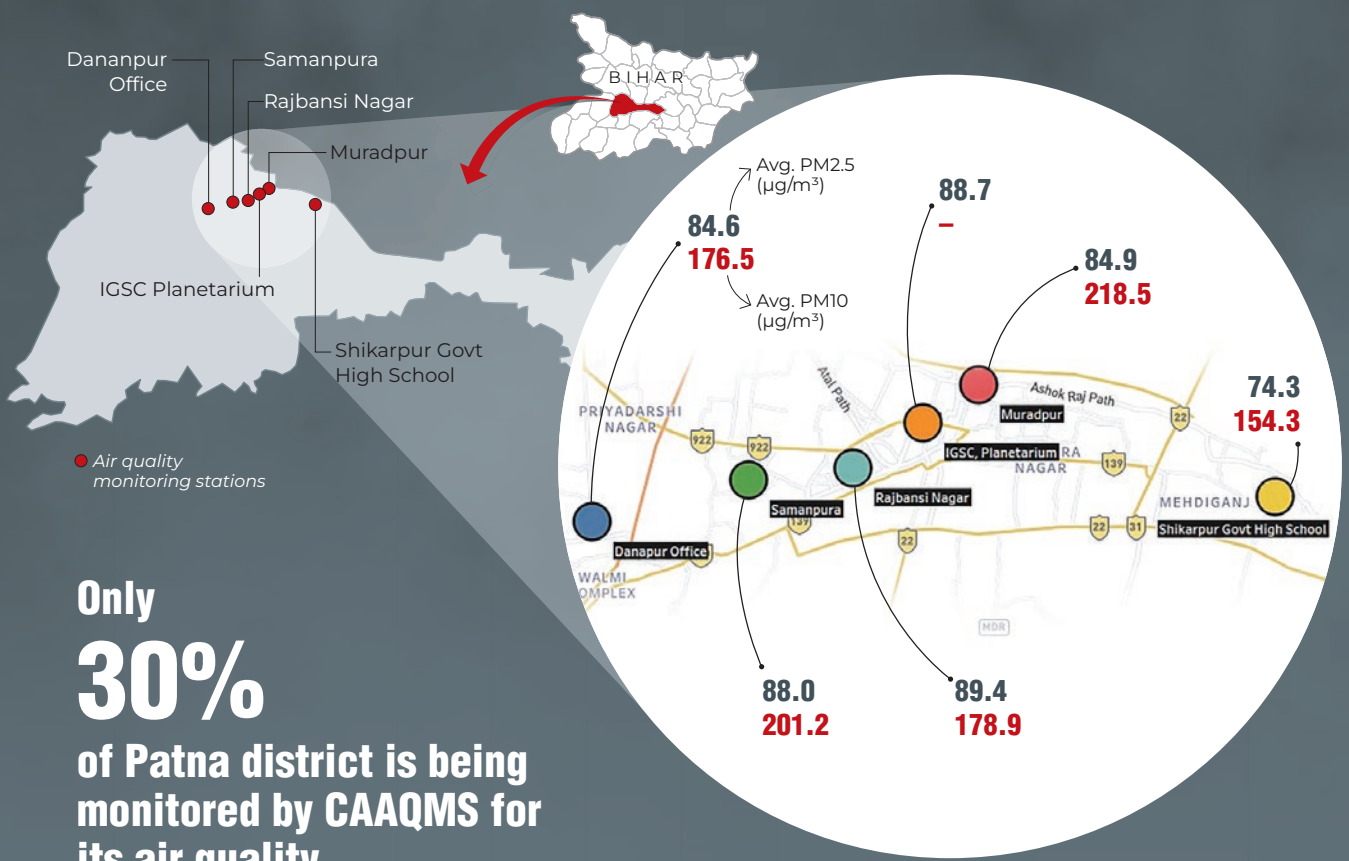
PATNA AIR QUALITY

Bihar Pollution State Control Board maintains Continuous Ambient Air Quality Monitoring stations (CAAQMS) at six locations in Patna city. All congregate in the northwestern part and cover only 30% of the Patna district.

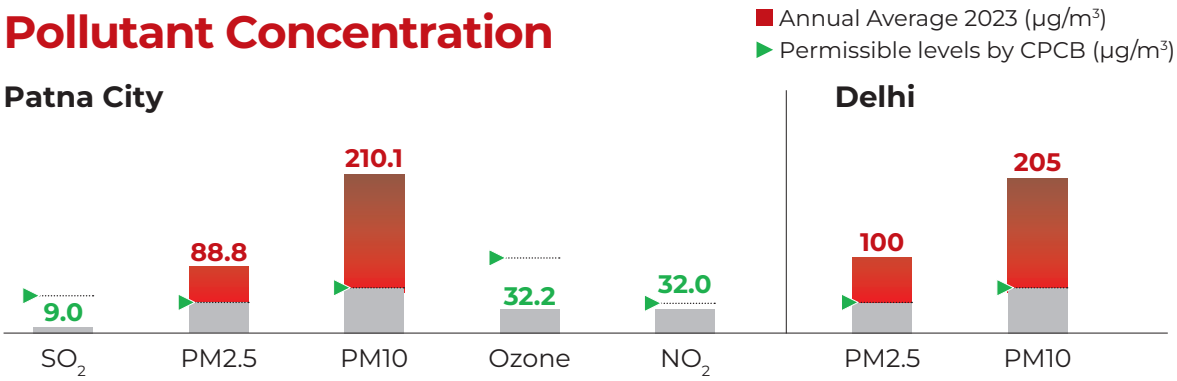


Only

30%

of Patna district is being monitored by CAAQMS for its air quality.

Pollutant Concentration



Source: iFOREST and Ministry of Environment, Forest and Climate Change.

The average concentration of **PM2.5 in 2023 was 88.8µg/m³** and that of **PM10 was 210.1µg/m³**.

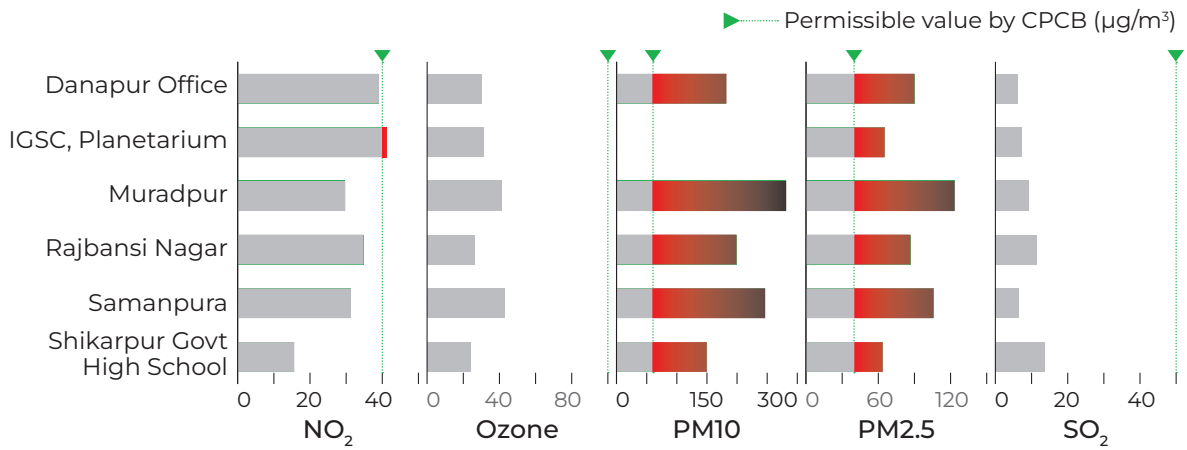
The average **PM10 and PM2.5 concentrations** are **fairly consistent** across all locations, making it **difficult to identify specific hot spots**. However, among the six monitoring locations, **Muradpur, Samanpura and Rajbansi Nagar** show the higher levels of particulate matter concentration.

The average concentrations of the pollutants – PM10 and PM2.5 are continuously increasing since 2021 , **NO_2 concentrations are continuously decreasing** in the assessment years (2021-23).

The **peak time** interval for the pollutants – PM10, PM2.5 and NO_2 is in the **evening around 7-11PM**. **SO_2**, records its highest concentrations during morning time, around **7AM – 11 AM**.

Overall quality of air pollution data from CAAQMS in Patna City is in **category 'Good' for years 2020, 2021, 2022 and 2023. In 2019**, due to low availability, the quality of air pollution data is poor.

Concentration of major pollutants: 2023



The **average yearly concentration** (2023) for **PM10**, at all locations **is around 2-4 times higher** than the National Ambient Air Quality Standards (NAAQS).

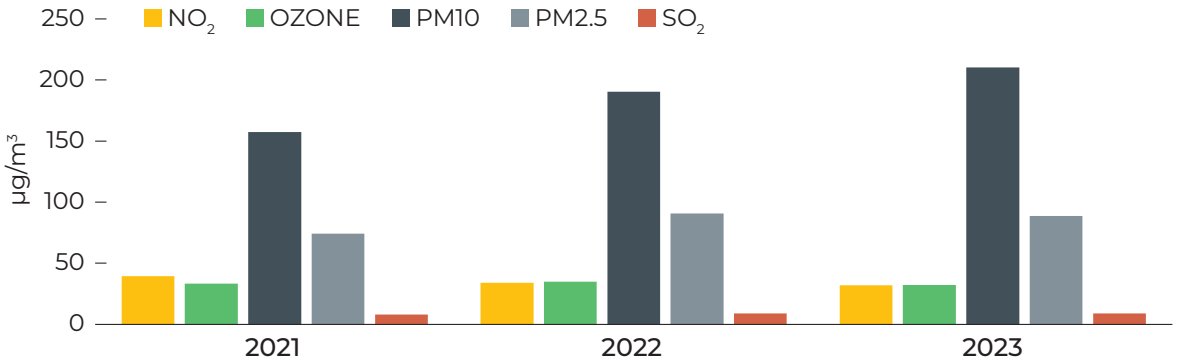
For **PM2.5** the **average yearly concentration** (2023), at all locations is **2-3 times above** the NAAQS levels.

For **NO_2**, **IGSC Planetarium** CAAQMS location has **above the NAAQS** concentration levels.

Concentration trends

ANNUAL

Average concentration of key pollutants: 2021 to 2023



The **average yearly** air pollutant concentrations for **PM10** have been **increasing in the three years** (2021-23). The PM10 concentration has increased by 33% between 2021 and 2023.

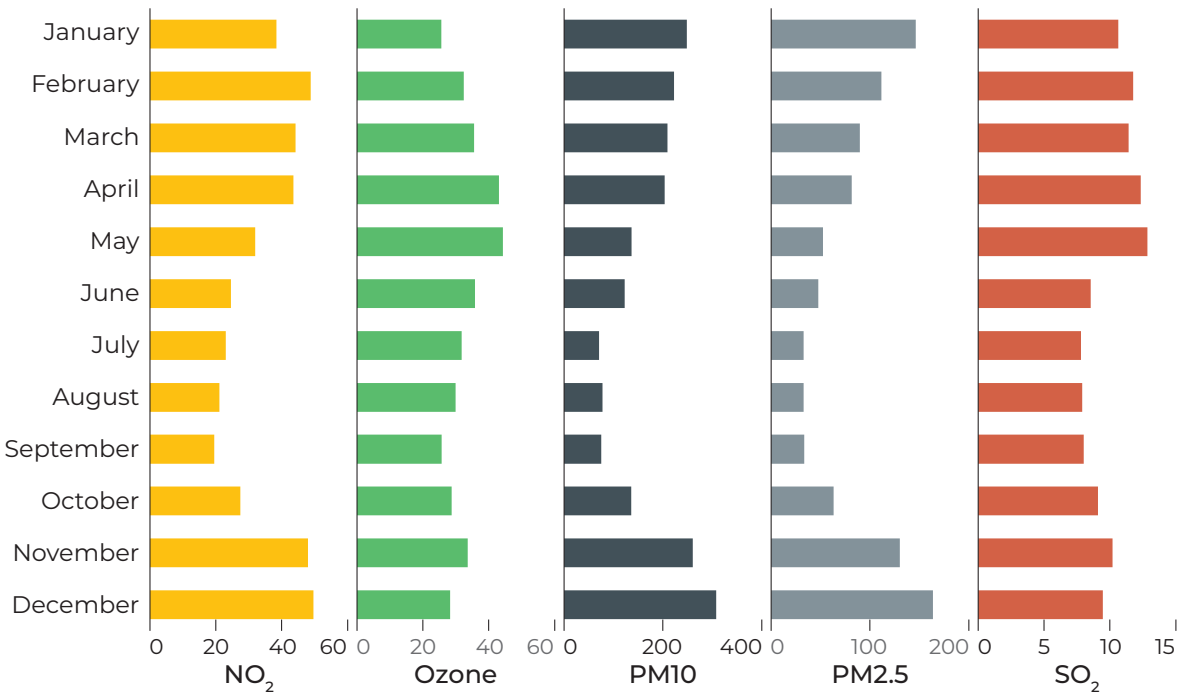
PM2.5 concentration **increased by 18%** between 2021 and 2023.

NO_2 concentration are **continuously decreasing** in the three assessment years (2021-23). It has fallen by 17% between 2021 and 2023.

Concentration of **ozone** has been **relatively stable** across all assessment years.

MONTHLY

Average Concentration(µg/m³) of Key Pollutants in different months for (Average 2021-23)



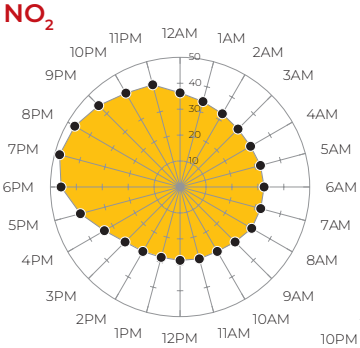
January and December are the months with **highest concentration** of **PM 10 and PM 2.5** in the three assessment years (2021-23).

April and May are the **most polluted months** in the last three years for **SO_2 and Ozone**.

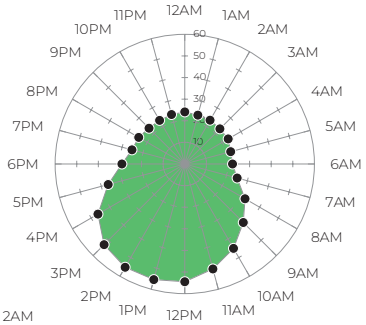
HOURLY

24-hourly trend of average concentration(µg/m³) of key pollutants (Average 2021-23)

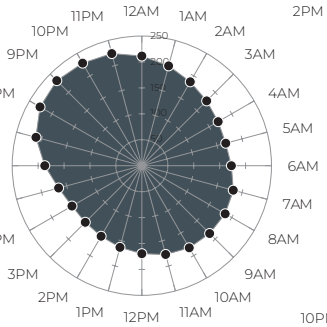
NO_2



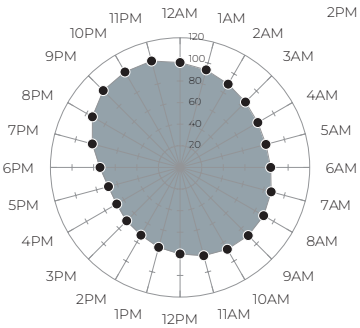
Ozone



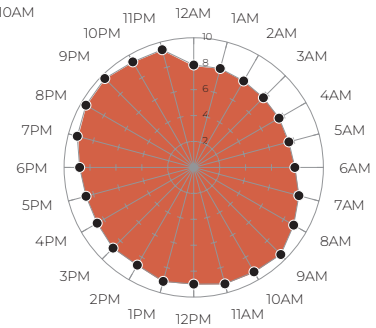
PM10



$PM_{2.5}$



SO_2



NO_2, PM10 and PM2.5 Hourly trend analysis shows that, the **peak concentration** is observed between **7-11PM.**

The **minimum concentrations** for **NO_2, PM10 and PM2.5** are between **12PM-3PM**. The same interval has the highest concentrations for Ozone.

SO_2, records its **highest concentrations** between **7AM – 11 AM.**

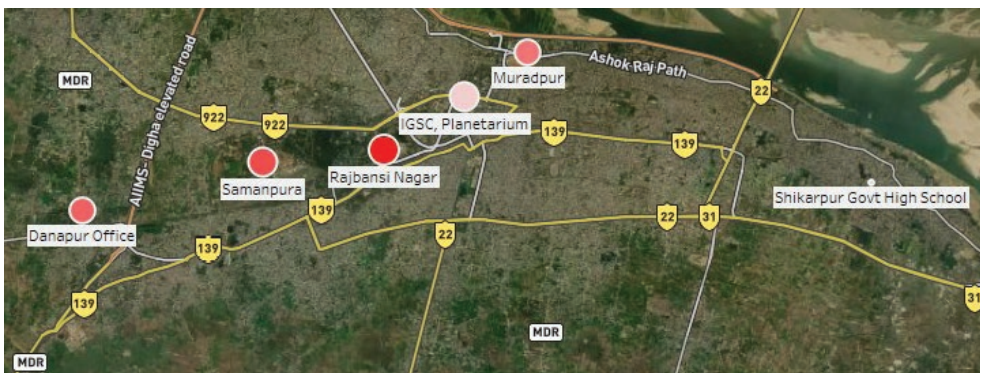
The **Hourly trends** in pollutants levels **are fairly consistent** across all months.

Pollutant hot spots in patna

The average PM10 and PM2.5 concentrations are fairly consistent across all locations, making it difficult to identify specific hot spots. However, among the six monitoring locations, Muradpur has highest concentration of PM10 and Rajbansi Nagar has highest concentration for PM2.5.

PM2.5 Hot spots

Spatial Representation of PM2.5 Hot spots for year 2021-23



For PM2.5, **Rajbansi Nagar** shows the highest concentration. The **Average Annual Concentration** for year 2021-23 of PM2.5 **at Rajbansi Nagar is 89.4ug/m³**. This value **is around 2.2 times** the permissible level.

PM10 Hot spots

Spatial Representation of PM10 Hot spots for year 2021-23

Muradpur noticed the peak average value of **PM10 in December 2023**. The average value of PM10 in December 2023 was 406 µg/m^3, which is **6.7 times the permissible level**.

The **Average Annual Concentration for year 2021-23** of **PM10 at Muradpur is 218 µg/m^3**, this value is **around 3.6 times the permissible level**.

What PM2.5/PM10 ratio reveals

A high ratio of PM2.5/PM10 implies higher presence of smaller particulate matter and thus also indicates that pollution sources in the region are more related to combustion rather than dust from land and construction activities. In Patna, the average PM2.5/ PM10 value varies between 0.4 and 0.5. This indicates that a combination of dust and combustion sources are contributing to Patna's pollution.

NO_2 Hot Spots

Spatial representation of NO_2 hot spots for year 2021-23

IGSC Planetarium sees the **highest concentration** of **NO_2** in Patna City. The **average annual concentration** for year 2021-23 of NO_2 at IGSC Planetarium is **66ug/m^3**, value being **around 2 times the permissible level**.

Air pollution data availability in patna

ANNUAL AVERAGE (2019 - 2023)

Years	NO_2	OZONE	PM10	PM2.5	SO_2
2023	88%	88%	74%	89%	88%
2022	88%	79%	76%	91%	83%
2021	78%	78%	74%	80%	78%
2020	64%	75%	60%	67%	64%
2019	14%	12%	0%	15%	15%

MONTHLY AVERAGE (2021-2023)

Months	NO_2	OZONE	PM10	PM2.5	SO_2
January	91%	86%	74%	88%	85%
February	90%	87%	74%	86%	90%
March	86%	80%	74%	82%	86%
April	85%	76%	75%	90%	85%
May	82%	74%	74%	88%	79%
June	73%	75%	68%	80%	72%
July	74%	76%	72%	84%	73%
August	80%	83%	74%	84%	81%
September	90%	89%	81%	91%	88%
October	90%	89%	81%	92%	89%
November	87%	85%	76%	86%	86%
December	89%	83%	72%	87%	82%

LOCATION WISE (2021-2023)

Locations	NO_2	OZONE	PM10	PM2.5	SO_2
Danapur Office	82%	92%	87%	89%	88%
IGSC, Planetarium	77%	51%	0%	77%	56%
Muradpur	86%	87%	88%	87%	91%
Rajbansi Nagar	95%	95%	94%	95%	94%
Samanpura	85%	82%	89%	88%	89%
Shikarpur Govt High School	82%	82%	83%	82%	78%

Overall quality of air pollution data from CAAQMS in **Patna City** is in category **'Good'** for 2021-2023. The year **2019 and 2020 wasn't** considered for analysis because the data quality was not **'Good'**.

Month wise data availability is 'Good' between 2021-23. As 2020 data availability is **'Poor' in months – (January to August)**, 2020 is not considered for analysis.

Location wise, the **IGSC Planetarium CAAQMS data quality** is overall **'Moderate'** with particularly 'Poor' PM10 data quality. **Rest all the CAAQMS** locations recorded **'Good'** quality data.

ANNEXURE

Context and significance of big data analytics for air pollution

- Understanding air pollution phenomena using big data analysis techniques helps support critical decision making for improving air quality
- The real time and continuous pollutant concentration data recorded by the ground air pollution monitoring stations in the city, typically known as Continuous Ambient Air Quality Monitoring Stations (CAAQMS), can be aggregated to form the big data that can be analysed to understand pollution patterns.
- CAAQMS record concentration of various pollutants at an average frequency of 15 seconds. Data recording at such short intervals of 15 seconds provides rich data for correlation with economic activities for source mapping.
- Big data regarding concentration of pollutants can also help policy makers understand the trends- Yearly, Monthly and Hourly of different pollutants in different locations and identify hot spots for suitable action.
- However, data cleaning to remove biases and poor quality data, is a critical step while using big data analysis before calculating average pollutant concentrations at every location.
- Recommendations based on this assessment can help in formulation of hyper-local action plans for the city.

Guidelines available for Air Pollution measurements

PM10	PM2.5	NO_2	SO_2	Ozone

- The key pollutants, as per the CPCB guidelines, for calculation of Air Quality Index and consideration of a zone as non-attainment or polluted zone are PM10, PM2.5, NO_2, SO_2 and Ozone .
- According to CPCB, the region or location is considered as polluted or is considered as a non-attainment region, if the annual average, taken of 104 measurements, that is 2-day data for each week, 4-hour sample for gaseous and 8-hour sample for PM, exceeds the values mentioned in the National Ambient Air Quality Standards (NAAQS). The permissible level or standard for the key pollutants are:
  - PM 10 : 60 µg/m^3.
  - PM2.5 : 40 µg/m^3.
  - NO_2 : 40 µg/m^3.
  - SO_2 : 50 µg/m^3.
  - Ozone : 100 µg/m^3.
- According to World Health Organization (WHO), a region or a zone is considered as prone to health risks, if the Annual average concentration and 99th percentile of day's average, particularly in case of SO_2, exceeds the values mentioned in the guidelines. The WHO guidelines for the key pollutants are :
  - PM 10 : 15 µg/m^3.
  - PM2.5 : 5 µg/m^3.
  - NO_2 : 10 µg/m^3.
  - SO_2 : 40 µg/m^3.
- According to National Centre for Biotechnology Information PM2.5/ PM 10 ratio is an important factor in understanding the source of pollution in the region. A high PM2.5/PM10 ratio (>0.5) typically suggests that fine particles and secondary particulates such as NO^{3-}, $SO^{4}2-$ NH4+, and organics, are major contributors. Conversely, a lower PM2.5/ PM10 ratio indicates the dominance of coarse particles.

METHODOLOGY ADOPTED

For Continuous Ambient Air Quality Monitoring Station (CAAQMS) data to be reliable, especially in cases where pollutant concentrations and meteorological parameters like wind speed are being recorded, a robust methodology for data cleaning, aggregation, and analysis is crucial. This ensures accurate yearly, monthly, and hourly trend analysis as well as hot spot identification based on 'Good' quality data.

Methodology

Collection of time series data (15 minute frequency) of pollutants recorded at different CAAQMS in the city from Central Pollution Control Board website.

↓

Aggregating data to form big-data of the complete city.

↓

Clearing out the monthly data points of pollutant, if the data recorded in any month for any year is less than 60%.

↓

Clearing out daily data points of pollutant, if the data recorded on any day is less than 60%.

↓

Data Visualisation and Analysis.

Data Quality Based on clean data availability

Data Availability %	Data Quality
>80%	Excellent
60%-80%	Good
40%-59%	Moderate
<40%	Poor

- According to Department of Environment, Government of NCT of Delhi, the pollutant concentration analysis over the annual, monthly and hourly timestamps is essential to identify major pollutants in the 2 km radius of the CAAQMS location.
- Major pollutant hots pots have been identified in this factsheet on the basis of relative average annual concentration of the pollutants across locations and the guidelines specified by Central Pollution Control Board.

Cleaned data → Relative pollutant concentration analyzed by taking an average of the pollutant for available data points

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