

The Price of Coal

Waste rock dumps of Kuzbass and the deferred bill for coal mining

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About the evidentiary limit. The work distinguishes between documented expense, physical object, risk and identified harm. The absence of a found document is not considered evidence of the absence of an event.

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At a waste rock dump near Apanas, 2020. Archive of Natalia Zubkova. The photograph shows the presence of the author and the visible scale of the industrially altered terrain; it does not measure temperature, gas composition or the boundaries of the internal heat source.

“I was shocked by the scale of the disaster, by the size of the dump.”

In 2020, I saw a waste rock dump near the village of Apanas. We filmed the consequences of coal mining. Behind the man-made terrain was a simple question: what happens to what's left after the coal is extracted?

I began collecting documents about the site after the filming. The research remained unfinished when I had to leave home in February 2021. I was able to return to it in 2026, together with Sergey

Nikolaevich and Viktor Andreevich and with access to contracts, court decisions, archival reference works, scientific publications, and satellite data.

This time the question became more precise: was coal really cheap if some of the costs arising from mining appeared only years or decades later? No single striking figure can provide the answer. But individual parts of the bill can be traced, revealing when they arose and who ultimately paid them.

This study does not presume intent or identify a culprit in advance. It seeks to reconstruct the physical and documentary sequence: coal was mined, rock was moved, the company ceased to exist, the physical site remained, and work and expenditure continued.

Abstract

The study considers Kuzbass waste rock dumps as long-lived physical objects whose environmental, engineering and financial impacts can outlive the mining period and the original enterprise. The central case is a burning waste rock dump near the village of Apanas, associated with the history of the Listvyansky open-pit mine.

Open-source documents were used to reconstruct the company's history, the site's parameters, the events of 2020, three non-overlapping items of public expenditure, the incomplete design and engineering-investigation cycle of 2023–2024, and the land decisions of 2025. At least **RUB 50,659,785.87** in public expenditure was documented. This amount is neither the total damage nor the full cost of the dump or its reclamation, and it cannot be used to calculate the “true price” of a tonne of coal.

Scientific publications are used to explain the mechanism of self-heating and its potential effects, but findings from other dumps are not attributed to Apanas. Our analysis of 11 valid winter and early-spring Landsat scenes from 2016–2025 identified a recurring local surface thermal anomaly: the central point of the waste rock mass was approximately 6.7–10.4 °C warmer than the adjacent disturbed control area. The method does not establish the depth, cause, or internal temperature of the heat source.

Comparative cases of Krasnobrodsky, Bachatsky, Vakhrushevsky, mine No. 12 and Sibirginsky show different liability regimes. The study does not confirm the universal formula “the state always pays for old dumps.” A more accurate conclusion is that the consequences of extraction can last longer than the economic life of the original enterprise, and their payment depends on the legal and historical fate of the site.

1. Research question, method and scope

1.1. What is meant here by a deferred bill?

Coal acquires a market price at the point of sale. The consequences of mining unfold on a different timescale. A waste rock dump occupies land, alters topography and water regimes, may retain combustible material and self-heat, and may require extinguishing, inspection, stabilization, reclamation, and monitoring. Each of these activities occurs on its own schedule and has its own payer.

In this study, a “deferred bill” is neither a single accounting entry nor a legally defined category. It is an analytical term for documented costs, obligations, territorial changes, and risks that arise after coal has been mined. A component of the bill is treated as established only insofar as the site, action, date, and source can be identified and, for monetary expenditure, no evident double counting is involved.

THREE LEVELS OF CLAIMS

Fact

directly recorded by document, measurement or observation

Synthesis

follows from a consistent set of independent information

Limit

the available data is insufficient for a stronger conclusion

1.2. Source corpus

The study combines regulations, state and municipal documents, procurement registries, judicial acts, archival reference books, scientific publications, official reports, materials from Natalia Zubkova and remote sensing of the Earth. If a primary document is available, it has priority over the media retelling. A secondary source is retained where it contains evidence, an official's response, or an unavailable primary publication.

An event chronology of 27 lines and a financial table were created for Apanas, which separately takes into account the contract price, registered payment, subcontract payments, fines and announced financing. For each key finding, it is recorded not only what the source proves, but also what it does not prove.

The satellite unit is based on Landsat 8/9 Collection 2 Level 2, Surface Temperature product and QA_PIXEL quality filtering. It is an independent, reproducible calculation, and not a replacement for a field survey.

1.3. What the study could not establish

Open data does not provide a complete register of physical waste rock dumps in Kuzbass, built according to a unified methodology. The complete closure record for Listvyansky, the exact year the Apanas fire began, the amount of coal to which a specific dump corresponds, the full future cost of the work and the quantitative exposure of residents to pollutants have not been established.

Therefore, the study does not calculate the cost of impacts per ton of coal. Nor does it equate the absence of a document being found with the absence of an event or duty. If the transfer of responsibility is not traced, the correct conclusion is that the line has not been reconstructed using available materials, and not “there was never a person responsible.”

2. Scale: several different numbers instead of one

Waste rock dumps cannot be represented responsibly by a single large figure. The documents contain different categories: disturbed lands, waste disposal sites, hydraulic dumps, objects of negative impact, objects of accumulated environmental harm, technological structures of existing enterprises and the legacy of liquidated mines. Their accounting units and boundaries do not coincide.

99.156 thousand hectares

all disturbed lands of Kuzbass at the end of 2024

312 objects

coal mining dumps registered in GRRORO throughout Russia

3 objects

specific self-heating hotspots identified by the minister in 2021

The report of the Ministry of Natural Resources and Ecology of Kuzbass reports that at the beginning of 2024, 96.471 thousand hectares of disturbed land were taken into account in the region. During the year, another 4.768 thousand hectares were disturbed, of which 4.264 thousand hectares were disturbed during the development of mineral deposits; 2.083 thousand hectares were reclaimed. At the end of the year the balance amounted to 99.156 thousand hectares.¹⁴

This is an important indicator of the overall territorial footprint, but not the area of waste rock dumps. It includes all types of disturbed land, and the report itself does not single out burning waste dumps or the legacy of closed businesses.

The information and technical reference book ITS 17-2024 gives another number: 312 dumps of overburden, waste and enclosing rocks from coal mining are registered in the state register of waste disposal facilities in Russia.¹⁶ This is the federal number of registered objects, and not the number of physical dumps in Kuzbass. The old array may not coincide with one registry entry, and one object may be separated by cadastral and technological boundaries.

A 2019 scientific publication describes a separate infrastructure of Kuzbass hydraulic dumps: about 7000 hectares of the structures in question and more than 3 billion m³ of potential additional dry overburden capacity.¹⁷ This is another distinct category: hydraulic dumps, not all waste rock dumps and not an inventory of burning sites.

In April 2021, the Minister of Coal Industry of Kuzbass Oleg Tokarev named three objects with recorded self-heating hotspots: the “Vnutrenny Poimenny” dump of the Sibirginsky open-pit mine, “Southern Field” of mine No. 12 and a dump at the liquidated Listvyansky open-pit mine near Apanas.¹² This is a dated minimum of named objects, but not an inventory of the entire region.

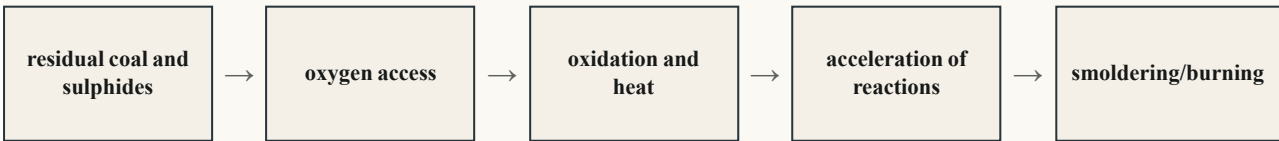
Section result

The full number of physical waste rock dumps and the single number of burning or self-heating objects in Kuzbass have not been established from open sources. The inability to reduce different categories into one figure is not a lack of arithmetic, but a limitation of the existing accounting system.

3. How a waste rock dump begins to burn

Coal particles and other carbonaceous material enter the dump together with overburden and host rock. Sulfide minerals, including pyrite, may also be present. Crushing and dumping increase the surface area available for reactions, while pores and fractures provide pathways for oxygen.

Low temperature oxidation of coal produces heat. Sulfide oxidation can affect thermal and chemical conditions. As long as heat is dissipated faster than it is generated, the system remains stable. When heat removal is insufficient, the temperature rises, reactions accelerate, and positive feedback can lead to smoldering and open burning.



The risk does not depend on a single attribute, but on a combination of composition, particle size, heterogeneity, porosity, fracturing, dump configuration, moisture, height and dumping regime. Water can participate in heat transfer and reactions, but severe water saturation can limit the supply of oxygen. Therefore, the word “humidity” alone does not determine the direction of the process.

Combustion can develop inside the waste rock mass and not coincide with visible smoke. Burnout of the combustible part and thermal transformation of the rock change its volume and strength. A crust may remain over the weakened zone, which later subsides. For high dumps, water saturation of the base, pore pressure and slope stability are additionally important.¹⁸¹⁹

Portola, Protasov and Seregin investigated the sources of endogenous fires on Kuzbass waste rock dumps using 15 wells up to 2.5 m deep. At an air temperature of about 0 °C, the surface at the studied points had +5...+14 °C, and at a depth of 0.5 m it was recorded from +35 to +433 °C. The authors examined CH₄, CO, SO₂, H₂S and O₂.²¹

Transfer limit: these values refer to the Kuzbass dumps examined by the authors. They explain the possibility of a sharp temperature gradient and complex gas regime, but are not measurements of the Apanas dump.

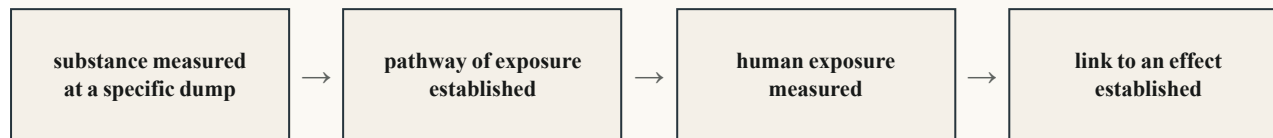
The cessation of visible smoke does not equal the proven cessation of the internal process. For such a conclusion, thermometry, gas monitoring, drilling, stability assessment and post-work observation are needed. Repeated self-heating is physically possible if the flammable material remains and oxygen access is restored. But it cannot be inferred from the general possibility that a particular reclaimed dump will necessarily catch fire again.

Not every waste rock dump burns. Sealing, air sealing, drainage and low combustible content can reduce the risk; natural revegetation and the suitability of the substrate for plants have been studied scientifically at individual waste rock dumps in Kuzbass. The category of an object in itself does not prove a fire.

4. What a burning waste rock mass emits—and what this means for people

The gas composition of the source depends on the rock, temperature, access to oxygen and the path of exit to the surface. The study by Portola et al measured methane, carbon monoxide, sulfur dioxide, hydrogen sulfide, and oxygen. Judicial materials for the Krasnobrodsky and Bachatsky branches consider burning dumps as sources of emissions of harmful substances.²⁴

The known toxicological properties of these substances vary. Carbon monoxide binds to hemoglobin and, in sufficient doses, disrupts oxygen transfer; sulfur dioxide irritates the respiratory tract; hydrogen sulfide is toxic and especially dangerous at high concentrations; methane in the open air is primarily important as a flammable gas and, when accumulated in a confined space, can displace oxygen. But knowledge of toxicity is only one piece of evidence.



For harm to the residents of Apanas to be established, the entire causal chain must be demonstrated: a substance at the specific site, a pathway of exposure, human exposure, and an established link to an effect. There is no published set of site protocols in the open corpus that would allow determination of residential concentrations, duration of exposure, and individual dose. There is also no epidemiological study separating the contribution of the dump from other sources.

There is also evidence that reduces the hypothesis. The response of Minister Oleg Tokarev, published in 2021, stated that daily monitoring of the gas atmosphere was carried out on the borders of the sanitary protection zones of the dumps and in the nearest populated areas and no excesses of the maximum permissible concentration were detected.¹² The publication does not contain the protocols themselves, the list of substances, coordinates and time series, so it is impossible to independently verify the completeness of this assessment. But it should not be excluded from the study simply because it weakens the assumption of proven exposure.

The correct result is limited: high-temperature zones were documented on the studied Kuzbass dumps and a number of gases were measured; for burning waste dumps, there is a physically plausible path of exposure to air and other environmental components. The quantitative exposure of Apanas residents and the medical consequences of this particular site have not been established.

5. Apanas: from the enterprise to the remaining object

5.1. Listvyansky open-pit mine

The interarchival directory of the Kemerovo region dates the beginning of the work of the Listvyansky open-pit mine to 1955.² The history of the termination of the enterprise consists of several legally different events: on 08.08.2000, a decision was made on voluntary liquidation;

On 13.09.2002, the company was declared bankrupt; on 29.09.2004, it was liquidated by court decision. Reducing this sequence to an approximate “closed in 2003” is incorrect.

1955	start of operation of the Listvyansky open-pit mine
08.08.2000	decision on voluntary liquidation
13.09.2002	declaration of bankruptcy
29.09.2004	legal liquidation by court decision
01.10.2008	by this date, funding for liquidation activities was stopped

The land footprint of the mining was documented long before the liquidation. L.P. Barannik in 1969 wrote about 1577 hectares of land affected by mining operations, the annual land take of more than 100 hectares of agricultural and forest land and the experimental sowing of pine on one of the dumps.³ These 1577 hectares refer to the entire mining area of that time, and not to the current Apanas site. An experimental site without coordinates cannot automatically be considered part of the modern contour.

HISTORICAL DOCUMENT 1969

Lands of "Listvyansky"

Mining workings	1577 ha
Annual withdrawal	more than 100 hectares of agricultural and forest land
Early reclamation experience	sowing pine on an experimental plot

Source: L.P. Barannik, “Forest recultivation of dumps”, PDF-p. 81–82.³

The Ugol magazine reported that as of 01.10.2008, funding for events at Listvyansky was stopped.⁴ The wording confirms the termination of funding, but does not provide grounds for asserting that all necessary work has been completed by this date. It does not prove the opposite - that nothing was done.

5.2. Divergent documentary lines

After the liquidation began, the production life of the territory did not stop overnight. The judicial act records the transfer of the employee to Razrez Kamyshansky LLC from 01.12.2000.⁵ The secondary copy of environmental statistics reported the transfer of major production sources to Kamyshansky, but did not list the composition of the assets. Licensing rights to subsoil areas are later traced through other companies and court documents.⁶

Assets and employees

partially traceable through forensic and secondary materials

Subsoil licenses

fix the right to use specific areas

Old physical dump

the transfer of the dump itself and the party bearing full responsibility have not been established from the available documents

A license, a land plot and a physical dump are not the same thing. The transfer of the right to mine coal does not prove the automatic transfer of the old dump and all environmental responsibilities. But the absence of a found transfer document also does not prove that the obligation legally did not exist.

5.3. What does line 924 say?

In the list of sites with signs of accumulated damage published by EcoStandard, line 924 describes the site in the village of Apanas as a “burning waste rock dump.” It indicates an approximate volume of 26 435 479 m³, type of waste “overburden rock”, area of 81.8096 hectares, cadastral number 42:09:0000000:1660, agricultural land and undemarcated state property. It is indicated about 800 m to the village of Apanas.¹

26 435 479 m³

approximate volume

81.8096 ha

approximate area

≈ 800 m

to the village of Apanas



Apanas waste rock dump, Kuzbass. Image courtesy of Natalia Zubkova. The photographer and date have not been established; a photograph shows the apparent state of an object at the time it was taken, but does not establish the temperature, composition of emissions, or the mechanism of internal processes.

The same text lists the companies to which the nearby license area was re-registered, and states: the administration of the Novokuznetsk municipal district did not have information about which of the listed legal entities was the last to exploit the dump itself. This sets a limit to the information of the administration, but not the legal absence of the responsible person.

Source status: the available PDF begins directly with the table and does not contain a title page, author, date, version number, or approval details. It was not possible to independently find the same line on the official state domain. Therefore, the data are attributed to the published EcoStandard list;

the file is not called a state registry.

5.4. Why can't the volume of a dump be converted into an amount of coal?

A volume of 26.4 million m³ of rock is not equivalent to the amount of coal mined. A defensible conversion would require the technical documentation for this particular dump, mine-surveying records, annual overburden and production figures, density data, and the history of material rehandling. A universal ratio of “tonnes of rock per tonne of coal” would disregard differences between mining areas and technologies. The study therefore does not calculate deferred costs per tonne of coal.

6. 2020: the legacy becomes an emergency

On 14.04.2020, due to the burning of a waste rock dump near Apanas, a state of emergency was introduced.¹¹ In an officially attributed message, the authorities explained the task by the need to prevent the fire from spreading towards populated areas and forests.

It was reported about fencing the territory, drilling wells, gas control and preparing design solutions. These actions are important not only as administrative consistency. They show the physical complexity of the site: the internal state of the waste rock mass cannot be assessed at a glance, and working near heated and burnt-out zones requires atmospheric control and stability.

20.11.2020

Residents reported pops and a brown cloud. After inspection, the district civil defense and emergency services reported rock subsidence above the burnt area on the southern side of the fifth block.⁴⁰

Limit: The documents found do not establish the physical cause of the bangs. Therefore, the event is not called a technically established explosion.

Two published videos record the Apanas dump at different moments in 2020: February 11 - STOPCOAL channel, November 8 - KUZPRESS.⁴¹⁴² The videos are not footage recorded by Natalia Zubkova. The mere fact of two records does not prove a change in state between dates without a separate frame-by-frame and spatial comparison.

By the end of 2020, the record included not only reports and investigations but also registered public payments. Sixteen years separated the legal dissolution of the original company in 2004 from the expenditure on fire-control work.

7. At least 50.66 million rubles: visible part of the bill

It was possible to trace three independent public expenditure items in public register records. They relate to different items of purchase and do not overlap with each other.

DOCUMENTED TRACEABLE MINIMUM

50 659 785.87 ₺

Period	What was paid	Contract / basis	Registered payment
2020	Elimination of sources of self-heating of rocks near Apanas	№ 3423800449620000062	RUB 37,519,585.40
2020	Construction supervision of these works	№ 3423800449620000067	RUB 268,596.67
2023–2024	Engineering investigations for the facility	№ 3423800449623000050	RUB 12,871,603.80
Total			RUB 50,659,785.87

7.1. Work carried out in 2020

The customer of the two contracts was the administration of the Novokuznetsk municipal district. Contract No. 3423800449620000062 with SIBSTROY LLC provided for the elimination of self-heating areas. The register entry records a budget payment for the full price - RUB 37,519,585.40.⁷ The record also requires the contractor to pay interest and penalties, so the contract is not described as “executed without complaint.”

A separate contract No. 3423800449620000067 with Dorstroymekhanizatsiya LLC covered construction control. The payment order dated 25.12.2020 records the payment of RUB 268,596.67.⁸ The separate contract item and the different contractor allow construction supervision to be counted as an independent expenditure item.

7.2. Engineering investigations, 2023–2024

Contract No. 3423800449623000050 with North-West Engineering Company LLC had a total price of 55 987 259.67 rubles. The primary justification table divided it into engineering investigations - RUB 12,871,603.80 - and design and estimate documentation - 43 115 655.87 rubles. Upon termination, the register indicates that RUB 12,871,603.80 were paid, that is, exactly the cost of the engineering investigations.⁹

A judicial act on the subcontract chain confirms that two stages of work were accepted, but a positive conclusion from the state expert review was not received and the final project result was not achieved. The municipal contract was terminated by agreement of the parties on 18.03.2024.¹⁰

7.3. Why the other identified amounts are not added

Sum	Why is it not included in the total?
RUB 40,848,760	2020 funding announced/committed may cover contracts already accounted for; adding would create a risk of double counting
RUB 43,115,655.87	price of the project component under the terminated contract; actual public payment has not been confirmed
5.1 million; 3.57 million; RUB 299,170	subcontract costs, accepted milestones and debt within the main contract chain, rather than new public costs
finances and penalties	payments by the contractor, not public-budget expenditure on the site

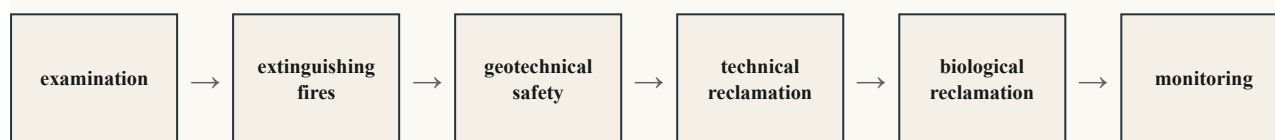
What does 50.66 million rubles mean?

At least this amount in public expenditure could be documented. It is not an estimate of environmental damage, the cost of the entire dump, the full cost of closure or reclamation, or the true price of coal. The figure documents a real monetary component of the bill years after the original company ceased to exist.

8. The unfinished story of Apanas

The paid engineering investigations were not a completed elimination project. The terms of reference included gas, thermal and georadar surveys, assessment of work in 2020, selection of a method for eliminating self-heating, technical and biological reclamation, estimates and a monitoring program. It is the breadth of the task that shows the difference between local extinguishing of fires and bringing the entire object to a stable state.

The court found that two stages of subcontracted surveys had been accepted. At the same time, the final result, which included a positive conclusion from the state expert review, was not achieved. These facts cannot be replaced either by the phrase “they did nothing” or by the phrase “the elimination project is ready.”



On 28.02.2025, the Government of Kuzbass adopted Resolution No. 91. It lists eight land plots that are transferred to the category of industrial and other special purpose land for the express purpose: “placing a dump of burning rocks in the area of the village of Apanas.”¹³ The total area of these areas is **748 433 m²**.

RESOLUTION OF THE KUZBASS GOVERNMENT NO. 91 · 28.02.2025

Eight plots - a separate land-use decision

The pre-existing land plot 42:09:0000000:1660 is not among these eight. The nine cadastral numbers found in the documents therefore do not constitute an arithmetic contradiction: one belongs to the earlier record and eight to the 2025 resolution.

The transfer of land itself shows the continuation of site preparation, but not the completion of liquidation or reclamation.

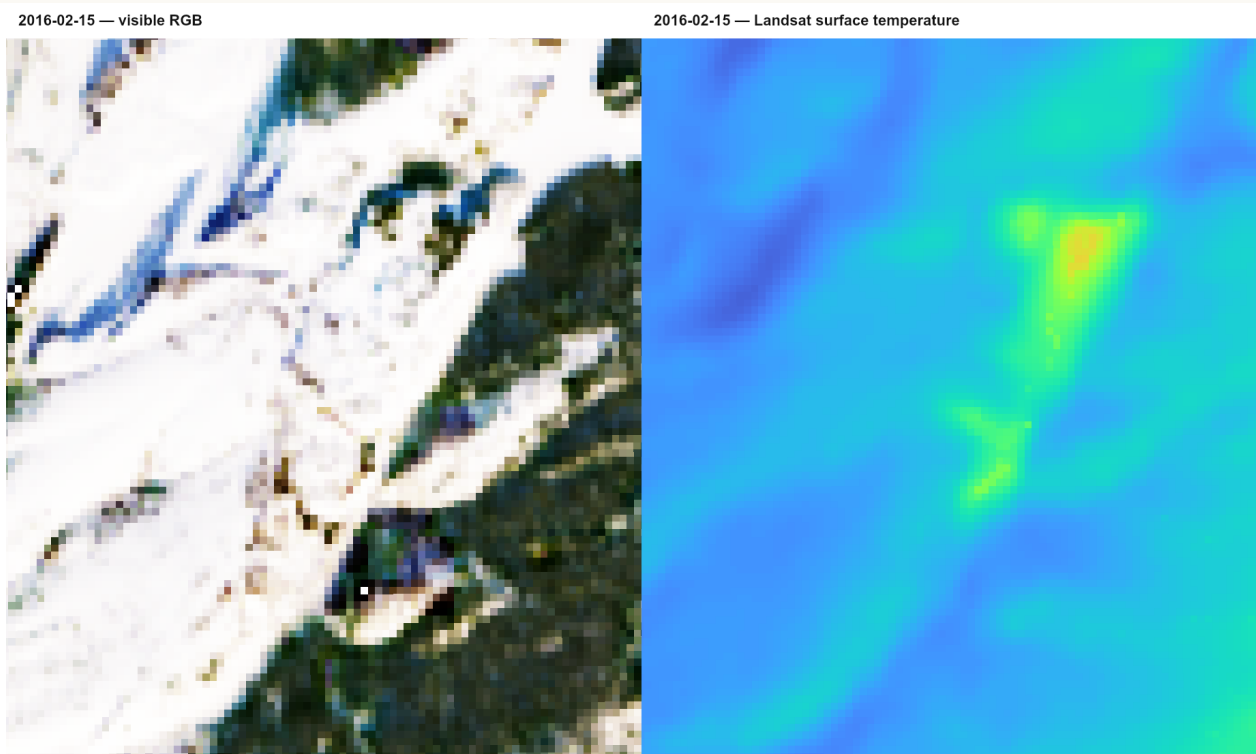
Rospirodnadzor Order No. 9-r of 29 February 2024 approved the schedule for examining sites of accumulated environmental harm. However, it was not possible to independently confirm that a specific line in the application belonged to Apanas. Therefore, it remains a general context, and the main site-specific evidence of the continuation of history is Resolution No. 91.

At the time the study was completed, the open sources contained no completed full-elimination project for the Apanas dump that had passed state expert review, no complete reclamation estimate, and no evidence of completed monitoring. This means only that no complete public set of documents was found; it does not prove that no non-public work was undertaken.

9. Apanas from Orbit: Surface Thermal Anomaly

Satellite analysis answered a limited question: Is the local surface temperature anomaly in the central part of the visible spoil mass repeated in winter and early spring compared to the adjacent disturbed area?

Landsat 8/9 Collection 2 Level 2 and temperature product ST_B10 were used. Digital number values were converted using the USGS formula: $ST(K) = DN \times 0.00341802 + 149.0$, then $ST(^{\circ}C) = ST(K) - 273.15$. Cloudy and shadowed pixels were excluded using QA_PIXEL.³⁶³⁷

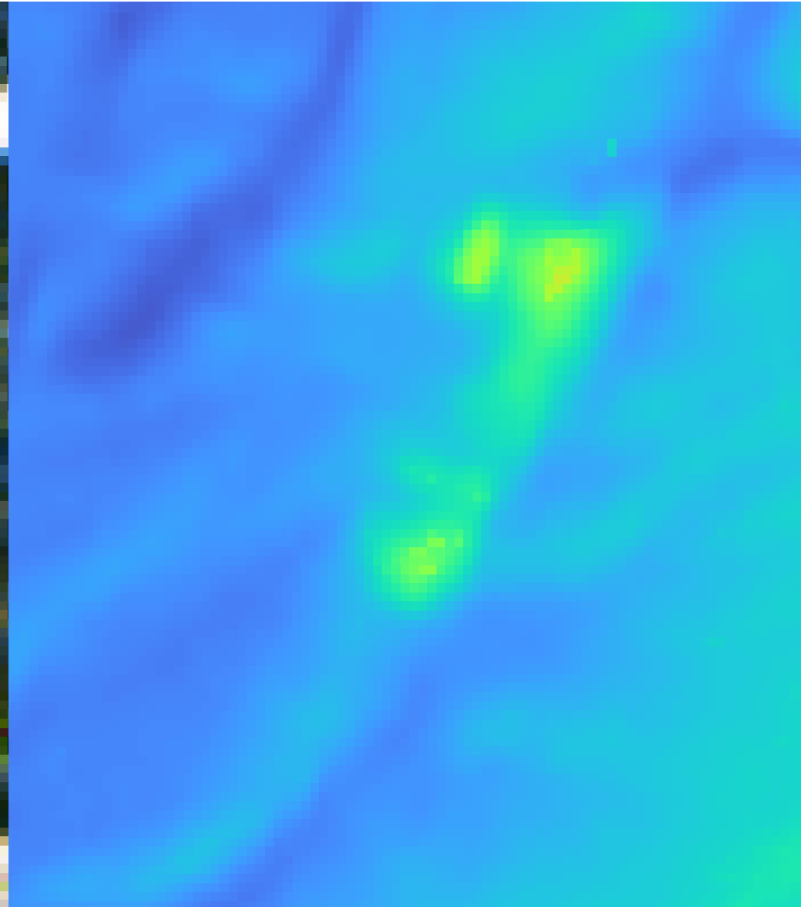


15.02.2016. On the left is a visible winter frame; on the right is the Landsat temperature product. The map shows the surface temperature of the pixel, not the internal heat source.

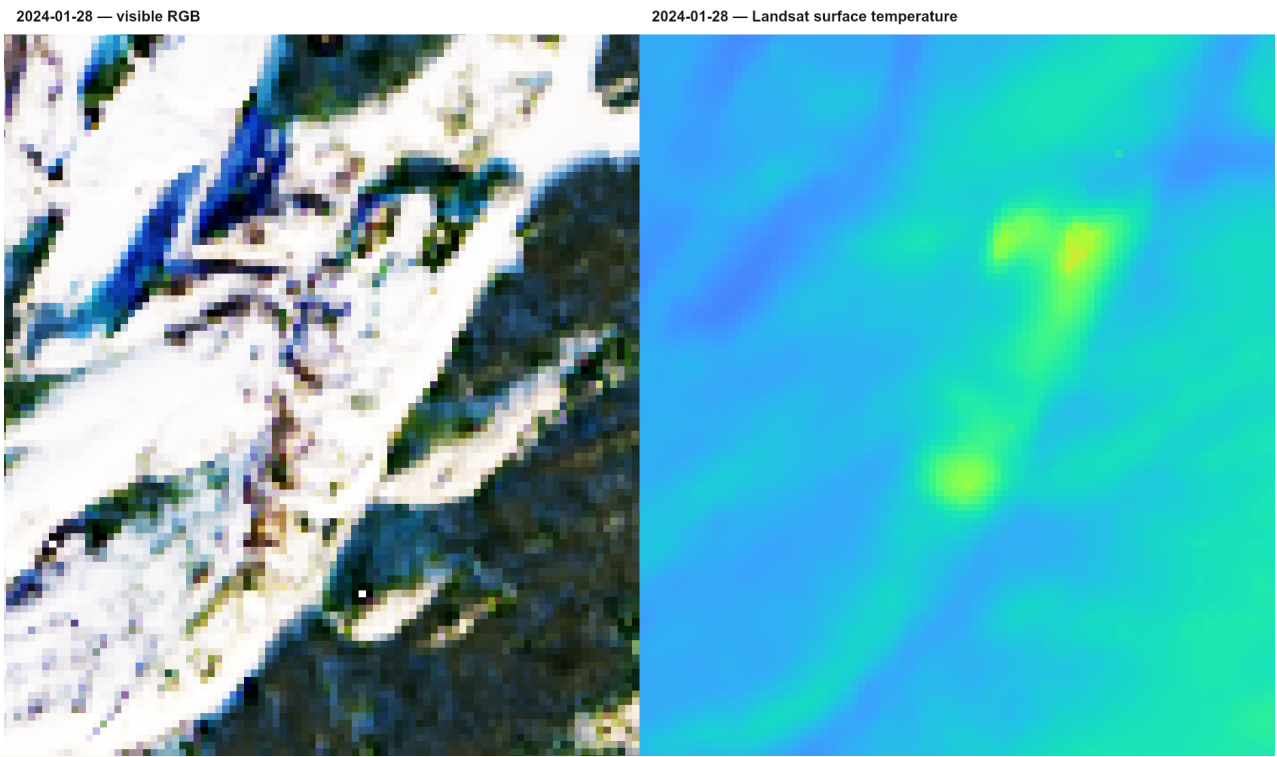
2022-01-31 — visible RGB



2022-01-31 — Landsat surface temperature



31.01.2022. The repeatability of the spatial pattern was checked not by the color of the map, but by the recalculated values of the same points and control surfaces.



28.01.2024. The control point was chosen in an adjacent mining-disturbed area to reduce the simple explanation of the difference as just exposed dark rock.

9.1. Eleven valid scenes

The analysis included 11 scenes from 2016–2025, in which the compared pixels passed a quality filter. In each scene, the center point of the waste rock mass under study was approximately **6.7–10.4 °C** warmer than the adjacent disturbed control area.

Date	Center, °C	North, °C	South, °C	Disturbed control, °C	Center - control, °C
15.02.2016	−9.56	−4.29	−20.42	−19.91	+10.35
17.03.2018	+9.24	+11.52	−1.17	+1.45	+7.80

Date	Center, °C	North, °C	South, °C	Disturbed control, °C	Center - control, °C
13.03.2020	+4.85	+9.51	−2.43	−2.14	+6.99
28.02.2021	−16.35	−11.35	−22.56	−23.11	+6.76
31.01.2022	−12.58	−10.31	−20.54	−21.02	+8.45
08.02.2022	−10.55	−7.95	−19.73	−18.81	+8.25
22.03.2023	+5.45	+6.72	−6.56	−1.21	+6.66
23.03.2023	+9.72	+11.57	−3.62	+1.75	+7.97
28.01.2024	−11.10	−10.11	−18.10	−18.00	+6.90
09.03.2024	+0.32	+3.63	−6.79	−7.09	+7.41
28.03.2025	+10.76	+10.76	−0.81	+2.22	+8.54

Acceptable conclusion: in the tested scenes, Landsat records **repeating local surface thermal anomaly**. Spatial and temporal repeatability is consistent with documentation of long-term self-heating, but does not by itself establish a cause.

A temperature product resolution of about 30 m means that a pixel can include snow, exposed rock, vegetation, and heated surfaces. The result is influenced by slope exposure, albedo, humidity and emissivity. Landsat does not determine the internal temperature, depth and volume of the fire, the exact boundaries of the underground source, or the legal status of the land represented by a pixel.

10. Reclamation is not a single final operation

The word “reclamation” often suggests a completed process. In practice, it encompasses several distinct objectives. Hazardous processes must first be stopped and the stability of the dump body secured. During the technical reclamation phase, the landform, drainage, isolation layers, and a suitable surface layer are then established. Biological reclamation creates vegetation cover. Subsequent monitoring is needed to determine whether the result persists.

1

Fire control

eliminate or contain heat sources

2

Safety

slope stability, cavities, water and access

3

Technical reclamation

landform, cover, drainage and soil layer

4

Biological reclamation

grasses, shrubs, trees and maintenance

5

Monitoring

temperature, deformation and vegetation checks

Even successfully created new vegetation cover does not automatically return the previous ecosystem. Original soils, microtopography, hydrology, forest age structure and ecological networks may be lost or altered. Therefore, technical reclamation, biological reclamation, functional restoration and restoration of the original ecosystem are different levels of result.

10.1. Mine No. 12: a process extending over time

The history of the South Field of Mine No. 12 shows the duration of the procedure itself. No later than 2016, there was a scientific design line for biological reclamation. In 2021, the Minister of Coal Industry reported on the recorded areas of self-heating of the waste rock dump and their elimination according to the project that passed the examination at the expense of the existing enterprise.¹²

Later, the enterprise reported the biological reclamation of 68 hectares of the Southern Field. In 2024, it proposed to transfer two areas with waste rock dumps to the municipality as reclaimed. After the inspection, the municipal property management committee identified non-compliance with the requirements and refused to accept the plots; then decisions were made to eliminate the deficiencies.

Open materials do not prove the complete spatial identity of the self-heating source, all 68 hectares and two transferred areas. Therefore, it is impossible to reduce the documents to the phrase “the same dump was reclaimed, and it caught fire again.” But the sequence shows something else: design, fire control, biological reclamation, inspection, acceptance and correction of deficiencies require money, time and institutional memory. Reclamation itself becomes a line item in a long-term bill.

10.2. Time as a separate measure

Successful reclamation in the future cannot retroactively restore the years during which the land’s ecological functions were altered. This temporal dimension cannot be represented adequately by land value alone.

The consequences of mining have more than just a price. They have time. Even future successful reclamation does not automatically return the decades during which the area was in an altered state. The study does not establish the exact year of disturbance for each section of the current area, so it does not turn this time measurement into a separate calculated value.

The consequences of mining have more than just a price. They have time.

Even a complete future recovery cannot bring back the decades that have already passed. The time gap can be described, but not always fairly monetized.

11. Other Kuzbass dumps: more than one liability scenario

Apanas shows a combination of the liquidated original enterprise and public expenses. But turning this case into a universal model would be a mistake. Other sites demonstrate corporate work, regulatory disputes and monitoring in operating plants.

11.1. Krasnobrodsky and Bachatsky

In case No. A27-2125/2017, supervision recorded burning waste rock dumps of the Krasnobrodsky and Bachatsky branches and incomplete elimination of emissions of harmful substances.²⁴ However, the repeated orders were canceled by the court as insufficiently specific and unenforceable: they did not clearly define the required actions and measurable results.

The two findings must not be conflated. Annulment of the orders does not mean that the court found no combustion or emissions. Conversely, the existence of an environmental problem does not make every regulatory demand legally enforceable. The case shows that the bill involves not only money and equipment but also the quality and precision of the regulatory instruction.

11.2. Vakhrushevskoe field

A 2025 scientific paper describes dump No. 2 of the Vakhrushevsky field with a design volume of about 50.1 million m³ and gives temperature ranges in one well: 60–79 °C at a depth of 1.5 m and 67–76 °C at a depth of 2.5 m.²² The publication contains an internal date conflict: the text and graph axis indicate 2016–2019, and the explanation of the results indicates 2021–2023 and a separate date 09.12.2022. Therefore, temperatures can be used as a characteristic of the observed heated zone, but it is impossible to reliably link the entire series to one period.

11.3. "Sibirginsky" as a counterexample

For the "Vnutrenny Poimenny" dump of the Sibirginsky open-pit mine, the official response published in 2021 linked the elimination of self-heating hotspots to the operating company. This is an important counterexample to the strong original hypothesis: not every liability automatically becomes a public-budget expense after self-heating occurs.

11.4. Five cases—four models

Object	Documented mode	What does it show	Limit
Apanas	liquidated enterprise, public works	delayed public-budget expense after the original company ceased	the full bearer of the legal obligation has not been established
Mine No. 12	operating enterprise, reclamation and acceptance	duration and multi-stage work	the identity of all physical contours has not been proven
Krasnobrodsky / Bachatsky	incumbent operator, supervision and litigation	the problem may be identified, but the order may be canceled due to uncertainty	the judicial act does not provide a full balance of subsequent work
Vakhrushevsky	scientific temperature monitoring	the heated zone can be maintained over time	publication dates conflict
"Sibirginsky"	corporate work of a going concern	the state does not always pay	there is no full open financial estimate

12. Who pays after a mine closes?

Liability depends on the time, the type of object and the legal structure. For an operating enterprise, responsibilities may arise from a license, land relations, industrial and environmental safety requirements, design decisions and supervisory regulations. When a company is dissolved, liquidation documents, succession, the fate of property and special public mechanisms become important.

Liquidation of a joint stock company terminates it without the transfer of rights and obligations through succession.²⁵ This is a general rule of corporate law. It does not automatically answer who owned a particular dump and what responsibilities might have been assigned to other persons.

Requirements for the liquidation of mining enterprises and reclamation have changed. Soviet-era regulations, early 1990s safety regulations, the 1995 Temporary Reclamation Regulations, and modern legislation cannot be applied as one immutable set of responsibilities. The legal assessment must be based on the norm in force at the relevant time.²⁶²⁷

The modern institution of accumulated environmental harm creates a public route for inspection, assessment and liquidation of objects for which the previous economic entity does not provide a solution. Decree of the Government of the Russian Federation No. 1370 provides for the allocation of funds from fees for negative impacts, fines and compensation for damage to environmental measures, including accumulated damage.²⁸ This is a general financial mechanism; it does not prove the origin of each ruble in the three Apanas contracts.

Right to mine

license for a specific subsoil plot

Right to land

cadastral plot and permitted use

Responsibility for the dump

operation, safety, elimination and monitoring

The Apanas research found no document clearly transferring the old dump and the full set of associated responsibilities together with a specific licence or asset. The conclusion is therefore limited to what the record establishes: the original company was liquidated; the dump remained; public contracting authorities commissioned and paid for work in 2020–2024; and, according to the available line in the published list, the administration reported that it had no information about the last operator.

13. International mechanisms for financing long-term mining legacies

Long-established coal regions address a similar problem across time through different institutions. The comparison neither ranks countries nor applies foreign expenditure figures to Apanas. It shows different mechanisms for connecting past mining legacies with future funding.

13.1. USA: industry levy and federal funds

Title IV of the SMCRA of 1977 created the Abandoned Mine Land program. It is financed by a levy on every ton of current coal production; the right to collect has been extended until 30.09.2034. By Sept. 30, 2025, the fund had collected \$14.233 billion with interest, and \$6.569 billion in collection-based grants had been distributed to states and tribes, according to OSMRE. The 2021 law added \$11.293 billion in federal funding.³⁰³¹

The mechanism connects part of the old heritage with a modern ton of coal, but is not limited to payment by the former polluter: it simultaneously involves the existing industry and the federal budget.

13.2. UK: recognized non-current liability

The Mining Remediation Authority is responsible for the legacy of coal mining, including mine water, subsidence, public safety and pumping stations. At 31 March 2025, the liability reserve was £1.709bn and the undiscounted forecast of future cash flows was £4.0604bn.³² Earlier reporting separately listed 41 waste rock dumps as the organization's responsibility and a forecast of £17 million over 50 years for safety, drainage and maintenance.³³

What is important here is not the comparability of the amount with Kuzbass, but the horizon: the state organization recognizes in advance that the obligations will continue for decades.

13.3. Germany: federal-state agreements

Since 1995, LMBV has been rehabilitating the non-privatized legacy of the East German lignite industry. According to the organization, approximately 12 billion euros have been provided through federal-state agreements; basic rehabilitation is financed 75% by the federation and 25% by the states. The agreement for 2023–2027 provides for 1.44 billion euros.³⁴³⁵

Legacy is seen as a multi-decade infrastructure challenge. This does not prove the completeness of the restoration and does not mean that only companies or only the state are paying for everything.

Country	Financial mechanism	Timing logic
USA	fee from current production + federal appropriations	modern industry participates in paying for historical heritage
United Kingdom	specialized public organization and reserves	obligations are recognized for decades to come
Germany	multi-year agreements between the federation and the states	rehabilitation is financed as a long-term program
Russia / Apanas	site-specific budget decisions and contracts	traced expenses arose after the liquidation of the original enterprise

14. What can be included in the price of coal

The study didn't find one "true cost." Instead, several irreducible dimensions were discovered.

Component of the bill	What has been established for Apanas	Can it be expressed in rubles?
Physical object	approximately 26.4 million m ³ of rock and 81.8096 hectares, according to the published list	not without a project and a complete cost estimate
Fire-control work	contract and registered payment of RUB 37.5196 million	yes, within the scope of the contract
Construction supervision	payment of RUB 0.2686 million	yes
Engineering investigations	payment of RUB 12.8716 million	yes
Complete elimination and reclamation	no completed project that had passed expert review was found	no reliable total
Monitoring	the need follows from the nature of the site and the project brief	the total future cost is unknown
Territorial change	the area is described; the original condition of the entire area has not been restored	cannot honestly be reduced to a single monetary figure
Ecological time	decades during which the area remained in an altered condition	not calculated or monetized
Public health	exposure and epidemiological causation have not been established	not assessed

The monetary minimum proves not the completeness of the bill, but its existence. Territorial parameters show the material scale, but not the cost of restoration. The hectare-year scenario shows time, but not damage. Scientific evidence explains risk but does not replace object exposure.

Therefore, the market price of coal and the full cost of the consequences of mining are not automatically one and the same indicator. The difference between them cannot be filled by an arbitrary estimate. It needs to be revealed element by element - with documents, physical measurements, projects and observation over time.

15. What has been confirmed, what has changed, what remains open

15.1. Confirmed

- the physical Apanas facility existed after the liquidation of the original enterprise;
- in 2020, burning became the basis for the state of emergency and publicly paid work;
- new engineering investigations were required in 2023–2024;

- three non-overlapping positions provide a documented minimum of RUB 50,659,785.87;
- the project cycle did not end with a positive conclusion from the state expert review;
- new land decisions followed in 2025;
- Winter Landsat scenes show a repeating local surface temperature anomaly.

15.2. The original hypothesis had to be weakened

The universal thesis “old dumps always remain with the state and the budget pays for everything” was not confirmed. At existing facilities, some of the work is carried out by enterprises. Case studies show the role of supervision and legal enforceability of requirements. The correct formula depends on the history of each object.

It was not possible to prove that the old dump was intentionally “lost” during the transfer of licenses. There is a documentary gap, but its cause and legal assessment have not been established. The right to call the event of 20.11.2020 an explosion was also not confirmed: pops, a brown cloud and subsequent subsidence were identified, but not the mechanism.

15.3. Remains unknown

- the total number of physical and burning waste rock dumps of Kuzbass;
- complete closure balance for Listvyansky;
- the identity of the party ultimately legally responsible for Apanas;
- the exact year the combustion began;
- mass, detailed composition and filling history of the site;
- the amount of coal to which the dump corresponds;
- the total cost of future work;
- quantitative exposure of residents;
- epidemiological causation;
- monetary value of environmental time.

Conclusion

The study began by asking whether coal was really cheap if some of the effects appeared long after it was sold. It was not possible to obtain a complete answer in rubles - and this is a significant result.

Apanas shows a consistency that is sufficient for a more limited but stable conclusion. The mine has been in operation since 1955. The original business went into voluntary liquidation, bankruptcy and was legally dissolved in 2004. The physical dump remains. In 2020, its burning led to a state of emergency and fire-fighting work. New engineering investigations were paid for in 2023–2024. The design result with a positive conclusion from the state expert review was not obtained. In 2025, the state needed a new decision on land.

At least 50.66 million rubles of public expenditures were documented. These are only three identified items, not the complete bill. Unverified, merely allocated, or unpaid amounts cannot be added to them. It is impossible to divide the total into tons of coal without the production history of the dump. It is impossible to assess health without exposure and causation. Reclamation cannot be passed off as an automatic return to the previous ecosystem.

The comparative cases did not support a simple formula for who pays. When a business is in operation, some responsibilities may remain corporate. When the site survives the company, the state has to create a different route - through supervision, the budget, the institution of accumulated environmental harm, or special long-term mechanisms.

The price of coal at the time of sale reflects the economics of that moment. And the physical, territorial and financial consequences can continue to take on a life of their own. Apanas allows us to document part of this gap, but does not allow us to close it with one figure.

This bill can be postponed. But the physical object does not disappear because of this.

Appendix 1. Landsat reproducibility

Data: Landsat 8/9 Collection 2 Level 2 via Microsoft Planetary Computer STAC catalog; winter and early spring scenes; temperature channel ST_B10/lwir11; QA_PIXEL.

Formula: $ST(K) = DN \times 0.00341802 + 149.0$; $ST(^{\circ}C) = ST(K) - 273.15$.

Comparison: central, northern and southern points of the massif; forest to the east; field to the west; adjacent disturbed area to the west. Exact coordinates, scene IDs and values are stored in `thermal\_points.csv`, `thermal\_points.json` and the `landsat\_thermal\_points.mjs` research archive script.

Filter: clouds, cloud shadows, and unusable pixels were excluded using QA_PIXEL. The scene was included only if the points being compared were valid.

Restrictions: spatial resolution, mixed pixel, albedo, topography, humidity, emissivity, and variable snow cover. The method detects surface temperature, but not the deep source.

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Online sources were checked for the study through 13.09.2026. Local copies, tables, calculations and service evidentiary matrix are stored in the working archive of the project.

TABLE APPENDIX 2

Appendix 2. Chronology of Apanas

date	event	source	what_has been proven	confidence_level	what_doesn't_prove
1955	Listvyansky coal mine with a design capacity of 300 thousand tons of coal per year was put into operation	Interarchival reference book of the Kemerovo region p.76–77	Start of operation and design capacity upon commissioning	high	Actual production each year and the relationship of a specific ton to a dump
1969	Data have been published on 1577 hectares of land affected by mining operations, the annual land take of more than 100 hectares of agricultural and forest land and experimental sowing of pine	Barannik L.P. 1969 local copy in archive	The scale of disturbances in the area of activity and the experience of reclamation	high	That 1577 hectares is the area of the current Apanas dump or the experimental site coincides with it
1960-1997	The section underwent departmental and corporate transformations	Interarchival reference book of the Kemerovo region p.76–77	Institutional chain of the enterprise	high	Transfer of a specific dump for each act
08.08.2000	A decision was made on voluntary liquidation and the creation of a liquidation commission	Interarchival reference book of the Kemerovo region p.76–77	Date of the corporate decision	high	Completion of liquidation and work on the dump
13.09.2002	OJSC Razrez Listvyansky declared bankrupt	Interarchival reference book of the Kemerovo region p.76–77	Bankruptcy stage	high	That all assets and responsibilities are transferred to a specific person
2003	State auction for the Apanasovsky site and reports of a price of 25.2 million rubles.	official auction notice + attributed business press	Fact of auction line and secondary price	medium-high	Bank payment and transfer of the old dump
29.09.2004	OJSC Razrez Listvyansky was liquidated by court decision	Interarchival reference book of the Kemerovo region p.76–77	Date of termination of the legal entity	high	Carrying out all environmental work
01.10.2008	As of this date, funding for activities at the mine has been discontinued	Magazine Coal No. 12 2008 original	Termination of funding by the specified date	high	Completion or failure to complete the full range of work
2014	The published list contains information about the site	List of objects with signs of accumulated environmental harm published by EcoStandard, line 924	Information contained in the published list	medium-high	Official document status continuity of status after 2014 and modern geometry
15.02.2016	Landsat records central pixel approximately 10.35 °C warmer than the disturbed reference site	local calculation thermal_points.csv and method 79	Surface temperature difference in a specific scene	medium-high	The cause of the anomaly and the temperature inside the dump

date	event	source	what_has been proven	confidence_level	what_doesn't_prove
2017-2018	Transfer of the right to use the site from Razrez Bungursky-Severny LLC to Razrez Apanasovsky LLC and license KEM 02104 TE	judicial materials on the modern site	Late licensing chain	high	Transition of the old external dump
11.02.2020	There is video footage of the Apanas dump	YouTube I4qMvT0pWKE	The object as shown on a specific date and the channel on which the recording was published	high	Temperature gases property or start of documentary research
13.03.2020	Landsat records surface thermal anomaly relative to control	thermal_points.csv	Pixel surface temperature after QA filter	medium-high	Deep hearth
14.04.2020	A state of emergency has been introduced due to a dump fire	official message from the Kuzbass Government	Fact and basis of the regime	high	The exact area and depth of combustion
24.04.2020	It was reported on fencing, drilling wells, gas monitoring and project preparation	official message from the regional body	List of organized events	high	Complete protocols and representativeness of measurements
09.07.2020	The allocation of 40848760 rubles was announced. from the reserve fund	regional/local traffic and budget chain	Amount of funding announced	medium-high	That this amount is in addition to the contract 37,519,585.40 rubles.
08.11.2020	There is a second video of the dump	YouTube 51fDG2cv5uA	Type of object on a specific date	high	Change in condition since February without separate visual analysis
20.11.2020	Residents reported pops and a brown cloud of service after inspection - about subsidence over the burnt-out area of block 5	initial civil defense and emergency message via saved publication	Observation and inspection result	medium-high	Physical mechanism of pops or explosion
end 2020	A water pipeline, power lines, sedimentation tanks, a ditch, and a road were constructed and test cooling of unit 5 was carried out.	official communications and subject matter of the contract	Carrying out a range of fire safety works	high	Complete extinguishing and reclamation of the entire dump
2021	The administration reported that further work to eliminate the self-heating hotspots and the dump required a new project and funding	official response/message from the administration	The difference between extinguishing and complete elimination	high	Future exact cost
2023	Engineering investigations have begun on the burning waste rock dump site in the area of Apanas village	contract 3423800449623000050 and judicial act	Fact of work and object	high	Achieving the final project result
2023-2024	Two stages of subcontract research were accepted, the last result did not receive a positive state expert review, the contract was terminated	judicial act + contract register	Execution of part of the work and lack of final result	high	That all received data is useless or that the elimination project is completed
28.01.2024	Landsat recaptures local surface thermal anomaly	thermal_points.csv and ST map	Repeatability of remote-sensing signal	medium-high	Internal temperature and combustion limits

date	event	source	what_has been proven	confidence_level	what_doesn't_prove
29.02.2024	Rosprirodnadzor issued order No. 9-r on the schedule for examining objects of accumulated environmental harm	official order	Existence of a federal schedule	high	That a specific application line refers to Apanas without reconciliation
28.02.2025	Eight sites have been converted to accommodate a dump of burning rocks in the Apanas area	Resolution of the Kuzbass Government No. 91	Purpose and number of sites	high	That the old site 42:09:0000000:1660 is included in these eight or that the boundaries are equal to the body of the dump
2025	Landsat stores surface anomaly in verified scene	thermal_points.csv	Remote repeatability 2016–2025	medium-high	Reason without ground verification
13.09.2026	An approved and completed complete elimination and reclamation project was not found in the open database	search log and dossier	Limit of available research	average	That such a document does not exist

Lines reproduced from the research dossier. An empty field does not mean a null value; constraints and sources are stored in the rows themselves.

TABLE APPENDIX 3

Appendix 3. Financial positions of Apanas

Part 1 of 3

year	customer	contractor	appointment	amount_type
2020	Administration of the Novokuznetsk municipal district	LLC SIBSTROY	Elimination of sources of self-heating of rocks	contract registered full payment
2020	Administration of the Novokuznetsk municipal district	LLC Dorstroymekhanizatsiya	Construction supervision of work to eliminate self-heating hotspots	contract; registered payment
2020	region/municipal area	not established	Funding for fire-control measures	announced/committed funding
2020	LLC SIBSTROY	budget/customer	Penalties and fines under the main contract	contractor's funds
2023-2024	Administration of the Novokuznetsk Municipal District	general contractor under contract 3423800449623000050	Engineering investigations	executed and paid item of the canceled contract
2023	general contractor	subcontractor	Three stages of engineering investigations	private subcontract price
2023	general contractor	subcontractor	Two stages accepted	accepted subcontract work
2024	subcontractors	subcontractor	Collected debt	judicial collection
2023	municipal customer	not established	Project position for further work	project/estimated item
2025-2026	not established	not established	Complete elimination extinguishing remediation monitoring	future value
TOTAL	—	—	Three non-overlapping traced public positions	minimum documented traceability

Part 2 of 3

year	contract_amount_rub	actually_paid_rub	funding_source	source
2020	37,519,585.40	37,519,585.40	public budget	contract 3423800449620000062 https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449620000062
2020	268,596.67	268,596.67	public budget	contract 3423800449620000067 https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449620000067
2020	40848760	not established separately	reserve fund of Kuzbass	https://sibdepo.ru/news/kuzbass-vydelit-40-millionov-na-tushenie-podzemnogo-pozhara-v-apanase.html
2020	21243.79	21243.79	contractor's private funds	contract register 3423800449620000062
2023-2024	12,871,603.80	12,871,603.80	public budget	https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449623000050
2023	5100000	do not add	private chain inside a municipal contract	https://base.garant.ru/66591128/
2023	3570000	do not add	private chain	https://base.garant.ru/66591128/
2024	299170	do not add	private dispute	https://base.garant.ru/66591128/
2023	43,115,655.87	0/not confirmed	a public budget was expected	project documents
2025-2026	not established	not established	not established	search for contracts and resolution No. 91
TOTAL	50,659,785.87	50,659,785.87	public funds	sum of three contract positions

Part 3 of 3

year	double_count_and_limit
2020	Included in the traceable minimum, there are penalties and fines, do not add on top all announced funding 40848760
2020	The separate item therefore stacks with the main contract
2020	Do not add to contracts due to risk of double counting
2020	Not a public expense and not included in 50.66 million
2023-2024	Included in the minimum but the final design result is not obtained
2023	Inserted into the main contract
2023	Not a separate budget expense
2024	Not a separate public expense
2023	Do not include as actual expense
2025-2026	Bill remains open
TOTAL	Not the price of the dump, not the damage, not complete elimination, not reclamation

Lines reproduced from the research dossier. An empty field does not mean a null value; constraints and sources are stored in the rows themselves.

TABLE APPENDIX 4

Appendix 4. Comparative cases of Kuzbass

Part 1 of 3

object	place	period	problem_type	Company status
Apanas dump of the former Listvyansky open-pit mine	Novokuznetsk district	1955-2026	combustion self-heating subsidence above the burnt-out area	the original OJSC was liquidated on 29.09.2004
Krasnobrodsky branch burning waste rock dumps	Krasnobrodsky/Prokopyevsky district	2016-2017	emissions of harmful substances from burning waste rock dumps	operating enterprise of Management Company Kuzbassrazrezugol
Bachat branch burning waste rock dumps	Belovsky District	2016-2017	emissions from burning waste rock dumps	operating enterprise of Management Company Kuzbassrazrezugol
Dump No. 2 of the Vakhrushevsky field of the Krasnobrodsky open-pit mine	eastern part of the quarry field near Kiselevsk	filling 2012-2014 observations 2016-2019 publication 2025	temperature regime and geotechnical properties	operating enterprise
Southern field LLC Mine No. 12	Kiselevsk	no later than 2016-2025	reclamation of self-heating areas, acceptance of sites and elimination of deficiencies	operating enterprise
“Vnutrenny Poimenny” dump of the Sibirginsky open-pit mine	Myski	2021	officially named self-heating hotspots	operating enterprise Southern Kuzbass
Ayutinskaya dump of the former mine No. 13-bis Rostovugol	Rostov region outside Kuzbass	purchase 2021	burning dump of the legacy of a closed enterprise	closed/former enterprise

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object	Work or response	price	who_paid	Primary source
Apanas dump of the former Listvyansky open-pit mine	Emergency drilling gas control extinguishing engineering survey land solutions	not less than 50,659,785.87 rubles of traced public expenses	regional and municipal budgets	official list of contracts resolution No. 91
Krasnobrodsky branch burning waste rock dumps	supervisory orders and challenges	not established	enterprise within the framework of its own activities amount unknown	Resolution of the AS of the West Siberian District 13.12.2017 A27-2125/2017 https://sudact.ru/arbitral/doc/ZXvQG1oNvsNs/
Bachat branch burning waste rock dumps	supervisory orders and challenges	not established	not established	same case A27-2125/2017
Dump No. 2 of the Vakhrushevsky field of the Krasnobrodsky open-pit mine	16 series of measurements once a quarter	not established	enterprise/scientific program	KuzSTU conference 2025 https://science.kuzstu.ru/wp-content/Events/Conference/BGD/2025/bgd2025/pages/Articles/118.pdf
Southern field LLC Mine No. 12	extinguishing project biological reclamation of 68 hectares attempt to transfer two plots to the municipality	not established	according to the authorities and the enterprise - enterprise funds	local dossiers 84-87 and primary references in them
“Vnutrenny Paimenny” dump of the Sibirginsky open-pit mine	according to the minister, the self-heating hotspots were to be eliminated under a project funded by the company	not established	enterprise	response from Minister Oleg Tokarev published by AiF 21.04.2021
Ayutinskaya dump of the former mine No. 13-bis Rostovugol	government contract for extinguishing	contract price about 189.62 million rubles NMCC about 190.57 million	federal public customer	official procurement register of the Ministry of Energy local file 48/50

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object	what_has been proven	limitation
Apanas dump of the former Listvyansky open-pit mine	main case of deferred public expenditure	complete elimination cost and responsibility have not been established
Krasnobrodsky branch burning waste rock dumps	combustion and incomplete emission control were included in the inspection	the court canceled the repeated orders due to uncertainty and unenforceability and did not recognize the absence of combustion
Bachat branch burning waste rock dumps	included in the same supervisory case	not to be confused with the 2013 Bachat earthquake
Dump No. 2 of the Vakhrushevsky field of the Krasnobrodsky open-pit mine	volume of approximately 50.1 million m3 and specific backfill/thermometry history	does not prove that the entire array was on fire and requires extraction of the actual temperature graph
Southern field LLC Mine No. 12	reclamation is a multi-stage undertaking and required control/acceptance	the complete spatial identity of the self-heating hotspot, the 68 hectares, and the two plots has not been established; the documents do not support the claim that the same dump was reclaimed and then caught fire again
“Vnutrenny Poimenny” dump of the Sibirginsky open-pit mine	an officially identified self-heating hotspot and a company-funded model at an operating site	the coordinates, cost of the measures, completion records, and current outcome are not fully documented
Ayutinskaya dump of the former mine No. 13-bis Rostovugol	the scale of the price of the concluded contract for a similar type of work	not actual payment down to the penny and not the basis for transferring the price to Apanas

Lines reproduced from the research dossier. An empty field does not mean a null value; constraints and sources are stored in the rows themselves.

TABLE APPENDIX 5

Appendix 5. Evidence Matrix

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id	block	statement	source	quote_or_page
D001	scale	At the end of 2024, there were 99.156 thousand hectares of disturbed land in Kuzbass	Report of the Kuzbass Ministry of Natural Resources for 2024	p.140
D002	scale	In 2024, 4.768 thousand hectares were disturbed, of which 4.264 thousand hectares were disturbed during field development	same report	p.140
D003	scale	In 2024, 2.083 thousand hectares were reclaimed	same report	p.140
D004	scale	GRRORO across Russia has registered 312 dumps of overburden waste and host rocks from coal mining	ITS 17-2024	section of ORO of the coal industry
D005	Apanas	The object is called a burning waste rock dump with a volume of 26,435,479 m3 and an area of 818,096 m2	List of objects with signs of accumulated environmental harm published by EcoStandard	line 924 PDF p.70
D006	Apanas	The dump is located approximately 800 m from Apanas on agricultural lands with undemarcated state property	same list published by EcoStandard	line 924
D007	Apanas	According to the list line, the administration did not have information about the last legal entity that operated the dump	same list published by EcoStandard	line 924
D008	Listvyansky	The mine began operation in 1955	Interarchival directory of the Kemerovo region	p.76-77
D009	Listvyansky	08.08.2000 a decision was made on voluntary liquidation 13.09.2002 bankruptcy 29.09.2004 liquidation by court	the same reference book	p.76-77
D010	land history	In 1969, 1577 hectares of land affected by mining operations were described, the annual land take of more than 100 hectares and experimental sowing of pine	Barannik L.P. 1969	PDF p.81-82

id	block	statement	source	quote_or_page
D011	Apanas	As of 01.10.2008, funding for activities at the Listvyansky open-pit mine has been discontinued	Coal No. 12 2008	corresponding table/view row
D012	Apanas ChS	On 14.04.2020, a state of emergency was introduced due to the burning of a waste rock dump	official message from the Kuzbass Government via A42	14.04.2020
D013	Apanas work	In April 2020, it was reported about fencing, drilling wells, gas control and project preparation	official message from the Ministry of Industry of Kuzbass/saved copy	24.04.2020
D014	Apanas event	On 20.11.2020, residents reported pops and a brown cloud, and services reported subsidence over the burnt-out area of block 5	Civil Defense and Emergency message in saved publication	20.11.2020
D015	Apanas money	The contract register records payment of RUB 37,519,585.40 for the elimination of self-heating hotspots.	contract register 3423800449620000062	contract performance record
D016	Apanas money	Construction control was completed and paid for RUB 268,596.67	contract register 3423800449620000067	contract performance record
D017	Apanas money	Engineering investigations paid for RUB 12,871,603.80	contract register 3423800449623000050	contract performance record
D018	Apanas research	Two stages of the subcontract were accepted; the final result did not receive a positive state expert review; the main contract was terminated	judicial act	reasoning section
D019	Apanas money	Three non-overlapping positions amount to RUB 50,659,785.87	arithmetic D015+D016+D017	37,519,585.40+268,596.67+12,871,603.80
D020	Apanas earth	Resolution No. 91 lists 8 sites for the disposal of a dump of burning rocks near Apanas	Government of Kuzbass Resolution 28.02.2025 No. 91	goal text and list
D021	self-heating	On the studied Kuzbass dumps in 15 wells, the temperature per 0.5 m reached the range of 35-433 C; CH4 CO SO2 H2S O2 was studied	Portola Protasov Seryogin 2024	p.140-145
D022	Krasnobrodsky	Supervision recorded burning dumps of the Krasnobrodsky and Bachatsky branches and incomplete elimination of emissions	Resolution of the AS of the West Siberian District A27-2125/2017	13.12.2017
D023	Krasnobrodsky	The court canceled the repeated orders as vague and unenforceable	same resolution	reasoning section
D024	Vakhrushevsky	Dump No. 2 was filled in 2012-2014 with a design volume of about 50.1 million m3, one well showed 60-79 C at 1.5 m and 67-76 C at 2.5 m	materials of the conference KuzSTU 2025	p.118.3-118.4

id	block	statement	source	quote_or_page
D025	Shakhta12	In 2021, the Minister named self-heating hotspots in the Southern Field and work on the project at the expense of the enterprise	Minister's response published by AiF	21.04.2021
D026	Landsat	In 11 valid scenes from 2016-2025, the center of the waste rock mass was 6.7-10.4 °C warmer than the neighboring disturbed control site	own reproducible calculation	thermal_points.csv and script
D027	USA	AML is financed by a fee per ton of mined coal, the fund has collected \$14.233 billion by 30.09.2025	OSMRE	AML Fund status
D028	United Kingdom	As of 31.03.2025, the liability reserve was 1.709 billion pounds and the undiscounted forecast was 4.0604 billion.	Mining Remediation Authority annual report 2024-25	note 13 p.128
D029	Germany	The rehabilitation of East Germany's lignite-mining legacy is financed 75% by the federal government and 25% by the states; approximately EUR 12 billion has been provided through the financing agreements.	LMBV	financing agreements
D030	right	Liquidation of a JSC terminates it without legal succession	208-FZ Art. 21	clause 1
D031	right	Resolution 1370 creates a budget route for funds from the NVOS fines and compensation for accumulated environmental harm	Government of the Russian Federation 02.08.2022 No. 1370	plan rules

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id	link	access_date	what_proves	what_doesn't_prove
D001	https://kuzbassecu.ru/wp-content/uploads/2025/06/doklad_v2-1.pdf	13.09.2026	regional balance of all disturbed lands	area of coal dumps
D002	https://kuzbassecu.ru/wp-content/uploads/2025/06/doklad_v2-1.pdf	13.09.2026	annual flow of disturbances and mining part	that the entire mining part is associated with coal
D003	https://kuzbassecu.ru/wp-content/uploads/2025/06/doklad_v2-1.pdf	13.09.2026	area of work according to the official balance	quality and long-term results
D004	https://meganorm.ru/mega_doc/norm_update_29032025/zaklyuchenie/0/its_17-2024_informatsionno-tehnicheskij_spravochnik_po.html	13.09.2026	federal number of registered objects	number of physical dumps in Kuzbass
D005	https://journal.ecostandard.ru/upload/iblock/d66/Obeauty-nakoplennoy-ushcherba-.pdf	13.09.2026	parameters specified in the list published by EcoStandard	official status of the document the exact modern geometry and depth of combustion
D006	https://journal.ecostandard.ru/upload/iblock/d66/Obeauty-nakoplennoy-ushcherba-.pdf	13.09.2026	description of location and land given in the list published by EcoStandard	official status of the document and ownership of the dump mass
D007	https://journal.ecostandard.ru/upload/iblock/d66/Obeauty-nakoplennoy-ushcherba-.pdf	13.09.2026	the contents of the published line and the limit of administration information indicated in it	the official status of the document and the fact that the person responsible did not legally exist
D008	https://arhiv42.ru/pictures/20160302114431Mezharhivnyj_spravochnik.pdf	13.09.2026	start date	the formation of the entire modern mass from the first day
D009	https://arhiv42.ru/pictures/20160302114431Mezharhivnyj_spravochnik.pdf	13.09.2026	different stages of business termination	completion of environmental work
D010	https://www.booksite.ru/les_hvo/1969/1969_5.pdf	13.09.2026	scale of activity and historical reclamation practices	coincidence with 81.8096 ha of Apanas
D011	https://www.ugolinfo.ru/Free/122008.pdf	13.09.2026	fact of termination of funding by date	completeness of work performed
D012	https://gazeta.a42.ru/lenta/news/78882-v-pravitelstve-kuzbassa-rasskazali-o-goryashem-otvale-u-poselka	13.09.2026	fact of the regime and the official reason	start of combustion
D013	local archive dossier 21 links 3-4	13.09.2026	organized measures	full protocols and success
D014	local dossier 21 source 13	13.09.2026	two levels of observation	mechanism of bangs and explosion
D015	https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449620000062	13.09.2026	price and payment of the contract item	complete disposal of the dump

id	link	access_date	what_proves	what_doesn't_prove
D016	https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449620000067	13.09.2026	separate expense item	quality and durability of the result
D017	https://openapi.clearspending.ru/restapi/v3/contracts/get/?regnum=3423800449623000050	13.09.2026	third public position	obtaining a positive examination
D018	https://base.garant.ru/66591128/	13.09.2026	move and result limit	that the materials accepted were of no value
D019	local table 08	13.09.2026	minimum traceable public expenditure	full cost of damage liquidation reclamation
D020	https://kemerovo-pravo.ru/postanovlenie/2025/02/28/n-91/	13.09.2026	number and purpose of land decisions	identity of sections of the dump body
D021	https://doi.org/10.30686/1609-9192-2024-4-140-145	13.09.2026	measurements on specific other objects and the complexity of the source	Apanas parameters
D022	https://sudact.ru/arbitral/doc/ZXvQG1oNvsNs/	13.09.2026	Contents of inspections and orders	exact concentrations and objects
D023	https://sudact.ru/arbitral/doc/ZXvQG1oNvsNs/	13.09.2026	legal reason for the outcome of the dispute	no combustion
D024	https://science.kuzstu.ru/wp-content/Events/Conference/BGD/2025/bgd2025/pages/Articles/118.pdf	13.09.2026	object parameters and long-term heated zone in the well	burning of the entire array
D025	https://kuzbass.aif.ru/society/nasledstvo_ugolshchikov_kak_dolgo_goryat_ugolnye_otvaly	13.09.2026	officially attributed position	cost and result
D026	local Landsat archive	13.09.2026	repeating surface temperature anomaly	internal temperature and reason
D027	https://www.osmre.gov/programs/reclaiming-abandoned-mine-lands	13.09.2026	financial mechanism and accumulated volume	full coverage of all obligations
D028	https://assets.publishing.service.gov.uk/media/68a6ebb09e1cebdd2c96a083/Mining_Remediation_Authority_annual_report_and_accounts_2024_to_2025.pdf	13.09.2026	extent of recognized long-term liability	cost of dumps only
D029	https://www.lmbv.de/unternehmen/finanzierung/verwaltungsabkommen/?print=print	13.09.2026	mechanism and scale of the program	Apanas cost
D030	https://ips.pravo.gov.ru/api/ips/legislation/document?baseid=None&hash=499af8c5985ef4c963b89151152983c0699711790f34a234f6cfa39c0948a3c2	13.09.2026	general legal effect of liquidation	the fate of every asset and claim
D031	https://www.consultant.ru/law/hotdocs/76647.html	13.09.2026	modern financing mechanism	that specific money went to Apanas

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id	confidence	status
D001	high	confirmed with reservation
D002	high	confirmed with reservation
D003	high	confirmed with reservation
D004	medium-high	confirmed with reservation
D005	high	confirmed with reservation
D006	high	confirmed with reservation
D007	high	confirmed with reservation
D008	high	confirmed
D009	high	confirmed
D010	high	confirmed with reservation
D011	high	confirmed with reservation
D012	high	confirmed
D013	medium-high	confirmed with reservation
D014	average	confirmed with reservation
D015	high	confirmed
D016	high	confirmed
D017	high	confirmed
D018	high	confirmed
D019	high	calculation confirmed
D020	high	confirmed
D021	high	confirmed with reservation
D022	high	confirmed
D023	high	confirmed

id	confidence	status
D024	average	the measurement period is internally inconsistent 2016-2019 versus 2021-2023
D025	medium-high	confirmed by secondary media
D026	medium-high	calculation with restrictions
D027	high	confirmed
D028	high	confirmed
D029	high	confirmed
D030	high	confirmed
D031	high	confirmed

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