

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 11 ISSUE : 06 Print / Issue Publication Date: October 2026

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2026.v11i06.003

Indexed In

Google SCHOLAR · OPEN ACCESS · doi · Crossref

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International Journal of Engineering Applied Sciences and Technology, 2026
Vol. 11, Issue 06, ISSN No. 2455-2143, Pages 15-20
Published Online October 2026 in IJEAST (http://www.ijeast.com)

INTEGRATED ENVIRONMENTAL MANAGEMENT IN KURUKSHETRA DISTRICT, HARYANA: A SECONDARY-DATA ASSESSMENT OF WASTE, WATER, AIR AND INSTITUTIONAL GOVERNANCE GAPS

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Abstract— **District Environment Plans are intended to translate national environmental rules and tribunal directions into locally coordinated, time-bound action. This study critically assesses the 2023 Revised District Environment Plan of Kurukshetra, Haryana, using structured secondary-data analysis. The plan was coded across municipal solid waste, plastic waste, construction and demolition waste, biomedical waste, hazardous waste, electronic waste, air quality, water quality, domestic sewage, industrial wastewater, mining and noise management. Reported service coverage, infrastructure availability, processing status, monitoring arrangements and implementation timelines were compared with Indian regulatory requirements and peer-reviewed evidence. The assessment identifies a marked implementation asymmetry. Door-to-door collection and source segregation were reported as universal across the five urban local bodies, yet wet-waste processing was nil, dry-waste processing centres and material recovery facilities were not operational, and plastic-waste collection centres were absent when the plan was prepared. The district generated approximately 215 tonnes per day of municipal solid waste, with Thanesar contributing about 65% of the total. Several proposed actions depended on land finalisation, cluster-based contracting and future infrastructure, creating a risk that collection performance could be mistaken for integrated waste management. The plan provides a valuable interdepartmental inventory, but its effectiveness is limited by self-reported indicators, uneven baselines, incomplete outcome measures and weak linkage between deadlines, budgets and verified environmental performance. A district environmental management architecture based on independently auditable indicators, material-flow accounting, public dashboards, risk-based prioritisation, decentralised organics treatment and stronger water-air-waste integration is proposed. The findings demonstrate that district planning can improve environmental governance only when administrative compliance is converted into measurable reductions in pollution loads and exposure.**

Keywords— **Air Quality, District Environment Plan, Environmental Governance, Kurukshetra, Municipal Solid Waste, Secondary Data, Wastewater, Water Quality**

I. INTRODUCTION

Rapid urbanisation, changing consumption patterns and the expansion of peri-urban settlements have increased the environmental management burden on Indian districts. Municipal authorities are expected to provide collection, segregation, treatment and safe disposal services while simultaneously controlling sewage, industrial effluent, air pollution, hazardous materials and noise. Indian studies have repeatedly shown that the most persistent deficiencies are not confined to waste generation; they arise from incomplete processing chains, inadequate municipal finance, fragmented institutional responsibilities, weak data systems and insufficient enforcement.3,4,5,6 [3], [4], [5], [6].

The Solid Waste Management Rules, 2016 shifted policy emphasis towards source segregation, door-to-door collection, decentralised processing, material recovery, scientific landfilling and defined responsibilities for local authorities and waste generators. The subsequent policy literature has reinforced the need to move from disposal-centred systems towards circular and resource-recovery approaches.2,7,8,9 [2], [7], [8], [9].

District Environment Plans emerged from directions of the National Green Tribunal in Original Application No. 360/2018. The model requires district administrations to integrate thematic action plans and monitor them through committees led by the District Magistrate. The Kurukshetra plan covers solid, plastic, construction and demolition, biomedical, hazardous and electronic wastes as well as air

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quality, water quality, domestic sewage, industrial wastewater, mining and noise. It therefore provides an unusually broad basis for examining whether local environmental planning is genuinely integrated or remains a compilation of departmental compliance statements.1,10 [10].

Kurukshetra is an environmentally and socially significant case. It is a major pilgrimage and educational centre, has an agrarian economy with rice and wheat processing industries, includes expanding urban and peri-urban settlements, and experiences seasonal extremes in temperature. Large religious gatherings around sacred water bodies increase the importance of sanitation, water quality and municipal service reliability. The district plan also reports a combined municipal solid-waste generation of about 215 tonnes per day across Thanesar, Pehowa, Shahabad, Ladwa and Ismailabad.1 [1].

This paper has four objectives: first, to synthesise the principal environmental management indicators reported in the revised plan; second, to identify inconsistencies between service coverage and treatment capacity; third, to interpret the findings using scientific literature and Indian regulatory expectations; and fourth, to propose an outcome-oriented implementation framework for district environmental governance. The study does not claim to measure current 2026 conditions; rather, it evaluates the status and commitments documented in the plan dated June 2023.

II. MATERIALS AND METHODS

A descriptive and evaluative secondary-data design was used. The principal source was the Revised District Environment Plan for Kurukshetra transmitted by the Deputy Commissioner and Haryana State Pollution Control Board on 23 June 2023. The document contains district profiles, thematic status tables, identified gaps, responsible agencies and implementation timelines. No human participants, personal records, field sampling or laboratory experiments were involved.1 [1].

The document was reviewed using a structured coding matrix. Each thematic area was coded against six dimensions: (1) pressure or waste-load information; (2) service coverage; (3) collection and transport capacity; (4) treatment, recycling or disposal infrastructure; (5) monitoring and institutional responsibility; and (6) stated gap and completion timeline. Quantitative values were transcribed only when they were explicitly reported. Where tables contained inconsistent values, the inconsistency was retained and discussed rather than silently corrected. [1].

A simple implementation-chain interpretation was applied. An indicator was classified as an upstream service indicator when it described collection, registration or identification; as a midstream capacity indicator when it described transport, segregation or transfer; and as a downstream outcome indicator when it described actual processing, compliant disposal, pollutant reduction or environmental quality. This distinction was used because high collection coverage does not by itself demonstrate safe treatment or pollution prevention.3,6,7

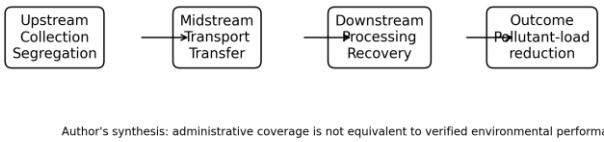


Fig. 2. Implementation-chain framework used for documentary gap assessment.

The district findings were compared with peer-reviewed literature on municipal waste management, material recovery, decentralised treatment, wastewater, groundwater contamination, air pollution, biomedical waste, plastic waste and electronic waste. Government rules and tribunal documents were used to interpret regulatory expectations. Because the underlying plan is an administrative document rather than a statistically designed dataset, inferential statistics were not applied. Descriptive totals, proportions and gap classifications were used. [2], [3], [4], [5], [6], [7], [8], [9].

III. RESULTS

District-Level Municipal Solid-Waste Profile

The five urban local bodies reported a combined municipal solid-waste generation of 215 tonnes per day (TPD): Thanesar 140 TPD, Shahabad 25 TPD, Pehowa 22 TPD, Ladwa 18 TPD and Ismailabad 10 TPD. Thanesar therefore accounted for approximately 65.1% of the reported district urban waste load. The combined population represented in the table was 382,439, producing an implied average of about 0.56 kg per person per day. This value is plausible for Indian urban areas, although it should be treated as an administrative estimate because the plan does not explain weighing frequency, seasonal variation or sampling methodology.1,3,4 [1].

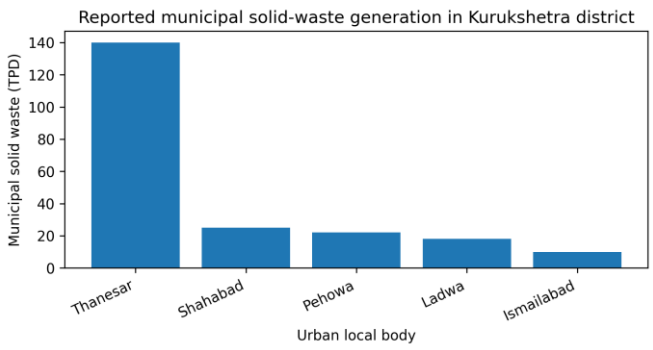


Fig. 1. Reported municipal solid-waste generation by urban local body. Source: District Environment Plan [1].

All five urban local bodies reported 100% door-to-door collection and 100% source segregation. Compartmentalised vehicles and GPS coverage were also reported as achieved or substantially available. These are important upstream

achievements because mixed collection undermines subsequent recovery. However, the downstream status was sharply different: wet-waste processing was reported as nil in every urban local body, each locality had a 100% wet-waste processing gap, and material recovery facilities were not available. Dry-waste processing information was deferred until establishment of processing centres. Thus, the plan documented a complete collection-and-segregation chain without a functioning treatment-and-recovery chain.1 [1], [3], [5], [8].

Table 1. Selected municipal solid-waste indicators reported for Kurukshetra district

ULB	Population	Waste (TPD)	Processing status
Thanesar	250,000	140	Wet: nil; MRF absent
Pehowa	38,855	22	Wet: nil; MRF absent
Shahabad	45,676	25	Wet: nil; MRF absent
Ladwa	31,775	18	Wet: nil; MRF absent
Ismailabad	16,133	10	Wet: nil; MRF absent
Total	382,439	215	0 TPD wet processing

Source: Compiled from the Revised District Environment Plan, Kurukshetra [1].

Plastic, Construction and Demolition, and Special Wastes

The plan required one plastic-waste collection centre in each urban local body, but reported zero centres at the time of preparation. Plastic-waste quantities were not available because reporting was linked to future land finalisation and processing arrangements. This is a significant data gap: without polymer-specific quantities and destination records, extended producer responsibility, recycling performance and leakage prevention cannot be locally evaluated. Indian plastic-waste scholarship similarly identifies weak segregation, informal handling and incomplete traceability as core obstacles.1,18 [1], [18].

Construction and demolition waste, biomedical waste, hazardous waste and electronic waste were included as separate thematic plans. Their inclusion is institutionally positive because these streams require distinct authorisation, collection and treatment pathways. However, the document frequently relies on inventories, registered generators and proposed collection systems rather than material-flow closure. Scientific management requires verified quantities generated, quantities collected, authorised destination, rejected fraction and final disposal. Biomedical and hazardous waste systems also require attention to occupational exposure, storage duration and manifest reconciliation.1,16,17 [1], [16], [17].

Water Quality, Sewage and Industrial Wastewater

The water component recognises the linkage between sewage, drains, surface-water quality and groundwater risk. The plan and annexed monitoring observations identify untreated sewage from unauthorised colonies and complexes as a source of groundwater, soil and environmental contamination. Recommended actions included sewer networks, individual treatment facilities where appropriate, control of solid waste entering drains and improved monitoring. This systems perspective is scientifically justified because urban groundwater contamination often reflects combined leakage from sewers, septic systems, drains, land disposal and industrial sources.1,12,13 [1], [11], [12], [13], [14].

A critical weakness is that infrastructure capacity and compliance status are not consistently translated into pollutant-load reduction. Treatment-plant capacity, actual inflow, bypass frequency, biochemical oxygen demand, chemical oxygen demand, faecal coliform, sludge handling and reuse quantities should be reported together. Capacity alone can overstate environmental performance when sewer connectivity is incomplete or plants operate below design conditions. The literature on Indian urban wastewater repeatedly emphasises the gap between wastewater generation, sewer connection, installed treatment and reliable operation.11,14 [11], [12], [13], [14].

Air Quality and Noise Management

The air-quality plan identifies monitoring and source-control responsibilities, but district environmental planning requires a clearer emissions-to-exposure pathway. Agricultural residue burning, road dust, transport, construction, brick kilns, small industries and open waste burning can contribute differently across seasons. A monitoring system based only on periodic concentration values cannot determine which interventions are effective unless it is linked with source inventories, meteorology and enforcement records. Health-based air-quality guidance further supports the need to treat particulate matter as an exposure problem rather than only a compliance statistic.15,19 [15], [19].

Noise management is included, but its indicators are comparatively thin. District plans should map silence zones, traffic corridors, construction areas, industrial receptors and festival-event peaks, and should report daytime and night-time exceedance frequencies. In a pilgrimage district, temporary population surges and amplified sound require event-specific monitoring protocols rather than annual administrative statements alone. [1], [15].

Institutional Architecture and Monitoring

The plan's principal strength is institutional breadth. It assigns responsibilities across the district administration, pollution control board, urban local bodies, development and panchayat agencies, public health engineering, irrigation, industries and other departments. This reflects the environmental reality that waste, water, air and land systems cross departmental

boundaries. The stated objectives also include conservation, restoration, Sustainable Development Goals, resource efficiency, decentralised planning, stakeholder participation, capacity building and interdepartmental coordination.1 [1], [10], [20].

The principal governance weakness is the dominance of completion dates over performance verification. Numerous actions were assigned deadlines in 2023, but the plan does not consistently state capital cost, operating cost, procurement stage, land status, baseline pollution load, verification method or consequences for non-compliance. This creates a risk of deadline-based reporting in which an activity is marked achieved without demonstrating sustained environmental benefit. Effective environmental governance requires transparent indicators, public reporting, independent audit and mechanisms for adaptive correction.6,10,20 [1], [20].

IV. DISCUSSION

Collection Success Does Not Equal Integrated Management

The most important finding is the disconnect between universal reported collection and segregation and the absence of operational processing facilities. This is not a minor technical gap. Segregated waste that is subsequently mixed, stockpiled or disposed without treatment does not deliver the environmental benefits of source segregation. Earlier national assessments found similar discontinuities between collection and scientifically adequate treatment, and more recent policy analyses continue to identify municipal finance, technical capacity and institutional coordination as limiting factors.3,4,5,7 [3], [4], [5], [6], [7], [8], [9].

For Kurukshetra, organics management should receive immediate priority because the plan estimates wet waste at approximately 148.6 TPD when the five local-body values are summed. Decentralised composting or biomethanation for markets, institutions, hotels, religious facilities and bulk generators can reduce transport demand and landfill pressure. Centralised or cluster facilities may still be needed for residuals and locations without adequate land, but dependence on a single future site creates system-wide vulnerability. A portfolio approach is more resilient than an all-or-nothing infrastructure model.7,9 [1], [7], [8], [9].

Data Quality and Environmental Accountability

The plan contains valuable operational detail, yet several indicators are self-reported and internally inconsistent. For example, Ismailabad's waste generation is shown as 10 TPD in the general table and 8 TPD in a processing table. Similar administrative plans commonly combine values from different reporting periods or measurement methods. The solution is not merely better editing; it is a district data protocol specifying units, measurement frequency, source agency, date, denominator, quality checks and responsible sign-off. [1], [20].

A public dashboard should distinguish inputs, outputs and outcomes. Inputs include expenditure, vehicles and staff. Outputs include households covered, tonnes collected and facilities constructed. Outcomes include tonnes actually recycled or biologically treated, reduction in open dumping, compliant effluent days, decrease in pollutant concentrations and closure of exposure pathways. Outcome indicators make it more difficult to substitute administrative activity for environmental improvement.6,20 [20].

Integration Across Waste, Water and Air

Waste, water and air cannot be managed as independent chapters. Unprocessed organic waste generates leachate and methane; plastic and mixed-waste burning produces particulate and toxic emissions; solid waste in drains aggravates flooding and water pollution; untreated sewage contaminates surface water and aquifers; and poorly managed sludge transfers pollutants from water treatment to land. District monitoring should therefore be organised around environmental pathways and receptors, not only departmental mandates.12,13,15 [12], [13], [15], [18], [19].

Kurukshetra's sacred ponds and event-related visitor flows strengthen the case for integrated risk planning. Pre-event inspections, temporary sanitation capacity, litter and plastic controls, water-quality sampling, noise management and post-event waste reconciliation should be integrated into a single environmental event protocol. Such a protocol would connect public health, tourism, religious administration and municipal services. [1], [15], [18].

Proposed District Environmental Performance Framework

A practical framework for the district is proposed in Table 2. The framework is designed to retain the plan's interdepartmental structure while shifting attention towards verified outcomes and risk reduction. [20].

Table 2. Proposed district environmental performance framework

Theme	Core indicators	Verification	Lead
Municipal waste	Generated, treated, recycled and landfilled tonnage	Monthly weighbridge reconciliation	ULBs; district nodal cell
Plastic waste	Polymer-wise recovery, rejects and EPR linkage	Quarterly processor audit	ULBs; HSPCB; PROs
Sewage	Flow, bypass, BOD/COD, coliform and reuse	Flow records and laboratory tests	PHED/ULBs; HSPCB
Water quality	Seasonal drains, ponds and groundwater	Risk-based public sampling	HSPCB; health agencies

Theme	Core indicators	Verification	Lead
	hot spots		
Air quality	PM2.5/PM10, source activity and open burning	Monitoring linked to source inventory	HSPCB; transport; ULBs
Governance	Budget, procurement, land readiness and outcomes	Dashboard and annual third-party audit	District Environment Committee

V. RECOMMENDATIONS

• Establish a district environmental data cell. The cell should maintain a single version-controlled database with metadata, spatial coordinates, measurement dates and documentary evidence for every indicator. [20].
• Prioritise organic-waste treatment. Bulk generators, markets, campuses, hotels, religious institutions and residential clusters should be mapped and assigned decentralised composting or biomethanation targets before relying solely on a future central facility. [7], [8], [9].
• Complete material recovery infrastructure with traceability. Each urban local body should have an operational material recovery facility or an auditable shared arrangement, supported by weighbridges, bale records and authorised end destinations. [3], [5], [8].
• Create a plastic-waste mass balance. Collection centres should report polymer categories, quantities received, recycler destinations, rejects and producer-responsibility linkages. [18].
• Integrate sewage and water-quality reporting. Treatment capacity must be reported with actual flow, connectivity, compliance, bypass and reuse; groundwater and surface-water hot spots should be sampled according to risk. [11], [12], [13], [14].
• Adopt source-oriented air planning. Seasonal inventories should link road dust, vehicles, crop-residue burning, construction, industry and waste burning with monitoring and enforcement actions. [15], [19].
• Use milestone-based budgeting. Land acquisition, tender award, construction, commissioning and stable operation should be separately budgeted and verified rather than represented by a single completion date.
• Publish independent annual performance audits. University laboratories or accredited third parties can validate environmental data while the District Environment Committee retains administrative accountability. [20].
• Develop event-specific environmental protocols. Major pilgrimage and festival periods should trigger temporary service expansion, water and noise monitoring, plastic controls and post-event waste audits. [1], [15], [18].
• Update the plan as a living document. The district should issue an annual revision that records completed actions, missed deadlines, reasons for delay, revised risk priorities and current regulatory requirements. [10], [20].

VI. LIMITATIONS

This study is based on a single administrative plan and does not independently verify field conditions, facility operation, laboratory results or post-deadline implementation. The plan contains tables compiled from multiple departments, and some values may represent different dates or estimation methods. The absence of raw datasets prevented statistical trend analysis and uncertainty estimation. The findings should therefore be interpreted as a critical assessment of documented planning and reported status, not as an environmental compliance audit of current conditions. [1].

VII. CONCLUSION

The Revised District Environment Plan of Kurukshetra is an important foundation for integrated local environmental governance. It recognises the full range of regulated waste streams and environmental media, assigns departmental responsibilities and provides numerous time-bound actions. Its reported universal door-to-door collection and source segregation demonstrate administrative mobilisation. Nevertheless, the plan also reveals a decisive implementation gap: collection systems were substantially developed while wet-waste processing, dry-waste recovery, material recovery facilities and plastic-waste collection infrastructure remained absent or dependent on future land and contracting decisions. The central lesson is that environmental planning should be judged by material-flow closure and pollutant reduction, not only by coverage percentages and dated action points. Kurukshetra can convert the plan into a high-value governance instrument by adopting auditable mass balances, integrated waste-water-air indicators, decentralised organics treatment, transparent dashboards, milestone-linked finance and independent verification. Such reforms would make the district plan a living environmental performance system rather than a static compliance document. [1], [2], [10], [20].

DECLARATIONS

Not applicable. The study used publicly available administrative documents and published literature and did not involve human participants or animals.

Consent to Participate
Not applicable.

Consent for Publication
Not applicable.

Conflict of Interest
The author declares no conflict of interest.

Funding
No external funding was received for this study.

Acknowledgements
The author acknowledges the District Administration, Kurukshetra, the Haryana State Pollution Control Board and



the agencies whose published documents informed this analysis.

Author Contribution

Prashant Ravish conceptualised the study, reviewed the documentary evidence, conducted the analysis and prepared the manuscript.

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