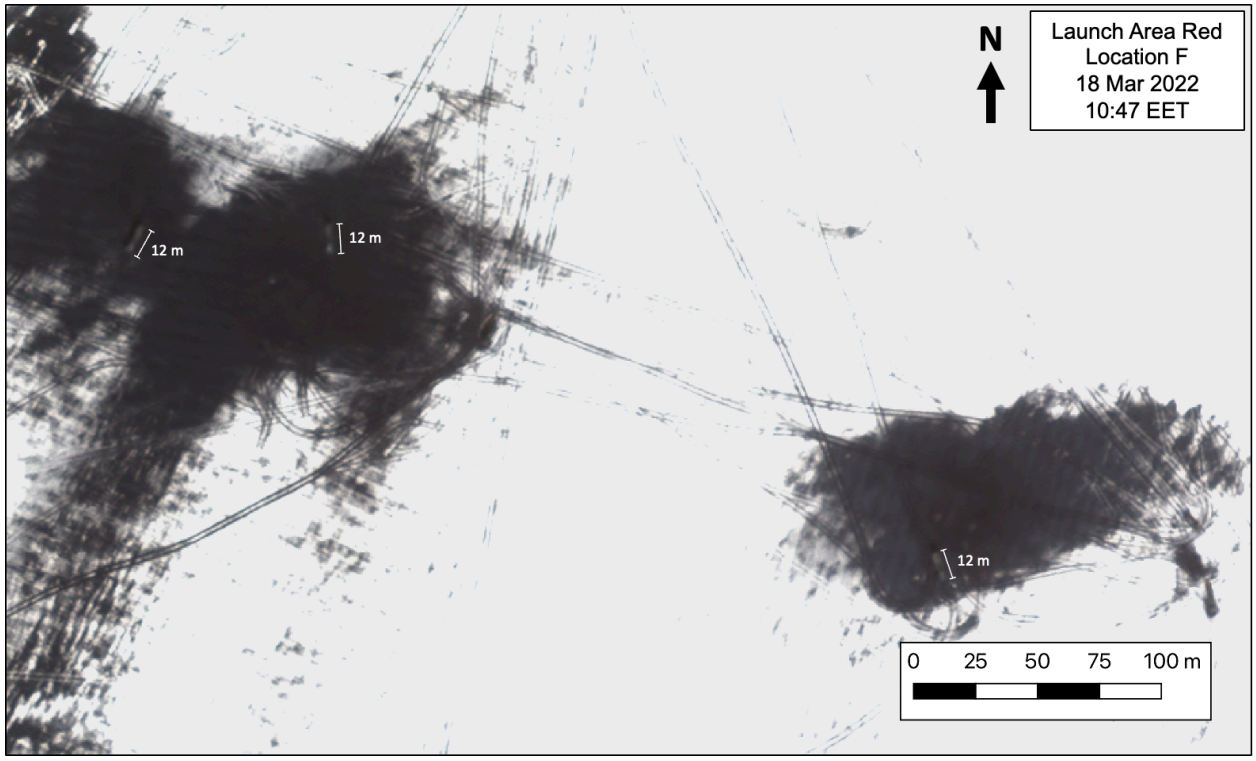



*Image 55: Location F, Launch Area Red in satellite imagery from 18/03/2022 depicting what appears to be three vehicles (Credit: © 2023 Planet Labs PBC).*

Further ortho-rectified imagery from Maxar Technologies which was captured on 23/03/2022 and measured using mensuration tools in Google Earth Pro confirms the presence of vehicles, of which four are approximately 12 m in length and two of approximately 9 m in length.

[105] https://maps.app.goo.gl/RSuzAZ5MRfsUxdq4A

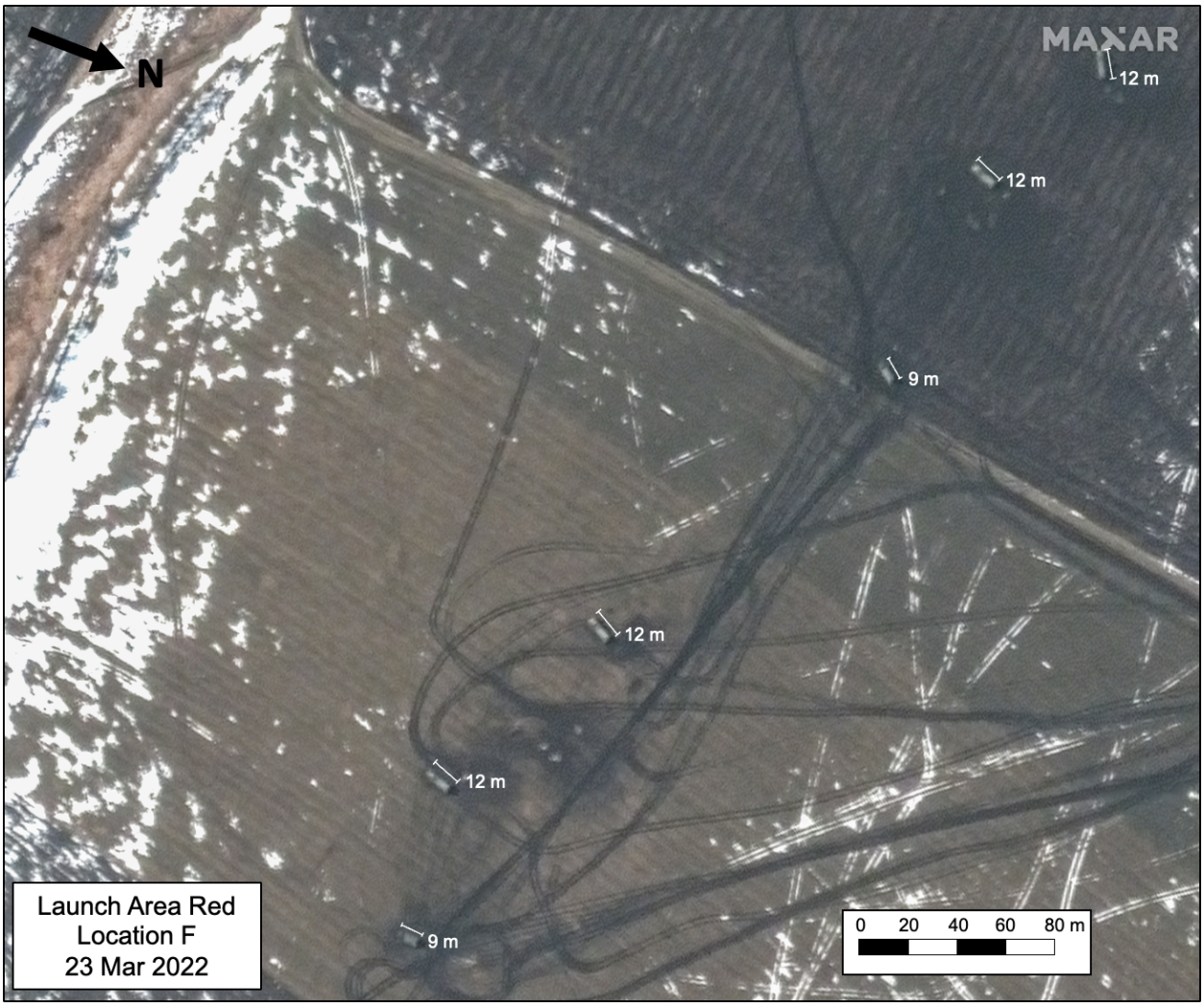



*Image 56: Location F, Launch Area Red in satellite imagery from 23/03/2022 depicting what appears to be four vehicles of 12 m in length (Credit: Maxar Technologies).*

Satellite imagery of Location F displays the following characteristics: it is located away from treelines; it contains areas cleared of snow consistent with a launch site; there are tracks leading to or from locations containing transporter loaders; it has the presence of large vehicles of approximately 12 m.

These factors indicate that the vehicles present at Location F are BM-30 launchers and that therefore this is a launch position. This was corroborated by both experts consulted for this report.

**Location G:** IVO 50.332, 36.320[106]

Location G contains an encampment in which there are 11 tents, each of 10 m in length. Immediately to the east of these tents there is a vehicle park of some kind, with multiple vehicles

[106] https://maps.app.goo.gl/9G68KtTsAZkGWNcj6

present. None of these vehicles are large enough to be BM-30 launchers, transporter loaders or ammunition transports.

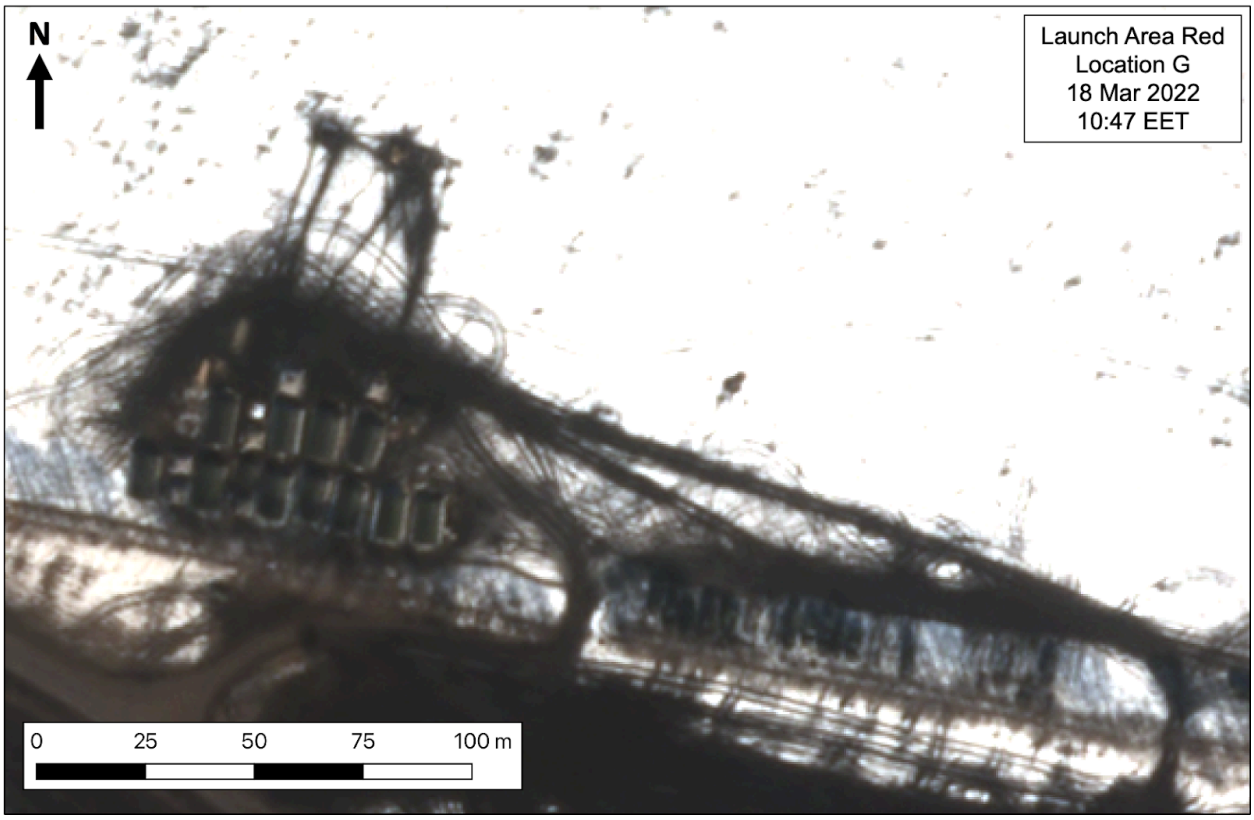



*Image 57: Location G, Launch Area Red in satellite imagery from 18/03/2022 depicting several tents and what may be vehicles (Credit: © 2023 Planet Labs PBC).*

The proximity of these tents to the launch and reloading locations indicates that this may be a headquarters of some kind. The military expert has suggested that this might be a field camp[107]; while the imagery and artillery expert[108] indicated that this may be a command post with command vehicles and associated tents.

**Additional sites**

Two additional sites associated with MLRS activity were identified which were not captured in high resolution imagery from 18/03/2022: Location H and Location I. One further site, Location J, consisting of a large number of tents and vehicles, was identified on the southern edge of Launch Area Red, however there was no strong indication that it was associated with BM-30 activity. It has been included here for completeness.

[107] Artillery expert Petro Pyatakov Col (ret).
[108] Senior ex-military satellite imagery expert.

**Location H:** IVO [50.302 36.306](https://maps.app.goo.gl/dNDnSBskpNzcvbfQ8)[109]

Location H comprises two subsites - in the north, an area near a treeline which has seen considerable localised activity, and in the south, a grouping of three or four areas in which snow has been removed, consistent with a launch position. While some activity is visible here from 27/02/2022, the localised activity in the north and likely launch position are first clearly identifiable on 11/03/2022.

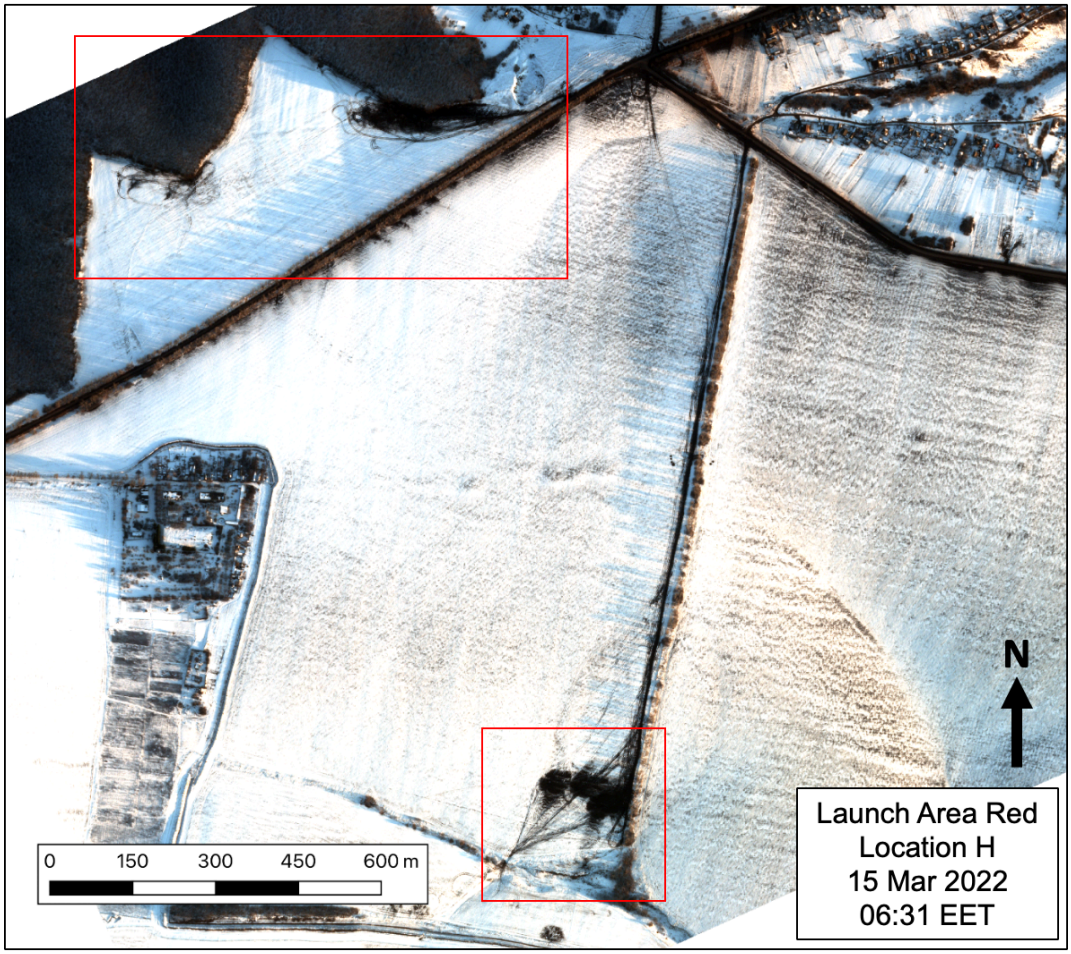



*Image 58: Location H, Launch Area Red in satellite imagery from 15/03/2022 depicting an area to the north displaying significant localised activity and an area to the south which is consistent with a launch position (Credit: © 2023 Planet Labs PBC).*

Satellite imagery of Location H displays the following characteristics: Significant vehicle activity next to a treeline and areas cleared of snow with vehicle tracks leading to and from these areas

Given the proximity to the BM-30 locations further to the north, it seems possible that this is also a BM-30 launch site. This was described by experts as a harbour area as there is a place

[109] https://maps.app.goo.gl/dNDnSBskpNzcvbfQ8

nearby for sheltering personnel, weapons and equipment. Additionally, it is near the starting positions, and as close as possible to the border to obtain greater depth of attack.[110]

**Location I:** IVO 50.352, 36.275[111]

Location I is consistent with a launch position. This location is first evident on PlanetScope imagery on 18/03/2022, however it is first captured on high resolution imagery on 21/03/2022. On that date it is possible to identify several large areas of cleared snow consistent with other launch positions.

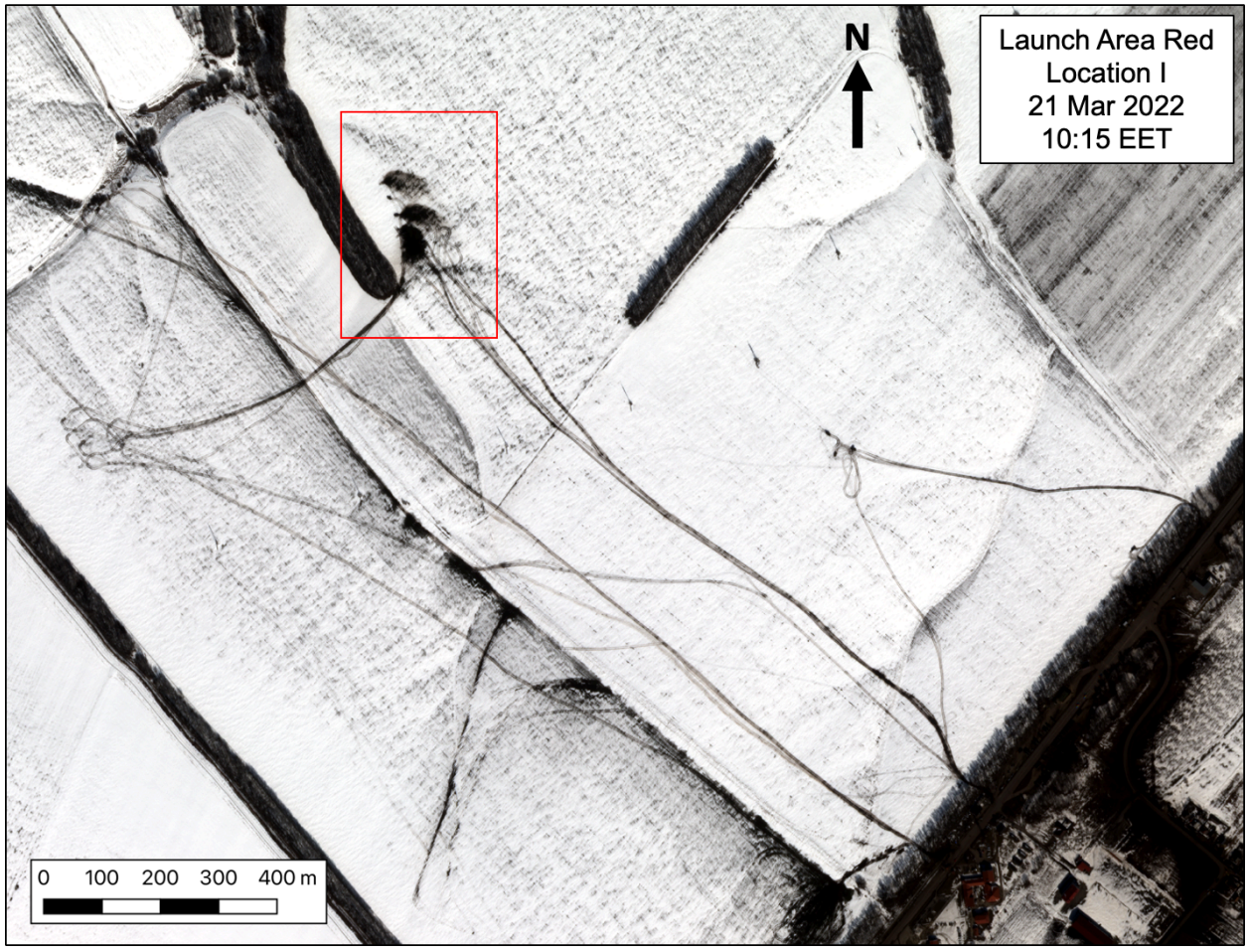



*Image 59: Location I, Launch Area Red in satellite imagery from 21/03/2022 depicting tracks and an area highlighted in red displaying cleared areas of snow consistent with a launch position (Credit: © 2023 Planet Labs PBC).*

Satellite imagery of Location I location displays the following characteristics: areas cleared of snow consistent with a launch site; multiple intercrossing vehicle tracks.

[110] Artillery expert Petro Pyatakov Col (ret).
[111] https://maps.app.goo.gl/QTFwrA49Ggpjc4DaA

While this location is slightly geographically separated from the rest of Launch Area Red, specifically by the E105 highway, the tracks leading to the apparent launch position do originate from the east, where Launch Area Red is. As such it has been included as part of that area. According to the artillery expert, this area was likely used as a temporary starting position for performing a separate task.[112]

**Location J:** IVO 50.309 36.313[113]

Location J was identified on the southern edge of Launch Area Red. It contains tents and what appears to be a vehicle park. It was not possible to identify if Location J was part of the BM-30 unit operating within Launch Area Red or if it was a separate formation; however, none of the vehicles at Location J appear to have been BM-30 launchers, transporter-loaders or ammunition transports. This location appears to have become active between 11-15/03/2022 until at least 21/03/2022. A satellite image taken on 07/04/2022 showed this location to be empty.

The artillery expert has suggested that this may be an area of probable location of the operational group of the rocket artillery brigade in the composition - brigade management up to 2 READONs of limited composition (field camp and use of urban infrastructure).[114]

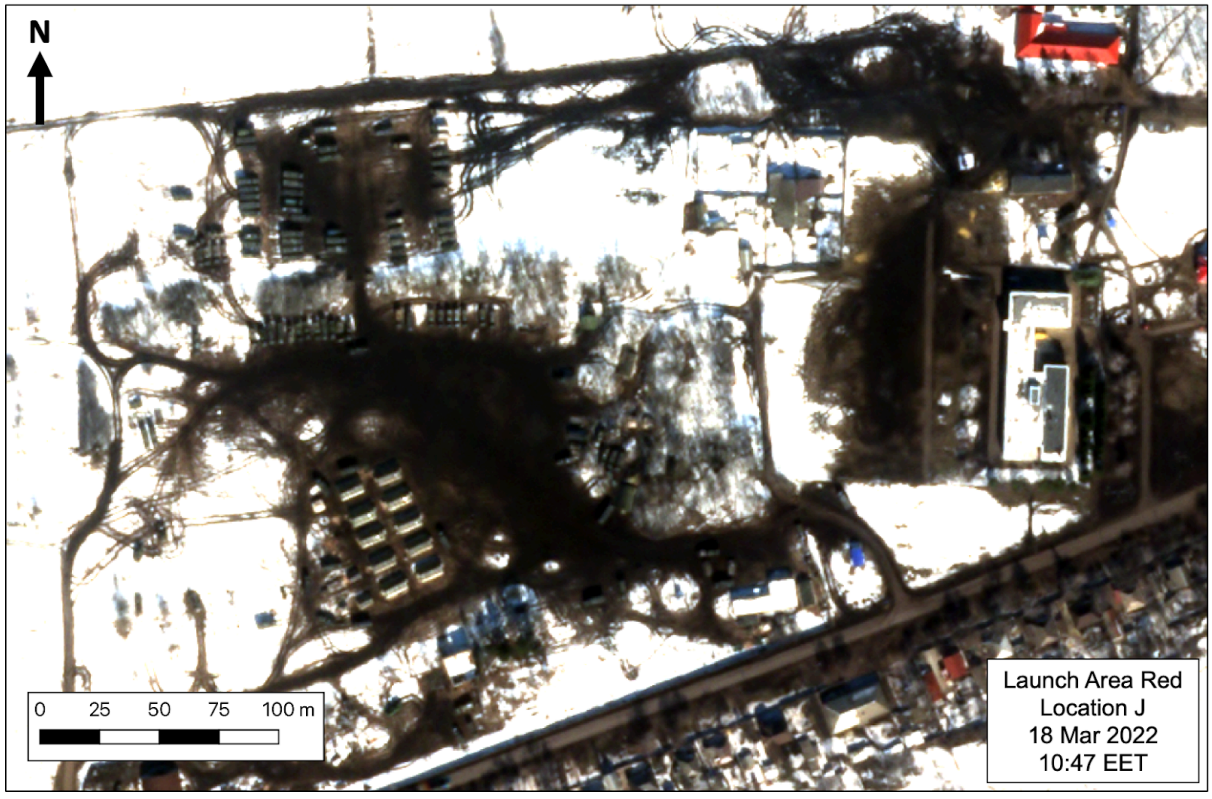



*Image 60: Location J, Launch Area Red showing a large number of tents and vehicles (Credit: © 2023 Planet Labs PBC).*

[112] Artillery expert Petro Pyatakov Col (ret).
[113] https://maps.app.goo.gl/6aYMVk2Lq1MVafyv9
[114] Artillery expert Petro Pyatakov Col (ret).

**Launch Area Red Summary**

Reviewing satellite imagery of Launch Area Red over the period in question revealed the presence of what appear to be BM-30 transporter loaders, launch vehicles, ammunition transports, burn marks and vehicle activity. All these factors indicate that Launch Area Red was a launch area for the BM-30 system. A review of vehicles visible in imagery taken on 18/03/2022 allows us to better understand the scale of the activity at this site. It was possible to identify:

1. Three locations which appear to be consistent with launch positions, containing nine or ten vehicles in total which are assessed to likely be launch vehicles.
2. Two locations which appear to be reloading areas for the launchers, containing ten transporter-loaders in total.
3. One location which may be a reloading area, in which there were 4 vehicles which were too small to be transporter-loaders.

It is likely that further vehicles were not visible in this capture, either due to activity taking them outside the area of the capture, or due to being hidden.

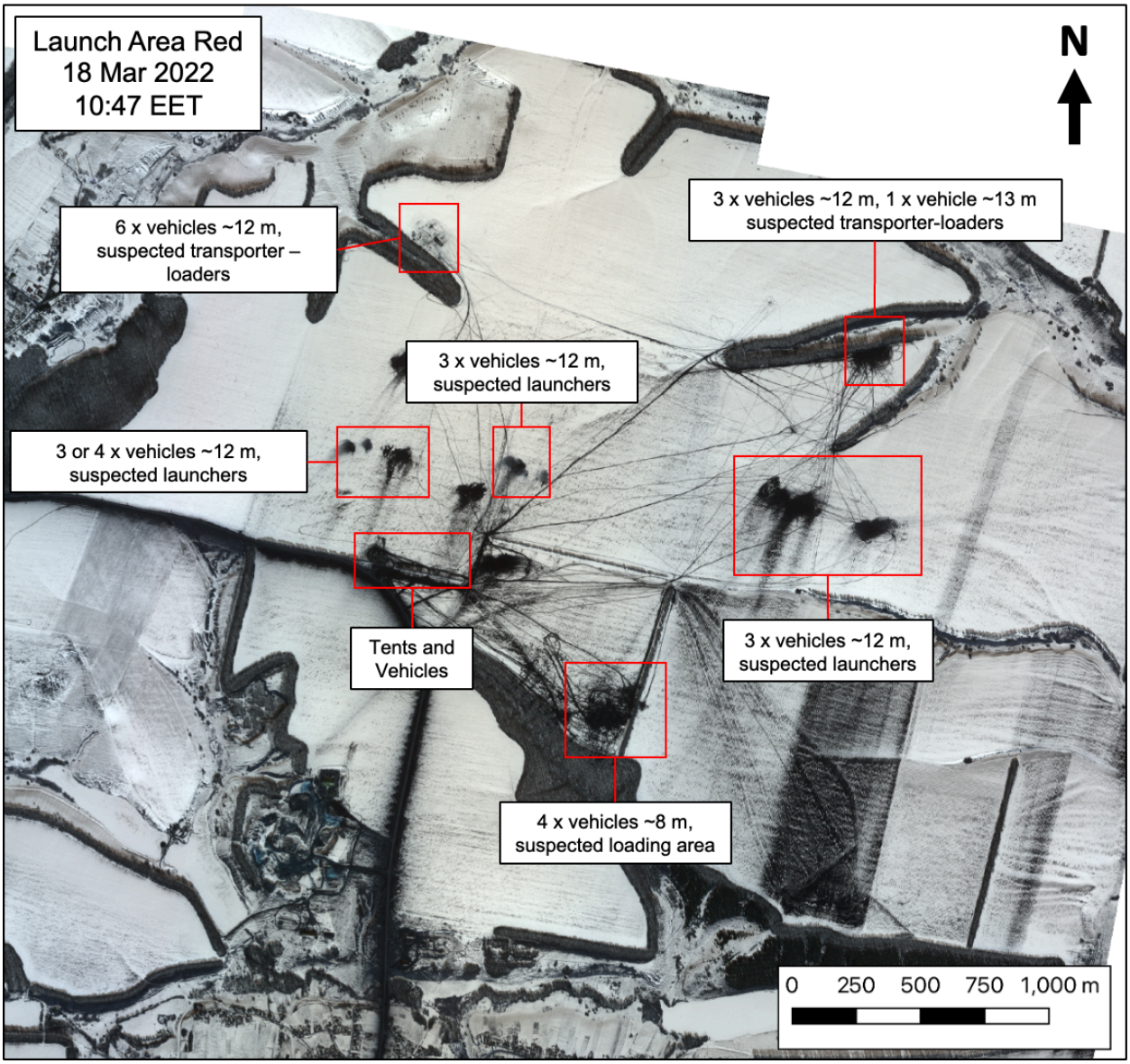



*Image 61: Summary of vehicles seen at Launch Area Red on 18/03/2022 (Credit: © 2023 Planet Labs PBC).*

The satellite imagery expert stated: "*Area Red comprises terrain that is entirely consistent with MLRS launches. Area Red as a whole is significant as it is clearly a Russian land force deployment area… The size of the deployment cannot be determined on imagery but is possibly Bde [Brigade] level.*"[115]

The artillery expert consulted corroborates this assessment: "*[Area Red] is probably the area of operational use of an operational group of the rocket artillery brigade in [...] of limited composition.*"[116]

[115] Senior ex-military satellite imagery expert.
[116] Artillery expert Petro Pyatakov Col (ret).

## Launch Area Orange

Launch Area Orange was identified in the vicinity of 50.30, 36.66[117].

High resolution satellite imagery of this area was not available during the period of interest, and as such the analysis of this area was primarily based on Planet Labs PlanetScope. With a resolution of approximately 3 m per pixel, some potential indications of MLRS activity was visible, however more granular details, such as the identification of specific vehicles from the BM-30 system, was not possible.

Using imagery from Planet Labs PlanetScope, it was possible to identify cleared areas of snow in the vicinity of Launch Area Orange. In a PlanetScope image captured on 27/02/2022, it was possible to identify a grouping of approximately 17 areas of clear snow which appeared to be consistent with other launch areas. In one PlanetScope image a launch of some kind is evident, but it could not be confirmed to be from a BM-30.

[117] https://maps.app.goo.gl/e5X3rka1yTcyKExm6

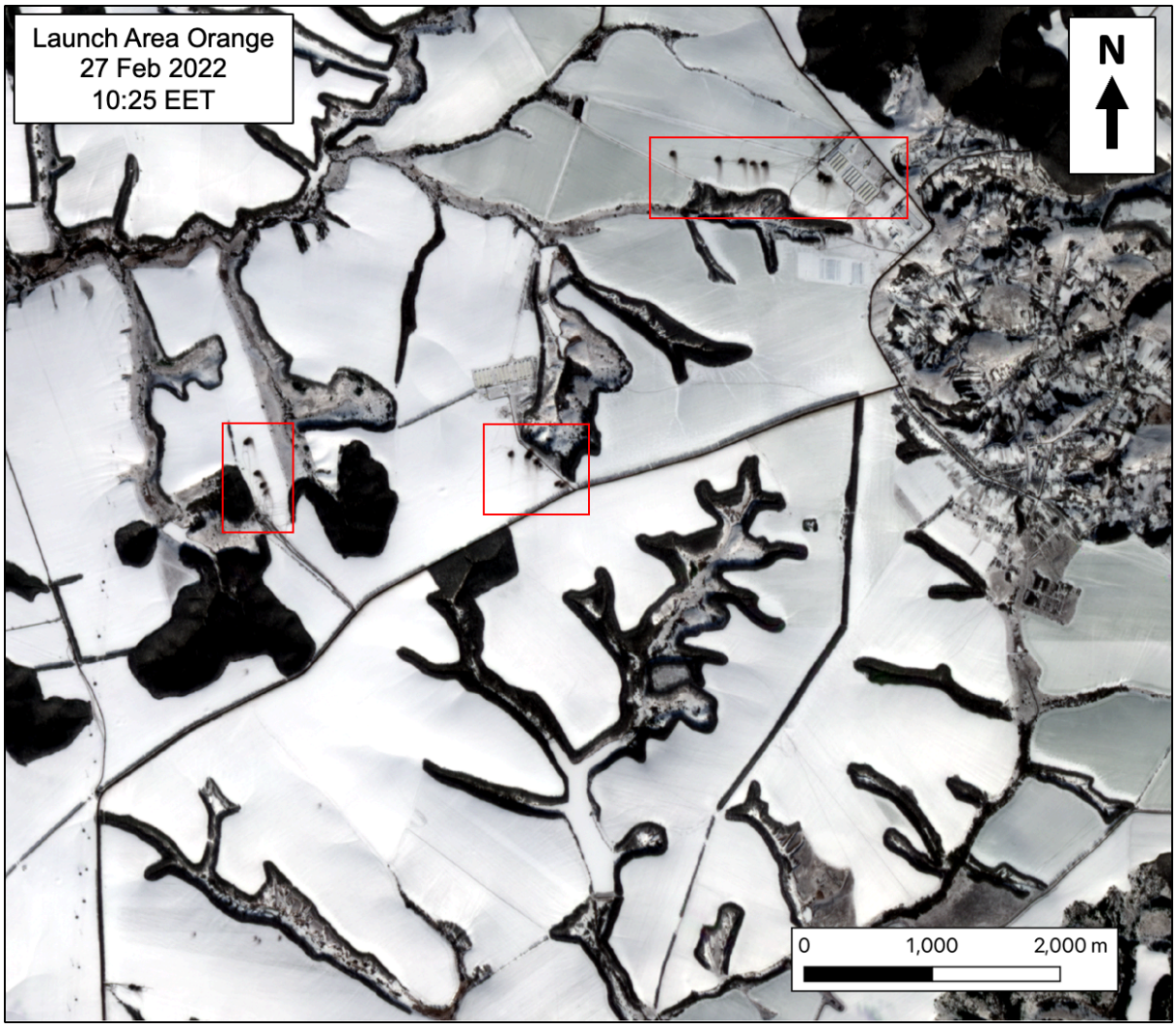



*Image 62: Points of interest within Launch Area Orange (Credit: © 2023 Planet Labs PBC).*

As such, without high resolution imagery, it was not possible to definitively link this area to a BM-30 area of operation and as such this area has been included for completeness.

There was a significant amount of vehicle activity in the vicinity of Launch Area Orange, with track marks and amongst fields and along treelines which only appeared after February 2022, indicating an increase of activity at this area after the full scale invasion.

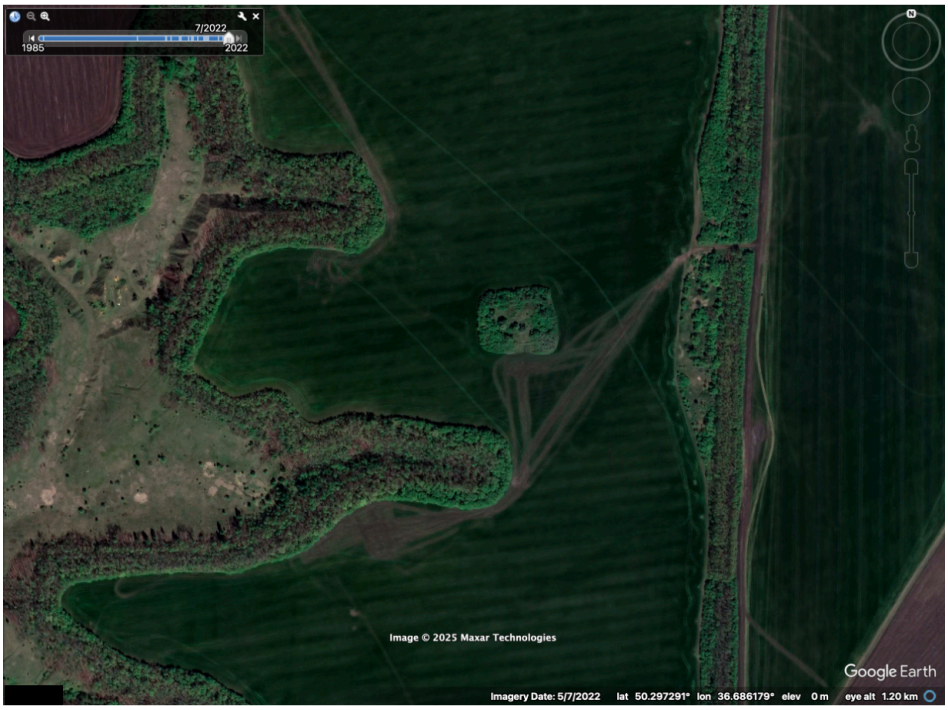



*Image 63: Example of activity seen in satellite imagery from 07/05/2022 at [50.296, 36.682](https://maps.app.goo.gl/RDuyCM1XGaawfL6u6)[118] (Credit: Google/Maxar Technologies).*

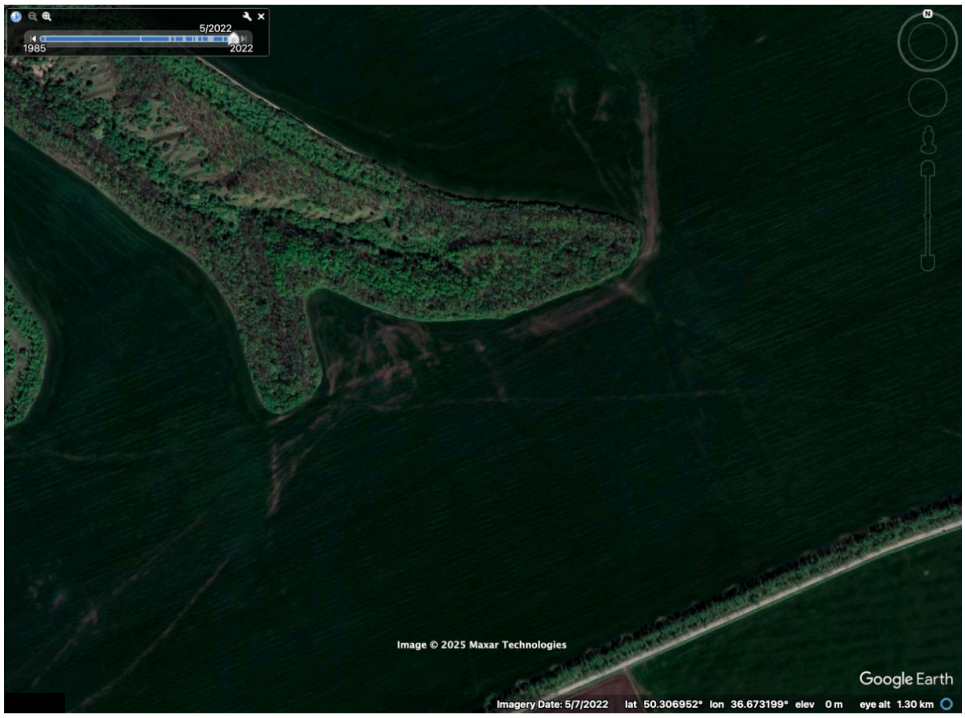



*Image 64: Example of activity seen in satellite imagery from 07/05/2022 at [50.307, 36.671](https://maps.app.goo.gl/XyNkPuUMspCkSh4A8)[119] (Credit: Google/Maxar Technologies).*

[118] https://maps.app.goo.gl/RDuyCM1XGaawfL6u6
[119] https://maps.app.goo.gl/XyNkPuUMspCkSh4A8

One image from 27/02/2022 appears to have captured this area moments after a rocket launch from 50.3003, 36.6532[120], with a distinctive white trail emerging from a position containing what appear to be burn marks. The satellite imagery expert noted that this image undoubtedly showed a launch of some kind, but that the exact type could not be confirmed without further information, and that a BM-30 launch was only one possibility.

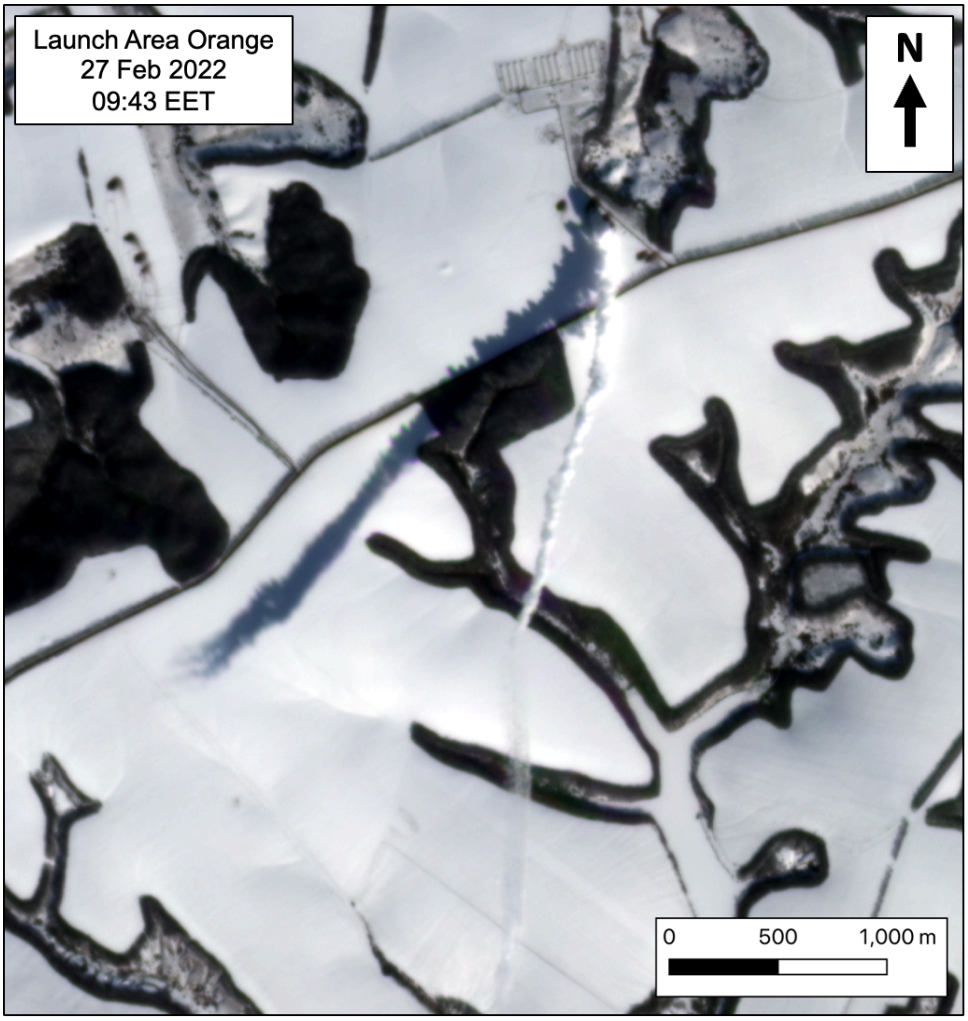



*Image 65: Missile launch identified from Launch Area Orange (Credit: © 2023 Planet Labs PBC, first identified by Michael Sheldon of the DFR Lab).*

The PlanetScope image from 27/02/2022 at 09:43 EET depicts a thick, white smoke trail originating from a firing position within the northerly grouping. A Grad rocket launch[121] includes many more rockets, which do not leave a thick smoke trail. A review of BM-27 Uragan launches in both warm[122] and cold[123] weather indicated that its 220 mm rockets do not leave a thick white smoke trail either.

[120] https://maps.app.goo.gl/R26LUBJhS3dbcGZHA
[121] https://www.youtube.com/watch?v=WLAopLm7icE&t=4s
[122] https://www.youtube.com/watch?v=7IDtjKWCOhI
[123] https://www.youtube.com/watch?v=_LaZp3sWD4g

BM-30 Smerch launches[124] certainly do create a thick, white smoke trail consistent to that seen in the 27/02/2022 09:43 EET imagery. However, it should be noted that Iskander ballistic missiles[125] also create a similar thick, white plume and as such could also be a candidate.

PlanetScope imagery from 10/03/2022 depicts five further points of interest of what appears to be cleared snow within this area. Given the poor weather and lack of imagery during that period, these could have appeared any time between 27/02/2022 and 10/03/2022.

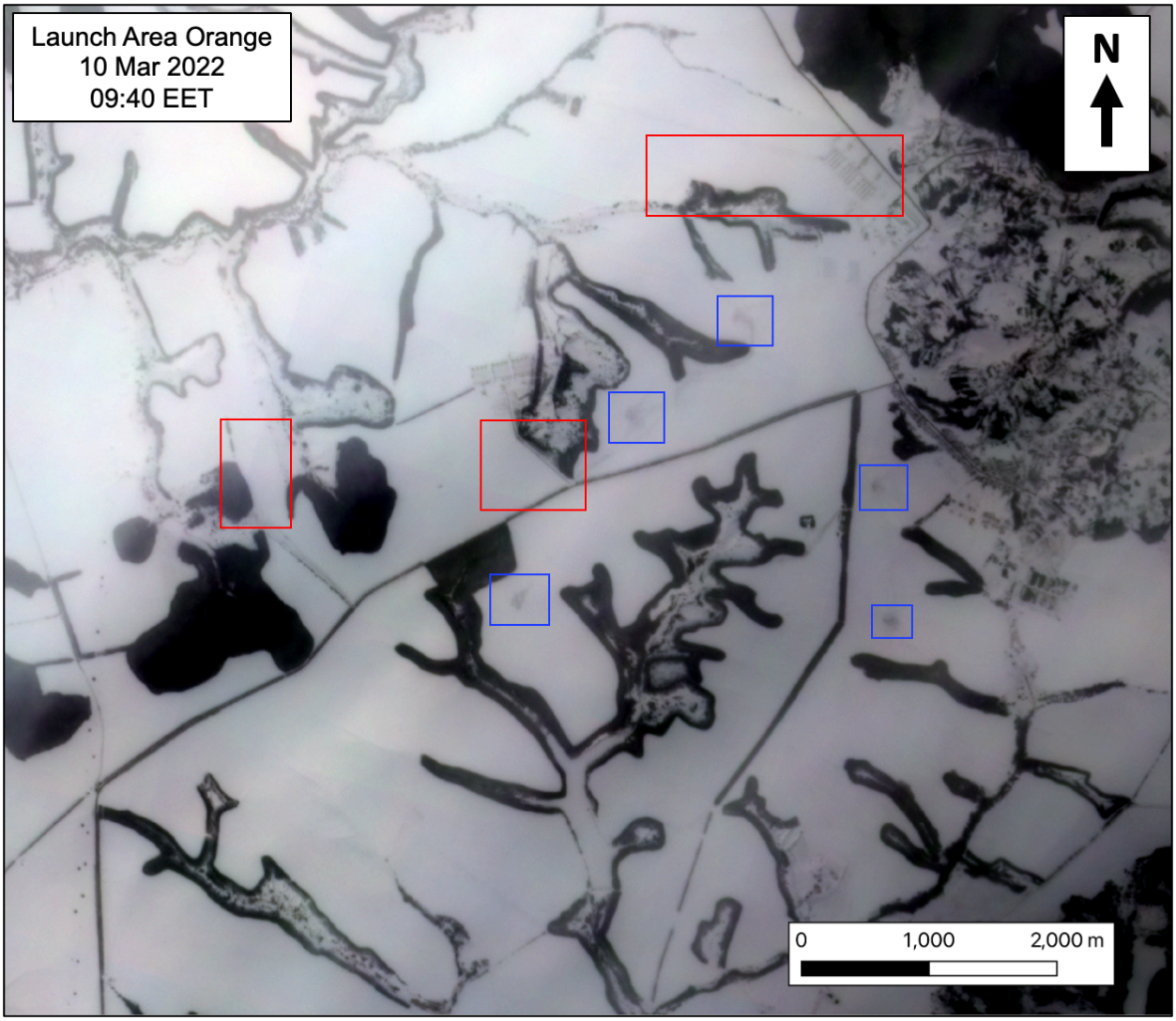



*Image 66: Launch Area Orange in satellite imagery from 10/03/2022 depicting new positions, highlighted in blue, within the northerly grouping. (Credit: © 2023 Planet Labs PBC).*

Although the positions first seen on 10/03/2022 are less clear than the positions seen on 27/02/2022, PlanetScope imagery from 28/03/2022 depicts black marks at the new points of

[124] https://t.me/mod_russia/16719
[125] https://www.youtube.com/watch?v=zLjGbjdmoOo

interest which were located on vegetation, indicating they are not simply areas clear of snow, but instead more permanent scarring.

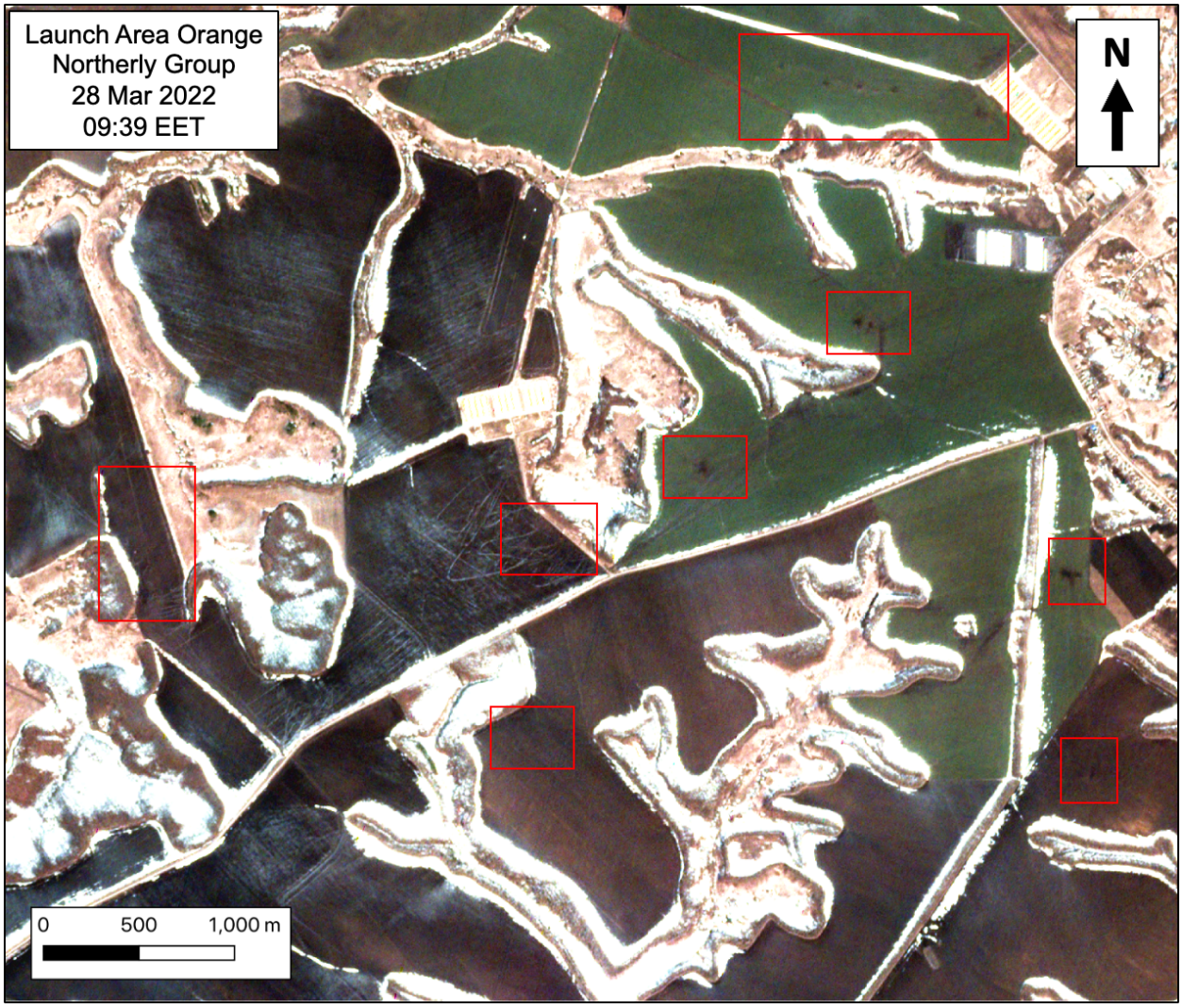



*Image 67: Launch Area Orange in satellite imagery from 28/03/2022 depicting all points of interest within the northerly grouping (Credit: © 2023 Planet Labs PBC).*

A review of satellite images indicated that while there was activity within Launch Area Orange from at least 27/02/2022 until 10/03/2022 at the latest, there was no further activity at this site within the timeframe of interest (24/02/2022 - 15/04/2022). The next activity at this site, namely suspected burn marks, appear to have taken place in early June 2022, which were identifiable in PlanetScope imagery taken on 09/06/2022[126].

[126] Planet Labs Scene ID: 20220609_081144_74_2477

**Launch Area Orange Summary**

Launch Area Orange appears to have been a Launch Area for some kind of rocket system, however the exact type could not be established with the available information. The military expert[127] consulted for this report indicated that this area was a possible location for operations of Smerch MLRS.

Scarring indicates it may have been active from at least 27/02/2022 until about 10/03/2022, before becoming active again in early June 2022. However, this assessment is low confidence due to the lack of high resolution imagery to examine the points of interest.

## Launch Area Yellow

Launch Area Yellow was identified immediately to the west of the hamlet of Yasne Zori in the vicinity of 50.36 36.47.[128]

It appears to have been in use from 24/02/2022, with activity apparent through March. Based on an analysis of medium resolution satellite imagery, the last identifiable launch activity during the period of interest appears to have taken place by 25/03/2022. Between 07/04/2022 and 16/04/2022 the last identifiable military vehicles left this area. After 16/04/2022 no further activity was identified until June and July 2022, when the Russian MoD released two videos which depicted BM-30 Smerch launches from this area.

[127] Artillery expert Petro Pyatakov Col (ret).
[128] https://maps.app.goo.gl/mCkkF3Y6zfA1zZHu8

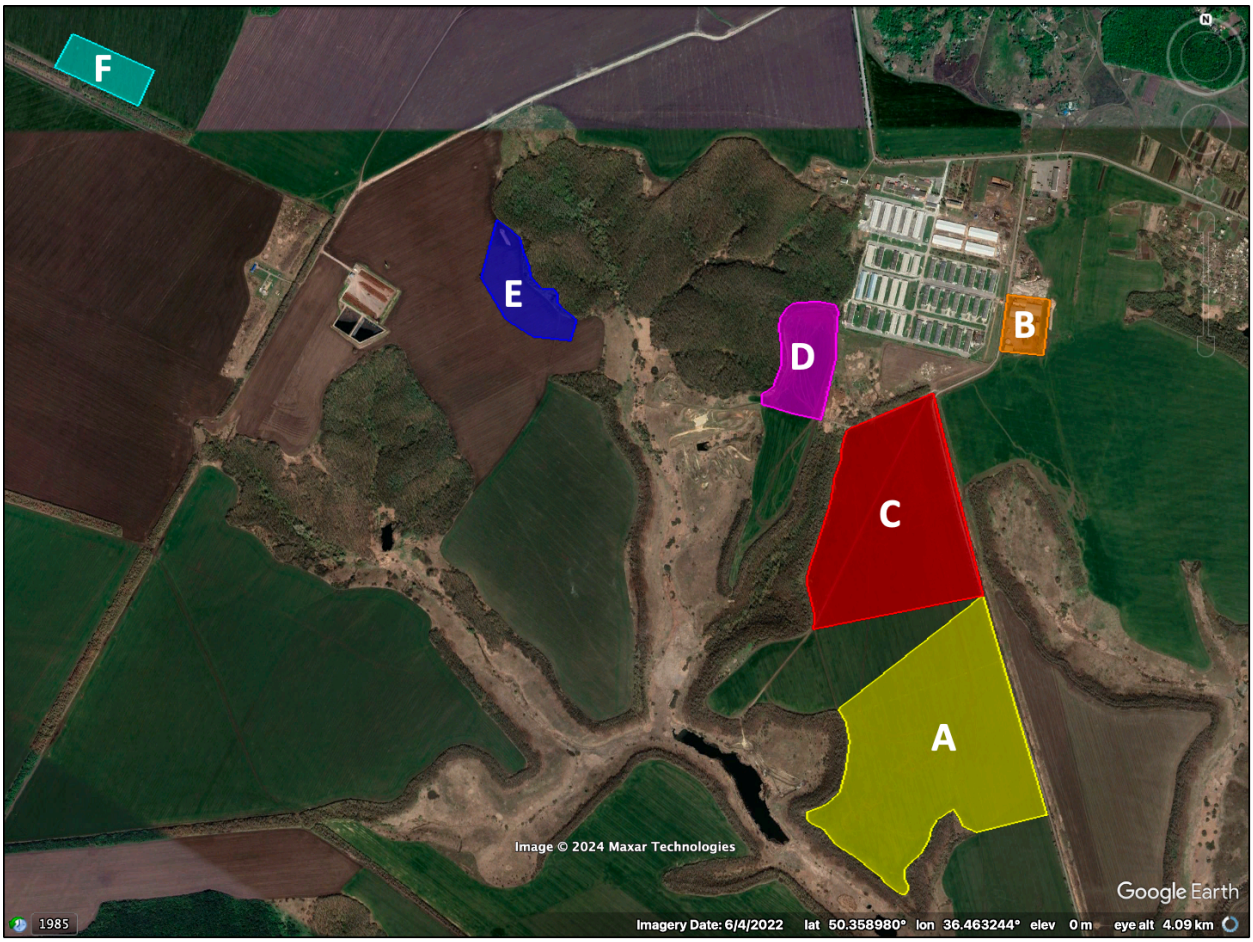



*Image 68: Summary of locations within Launch Area Yellow (Credit: Google/Maxar Technologies).*

**Location A:** IVO [50.354, 36.483](https://maps.app.goo.gl/Xu5V12g56hPN5rv8A)[129]

Location A was identified as a launch position for MLRS due to the presence of what appear to be multiple burn marks in a row. Marks are first evident in medium resolution satellite imagery on 24/02/2022.

[129] https://maps.app.goo.gl/Xu5V12g56hPN5rv8A




*Image 69: Launch Area Yellow, Location A with burn marks highlighted in red (Credit: © 2023 Planet Labs PBC).*

Later high resolution satellite imagery of this location show burn scarring at this location, with tracks to and from these scars. However, the time between the capture of the PlanetScope imagery on the 24/02/2022 and this high resolution imagery lowers the confidence in this assessment.




*Image 70: Launch Area Yellow, Location A in imagery from 07/04/2022 clearly depicting scars (Credit: Google/Maxar Technologies).*




*Image 71: Launch Area Yellow, Location A in imagery from 16/04/2022 clearly depicting scars (Credit: Google/Maxar Technologies).*

In the high resolution imagery it appears there are two groups of five burn marks. This is an unusual number of launchers for a battery of MLRS and, as such, it is considered possible that

the marks were created by the same battery of MLRS firing, reloading and then returning to an adjacent position to fire again.

**Location B:** IVO 50.369, 36.489[130]

Location B consists of a collection of what appear to be green-coloured vehicles within the compound of an industrial facility. Several of the vehicles within this compound are approximately 10 m in length. It was not possible to conclusively identify any specific vehicle at this location. A review of satellite imagery before and after 24/02/2022 indicates that the number and type of vehicles were not present in this compound before the full-scale invasion.

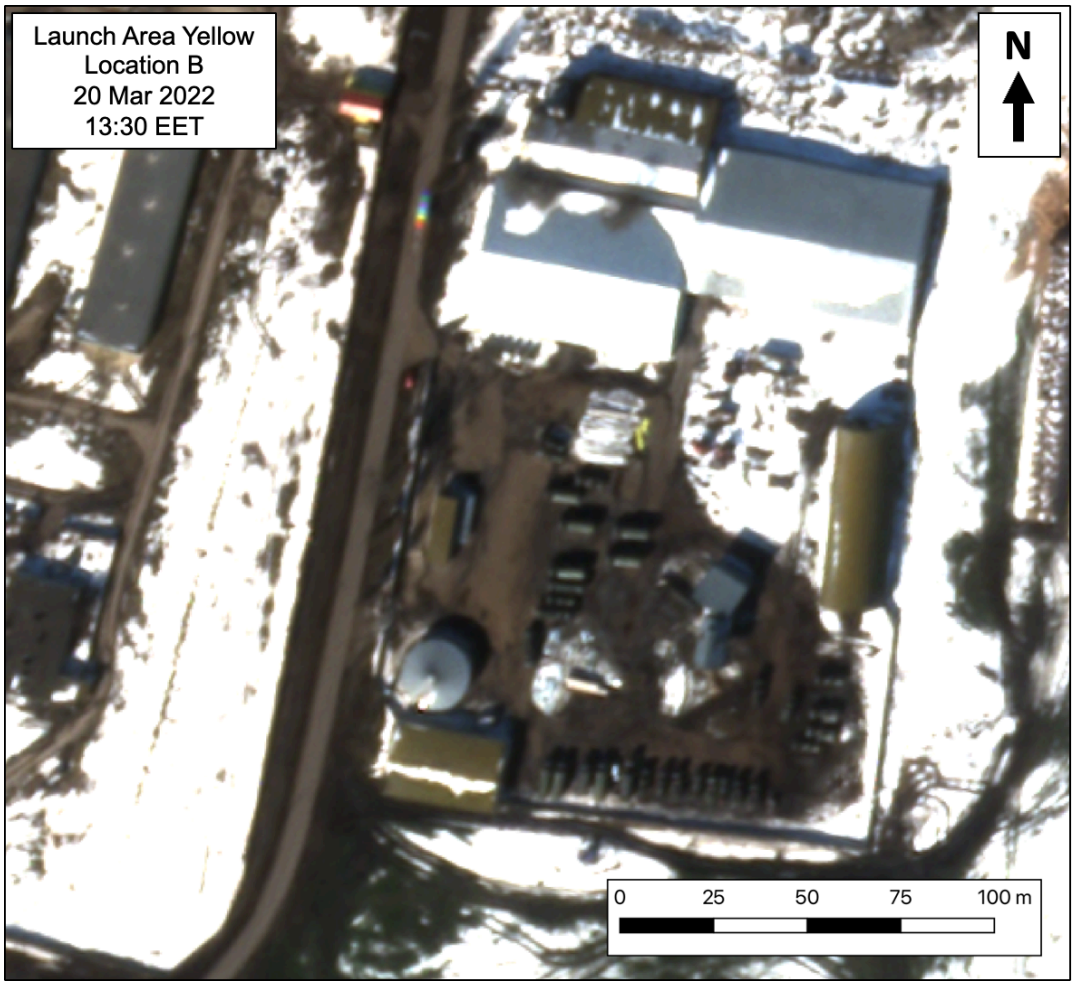



*Image 72: Launch Area Yellow, Location B depicting a large number of large, dark-coloured vehicles (Credit: © 2023 Planet Labs PBC).*

Imagery from Maxar Technologies via Google Earth Pro indicates that these vehicles were no longer present in Maxar Technology satellite imagery from 16/04/2022 available on Google Earth Pro. They were also not present in Planet Labs imagery captured on 21/04/2022.

[130] https://maps.app.goo.gl/4UinGMJXyMxXPvUo8




*Image 73: Location B as seen on 07/04/2022 (Left) and 16/04/2022 (Right) (Credit: Google/Maxar Technologies).*

**Location C:** IVO [50.362, 36.482](https://maps.app.goo.gl/19mcwNpWJsUBXmFz7)[131]

Location C is an area with a significant number of vehicle tracks and what appear to be burn marks, some in sets of four in a linear formation. Activity began in this area on 24/02/2022 and appears to have continued until late March. The level of activity indicates that a battery of MLRS was present at this location.

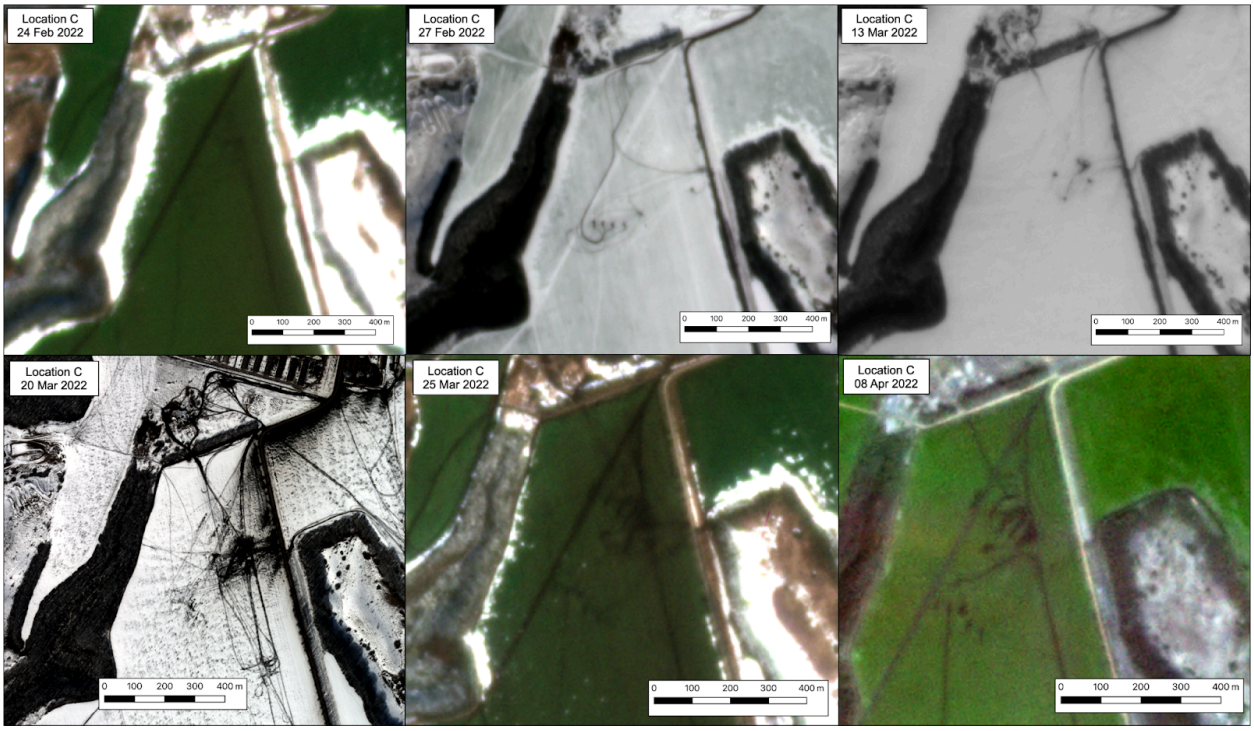



*Image 74: Launch Area Yellow, Location C showing activity from 24/02/2022 until 08/04/2022 (Credit: © 2023 Planet Labs PBC).*

[131] https://maps.app.goo.gl/19mcwNpWJsUBXmFz7

**Location D:** IVO 50.369, 36.477[132]

Location D is an area in which there was a significant vehicle movement and is next to a treeline which appears to have been used as a hiding place for vehicles. There is a significant number of tracks moving to and from this location.




*Image 75: Launch Area Yellow, Location D on 16/04/2022 depicting a large amount of vehicle activity (Credit: Google/Maxar Technologies).*

As with Location C, activity in this area appears to have begun on 24/02/2022 and continued until late March. While the activity and location at this site may be consistent with a reloading area, no vehicles could be identified on satellite imagery and as such the purpose of Location D could not be established with confidence.

**Location E:** IVO 50.370, 36.463[133]

Location E was conclusively identified as a launch position due to a video[134] posted by the Russian MoD to its official telegram channel on 13/06/2022 depicting BM-30 launches. Judging from the differing weather conditions throughout the video, it likely uses footage of launches from different dates. However two sections of footage were established to depict a launch from 50.3701, 36.4582.[135]

[132] https://maps.app.goo.gl/QkPeyqQaHddbBmkz6
[133] https://maps.app.goo.gl/FjwTWzaimYyzaw4d9
[134] https://t.me/mod_russia/16719
[135] https://maps.app.goo.gl/e2mFD6RpMbD2paK8A




*Image 76: Top Left: Google Earth Pro screenshot imitating viewpoint of the Russian MoD video (Credit: Google/Maxar Technologies). Top Right: Planet Labs SkySat showing development of grassy area (Credit: © 2023 Planet Labs PBC). Bottom: The video[136] posted by the Russian MoD (Credit: Russian MoD).*

[136] https://t.me/mod_russia/16719




*Image 77: Top: The video posted by Russian MoD (Credit: Russian MoD). Bottom: Google Earth Pro screenshot imitating viewpoint of the Russian MoD video (Credit: Google/Maxar Technologies).*

The grassy area from which the BM-30 launcher fires only developed from late May and as such the video must have been filmed in late May or early June 2022. While these dates are outside

the period of interest, this video does clearly demonstrate that this area was used as a launch position for a BM-30 system.

**Location F:** IVO 50.377, 36.441[137]

Location F was conclusively identified as a launch position due to a video[138] posted by the Russian MoD to its official Telegram channel on 27/07/2022 depicting at least one BM-30 launch from this location. As with the video for Location F, different weather conditions indicate that this video uses footage from different dates. However, two sections appear to show launches from the same location, at 50.3782, 36.4408.[139]

[137] https://maps.app.goo.gl/s396NQ4GxDMmFxGv9
[138] https://t.me/mod_russia/17968
[139] https://maps.app.goo.gl/3rm6ahAyDdhrGknw7




*Image 78: Top: [Footage](#)[140] posted by Russian MoD showing BM-30 launches (Credit: Russian MoD). Bottom: Google Earth Pro screenshot imitating viewpoint of the Russian MoD video (Credit: Google/Maxar Technologies).*

[140] https://t.me/mod_russia/17968

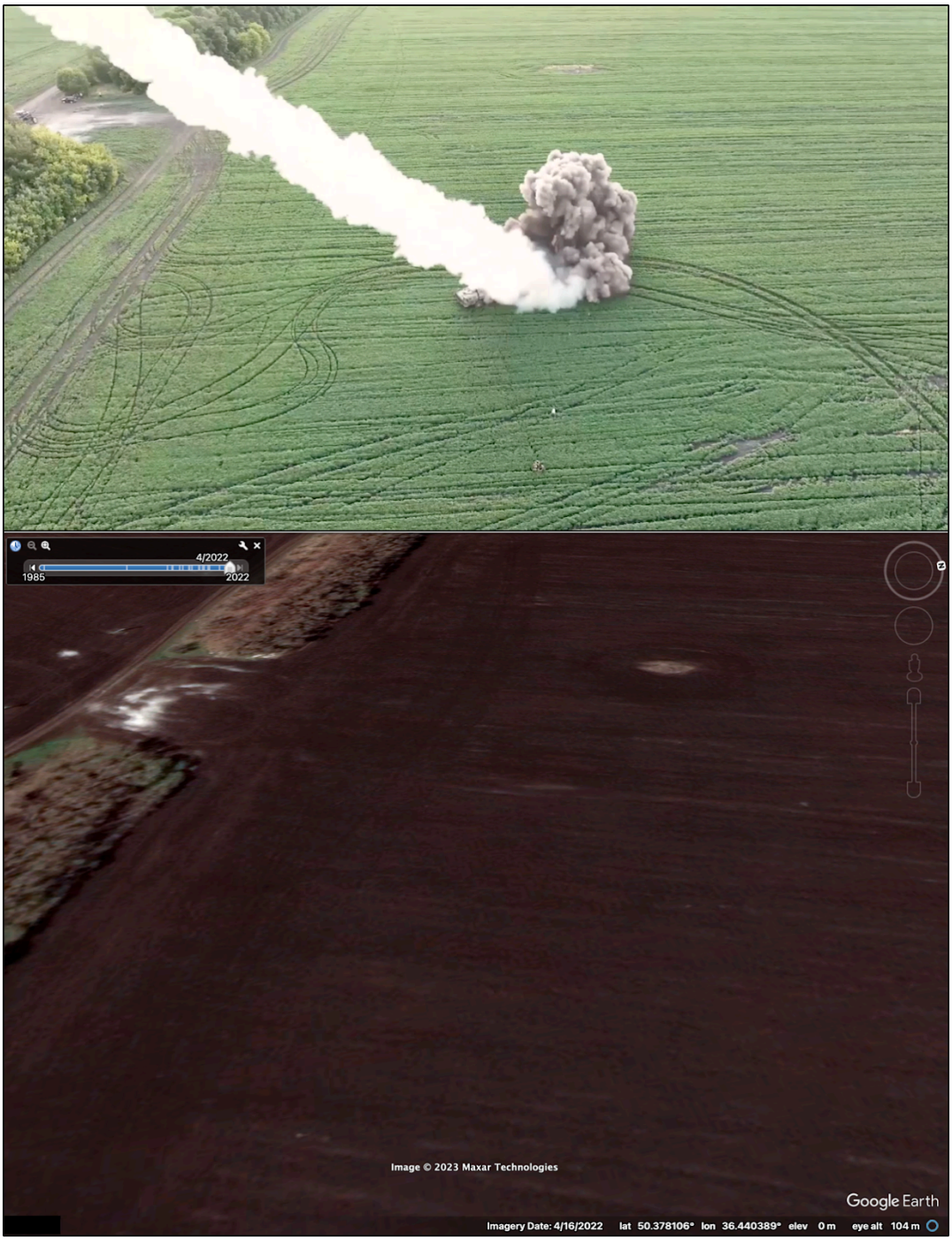



*Image 79: Top: [Footage](#)[141] posted by Russian MoD showing BM-30 launches (Credit: Russian MoD). Bottom: Google Earth Pro screenshot imitating viewpoint of the Russian MoD video (Credit: Google/Maxar Technologies).*

While the date of posting indicates these launches are outside the period of interest, this video does clearly demonstrate that Location F was used as a launch position for a BM-30 system.

[141] https://t.me/mod_russia/17968

**Launch Area Yellow Summary**

Launch Area Yellow appears to have been active from 24/02/2022 until late March during the period of interest. It was then used as a launch area for BM-30 in the summer of 2022. The scars which are consistent with burn marks in linear formations indicate a unit of MLRS conducted fire missions from this area, however the exact type of MLRS operating during the period of interest could not be established with high confidence. Vehicles of 10 m in length were present at Location B, which could be consistent with BM-27 Uragan, however Location D does indicate that some vehicles were hidden in treelines during this time.

Additionally, videos released by the Russian MoD clearly show BM-30 launchers launching from this area in the summer of 2022. Therefore, while this could possibly be a launch area used by BM-30 during the period of interest, this could not be established with high confidence.

The satellite imagery expert we spoke to noted that if the scorch marks seen in Location A are indeed from launches, then this demonstrates a significant strike, at least at battalion level, however, he also noted that determining the exact formation sizes of military capabilities with limited satellite coverage is extremely difficult.[142]

The artillery expert we consulted considered it likely that this area depicted activity that was consistent with a unit consistent with the size of a rocket artillery brigade.[143]

## Launch Area Blue

Launch Area Blue is in the vicinity of 50.45, 36.43.

It appears to have been used as a launch area and harbour area from at least 24/02/2022 until 27/02/2022. After 27/02/2022 activity continued at the site, but no further launch positions could be identified, although it should be noted that this does not conclusively demonstrate that no further launches happened from this area. Vehicle tracks at the site indicate that launchers returned to the same positions in order to launch fire missions multiple time. Activity post 27/02/2022 appears to have been concentrated in the vicinity of a barn or warehouse on the west side of the position where large vehicles which appear to be consistent with the BM-30 system were present until late April 2022.

The assessment was corroborated by the satellite imagery expert: "*Area Blue comprises terrain that is entirely consistent with MLRS launches. Comprising low-level farmland, with copses and dense treelines, and easy access to nearby metalled roads, this is doctrinally exactly the type of terrain that would be used for MLRS firings employing 'shoot and scoot' tactics. [T]his area also puts potential Ukrainian targets comfortably in range, depending on the variant of MLRS being employed. These tactics involve pre-surveying a suitable location, pre-positioning MLRS in a*

[142] Senior ex-military satellite imagery expert.
[143] Artillery expert Petro Pyatakov Col (ret).

*hidden location close to the launch point, deploying launchers at the appropriate time (either to coordinate with a broader operation or to strike targets of opportunity) and then retreating into the treeline. The tactics minimise the exposure time for the launchers and mitigate the opportunity for counter-battery fire or other counter artillery fire (for example) armed drones."*[144]

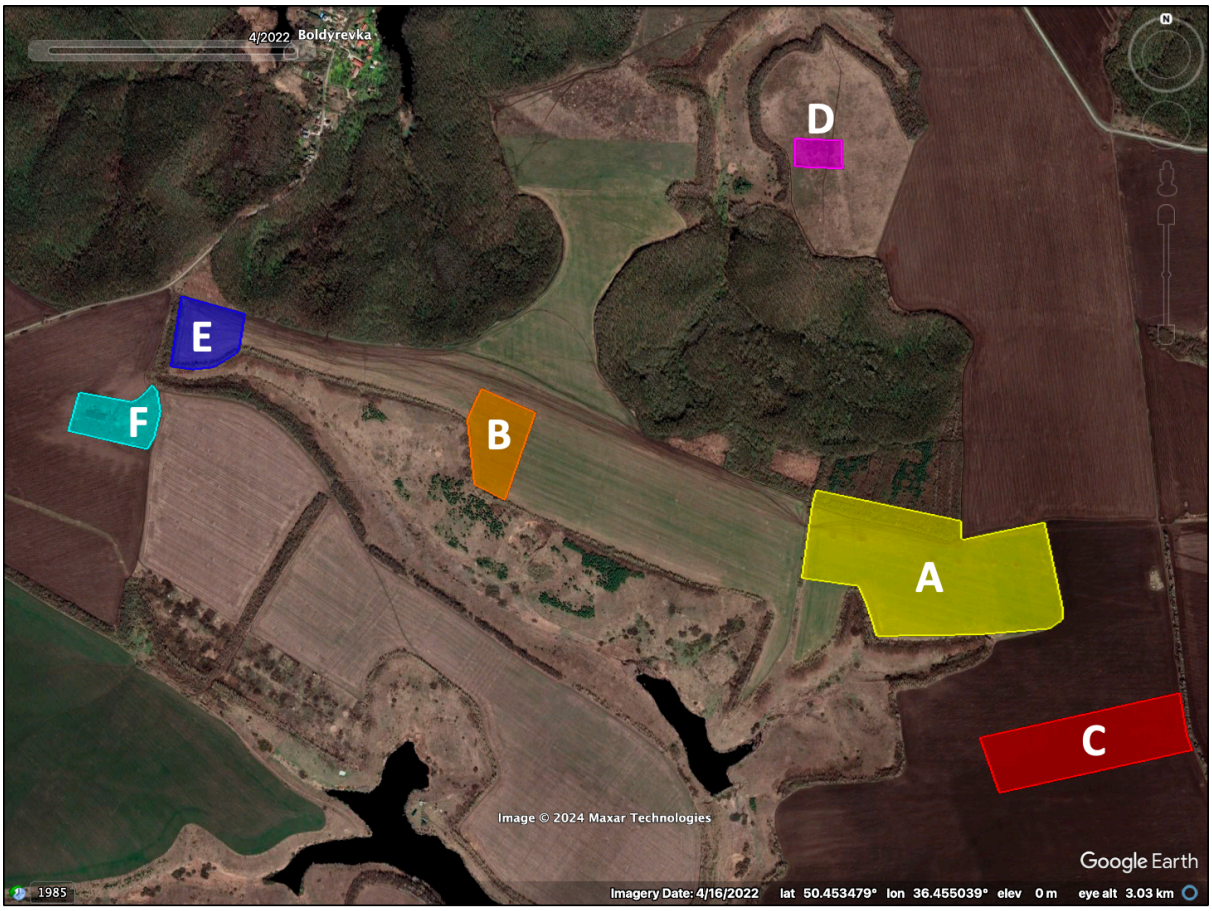



*Image 80: Summary of locations within Launch Area Blue (Credit: Google/Maxar Technologies).*

**Location A:** IVO 50.444, 36.447[145]

Location A contains many indicators of being a launch position. A multitude of tracks lead from clear craters with burn marks or other discoloration on their northern edges to another location which has been identified as a reloading area (see; Location E). Immediately to the north of these launch positions tracks lead into the trees, indicating a possible harbour area. The number of firing points indicates between four and six launchers, with one set of tracks that may indicate that a vehicle moved into position but did not fire.

[144] Senior ex-military satellite imagery expert.
[145] https://maps.app.goo.gl/NY6EY3FwaJKvkX9Z9

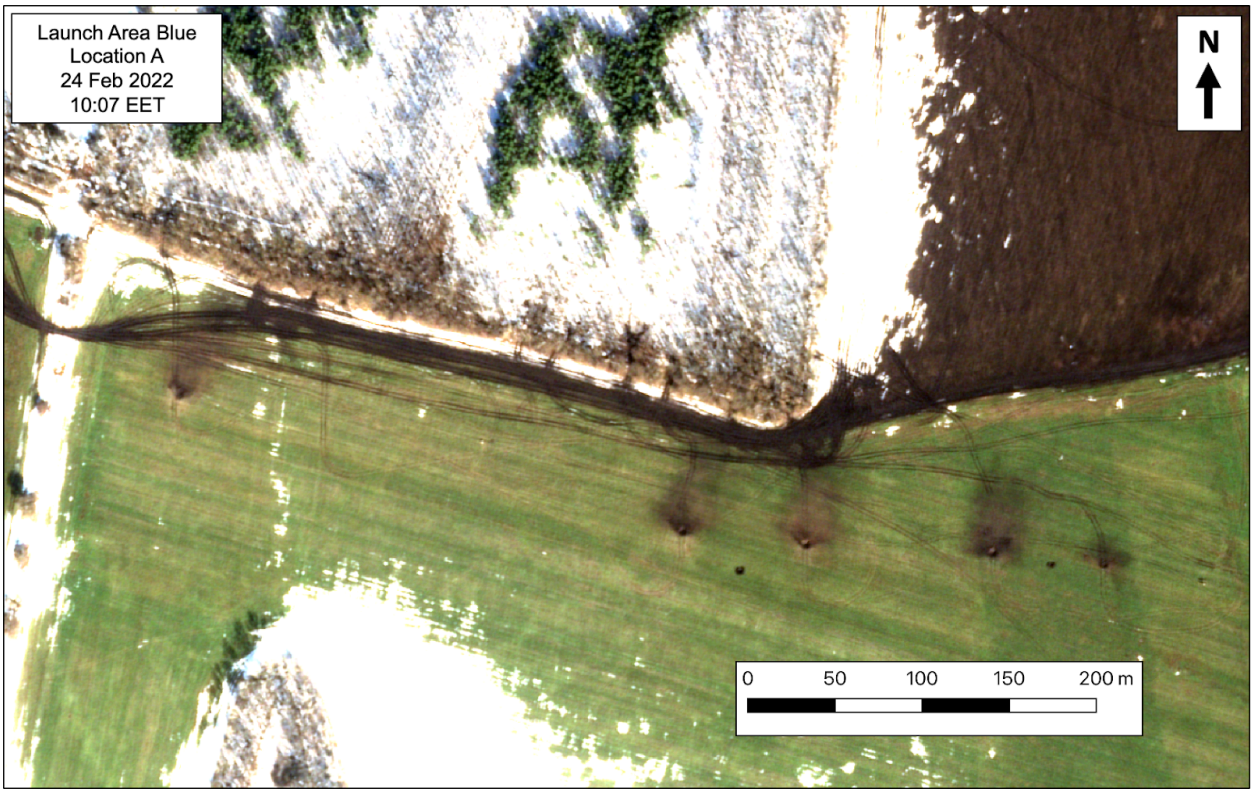



*Image 81: Launch Area Blue, Location A depicting craters and burn marks indicative of firing points (Credit: © 2023 Planet Labs PBC).*

Satellite imagery displays multiple tracks leading to and from the same firing points, indicating that these firing points may have been used more than once.




*Image 82: Comparison of tracks to firing points at Location A. Top: SkySat from 24/02/2022 (Credit: © 2023 Planet Labs PBC). Bottom: Maxar Technologies imagery from 16/04/2022 (Credit: Google/Maxar Technologies).*

A video[146] posted on 24/02/2022 at 21:36 EET appears to show a launch from this location. The video shows a MLRS launch at night and its point of origin could be geolocated to Belgorod. As the video appears to have been filmed from a private dwelling, we have not included the full geolocation.

[146] https://t.me/istocni_front/1066

| Date Posted | URL | Description in post (Machine translation) | Location |
|---|---|---|---|
| 24/02/2022 | https://t.me/istocni_front/1066 | ! Belgorod grenadier in the territory of Ukraine. The video was filmed for over 10 minutes. | Belgorod |




*Image 83: Top: video showing MLRS launch, with red line depicting line along which launch occurred (Credit: @istocni_front). Bottom: map showing line along which launch occurred in comparison to Location A, Launch Area Blue (Credit: Google/Maxar Technologies).*

The satellite imagery expert noted that, at Location A:

> "*It is impossible to determine the identity of the systems involved from available satellite imagery alone without the presence of the launchers, however both the tracks and the launch signature are consistent with BM-30. The approximate width of vehicle tracks is consistent with the width of the MAZ-543M chassis upon which the standard launch vehicle is made at 2.5m (designated as 9A52-2). It is also worth noting that the URAL-375D chassis upon which the BM-21 is based, is 2.4m. Imagery quality and orthorectification limitations prevent sufficiently accurate mensuration to distinguish track width to the required fidelity to differentiate between the two.*"

**Location B:** IVO 50.447, 36.430[147]

At Location B three vehicles of approximately 12 m in length and displaying the distinctive double line of the BM-30 transporter-loader vehicles were identified. They were accompanied by a single 8 meter long vehicle that was not possible to identify, but which may possibly be a refueling bowser or ZIL-131 or KAMAZ with a cabin, such as a field repair shop.




*Image 84: Launch Area Blue, Location B depicting three vehicles of approximately 12 m in length and one vehicle of approximately 8 m in length (Credit: © 2023 Planet Labs PBC).*

The presence of these distinctive vehicles indicates this was a reloading point of some kind.

[147] https://maps.app.goo.gl/4o7HSz3Mn2BWCBGz9

**Location C:** IVO 50.439, 36.454[148]

At Location C nine vehicles were identified in a linear formation. Of these nine vehicles, six were measured as being approximately 12 m long, while three were approximately 9 m long.

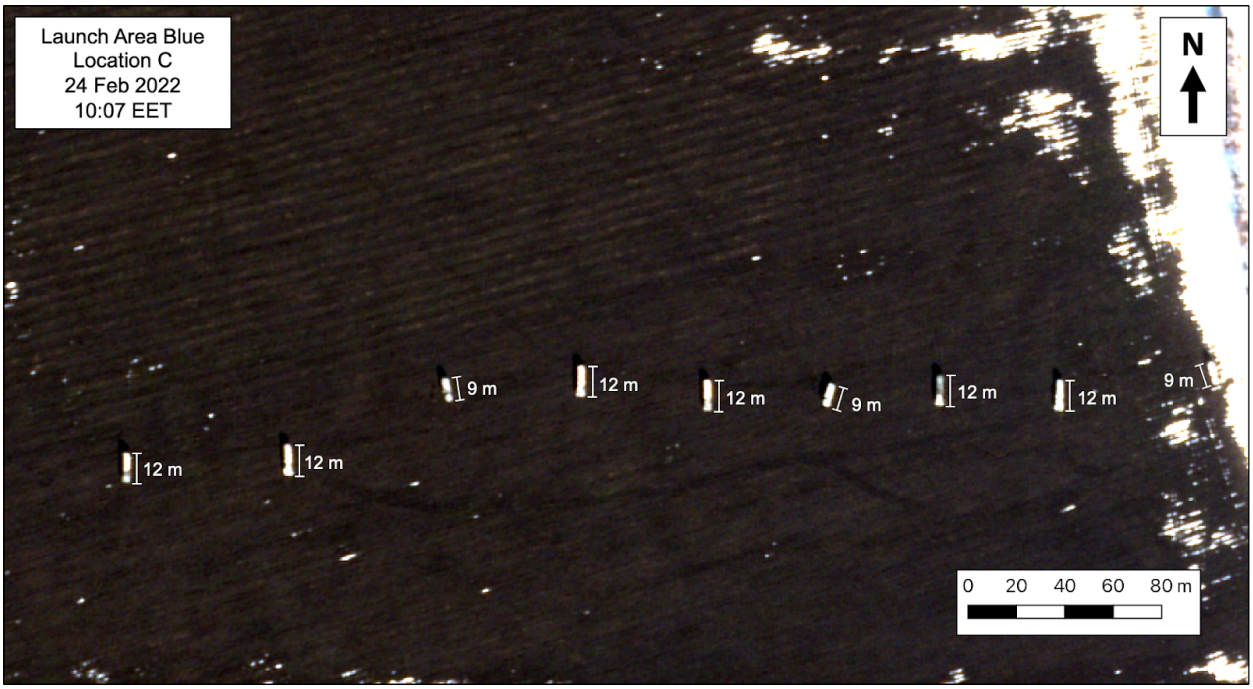



*Image 85: Launch Area Blue, Location C depicting six vehicles of approximately 12 m in length and three vehicles of approximately nine m in length (Credit: © 2023 Planet Labs PBC).*

The lack of a double line on the 12 m long vehicles, and the fact that they are arrayed in a linear formation, further forward than the reloading area, indicates that these are BM-30 launchers. Additionally, this number is also consistent with 6 firing points at Location A. The artillery expert noted that he belives the smaller vehicles are “command staff fire control vehicles”.

A video[149] posted on 24/02/2022 may show launches from Location C in the morning of 24/02/2022. The video was posted at 07:27 AM EET and shows MLRS launches from two different locations. One of these locations appears to align with Location C. It should be noted that the features used for this intersection[150] were relatively close together, and so may not be very accurate. As the video appears to have been filmed from a private dwelling, we have not included the full geolocation.

[148] https://maps.app.goo.gl/jtXF3Z3Vds7C49Qp7
[149] https://x.com/lpr_khv/status/1496718381587873799?s=20
[150] https://www.armystudyguide.com/content/army_board_study_guide_topics/land_navigation_map_reading/find-a-location-using-int.shtml

| Date Posted | URL | Description in post (Machine translation) | Location |
|---|---|---|---|
| 24/02/2022 | https://x.com/lpr_khv/status/1496718381587873799 | ⚡ Ballistic strikes on Kharkov from the Tavrovo region of the Belgorod region.<br>Video from a member of our chapter from Belgorod. | Belgorod |




*Image 86: Top: video showing MLRS launch, with red line depicting line along which launch occurred. (Credit:@lpr_khv) Bottom: map showing line along which launch occurred in comparison to Location C, Launch Area Blue (Credit: Google/Maxar Technologies).*

**Location D:** IVO 50.455, 36.443[151]

Location D contains strong indicators of being an MLRS launch position. Two craters with burn marks or other discoloration on their northern edges with vehicle tracks leading to them are clearly present.

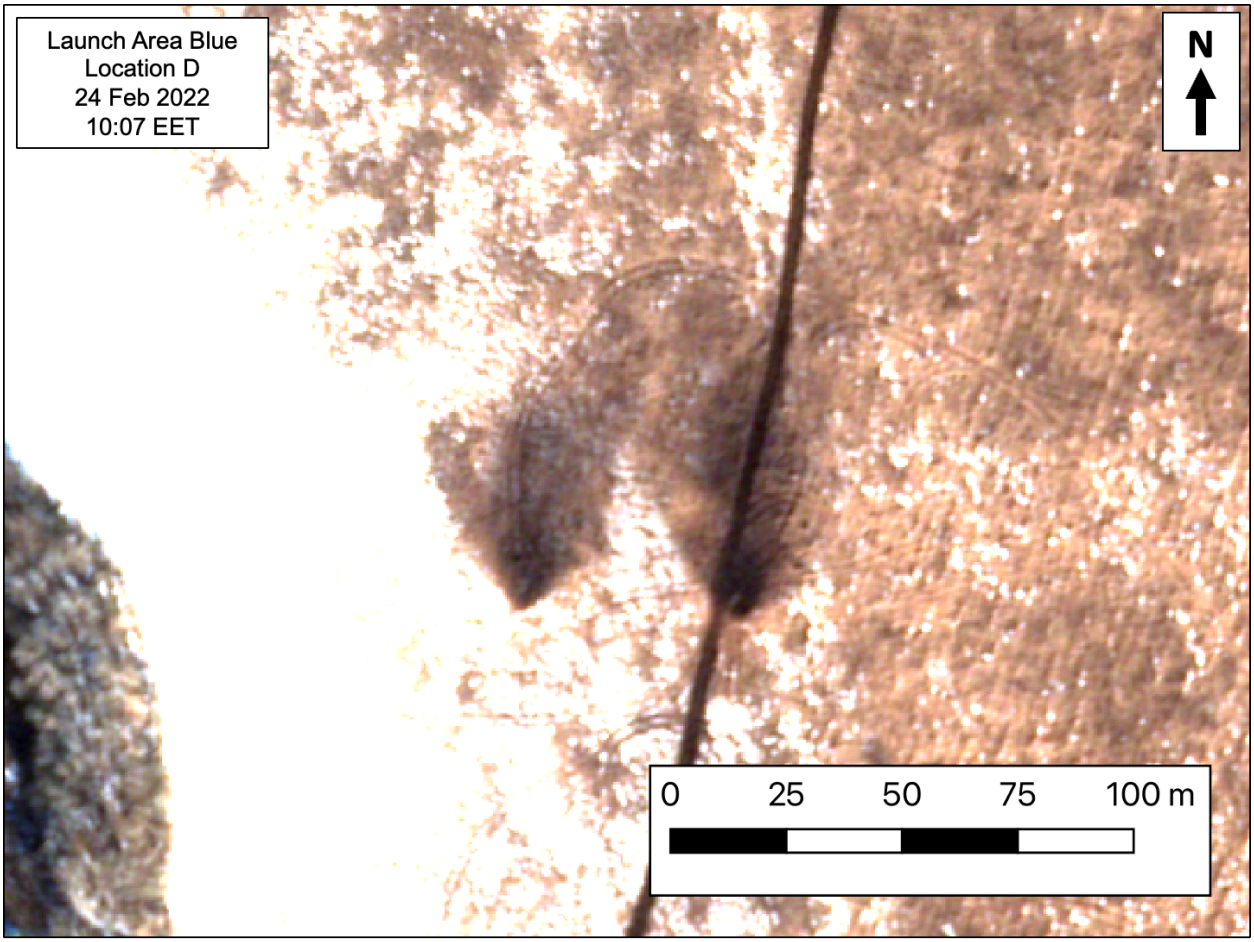



*Image 87: Launch Area Blue, Location D depicting what appear to be two firing points (Credit: © 2023 Planet Labs PBC).*

The satellite imagery expert noted: "*a very high confidence that the image depicts a dual launch point for MLRS, likely to be BM-30 due to the extent of the scorch marks.*"

**Location E:** IVO 50.450, 36.418[152]

Location E, on the western edge of Launch Area Blue, contains indications that it was a reloading area.

[151] https://maps.app.goo.gl/GDEkBxAkfbc3ZJDd8
[152] https://maps.app.goo.gl/WDQpBgnAYcXRESee7




*Image 88: Launch Area Blue, Location E depicting what may be metal scrap from missile packaging. Top: SkySat from 15/04/2022 (Credit: © 2023 Planet Labs PBC). Bottom: Maxar Technologies imagery from 25/04/2022 (Credit: Google/Maxar Technologies).*

There are a multitude of tracks leading to and away from this location. The objects scattered in this area may be the metal frames in which rockets for the BM-30 system are delivered. Its

positioning, behind the transporter-loader vehicles, which are in turn behind the launch vehicles, is also indicative of a reloading area.

The objects which may be metal frames seen at Location E were removed by 20/05/2022, although six large vehicles, which appear to be articulated lorries, were present on that date.




*Image 89: Six large vehicles seen at Location E on 20/05/2022 (Credit: Maxar Technologies).*

The satellite imagery expert noted that: "*This POI [Location E] is entirely consistent with discarded BM-30 missile canister frames. They have been in place since at least 07 Apr 22. There are also at least four cleared areas in the treeline in the immediate vicinity that are likely to be lay-up points for launchers, with tracks leading to the discarded packaging.*"

**Location F:** IVO 50.448, 36.414[153]

The exact nature of Location F could not be identified, but it may be an administration area of some kind. A large number of tracks lead to this location and a review of satellite imagery indicates that there was significant activity here from at least 27/02/2022 until at least May 2022.

In the image below on 15/04/2022 it was possible to identify at least three vehicles of approximately 12 m in length and two vehicles which may be 10 m in length. A further object which may be a vehicle was spotted on the south east corner of the barn but could not be clearly identified.




*Image 90: Multiple large vehicles seen at Location F, Launch Area Blue on 15/04/2022 (Credit: © 2023 Planet Labs PBC).*

The satellite imagery expert noted that: "*I would agree that the report's assessment of vehicles observed on the imagery of 15 Apr 22 being consistent with those of BM-30, however this is low confidence and derived more from associated activity and location relative to identified MLRS*

[153] https://maps.app.goo.gl/NQk2VjXq8Ao9jCJu6

*firing positions than a positive identification, as the resolution* [of the 15/04/2022 imagery] *cannot confirm the case.*"

Additional imagery provided by Maxar Technologies showed large vehicles of approximately 12 m in length present at Location F until 20/05/2022. The two western vehicles have features which may be consistent with a BM-30 transporter-loader; namely a cargo area which is bisected down the center and shadows consistent with a larger cab, which is present on the BM-30 transporter-loader, but not launcher.




*Image 91: Vehicle present at Launch Area Blue, Location F seen on 20/05/2022 (Credit: Maxar Technologies).*

**Launch Area Blue Summary**

Available information strongly indicates that Launch Area Blue was used from 24/02/2022 until 27/02/2022 as an area of operation for BM-30 systems. It includes multiple launch positions, launch vehicles, transporter-loading vehicles and a location which is indicative of a reloading area. While launch activity appears to have ceased after 27/02/2022, BM-30 activity at a warehouse or barn at Location F continued until at least May 2022.

The presence of six 12 meter vehicles, which are likely launch vehicles, at Launch Area Blue on 24/02/2022 indicates that an overstrength battery or a battalion size unit of BM-30 may have been active in this area.

This is consistent with the analysis provided by the artillery expert consulted for this report, who noted that the area, and specifically the building at Location F, was the "*base area of operation of a probable rocket artillery division (task force)*".

The satellite imagery expert noted that *"The whole AOI is characterised by off road vehicle tracks consistent with MLRS activity. It is possible that some of these tracks may have been caused by farm vehicles (many Russian heavy tractors have a similar wheelbase width to those of Smerch). However, the fact that most of these tracks hug tree lines and other terrain features and associated turning circles (often indicative of setting up firing positions), and connectivity to identified firing positions indicate at least some of them are likely to be associated with Smerch activity."*

## Launch Area Violet

Launch Area Violet is centred on 50.41, 36.49[154]

It appears to only have been used as a launch area on 24/02/2022, with no further use visible in high or medium satellite imagery after this date. On the north edge of this area there is a large concentration of activity that may be a radar position. Within this Launch Area there are two firing positions (Location A and C) and a reloading position (Location B).

[154] https://maps.app.goo.gl/BNYp8jkgmRNg9a1j6

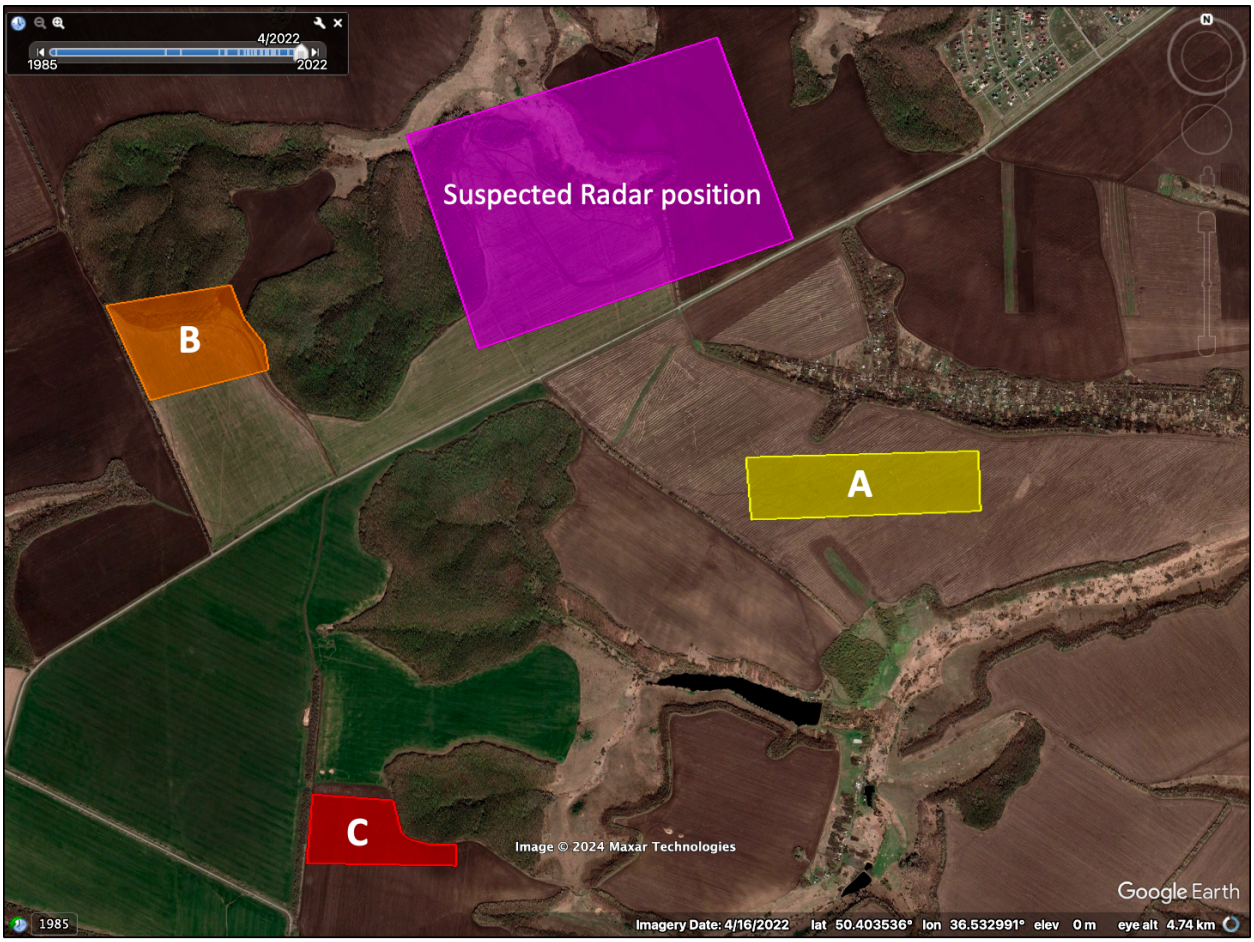



*Image 92: Summary of locations at Launch Area Violet (Credit: Google/Maxar Technologies).*

**Location A:** IVO 50.415, 36.516

This location, positioned in the middle of a field, displaying clear burn marks and three vehicles of approximately 12 m in length, is strongly indicative of a BM-30 launch position.

On the west of Location A, three objects were identified, two of which appear to be approximately 12 m in length and one approximately 10 m in length. The tracks leading to these objects indicate they are indeed vehicles, while the two evident burn marks indicate they are indeed MLRS. These factors indicate that the two larger vehicles are BM-30 launchers.

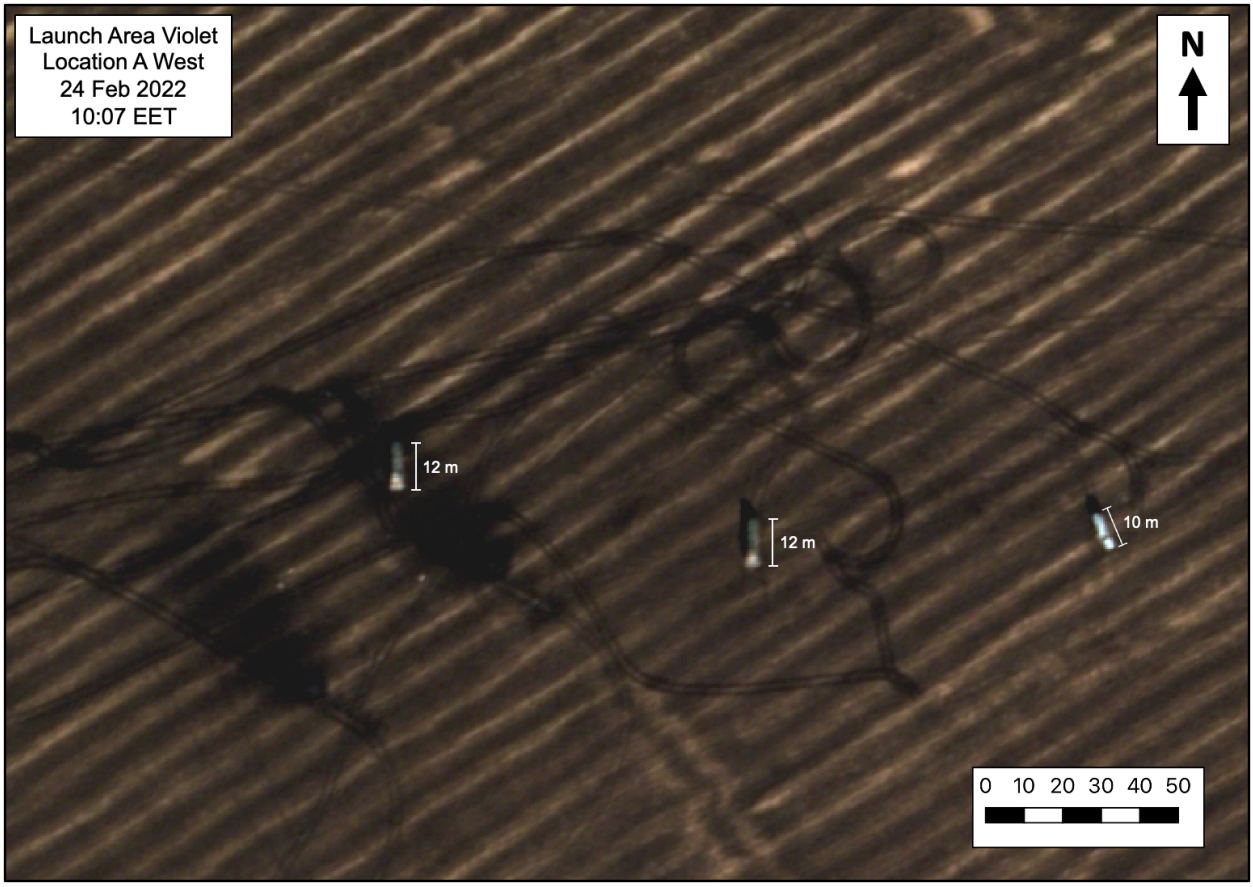



*Image 93: Launch Area Violet, satellite imagery from 24/02/2022 depicting Location A West (Credit: © 2023 Planet Labs PBC).*

On the east side of Location A two further vehicles were identified, one of which is approximately 12 m in length, while the other is approximately 9 m. The most western of these vehicles and its shadow visually matches a BM-30 launcher with its launch tubes in a raised position. The other vehicle may be a command vehicle, however this was not possible to establish with high confidence.




*Image 94: Launch Area Violet, satellite imagery from 24/02/2022 depicting Location A East (Credit: © 2023 Planet Labs PBC).*

**Location B:** IVO 50.421, 36.477[155]

Tracks from Location A head in a westerly direction, towards Location B where several vehicles are present immediately next to a treeline. Four of these vehicles are approximately 12 m in length and display the distinctive double line of a BM-30 transporter-loader. Immediately next to three of these suspected transported-loaders are vehicles approximately 15 m in length, which is consistent with BM-30 ammunition transport vehicles. As such it appears that this satellite image captures the process of transporter-loaders being resupplied with ammunition.

[155] https://maps.app.goo.gl/wiR2CJRsUPeAMW2R6

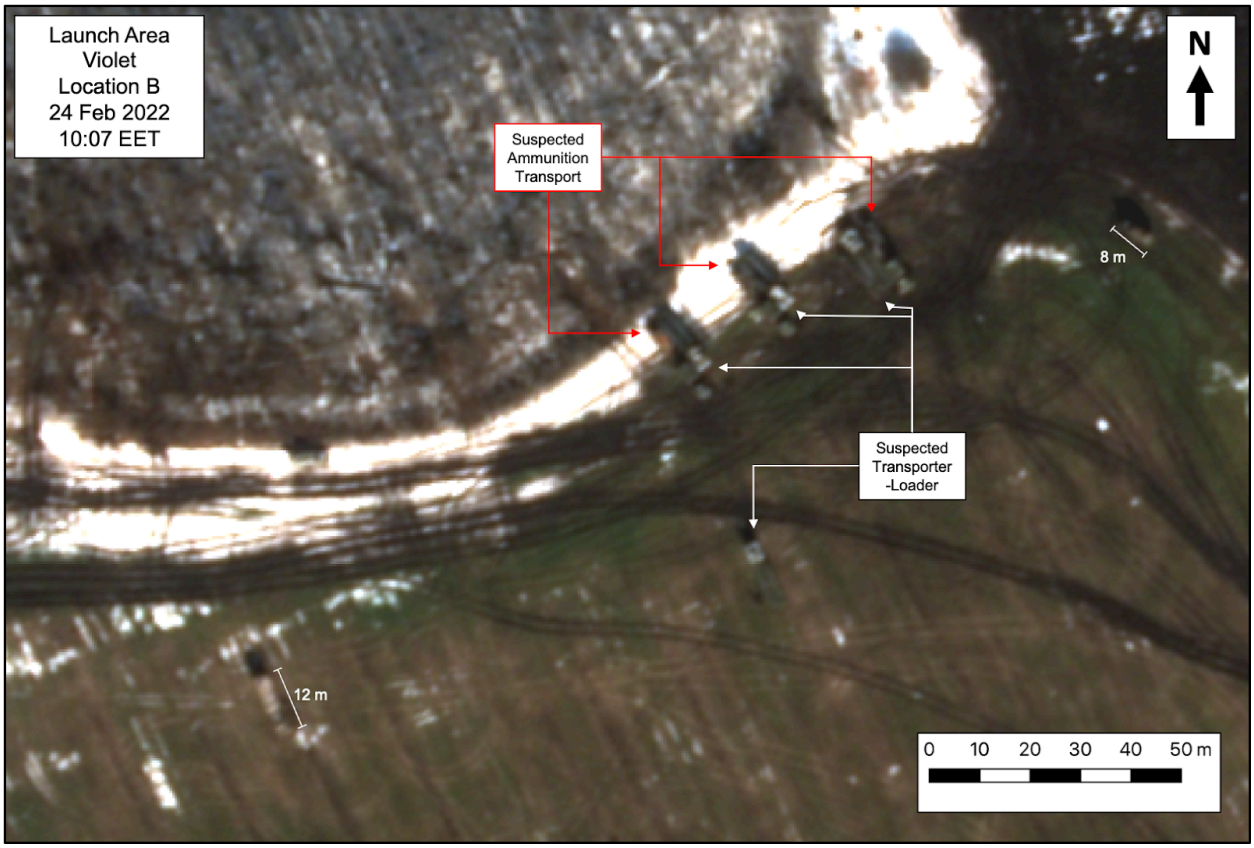



*Image 95: Launch Area Violet, satellite imagery from 24/02/2022 depicting Location B (Credit: © 2023 Planet Labs PBC).*

Additionally, this site includes other features consistent with a reloading area. It is located immediately next to a treeline, which appears to have tracks leading into it. There are a large number of vehicle tracks going to and from this location, including to locations which appear to be launch positions. There is significant activity at the location itself, with tracks moving around the location rather than simply transiting through it.

**Location C:** IVO 50.401, 36.486[156]

Location C was identified as a launch position as a result of a video[157] depicting two MLRS launchers firing several rockets, while two other launch vehicles are positioned nearby. Two further vehicles are seen in the field. The thick white smoke is consistent with a BM-30 launch.

| Date Posted | URL | Description in post (machine translated) | Location |
|---|---|---|---|
| 24/02/2022 | https://x.com/gt_lotrz/status/1496822411790102528 | Belgorod | 50.3941, 36.4849 |

[156] https://maps.app.goo.gl/GLdqSLtAgPy8BJ3V6
[157] https://twitter.com/gt_lotrz/status/1496822411790102528




*Image 96: Still from video showing two Smerch launchers firing (credit: @gt_lotrz).*

The video was posted in the afternoon of 24/02/2022, however the sun is very low in the sky and therefore must have been filmed on the morning of 24/02/2022. Using this information and a sketch of the area depicted by the video, it was possible to identify that this video was filmed immediately to the south of the firing position, from a public road (50.3941, 36.4849[158]).

[158] https://maps.app.goo.gl/tTeuFYq46br5F37a6




*Image 97: Top: Detail of house seen in video depicting Location C (Credit: @gt_lotrz). Bottom: Google Street video[159] from 50.3941, 36.4849[160] (Credit: Google).*

[159] https://maps.app.goo.gl/G6CwnowvBA5yMfpp7
[160] https://maps.app.goo.gl/T3guhLcdj1gApNrH8

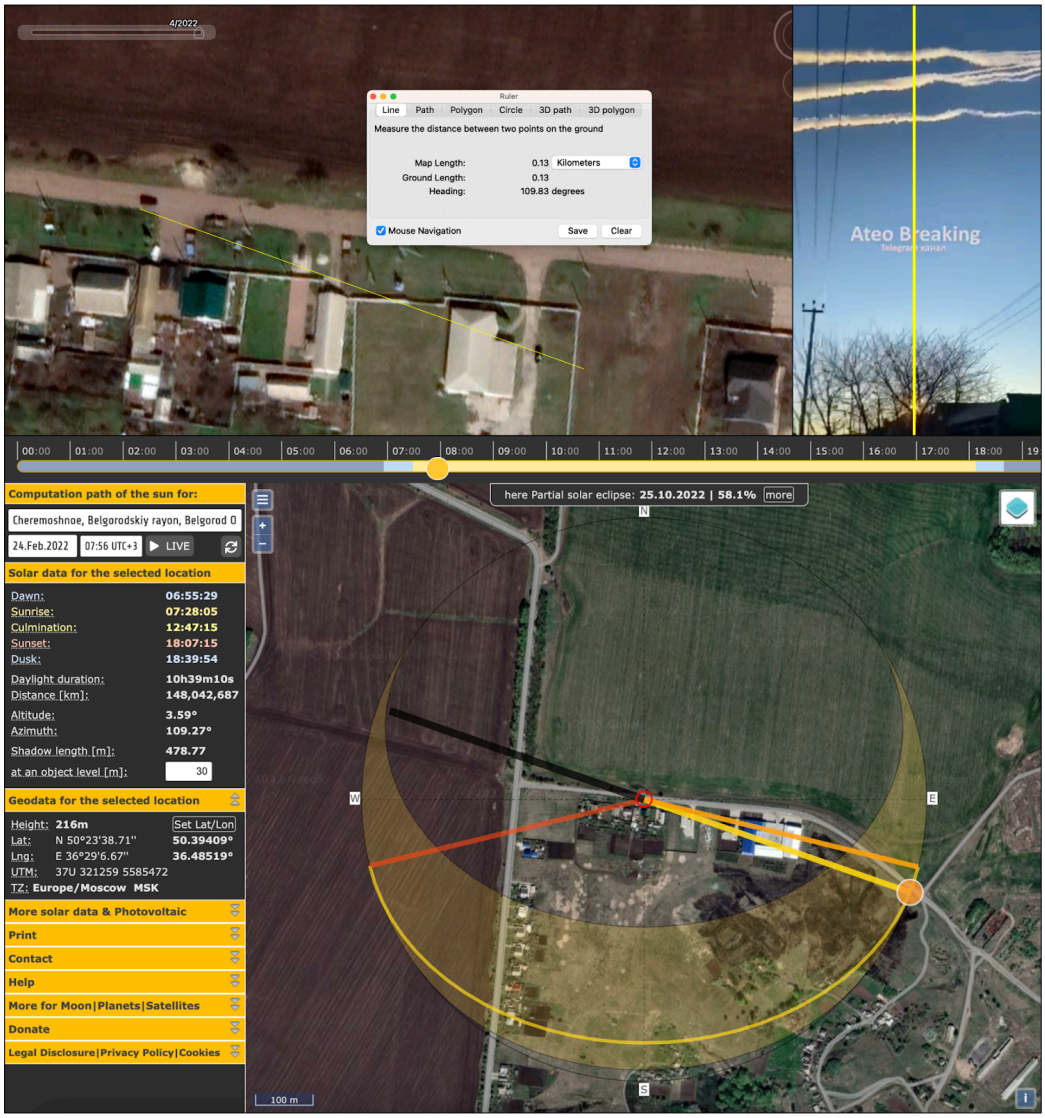



*Image 98: Top Left: Depiction of line of sight of video towards the Sun (Credit: Google/Maxar Technologies). Top Right: line of sight towards the Sun as seen in video of launches (Credit: @gt_lotrz). Bottom: SunCalc depicting likely time of video (Credit: SunCalc).*

Using the location of the sun in the video it was possible to identify that this video was filmed at about 08:00 AM, but certainly between dawn at 07:30 AM and 09:00 AM.

A second video[161] was identified which appears to show a launch from Location C. As this was filmed from a private dwelling we have not published the exact geolocation. This video was posted at 08:56 AM EET on 24/02/2022. The viewpoint and landmarks allow us to draw a line along which the launch must have occurred. This line falls in both Launch Area Violet and Launch Area Yellow, however, Launch Area Violent is closer and is on top of a hill which would obscure the view of Launch Area Yellow. As such this video likely shows a launch from Launch Area Violet, specifically Location C.

[161] https://x.com/eatlovepray211/status/1496740684535320577

| Date Posted | URL | Description in post | Location |
|---|---|---|---|
| 24/02/2022 | https://x.com/eatlovepray211/status/1496740684535320577 | Russian MLRS launch being fired towards #Ukraine. Reportedly from Belgorod Oblast. | Belgorod |




*Image 99: Top: A still (00:03) from video depicting launch south of Belgorod, with red line depicting the bearing to the launch (Credit: @EatLovePray211). Bottom: Bearing to launch as depicted on map. Note the proximity of the line to Location C, Launch Area Violet (Credit: Google/Maxar Technologies/ Airbus).*

The video shows a very distinctive event, namely a large launch of missiles. As such it must have occurred on 24/02/2022, after the full-scale invasion occurred. As it is in daylight the time of this launch must have been between dawn at about 07:30 AM EET and 08:56 AM EET (the time the video was posted) on 24/02/2022.

**Launch Area Violet Summary**

Three BM-30 launchers were identified at Location A, and four BM-30 transporter-loaders and a single 12 m long vehicle were identified in the reloading area at Location B. A video was identified which depicted at least four BM-30 launchers at Location C, however due to the time difference between the time of the satellite imagery depicting Location A and the said video depicting Location C, it was not possible to conclusively state if they are different vehicles. As such, the activity at Launch Area Violet is certainly consistent with that of a battery, and possibly two batteries of BM-30 Smerch.

The satellite imagery expert noted that they had high confidence that Location A was a launch site and that the two vehicles at Location A East are very consistent in layout with BM-30.

The artillery expert noted that this appeared to be the area of operation of a rocket artillery battery, with two launchers carrying out a fire mission, with a further two in reserve in case of mechanical failure or a target of opportunity.

## Launch Area Green

Launch Area Green is centred on 50.38, 36.36.

It appears to have been used as a launch area, harbour area and reloading site for a large concentration of BM-30 from late March into April. The first strong indication of its use as a MLRS site is visible from 25/03/2022, with large vehicle tracks leading to locations where BM-30 launchers were identified. While there was activity in this vicinity before 25/03/2022, it is not possible to conclusively tie it to a BM-30 system before this date. These dates where Launch Area Green became active appears to align with a significant reduction of activity in Launch Area Red.

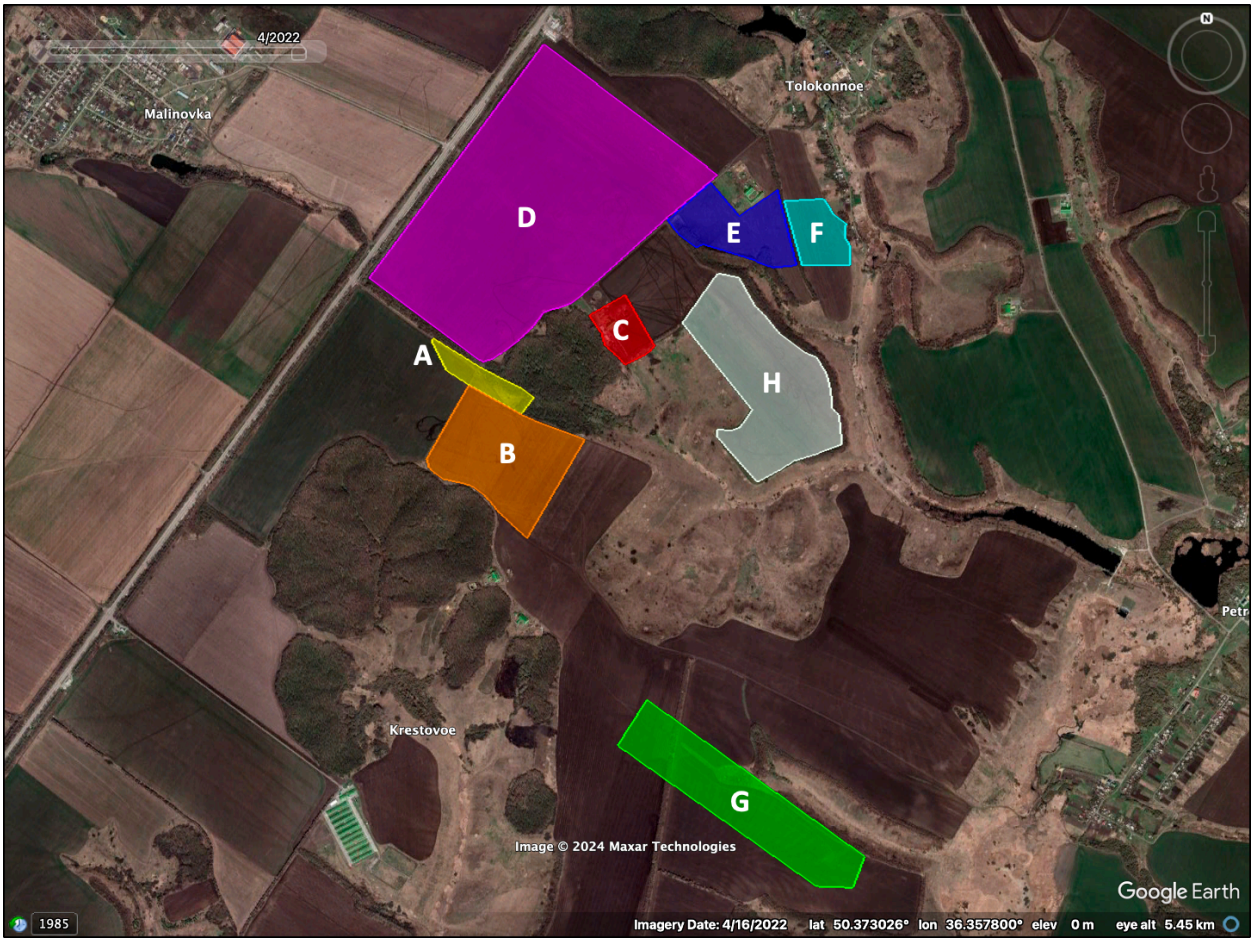



*Image 100: Summary of locations at Launch Area Green (Credit: Google/Maxar Technologies).*

**Location A:** IVO [50.381, 36.351](https://maps.app.goo.gl/WVj5BMtFc3btW9AS9)[162]

Location A was identified as a harbour area and reloading area for a BM-30 system. This location appears to have been in use from 25/03/2022, when activity at this site noticeably increases on Planet Labs PlanetScope imagery. High resolution imagery from both Maxar Technologies and Planet Labs show four vehicles consistent with BM-30 transporter-loader vehicles at this location. These vehicles are about 12 m in length and display the distinctive double stripe associated with a BM-30 transporter loader.

[162] https://maps.app.goo.gl/WVj5BMtFc3btW9AS9




*Image 101: Launch Area Green, Location A depicting several reloading vehicles within a treeline (Credit: Maxar Technologies).*

This location has all the characteristics of a lay-up point and imagery indicates possible reloading activity.




*Image 102: Launch Area Green, Location A on 14/04/2022. Note possible reloading taking place in the top left of the image (Credit: © 2023 Planet Labs PBC).*

**Location B:** IVO 50.378, 36.351[163]

Location B, which was identified as the fields immediately to the south and south west of Location A, displayed activity since 27/02/2022. However, it was not possible to definitively connect this activity to a BM-30 system.

[163] https://maps.app.goo.gl/xuayabdPKX2AMAyG6




*Image 103: Activity seen at Location B, Launch Area Green (Credit: © 2023 Planet Labs PBC).*

However, starting from 25/03/2022, Location B appears to have been used multiple times as a launch location for a MLRS system, displaying a large number of vehicle tracks and large burn marks.

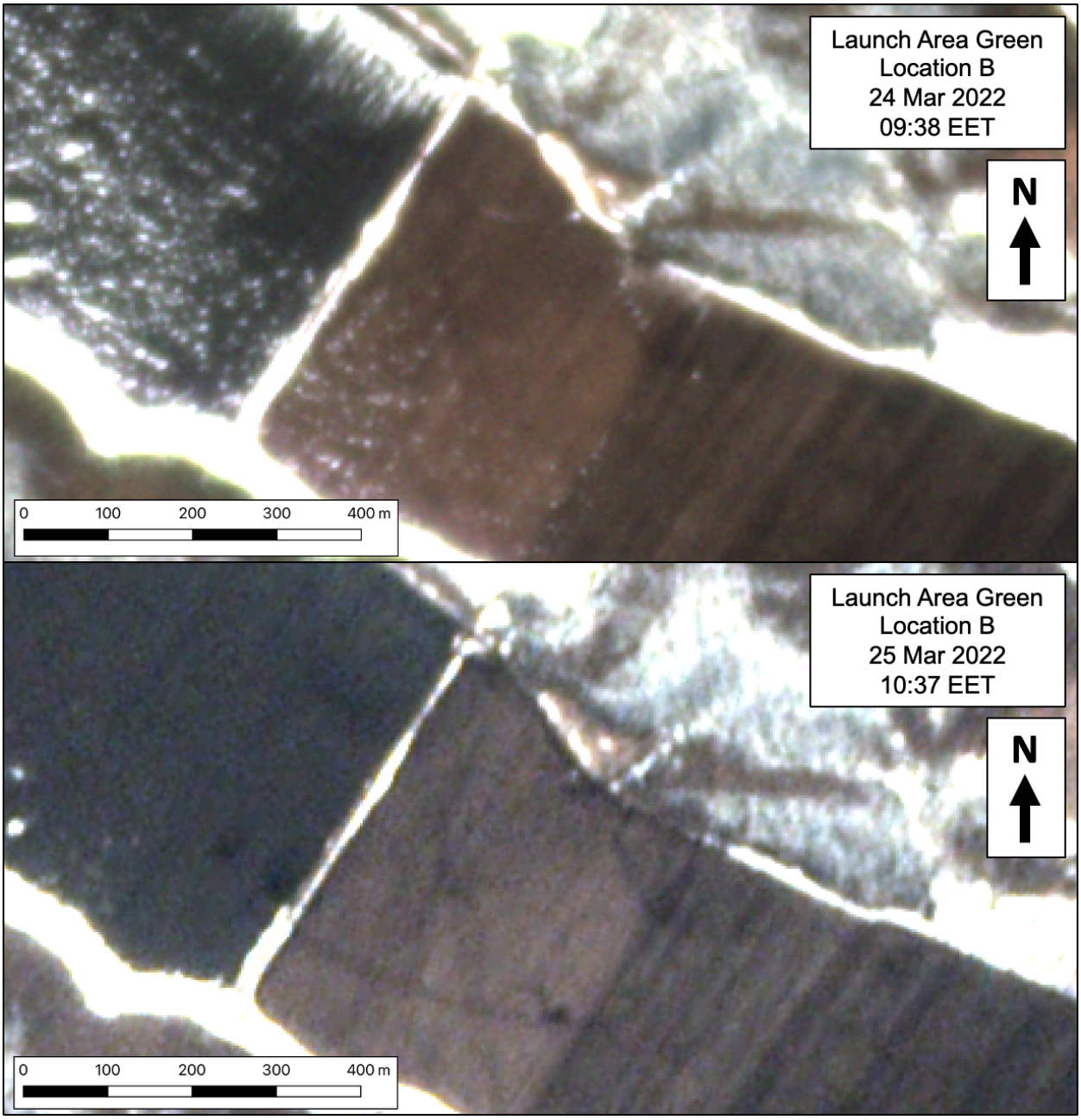



*Image 104: Top: PlanetScope imagery from 24/03/2022. Bottom: PlanetScope imagery from 25/03/2022. Note the appearance of what appear to be vehicle tracks and possible burn marks (Credit: © 2023 Planet Labs PBC).*

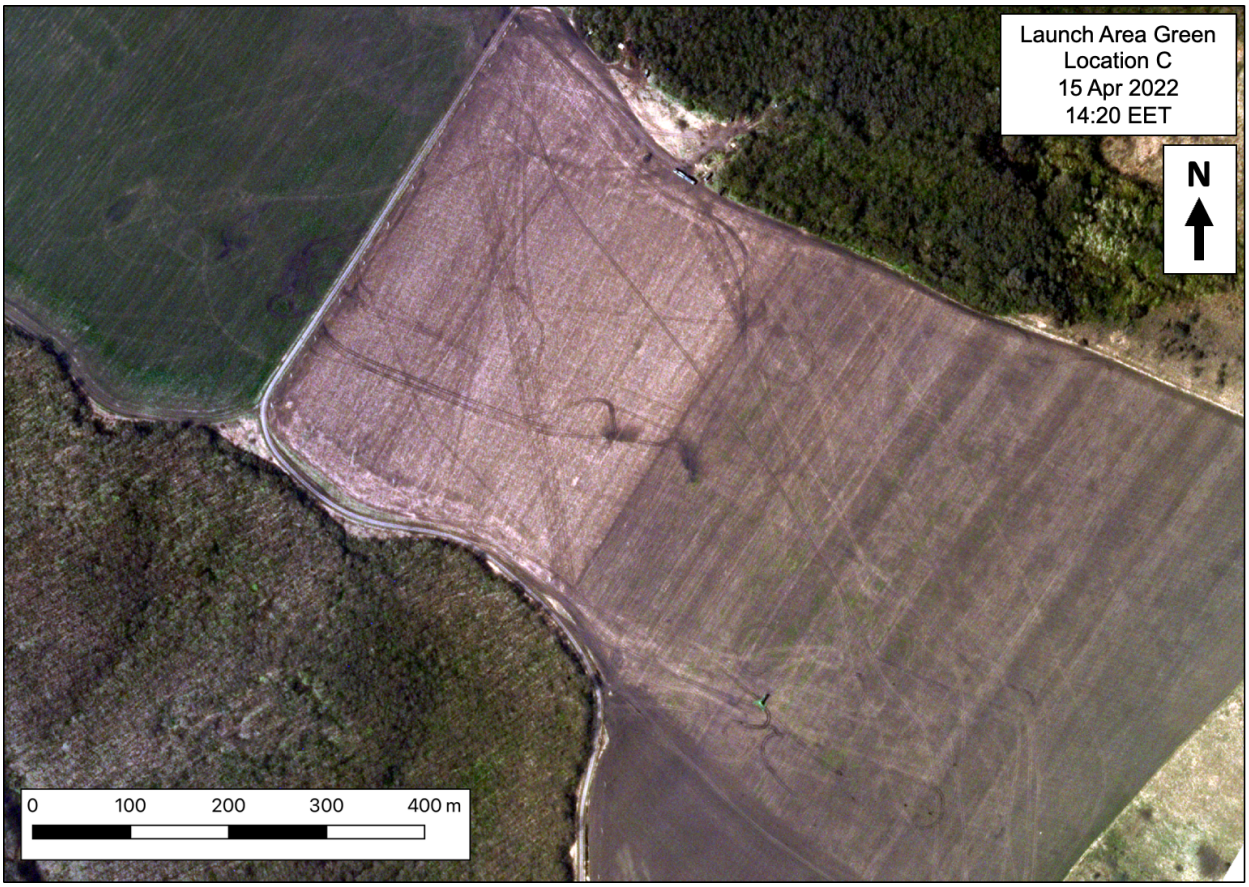



*Image 105: PlanetScope imagery from 15/04/2022. Note the appearance of what seem to be vehicle tracks and burn marks, as well as possible BM-30 reloading activity on the northern edge of the field at Location A. (Credit: © 2023 Planet Labs PBC).*

**Location C:** IVO 50.384, 36.359[164]

Location C is a compound which may be an agricultural facility of some kind. It appears to have been used as a vehicle parking area from at least mid-April onwards. It may have been used earlier, however the presence of these vehicles is not evident in medium resolution imagery.

[164] https://maps.app.goo.gl/h7nQQEECbtc5dfzp8

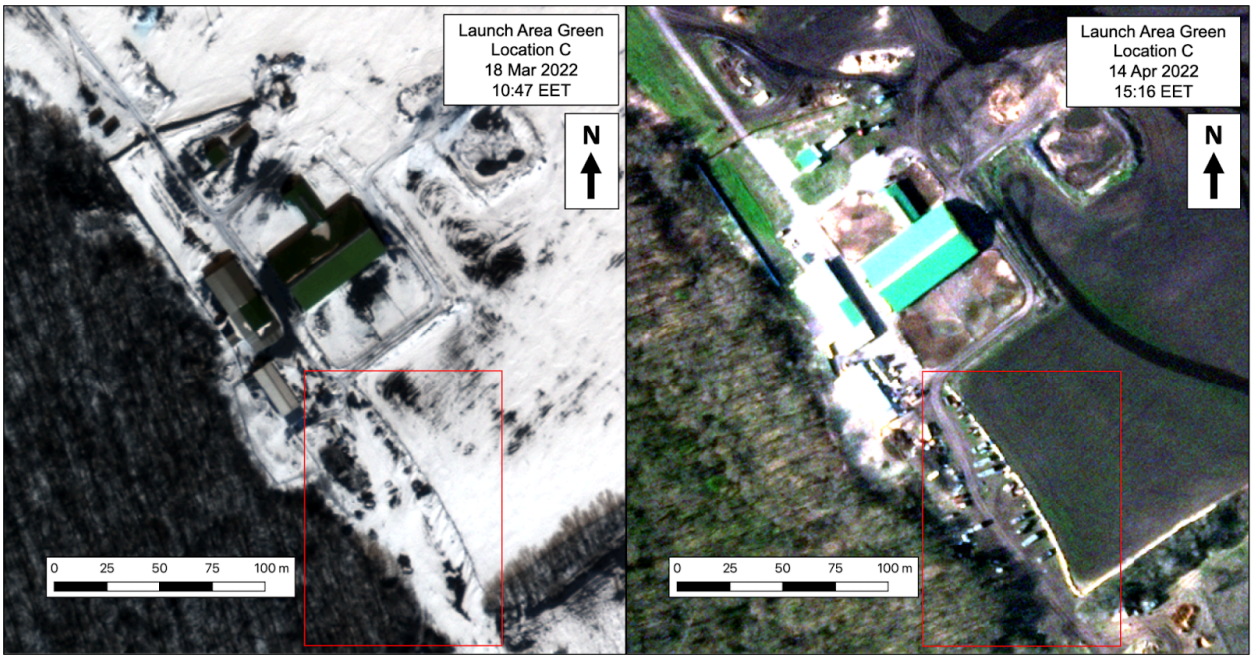



*Image 106: Location C on 18/03/2022 and 14/04/2022. Note presence of vehicles in the latter image (Credit: © 2023 Planet Labs PBC).*

The artillery expert stated that this location may have been a "*base area for location, industrial infrastructure, barracks, headquarters, workshops for routine repair and maintenance of weapons and equipment*" whilst the satellite imagery expert noted there was a "*likelihood it has been commandeered by a military unit as a lay-up/make shift command post*."

**Location D:** IVO 50.387, 36.354[165]

Location D is a field on the west side of Launch Area Green and appears to have been used as a launch position from 25/03/2022. The large number of vehicle tracks and apparent burn marks in this field suggest it was used as a launch area multiple times until the end of April.

[165] https://maps.app.goo.gl/hYCz4UrJo5GDGVhN9




*Image 107: Location D on 25/03/2022, the first day heavy vehicle tracks become apparent in this field (Credit: © 2023 Planet Labs PBC).*




*Image 108: Location D on 15/04/2022, note the burn marks and vehicle activity (Credit: © 2023 Planet Labs PBC).*

At least one BM-30 was geolocated to Location D, IVO 50.393, 36.360 (for full geolocation, see section: **BM-30 Systems South of Belgorod: Western Military District**).



*Image 109: A still from footage[166] released on 21/04/2022 at 00:27 showing a launch at Location D (Credit: Russian MoD).*

**Location E:** IVO 50.389, 36.366[167]

Location E is an area of open ground bordered by a forest to the south and a farm or agricultural facility to the north-east. The southern treeline appears to have been used as a vehicle harbour, while the open area between this treeline and the agricultural facility was used as a reloading area for BM-30 systems.

Activity is first evident at this location on 29/03/2022, after which there was significant activity, with multiple transporter-loaders, launchers and ammunition transports identified at this location. Areas of discoloured ground appear to be consistent with piles of scrap metal used as crates for missiles.

[166] http://t.me/mod_russia/17968
[167] https://maps.app.goo.gl/78BKRXjSkLynbR9h7




*Image 110: Location E on 25/03/2022 and 29/03/2022 showing significant vehicle activity occurring between those two dates in the red box (Credit: © 2023 Planet Labs PBC).*

In the image below from 14/04/2022 it is possible to see the following:

1. Suspected piles of scrap from rocket crates.
2. Vehicle harbour in treeline.
3. Reloading of a launch vehicle.
4. Ammunition transports.
5. Launch position, with what appears to be a launch vehicle present.




*Image 111: Summary of activity seen at Location E (Credit: © 2023 Planet Labs PBC).*

The launch position, marked as no. 5, also featured in two videos released by the Russian MoD showing the same operation of BM-30 Smerch.[168] In this clip two launch vehicles are present, both with craters behind them, indicating they have already fired. The location of these two launch vehicles matches two vehicles seen in Maxar imagery from 16/04/2022.

[168] https://t.me/mod_russia/14575 (00:33), https://t.me/mod_russia/15556 (00:43). Note that while the clip of this launch position is the same in both these videos, the rest of the footage in these two videos differ in other sections.




*Image 112: Left: Still from Russian MoD video. (Credit: Russian MoD) Right: Image from Maxar Technologies on 16/04/2022 (Credit: Maxar Technologies).*

**Location F:** IVO 50.388, 36.373[169]

Location F is a field immediately to the east of Location E and is first clearly evident as a launch position for a BM-30 system from 14/04/2022, although there are indications of it being in use from 07/04/2022. As well as a launch position, there appears to also be an area in a treeline used as a vehicle harbour.

[169] https://maps.app.goo.gl/9AdtmzB3JsgTCrvV7




*Image 113: Location F on 14/04/2022. Note the two vehicles in the field, both of approximately 12 m in length (Credit: © 2023 Planet Labs PBC).*




*Image 114: Location F on 16/04/2022. Note the two vehicles: one in the field and one in a clearing in a stand of trees to the north-east (Credit: Maxar Technologies).*

As with Location E, it is possible to identify this location in footage[170] published by the Russian MoD depicting BM-30 Smerch launches.




*Image 115: Left: Imagery from Google Earth Pro on 16/04/2022 (Credit: Google/Maxar Technologies), Right: Still from Russian MoD video depicting BM-30 Smerch Launch (Credit: Russian MoD).*

[170] https://t.me/mod_russia/15556 (00:49)




*Image 116: Top: Still from Russian MoD video depicting BM-30 Smerch Launch (Credit: Russian MoD). Bottom: Imagery from Google Earth Pro on 16/04/2022 (Credit: Google/Maxar Technologies).*

**Location G:** IVO 50.362, 36.368[171]

Location G is the field to the south-east of the Launch Area Green where there appear to be multiple craters and the presence of vehicles of approximately 12 m in length, indicating a launch position. A smaller vehicle present was noted to likely be a command vehicle by the artillery expert.

[171] https://maps.app.goo.gl/rQ38dGSZ37e2ksnXA

While geographically more remote than the other locations in this Launch Area, the activity in this location can clearly be linked to Launch Area Green by the multiple vehicle tracks which lead to and from this location. Whilst not captured on Planet Labs Skysat, this location is visible in Maxar Technologies imagery available on Google Earth Pro.

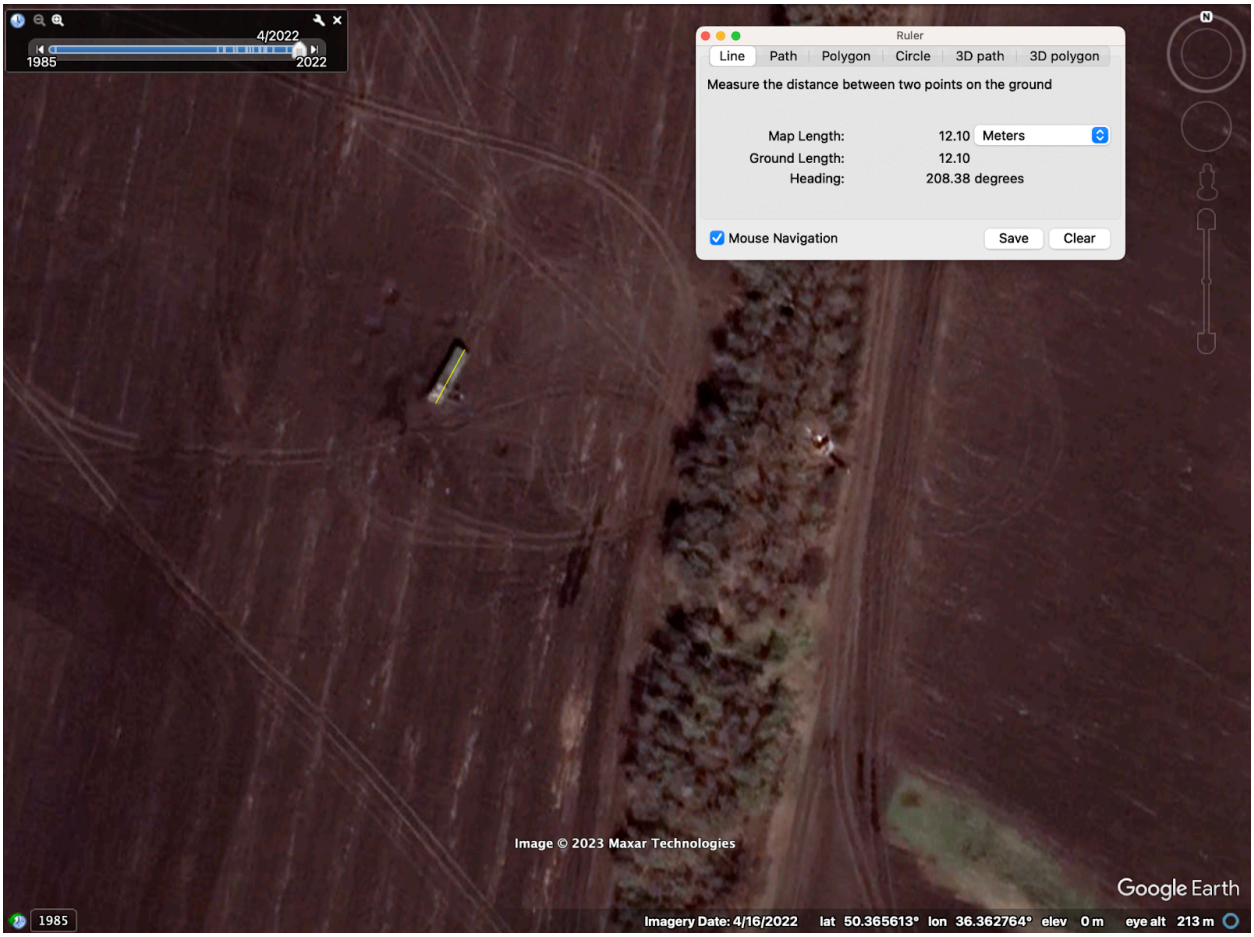



*Image 117: Vehicle of approximately 12 m in length identified on the west side of Location G. Note the vehicle tracks and what appears to be multiple craters around the vehicle (Credit: Google/Maxar Technologies).*

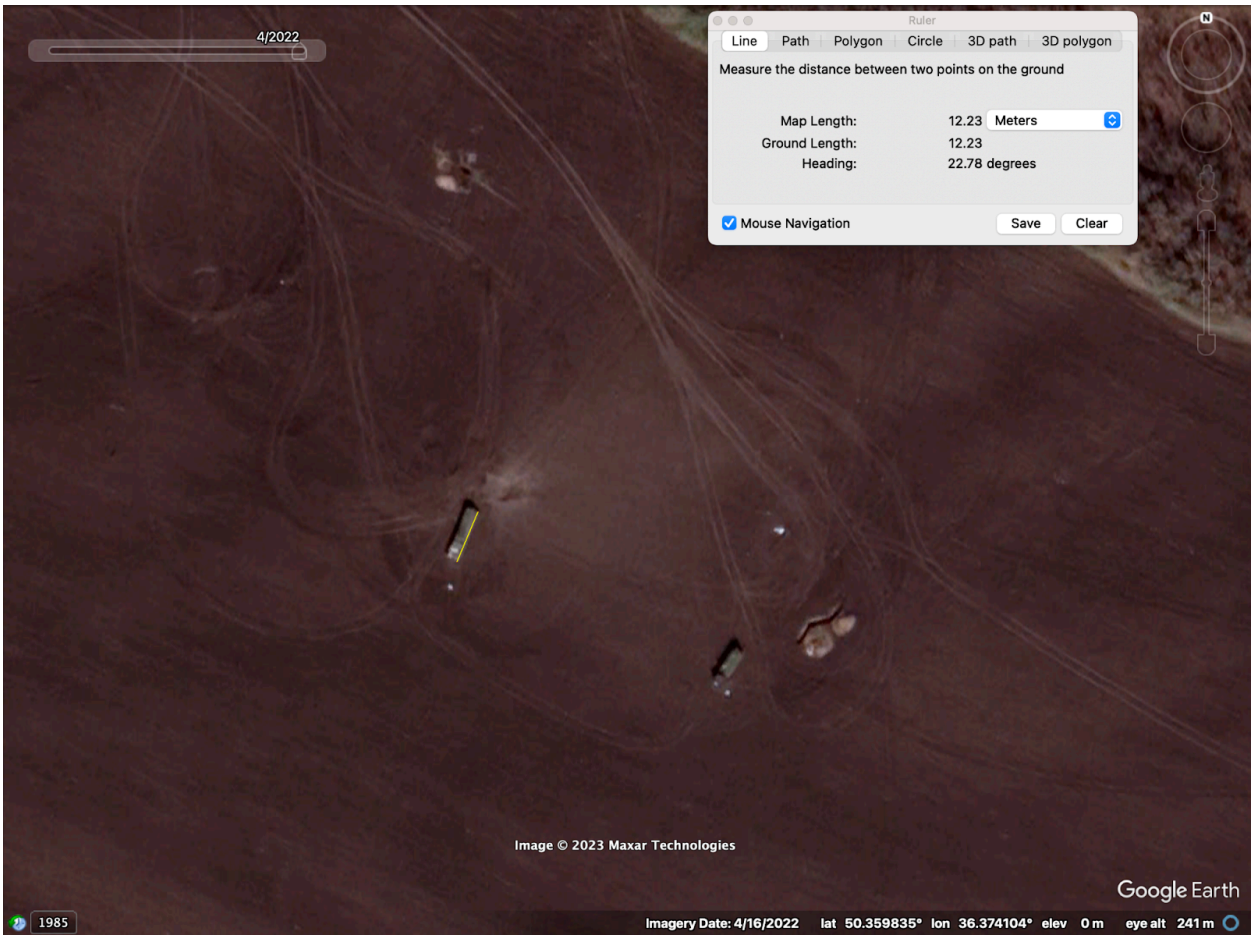



*Image 118: A vehicle of approximately 12 m in length (Yellow Line) identified on the east side of Location G, alongside a vehicle of approximately 10 m in length. Note the vehicle tracks and what appears to be several craters around the larger vehicle (Credit: Google/Maxar Technologies).*

**Location H:** IVO 50.380, 36.371[172]

Location H is a field on the east side of Launch Area Green which displays multiple vehicle tracks and craters consistent with MLRS firing points. PlanetScope imagery indicates that activity at this location began on 25/03/2022. In SkySat imagery on 14/04/2022 at least one vehicle of approximately 12 m in length is visible at this location.

[172] https://maps.app.goo.gl/VJUsVLHcCmghXa8V6

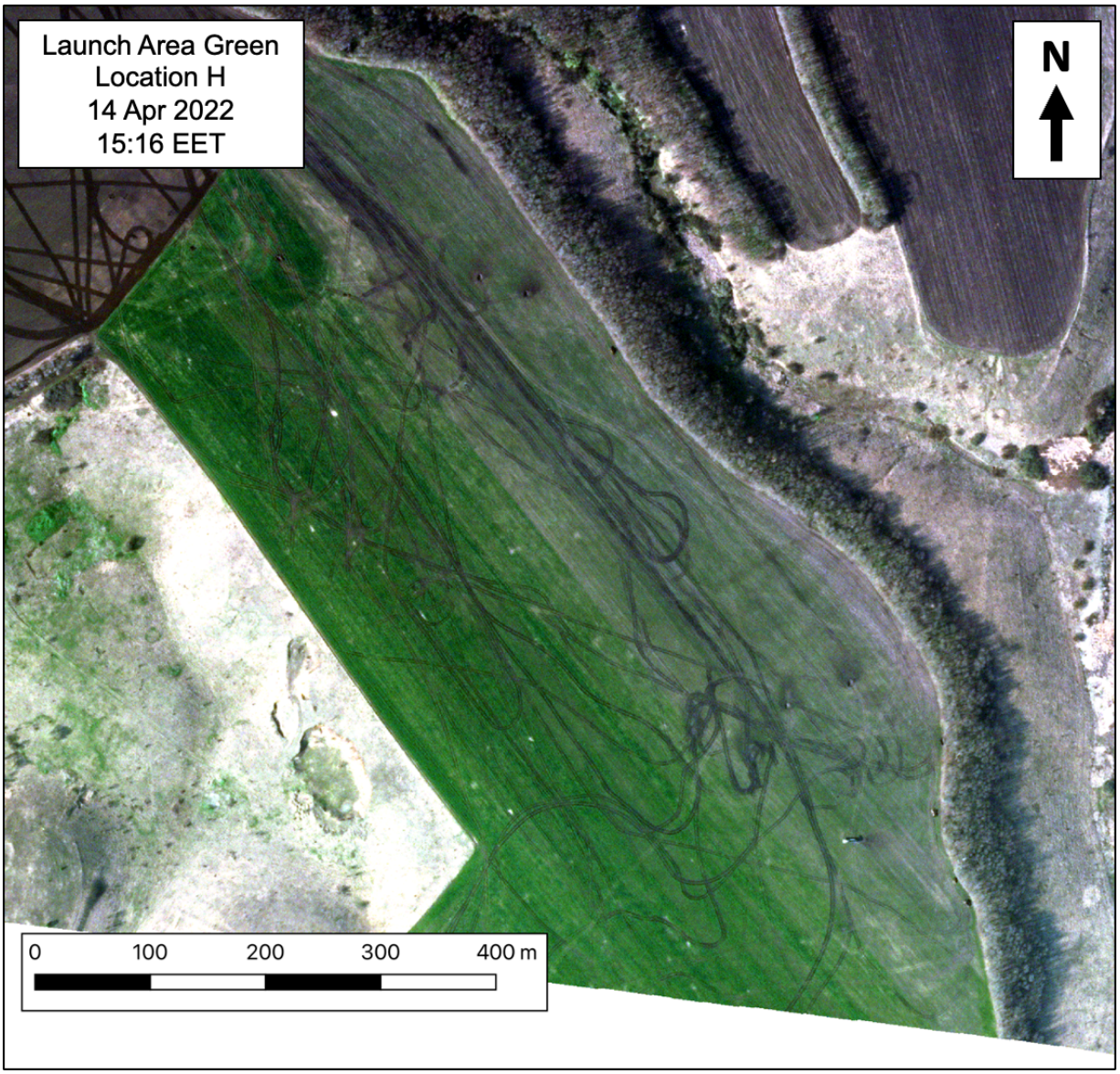



*Image 119: Location H as seen on 14/04/2022. Note the burn marks, craters, vehicle and vehicle tracks (Credit: © 2023 Planet Labs PBC).*

Other satellite imagery indicates that this field was heavily used as a launch position, with craters and burn marks scattered across the field.

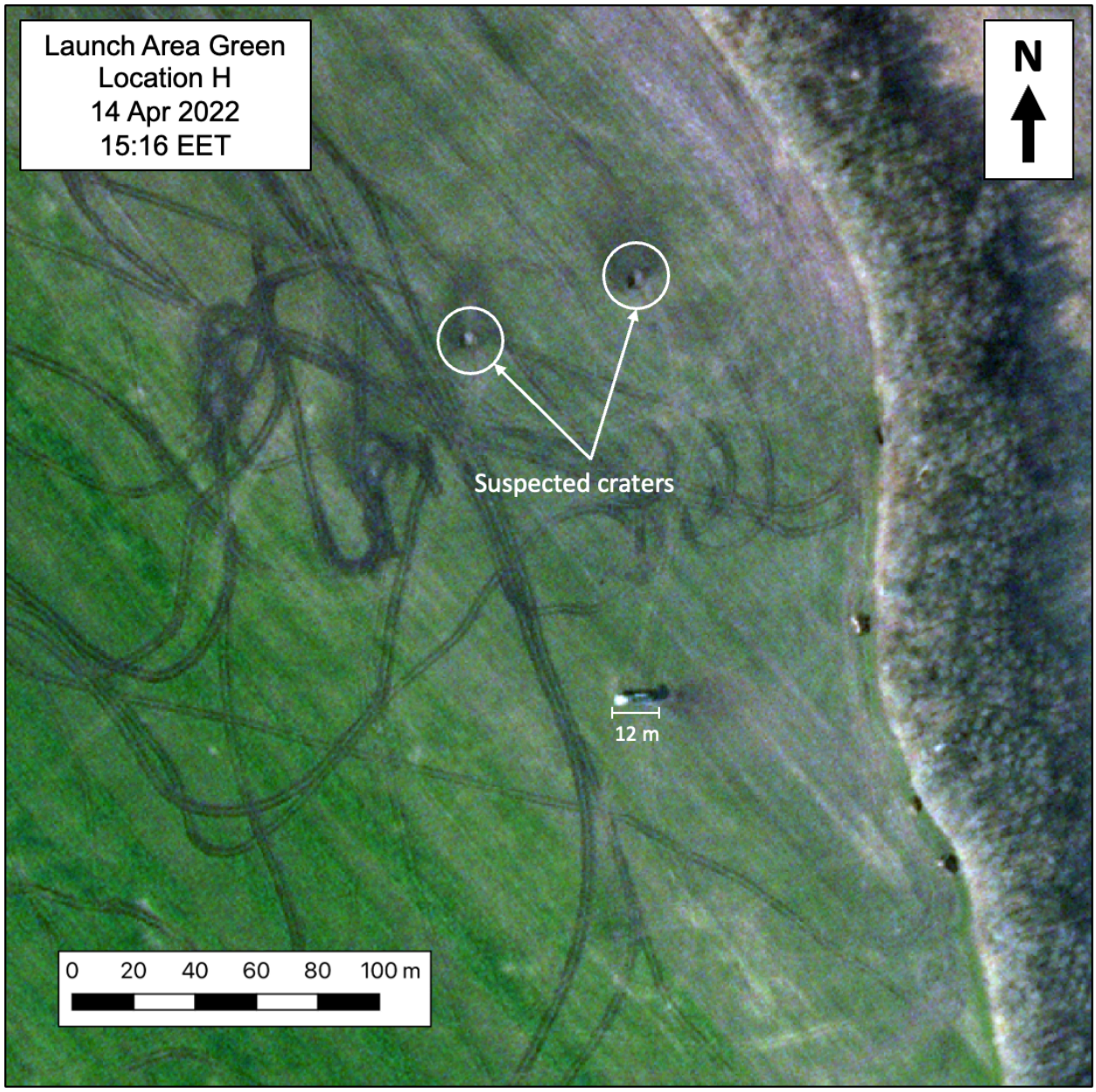



*Image 120: Detailed image of Launch Area H depicting a vehicle of approximately 12 m in length and what appear to be two craters (Credit: © 2023 Planet Labs PBC).*

**Launch Area Green Summary**

Satellite imagery demonstrates that Launch Area Green was certainly used as a launch area for multiple BM-30 Smerch systems from 25/03/2022 until late April 2022. It is notable that activity began at this location at about the same time that activity decreased in Launch Area Red. It is also notable that the level of activity at Launch Area Green appears to be roughly consistent with that seen at Launch Area Red, which was considered by the artillery expert to be roughly consistent with an operational grouping of a rocket artillery brigade.

## Launch Areas Summary

Analysis of satellite imagery depicting the area of interest indicated by the collective directions of origin resulted in the identification of six areas in which it was suspected that MLRS systems were operating during the period of interest. In all but Launch Area Orange the presence of BM-30 systems could be established through visual identification of a launch or reloading vehicle.

The only area in which it was not possible to identify specific BM-30 vehicles, Launch Area Orange, contained what appeared to be burn marks. A satellite image from Planet Labs captured a launch which is consistent with either a BM-30 or Iskander ballistic missile system, but not BM-27 Uragan or Grad.

No single site was used over the entire period of interest. Instead launch areas were identified as being used for a period of a few days or weeks, before new areas became active. Although limited by a period of bad weather in early March which prevented the use of optical satellite imagery, the list below outlines our current understanding of when Launch Areas were active:

- Launch Area Violet: 24/02/2022 - 24/02/2022
- Launch Area Yellow: 24/02/2022 - 25/03/2022 (also used in summer 2022)
- Launch Area Blue: 24/02/2022 - 27/02/2022 (some activity until 16/04/2022)
- Launch Area Red: 27/02/2022 - 23/03/2022 (some activity until late April)
- Launch Area Orange: 27/02/2022 - 10/03/2022
- Launch Area Green: 25/03/2022 - 30/04/2022 (activity may have continued after this date)

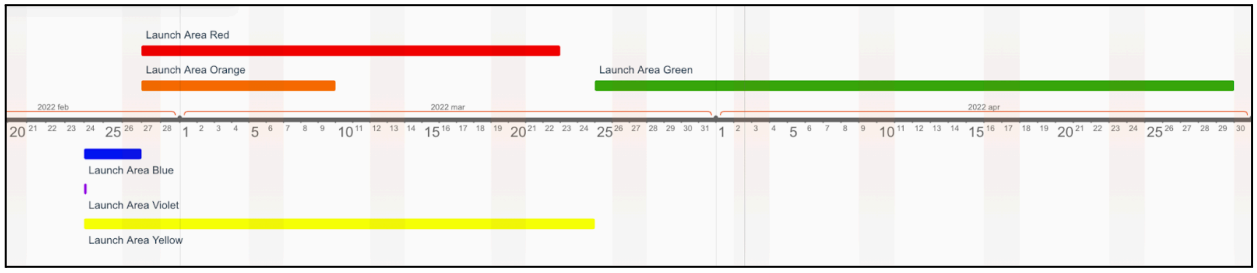



*Image 121: Timeline.*

Without comprehensive high resolution imagery covering the entire area, assessing the level of activity, and so the exact size of the unit, operating in this area cannot be done with confidence. In order to reach a rough estimate of activity within each launch area, burn marks at launch areas were used to estimate the number of vehicles present.

For example, in cases where only burn marks were identified, four or more marks in a row were considered indicative of at least a battery, while extra sets of marks were considered indicative of the possibility of an extra battery. It should be noted that vehicles were often identified in treelines, and as such the identified vehicle counts should be regarded as a minimum number.

For example, in Launch Area Yellow, seen below, two sets of five burn marks can be seen immediately next to each other, which both first appeared on 24/02/2022. This would be considered indicative of the presence of at least one, and possibly two batteries.




*Image 122: Launch Area Yellow, Location A - note the two sets of five burn marks (Credit: Google/Maxar Technologies).*

Hence, the following levels of activity were estimated (note that Launch Area Orange has been excluded, as it was not possible to positively identify BM-30 at that location):

- Launch Area Violet: One battery of four launchers, possibly two batteries.
- Launch Area Yellow: One battery of five launchers, possibly two batteries totalling 10 launchers.
- Launch Area Blue: One battery of six vehicles, possibly indicating two understrength batteries.
- Launch Area Red: a battalion of three batteries, but possibly four batteries.
- Launch Area Green: a battalion of three batteries, but possibly four batteries.

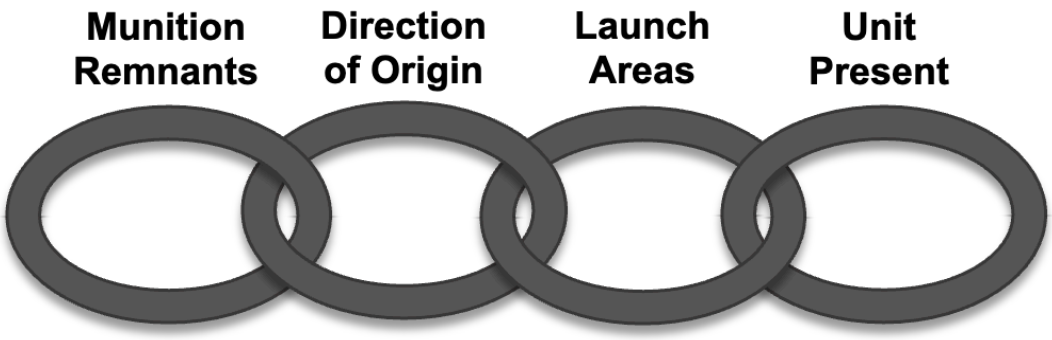
When dates and level of activity are compared we can attain a better understanding of the total size of the BM-30 unit operating in this area.

1. The activity at Launch Areas Violet, Yellow and Blue are concurrent, and each comprise a minimum of a battery, and possibly two batteries in each area.
2. The activity at Launch Area Red indicates at least a battery and possibly up to a battalion or larger unit.
3. The activity at Launch Area Green, which does not appear to be concurrent with any other launch area, indicates at least a battalion, but possibly a larger unit.

Given this information it is possible that within this area of operations there may have been a battalion, or possibly up to two battalions, of BM-30 Smerch. If the convoys of BM-30 identified in Kursk do represent a battalion-level unit (See: **BM-30 Systems In Kursk**), as indicated by the artillery expert, then the actual size of the unit within this area of operations could be a brigade-level unit.

We asked the artillery expert about their opinion regarding this assessment, including the individual launch areas. He stated that the level of activity seen is representative of a brigade-level unit. He also noted that “Most likely, personnel from other rocket artillery military units not directly involved in hostilities were involved. First of all, to staff the unit with officers and specialists, as well as to gain combat experience.”

# VI. Establishing the Unit Present in the Area of Interest




A vital part of accountability in conflict is identifying the military unit responsible for the act in question. This chapter explores information strongly indicating that the 79th Guards Rocket Artillery Brigade was responsible for the BM-30 activity within the identified AoI.

It is a matter of public record that the Western Military District was responsible[173] for the Kharkiv Axis. By February 2022, the Western Military District had two units which field BM-30 Smerch or Tornado-S: the 79th Rocket Artillery Brigade, based in Tver, near Moscow;[174,175] and the 244th Rocket Artillery Brigade, based in Kaliningrad,[176,177] the Russian exclave between Poland and Lithuania. The 244th Brigade is reported to have only received Smerch in March 2020.[178]

A previous investigation by CNN and the Center for Information Resilience identified the 79th Brigade as likely having been responsible[179] for Smerch attacks on Kharkiv. Ukrainian military intelligence also claimed that the 79th Brigade was responsible[180] for shelling in the Sumy and Kharkiv oblasts.

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[173] https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf

[174] https://informnapalm.org/en/unit-79th-rocket-artillery-brigade-western-militart-district-among-group-russian-invasion-forces/

[175] https://fishki.net/1245767-reaktivno-artillerijskaja-brigada-rszo-smerch-v-tveri.html

[176] https://www.cna.org/archive/CNA_Files/pdf/russian-forces-in-the-western-military-district.pdf (p.44)

[177] https://iz.ru/991480/bogdan-stepovoi-roman-kretcul-anton-lavrov/vybit-zalpom-v-kaliningrade-poiavilis-novye-reaktivnye-sistemy

[178] https://iz.ru/991480/bogdan-stepovoi-roman-kretcul-anton-lavrov/vybit-zalpom-v-kaliningrade-poiavilis-novye-reaktivnye-sistemy

[179] https://edition.cnn.com/2022/05/12/world/russia-general-ukraine-syria-cluster-bombs-intl-cmd/index.html

[180] https://gur.gov.ua/content/personalnye-dannye-komandnoho-sostava-79-reaktyvnoartylleryiskoi-bryhady-v-ch-53956-tver-zapadnoho-voennoho-okruha-vs-rf.html

In order to assess the hypothesis that the 79th Brigade was indeed operating within this AoI, images and videos of BM-30 systems were examined from before, during and after the invasion from both official and unofficial sources. From this information, it was possible to identify differences in 300 mm MLRS systems, including parade markings, stickers from arms fairs, number plates and the difference between the Smerch and Tornado-S models. This information was consistent with previous claims that the 79th Brigade was active in the launch areas in the AoI south of the city of Belgorod.

# Media related to Smerch and Tornado-S Systems

## Moscow Victory Day Parades

One of the best sources of high quality imagery of Smerch and Tornado-S systems is the annual Victory Day parade in Moscow, which showcases Russian military equipment. High definition still images and YouTube videos of these parades are freely available and the official announcer helpfully states the weapon system, unit and commander of each contingent of the parade. Since 2010, Smerch systems of the 79th Brigade were present in 2010, 2011, 2018 and 2019, while Tornado-S systems of the 439th Brigade were present in 2020 and 2021. A table of videos depicting these parades can be seen below.

| Year | Unit | Model | URL | Time |
|---|---|---|---|---|
| 2021 | 439th Brigade | Tornado-S | https://www.youtube.com/watch?v=gErzwZncThg | 55:23:00 |
| 2020 | 439th Brigade | Tornado-S | https://www.youtube.com/watch?v=-3gm_ivRycc | 1:34:07 |
| 2019 | 79th Brigade | Smerch | https://www.youtube.com/watch?v=zNf6gVb8sUE | 59:31:00 |
| 2018 | 79th Brigade | Smerch | https://www.youtube.com/watch?v=6u97lqK8MwY | 1:00:28 |
| 2017 | None Present | N/A | https://www.youtube.com/watch?v=kX-7WRwmMyM | From 43:47 |
| 2016 | None Present | N/A | https://www.youtube.com/watch?v=Za8aKqxuDic | From 43:17 |
| 2015 | None Present | N/A | https://youtu.be/kDFVNhlBE7U | From 54:25 |
| 2014 | None Present | N/A | https://www.youtube.com/watch?v=9Fgzl0nHBf0 | From 40:28 |
| 2013 | None Present | N/A | https://youtu.be/lcm_D8JVD_c | From 39:33 |
| 2012 | None Present | N/A | https://www.youtube.com/watch?v=zR7756NTD9c | From 46:33 |

| | | | | |
|---|---|---|---|---|
| 2011 | 79th Brigade[181] | Smerch | https://www.youtube.com/watch?v=dYUwJ1PRxSA | 54:39:00 |
| 2010 | 79th Brigade[182] | Smerch | https://youtu.be/9cfACXjU8kc | 54:32:00 |

## Smerch vs Tornado-S

The Russian Army fields both the 300 mm BM-30 Smerch and Tornado-S, which are very similar systems. While appearing visually similar, Tornado-S is essentially a deep upgrade of Smerch.

Janes describes[183] the differences between the two systems:

"*Externally the Tornado-S launch vehicle appears almost identical to the baseline BM-30 Smerch 9A52-2, but for a GLONASS receiver mounted on the forward-left portion of the crew compartment. Moreover, beyond this external differentiator, the upgraded mission systems include an automated digital fire control system (FCS), which enables the launcher to be automatically aimed at target co-ordinates received over the battle management system. The crew can also undertake the fires mission from within the truck cabin, instead of from the post located on the rear-left of the launcher. The external post remains however, and this is thought to be as a manual back-up in case of emergency.*"

This Russian documentary[184] segment also describes the differences between the two systems, as well as providing a side-by-side visual comparison.

For example, in 2019, a BM-30 Smerch system took part in the parade, and was announced[185] as part of the 79th Guards Rocket Artillery Brigade. Note that, unlike Tornado-S, these vehicles do not have a GLONASS receiver, and that they have a ladder on the aiming post on the rear left of the vehicle.

[181] Unit derived from commander stated by the announcer: Colonel Alexander Aleshin; https://mizugadro.mydns.jp/t/index.php/%D0%92%D1%87_53956
[182] Unit derived from commander stated by the announcer: Andrey Repnikov; https://russian-torturers.com/ru/profile/1487
[183] https://web.archive.org/web/20220319221356/https://www.janes.com/defence-news/news-detail/ukraine-conflict-russian-forces-employ-guided-rockets
[184] https://youtu.be/MLWZDN9mWn0?t=1350 (22:30)
[185] https://youtu.be/zNf6gVb8sUE?t=3572



*Image 123: BM-30 Smerch at the Victory Day Parade 2019. Note the lack of a GLONASS receiver, marked in red, and the presence of firing post with the ladder marked in Blue (Credit: © Freeskipper/Dreamstime.com[186]).*

In 2020, the Tornado-S system was used for the parade, and was announced[187] as part of the 439th Guards Rocket Artillery Brigade. In images from this parade, it is possible to identify the GLONASS receiver,[188] as well as a modified aiming post on the rear left of the vehicle which does not have a ladder. This Tornado-S also has an additional external cabinet on the cab, which is not present on the BM-30 Smerch.

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186 https://www.dreamstime.com/multiple-rocket-launchers-smerch-red-square-dress-rehearsal-parade-honor-victory-day-moscow-russia-may-image167264345

187 https://youtu.be/-3gm_ivRycc?t=5648 (01:34:08)

188 https://armyrecognition.com/military-products/army/artillery-vehicles-and-weapons/multiple-launch-rocket-systems/tornado-s-9k515-mlrs



*Image 124: Tornado-S at the Victory Day Parade 2020. Note the GLONASS receiver marked in red, the extra cabinet marked in white, and the firing post without ladder marked in blue (Credit: Andrey Rykov/Dreamstime.com[189]).*

## Ribbon of St. George

In addition to the structural differences between the Tornado-S and the BM-30 Smerch launch vehicles, the Victory Day parades also reveal a difference between how units mark their vehicles with ceremonial ribbons of St. George. These ribbons were first used in 2014. Prior to that a red star was used instead.

For example, the 79th Brigade, which participated in the Victory Day parades in 2018 and 2019, placed two St. George's Ribbons on each vehicle: one on the front right of the driver's cab, and one on the middle segment of the launch tubes on the left hand side. Meanwhile, the 439th Brigade, which participated in Victory Day Parades in 2020 and 2021, also placed two St. George's Ribbons on each vehicle: one on the front right of the driver's cab, however, slightly more central in relation to the door vents than the 79th Brigade, and one on an equipment locker midway down the left hand side of the vehicle.

189

https://www.dreamstime.com/russia-moscow-june-victory-day-parade-bm-smerch-mobile-heavy-multiple-rocket-launcher-system-maz-m-chassis-drives-down-krasnaya-image213913018



*Image 125: Top: Smerch of the 79th Brigade with St George's Ribbon on launch tube at the Victory Day Parade 2019 (Credit: © Freeskipper/Dreamstime.com[190]). Bottom: Tornado-S of the 439th Brigade with St George's Ribbon on equipment locker at the Victory Day Parade 2020 (Credit: © Freeskipper/Dreamstime.com[191]).*

190

https://www.dreamstime.com/multiple-rocket-launchers-smerch-red-square-dress-rehearsal-parade-honor-victory-day-moscow-russia-may-image167264345

191

https://www.dreamstime.com/smerch-multiple-launch-rocket-system-moscow-street-parade-dedicated-to-th-anniversary-victory-russia-june-image191379734

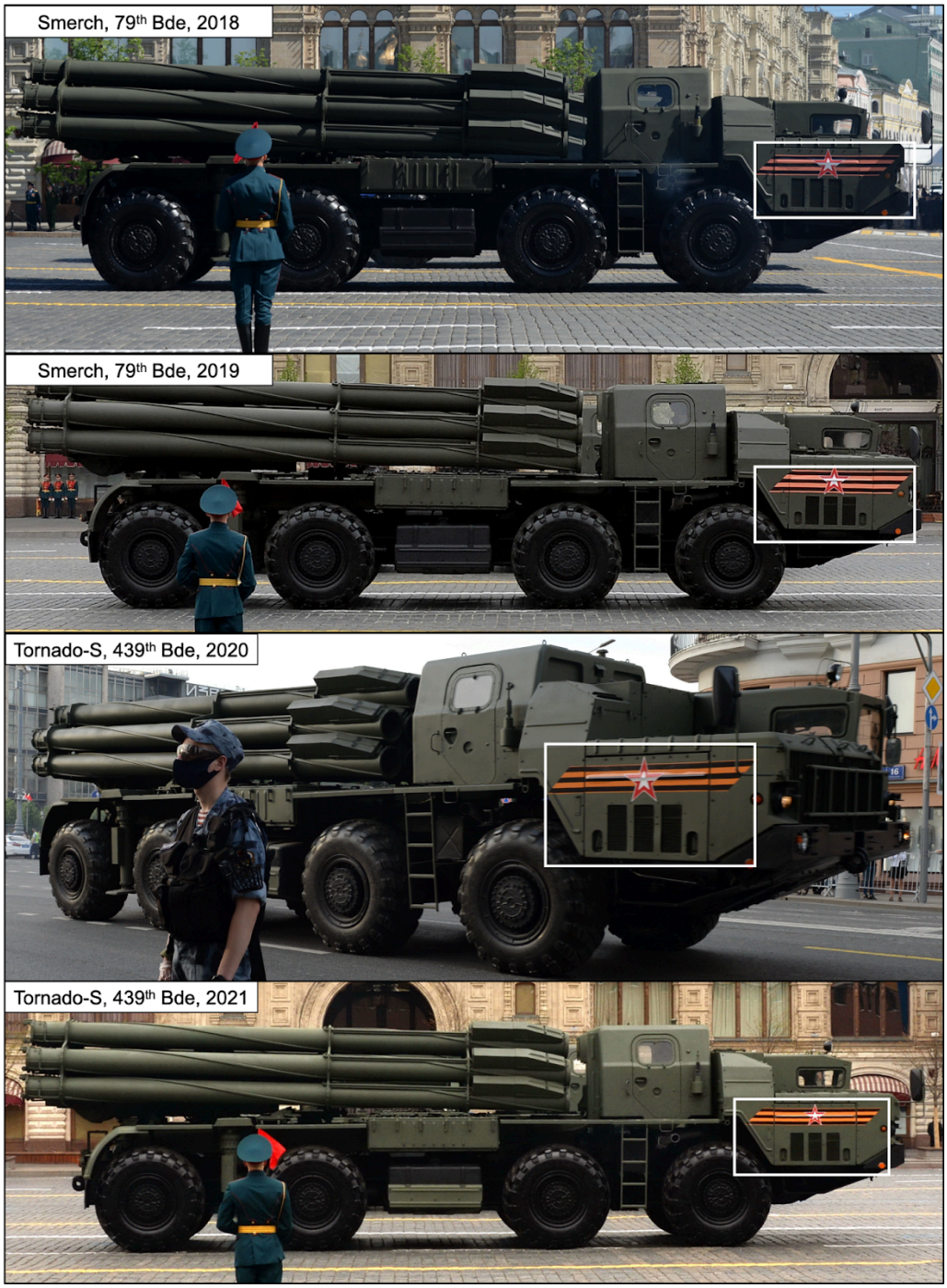



*Image 126: St George's Ribbon placement on Smerch of the 79th Brigade in 2018 and 2019 and on Tornado-S of the 439th Brigade in 2020 and 2021. Note the slightly more central placement of the ribbon in relation to the door vents in 2020 and 2021 (Credit for all: © Freeskipper/Dreamstime.com,[192,193,194,195]).*

[192] Dreamstime.com reference ID 117611187
[193] Dreamstime.com reference ID 153476379
[194] Dreamstime.com reference ID 194631096
[195] Dreamstime.com reference ID 224726303

## Army Forum: Event Stickers

One detail which becomes relevant in identifying the origin of BM-30 Smerch or Tornado-S systems is the presence of badges and insignia from certain events. Each year since 2015,[196] the Russian military has held[197] an "International Military-Technical Forum" (Army Forum), which showcases Russian weapons, such as small arms, vehicles and heavy weapons. This has also included Smerch and Tornado-S.

Being a trade show, there is a large amount of open source content depicting these weapon systems. A review of this imagery indicates that BM-30 Smerch systems were present 2015 - 2020 and that a Tornado-S system was used in 2021. These systems fill two functions at the Army Forum. The first is as a display model, where one or two launchers are displayed alongside many other weapon systems as part of the exhibition. The second is at the firepower demonstration, where a launcher and sometimes a reloader appear on a live-firing range.

It is notable that from 2016 onwards, most vehicles are adorned with a sticker of some kind, usually including the text "Army Forum" in cyrillic or latin characters. Whilst these have differed through the years, they are a very good indication that a particular vehicle has participated in this particular event. Whilst the Army Forum has expanded into other regions, a review of open source videos of these events indicates that the only location where these stickers are seen is at the site of the original event, at the Patriot Park in Moscow.

From 2017-2019 the stickers placed on BM-30 Smerches remained the same, namely a white star on a red background behind the latin characters "#ForumArmy".




*Image 127: Army Forum stickers 2017 - 2019 (Credit, from left to right: @NADO_POSMOTRET,[198] © Igor Dolgov/ Dreamstime.com,[199] © Alexey Kudenko/Sputnik[200]).*

[196] https://tass.com/russia/800781
[197] https://tass.ru/info/18502945
[198] https://www.youtube.com/watch?v=hRHxUzt6354 (03:11)
[199] https://ru.dreamstime.com/bm-smerch-image131956669
[200] https://sputnik-abkhazia.ru/20190628/1027763889.html

In 2020, the sticker was updated to remove the hashtag, leaving just the words “ForumArmy”. It should also be noted that a Tornado-S launch vehicle was used for the firepower demonstration in 2021.

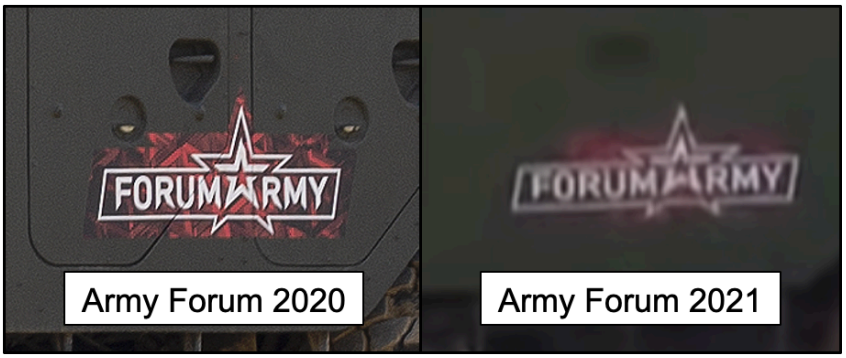



*Image 128: Army Forum stickers from 2020 and 2021 (Credit: © Viktor Karasev/Dreamstime.com[201] (Left); Russian MoD[202] (Right).)*

At Army Forum, number-plates of the vehicles are often clearly displayed, indicating, amongst other information, the Military District to which the vehicle belongs. This is indicated by the number in the bottom right of the number-plate. As previously noted, there are only two units fielding Smerch or Tornado-S in the Western Military District: the 244th Brigade based in Kaliningrad and 79th Brigade based in Tver, near Moscow.

However, the 244th Brigade are only reported[203] to have received Smerch in March 2020. In 2021, the vehicles at Army Forum were Tornado-S, while the Smerch vehicles which attended in 2020 had previously been seen attending in 2018, meaning they must have been part of the 79th Brigade. Therefore any Smerch or Tornado-S seen displaying the military code “50” at the Army Forum must have been part of the 79th Rocket Artillery Brigade.

201 https://www.dreamstime.com/moscow-region-russia-august-combat-vehicle-mlrs-smerch-training-ground-fragment-demonstration-program-military-image244590423

202 https://www.youtube.com/watch?v=ZpH9hTtfWps (45:50)

203 https://iz.ru/991480/bogdan-stepovoi-roman-kretcul-anton-lavrov/vybit-zalpom-v-kaliningrade-poiavilis-novye-reaktivnye-sistemy




*Image 129: A BM-30 system at the 2016 Army Forum. Note the "50" on the numberplate indicating this vehicle is part of the Western Military District and so therefore the 79th Brigade. Note also the sticker highlighted below (Credit: © Igor Dolgov/Dreamstime.com).*

With this information, a table of Smerch and Tornado-S systems which appeared at the Army Forums from 2015-2021 was created, noting their number plate when seen in open source media. In every case where it was possible to identify the unit, the vehicle was identified to be part of the 79th Brigade. This may be because the event is based in Moscow, near the 79th Brigade's home base in Tver, and hence provides vehicles for this event. Certainly, the Russian MoD noted that the initial Army Forum in 2015 was presented[204] by the Western Military District, including their weapons and personnel.

[204] https://structure.mil.ru/structure/okruga/east/news/more.htm?id=12039286@egNews

| Year | Role | Vehicle type | Number plate | Military District | Unit | Paint Colour | Sources |
|---|---|---|---|---|---|---|---|
| Army Forum 2015 | Display Launcher | Smerch | White Board | Likely Western Military District[205] | Likely 79th Bde | Green paint | https://youtu.be/ZN4hFmQhTkA?t=993 (16:32); https://www.youtube.com/watch?v=Td4wbWLt8cs (12:49); https://www.st-kt.ru/articles/armiya-2015-voenno-transportnaya-sila |
| | Firepower Demo Launcher | Smerch | None present | Likely Western Military District[206] | Likely 79th Bde | Green paint | https://ru.dreamstime.com/%D1%80%D0%B5%D0%B4%D0%B0%D0%BA%D1%86%D0%B8%D0%BE%D0%BD%D0%BD%D0%BE%D0%B5-%D1%84%D0%BE%D1%82%D0%BE-bm-smerch-image61723301 |
| | Firepower Demo Reloader | None present | N/A | N/A | N/A | N/A | https://www.youtube.com/watch?v=VLw5KDDyfww (05:35) |
| Army Forum 2016 | Display Launcher | Smerch | 5636 XT 50 | Western Military District | 79th Bde | Green paint | https://bastion-opk.ru/smerch_rszo-2016/; (seen in Tver here: https://fishki.net/1245767-reaktivno-artillerijskaja-brigada-rszo-smerch-v-tveri.html) |
| | Firepower Demo Launcher | Smerch | 6320 XT 50 | Western Military District | 79th Bde | Green paint | https://ru.dreamstime.com/%D1%80%D0%B5%D0%B4%D0%B0%D0%BA%D1%86%D0%B8%D0%BE%D0%BD%D0%BD%D0%BE%D0%B5-%D1%84%D0%BE%D1%82%D0%BE-bm-smerch-image80746476; https://ru.dreamstime.com/%D1%80%D0%B5%D0%B4%D0%B0%D0%BA%D1%86%D0%B8%D0%BE%D0%BD%D0%BD%D0%BE%D0%B5-%D0%B8%D0%B7%D0%BE%D0%B1%D1%80%D0%B0%D0%B6%D0%B5%D0%BD%D0%B8%D0%B5-bm-smerch-%D0%B8-%D0%BA%D0%BE%D1%80%D0%B0%D0%B1-%D1%8C-%D0%BF%D0%B5%D1%80%D0%B5%D1%85%D0%BE-%D0%B7%D0%B0%D0%B3%D1%80%D1%83%D0%B7%D0%BA%D0%B8-image80805340 |
| | Firepower Demo Reloader | Smerch | 1431 TM 50 | Western Military District | 79th Bde | Green paint | https://ru.dreamstime.com/%D1%80%D0%B5%D0%B4%D0%B0%D0%BA%D1%86%D0%B8%D0%BE%D0%BD%D0%BD%D0%BE%D0%B5-%D0%B8%D0%B7%D0%BE%D0%B1%D1%80%D0%B0%D0%B6%D0%B5%D0%BD%D0%B8%D0%B5-bm-smerch-%D0%B8-%D0%BA%D0%BE%D1%80%D0%B0%D0%B1-%D1%8C-%D0%BF%D0%B5%D1%80%D0%B5%D1%85%D0%BE-%D0%B7%D0%B0%D0%B3%D1%80%D1%83%D0%B7%D0%BA%D0%B8-image80805340 |

[205] https://structure.mil.ru/structure/okruga/east/news/more.htm?id=12039286@egNews
[206] https://structure.mil.ru/structure/okruga/east/news/more.htm?id=12039286@egNews

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Army Forum 2017 | Display Launcher | Smerch | Unknown | Unknown | Unknown | Camo paint | https://www.youtube.com/watch?v=0o_wkqdZfTY (00:20) https://www.youtube.com/watch?v=hRHxUzt6354 (3:16); https://youtu.be/V1iwXJVlo4k?si=wM-ARXPOXeCiFv8j (00:47); https://riamediabank.ru/media/3176277.html?query=%D0%90%D1%80%D0%BC%D0%B8%D1%8F-2017%20%D0%A1%D0%BC%D0%B5%D1%80%D1%87&selection=media&sort=date&order=desc&context=search |
| | Firepower Demo Launcher | None present | N/A | N/A | N/A | N/A | https://www.youtube.com/watch?v=hRHxUzt6354 (from 00:00); https://www.youtube.com/watch?v=-rRJiE0U7KY (from 01:45:42) |
| | Firepower Demo Reloader | None present | N/A | N/A | N/A | N/A | https://www.youtube.com/watch?v=hRHxUzt6354 (from 00:00); https://www.youtube.com/watch?v=-rRJiE0U7KY (from 01:45:42) |
| Army Forum 2018 | Display Launcher | Smerch | Unknown | Unknown | Unknown | Green paint | https://www.youtube.com/watch?v=bDH4sTiAbOc (05:52) |
| | Display Launcher | Smerch | None present | Unknown | Unknown | Camo paint | https://www.youtube.com/watch?v=Em3Wowu-ln4 (01:28:07); https://www.youtube.com/watch?v=iuYuwuYm9uw (12:32); https://www.youtube.com/watch?v=1HNIsMyBpaA (01:01) |
| | Firepower Demo Launcher | Smerch | 7841 XT 50 | Western Military District | 79th Bde | Green paint | https://ru.dreamstime.com/bm-smerch-image131956669 |
| | Firepower Demo Reloader | Smerch | 7844 XT 50 | Western Military District | 79th Bde | Green paint | https://ru.dreamstime.com/bm-smerch-image131956669 |
| Army Forum 2019 | Display Launcher | Smerch | Unknown | Unknown | Unknown | Green paint | https://www.youtube.com/watch?v=FT8b3MiWfCk (00:18); https://www.youtube.com/watch?v=fNELWZICskY (00:15) |
| | Display Launcher | Smerch | Unknown | Unknown | Unknown | Camo paint | https://www.youtube.com/watch?v=FT8b3MiWfCk (01:38) |
| | Firepower Demo Launcher | Smerch | 7842 XT 50 | Western Military District | 79th Bde | Green paint | https://www.youtube.com/watch?v=NSIL_UaCK8Y (28:43); https://www.youtube.com/watch?v=f7DF_Ys1-i0 (20:42); https://riamediabank.ru/media/5930548.html?query=%D0%90%D1%80%D0%BC%D0%B8%D1%8F-2019%20%D0%A1%D0%BC%D0%B5%D1%80%D1%87&context=search |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Firepower Demo Reloader | Smerch | 7845 XT 50 | Western Military District | 79th Bde | Green paint | https://www.youtube.com/watch?v=NSIL_UaCK8Y&t=2003s (25:56); https://www.youtube.com/watch?v=f7DF_Ys1-i0 (20:42); https://riamediabank.ru/media/5930110.html?query=%D0%90%D1%80%D0%BC%D0%B8%D1%8F-2019%20%D0%A1%D0%BC%D0%B5%D1%80%D1%87&context=search |
| Army Forum 2020 | Display Launcher | Unknown | Unknown | Unknown | Unknown | Unknown | https://www.youtube.com/watch?v=my1gDAmrdog (10:49) |
| | Firepower Demo Launcher | Smerch | 7841 XT 50 | Western Military District | 79th Bde | Green paint | https://youtu.be/Fnu33K2e-fE (23:49) |
| | Firepower Demo Reloader | Smerch | 7844 XT 50 | Western Military District | 79th Bde | Green paint | https://youtu.be/Fnu33K2e-fE (23:49) |
| Army Forum 2021 | Display Launcher | Tornado | Unknown | Unknown | Unknown | Green paint | https://www.youtube.com/watch?v=2pogyrPaUeU (18:38) |
| | Firepower Demo Launcher | Tornado | None present | Unknown | Unknown | Green paint | https://www.youtube.com/watch?v=ZpH9hTtfWps (45:40); https://www.youtube.com/watch?v=RRuVc04Ttm4 (03:09) |
| | Firepower Demo Reloader | None present | N/A | N/A | N/A | N/A | https://www.youtube.com/watch?v=ZpH9hTtfWps 45:40; https://www.youtube.com/watch?v=RRuVc04Ttm4 (from 03:09) |

## BM-30 Systems In Kursk

Shortly prior to the full scale invasion, convoys of BM-30 systems were filmed on the move in Kursk. At least one of these convoys contained multiple vehicles with Army Forum stickers, strongly indicating they are from the 79th Brigade.

During this period, in January and February of 2022, Kursk appears to have been one of the key assembly areas for Russian troops, with large numbers of military vehicles seen[207] at the Ryshkovo railhead, and a large assembly area[208] seen to the east of the city of Kursk at 51.779, 36.424[209].

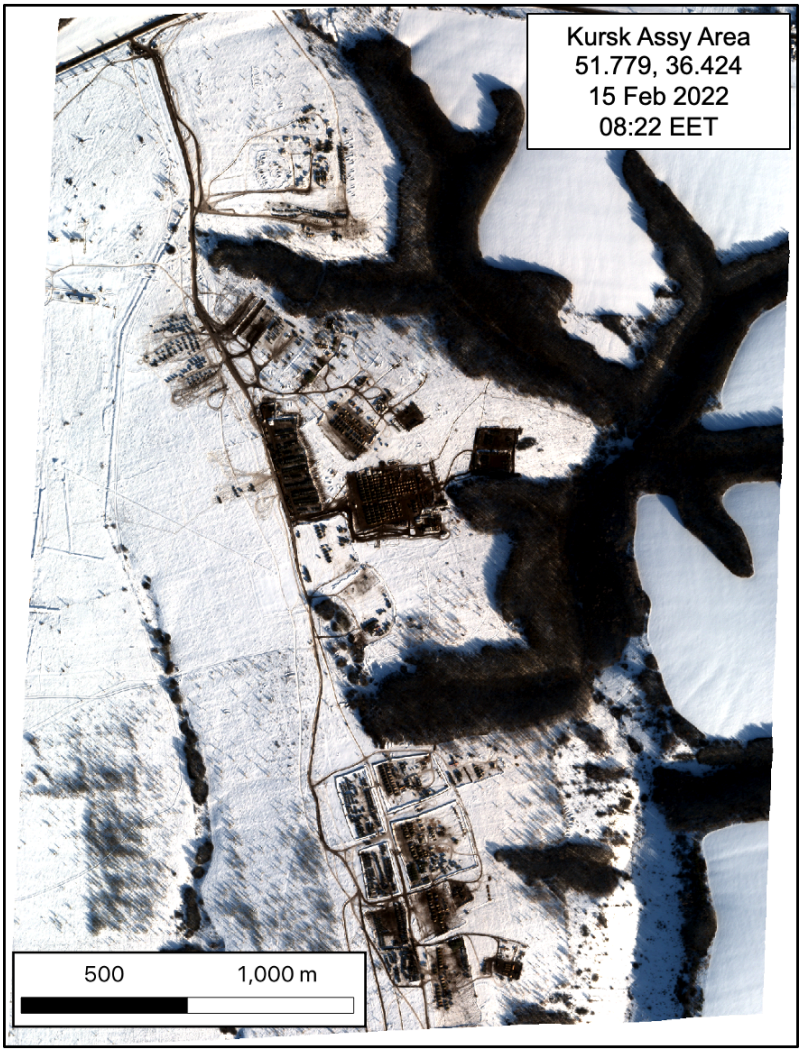



*Image 130: Kursk assembly area at 51.779, 36.424 (Credit: © 2023 Planet Labs PBC).*

[207] https://twitter.com/GirkinGirkin/status/1492522158282747908
[208] https://www.reuters.com/news/picture/satellite-images-show-build-up-of-russia-idUKRTS5JCLI/
[209] https://maps.app.goo.gl/H7GJAMk3r5mNX4PQ7

| Date Posted | URL | Description of post | Location |
|---|---|---|---|
| 07/02/2022 | https://twitter.com/GirkinGirkin/status/1490682550343421954 | Battalion-level convoy seen in Kursk. | 51.6509, 36.1582 |
| 09/02/2022 | An eyewitness Youtube video, source redacted. | Battalion-level convoy seen in Kursk. | 51.7226, 36.2578 |
| 10/02/2022 | https://twitter.com/worldonalert/status/1491826402706042884 | Battalion-level convoy seen in Kursk. | 51.7239, 36.3308 |
| 12/02/2024 | https://x.com/GirkinGirkin/status/1492522158282747908 | Two possible BM-30 vehicles, possibly a launch vehicle and one other, seen in a railway yard. | 51.6554, 36.1398 |

**Kursk Video 1**[210]
**Date posted:** 07/02/2022
**Location:** 51.6509, 36.1582[211]

In this video 28 vehicles are seen in the convoy. Three of these are civilian cars, distinguishable by their white number plates. These may be unrelated to the convoy. The military vehicles seen in order are:

1. SUV;
2. Command vehicle, likely MP32M1, with small trailer;
3. Command vehicle, likely MP32M1, with large trailer;
4. BM-30 launcher;
5. BM-30 launcher;
6. Command vehicle, likely MP32M1;
7. BM-30 launcher;
8. BM-30 launcher;
9. Command vehicle, likely MP32M1;
10. BM-30 launcher;
11. BM-30 launcher;
12. ZIL-131 truck;
13. Command vehicle R-149AKSh-1[212];
14. Transporter-loader;
15. Transporter-loader;
16. Transporter-loader;
17. Transporter-loader;
18. Transporter-loader;

[210] https://twitter.com/GirkinGirkin/status/1490682550343421954
[211] https://maps.app.goo.gl/cD9AZoHy3FGoKVz6A
[212] https://armyrecognition.com/news/army-news/2019/russian-central-military-district-signal-units-receive-advanced-hardware

19. Transporter-loader;
20. KamAZ truck;
21. Tanker;
22. R-166-0.5 signals vehicle[213];
23. ZIL-131 truck with large trailer;
24. KamAZ truck;
25. Police car.

**Kursk Video 2[214]**
**Date Posted:** 09/02/2022
**Location:** 51.7226, 36.2578[215]

In this video another convoy of 23 vehicles is seen. These vehicles are visibly different from those seen in Kursk Video 1, displaying no stickers and slightly different features, such as cold-weather engine covers and headlight covers. The following vehicles are seen in order:

1. Command vehicle, likely MP32M1;
2. BM-30 launcher;
3. BM-30 launcher;
4. Command vehicle, likely MP32M1;
5. BM-30 launcher;
6. BM-30 launcher;
7. Transporter-loader;
8. Transporter-loader;
9. Transporter-loader;
10. Transporter-loader;
11. Command vehicle, likely MP32M1;
12. R-166-0.5 signals vehicle[216];
13. Command vehicle, likely MP32M1;
14. Command vehicle R-149AKSh-1[217];
15. ZIL-131 truck;
16. KamAZ truck with trailer;
17. KamAZ truck with trailer;
18. KamAZ truck;
19. Tanker;
20. Tanker;

[213] https://www.bellingcat.com/news/2015/09/16/sighting-of-r-166-0-5-signals-vehicle-affirms-inflow-of-russian-military-into-syria/
[214] An eyewitness Youtube video, source redacted.
[215] https://maps.app.goo.gl/ew8DEdPN89LPvMeV7
[216] https://www.bellingcat.com/news/2015/09/16/sighting-of-r-166-0-5-signals-vehicle-affirms-inflow-of-russian-military-into-syria/
[217] https://armyrecognition.com/news/army-news/2019/russian-central-military-district-signal-units-receive-advanced-hardware

21. Ammunition transport vehicle;
22. ZIL-131 truck with trailer;
23. Police car.

**Kursk Video 3**[218]
**Date Posted:** 10/02/2022
**Location:** 51.7239, 36.3308[219]

In this video a convoy of 13 vehicles is seen. These vehicles are different from those seen in Kursk Video 1, displaying no stickers and slightly different features, such as cold-weather engine covers and headlight covers. The following vehicles are seen in order:

1. BM-30 launcher;
2. BM-30 launcher;
3. Transporter-loader;
4. Transporter-loader;
5. Transporter-loader;
6. Transporter-loader;
7. Command vehicle, likely MP32M1;
8. R-166-0.5 signals vehicle[220];
9. Command vehicle, likely MP32M1;
10. Command vehicle R-149AKSh-1[221];
11. KamAZ truck with trailer;
12. KamAZ truck with trailer;
13. KamAZ truck;
14. Tanker;
15. Tanker;
16. Ammunition transport vehicle;
17. ZIL-131 truck with trailer;
18. Police car.

**Kursk Video 4**[222]
**Date posted:** 07/02/2022
**Location:** 51.6554, 36.1398[223]

In this video two possible BM-30 vehicles are seen in a railway yard, possibly a launch vehicle

[218] https://twitter.com/worldonalert/status/1491826402706042884
[219] https://maps.app.goo.gl/r1RLWpRd8jG5qZqP8
[220] https://www.bellingcat.com/news/2015/09/16/sighting-of-r-166-0-5-signals-vehicle-affirms-inflow-of-russian-military-into-syria/
[221] https://armyrecognition.com/news/army-news/2019/russian-central-military-district-signal-units-receive-advanced-hardware
[222] https://x.com/GirkinGirkin/status/1492522158282747908
[223] https://maps.app.goo.gl/mrj3BRzSTWCewDWV6

and one other. However, the video is inconclusive.

It appears that Kursk Video 2 and Kursk Video 3 show the same convoy. The type and order of vehicles seen in Kursk Video 3 matches Kursk Video 2. They were also filmed only 5 km away from each other, with a major road between the two locations, driving in a consistent direction. Additionally, one of the launchers appears to have its fabric cover poorly adjusted in the same way.



*Image 131: Left: Launcher seen in Kursk Video 2 (Source: Redacted[224]). Right: Launcher seen in Kursk Video 3 (Credit: @worldonalert[225]).*

An expert[226] in rocket artillery systems was sent details of these two convoys. He noted that, while the number of launchers and reloading vehicles is fewer than you would expect of a battalion, the number and type of command vehicles indicate that each of these convoys represented a battalion-level formation (or "Division" in Ukrainian and Russian parlance).[227] He stated that the limited number of launchers per command vehicle is common when equipment isn't available due to unreadiness, when units are understaffed or when there is limited ammunition. The expert in satellite imagery and artillery systems agreed with this assessment.

The presence of two battalions of BM-30 Smerch at Kursk, which was used as an assembly area, is notable. Analysis of the launch areas indicated that a unit of about brigade strength was also present in the AoI south of the city of Belgorod. It is unlikely that the Smerch systems seen in Kursk were then moved to another axis, and it therefore appears probable that these systems were headed to Belgorod to support the advance on Kharkiv.

[224] An eyewitness Youtube video, source redacted.
[225] https://twitter.com/worldonalert/status/1491826402706042884
[226] Artillery expert Petro Pyatakov Col (ret).
[227] Artillery expert Petro Pyatakov Col (ret).

## Kursk Smerch Systems and the 79th Brigade

The Smerch vehicles seen in Kursk Video 1 can be linked to the 79th Brigade by the stickers seen on the vehicles. Within this convoy there are three vehicles bearing stickers which match those used at the Army Forum: two BM-30 launchers and a reloading vehicle. While the video is not high definition, it is possible to identify that one of the stickers on a launch vehicle begins with a hashtag, whilst the other two, on a launch vehicle and transporter loader, do not have a hashtag.



*Image 132: Stills from Kursk Video 1 depicting the Army Forum stickers. Note that the first sticker begins with a hashtag, while the second and third do not.*

It is notable that of all the Smerch and Tornado-S systems seen at Army Forum with identifiable number plates, all have been part of the Western Military District and so the 79th Guards Rocket Artillery Brigade. This is consistent with the primary Army Forum event taking place[228] in Moscow, near where the 79th Brigade is based, in Tver.

The launch vehicle sporting the "#ArmyForum" sticker within Kursk Video 1 must have attended the Army Forum in either 2018 or 2019 (in 2017 no Smerch vehicles participated in the firepower demonstrations and the only Smerch on display was painted in camouflage, rather than dark green). The other two vehicles must have been present in 2020, the year that stickers without hashtags were used, as in 2021 the launch vehicles present at the Army Forum were Tornado-S rather than Smerch, and no reloading vehicles participated.

Using the table of Smerch systems seen at Army Forum, the first launcher sporting the "#ArmyForum" sticker must be either the vehicle with the number plates 7841 XT 50 or 7842 XT 50 from the 79th Brigade, or one of the two other launchers painted dark green where the number plates were not clearly displayed.

The launcher sporting the Army Forum sticker without a hashtag is either the launcher bearing the number plate 7841 XT 50 from the 79th Brigade, or one other launcher with an unknown number plate.

[228] https://www.understandingwar.org/sites/default/files/Russian%20Ground%20Forces%20OOB_ISW%20CTP_0.pdf

The transporter-loader  vehicle sporting the Army Forum sticker without a hashtag must have participated in the 2020 Army Forum, since no reloading vehicle participated in 2021. As such this must be the transporter-loader vehicle with number plate 7844 XT 50 from the 79th Brigade.

### Connection with Vehicle Seen in Tver

It is possible that the transporter-loader featuring the Army Forum sticker in Kursk Video 1 was also seen in Tver Video 1[229], which depicts BM-30 launchers in Tver, the home base of the 79th Brigade.

| Date Posted | URL | Description in post | Location |
|---|---|---|---|
| 25/12/2021 | https://twitter.com/XRageThe/status/1474856586715832332 | In Tver, a convoy of transport-loading vehicles of the "Smerch" MLRS was seen | 56.8475, 35.8179 |

**Tver Video 1**[230]
**Date Posted:** 25/12/2021
**Location:** 56.8475, 35.8179[231]

[229] https://twitter.com/XRageThe/status/1474856586715832332
[230] https://twitter.com/XRageThe/status/1474856586715832332
[231] https://maps.app.goo.gl/sRqNanobSeeAfyuU6

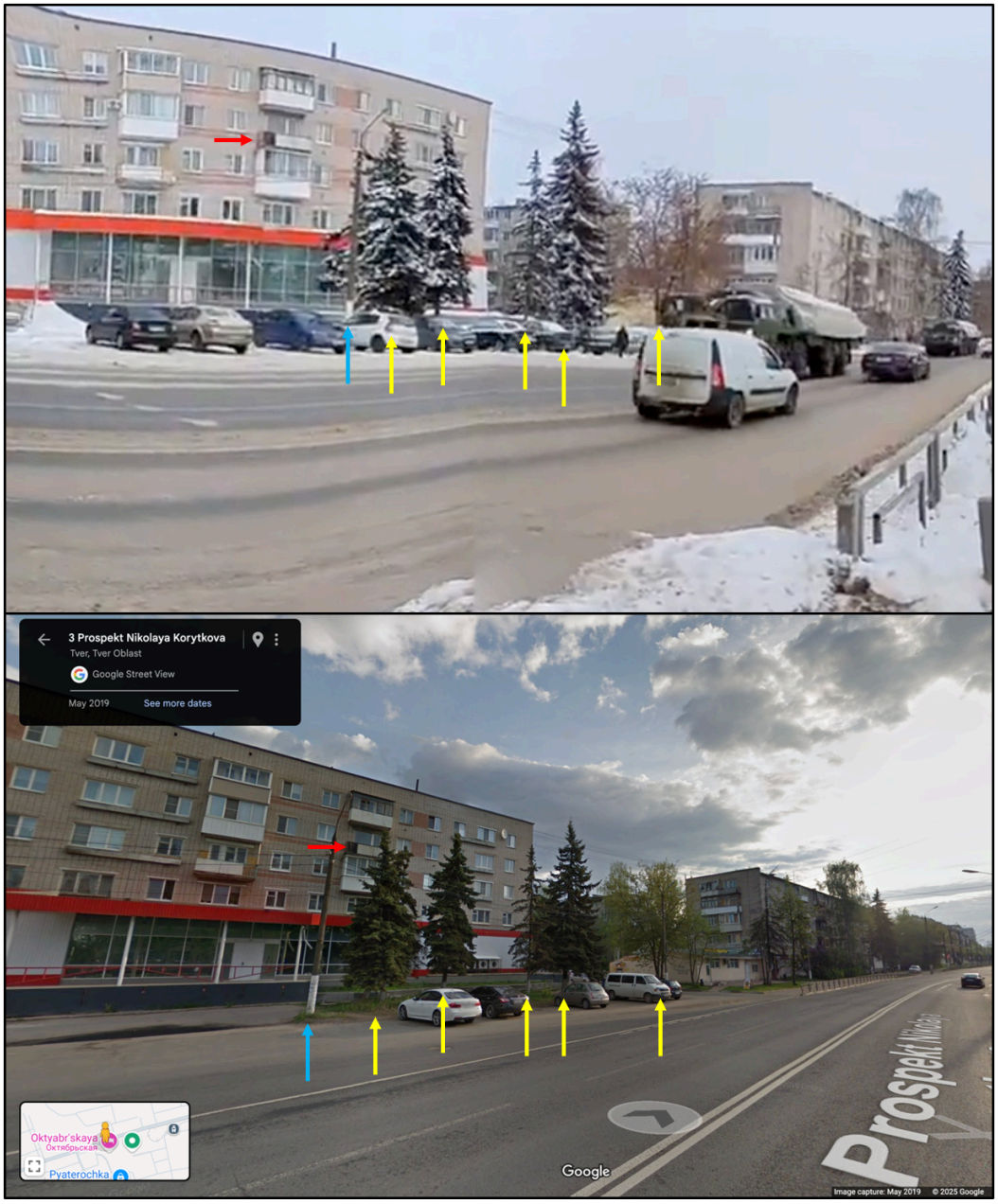



*Image 133: Top: Panoramic created using two still frames from Tver Video 1 (Credit: @RAGEXNEWS[232]). Bottom: Google Maps view of this location (Credit: Google).*

Within Tver Video 1, a transporter loader, identifiable by its distinctive double cab, is seen with an Army Forum sticker placed on the left side of the cab. The marks and rips on the cover of this vehicle appear to be consistent with the cover seen on one of the vehicles in Kursk, although there seems to have been an attempt to fix the large rip. Due to the quality of the video, it cannot be established with certainty that these marks are the same, and further analysis would be required to confirm this.

[232] https://x.com/RAGEXNEWS/status/1474856586715832332?s=20

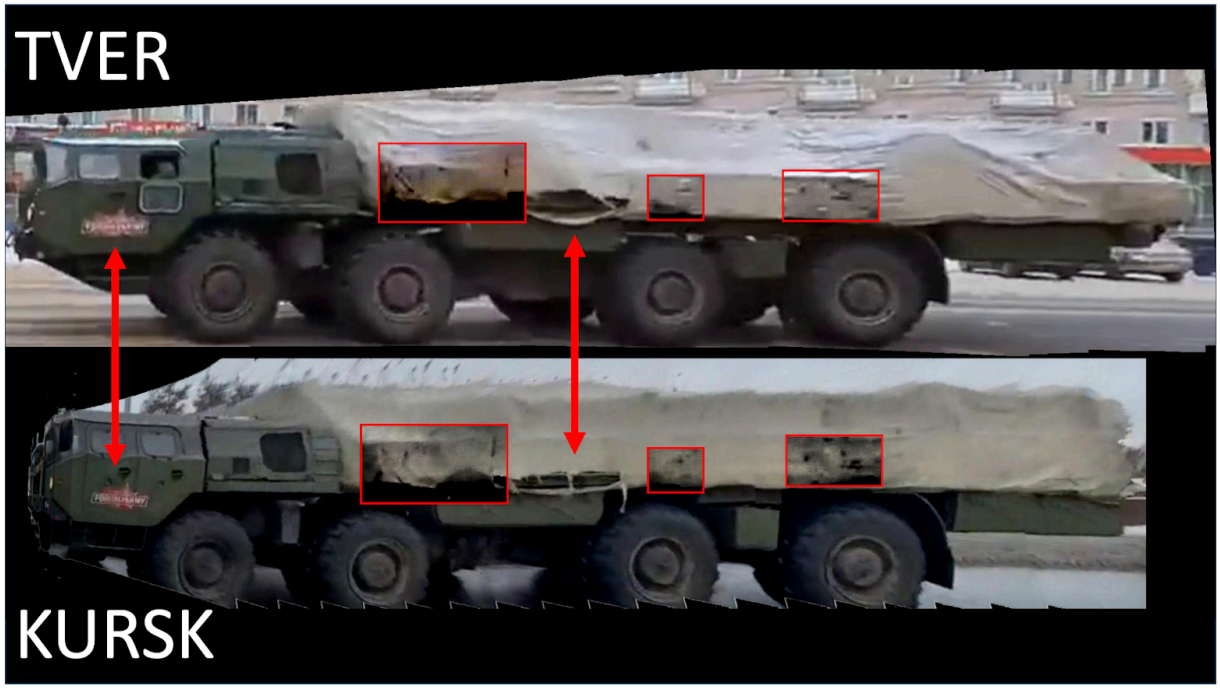



*Image 134: Top: Transporter-loader seen in Tver Video 1 (Credit: @RAGEXNEWS[233]). Bottom: Transporter-loader seen[234] in Kursk.*

## BM-30 Systems South of Belgorod: Western Military District

During the research it became clear that few Smerch or Tornado-S launches had been filmed by ordinary people inside Russia. Some videos of launches do exist, especially from the first few days of the full-scale invasion, but they are not close enough to show distinguishing features on the launchers or other vehicles.

However, the Russian MoD published multiple videos over 2022 showing Smerch launches. Those were possible to geolocate to the AoI, south of the city of Belgorod. These videos are in high definition and sometimes explicitly name which military district the unit belonged to.

In analysing these videos, the source, namely the official Telegram account for the Russian MoD was assessed. Whilst the Russian Federation has previously engaged in extensive disinformation campaigns,[235] these tend to have been designed for a foreign audience. The videos below were posted in the Russian language to the Russian Telegram channel, and designed to demonstrate Russian military capacity to a domestic audience. The videos were analysed to assess the limited claims made within them. Specific claims, for example, that a specific target was struck by a specific launch is seen on film, should be verified before being

[233] https://x.com/RAGEXNEWS/status/1474856586715832332?s=20
[234] https://twitter.com/GirkinGirkin/status/1490682550343421954
[235] https://euvsdisinfo.eu/ukraine/

relied upon, however, more general claims, such as “these are Smerch launchers” or “this is the work of a specific military district” are considered to be more reliable.

| Date Posted | URL | Description in post (machine translated) | Notes |
|---|---|---|---|
| 21/04/2022 | t.me/mod_russia/14575 | 💥 Combat work of the crews of the Smerch multiple launch rocket systems | Video containing multiple clips of Smerch operations.<br><br>Some scene geolocatable to Launch Area Green<br><br>Vehicles with markings seen. |
| 24/04/2022 | t.me/mod_russia/14713 | 🇷🇺💥 The crew of the Smerch multiple launch rocket system performs a combat mission | Set of still images, geolocated to 50.393 36.360.<br><br>In one clip, the front left door of the launch is obscured. |
| 13/06/2022 | t.me/mod_russia/16719 | 📹 Footage of combat operations by Smerch multiple launch rocket system crews<br>▫️ According to intelligence, the Ukrainian Armed Forces units have concentrated ammunition, military equipment and weapons to supply their troop group.<br>▫️ The intelligence data was confirmed by technical intelligence means.<br>💥 Smerch MLRS crews, having received the task of destroying warehouses, launched a salvo. | Video with multiple clips of Smerch operations.<br><br>Two scenes, at 00:17 and 00:21, were geolocated to Location E, Launch Area Yellow, 50.3701, 36.4582.<br><br>Smerch seen with a marking that may be a sticker on the right hand door. |
| 27/07/2022 | t.me/mod_russia/17968 | 💥 Combat work of the Smerch multiple launch rocket system crews of the Western Military District<br>The Russian Armed Forces continue to launch missile strikes against military infrastructure facilities and combat equipment of the Ukrainian Armed Forces during a special military operation.<br>▫️ According to intelligence, the Ukrainian Armed Forces units have concentrated ammunition, military equipment and weapons to supply their troop group.<br>The data was confirmed by technical reconnaissance means, after which the Smerch multiple launch rocket system unit struck the Ukrainian Armed Forces logistics center.<br>🎯 The crews have no doubts about the accuracy of their systems. All targets are guaranteed to be destroyed, and intelligence reports on the pinpoint accuracy of the missilemen's work.<br>▫️ Smerch MLRS crews disable and destroy command posts, warehouses with weapons, ammunition and fuel and lubricants, communication centers, air defense systems and other important targets located at a great distance. | Explicitly names the Western Military District.<br><br>Multiple clips of Smerch operations IVO Launch Area Green and Yellow.<br><br>Multiple markings seen, including the ribbon of St. George. |
| 22/09/2022 | t.me/mod_russia/20050 | 📹 Combat work of the Smerch multiple launch rocket system crews of the Western Military District during a special military operation<br>▫️ The Armed Forces of the Russian Federation continue to strike with missile weapons at military infrastructure facilities and combat equipment of the Ukrainian Armed Forces.<br>💬 "We are capable of hitting identified objects at a distance of up to 70 and even up to 90 kilometers. "Smerch" receives a task when some enemy reserves are revealed. ... All we need is to receive intelligence data and, accordingly, strike," said Nikolai Uragan, the | Explicitly names the Western Military District.<br><br>The third video at 1:10 depicts launch at 50.444, 36.480, north-east of Launch Area Green.<br><br>No markings visible. |

| | | | |
|---|---|---|---|
| | | head of the MLRS crew.<br>💬 "I receive a command, receive a target, enter special data into the program, make a calculation, fill out all the documentation. Most of the work takes place in this machine. Then I pass it on to the commander, pass it on to the combat vehicle crew. All they have to do is aim and make an accurate launch," said Yegor, the head of the automated control system crew. | |
| 31/10/2022 | t.me/mod_russia/21327 | No Hiding Place: Footage of the Night Operations of the Smerch MLRS Crews of the Western Military District<br>The Armed Forces of the Russian Federation continue to strike at military infrastructure facilities and combat equipment of the Ukrainian Armed Forces during a special military operation.<br>The Smerch MLRS divisions are tasked with destroying especially important enemy targets.<br>The Smerch MLRS crews disable and destroy ⬇️<br>● command posts,<br>● warehouses with weapons, ammunition and fuel and lubricants,<br>● communication nodes,<br>● air defense systems and other important facilities located at a great distance.<br>The targets of the long-range rocket system's shells are tens of kilometers away. Effective operation is possible at a distance of up to 90 kilometers. But even at the maximum range, the crews cover the target with pinpoint accuracy.<br>📐 The key to accurate hits is meticulous calculation. Everything is taken into account - from temperature, wind direction and strength to pressure.<br>🔄 The Smerch MLRS crews are always on the move. The artillerymen change their starting positions and shelters where they can replenish their ammunition, refueling points for equipment and rest areas several times a day. | Explicitly names the Western Military District.<br><br>No scenes geolocatable.<br><br>No markings visible. |
| 21/11/2022 | t.me/mod_russia/21905 | Tested in combat conditions: how the new MLRS performed during a special operation<br>The Tornado-S MLRS crews of the Western Military District disable and destroy command posts, warehouses with weapons, ammunition and fuel and lubricants, communication centers, air defense systems and other important targets located at a great distance.<br>▫️ The Tornado-S multiple launch rocket system is a deeply modernized version of the Smerch MLRS. The improvement affected the ammunition, communications and control systems. As a result, the developers managed to significantly increase the firing range, accuracy and firepower of this type of MLRS.<br><br>▫️ Like its predecessor, the Tornado-S has 12 guides for 300-mm rockets. At the same time, the system is capable of hitting targets at a significantly greater range than the Smerch: 120 km versus 70-90 km.<br>▫️ Each munition of this MLRS can receive an individual flight mission and use the capabilities of the GLONASS navigation system, which significantly increases the accuracy of the strike.<br>▫️ Shells can be fired at different distances and in different directions. The launch angle is almost 90 degrees. This means that one Tornado-S installation can destroy several Ukrainian Armed Forces strongholds on the front line, a transport interchange on the enemy's second line of defense, and an ammunition depot in the deep rear in one salvo. | Explicitly mentions the Western Military District.<br><br>Launch vehicle confirmed to be a Tornado-S.<br><br>The vehicle is in good condition compared to Smerches seen in other videos. |

| | | | |
|---|---|---|---|
| | | ▫️ The Tornado-S software and hardware allow for automatic information exchange with a high level of protection against interception, display and store the received information, navigate the terrain autonomously using an electronic map, and also guide and launch missiles without having to leave the cabin. The Tornado MLRS is considered one of the best in the world and surpasses foreign analogues in many respects. | |
| 25/11/2022 | t.me/mod_russia/22062 | We understand each other without words: how the Smerch MLRS crew of the Western Military District works in the area of a special operation<br>▫️ The Smerch MLRS divisions are tasked with destroying especially important objects of the enemy's military infrastructure located tens of kilometers away. But even at extreme range, the crews cover the target with pinpoint accuracy.<br>💪🏻 Rocket artillery crews are on constant duty along the front line. From receiving the task to the crushing blow, only a few minutes.<br>🎯 The crews have no doubts about the accuracy of their systems. All assigned targets are guaranteed to be destroyed. | Explicitly names the Western Military District.<br><br>Launch vehicle with St George's ribbon seen. |
| 04/02/2023 | t.me/mod_russia/23945 | At the enemy's positions "Tornado": combat work of the crews of the multiple launch rocket systems of the Western Military District in the special operation zone<br>💥 According to intelligence, the units of the Armed Forces of Ukraine have concentrated military equipment, weapons and ammunition to supply the group of their forces. The intelligence data was confirmed by technical reconnaissance means, after which the units of the Tornado-S MLRS struck military facilities of the Armed Forces of Ukraine.<br>🤝 The crews have no doubts about the accuracy of their systems. All targets are guaranteed to be destroyed, and intelligence reports exceptional jewelry precision of the missilemen.<br>💪🏻 The crew has been carrying out combat missions since the very beginning of the Central Military District. The artillerymen, in their own words, have long become one fighting family, where everyone is cheerful and focused on Victory. | Explicitly names the Western Military District.<br><br>Launch vehicle confirmed to be a Tornado-S.<br><br>No painted vehicle marking. |
| 09/02/2022 | t.me/mod_russia/24054 | We hit targets at any time: night combat work of the Tornado-S MLRS crews of the Western Military District during a special operation<br>💥 The Tornado-S MLRS crews disable and destroy command posts, ammunition and fuel depots, communication nodes and other important targets located at a great distance.<br>🔎 The vehicle is equipped with an automatic navigation system. This allows the combat vehicle to take up a starting position in the shortest possible time.<br>✉️ In the cabin - children's drawings and letters. Courageous and brave military personnel treat such messages with trepidation and take them with them on combat missions.<br>💬 "These children's letters and drawings. I think this is important. It means that people remember and know that we are here and why we are here. We are fighting for the Motherland and for the truth," said the crew chief with the call sign "Thunder". | Explicitly names the Western Military District.<br><br>Launch vehicle confirmed to be a Tornado-S.<br><br>No painted vehicle marking. |

These videos depict launches in Launch Area Yellow, Launch Area Green and one further isolated launch position to the east of Launch Area Blue. The first of these videos was published on 21/04/2022, and so earlier launch areas are unlikely to have been captured on film.

It is notable that the tactical vehicle marking seen in videos of Smerch vehicles from the Western Military District is a Z in a square box.



*Image 135: "Z" in a square marking, as seen[236] on Smerch vehicles of the Western Military District (Credit: Russian MoD).*

In the videos which can be geolocated to the launch areas south of Belgorod, Smerch vehicles can be seen sporting various markings, such as stickers and the remains of stickers. Whilst the Russian MoD made attempts to obscure these markings, it is possible to identify that they are consistent with those seen on vehicles of the 79th Brigade. These examples have been listed below.

**Example 1:** Launch vehicle with markings on cab
**Video:** t.me/mod_russia/14575[237] (00:00)
**Date published:** 21/04/2022

In this example two launch vehicles are seen being loaded. The loading vehicle in the background of the video has markings which are consistent with those seen on Smerch and Tornado-S launches which participated in the Victory Day parades in Moscow. While the quality of the video means an exact match is difficult to be sure of, it was not possible to identify any other marking on any other Smerch seen in open source media which could match Example 1.

[236] https://t.me/mod_russia/20050
[237] https://t.me/mod_russia/14575

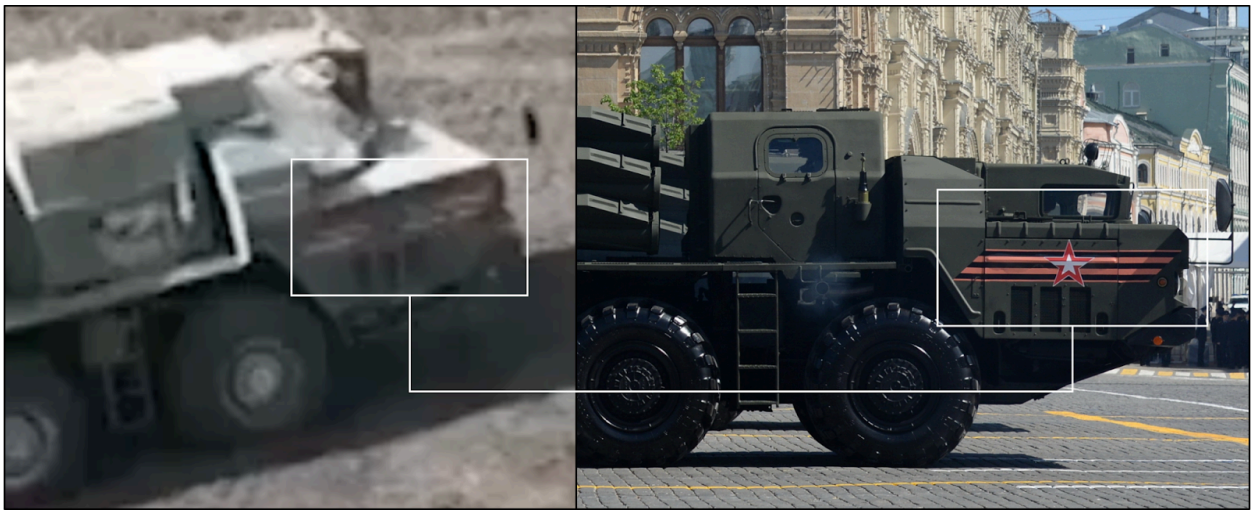


*Image 136: Left: Launcher seen in Example 1 (Credit: Russian MoD). Right: Smerch launch vehicle seen in Victory Day Parade in Moscow in 2018 (Credit: © Freeskipper/Dreamstime.com).*

Example 1 is in a segment of a video released by the Russian MoD titled “Combat work of the crews of the Smerch multiple launch rocket systems”. As well as the video specifically stating this is work of a Smerch, the apparent lack of a GLONASS antenna supports the conclusion that this is a Smerch rather than Tornado-S. This strongly indicates it is from the 79th Brigade, as the other unit seen participating at the Victory Day Parade with this marking, the 439th Brigade, used the Tornado-S.

While the scene in Example 1 could not be geolocated, other scenes within this video depicting Smerches with the recognition marker of a Z-in-a-square, were geolocated to Launch Area Green (see: Launch Area Green).

**Example 2: Launch vehicle, cab door obscured**
**Video:** t.me/mod_russia/14575[238] (00:18)
**Date published:** 21/04/2022
**Images:** t.me/mod_russia/14713[239]
**Date published:** 24/04/2022
**Location:** IVO 50.393, 36.360[240] (See Example 4)

In this example a Smerch can be seen launching several rockets from a field. It is seen in both the video titled “Combat work of the crews of the Smerch multiple launch rocket systems”, as well as a series of still images released by the Russian MoD. Both sources show the same launcher in the same place.

[238] http://t.me/mod_russia/14575
[239] https://t.me/mod_russia/14713
[240] https://maps.app.goo.gl/xGGP6Qbv3ntptTEp7

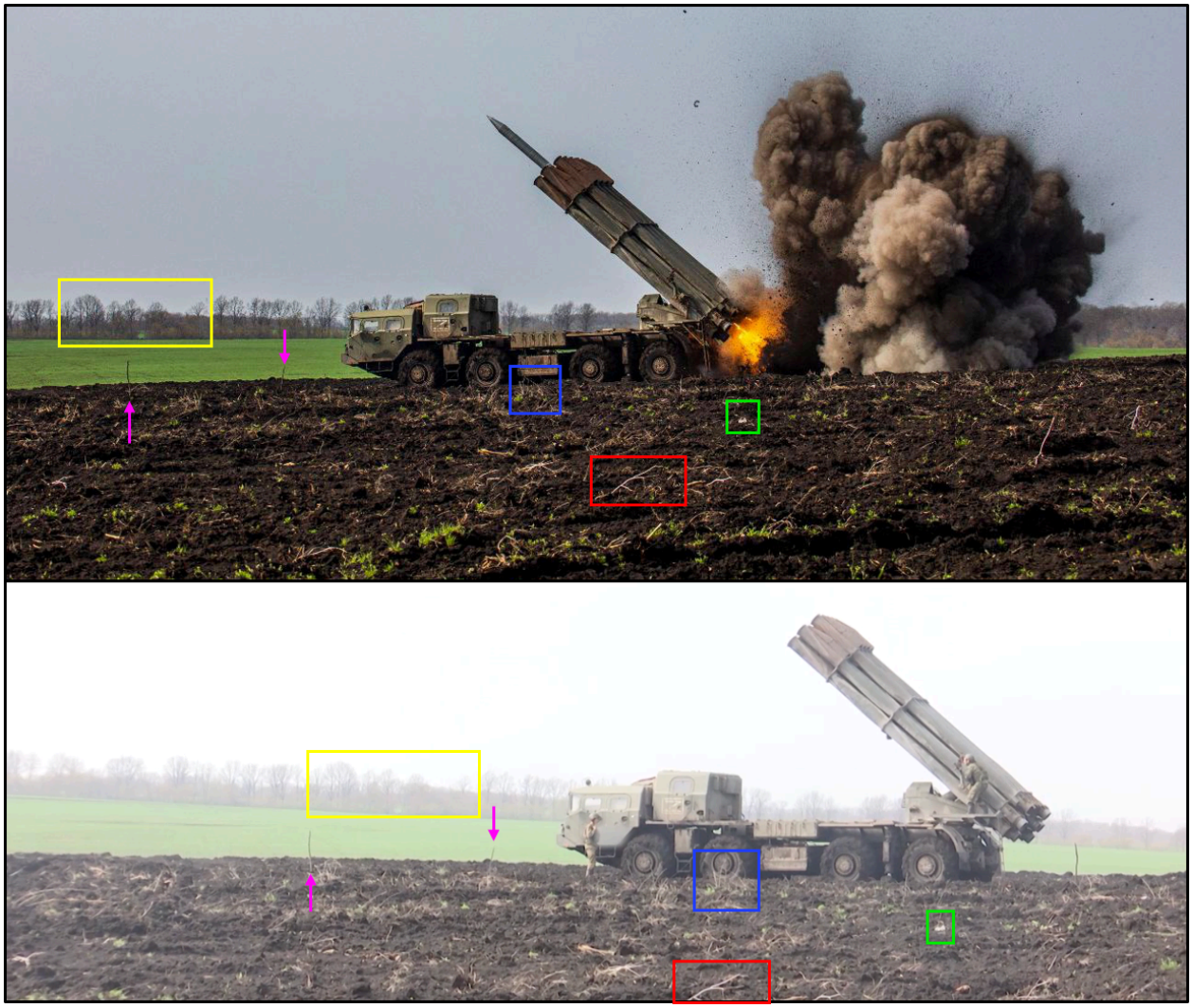


*Image 137: Top: Image from set of images showing Smerch launches, published on 24/04/2022. Bottom: Still from video (00:22) released on 21/04/2022 showing Smerch launches (Credit: Russian MoD).*



*Image138: Top: Image from set of images showing Smerch launches, published on 24/04/2022. Bottom: Still from video (00:22) released on 21/04/2022 showing Smerch launches. While the matching features are highlighted, they do not represent the totality of the matching features (Credit: Russian MoD).*

Whilst both sources show the same Smerch launcher in the same place, both have significant differences around the front left door of the drivers cab. In the video from 21/04/2022 this door is blurred, whilst in the set of images published on 24/04/2022 the door is different in each image, despite the rest of the vehicle being recognisably the same. It is therefore clear that there has been an attempt to obscure this part of the vehicle, either by blurring or slightly more subtle digital manipulation.



*Image 139: Door as seen in three different images from those published on 24/04/2022. Note the patterns and colours of the door panel are different between all versions (Credit: Russian MoD).*

However, during the video published on 21/04/2022 a person stands next to this door, a result of which is that the blurring no longer covers the entire door. A fraction of the door is exposed for a few frames, revealing what appears to be three sides of a light-coloured box shape. This shape is consistent with the edge of an Army Forum sticker, which has a white box around the outside of the logo. This cannot be a part of the soldier's uniform, as whilst the soldier moves, this marking does not.




*Image 140: Left: Still from a video published on 21/04/2022 at 00:22 highlighting a marking on the vehicle. Center: Army Forum stickers as seen with and without hashtag. Right: The same still as left, but with adjusted sharpness (+73%), brightness (+16%) and contrast (-59%) of the image to reveal the marking more clearly.*

Other scenes within this video depicting Smerches with the recognition marker of a Z-in-a-square, were geolocated to Launch Area Green (see: Launch Area Green). This specific scene was geolocation to IVO 50.393, 36.360[241], which can be seen in Example 4)

**Example 3:** Smerch with unidentifiable door marking
**Video:** t.me/mod_russia/16719[242] (00:18)
**Date published:** 13/06/2022
**Location:** Launch Area Green, Location E, 50.3701, 36.4582[243]

In this footage it is possible to see what is stated to be a Smerch launching a salvo of missiles. It is also possible to see that the launch vehicle has a discolouration above the vent grills on the right side of the vehicle, where stickers for both the Army Forum and the St George's ribbon are placed. However, it was not possible to identify exactly what marking this could be.



*Image 141: Still from video (00:18) posted by Russian MoD on 13/06/2022 claiming to depict a Smerch launch (Credit: Russian MoD).*

**Example 4:** Video regarding “work of the Western Military District”
**Video:** t.me/mod_russia/17968[244] (00:03)

[241] https://maps.app.goo.gl/xGGP6Qbv3ntptTEp7
[242] https://t.me/mod_russia/16719
[243] https://maps.app.goo.gl/RYdcYoGAi1a6Lh7r9
[244] http://t.me/mod_russia/17968

**Date published:** 27/07/2022
**Locations:** various scenes IVO the identified AoI

This video is of particular importance, as it was posted to the Russian MoD Telegram channel with a description explicitly stating that it depicted “Smerch multiple launch rocket system crews of the Western Military District”. Several of the scenes in this video can be geolocated to areas south of Belgorod.

Some markings on the vehicles strongly indicate the presence of 79th Brigade vehicles. Twice in the video we see a Smerch with the ribbon of St. George on the launch tubes. This matches the markings of launch vehicles of the 79th Brigade that have participated in the Victory Day Parades in Moscow.



*Image 142: Smerch launch vehicle(s) seen in video at 00:03 (Top) and 00:36 (Bottom) clearly displaying the ribbon of St. George, which matches the placement on Smerch vehicles of the 79th Brigade seen in Moscow’s Victory Day Parade in 2019. (Credit: Russian MoD (Top, Middle); © Freeskipper/Dreamstime.com (Bottom)).*

This particular vehicle could be geolocated to 50.3801, 36.3708[245], Location H in Launch Area Green, near where several other scenes from this video were filmed.




*Image 143: Top: Panoramic of two stills from a video published by the Russian MoD on 27/07/2022 at 00:03. Bottom: ground-eye view in Google Earth Pro. Note the re-entrant in the hill in the background. N.B the trees seen in the top image would not be visible in the bottom image, as Google Earth Pro ground-eye view does not show trees (Credit: Google/Maxar Technologies/Landsat/Copernicus).*

[245] https://maps.app.goo.gl/iesTNAJbAvr8XFBW9

Also visible in this video is one vehicle with a marking consistent with what would be left after the removal of a sticker. It appears to be consistent with a ribbon of St. George. This can be seen in the same position as where the ribbon of St George is seen in the Moscow Victory Day Parades. It is noteworthy that this is a Smerch rather than a Tornado-S, meaning it must be part of the 79th Brigade, rather than 439th Brigade.




*Image 144: Top and Middle: A visible mark on the side of the front-right door of Smerch as seen in a video published on 27/07/2022 (Credit: Russian MoD). Bottom: St.Geroge's ribbon position as seen on a Smerch of the 79th Brigade in 2019 (Credit: © Freeskipper/Dreamstime.com[246]).*

[246] Dreamstime.com reference ID 117611187

This video also contains video of the same Smerch launch as seen in both photographs and video from Example 2.

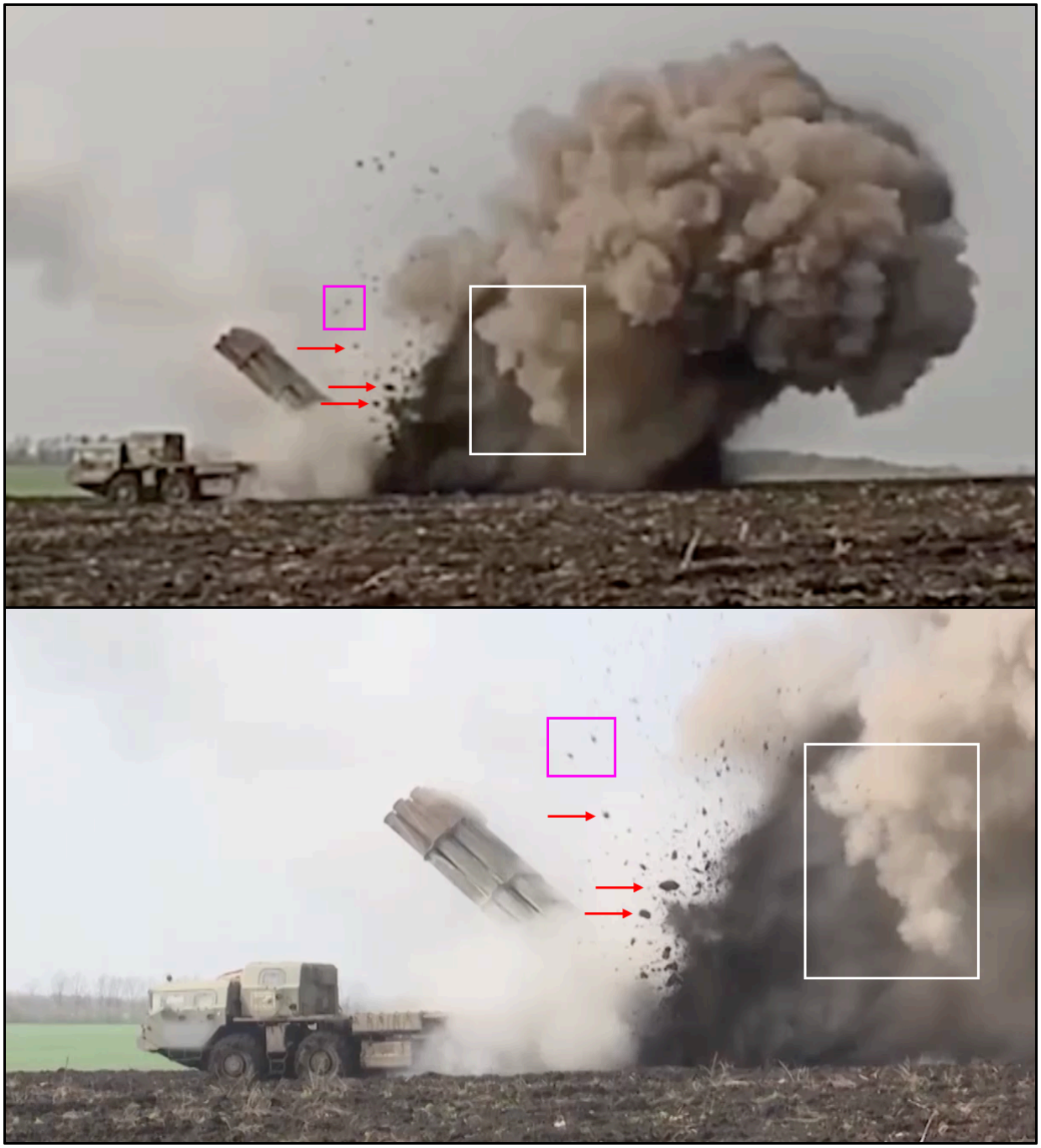


*Image145: Top: Footage from a video published on 27/07/2022 at 01:22. Bottom: A still from footage released on 21/04/2022 at 00:28 (Credit: Russian MoD).*

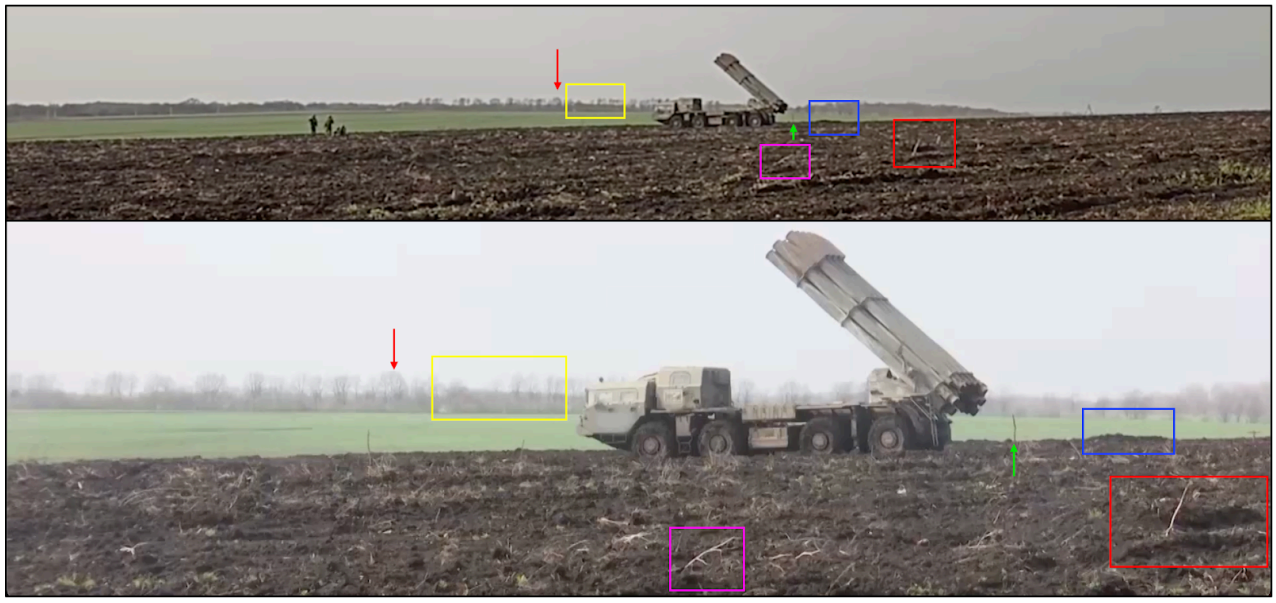


*Image 146: Top: Footage from a video published on 27/07/2022 at 01:20. Bottom: Still from footage released on 21/04/2022 at 00:27 (Credit: Russian MoD).*

With the aid of the footage published on 27/07/2022, it is possible to geolocate this launch to Launch Area Green, Location D, IVO 50.393, 36.360.[247]



*Image 147: Top: Google Streetview from 50.3952, 36.3594[248] (Credit: Google). Bottom: Panoramic from stills of footage published on 27/07/2022 (Credit: Russian MoD).*

Two other scenes in the video published on 27/07/2022 can also be geolocated to Launch Area Yellow, Location F, IVO 50.3782, 36.4408.[249]

[247] https://maps.app.goo.gl/xGGP6Qbv3ntptTEp7
[248] https://maps.app.goo.gl/UbiEjAKeTv5MUVUM8
[249] https://maps.app.goo.gl/gEWUhuQCaTTxrGm98



*Image 148: This scene, at 01:30, was also geolocated to IVO 50.378, 36.440.[250] See: Launch Site Yellow (Credit: Russian MoD).*



*Image 149: This scene, at 01:30, was also geolocated to IVO 50.378, 36.440.[251] See: Launch Site Yellow (Credit: Russian MoD).*

[250] https://maps.app.goo.gl/a62cGce7jiGLz5ZX6
[251] https://maps.app.goo.gl/JkU4Qq3Qfq5WRh8Q8

**Example 5:** Video regarding Smerches of the “Western Military District”
**Video:** t.me/mod_russia/20050[252] (Video 3, 01:11)
**Date published:** 22/09/2022
**Location:** 50.444, 36.480[253], north-east of Launch Area Green

This post by the Russian MoD, which explicitly states that it depicts the work of the Western Military District, contains three videos, two of which are interviews with soldiers. The third video shows two launches at 01:11 and 01:14, the first of which can be geolocated to 50.444, 36.480[254], north-east of Launch Area Green.




*Image 150: Top: Launch seen at 01:11 in a video published on 22/09/2022 (Credit: Russian MoD). Bottom: View of 50.444, 36.48[255] from the west, matching the view of the footage above. Rough location of launcher indicated by yellow pin (Credit: Google/Maxar Technologies/Landsat/Copernicus).*

[252] https://t.me/mod_russia/20050
[253] https://maps.app.goo.gl/vzGvY2wPZ7zkLLP69
[254] https://maps.app.goo.gl/vzGvY2wPZ7zkLLP69
[255] https://maps.app.goo.gl/vzGvY2wPZ7zkLLP69

**Example 6:** Video regarding use of Tornado-S by the Western Military District
**Video:** t.me/mod_russia/22062[256] 00:03, 00:09, 00:17, 00:56
**Date published:** 21/11/2022

This video is notable as it is the first time Tornado-S is seen within Russian MoD videos since the full scale invasion. The video description includes the explicit statement that the Western Military District is responsible for operating this system. Note that parts of the video have been mirrored, although this may be for aesthetic reasons, rather than to hide a particular detail.

It is notable that the launch vehicle is in good condition and very clean compared to Smerches seen in videos released by the Russian MoD. This likely indicates that this vehicle has only just arrived in the area of operations, unlike the BM-30 Smerches, which by November 2022 had been operating for several months.



*Image 151: Note the GLONASS antenna (Left) and the extra cabinet (Right) which confirm this is indeed a Tornado-S (Credit: Russian MoD).*

**Example 7:** Video regarding Smerches of the "Western Military District"
**Video:** t.me/mod_russia/22062[257] 00:03, 00:09, 00:17, 00:56
**Date published:** 25/11/2022

In this post by the Russian MoD, the ribbon of St George on the launch tube of a Smerch is seen multiple times, likely on the same launch vehicle. The explicit mention of the Western Military District strongly supports the conclusion that the ribbon in this location on a Smerch is indicative of the 79th Brigade.

[256] http://t.me/mod_russia/22062
[257] http://t.me/mod_russia/22062



*Image152: Note the St George's Ribbon seen in this video, clockwise from top left: 00:03, 00:09, 00:56, 00:17 (Credit: Russian MoD).*

## Other Launch Areas

In order to build a more complete picture of where BM-30 systems were deployed during the first months of the full scale invasion by the Russian Federation, incidents within the Ukraine Civilian Harm Database which included the use of cluster munitions were examined. This identified three areas in which content related to the use of 300 mm MLRS had been posted from:

1. Kharkiv Oblast, focused on the city of Kharkiv;
2. Donetsk Oblast;
3. Mykolaiv Oblast, focused on the city of Mykolaiv.

These three locations match three of the major axes along which Russian forces attacked during the full scale invasion. Other axes along which the Russian Federation attacked included[258] Kyiv and Sumy. Notably, it was not possible to identify any indications of a BM-30 system around Kyiv or northern Ukraine within the Civilian Harm Database, although the Ukraine Civilian Harm Database is not an exhaustive resource, and that it is still possible that Smerch or Tornado-S were operating on the Kyiv or northern Ukraine.

258 https://researchcentre.army.gov.au/sites/default/files/spotlight_brief_2-22_operational_overview_of_the_russian_invasion.pdf, p.23

Alongside the Western Military District being responsible for the Kharkiv axis, analysis of the initial phases of the full scale invasion indicate that the Southern Military District was responsible for the southern axes, launching[259] from Crimea and into Kherson and Mykolaiv. Meanwhile the Central Military District appears to have been active in the Donbass, with reports[260] of its units deployed there.

## Central Military District

As with the Western Military District, the Russian MoD released multiple pieces of media relating to the use of BM-30 Smerch systems. In videos released by the Russian MoD, soldiers can be seen wearing a distinctive patch, and, unlike the Western Military District, the Russian MoD stated areas in which Smerch had been active. It was not possible to identify the artillery unit which operated these Smerches.

Reports indicate[261] that the Central Military District was initially engaged in the north-eastern axis, focusing on the assault[262] on Chernihiv and Sumy. However, media released by the Russian MoD from July 2022 onwards indicates the presence of BM-30 Smerch in the Donbas. None of these sources indicate that any Central Military District Smerches operated in Kharkiv during 2022-2023.




*Image153: Tactical marking seen on Smerch and recognition flash of CMD. Top: A video published on 25/07/2022. Bottom: A video published on 10/04/2023.*

[259] https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf, p.9
[260] https://static.rusi.org/359-SR-Ukraine-Preliminary-Lessons-Feb-July-2022-web-final.pdf, p.31
[261] https://www.csis.org/analysis/russias-ill-fated-invasion-ukraine-lessons-modern-warfare
[262] https://researchcentre.army.gov.au/sites/default/files/spotlight_brief_2-22_operational_overview_of_the_russian_invasion.pdf

| Date Posted | URL | Description in post (machine translated) | Notes |
|---|---|---|---|
| 25/07/2022 | https://t.me/mod_russia/17920 | 💥 Combat work of the crews of the Smerch multiple launch rocket systems of the Central Military District, performing combat missions as part of a special military operation<br>▪️ During the execution of the tasks, the crews of the Smerch MLRS combat vehicles marched to firing positions and, after receiving coordinates from unmanned aircraft, launched a missile strike with 300-mm rockets on the positions and field warehouse of Ukrainian nationalists. | Explicitly stated to be CMD.<br><br>Scored circle vehicle marking.<br><br>CMD patches visible. |
| 21/11/2022 | https://t.me/mod_russia/21910 | The enemy is waiting for the "Smerch": combat work of the crews of multiple launch rocket systems in the special operation zone 💥 The crews of the "Smerch" destroy military infrastructure facilities and logistics nodes of the Armed Forces of Ukraine, located in the rear of the enemy's defensive lines. The combat work of the MLRS takes several minutes: obtaining coordinates, taking up a firing position, targeting, firing a salvo and changing position. 💥 The flight range and low deviation coefficient of 300 mm shells allow for the pinpoint elimination of ammunition storage bases, equipment concentration sites and cutting off reserve units from the main forces. | Appears to be CMD, based on patch and vehicle marking. |
| 10/04/2023 | https://t.me/mod_russia/25521 | Artillery sniper: combat work of the Smerch MLRS crews of the Central Military District in the area of a special operation The rocket systems crews destroy the enemy's military infrastructure facilities and logistics hubs located in the rear of the enemy's defensive battle formations. ⏲ The combat work of the Smerch takes several minutes: obtaining coordinates, taking up a firing position, aiming, firing a salvo and changing position. 💥 The flight range and low deflection coefficient of 300-mm shells allow for the pinpoint elimination of ammunition storage bases, equipment concentration sites and cutting off reserve units from the main forces. | Explicitly stated to be CMD.<br><br>Circle in triangle vehicle marking.<br><br>CMD patches visible. |
| 15/05/2023 | https://t.me/mod_russia/26575 | Smerch day and night: multiple launch rocket system crews launched fire strikes on Ukrainian Armed Forces positions 💥 Having received the target coordinates, the Smerch MLRS crews of the Central Military District moved to the combat area. Having taken up firing positions, the servicemen hit targets at distances of more than 20 km with high accuracy, as a result of which lightly armored vehicles were destroyed, as well as Ukrainian Armed Forces personnel located in the rear of the defensive lines. 🌓 Fire strikes were carried out both in daylight and at night. 🎯 The high accuracy of 300-mm rockets allows for the destruction of ammunition storage bases, equipment concentration areas, command posts and logistics hubs of the enemy. | Explicitly stated to be CMD.<br><br>Circle in triangle vehicle marking.<br><br>CMD patches visible. |
| 14/06/2023 | https://t.me/mod_russia/27431 | Statement by the head of the press center of the Center group 💥 In the Krasno-Limansky direction, the Smerch multiple launch rocket system crew of the Center group of forces hit the enemy's equipment concentration site. 💥 The group's bomber aviation destroyed three temporary deployment points, a strong point, and equipment concentration sites. 💥 Army aviation and artillery of the Center group of forces struck the manpower and equipment of the 63rd and 67th mechanized brigades of the Ukrainian Armed Forces in the areas of the Torskoye and Serebryanskoye forestry settlements. ▪️ The Verba MANPADS crew destroyed the Furia unmanned aerial vehicle. | Press release. Notes Smerchs of CMD operating in the vicinity of Krasno-Limansky. |

| | | | |
|---|---|---|---|
| 30/06/2023 | https://t.me/mod_russia/27978 | Statement by the head of the press center of the Center group ▪ In the Krasnolimansky direction, the Smerch multiple launch rocket system of the Center group of forces struck a concentration of enemy manpower and fire weapons. ▪ In addition, during the counter-battery battle, artillery units destroyed two D-30 howitzers, infantry fighting vehicles and pickup trucks of the Ukrainian Armed Forces. The aviation of the group of forces struck eight areas of concentration of enemy manpower and fire weapons. ▪ In the Torsky area and in the Serebryansky forestry area, the movement of units on equipment of the 63rd and 42nd mechanized brigades of the Ukrainian Armed Forces was discovered. As a result of the combat work of the artillery units of the Center group, two infantry fighting vehicles and three pickup trucks were destroyed. The enemy suffered significant losses in personnel. | Press release. Notes Smerchs of CMD operating in the vicinity of Krasno-Limansky. |
| 06/07/2023 | https://t.me/mod_russia/28137 | Statement by the head of the press center of the Center group ▪ In the Krasnolimansky direction, the Smerch multiple launch rocket system and the crew of the Solntsepёk heavy flamethrower system struck areas of concentration of enemy manpower and fire weapons. In addition, the Tor-M1 anti-aircraft missile system shot down an unmanned aerial vehicle of the Ukrainian Armed Forces. Bomber aircraft struck a command and observation post, a temporary deployment point, and a stronghold of nationalists. ▪ In the Torsky area and in the Serebryansky forestry area, air strikes and artillery fire from the Center group repelled attempts to attack units of the 95th airborne assault brigade and the 42nd mechanized brigade of the Ukrainian Armed Forces. The enemy suffered significant losses in manpower and equipment, and four airborne assault brigade fighters surrendered. | Press release. Notes Smerch of CMD operating in the vicinity of Krasno-Limansky. |

It was not possible to ascertain the unit which was operating the BM-30 Smerch vehicles of the Central Military District. As the Central Military District is notably smaller[263] than the Western Military District or the Southern Military District, it may be possible that a unit was detached from another formation to the Central Military District.

## Southern Military District

The Southern Military District was responsible[264] for the southern axis, from Crimea through Kherson. Unlike the Central and Western MIlitary Districts, there does not appear to have been much media published by the Russian MoD regarding operations of Smerch or Tornado-S units on this axis. However, there are several videos and images created by ordinary citizens and then published online which depict Smerch/Tornado-S in Kherson.

The tactical markings seen on Smerches in Kherson consist of a simple Z painted on the side of the vehicle.

263 https://www.understandingwar.org/sites/default/files/October%2012%2C%202023%20Russian%20Orbat_Final.pdf, p.13

264 https://researchcentre.army.gov.au/sites/default/files/spotlight_brief_2-22_operational_overview_of_the_russian_invasion.pdf, p.19




*Image154: Top: video posted on 15/03/2022 depicting Tornado-S with Z marking (Credit: @milinfolive[265]).*

| Date Posted | URL | Description in post (machine translated) | Notes |
|---|---|---|---|
| 22/02/2022 | https://twitter.com/GirkinGirkin/status/1496065537729830915 | Rostov region | 47.3884, 39.9134. |
| 15/03/2022 | https://t.me/truexakhersonua/6321 | #nampishut<br>😱 Kherson microdistrict Shumensky 14.20<br>Orcs hide their tornadoes in the city because they started getting good beatings in Chernobaevka<br>I managed to film only 1/3 of the column | Kherson<br>(Filmed from private dwelling). |
| 15/03/2022 | https://t.me/milinfolive/78829 | Russian 300-mm MLRS BM-30 "Smerch" with their TZM and support vehicles in Kherson. | Location: 46.6489, 32.6090 |
| 15/03/2022 | https://t.me/vorposte/16191 | 🇷🇺🇺🇦🔥 High activity of Russian military equipment in Kherson. The column contains 9K58 Smerch multiple launch rocket systems | Post deleted, archive available.<br>Multiple locations, including 46.6489, 32.6090, 46.6479, 32.6040, 46.6485, 32.6092. |
| 19/03/2022 | https://t.me/vorposte/16546 | 🇷🇺🇺🇦🔥 Column of the Russian Federation with "Smerch" MLRS in Kherson. | Post deleted, archive available.<br>Location: 46.6506, 32.6079. |
| 04/04/2022 | https://t.me/WarDonbass/54704 | MLRS "Smerch" sent gifts to Kim's militants in Nikolaev. | Launch location: 32.8153, 46.7644. |

At least one video from the city of Kherson strongly indicates the presence of a vehicle from the 439th Rocket Artillery Brigade. This video[266] depicts a column of vehicles, including transporter-loaders and Tornado-S launch vehicles. One of the Tornado-S launch vehicles has what is recognisable as part of the St. George's Ribbon visible on the front right door. The

[265] https://t.me/milinfolive/78829
[266] https://t.me/milinfolive/78829

presence of this ribbon on a Tornado-S strongly indicates this is a vehicle from the 439th Brigade. The only other unit to have participated in the Moscow Victory Day Parade with these ribbons participated with a Smerch, not a Tornado-S.

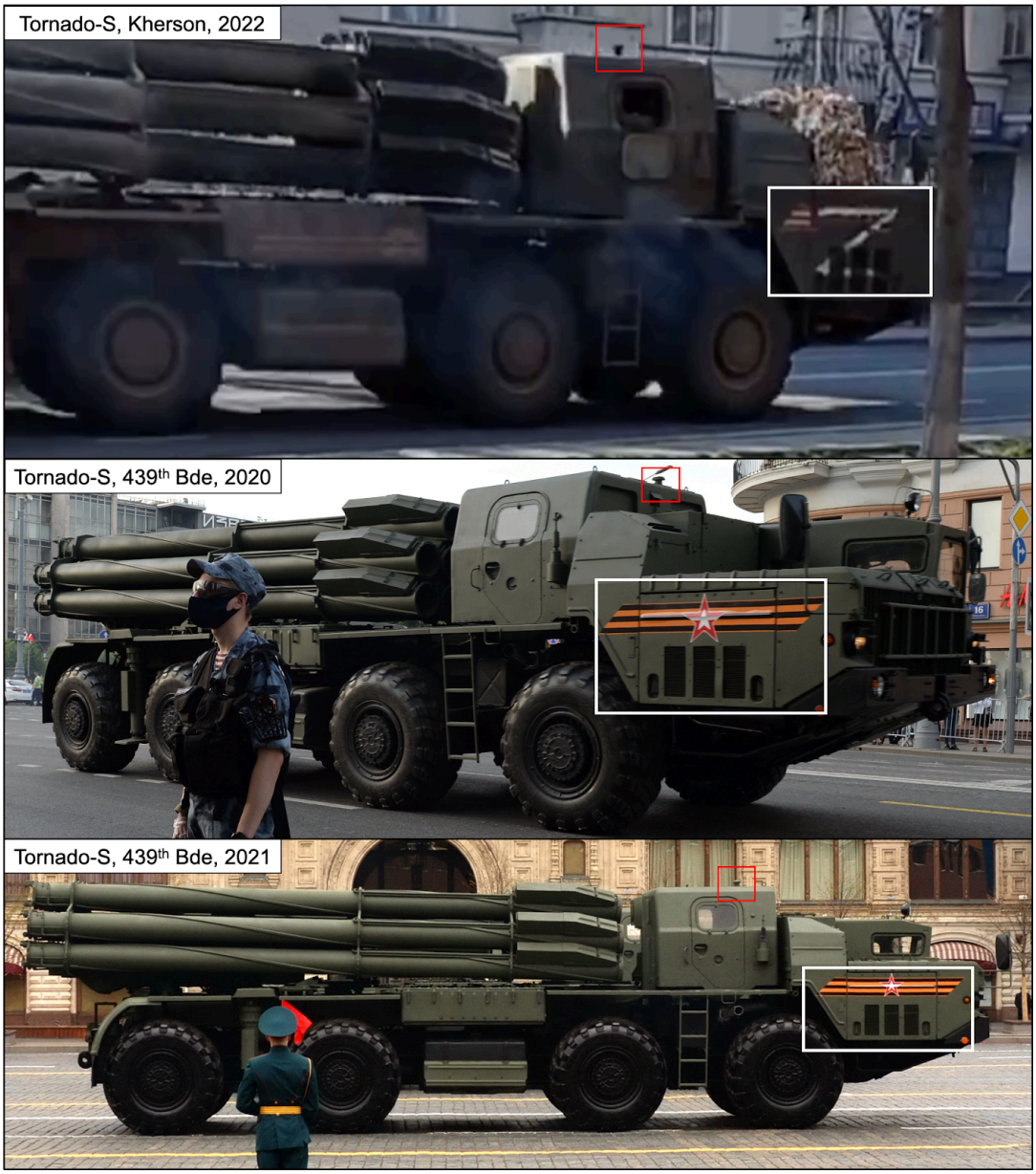



*Image 155: Top: A video posted on 15/03/2022 depicting Tornado-S with partial Ribbon of St. George (Credit: @milinfolive). Middle and Bottom: Tornado-S of the 439th Brigade during the Victory Day Parades in Moscow (Credit: Freeskipper/Dreamstime.com).*

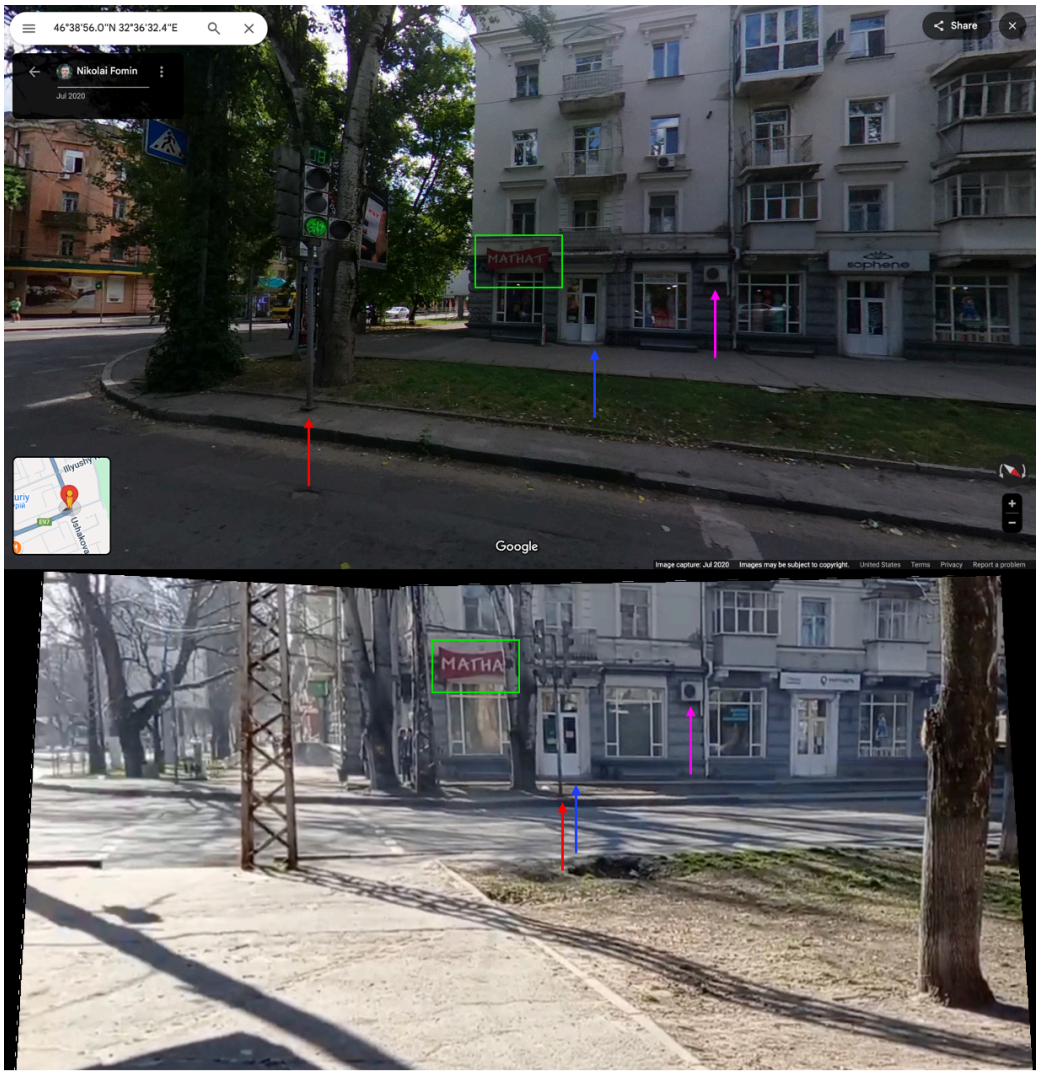



*Image 156: Bottom: Panoramic of video depicting launch vehicle with ribbon of St. George (Credit: @milinfolive). Top: Google Street View of this location (Credit: Google).*

The presence of vehicles from the 439th Brigade is consistent with them being part of the Southern Military District[267], and so part of the offensive from Crimea into Kherson.

Interestingly, a convoy of Smerch vehicles from the Southern Military District, identifiable by their numberplates, was also filmed[268] in Rostov-on-Don, specifically from the M-4 motorway at 47.3884, 39.9134[269], and posted on 22/02/2022. The number plates of the systems seen in this video include the number "21" in a small box on the right. This is a military code[270] indicating

267 https://informnapalm.org/ua/rszv-smerch-439-oyi-reaktyvnoyi-artylerijskoyi-brygady-u-skladi-rosijskogo-ugrupuvannya-syl-vtorgnennya/

268 https://twitter.com/GirkinGirkin/status/1496065537729830915?s=20

269 https://maps.app.goo.gl/rRvvVUNzXF9pgxNG8

270 https://www.bellingcat.com/resources/how-tos/2022/02/08/tracking-russian-military-vehicles-on-the-move/

what unit the vehicle is part of. In this case, “21” represents the Southern Military District[271] (previously called the North Caucasian Military District[272]).




*Image 157: Example of a numberplate seen in the video, note the “21” on the bottom right of the plate (Credit: @GirkinGirkin).*

This convoy of BM-30 vehicles was moving[273] in a north-easterly direction, but it was not possible to ascertain for certain what their final destination might be. This location and movement is, however, still notable, since it is some way away from Crimea, where the primary thrust of the Southern Military District took place. Given the road network, there is the possibility this convoy was moving towards the Donbas. There are some indications that elements of the Southern Military District were deployed[274] to the Eastern front.

[271] https://platesmania.com/ru/regionstat-21-2
[272] https://eng.mil.ru/en/structure/okruga/south/history.htm
[273] https://x.com/GirkinGirkin/status/1496065537729830915
[274] https://researchcentre.army.gov.au/sites/default/files/spotlight_brief_2-22_operational_overview_of_the_russian_invasion.pdf, p.16

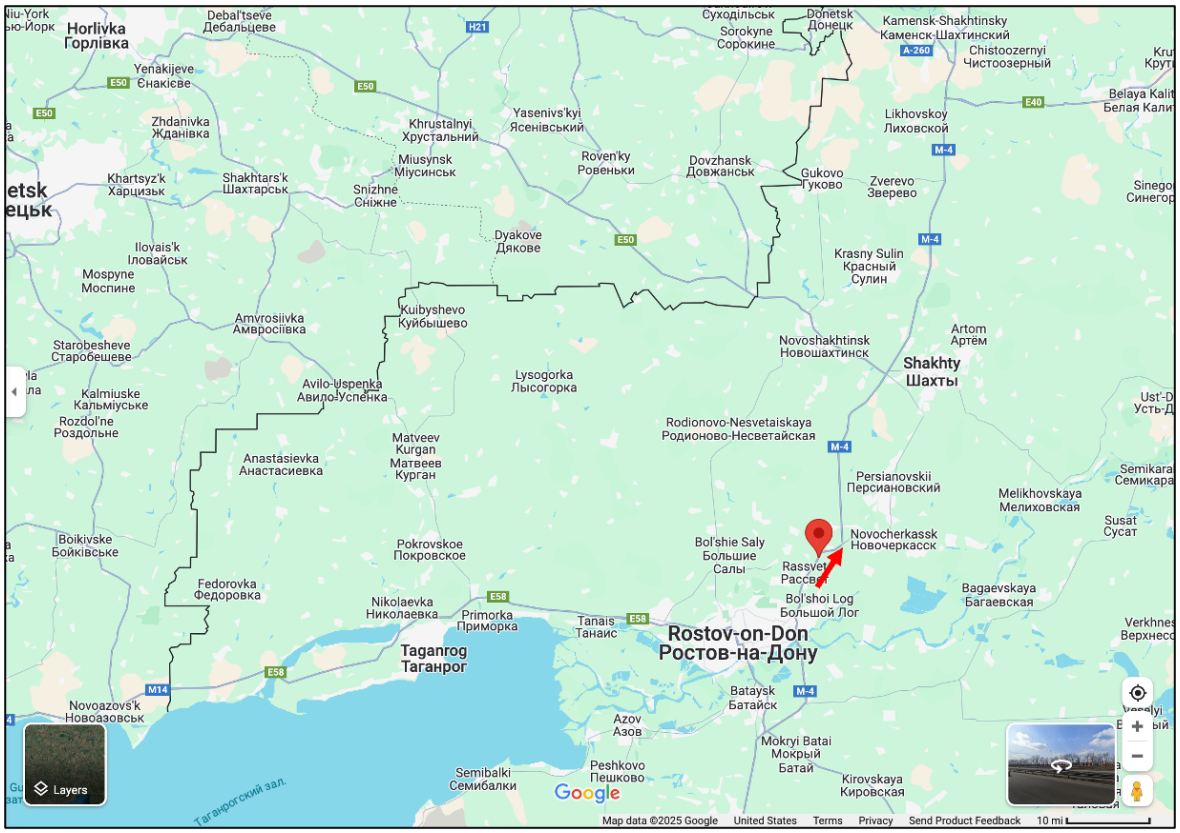



*Image 158: Location of convoy indicated by the red pin and direction of travel indicated by red arrow (Credit: Google).*

## Unit Present: Conclusion

Analysis of available open source information strongly indicates that the 79th brigade was operating in the launch areas to the south of Belgorod. Using stickers from both Victory Day Parades in Moscow and the Army Forum as identifying features, it was possible to identify 79th brigade's BM-30 Smerch vehicles: in their home base in Tver; moving through Kursk prior to the full-scale invasion; and finally launching missiles from the AoI identified by the direction of origin assessment.

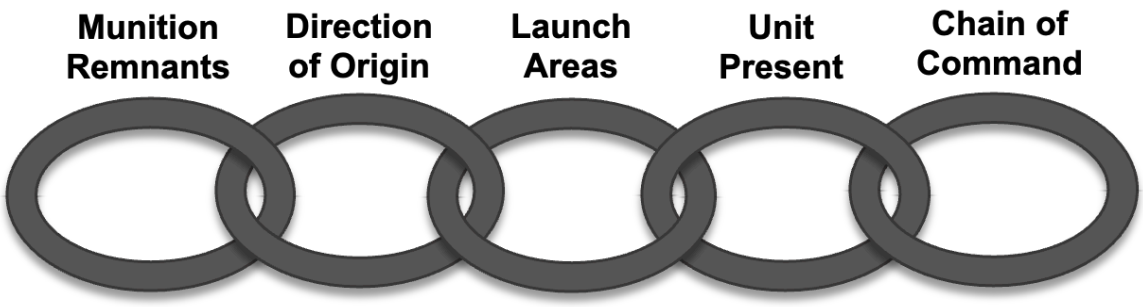
As well as the analysis of stickers from Army Forum and Victory Day Parades, the Russian MoD published four videos explicitly depicting the operation of Smerches from the Western Military District. Multiple scenes from two of these videos could be geolocated to launch areas in the AoI, strongly supporting the presence of the 79th brigade there.

Of these four videos, two showed markings such as the Ribbon of St. George on the launch tube of a launch vehicle, and residue which is consistent with the placement of a sticker of the Ribbon of St. George.

The presence of these markings in videos explicitly stated by the Russian MoD to depict the Western Military District supports the conclusion that these markings indicate the presence of the 79th Brigade, which is the only Smerch unit to have these markers in the District.

The size of the units seen on the move in Kursk, namely two battalions, supports the conclusion of the satellite imagery assessment that a brigade-level unit, which possibly represented the whole of the 79th Brigade, was present in this AoI.

# VII. Chain of Command of the 79th Brigade




There is limited open source information regarding most members of the 79th Brigade. Reviews of social media profiles, Russian military forums and media revealed little consistent information regarding most commanders in this unit. Before 2014 this does not seem to have been the case, with local journalists touring and photographing[275] the unit inside its home base in Tver, including with photos of its commander and soldiers with unobscured faces.

However, since 2014 there has clearly been a concerted effort by the Russian MoD to tighten operational and personal security. New laws[276] were introduced to prevent soldiers leaking information about their activities and many soldiers within the 79th Brigade appear to have limited their posting on social media.

Despite this push for greater information security, senior commanders have continued to have a semi-public role. For example, at the Victory Day parade in Moscow, commanders are announced by their name and the name of the unit they command. Similarly, a visit by a brigade commander to a local civic event in Tver is a matter of note and may be written about by the local press.

The section presents this information, identifying the brigade commander of the 79th Brigade and their higher chain of command.

[275] https://fishki.net/1245767-reaktivno-artillerijskaja-brigada-rszo-smerch-v-tveri.html
[276] https://www.bbc.com/news/world-europe-47302938

# Brigade Commander: Colonel Evgeny Yurievich Gerashchenko

## Prior Commanders

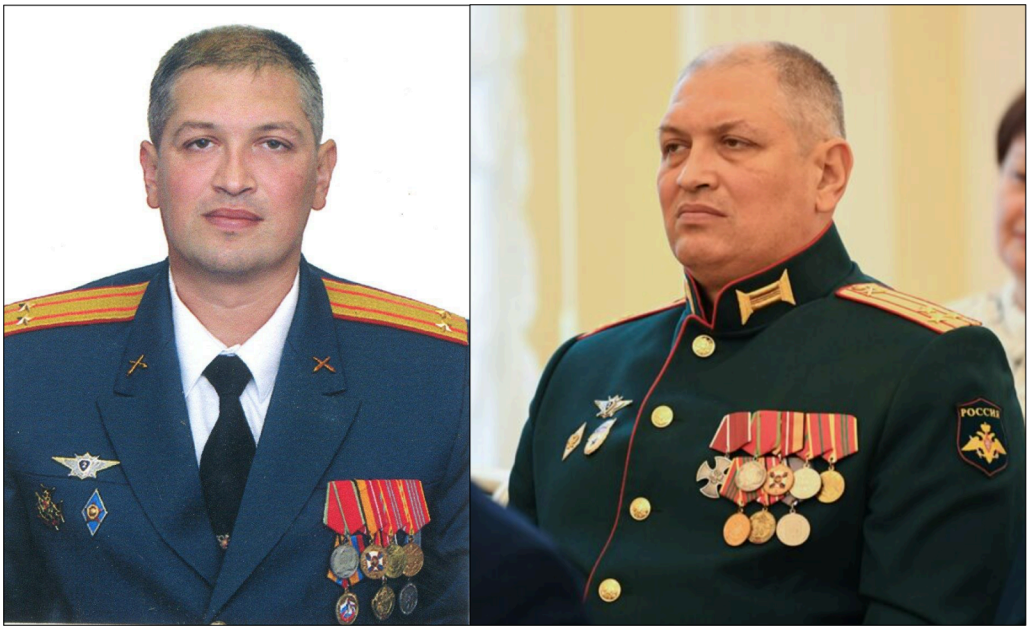


*Image 159: Colonel Evgeny Yurievich Gerashchenko, (Credit left: Myrotvorets[277], Right: Top Tver[278]).*

Whilst this section aims to identify the commander of the 79th brigade and their superior commander during the battle of Kharkiv, it is important to understand who preceded and succeeded them. With this information it is possible to establish when individuals arrived or left specific postings.

On 26/04/2017[279] and 27/04/2017[280] Igor Aleksandrovich Tolstikhin was thanked as the commander of Unit 53956 (the 79th brigade) by the Tverskoy Industrial and Economic College. Later, on 25/05/2017,[281] 27/10/2017[282] and 18/10/2018,[283] the commander of the 79th Brigade was named as Colonel Igor Vladimirovich Yanin, who was thanked for hosting students from the Tverskoy Industrial and Economic College as they visited the base of the 79th brigade.

The “Veterans Support Fund and Reserve officers of the Armed Forces” posted an article dated 11/09/2020 congratulating Yanin’s move from the 79th brigade to the post of military commissar

[277] https://myrotvorets.center/criminal/herashchenko-evhenyi-yurevych/
[278] https://toptver.ru/society/v-den-konstitucii-rf-igor-rudenja-vruchil-gosudarstvennye-i-regionalnye-nagrady-zhiteljam-tverskoj-oblasti/
[279] https://tverpek.ru/cat/42/events/OpenSpace/1875
[280] https://tverpek.ru/cat/42/events/OpenSpace/1531
[281] https://tverpek.ru/cat/42/events/OpenSpace/1553
[282] https://tverpek.ru/cat/42/events/OpenSpace/1665
[283] https://tverpek.ru/cat/42/events/OpenSpace/2033

of the Tver Region.[284] This is also reflected in an article from 28/04/2021[285] and confirmed by the Russian MoD in an article from September 2021.[286]

From 2021 Colonel Gerashchenko is named in open sources as the commander of the 79th Brigade. The sources that this information comes from include Ukrainian government, Ukrainian civil society, and sources from within Russian civil society and official documents.

## Russian Sources: Civil Society

Several Russian sources name Gerashchenko as the commander of the 79th brigade. The primary source is the “Veterans Support Fund and Reserve officers of the Armed Forces” (Veterans Support Fund), which appears to be a charity dedicated to supporting former Russian army officers. This charity reports news from across the Russian army, although it appears to focus on the Western Military District.

This charity mentions Gerashchenko as the commander of the 79th brigade twice. On 24/07/2022, it congratulated Gerashenko on the occasion of his 45th birthday, explicitly naming him as the commander of the 79th brigade.[287]



News

July 24, 2022

Colonel Yevgeny Gerashchenko turns 45

On July 24, 2022, the commander of the 79th Guards Rocket Artillery Novozybkov Red Banner Orders of Alexander Suvorov and Alexander Nevsky Brigade, Colonel Evgeny Gerashchenko, turned 45 years old. Chairman of the Board of the National Association "Megapir" - President of the "OFFICERS' BROTHERHOOD" Foundation, Colonel General Vladimir Zaritsky congratulated him on his anniversary.

*Image 160: Screenshot of page from Veterans Support Fund.*

The Veterans Support Fund mentioned Gerashchenko a second time on 15/11/2022 as the commander of the 79th brigade, celebrating the 30th anniversary of the founding of that unit.[288]

[284] https://www.bbc.com/news/world-europe-47302938
[285] https://torjok.bezformata.com/listnews/voennogo-komissara-tverskoy-oblasti/93362082/
[286] https://veteran.mil.ru/files/morf/military/archive/Gazeta-120921.pdf
[287] https://www.fondob.ru/posts/polkovniku-evgeniiu-gerashchenko-ispolnilos-45-let [Archived: https://web.archive.org/web/20230531094444/https://www.fondob.ru/posts/polkovniku-evgeniiu-gerashchenko-ispolnilos-45-let]
[288] https://www.fondob.ru/posts/tverskaia-79-ia-gvardeiskaia-reaktivnaia-artilleriiskaia-brigada [Archived: https://web.archive.org/web/20221201024358/https://www.fondob.ru/posts/tverskaia-79-ia-gvardeiskaia-reaktivnaia-artilleriiskaia-brigada]

Tver 79th Guards Rocket Artillery Brigade Celebrates Its 30th Anniversary

November 16, 2022 marked the 30th anniversary of the formation of the 79th Guards Rocket Artillery Novozybkov Red Banner Orders of Suvorov and Alexander Nevsky Brigade. Chairman of the Board of the National Association "Megapir" - President of the "OFFICERS' BROTHERHOOD" Foundation Colonel General Vladimir Zaritsky congratulated the brigade commander Colonel Yevgeny Gerashchenko on the anniversary.

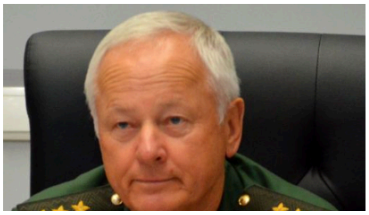


*Image 161: Screenshot of page from Veterans Support Fund.*

Gerashchenko has also been mentioned in local press. The Tverskoy Prospect website, a news website for the Tver region, published an article on 12/12/2023 about a medal presentation ceremony. In this article it notes that Yevgeny Gerashchenko was presented with Tver Region Governor's Commemorative Badge “For Valiant Service in the Tver Region” and stated that he was the “Commander of Military Unit 53956”.[289] Unit 53956 is the unique number for the 79th brigade. This article also features a photograph of Gerashchenko at the event.



*Image 162: Colonel Gerashchenko at medal presentation (Credit: Tverskoy Prospect).*

This same event was reported by other outlets, who also named Gerashchenko as the commander of the 79th brigade.[290,291]

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289 https://tp.tver.ru/v-den-konstituczii-rf-gubernator-igor-rudenya-vruchil-gosudarstvennye-i-regionalnye-nagrady-zhitelyam-tverskoj-oblasti/

290 https://nelidovo.bezformata.com/listnews/regionalnie-nagradi-zhitelyam-tverskoy/125250994/

291 https://toptver.ru/society/v-den-konstitucii-rf-igor-rudenja-vruchil-gosudarstvennye-i-regionalnye-nagrady-zhiteljam-tverskoj-oblasti/

## Russian Sources: Court Documents

The earliest mention of Gerashchenko as the commander of the 79th brigade came from court documents. These were first identified on websites which provide a service to citizens to access information from Russian court cases, whether for informational or for due diligence purposes. These cases were then checked on the official court websites, to ensure that they were accurate.

In Case No. 9a-752/2021 ~ M-3172/2021, published on the Act of Fact website,[292] Geraschenko was named as the commander of Unit 53956 (the 79th brigade) on 13/12/2021.

The Moscow District Court of Tver confirmed that this case involved Unit 53956 as the plaintiff and Chief State Labor Inspector of the State Labor Inspectorate in the Tver Region Ksenia Vyacheslavovna Mednikova as the defendant.[293]

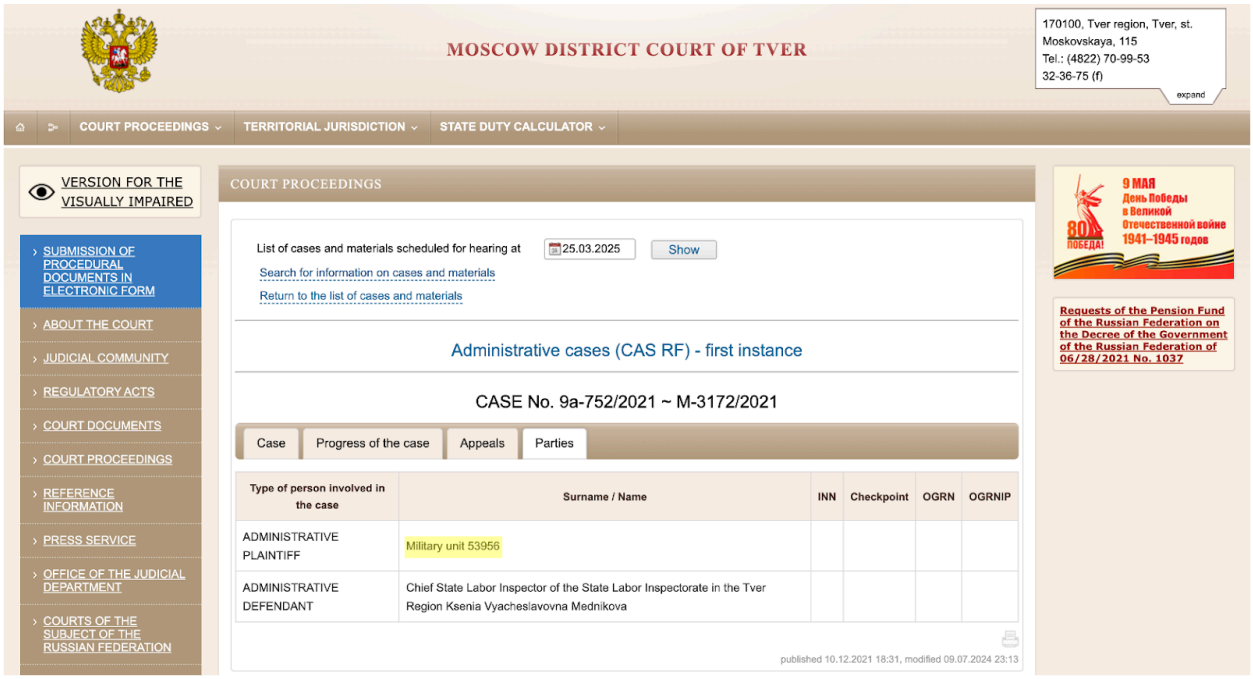



*Image 163: Screenshot of Moscow District Court of Tver record of this case [machine translated by Google].*

Case No. 33a-717/2022, which is a follow-on from the case above, was published on Reputation, a due diligence website. E. Gerashchenko was named as the commander of Unit 53956 (the 79th brigade) on 16/02/2022.[294]

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[292] https://actofact.ru/case-69RS0038-9a-752-2021-m-3172-2021-2021-12-10-0-0/

[293] https://moskovsky--twr.sudrf.ru/modules.php?name=sud_delo&name_op=case&_uid=0fc1f6d8-7859-4e16-9985-c47532865f3a&_deloId=41&_caseType=0&_new=0&srv_num=3

[294] https://reputation.su/sudrf/250899816

The official website for Tver Regional Court confirmed this case, including that the plaintiff, E. Gerashchenko, is the commander for the 79th Brigade.[295]

Interestingly, this case also refers to an order from the Minister of Defense of the Russian Federation dated 19/01/2021 appointing Gerashchenko as the commander of Unit 53956 (the 79th brigade). This is consistent with Colonel Yanin leaving this post in late 2020.

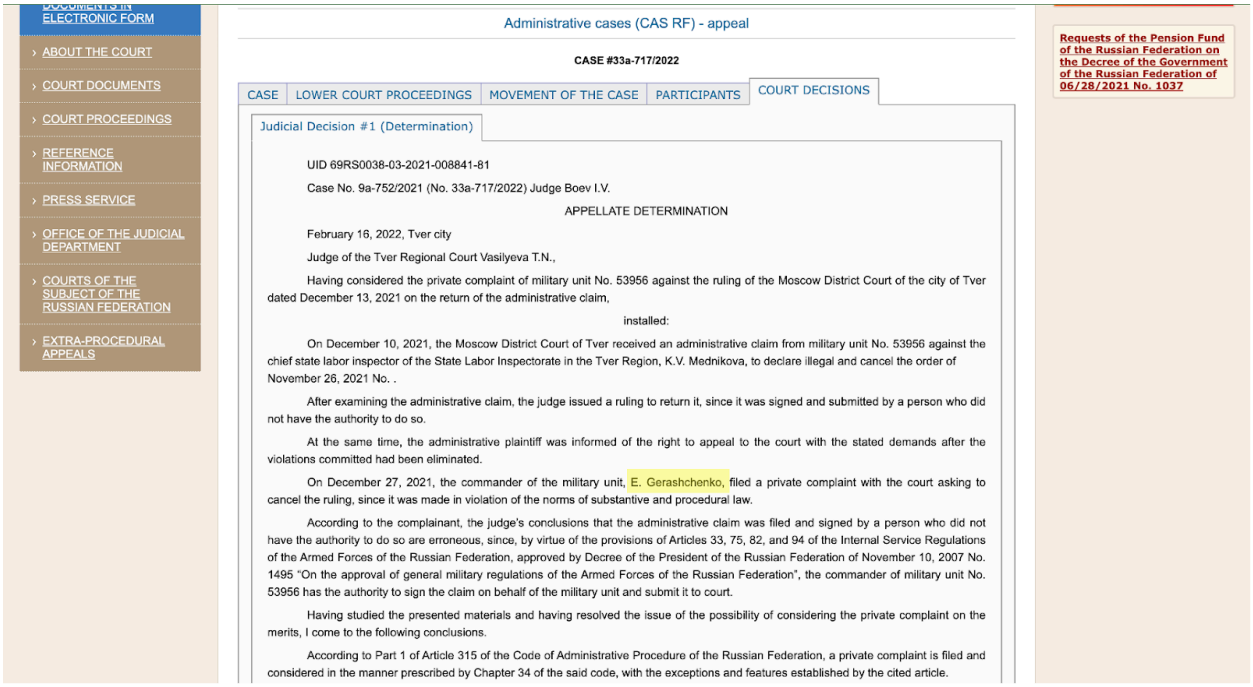



*Image 164: Screenshot of Tver Regional Court record of this case [machine translated by Google].*

## Ukrainian Government: Kharkiv Regional Prosecutors Office

On 27/02/2025, Kharkiv Regional Prosecutor's Office announced[296] on its official Telegram channel that it has identified four Russian military commanders who organized and ensured the large-scale shelling of Kharkiv on February 28, 2022, killing eight and wounding one person, damaging high-rise buildings, school and kindergarten. The commanders are suspected of violating the laws and customs of war, combined with premeditated murder, committed by a group of persons.

295
https://oblsud--twr.sudrf.ru/modules.php?name=sud_delo&srv_num=3&name_op=case&case_id=14417967&case_uid=0ad51d51-bf5a-4cda-936e-fd9a5ac937b9&delo_id=42
296 https://t.me/prokuratura_kharkiv/21628

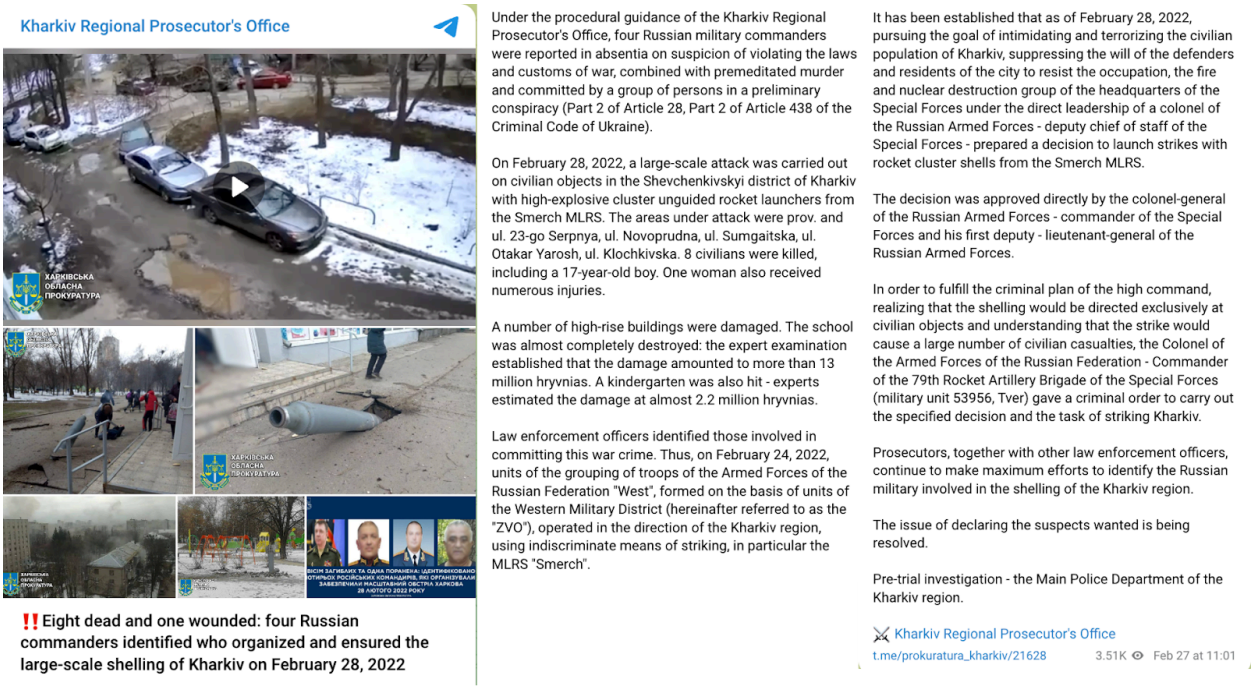



*Image 165: Screenshots of Kharkiv Regional Prosecutors Office Telegram post from 27/02/2025 [machine translated by Google].*

It is also to be noted that one of the blurred images of the Russian military leadership posted in the same post by the Kharkiv Regional Prosecutor's Office appears to contain the same face shot of Gerashchenko visible in the Image 159.

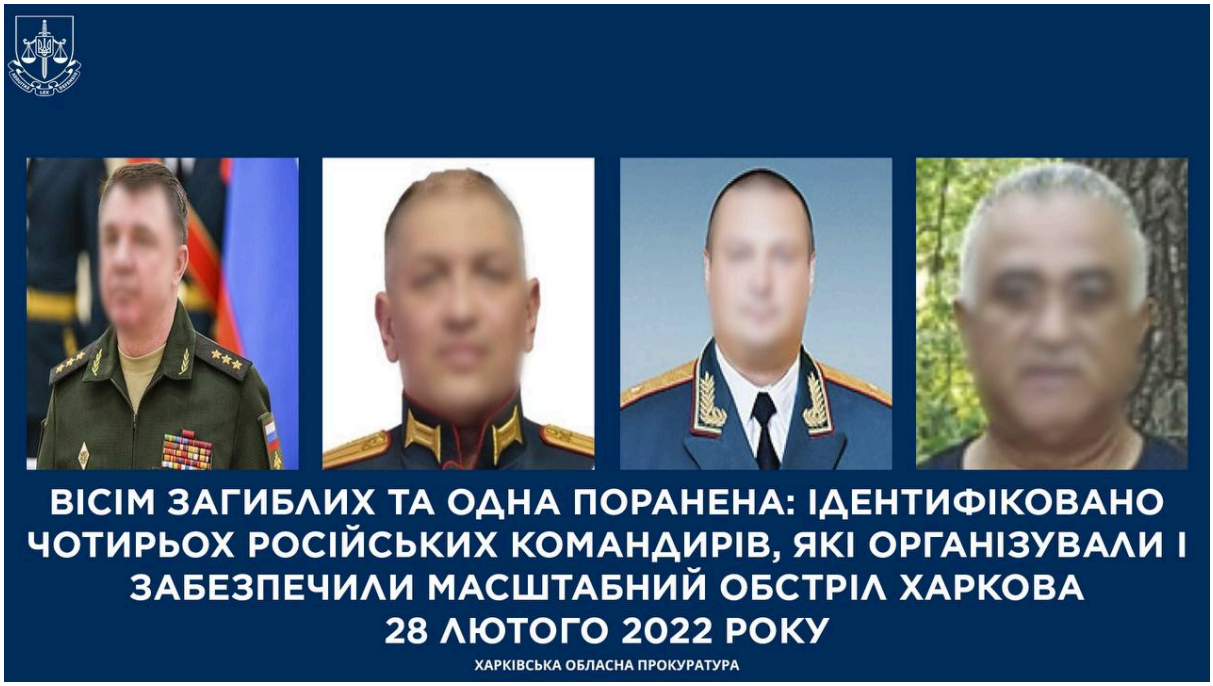



*Image 166: Screenshot of an image from Kharkiv Regional Prosecutor's OfficeTelegram post, containing what appears to be Gerashchenko's face shot (second from left).*

## Ukrainian Government: The Book of Executioners

The Ukrainian website "The Book of Executioners"[297] lists Gerashchenko as being the commander of the 79th Brigade, claiming that "*He took direct part in the open military invasion of Ukraine.*" The Book of Torturers is an official[298] Ukrainian website, stating that "*All criminals presented on the site are confirmed and verified by one of the law enforcement or intelligence agencies of Ukraine. There are no random people on the resource and there are no fake names behind which criminals try to hide in social networks.*"

Although this is an official Ukrainian source, it does not confirm precisely when Gerashchenko took command, nor does it provide the information on which it is assessed that he is the commander of the 79th Brigade. It does provide various pieces of other personal information, including a deleted Odnoklassniki page[299], although an archived version[300] of this page displays very limited information.

## Ukrainian civil society: Myrotvorets

The Ukrainian group Myrotvorets also has a page naming Gerashchenko as the commander of the 79th Brigade.[301] While Myrotvorets does not appear to have any official status, it does have significant links with the Ukrainian SBU, including one of its founders being a former employee.[302] It is known for publishing lists of people it regards as being enemies of Ukraine.

The Myrotvorets page on Gerashchenko contains a large amount of personal data, including two links to "Notices of Suspicion" against Gerashchenko from Ukrainian prosecutors in 2024[303] and 2025, although both are now inaccessible.[304] It cites at least some of its information for this page from the Telegram account @osintbees. However, the information indicating he was the commander of the 79th brigade appears to be a link[305] from the "Veterans Support Fund and Reserve officers of the Armed Forces", a Russian website.

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[297] https://russian-torturers.com/ru/profile/1482

[298] https://www.reuters.com/world/europe/ukraine-launching-book-executioners-detail-war-crimes-zelenskiy-2022-06-07/

[299] https://ok.ru/profile/121059494133

[300] https://archive.ph/uZtQl

[301] https://myrotvorets.center/criminal/herashchenko-evhenyi-yurevych/

[302] https://www.thetimes.com/world/russia-ukraine-war/article/ukraines-blacklist-killers-lawyers-writers-and-spies-0gccbbwp0

[303] https://web.archive.org/web/20240420031144/https://www.gp.gov.ua/ua/posts/povidomlennya-pro-pidozru-gerashhenko-jeyu-ta-povistki-pro-viklik-na-16022024-17022024-19022024-z-perekladom

[304] https://www.gp.gov.ua/ua/posts/povidomlennya-pro-pidozru-gerashhenka-jeyu-zavizyona-ov-zuravlyova-oo-kulijeva-sa-ta-povistki-pro-viklik-ostannix-na-03032025-04032025-05032025-z-perekladom

[305] https://www.fondob.ru/posts/polkovniku-evgeniiu-gerashchenko-ispolnilos-45-let

## Conclusion

This multitude of sources, from both Ukraine and Russia, clearly show that Colonel Geraschenko was the commander of the 79th brigade during the initial stages of the full scale invasion of Ukraine until at least 15/11/2022. Court documents name him as commander of the 79th brigade as early as December 2021, and refer to an order from the Russian Minister of Defence appointing him as a commander on 19/01/2021.

# Higher Command: Colonel General Alexander Zhuravlev



*Image 167: Colonel General Alexander Zhuravlev (Credit: Russian MoD).*

While Colonel Gerashchenko commanded the 79th brigade, he would have been, in turn, receiving orders from a higher commander. The 79th brigade itself is not subordinate to a specific Army or Corps within the Western Military District. Instead it sits directly under the commander of the District.[306] A CNN and CIR report stated that multiple military experts told them that the commander of the Western Military District is the only officer with the authority to order a Smerch rocket attack in his district.[307]

It is a matter of public knowledge and widely reported that the commander of the Western WIlitary District during the period of interest was Colonel General Alexander Zhuravlev. Reports

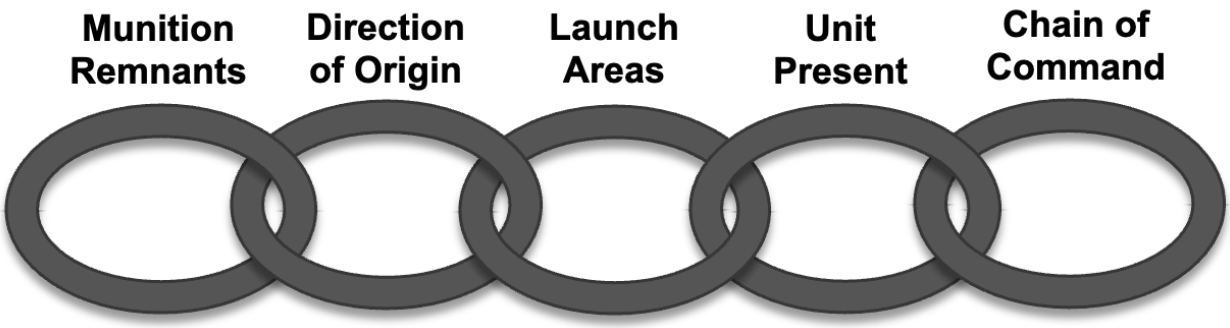
[306] https://www.cna.org/archive/CNA_Files/pdf/russian-forces-in-the-western-military-district.pdf, p.26
[307] https://edition.cnn.com/2022/05/12/world/russia-general-ukraine-syria-cluster-bombs-intl-cmd/index.html

indicate he was appointed to this position in November of 2018,[308,309] which is supported by the official website of the Russian MoD.[310]

There is mixed reporting about who succeeded Zhuravlev, and the Russian MoD appears to have severely limited posting updated information about its structure after the full scale invasion. Media reports name either Andrei Sychevoy[311] or Lieutenant General Roman Berdnikov[312,313] as Zhuravlev's successor, however it's not clear precisely who took command. What is clear is that by October 2022, Zhuravlev no longer commanded the Western Military District.[314,315]

[308] https://www.kommersant.ru/doc/3797395
[309] https://tass.ru/encyclopedia/person/zhuravlev-aleksandr-aleksandrovich
[310] https://structure.mil.ru/management/details.htm?id=12152558@SD_Employee
[311] https://www.merkur.de/politik/putin-ukraine-krieg-news-russland-armee-verluste-top-general-schurawljow-zr-91636103.html
[312] https://www.fontanka.ru/2022/10/02/71702585/
[313] https://understandingwar.org/backgrounder/russian-offensive-campaign-assessment-october-3
[314] https://www.rbc.ru/politics/03/10/2022/63398ef39a794781bd17a8ec?from=newsfeed
[315] https://www.fontanka.ru/2022/10/02/71702585/

# VIII. Conclusion




The widespread use of cluster munitions in urban areas of Kharkiv was one of the more notable aspects of the initial stage of the full-scale invasion of Ukraine. These weapons, which are designed to affect large areas and cannot be precisely targeted, hit[316] hospitals, schools, residential areas and queues for humanitarian aid. The use of cluster munitions in this way may represent indiscriminate attacks.

In 2023 the Russian Federation denied[317] that it was using cluster munitions in Ukraine despite the overwhelming amount of information from human rights and accountability organisations documenting their use. This has followed a pattern of the Russian Federation denying well documented facts on the ground, from the use of cluster munitions[318] in Syria, to the build up to the full-scale invasion[319] of Ukraine.

The intent of this investigation, which began in May of 2022, was to collect as much open source information regarding cluster munition attack in Kharkiv as possible with the intent that this information could be used for future accountability efforts. This information was collected, analysed and preserved using the Methodology, increasing the likelihood that this information could be used as evidence.

It is important to note that open source information cannot show the totality of the use of cluster munitions in Kharkiv. It is vital that this report be read alongside witness statements, physical evidence and expert testimony. Instead, this report, and the incident reports that underlie it, have aimed to answer the question of who bears responsibility for those attacks using 9M55K cluster munitions.

In order to identify who was responsible for this attack, this investigation built a chain, linking munitions remnants seen in specific attacks to an area of operations south of Belgorod,

[316] https://www.hrw.org/news/2023/05/29/cluster-munition-use-russia-ukraine-war
[317] https://www.hrw.org/news/2023/09/06/russia-denies-its-widespread-use-cluster-munitions
[318] https://www.hrw.org/news/2016/07/28/russia/syria-widespread-new-cluster-munition-use
[319] https://news.sky.com/story/ukraine-crisis-putin-says-military-drills-purely-defensive-and-not-a-threat-as-western-leaders-warn-invasion-imminent-12545284

identifying the unit that was present in that area, and ultimately the commander of that unit. To do this it has used a huge range of open source, from imagery filmed at the site of attacks by Ukrainian citizens, videos released by the Russian MoD, satellite imagery, court documents and analysis of the invasion itself. Where appropriate, it has sought expert opinion in order to uncover or confirm knowledge which was outside the expertise of the J&A Unit.

The conclusion of this investigation is that, from the first day of the full scale invasion, the 79th Guards Rocket Artillery Brigade, led by Colonel Evgeny Yurievich Gerashchenko, carried out a series of attacks on the city of Kharkiv using cluster munitions, killing and wounding multiple civilians and damaging civilian infrastructure. This was done in support of the Western Military District's attempt to capture the city of Kharkiv, under command of Colonel General Alexander Zhuravlev.

# Annex I: Integration of SGBV in the J&A Unit's Investigative Process

In order to ensure that gender perspective is integrated into the investigative process, the J&A Unit implemented several systems to combat gender bias and try to integrate a gender perspective into the team's work. As part of this effort, the J&A Unit received training on sexual and gender-based violence (SGBV) and the intersectional factors that may affect a given individual or group, and how these may present themselves in open sources.

Investigators are instructed throughout the investigative process to look for indicators of potential SGBV and if present - tag them as "SGBV red flag". These elements are also present within the Methodology's Table of Factual of Inquiries, to ensure that investigators have this in mind throughout the course of their investigations. Investigators are also instructed to note the sex and age of those impacted by their investigation, if the information is available and/or visible in the content they review.

An important part of a gender analysis is obtaining sex disaggregated data in order to assess the harms that may be affecting people differently based on their gender and sex. For this investigation set, because of the use of cluster munitions, the areas affected are quite large - making it difficult to assess who was harmed directly as a result of a specific incident or as a result of the general hostilities within the time frame - and thus what is the sex breakdowns of those affected. Of the 32 incidents, seven incidents were determined to be directly related to deaths or injuries (CIV0082, CIV0097, CIV0083, CIV00761, CIV0213, CIV0533, CIV0798). Because this investigation relies on user-generated content, it is difficult to determine whether someone visible in the content is alive or injured, or their sex. These determinations are made by what is visible in the user-generated content, paired with other information available in open sources.

This analysis found no incidents that were immediate "red flags" for SGBV. This is likely because the J&A Unit's investigators focused on apparent indiscriminate use of cluster munitions in the early days of the full scale invasion. However, several "red flags" with regards to crimes against and affecting children were identified in the course of this investigation, such as attacks affecting schools and childcare.

# Annex II: Archiving

The term ‘archiving’ is shorthand within the Open Source Investigation (OSI) community for the acquisition of a copy of a piece of online content so that, in the event the original is removed from the internet, a full copy has been retained. Archiving URLs, in particular of audio-visual content, is crucial for online investigations, as it can become inaccessible if hidden or deleted by users or platforms.

User generated content (UGC) can become inaccessible to investigators if it is hidden or deleted by a platform’s user or by the platform if it breaches their content policies. This presents a significant challenge when performing online investigations as it can mean loss of access to key evidence.

Archiving is the process of acquiring and preserving a copy of open source information so that it can be preserved for future access. This allows us to retain custody of relevant information should the original copy become unavailable. It also allows us to track changes and alterations to content which may be significant to an investigation.

A significant challenge of archiving is the volume of information that is available and potentially relevant to our investigations. To address this, automation has been built in our workflow to enable the swift capture of OSI. Still, experience shows that no automated process can be blindly relied upon so investigators take ownership of verifying the archiving process success status and act as described below.

## Archiving Workflow

The archiving process begins when investigators discover relevant OSI, which is logged into a tracking system. Automated tools, including Mnemonic[320] and Bellingcat’s Auto Archiver, attempt to preserve the content and metadata using APIs.

Preserving data integrity is fundamental to archiving. Both Mnemonic and Auto Archiver store content in widely supported formats and timestamp each archive to validate authenticity. Content hashes are generated to enable the identification of tampering, and external timestamping services employed by Mnemonic ensure integrity by providing immutable records of archival times. However, archiving faces constant challenges from dynamic web environments, authentication barriers, and changing platform behaviors. A robust approach involving proactive monitoring, redundancy, and adaptability is necessary to maintain the reliability of archived content in this evolving landscape.

Despite these redundancies, failures still occur, prompting investigators to retry using tools like Webrecorder[321] or relying on local backups from Hunchly[322]. Continuous feedback with

[320] https://mnemonic.org
[321] https://webrecorder.net/
[322] https://hunch.ly/

developers helps improve system reliability. Multiple attempts are made until successful archiving is confirmed in at least one system. If content becomes unavailable without a successful archive, it is considered lost.

To keep up with the changing digital picture, our archiving workflow evolved throughout the duration of this investigation. We present the final version of this archiving workflow in the graph below.

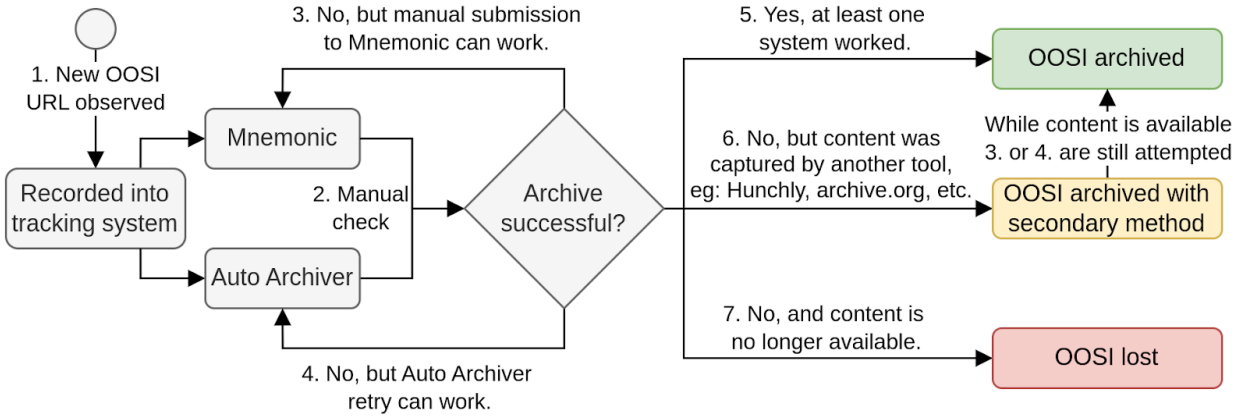



*Image 1: Archiving workflow for a new OSI URL final archiving state.*

Once a new piece of relevant digital content is found by an Investigator (1.), it is entered into a tracking system - a Google Spreadsheet instance. We rely on a redundant approach via two automated archiving systems. The first is handled by Mnemonic — an organisation dedicated to archiving digital documentation of human rights violations and international crimes — which consists in a daily ingestion of URLs that are then archived using mostly official Application Programming Interfaces (APIs). The second is Bellingcat's Auto Archiver, which retrieves digital media and other relevant metadata using a mix of official and third party APIs. Both Mnemonic's system and Bellingcat's Auto Archiver increased in their capability during the process of this investigation, enabling the acquisition of information from different websites as well as increasing the amount of metadata captured from them. Still the sheer complexity of online platforms and content serving methods mean there is always a risk that an archive operation fails, even with the double redundancy of our automated setup. So, Investigators go back to the recorded URL and query both systems for a successful archive result (2.).

If neither automated system is successful, there is a retry cycle. For Mnemonic the investigator uses Webrecorder's ArchiveWebPage[323] browser extension to capture a Web Archive Collection Zipped (WACZ[324]) file, an industry standard format which is easily replayable and auditable, and then submits it to Mnemonic's platform (3.). For the Auto Archiver, the process consists of deleting the previous attempt record from the Google Spreadsheet and waiting for it to retry the capture (4.). A constant feedback loop is essential with the developers of those systems throughout the process so as to detect and fix issues. Steps 3. and 4. are not mutually exclusive

[323] https://archiveweb.page
[324] https://specs.webrecorder.net/wacz/1.1.1

and can happen multiple times before a successful archive is reached. A successful archive is reached when one of these, but ideally both systems, has successfully archived the content and metadata (5.).

There is, in our methodology, another source of redundancy for archiving. Each researcher instals and enables the Hunchly[325] browser extension during the investigation process. Hunchly keeps a local copy of all the pages visited, including media files, along with capture metadata. If Mnemonic and the Auto Archiver are unsuccessful, this local copy stands as the best archive effort. The same applies to other public archive sources such as web archives, or as a last resort, local copies or screenshots obtained by an investigator (6.). While the content is still available online, there are continuous efforts to have Mnemonic and the Auto Archiver capturing it successfully.

If the content becomes unavailable during the process and there is no archive on Mnemonic, the Auto Archiver, or in any other online or local source the content is considered lost.

# Preservation

Another important aspect of the archiving process is ensuring we can keep accessing and viewing the stored data and metadata many years and decades into the future. Both Mnemonic and the Auto Archiver store the archived content in standard storage systems and in commonly used file formats. The storage preferred by both systems is a highly reliant online object store system (AWS S3 or similar) that treats each individual file as a unit and independently stores metadata on file creation times. Both systems use conventional file formats supported by mainstream browsers and operating systems instead of proprietary formats. The only niche format used is WACZ[326] which has become an industry standard format for replayable online content. WACZ is an open, and therefore replayable, format; it will have continued support as it has been adopted by the foremost online archives.

## Integrity - Hashing and Timestamping

Mnemonic and the Auto Archiver store metadata alongside each archived piece of content, one of these is a content hash of the file. Knowing this hash allows anyone to do an integrity check of the archived file against manipulation or corruption: if the hash is recalculated in the future its value is the same unless the file has been modified. The common concern with hashing and integrity checking is if a malicious actor wants to alter a file it could also recalculate its hash and replace the old hash value thus creating the illusion that the file was not modified. In fact, we mitigate this risk in multiple ways, essentially nullifying. First, having two systems archiving the content independently would force any malicious actor to independently gain access to both systems. Second, the process of storing the content in S3 compatible storage systems

[325] https://www.hunch.ly
[326] https://specs.webrecorder.net/wacz/1.1.1/

delegates the task of logging modification timestamps to an external service; modification times are not editable and are auditable for each file. Third and most importantly, both systems timestamp the archived content hashes in external services at the time of archival. This timestamp guarantees that a hash existed at a moment in time so no modification would be possible after that moment. Mnemonic uses at least one external paid hash timestamping service. The Auto Archiver uses several free RFC3161 compatible timestamp authorities and stores all the necessary files for an autonomous integrity check at any future moment.

## Archiving Challenges

The multitude of online sources creates an intractable environment for archiving. Online services implement authentication walls, invite-only access, rate limiting, throttling, CAPTCHAs, custom blocking based on geographical information or device characteristics, dynamic content loading, interactive content, differential access on web vs installed applications, and more. On top of that, regular updates to these services mean archiving approaches are time-bound and occasionally stop working on a moment's notice. This environment is a constant challenge and permeates whatever redundancy systems are in place. Our approach is then one of constant monitoring and reactivity.

# Annex III: Direction of Origin Confirmation

**Research Protocol**

**Project title: Assessing the accuracy of estimations of the orientation of a rocket model from 2D images.**

## Issue:

This study concerns the estimation of the orientation of motors and cargo sections of rockets observed in online photographs and videos. This is important, as this orientation can give an indication about the direction from which these munitions originated.

The experiment asks to what extent it is technically possible to assess the 3D orientation of cylindrical objects in a landscape from the 2D representations of those objects in an image of the scene.

The test is an opportunity to measure the accuracy of the investigators' assessment when the true orientation is available to compare with the assessed orientation. It is necessary because investigators cannot go to Ukraine to measure the true orientation of the munitions in question.

The results of assessment will then be used to create a standardised arc which can be applied by investigators to real-world examples of 9M55K rocket impacts.

A pilot study performed by Bellingcat suggests that the test and resultant statistical analysis will provide guidance as to how certain we can be, based on visual assessment of images, that the projectile protrudes in a direction within an identified range.

Some real-life examples are as follows. The depth to which the munition lodges into the ground differs from case to case, as does the angle from the ground.



*Image 1: 300 mm rocket motor in Ukraine.*



*Image 2: 300 mm rocket motor in Ukraine.*



*Image 3: 300 mm rocket motor in Ukraine.*

# The Munition Model

The munition model for this experiment has been constructed from a metal pipe with a diameter of 300 mm. This is the same diameter as that of the 9M55K rocket which is fired by the BM-30 Smerch. Fins have been added to the rear of the model in order to match those seen on the 9M55K.

The model consists of three segments, each of which is 750 mm long. These segments can be attached and detached using clamps, lengthening or shortening the model as required. Therefore the model can be either 750 mm, 1500 mm or 2250 mm long.

The pipe itself has been painted matt grey in order to match the paint seen on 9M55K missiles.



*Image 4: Munition model fully assembled.*



*Image 5: Munition model disassembled, with clamps below the segments.*

The model is posed using a screw-in ground anchor with a rod attached. This anchor can be screwed into the ground at different angles, after which the model is placed on the rod, holding it in a position.



*Image 6: Rods and ground-screw on which the model is mounted.*

# Test Exercise and Participants

The participants in the study are seven employees of Bellingcat, who have been working on investigations into events in Ukraine. They are professional investigators with at least one year's full-time experience at analysis of online imagery.

The participants will examine images presented to them and assess the orientation of the model munition, specifically the bearing along which it points. The assessed orientations by the raters will then be compared with the true orientations.

# Input data

1. Photographs of the model protruding from the ground in a geolocated setting.
2. The co-ordinates of the model.

# Variables

## Independent variable

The independent variable will be the bearing towards which the model is pointing. The true bearing along which the munition points will be predefined by a random number generator[327] between 0 to 360. The model will be placed pointing along this bearing.

## Extraneous variables

| Name of variable | Description | How to control |
|---|---|---|
| Location of model | The architecture of Kharkiv consists of both residential houses, brutalist concrete high-rise flats, and more modern high rise buildings. | A location will be selected which roughly matches the mix of urban and parks which Kharkiv consists of. In this case Burgess Park in London provides a suitable location, including a mixture of buildings which are similar to those in Kharkiv. |
| Angle of model to horizontal | Once it has impacted the ground, the angle of rocket motors to horizontal can vary. This likely has an impact on the ability of the analyst to assess the direction in which the munition points. | In order to control for this, the model will be placed in either a "high" or "low" orientation. A low orientation indicates an angle between the ground and the munition tube of between 45-85°. A high orientation indicates an angle of between 05-44°. Half of the serials will have the model in a high orientation, and half will be in a low orientation. |
| Length of model | Once a rocket motor has impacted the ground, the length of the motor remaining above the ground can vary. | The length of the model will be changed in order to imitate the variable lengths of 9M55K motors seen in Kharkiv. This will be done using two additional tube sections which can be added to the tail section, giving the option of the model being 750 mm, 1500 mm or 2250 mm long. The experiment will include 8 examples of each length. |
| Angle of photograph to model | It is assessed that the angle at which the photograph is taken in relation to the model could have an effect on an investigator's analysis of the direction in which it points. | For each serial the angle the photograph is taken at will change by 15 degrees in relation to the model. (See image: 7) |

[327] random.com

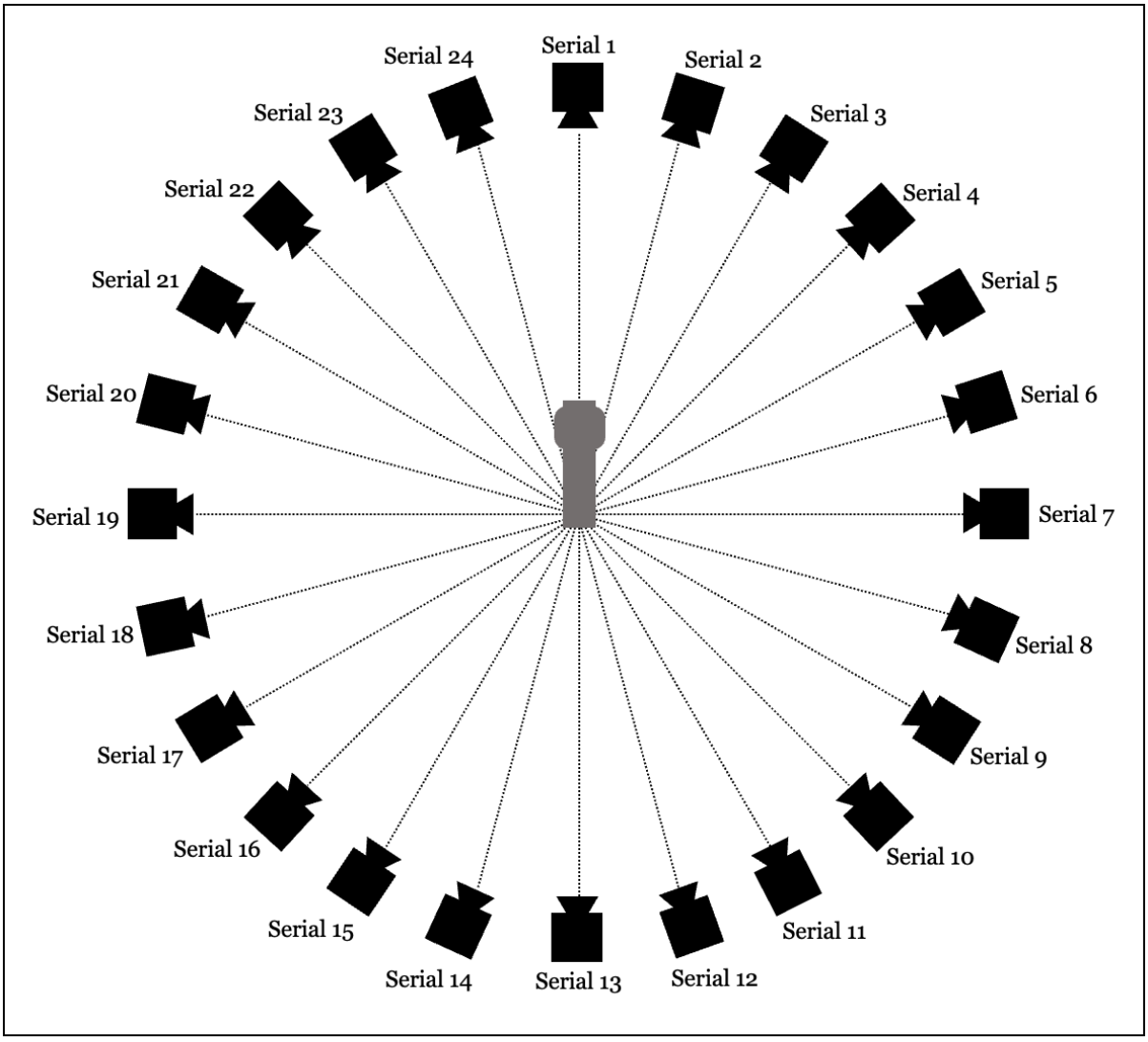



*Image 7: Bird's-eye illustration of how the angle of the photograph in relation to the model will change for each serial.*

## Set 1: Multiple Locations, Varying Orientations and Angles to Ground

The model is situated pointing along different bearings in 24 different locations. The model will either have a high or a low angle, and will be 1, 2 or 3 sections long. This will result in 24 different orientations of the model.

The height from the ground at which the images will be taken will be approximately 1400 mm, which is consistent with a person holding up a phone to take an image. The camera used to take these images will be an iPhone 13 mini.

| Serial | Location | Direction of bearing | Angle to horizontal (high or low) | Length (1-3) | Angle of photograph (°) |
|---|---|---|---|---|---|
| **1** | **Loc 1** | 117 | high | 1 | 0 |
| **2** | **Loc 2** | 32 | high | 2 | 15 |
| **3** | **Loc 3** | 13 | high | 3 | 30 |
| **4** | **Loc 4** | 185 | low | 1 | 45 |
| **5** | **Loc 5** | 34 | low | 2 | 60 |
| **6** | **Loc 6** | 174 | low | 3 | 75 |
| **7** | **Loc 7** | 7 | high | 1 | 90 |
| **8** | **Loc 8** | 355 | high | 2 | 105 |
| **9** | **Loc 9** | 334 | high | 3 | 120 |
| **10** | **Loc 10** | 0 | low | 1 | 135 |
| **11** | **Loc 11** | 36 | low | 2 | 150 |
| **12** | **Loc 12** | 347 | low | 3 | 165 |
| **13** | **Loc 13** | 101 | high | 1 | 180 |
| **14** | **Loc 14** | 90 | high | 2 | 195 |
| **15** | **Loc 15** | 87 | high | 3 | 210 |
| **16** | **Loc 16** | 191 | low | 1 | 225 |
| **17** | **Loc 17** | 95 | low | 2 | 240 |
| **18** | **Loc 18** | 279 | low | 3 | 255 |
| **19** | **Loc 19** | 141 | high | 1 | 270 |
| **20** | **Loc 20** | 322 | high | 2 | 285 |
| **21** | **Loc 21** | 23 | high | 3 | 300 |
| **22** | **Loc 22** | 78 | low | 1 | 315 |
| **23** | **Loc 23** | 301 | low | 2 | 330 |
| **24** | **Loc 24** | 272 | low | 3 | 345 |

### Output Data

The assessment will be done using Google Forms. For each serial the investigator will be presented with an image of the model in the given orientation and a set of co-ordinates. They will then make an assessment of the bearing along which the model is pointing using this image. This assessed bearing will then be written in degrees in the answer box.

This will be done for each of the 24 serials listed above. As in reality, the investigators can use any resource for their assessment, but cannot visit the actual location of the model.

With 24 different orientations of the model and seven raters for each image, there will be a total of 168 data points produced for this set.

The difference between the assessed bearing and the true bearing will then be measured and recorded by the assessor. The result will be 168 assessed bearings which can then be compared against the true bearing.

## Methodology and Statistical Plan

*Establishing the images and inputting reference data: Nick Waters*

The images will be prepared and photographed by the lead investigator of Bellingcat's J&A Unit, Nick Waters. He will be responsible for assessing the true bearing of the model and entering this data into the system, matching it to each serial

The model will be placed in the orientations detailed in the table for each serial. For each serial a measurement of the angle to horizontal and the bearing of the model will be taken.

The measurement of the angle to horizontal will be taken using a digital level placed on top of the model, aligned along its length.

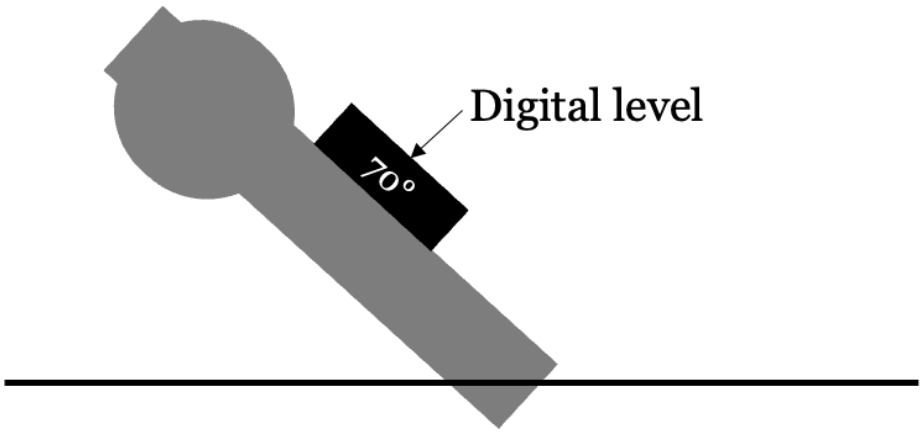



*Image 8: Illustrative example of the measurement of the model's angle to horizontal.*

The bearing of the model will be measured using a prismatic compass, using a plumb line placed at the end of the model. The person taking the measurement will align this plumb line to the center of the model while measuring with the prismatic compass. They will remain at least 2 m from the model while carrying out this measurement in order to prevent the magnetic field of the munition altering the compass.

The result of this measurement will be the exact opposite direction in which the model is pointing. In order to account for this, the measured bearing will have 180 degrees added in order to calculate the true direction in which the model is pointing.

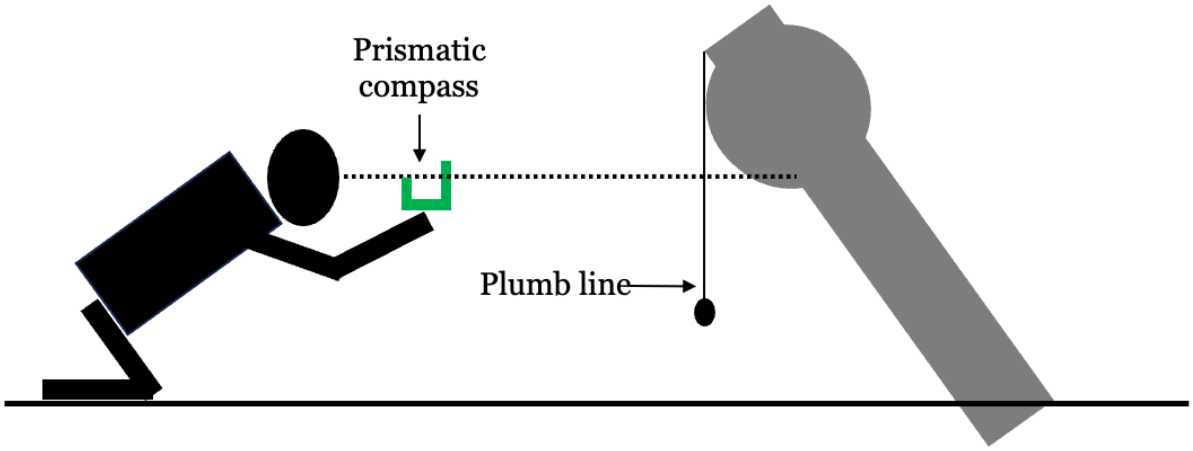



*Image 9: Illustration of measuring the bearing along which the model points.*

The location will be identified using decimal co-ordinates to six decimal places. There is no need for the investigator to conduct a geolocation, as in a real investigation, any munition remnant being assessed in this way would already have been geolocated.

### Statistical Analysis

Once the answers have been collected, the following steps will be carried out for the statistical analysis:

1. Compute angular error (with +/- sign) across the dataset.
2. Plot histogram of data and ensure it looks like it could be modeled by the normal distribution. (This can also be assumed from the direction of origin proof of concept)
3. Compute the mean and ensure it is close to zero. Large means (close to the standard deviation) might indicate a bias in the experimental design.
4. Two standard deviations on either side of the mean captures 95% of probable true bearings. This is an arc with an angle which is 4x standard deviation.

The data from this test will be gathered and plotted in a histogram where the x-axis is the difference between the assessed bearing and the actual bearing, and the y-axis is the frequency of that answer. An example of this graph from the proof of concept test is below.

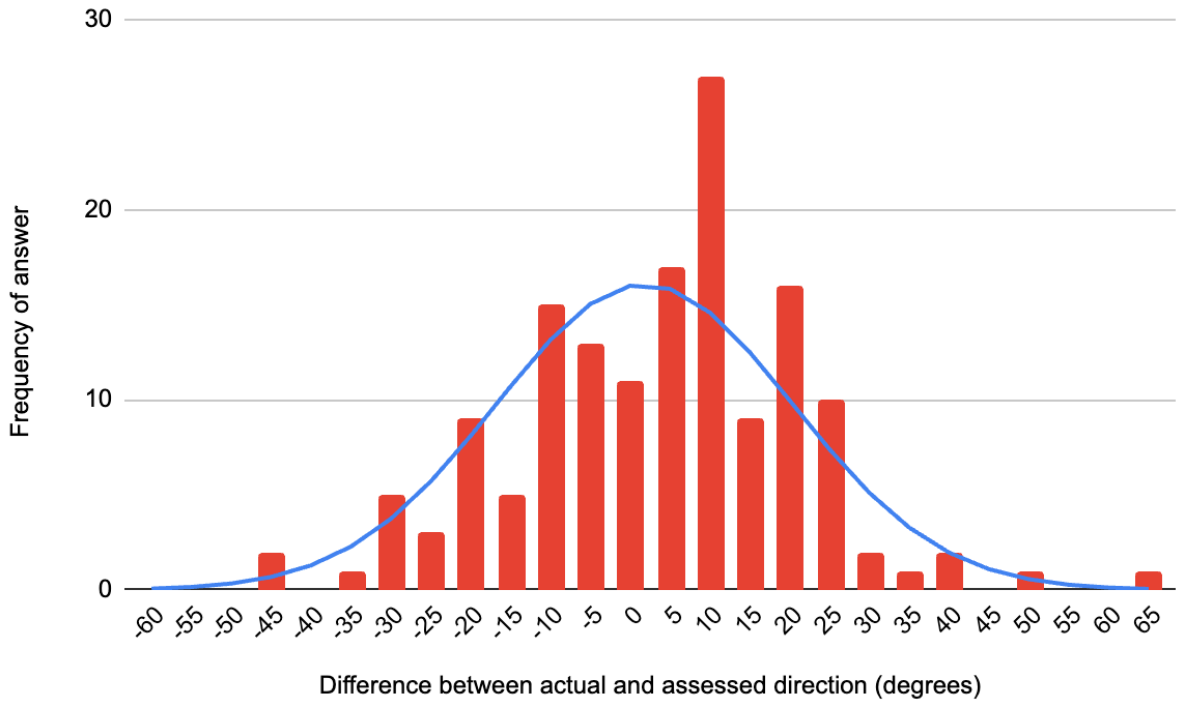



*Image 10: Histogram of results from the direction of origin proof of concept.*

It is hypothesised, based on the direction of origin proof of concept, that this will result in a histogram that can be approximated by the normal distribution, i.e., a bell curve.

Since 95% of values drawn from a normal distribution will fall within two standard deviations of the mean, a measurement of two standard deviations will be used to create a standardised range arc from this data.

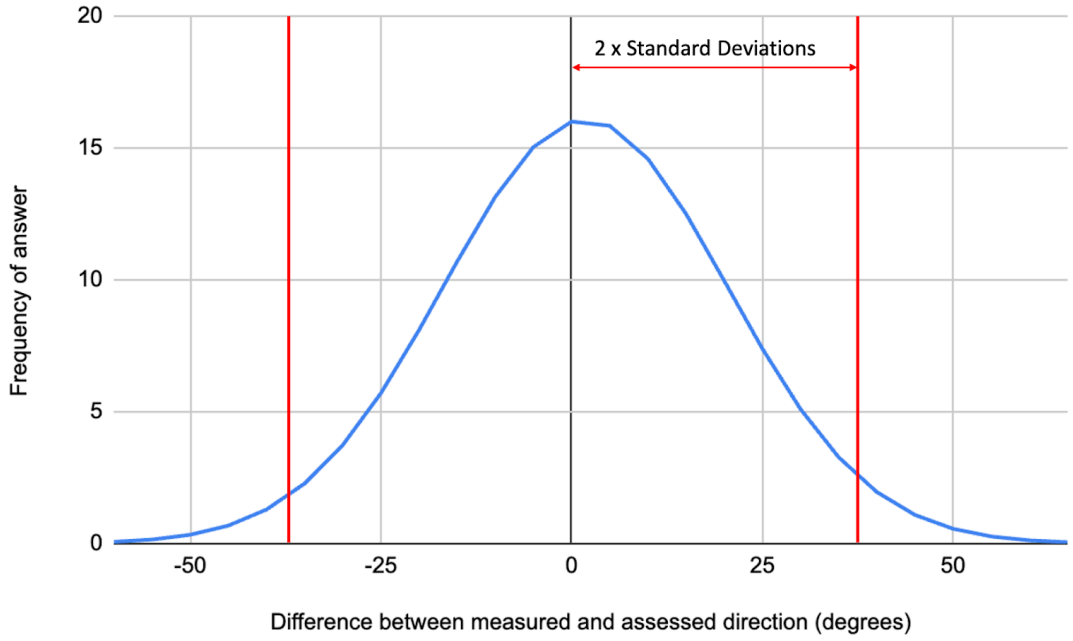



*Image 11: Histogram of results from the direction of origin proof of concept, with the addition of two standard deviations from the mean.*

In the proof of concept test, 95% of the bearings (or two standard deviations) assessed by investigators would fall within 37.2 degrees of the actual bearing. This resulted in a standardized arc template for 9M55K rockets which could be applied by investigators to rocket motors and cargo sections embedded in the ground. The angle of this arc was 74.4 degrees across (37.2 x 2).

It should be stressed that, while this arc has an angle of 74.4 degrees to include 95% of assessments made by an analyst, the experiment showed that analysts would only occasionally identify a bearing that was significantly inaccurate. The majority of the answers tended towards the actual direction the object was pointing.

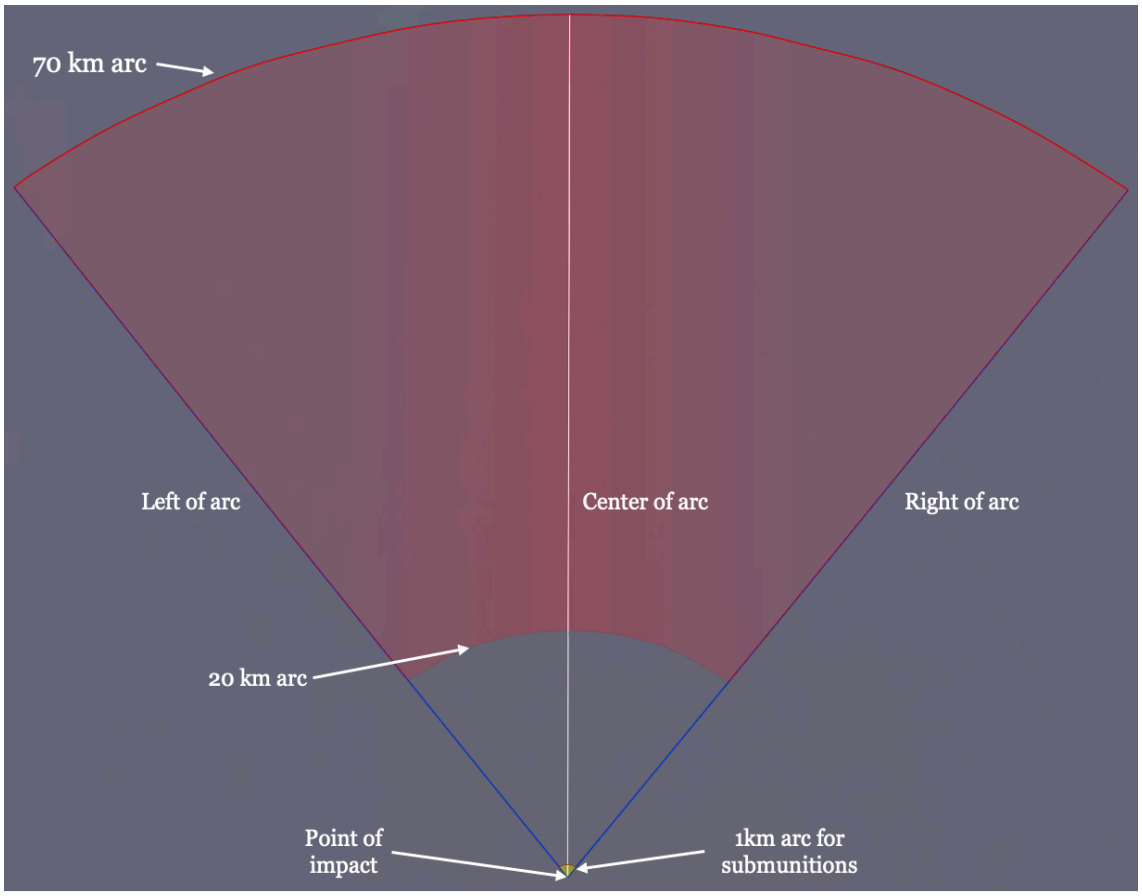



*Image 12: Standardised arc with angle of 74.4 degrees created as a result of the proof of concept test.*

The same method will be applied to the results of this experiment, resulting in a standardised arc template.

## Transferability to Real-World Conditions

The real-world analysis that this study is intended to validate is taking place in the context of the war in Ukraine. Images and videos of cluster munition casings do not suffer from poor resolution or illumination, nor atypical contrast or colour representation and as such, these features have not been controlled for because they have not been identified as obvious potential sources of error.

## Results

| Serial | True orientation (degrees) | Person 1 answer | Natasha Difference | Person 2 answer | Person 2 difference | Person 3 answer | Person 3 difference | Person 4 answer | Person 4 difference | Person 5 answer | Person 5 difference | Person 6 answer | Person 6 difference | Person 7 answer | Person 7 difference |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 117 | 89 | 28 | 75 | 42 | 97 | 20 | 99 | 18 | 102 | 15 | 104 | 13 | 95 | 22 |
| 2 | 32 | 37 | -5 | 35 | -3 | 15 | 17 | 14 | 18 | 27 | 5 | 28 | 4 | 31 | 1 |
| 3 | 13 | 15 | -2 | 356 | 17 | 19 | -6 | 3 | 10 | 13 | 0 | 330 | 43 | 21 | -8 |
| 4 | 185 | 171 | 14 | 170 | 15 | 177 | 8 | 172 | 13 | 167 | 18 | 154 | 31 | 170 | 15 |
| 5 | 34 | 35 | -1 | 19 | 15 | 22 | 12 | 5 | 29 | 39 | -5 | 14 | 20 | 28 | 6 |
| 6 | 174 | 179 | -5 | 176 | -2 | 161 | 13 | 188 | -14 | 177 | -3 | 184 | -10 | 190 | -16 |
| 7 | 7 | 355 | 12 | 73 | -66 | 13 | -6 | 86 | -79 | 48 | -41 | 15 | -8 | 13 | -6 |
| 8 | 355 | 332 | 23 | 357 | -2 | 315 | 40 | 334 | 21 | 355 | 0 | 322 | 33 | 349 | 6 |
| 9 | 334 | 311 | 23 | 322 | 12 | 304 | 30 | 29 | -55 | 345 | -11 | 307 | 27 | 3 | -29 |
| 10 | 0 | 354 | 6 | 349 | 11 | 351 | 9 | 351 | 9 | 354 | 6 | 352 | 8 | 7 | -7 |
| 11 | 36 | 32 | 4 | 14 | 22 | 359 | 37 | 30 | 6 | 37 | -1 | 16 | 20 | 24 | 12 |
| 12 | 347 | 5 | -18 | 341 | 6 | 346 | 1 | 353 | -6 | 359 | -12 | 339 | 8 | 340 | 7 |
| 13 | 101 | 101 | 0 | 108 | -7 | 102 | -1 | 102 | -1 | 102 | -1 | 103 | -2 | 107 | -6 |
| 14 | 90 | 99 | -9 | 112 | -22 | 108 | -18 | 75 | 15 | 85 | 5 | 148 | -58 | 102 | -12 |
| 15 | 87 | 96 | -9 | 114 | -27 | 98 | -11 | 64 | 23 | 55 | 32 | 92 | -5 | 98 | -11 |
| 16 | 191 | 185 | 6 | 230 | -39 | 213 | -22 | 197 | -6 | 200 | -9 | 212 | -21 | 196 | -5 |
| 17 | 95 | 100 | -5 | 108 | -13 | 107 | -12 | 100 | -5 | 84 | 11 | 84 | 11 | 95 | 0 |
| 18 | 279 | 285 | -6 | 318 | -39 | 304 | -25 | 304 | -25 | 292 | -13 | 310 | -31 | 270 | 9 |
| 19 | 141 | 132 | 9 | 163 | -22 | 141 | 0 | 136 | 5 | 108 | 33 | 125 | 16 | 111 | 30 |
| 20 | 322 | 346 | -24 | 348 | -26 | 353 | -31 | 2 | -40 | 350 | -28 | 1 | -39 | 328 | -6 |
| 21 | 23 | 66 | -43 | 78 | -55 | 66 | -43 | 22 | 1 | 70 | -47 | 75 | -52 | 29 | -6 |
| 22 | 78 | 80 | -2 | 84 | -6 | 78 | 0 | 96 | -18 | 87 | -9 | 73 | 5 | 79 | -1 |
| 23 | 302 | 310 | -8 | 309 | -7 | 309 | -7 | 312 | -10 | 334 | -32 | 300 | 2 | 282 | 20 |
| 24 | 272 | 265 | 7 | 264 | 8 | 280 | -8 | 300 | -28 | 286 | -14 | 274 | -2 | 272 | 0 |

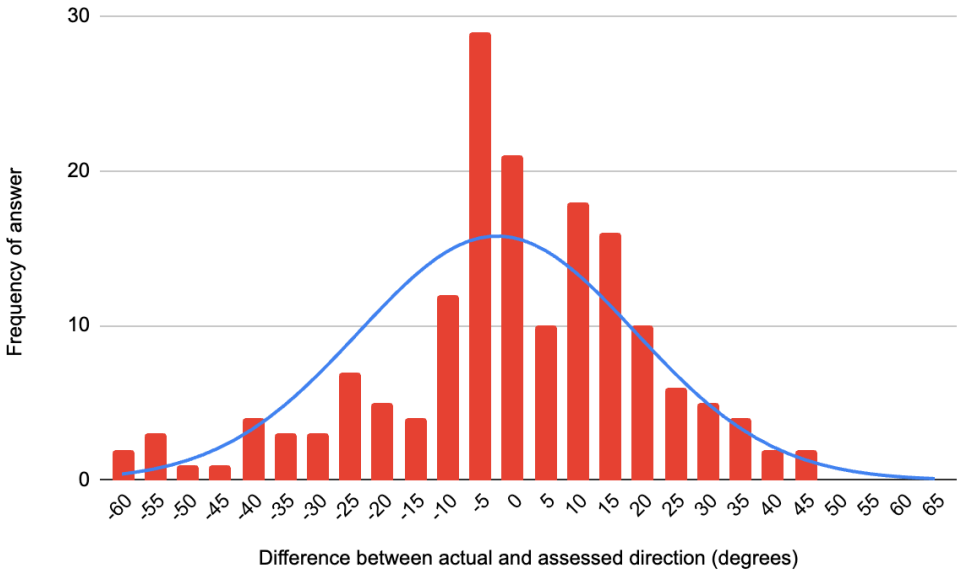



*Image 13: Histogram of results from the direction of origin proof of confirmation.*

The mean of the dataset is -2.3095 degrees, indicating little bias towards one direction or the other. The standard deviation of this distribution is 21.2. 95% of values drawn from a normal distribution will fall within two standard deviations of the mean, or 42 degrees in either direction. This is slightly larger than the direction of origin proof of concept.

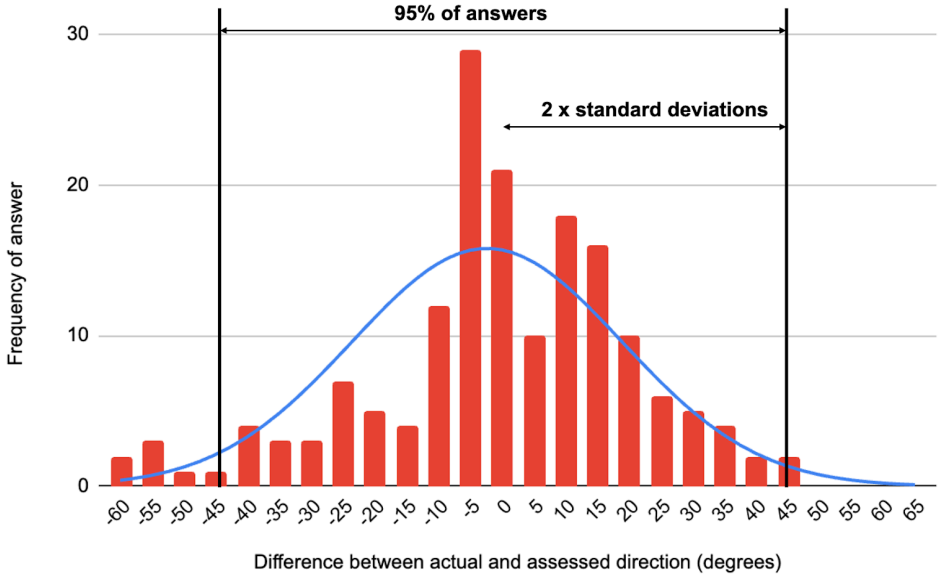



*Image 14: Histogram of results from the direction of origin proof of confirmation, displaying 2x standard deviations.*

This standard deviation is slightly larger than the direction of origin proof of concept.

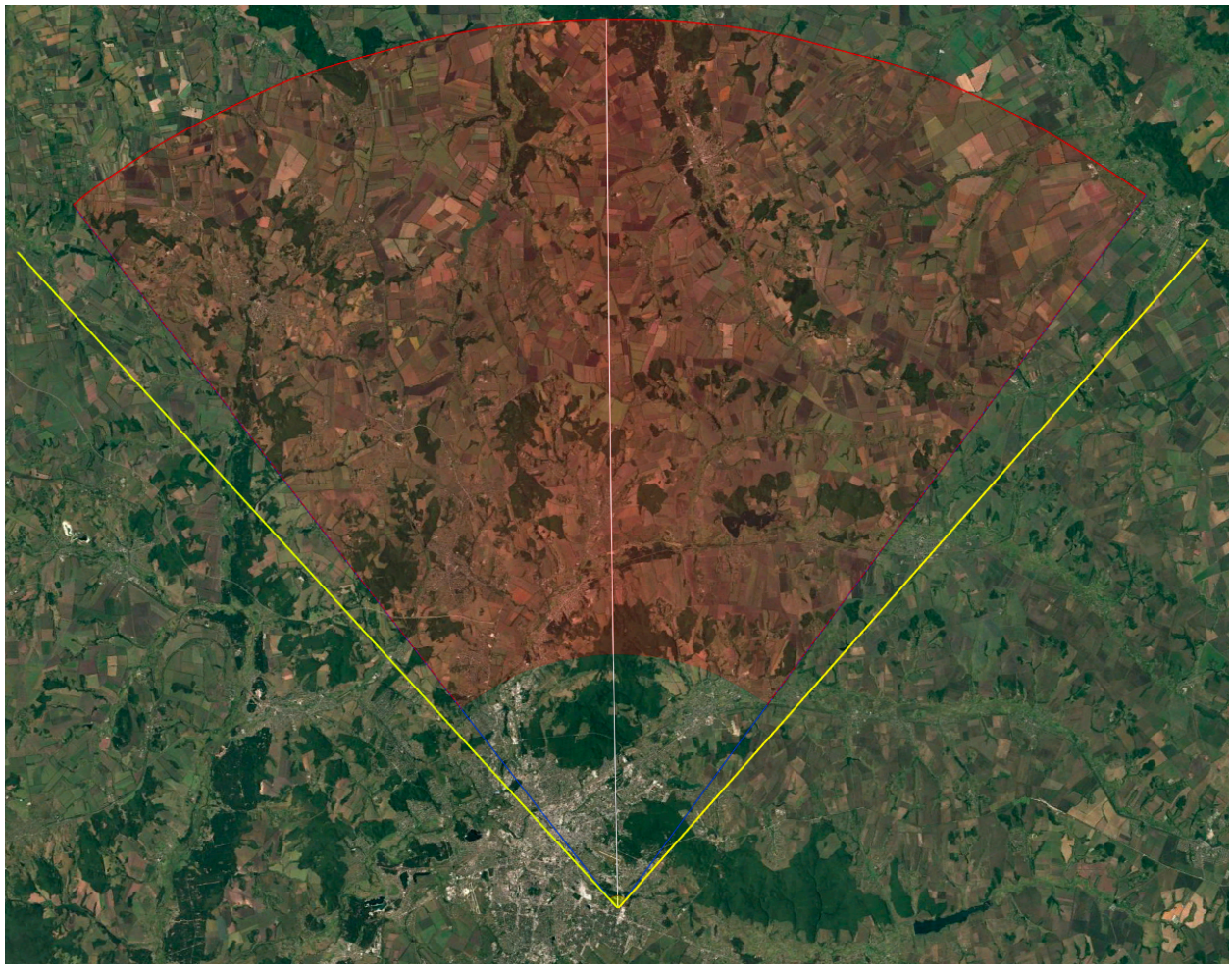


*Image 15: Comparison of arc created after the direction of origin proof of concept compared against the left and right of arcs based on the direction of origin confirmation.*

On the basis of this, a second arc was developed, with an angle of 84 degrees.

Once answers were received, the differences between the actual and assessed bearing were plotted on a graph as described in the Statistical analysis section.

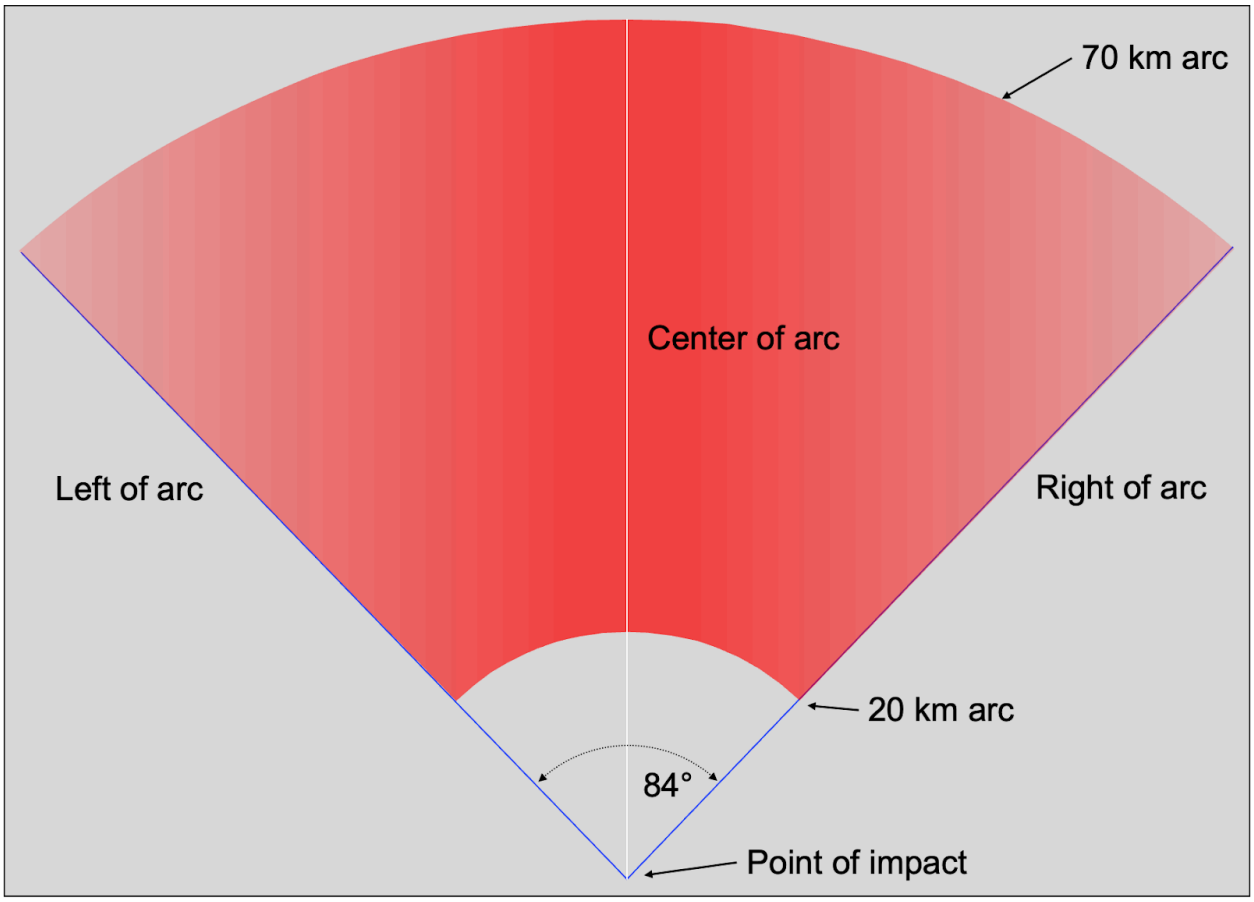



*Image 16: Area of origin arc resulting from direction of origin confirmation of concept.*

As with the arc developed for the Direction of Origin Proof of Concept, it should be stressed that, while this arc has an angle of 84 degrees to include 95% of assessments made by an analyst, the experiment showed that analysts would only occasionally identify a bearing that was significantly inaccurate. The majority of the answers tended towards the actual direction the object was pointing.

# Annex IV: Civilian Harm Map and the Global Authentication Project

It became apparent that the amount of open source imagery coming from Ukraine was too much for the team of researchers to identify, archive, and analyse in a timely manner by themselves. Bellingcat then decided to launch the Global Authentication Project (GAP) with the goal of recruiting volunteers to help with the verification of this open source imagery. GAP consists of ordinary people from all walks of life who have been vetted by Bellingcat staff, trained in open source research methods, and assigned tasks by Bellingcat researchers. Working together, the GAP members and Bellingcat researchers can comb through large amounts of open source data to analyse, archive, and document ongoing events.

The key task of the GAP volunteers was to geolocate open source images coming from Ukraine by determining where they were captured. Geolocation is the backbone of the image authentication process for this type of materials - when completed it provides almost certainty that an image shared on social media really was captured at a specific location. Geolocation by itself excludes the majority of misleading online content.

The geolocation workflow begins with a Bellingcat researcher from the Justice & Accountability Unit identifying images on social media showing civilian harm in Ukraine. At this stage, the researcher does not make a determination regarding whether the image actually shows civilian harm in Ukraine, or who was responsible. The goal is to capture as much potentially relevant information as possible for analysis later. The researcher adds these images, along with their corresponding links to the social media post in which they were shared, to an internal database.

Once in this database, a Bellingcat researcher conducts a triage on the content and tags those showing graphic violence. This content is passed onto the GAP. Single images, or sets of images that appear to show the same event, are called “incidents.”

Then the GAP volunteers begin to geolocate the content for each incident. They do this using an internal platform named Atlos[328] that was custom-built to facilitate collaboration and interaction among researchers and volunteers. The platform allows for the volunteers to comment on individual incidents, ask questions to researchers, and show their work.

Once a volunteer geolocates an image, the incident is considered to be partially authenticated, and is flagged for review by a Bellingcat researcher. The researcher then checks the volunteer’s work, and determines whether the geolocation was carried out correctly. If so, the incident is marked as geolocated, and it is then displayed on the map. If not, then the researcher flags the incident as not completed, and it is sent back to volunteers who then attempt to complete the geolocation again. Only incidents that have been checked through this process are displayed on the Ukraine Civilian Harm Map.

[328] https://www.atlos.org/

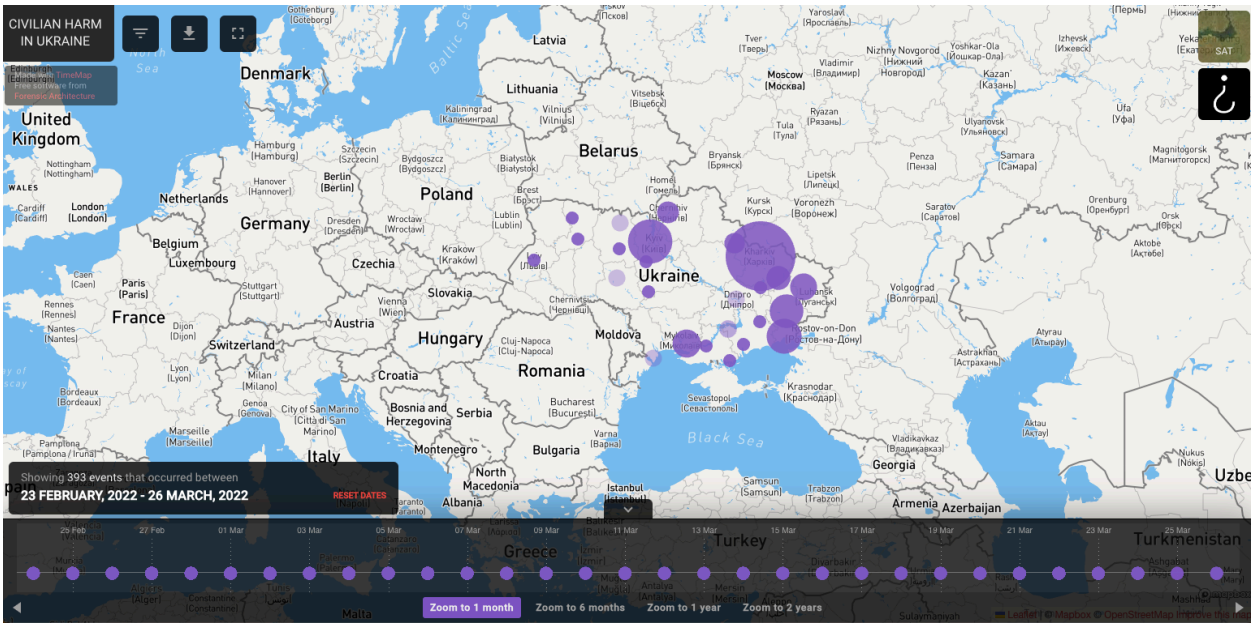



*Image 1: Screenshot from the [Ukraine Civilian Harm Map](https://ukraine.bellingcat.com/)[329] depicting verified civilian harm incidents from 23 February to 26 March 2022.*

Sometimes, neither volunteers nor researchers are able to geolocate an incident. This may be because there may not be enough visual information available to determine where the image was taken, or when. Other times, the geolocation process determines that an image is not from Ukraine. In these cases, the incidents are marked accordingly, and they are not displayed on the Ukraine Civilian Harm Map.

[329] https://ukraine.bellingcat.com/