IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

EVALUATION OF PHYSICO-CHEMICAL PARAMETERS OF WATER QUALITY IN BUDNI TEHSIL, DISTRICT SEHORE (M.P.), INDIA

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Abstract:

The present study evaluates the seasonal variations in physico-chemical water quality parameters in Budni Tehsil, Sehore District, Madhya Pradesh. A total of 48 water samples were collected from surface and subsurface sources during the Kharif and Rabi seasons (2022–23). Sixteen key parameters—including temperature, pH, turbidity, EC, TDS, hardness, alkalinity, chloride, fluoride, nitrate, sulphate, phosphate, calcium, magnesium, sodium, and potassium—were analysed following APHA (2005 and 2017) methods. Higher turbidity, EC, TDS, and temperature were recorded during the Kharif season due to monsoon runoff and soil erosion. Nitrate and hardness exceeded BIS and WHO limits in several samples, reflecting fertilizer application, pesticide use, and natural mineral leaching. Overall, most parameters remained within permissible limits, but elevated nitrate and hardness indicate potential health risks. The study highlights the need for regular monitoring and sustainable water management practices in the region.

Keywords: Water Quality, Physico-Chemical Parameters, Seasonal Variation, Groundwater, APHA Methods, Nitrate.

INTRODUCTION

Water is a fundamental natural resource essential for sustaining human life, agriculture, and ecological balance. The assessment of water quality has become increasingly important due to rising population growth, industrialization, and intensified agricultural activities (WHO, 2017and 2022). In rural regions of India, groundwater is the major source of drinking and domestic water, and its quality is significantly influenced by natural processes as well as anthropogenic activities (BIS, 2012) and (CPCB).

Physico-chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, hardness, alkalinity, and major ions serve as critical indicators for evaluating water suitability for drinking and irrigation (APHA, 2017). Variations in these parameters reflect the influence of climatic conditions, geological formations, and surface runoff. Seasonal changes, particularly between monsoon and post-monsoon periods, play an important role in altering the chemical composition of water through leaching and dilution effects (Gupta et al., 2019).

Agricultural regions commonly experience water contamination due to excessive application of fertilizers and pesticides. These agrochemicals leach into soil and groundwater, resulting in elevated levels of nitrate, hardness, and dissolved solids, which may pose potential health risks to local populations (Kumar & Singh, 2020).

Budni Tehsil, located in Sehore District of Madhya Pradesh, is primarily an agricultural area where both surface and subsurface water sources are extensively used. Seasonal runoff, soil erosion, and agrochemical usage significantly influence water quality in this region, making regular monitoring essential for safeguarding public health and maintaining sustainable water resources.

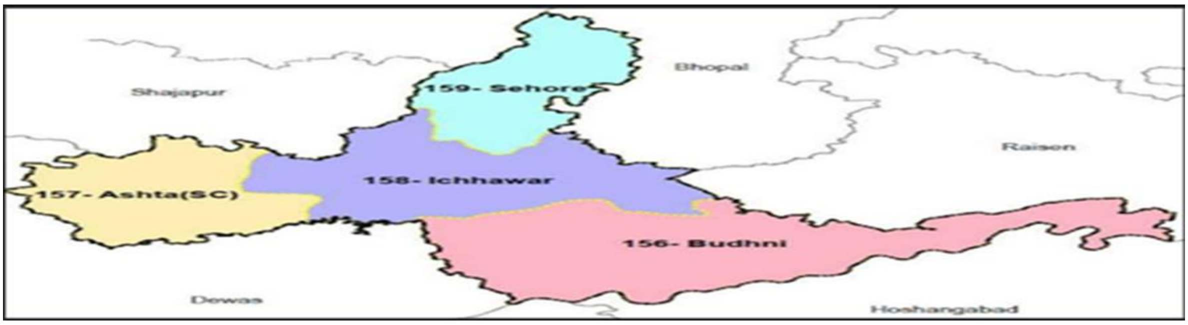

Figure 1: Map of Budni

Source: *District Survey Report, Sehore District, Government of Madhya Pradesh (2023).*

The present study aims to evaluate the physico-chemical characteristics of water samples collected from selected locations in Budni Tehsil during Kharif and Rabi seasons. The findings will provide insight into seasonal variations, pollution sources, and the overall suitability of water for domestic use.

REVIEW OF LITERATURE:

Water quality assessment is essential due to increasing environmental pressures and human activities. Physico-chemical parameters are key indicators for determining the suitability of water for domestic and agricultural use (Trivedi & Goel, 1986). Seasonal variations strongly affect water chemistry, particularly in monsoon-dominated regions where agricultural runoff and groundwater recharge influence contamination levels (Patil & Patil, 2010).

Studies in India have reported elevated EC, TDS, hardness, and nitrate in agricultural areas due to excessive fertilizer and pesticide use (Singh et al., 2018). Nitrate contamination in rural groundwater is common and often linked to nitrogen fertilizers and poor sanitation (Subba Rao, 2012). Research from Madhya Pradesh and nearby regions indicates that monsoon runoff increases turbidity, EC, and dissolved solids, while groundwater hardness and alkalinity rise due to mineral dissolution (Khatri & Tyagi, 2014; Sharma et al., 2019).

Standard analytical protocols such as APHA methods ensure accurate water quality monitoring (APHA, 2017). Previous studies emphasize the need for continuous monitoring and sustainable farming practices to reduce contamination (Kumar & Singh, 2020). However, limited work has specifically examined seasonal water quality variations in Budni Tehsil, highlighting the need for detailed investigation.

The reviewed literature clearly indicates that physico-chemical parameters of water are influenced by climatic conditions, seasonal changes, agricultural activities, and geological factors. However, limited studies have focused specifically on the Budni Tehsil region of Madhya Pradesh. This justifies the need for a detailed seasonal assessment of water quality in this area.

MATERIALS AND METHODS

Study Area: Budni Tehsil is located in Sehore District of Madhya Pradesh, India, and is predominantly an agricultural region where groundwater and surface water are the primary sources of domestic and drinking water. The area experiences a tropical climate with distinct Kharif (monsoon) and Rabi (winter) seasons, which significantly influence water availability and quality.

Sample Collection: A total of 48 water samples were collected from 24 selected locations, comprising both surface (rivers, ponds) and subsurface sources (wells, hand pumps). Sampling was conducted during two major agricultural seasons—Kharif and Rabi (2022–23)—to assess seasonal variations. Samples were collected in pre-cleaned polyethylene bottles, properly labelled, and transported to the laboratory under controlled conditions to avoid contamination.

Parameters Analysed: A total of 16 physico-chemical parameters were analysed: Physical Parameters: Temperature, Colour, Odour, Turbidity, Chemical Parameters: pH, EC, TDS, Total Hardness, Alkalinity, Chloride, Fluoride, Nitrate, Sulphate, Phosphate, Major Cations: Sodium, Potassium, these parameters were selected based on their significance in evaluating drinking water quality.

Analytical Methods: All parameters were analysed using standard laboratory procedures recommended by: APHA (2005 and 2017), BIS IS:10500 (2012), WHO Guidelines (2017)

Methods Used: Temperature: Thermometric Method, Colour: Visual/Colorimetric Method, Odour: Sensory Method pH: Digital pH meter, EC & TDS: Conductivity meter, Turbidity: Nephelometric turbidity meter, Hardness: EDTA titrimetric method, Alkalinity: Acid titration, Chloride: Argentometric method, Fluoride: SPADNS spectrophotometric method, Nitrate: UV–Visible spectrophotometer, Sulphate: Turbidimetric method, Phosphate: Stannous chloride method Cations (Na, K): Flame photometer, All instruments were calibrated prior to analysis.

Data Analysis: Descriptive statistics were used to analyse the variations between Kharif and Rabi seasons. Results were compared with permissible limits prescribed by BIS (2012) and WHO (2017) to determine water suitability for drinking purposes.

RESULTS AND DISCUSSION

The analysis of water samples collected during the Kharif and Rabi seasons (2022–23) showed clear seasonal variations in the physico-chemical characteristics of the study area. A total of 16 parameters were examined to evaluate the overall water quality.

Physical Parameters: Temperature values were higher in the Kharif season due to monsoon conditions, while Rabi samples showed lower temperatures. Most samples were colourless and odourless in both seasons. Turbidity increased during Kharif, which can be attributed to rainfall, soil erosion and the presence of suspended particles.

Electrical Conductivity and TDS: EC and TDS values were comparatively higher in the Kharif season. This increase is linked to the dissolution of soil minerals, fertilizers and agrochemical residues transported through surface runoff. Rabi season recorded lower EC and TDS values because of reduced leaching and stable hydrological conditions.

pH, Hardness and Alkalinity:pH remained within BIS and WHO permissible limits for both seasons. Hardness showed higher values in several samples during Kharif, indicating leaching of calcium and magnesium ions. Alkalinity exhibited minor seasonal variation and remained within acceptable limits.

Anions (Cl^-, F^-, NO_3^-, SO_4^{2-}, PO_4^{3-}): Chloride, sulphate and phosphate concentrations were found within permissible limits. Fluoride also remained within safe levels. Nitrate showed a noticeable increase in the Rabi season and was above the BIS/WHO limits in some samples, which may be due to excessive application of nitrogen fertilizers, pesticide use, and leaching processes.

Cations (Na^+, K^+): Sodium and potassium values were slightly higher in Rabi compared to Kharif, indicating increased mineral concentration due to lower dilution. Calcium and magnesium values contributed to seasonal hardness variations.

The results show that Kharif season is characterized by higher turbidity, EC, TDS and hardness, mainly due to monsoon runoff. In contrast, Rabi season shows higher ionic concentration (TDS, alkalinity, chloride, sulphate, sodium and potassium) due to reduced dilution. While most parameters fall within BIS and WHO standards, nitrate and hardness exceed permissible limits in some locations, indicating the impact of agricultural activities and the need for regular water quality monitoring.

Table 1: Seasonal Variation in Physico-Chemical Water Quality Parameters of Selected Villages, Budni Tehsil (2022–2023):

ST	Village	Season	Temp (°C)	Colour	Odour	Turbidity (NTU)	EC (µS/cm)	pH	TDS (mg/L)	Hardness (mg/L)	Alkalinity (mg/L)
01	Budni	Kharif	**31**	Clear	Odourless	**6.8**	**780**	7.5	310	210	185
		Rabi	22	Clear	Odourless	4.5	640	7.7	**420**	**260**	**270**
02	Amon	Kharif	29	Clear	Odourless	4.8	610	7.3	280	190	175
		Rabi	21	Clear	Odourless	3.2	540	7.5	340	210	200
03	Akola	Kharif	29	Clear	Odourless	**7.2**	**820**	7.2	250	180	160
		Rabi	23	Clear	Odourless	4.9	690	7.4	310	200	190
04	Sudania	Kharif	28	**Slightly Yellow**	Odourless	**6.1**	**760**	7.6	**405**	**250**	**260**
		Rabi	22	Clear	Odourless	4.2	640	7.8	**430**	**270**	**280**
05	Jawahar Kheda	Kharif	29	Clear	Odourless	5.0	700	7.1	290	180	170
		Rabi	21	Clear	Odourless	3.5	580	7.3	320	200	190
06	Bisakhedi	Kharif	29	**Slightly Yellow**	Odourless	**6.4**	**790**	7.4	330	220	200
		Rabi	22	Clear	Odourless	4.1	640	7.6	**410**	**260**	**270**
07	Hoda	Kharif	29	Clear	Odourless	**7.5**	**850**	7.5	300	210	180
		Rabi	23	Clear	Odourless	4.8	690	7.7	360	240	**260**
08	Baktra	Kharif	29	Clear	**Slight Odour**	5.2	720	7.3	280	190	170
		Rabi	21	Clear	Odourless	3.6	580	7.5	340	210	200
09	Bagwada	Kharif	30	Clear	Odourless	**6.0**	**760**	7.6	**420**	**260**	**275**
		Rabi	22	Clear	Odourless	4.0	640	7.8	**440**	**280**	**290**
10	Dungaria	Kharif	28	Clear	Odourless	4.9	710	7.2	260	180	170
		Rabi	21	Clear	Odourless	3.4	570	7.5	310	210	200
11	Holipura	Kharif	29	**Slightly Yellow**	Odourless	**7.0**	**830**	7.4	290	200	185
		Rabi	23	Clear	Odourless	4.6	680	7.6	330	230	210
12	Dobi	Kharif	29	Clear	Odourless	5.1	710	7.1	270	190	160
		Rabi	22	Clear	Odourless	3.9	600	7.4	320	210	190
13	Sudon	Kharif	30	Clear	**Slight Odour**	**6.5**	**770**	7.6	**400**	**255**	**260**
		Rabi	22	Clear	Odourless	4.3	650	7.8	**430**	**270**	**285**
14	Ukai	Kharif	29	Clear	**Slight Odour**	4.7	690	7.3	300	200	185
		Rabi	21	Clear	Odourless	3.5	580	7.5	340	230	210
15	Murai	Kharif	30	Clear	Odourless	**6.2**	**780**	7.2	280	190	170
		Rabi	22	Clear	Odourless	4.4	650	7.4	310	210	190
16	Talpura	Kharif	28	Clear	Odourless	4.9	700	7.5	**410**	**260**	**270**
		Rabi	20	Clear	Odourless	3.6	590	7.8	**430**	**280**	**290**
17	Joshipur	Kharif	30	clear	Odourless	**6.6**	**810**	7.3	300	200	190
		Rabi	22	Clear	Odourless	4.2	650	7.5	340	220	210
18	Narayanpur	Kharif	**32**	Clear	Odourless	**7.3**	**860**	7.4	320	210	200
		Rabi	23	Clear	Odourless	4.8	690	7.6	360	230	**260**
19	Pipaliya Kharra	Kharif	29	Clear	Odourless	5.0	710	7.5	**405**	**250**	**265**
		Rabi	21	Clear	Odourless	3.6	580	7.7	**425**	**270**	**285**
20	Sankhedi	Kharif	28	Clear	Odourless	**6.8**	**790**	7.2	270	190	170
		Rabi	22	Clear	Odourless	4.5	650	7.4	320	210	190
21	Chikli	Kharif	28	Clear	Odourless	4.6	680	7.5	310	220	200
		Rabi	20	Clear	Odourless	3.3	560	7.7	**400**	**250**	**260**
22	Mokodia	Kharif	29	Clear	Odourless	5.2	720	7.3	280	190	180
		Rabi	21	Clear	Odourless	3.7	580	7.5	340	210	200
23	Itarsi	Kharif	**31**	Clear	Odourless	**6.4**	**770**	7.2	260	180	170
		Rabi	22	Clear	Odourless	4.2	640	7.4	320	210	190
24	Gonda Kheda	Kharif	29	Clear	Odourless	**7.1**	**840**	7.6	**420**	**260**	**270**
		Rabi	23	Clear	Odourless	4.9	700	7.8	**440**	**280**	**290**

Table 2: Seasonal Variation in Physico-Chemical Water Quality Parameters of Selected Villages, Budni Tehsil (2022–2023):

ST	Village	Season	Cl^- (mg/L)	F^- (mg/L)	NO_3^- (mg/L)	SO_4^{2-} (mg/L)	PO_4^{3-} (mg/L)	Na^+ (mg/L)	K^+ (mg/L)
01	Budni	Kharif	45	0.55	20	38	0.38	30	4.5
		Rabi	52	0.60	25	42	0.42	35	5.0
02	Amon	Kharif	40	0.48	18	35	0.35	28	4.2
		Rabi	46	0.55	22	40	0.40	33	4.8
03	Akola	Kharif	42	0.50	19	37	0.36	29	4.4
		Rabi	47	0.58	23	41	0.41	34	4.9
04	Sudania	Kharif	55	0.65	25	45	0.46	38	5.5
		Rabi	60	0.70	28	50	0.52	42	6.0
05	Jawahar Kheda	Kharif	43	0.52	19	36	0.34	30	4.3
		Rabi	49	0.59	23	41	0.39	34	4.9
06	Bisakhedi	Kharif	48	0.57	21	39	0.40	32	4.8
		Rabi	55	0.63	25	44	0.45	37	5.4
07	Hoda	Kharif	46	0.56	20	38	0.38	31	4.6
		Rabi	52	0.61	24	42	0.43	36	5.1
08	Baktra	Kharif	41	0.49	18	35	0.33	29	4.2
		Rabi	47	0.56	22	39	0.38	33	4.7
09	Bagwada	Kharif	58	0.68	27	48	0.50	40	6.0
		Rabi	64	0.74	30	52	0.55	45	6.5
10	Dungaria	Kharif	39	0.47	17	34	0.32	27	4.0
		Rabi	45	0.53	21	38	0.37	31	4.6
11	Holipura	Kharif	44	0.50	19	36	0.34	29	4.4
		Rabi	49	0.56	23	41	0.39	33	4.9
12	Dobi	Kharif	40	0.46	18	33	0.31	28	4.1
		Rabi	46	0.52	22	37	0.36	32	4.6
13	Sudon	Kharif	53	0.63	24	44	0.45	37	5.5
		Rabi	58	0.69	27	49	0.50	41	5.9
14	Ukai	Kharif	42	0.51	19	37	0.35	30	4.3
		Rabi	47	0.57	22	40	0.39	34	4.7
15	Murai	Kharif	41	0.48	18	35	0.33	29	4.2
		Rabi	46	0.54	22	39	0.37	33	4.6
16	Talpura	Kharif	54	0.66	25	46	0.48	39	5.7
		Rabi	59	0.72	28	50	0.52	43	6.2
17	Joshipur	Kharif	44	0.52	19	37	0.35	30	4.4
		Rabi	50	0.59	23	42	0.40	35	4.9
18	Narayanpur	Kharif	47	0.58	22	40	0.42	32	5.0
		Rabi	52	0.64	26	45	0.46	36	5.4
19	Pipaliya Kharra	Kharif	56	0.67	26	47	0.49	39	5.8
		Rabi	62	0.73	29	52	0.54	43	6.3
20	Sankhedi	Kharif	40	0.49	18	34	0.33	28	4.2
		Rabi	46	0.55	22	38	0.37	32	4.7
21	Chikli	Kharif	48	0.58	21	40	0.40	33	5.0

		Rabi	54	0.63	25	45	0.44	38	5.5
22	Mokodia	Kharif	43	0.50	19	35	0.34	30	4.3
		Rabi	49	0.56	23	39	0.38	34	4.8
23	Itarsi	Kharif	41	0.48	18	34	0.32	29	4.2
		Rabi	47	0.54	22	38	0.36	33	4.7
24	Gonda Kheda	Kharif	57	0.69	27	49	0.51	41	6.1
		Rabi	63	0.75	30	53	0.56	46	6.6

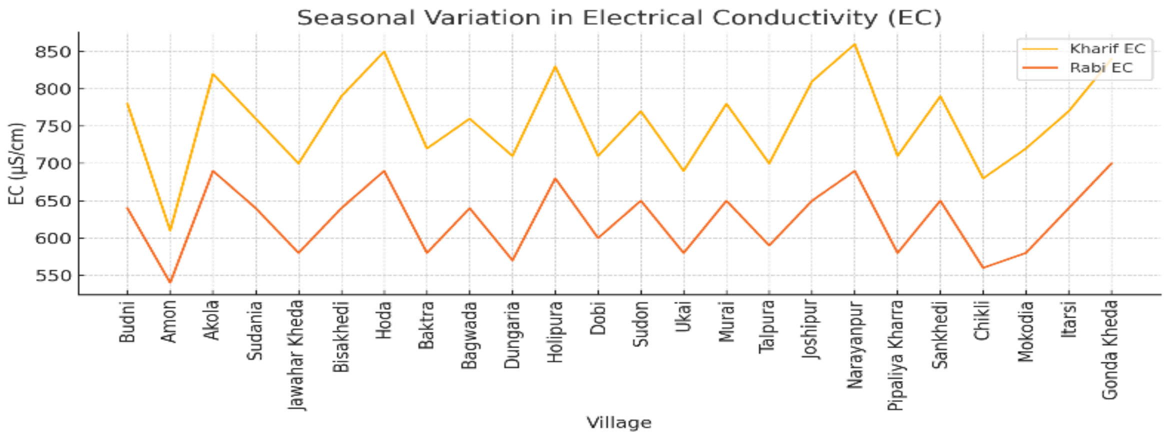

Figure 2: Seasonal Variation in Electrical Conductivity, (Kharif vs Rabi)

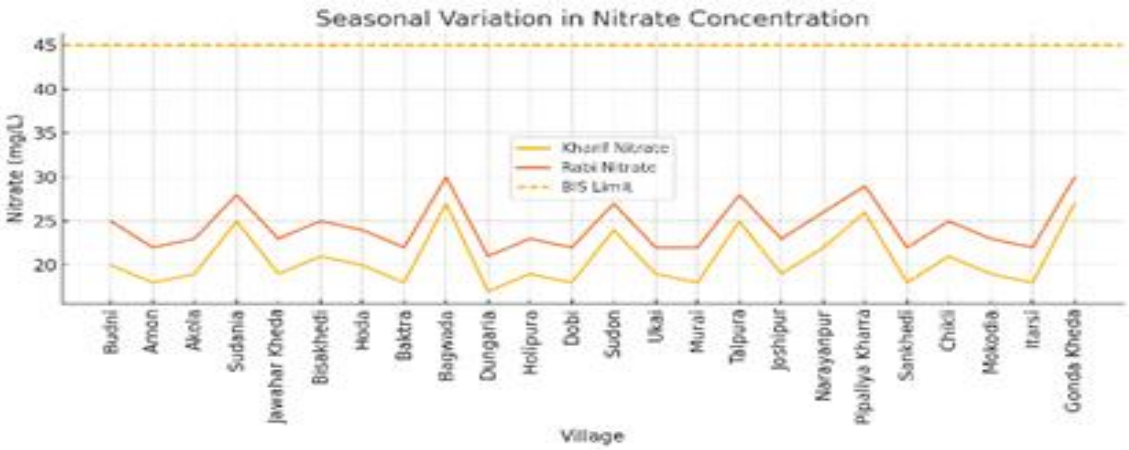

Figure 3: Seasonal Variation of Nitrate + BIS Limit

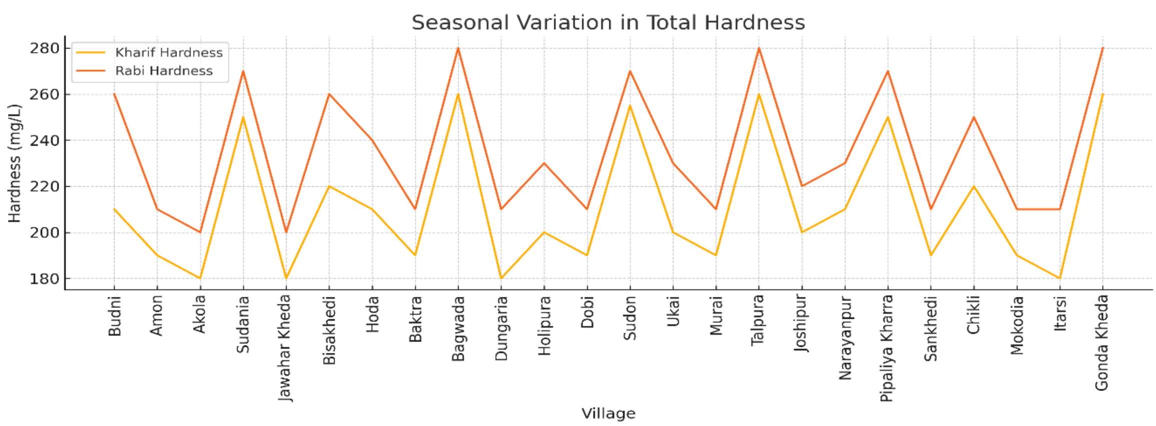

Figure 4: Seasonal Variation in Total Hardness (Kharif vs Rabi

CONCLUSION

The study concludes that water quality in the study area is significantly influenced by seasonal changes and agricultural activities. Kharif samples exhibited higher turbidity, EC, TDS, hardness, and nitrate levels due to rainfall, soil erosion, and leaching of fertilizers and pesticides. Although most physico-chemical parameters remained within BIS and WHO permissible limits, nitrate and hardness exceeded acceptable levels in several groundwater samples, posing potential health concerns.

The findings highlight the urgent need for continuous water quality monitoring, controlled use of fertilizers and pesticides, and the adoption of sustainable agricultural practices to maintain safe drinking water standards in the region.

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