CONSTRUCTION AND DEMOLITION WASTE

Closing the waste loop for sustainability

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1 INTRODUCTION

- In a rapidly urbanising India, the construction sector is emerging as a significant contributor to air pollution as well as a massive consumer of material resources. India's resource extraction rate stands at 1,580 tonne per acre compared to the world average of 450 t/acre.

- The National Clean Air Programme mandates that the 131 non-attainment cities in India must reduce their particulate pollution by 40 per cent by 2026. Construction and demolition (C&D) waste management has, therefore, become integral to all efforts to cap pollution levels.

- Policy mandate and dedicated funding is available for managing this waste. What cities require is information and guidance on the eco-system approach needed for C&D waste management, which is at a nascent stage in India and not as evolved as management of other waste streams.

- This CSE review shows that most cities lack institutional preparedness to carry out systematic and scientific management of C&D waste. Pace of adoption of the C&D Waste Management Rules, 2016 is slow, and there are gaps in implementation. Strong guidance is needed to deepen understanding of the system design and strategies for implementation.

Why this report?

In rapidly urbanising India, the construction sector has emerged as an important source of local air pollution and toxic exposure in cities. The frenetic pace of this sector is increasing the material and energy intensity of the built environment — this, in turn, is locking in enormous amounts of carbon in the built structure. While responsible construction is needed to reduce environmental and pollution impacts, recovery of material from the waste for further re-use is also necessary to reduce material intensity and substitute some parts of the virgin material to put a halt to environmental degradation. Management of waste from construction and demolition (C&D) of buildings and infrastructure is increasingly becoming central to pollution control efforts in cities.

C&D waste management and construction dust mitigation are integral to all clean air action plans of the 131 non-attainment cities (NACs) under the National Clean Air Programme (NCAP) of the Union Ministry of Environment, Forest and Climate Change. These cities have not met the National Ambient Air Quality Standards. Under NCAP, these cities are required to reduce particulate pollution by 20-30 per cent from 2017 levels by 2024, and also meet the subsequent tighter target of 40 per cent reduction by 2026. Their clean air action plans and micro-action plans have laid down the action required, specific targets, funding strategies and monitoring plans. State-level action plans are now being framed for a larger regional approach.

Additionally, the Swachh Bharat Mission 2.0 (SBM 2.0) and the Swachh Sarvekshan programme of the Union Ministry of Housing and Urban Affairs provide support for waste management in cities. They also rank cities to assess their action on waste management within a competitive framework to encourage improvement in waste management practices. In the 2021 version of Swachh Sarvekshan, the scoring method for ranking cities has been made more robust with respect to the C&D waste stream.

Both clean air plans and waste management programmes have attracted dedicated funding. In addition to the separate funding line for the NCAP, the XVth Finance Commission has created a corpus of Rs 29,250 crore for urban local bodies (ULB) as a performance-linked funding. Air quality funding targets a 5 per cent reduction in particulate pollution annually over a period of five years until 2024. This grant is disbursed annually based on the performance of an identified cohort of 42 million-plus cities.

It may be noted that the multi-sector plans currently being implemented by cities include C&D waste management as a focal point. This implementation draws

upon the legal mandate and provisions enshrined in the C&D Waste Management Rules and Regulations of 2016.

The policy mandate and dedicated funding have created an opportunity to fast-pace the transition to efficient circularity. Against this backdrop, it is important to understand the status and scope of action and its effectiveness in controlling pollution as well as ensuring material recovery from waste to minimise damaging impacts. As this is a new area of intervention in most cities of India, there is enormous demand for information and guidance on the eco-system approach needed for C&D waste management — this includes on-site management, segregated collection and transport, processing and recycling, uptake of recycled products, coordination with bulk generators, enforcement and penalty, application of user fee and smart monitoring. Management of C&D waste requires a complex set of measures, systems, infrastructure, and enforcement strategies.

Keeping this in mind, Centre for Science and Environment (CSE) has made an attempt — through this report — to review the current status and gaps in action and identify the way forward. In most cities, C&D waste management is at a nascent stage and is not as evolved as the management of other streams of municipal solid waste. A learning curve from the current practices and some of the emerging good practices can help guide cities about the implementation strategies.

Why is C&D waste a problem?

According to the National Investment Promotion and Facilitation Agency, India's construction industry is expected to reach US $1.4 trillion by 2025, and contribute about 13 per cent to the national economy.[1] India will be adding billions of square meters of space under different schemes and programmes to create affordable housing units, commercial spaces, cold storage, industrial corridors, smart cities, roads and highways, among other things. This will not only generate enormous amounts of waste, but also increase the demand for natural and virgin building materials that require mining.

The draft National Resource Efficiency Policy report put out in 2019 states that India has already increased its material consumption six times from 1.18 billion tonne in 1970 to seven billion tonne in 2015. India's resource extraction rate stands at 1,580 tonne per acre as compared to the world average of 450 tonne per acre; its material productivity is low. While India imports many critical raw materials such as sand, it has a much lower recycling rate at 20-25 per cent compared to developed countries of Europe (70 per cent), says the report.[2]

Besides the impacts that mining and resource extraction already exert, mismanagement of C&D waste — often dumped unscientifically in ecologically sensitive areas such as wetlands or low-lying areas — causes serious environmental damage. To add to this, the construction process in itself is a major dust and particles generator that leads to local pollution and exposure. This is a major concern as air pollution has emerged as a key public health issue in Indian cities. Some of the more disturbing serious health effects include lung cancer, silicosis, chronic obstructive pulmonary disease and asthma.

In fact, every stage of the construction process is a source of toxic dust. There is silica dust from sand, stone, rock, brick, concrete and mortar; dust from masonry work, tunneling, road milling, mixing of cement and concrete; mining dust generated from cutting and drilling through sandstone and granite; stone-crushing dust generated while making aggregates and polishing stone; wood dust; and dust from demolition of old buildings that have used more of lead and asbestos, which are highly toxic.

How are cities managing their C&D waste?

Despite the policy mandate and dedicated funding, action on C&D waste management is still very nascent and limited in most cities.

What is driving and deciding the boundaries of action in cities is the set of indicators that have been adopted for tracking and monitoring implementation of C&D waste management under both the NCAP and Swachh Sarvekshan. The Central Pollution Control Board (CPCB) has developed a set of indicators for review and evaluation of NCAP implementation; ULBs and concerned departments are expected to report progress based on these indicators.

Further, Swachh Sarvekshan 2021 has increased the weightage for C&D waste management over the 2020 levels — from a total of 50 points to 100 points. While this has spurred action and increased accountability in cities, the criteria for tracking progress also needs to be refined to strengthen comprehensive implementation. Action has been initiated on dust control in construction sites, systematic collection and transportation of material, and setting up of recycling plants, but its scope and intensity varies from city to city.

It has become necessary to assess the adequacy of the current action, identify the gaps in it, understand the direction of change needed, capture the learning curve from different cities and frame a roadmap to inform and support implementation

across cities. This can help leverage the programme funding more efficiently and effectively.

In view of this, CSE has carried out an extensive review of the action underway in cities under NCAP with overlaps of the Swachh Sarvekshan programme. This review has taken cognisance of the progress reports submitted by NCAP cities and additional information available from related government documents of the states. In addition, CSE has carried out deep dive investigations in selected cities to draw lessons from the ground. These cities include Delhi, Jaipur, Gurugram, Kolkata, Bhubaneswar, Pune and Pimpri-Chinchwad.

These are a widely diverse group of cities representing those that have taken more advanced action, and those that have just begun the process or are at the early stages of planning. Ground-level assessment has taken into account statutory orders and mandates, and steps taken to curb illegal dumping, improve collection systems, enforce user charges, processing, recycling and reuse of C&D waste (see *Figure 1: City-wise progress on measures related to C&D waste management*). These city case studies are diagnostic in nature (see Annexures 1 to 11 for details).

What are the key findings of CSE's field study?

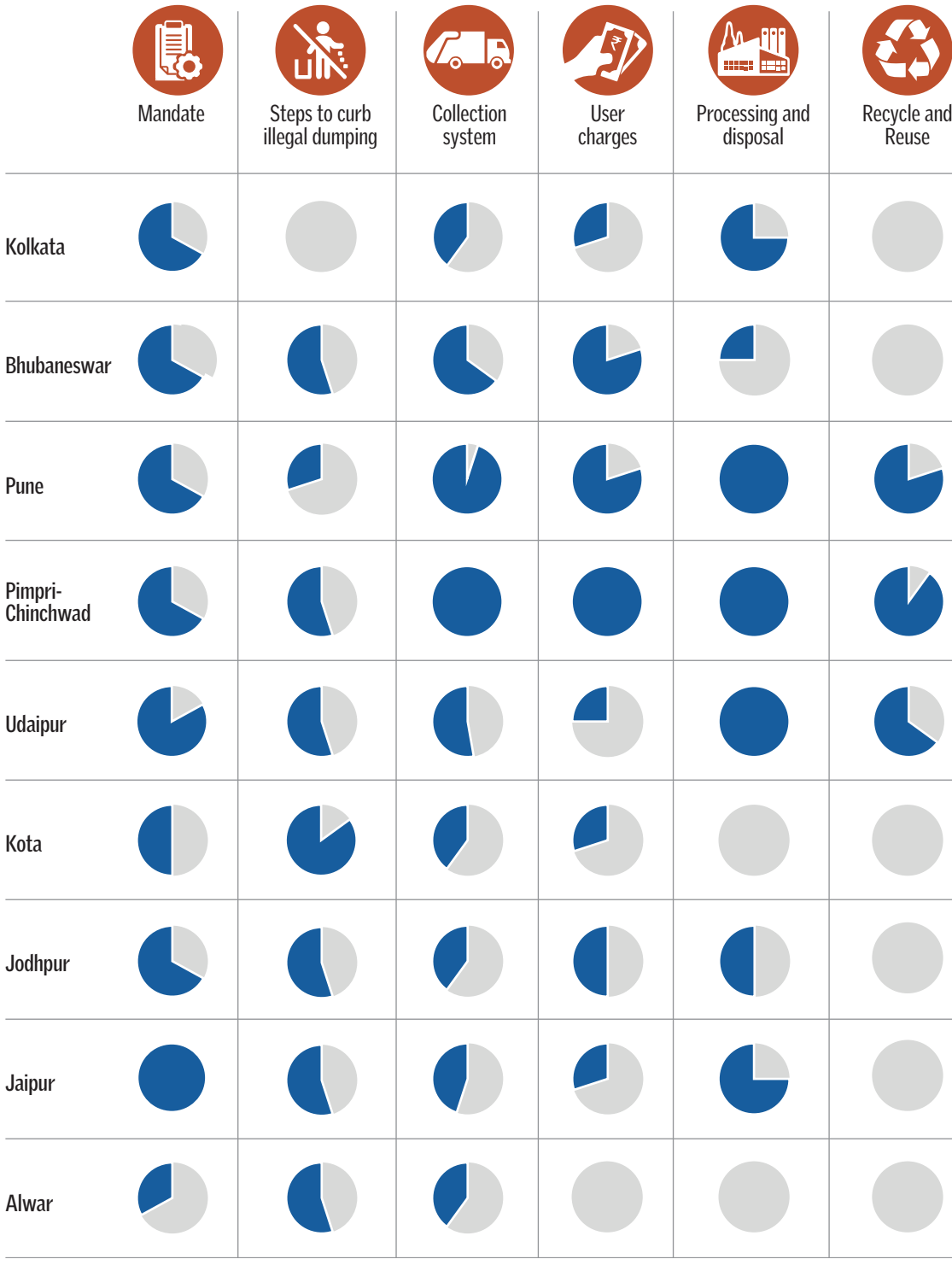
The lessons drawn from the review of the progress reports submitted by cities and field investigations are related to

- Quantification of C&D waste
- On-site management of C&D waste and dust generation
- Segregated collection and transport of C&D waste
- The mandate for bulk waste generators
- Role of the informal sector
- Processing and recycling of the waste
- Market uptake of recycled products

These are the primary requirements under the C&D Waste Rules and Regulations, 2016.

Broadly, the review has shown that institutional preparedness in most cities is still not adequate to be able to carry out systematic and scientific management of C&D waste. The pace of adoption of the C&D Waste Management Rules, 2016 has been slow; there are several gaps in implementation as well. Every city is developing its management system in a different manner, thus giving rise to different kinds of challenges. The current approach towards planning and spending of available funds is fragmented and may not yield effective solutions in the longer term.

Figure 1: City-wise progress on measures related to C&D waste management



This requires strong guidance to deepen understanding of the system design and strategies for implementation. This section deals with the gaps, and offers an action agenda to guide cities towards a well-rounded C&D waste management system.

Gaps in data

Data gaps impede C&D waste management — guidance needed on waste quantification

All ULBs need a more robust system of maintaining quantitative and qualitative data on construction sites and C&D waste generation. Currently, cities do not have instruments to collate information on building construction or redevelopment projects spread geo-spatially to identify construction-intensive zones and assess C&D waste generation. It is possible to access information on the number, type and scale of construction projects that have been approved under the Real Estate (Regulatory and Development) Act, 2016 and after the Environment Impact Assessment (EIA) and other approval processes. But the methods for estimating C&D waste generation are still uncertain. Agencies like TIFAC and SBM 2.0 have provided their respective methods for estimating the volume, but discrepancies abound among the various estimations.

In fact, some of these methods need to be improved upon to avoid the risk of underestimation. Details of sub-streams and their characteristics are needed for planning the processing technologies, collection, infrastructure and operations. The quarterly progress reports submitted by cities under NCAP shows that most cities do not have such information. Very few cities that are in the process of setting up C&D recycling plants, carry out assessments for system planning. But this is not part of their regular planning exercise and is, sometimes, grossly underestimated. Also, with the informal sector active in cities, much of C&D waste goes into backfilling which is not accounted for. Therefore, C&D waste generation data at the ward level is needed so that it can be internalised in the formal system of collection, processing and recycling. This requires details of sub-streams (concrete, bricks and mortar, wood, steel and sand), geographic location, land use, floor area, typology of the building, and age of the building (in case of demolition), among other things.

Gaps in infrastructure

Inadequate segregated collection and collection points

Many cities have not yet designated collection points to improve segregated collection — as directed by the C&D Waste Management Rules, 2016. Even

cities that are setting up centralised processing facilities, have not yet identified collection points and are depending on direct transportation of C&D waste to the plant from the generation points. But studies have shown that intermediate collection points or transfer stations are needed to optimise trips required to haul the waste from source to the centralised facility. While bulk waste generators can send waste directly, the smaller generators cannot.

In Delhi, the North Delhi Municipal Corporation has designated collection points in every ward. This has increased collection of the waste and optimised the number of trips made to the processing facility. Cities like Gurugram in Haryana are using information systems through third parties which helps aggregate waste transfer trips better with effective short-haul and long-haul combinations.

Processing and recycling facilities still in a nascent stage — need strong guidance

Under NCAP, cities submit progress reports that are uploaded in the 'Portal for Regulation of Air-pollution in Non-Attainment cities' (PRANA) of the CPCB. This portal has provided a list of 18 cities that have recycling and processing plants — these include Delhi, Gurugram, Noida, Ghaziabad, Agra, Varanasi, Pune, Pimpri, Chandigarh, Indore, Rae Bareli, Jabalpur, Bhopal, Ahmedabad, Surat, Thane, Hyderabad, Vijayawada, and Bhilai.

While there is a lot more underway to leverage the new funding for clean air and waste management, all ULBs cannot afford to set up their individual recycling plants as they may not generate the critical volume of waste needed for sustained use of the plants. In such cases, a cluster approach is needed in which several smaller ULBs pool their C&D waste and share the recycling plant on an asset-sharing basis. Moreover, with so many cities setting up recycling plants, there is an enormous demand for information on the choice of appropriate technologies, running of the plants, and market uptake of recycled products. This requires strong guidance.

Underdeveloped market for recycled products

The business model for C&D waste recycling plants can work only if there is a well-developed market for the uptake of the recycled material. A range of products are produced at recycling plants, including recycled aggregates, paver blocks etc. But several of these plants face the challenge of market absorption of these products as the market linkage is weak. A legal mandate for use of recycled products in all construction projects can stimulate the market. National rules and several state-level policies require a certain percentage of construction material to be derived

from C&D waste. But cities do not yet have clear or well-collated information on material vendors and availability. A network of authorised material vendors will be required to increase uptake of recycled C&D products when the processing facilities get operational. Tracking quarterly sales of recycled C&D products will inform cities of the demand-supply dynamics that will further guide the requirement of processing facilities.

Moreover, even though recycling plants are exempted from GST, the recycled products are in a higher bracket of GST compared to virgin material. This increases the price of the recycled products.

Gaps in regulations

Not all cities have notified C&D waste bye-laws — this needs to be implemented across all cities

A crucial step towards the adoption of C&D Waste Management Rules of 2016 is the notification of C&D waste bye-laws in cities. Some cities have notified solid waste bye-laws that include C&D waste as a separate stream; others are in the process of preparing the bye-laws.

Through these bye-laws, the entire process of C&D waste segregation, storage, collection, transportation, processing and reuse, as required under the Rules, along with the generator responsibility, can be detailed out. Bye-laws also guide and legally bind the waste generators, ULBs, public authorities, service providers and other actors that are necessary for scientific management of C&D waste. The 2016 Rules also require cities to legalise user fee and penal action for non-compliance through their bye-laws.

Need notification of collection points/transfer stations

As per the C&D Waste Rules of 2016, ULBs need to notify collection points/ transfer stations for C&D waste that are identified based on adequate studies. This increases collection efficiency and optimises transportation to bring down related costs and emissions.

Self-declaration by construction sites, especially bulk waste generators, not a common practice

For building construction projects above 20,000 sq m of built-up area, state pollution control boards (SPCBs) need to ensure compliance with the environmental requisites of C&D waste management. For projects smaller than 20,000 sq m (which account for a majority of construction in our cities), instruments need to

be devised by ULBs. Self-declaration and periodic reporting by project proponents to the ULB, based on internal auditing as part of the building permission process, can enable this. A list of non-compliances also needs to be prepared and notified, along with the corresponding penalties and the authorities/agencies that would be expected to issue these penalties.

Need an enabling mechanism for uptake of recycled C&D products

The C&D Rules of 2016 suggest replacing 10-20 per cent of construction materials with recycled C&D waste. Currently, cities do not have such a mandate to create an enabling environment for recycling and reuse of this waste. State governments/ ULBs need to notify mandatory use of recycled C&D products in the construction cycle and close the loop under a circular economy. A government order that mandates use of recycled C&D products in all public construction works could be an effective instrument. Only a few cities including Delhi have notified this mandate.

Gaps in enforcement

Informing public and waste generators about rules and compliance

Anyone undertaking construction needs to be aware of the rules, responsibilities and penalties for non-compliance. Field investigations in cities show that waste generators (especially non-bulk generators) are not aware of their duties with respect to C&D waste. Multiple violations were observed, such as failure to segregate, storage outside the building premises, and illegal dumping (particularly near construction sites, highways and roads).

A user manual that describes the entire process of C&D waste management, its benefits and what the generators need to do is needed for wide dissemination. Need-based events for small-scale developers, developers' associations, architects and planners and campaigns to maximise public outreach can also help. Since they are unaware about the formal system, generators prefer to rely on the informal sector.

Inadequate institutional systems in ULBs for enforcement and coordination

ULBs require dedicated cells for monitoring and inter-departmental coordination. Cities function through a centralised system which leaves gaps in operations, monitoring and enforcement. With enormous construction activity taking place and

with day-to-day compliance monitoring requirements, decentralised management systems will be needed to optimise functions including maintenance of data inventories, increased collection, inspections and enforcement. Enforcement, in fact, requires a closer-to-ground overview and is human resource-intensive. ULBs are usually short-staffed and face challenges in deploying resources for inspection and enforcement. This also needs outsourcing of enforcement responsibilities.

Dedicated helpline and MIS for collection requests and grievances not implemented across cities

Cities need to set up a dedicated helpline for collection of C&D waste to smoothen the collection process. As digital infrastructure kicks in, cities are automating the process of waste collection that enables generators to raise collection requests, pay user fees, and share grievances by geo-tagging photos through one dedicated channel. This channel helps ULBs manage and prioritise requests and respond promptly. Such automated systems help generate data and plan for infrastructure in the long run.

Standard operating procedures and MIS of challans inadequate

Scientific management of C&D waste needs a new generation of standard operating procedures (SOPs) for the different institutions involved in the process. These SoPs must guide those involved in segregation, collection, storage, transportation, processing and overall handling of C&D waste. Once requisite infrastructure and legislative frameworks are in place, multiple actors or institutions need to work together to be able to efficiently collect, store, transport, process and reuse while at the same time ensuring environmental compliance at all stages. In order to do this, ULBs need to establish inter- and intra-departmental communication, monitoring and reporting systems. Also, the quarterly progress reports on clean air action plans require cities to fill in the number of challans issued for a particular non-compliance. In order to track challans issued and the reasons, cities need management information systems (MIS). Analysis of the data gathered in the MIS on non-compliances can guide cities and help with designing effective regulations, management practices, etc.

Informal sector for collection, segregation and primary processing not well integrated

The informal sector needs to be integrated with the mainstream and formal waste collection process as this can optimise collection and processing efficiency cost effectively. This is also an important livelihood source. A manual that describes the entire process of C&D waste management, its benefits and what the generators need to do in the context of the city needs to be prepared and disseminated widely.

In fact, in some ULBs, it has been noted that the informal sector also sets up crude decentralised processing machinery to process C&D waste at the neighbourhood level — these initiatives can end up generating a lot of dust.

Gaps in capacity

While ULBs are responsible for planning and implementation of C&D waste management, SPCBs are the key regulators for checking compliance with environmental norms at different stages of building construction as well as C&D waste management. Additionally, the local police are penalised on certain non-compliances such as C&D waste being dumped outside building premises causing obstructions in the right of way and uncovered transportation of C&D waste. Currently, there is no system to harmonise the actions of all actors. As cities are in the process of setting up the new generation of services and systems, a dedicated cell needs to be created to monitor and enable inter- and intra-departmental coordination. This cell must have representatives from the air quality monitoring cell and experts to enable better monitoring and compliance.

This requires ample capacity building of all stakeholders involved. All staff (municipal and concessionaire) responsible for collection, handling and transportation and treatment of C&D waste need to be trained on respective SOPs (at the collection point, during transportation, at the processing facility, etc). ULBs need to be trained on coordination, communication, use of MIS, and planning and development of infrastructure, as well as on non-compliances and enforcement systems.

Concessionaires should be integrated in the capacity building programme. With the setting up of C&D waste processing facilities in cities, much of the collection and transportation work will be transferred to concessionaires. This makes the concessionaire an important actor in the entire process.

An agenda for action

Adopt an ecosystem approach for C&D waste management

The current approach towards C&D waste management in cities is largely ad hoc and fragmented. For instance, a few cities are focusing on recycling plants even before notifying their bye-laws or mandating reuse of C&D waste in construction. Other cities may have their bye-laws notified, but are not collecting C&D waste as part of day-to-day practice due to the absence of a collection system and designated resources.

An ecosystem approach is crucial to fully deal with the issues linked with C&D waste. This approach involves addressing estimation of volume, collection system, bye-laws with user charges, penalties and fines, surveillance and enforcement, recycling plants and associated compliances, uptake of C&D waste products, and public awareness and capacity building. Cities must prepare a dashboard/checklist for these aspects to track the progress.

Expedite framing and notification of comprehensive bye-laws

Preparation and notification of bye-laws is a vital step in legally binding the generator to hand over C&D waste to the ULB and bring it into a formal value chain of treatment and reuse. Many cities have notified only penalties and fines as C&D waste bye-laws — this is not enough. The bye-laws must include provisions for at-source segregation, submission of a waste management plan, payment of user charges, mandatory use of recycled products and related incentives, roles and responsibilities of different stakeholders like the ULB, service providers, state pollution control board, traffic police, etc. Cities must make all developers and waste generators liable and accountable.

Ensure a well laid out and accessible collection system

Recycling plants need continuous waste feed to make them financially feasible. Only an easily accessible collection can ensure that. Cities must prioritise setting up a collection system first, instead of recycling plants. There are different systems that cities are currently putting in place — such as on-call collection systems or deliberate disposal at notified collection points. Cities are also exploring the possibility of linking assessment of C&D waste and its collection with building permissions as they move towards online building permission systems.

In this system, the ULB is notified of the location of the construction site, the built-up area and an estimated volume of C&D waste from the building permission request uploaded by the beneficiary/generator. Thus, the ULB can monitor and track the site for collection of C&D waste. Online payment systems bring more efficiency. Another crucial step is to identify bulk generators like PWD, NBCC, DMRC, etc and mandate them to hand over the waste directly at a recycling plant or at a notified disposal sites.

Estimate the volumes of C&D waste to design effective systems

No city has clear and credible data on how much C&D waste it has that needs to be processed, and how much is being generated every day. As C&D waste collection is largely residual of solid waste collection, cities have not developed a proper database for this stream. Online platforms such as state RERA websites,

PARIVESH and Delhi's online platform under its anti-dust drive are sources that inform about the number of projects and volume of construction. These sources must be utilised by cities to estimate waste generation. This step is crucial to plan for recycling infrastructure and avoid piecemeal augmentation.

Plan for collection and treatment infrastructure

So far, cities have not planned for collection points and recycling facilities in their master plans. As a result, the sites that are getting identified for setting up plants and waste collection are ad hoc and not technically planned. The 2016 C&D Rules provide for conditions that must be followed for identification of sites for recycling. For collection points, width of the access roads, activities and population in the surroundings are some of the areas that need to be considered while planning.

According to the Building Material and Technology Promotion Council's (BMTPC) ready reckoner on C&D waste, a collection point or transfer station should cater to a radius of not more than three km. Transportation can make or break the financial feasibility of a recycling plant — cities must strive to minimise it. Decentralisation can enable this by cutting down on vehicular km travelled to a regional or centralised recycling facility and reducing empty trips. Mini, mobile and semi-mobile crushers may be utilised in a cluster approach for decentralised processing.

Promote efficient construction management practices to minimise waste and dust emissions

There are several compliance requirements placed by the C&D Waste Management Rules, 2016 and Environment (Protection) Amendment Rules, 2018. Besides these, there are other guidelines for dust control and safe handling of C&D waste. This report is a guidebook that compiles all these guidelines. Cities must internalise these and make developers responsible and accountable for good construction practices and dust control.

For instance, Delhi is following an approach involving self-declaration and fortnightly upload of self-audits on an online platform anchored by the Delhi Pollution Control Committee. This system was implemented as part of Delhi's anti-dust drive. Under this drive, all projects with plot areas greater than 500 sq m are required to register on the platform and take necessary steps for compliance. These projects are video-fenced with remote connectivity — basically, CCTV cameras at construction sites are linked to a central server, and regulators can track remotely whether dust control norms are being followed.

Adopt dynamic user charges and create a funding stream for legacy waste

Many cities are working with fixed user charges that are based on tonnage. This method eliminates the hefty cost that is incurred due to transportation. Especially in large cities with longer distances, transportation forms the biggest component of user charges. This is why cities like Pune and Pimpri-Chinchwad are going ahead with charges that factor in the distance travelled to haul C&D waste: this amounts to around Rs 22.04 per km per tonne and Rs 15 per km per tonne, respectively for the two cities.

Other than this, cities must plan for a top-up in user charges to pay for treatment of legacy waste. There are tonnes of C&D waste lying in cities that are growing exponentially — Gurugram, for instance, is holding on to eight lakh tonne of legacy waste. Cities find it difficult to pay for treatment of this waste due to the hefty costs.

Prioritise budgets to maximise air pollution mitigation potential

Currently, budget allocation by cities in the sector is ad hoc and not linked with performance or assessment of mitigation potential of action. There is limited understanding of the scope of the programme, infrastructure design, technology requirements, mitigation potential of the actions for C&D waste management and dust control, and overall greening of the construction sector. Priority in budgets must be given to actions with high mitigation potential and long-term impact. This requires mapping of pollution generation potential of each phase of construction and demolition, material transfer, collection and recycling and the technological and infrastructure interventions needed for pollution control. While a lot of investments in mitigation measures and technologies will have to be done by the construction agencies, it is necessary to map out the areas that will require public funding. ULBs will have to invest in monitoring systems and infrastructure, digital tracking and digital servers, geo-tagging and waste management sites, etc. Currently, there is no clarity about what is fundable — as a result, fund allocation for the sector is minimal and not well rationalised.

Put in place extensive awareness and capacity building and enforcement measures

Being a relatively new waste stream, there is very little awareness about C&D waste. Cities need to bring this stream to the forefront and make the public aware about the do's and don'ts. This needs investment in IEC activities. ULB staff, service providers, developers and other generators need to be trained on the standard operating procedures and required compliances regarding this stream.

Efforts must also be made to eliminate doubts about the quality and performance of recycled C&D waste products. Demonstration visits must be organised along with training programmes.

Cities have shown better enforcement when a third party is involved — as has been the case in Gurugram. Advanced solutions like video-fencing with remote connectivity (as done in Delhi) are also promising better enforcement and inter-departmental coordination. Cities that are at the planning stages of their enforcement strategies must consider these solutions. They must utilise the funds available under programmes like 15FC and SBM 2.0 to enable this.

Address the issue of dust emissions from construction sites

From an air pollution mitigation perspective, enforcement of dust control measures in construction sites is critical. The CPCB has already issued a checklist for dust control measures. Several best practices have emerged globally that can provide guidance on the action needed. Field investigations have exposed on-ground challenges with respect to enforcement and adequacy of the measures.

Strengthen on-site construction dust control: While checklists of action related to dust barriers, covering of stockpiles, dousing dust from movement of vehicles, etc have been detailed out, actual implementation is often cosmetic and ineffective. Much stronger enforcement and adoption of appropriate techniques are essential for controlling fugitive dust during material handling, construction process, material processing and transport of materials.

Control dust from transportation of C&D waste: Cities use a range of vehicles for activities such as hauling of construction materials and drain silt, road sweeping, water sprinkling, etc. These vehicles are either owned by the ULB or are contracted. A proper inventory of these vehicles is required, and they should be GPS-enabled in order to improve compliance monitoring as well as generate data for future assessments.

Enforce the standard checklist of measures for dust control: According to the Environment (Protection) Amendment Rule 2018, there are several dust mitigation measures such as prohibition on grinding or cutting of building materials, roadside storage of materials and transportation of uncovered materials, among other things. These measures need to be adopted and complied with. In order to make developers as well as the general public aware of these measures, a standard checklist can be a helpful tool. The CPCB's 2017 guidelines on dust mitigation measures in handling construction material and C&D waste are a good reference

for this checklist.[3] The checklist would also lead to better compliance monitoring if it is linked with building permissions.

Put in place guidelines for sustainable and safe construction site management: Knowledge and awareness on scientific construction site management is currently weak in cities. Appropriate stockpiling and handling of materials, space planning for material storage, planning for vehicle circulation, wheel washing zones, unloading of materials preventing fugitive dust emissions etc are processes and measures on which developers need to be guided.

Hotspot action to control local dust pollution: Under the clean air action planning process, Delhi and cities of NCR (like Gurugram) and Rajasthan (Jaipur, for one) have undertaken implementation of hyper-local action plans at the neighborhood level. This has created an opportunity to address construction sites more granularly. In Jaipur, grids of 2X2 km have been marked and overlaid on the city; pollution-causing activities such as building construction, waste dumpsites and C&D waste processing plants have been superimposed over the grids. The grids around pollution hotspots have been provided a detailed action plan consisting of preventive and mitigative measures for air pollution. Similar studies need to be conducted in other cities, like the Kolkata Metropolitan Area.

Put in place winter plans for special enforcement to control construction dust as part of graded response action plan: Cities in Delhi-NCR, Kolkata, and a few cities and towns in the Indo-Gangetic Plains have adopted special enforcement measures as part of their graded response action plans (GRAPs) for winter season, a time when smog episodes build up. Currently, these cities do not have a GRAP that brings construction activities to a halt when the AQI (air quality index) rises. Further, no authority is empowered to issue such a notice. Earlier, the Environment Pollution (Prevention and Control) Authority (EPCA) was the key body that regulated multiple pollution-causing activities — including construction — in Delhi-NCR through GRAP. An appropriate authority needs to be empowered to halt construction activities in event of high AQI. Cities like Delhi are now implementing air quality sensor networks to monitor the local impacts of construction activities and to refine strategies.

Install dedicated helpline and MIS on construction dust control: With digital infrastructure kicking in, cities are automating their processes. Enabling project proponents to share grievances by geo-tagging photos through one dedicated channel is one such process. This channel helps ULBs manage and prioritise actions and respond promptly. Such automated systems also help track progress

of municipal work contracts, generate data and plans for policies in the long run. The QPR template asks cities to fill in the number of challans issued for a particular non-compliance. In order to keep a track of challans issued and why, cities must set up an MIS. Analysis of the data gathered in the MIS will guide cities on information such as which are the maximum violations, where are they coming from and who is penalising.

Notify penal action for non-compliance: Some cities have mentioned in their quarterly progress reports that a general undertaking is given by project proponents at the time of receiving building permissions: the undertaking states that the project proponent will comply with the environmental norms. Several cities have notified a list of measures to be taken to minimise dust pollution at construction sites. A similar but detailed checklist with all the measures for dust control must be notified in each city — these measures should be made mandatory for project proponents and other actors (material vendors, transporters, etc). Penal action along with a list of authorities that will penalise must also be specified for each non-compliance. For building construction projects above 20,000 sq m of built-up area, the SPCBs need to ensure compliance with dust mitigation measures. For projects smaller than 20,000 sq m built up area, ULBs need to devise specific instruments. Self-declaration and periodic reporting by project proponents should be made a part of the building permission process.

Initiate public communication on dust control: In order to enforce dust control norms and related compliances, the public, especially small-scale developers, need to be made aware of their responsibilities. Field investigations show that small-scale developers are not aware of what they are required to do to curb dust emissions. A checklist that comprises all sources of dust in the construction process, associated compliance requirements and what the generators need to do needs to be prepared and disseminated widely. Cities also need more citizen participation. Geo-tagging of non-compliances as and when observed by citizens and filing of complaints on a mobile app or helpline can improve surveillance and enforcement. But for this, mass awareness campaigns and wide dissemination of compliance checklists are needed to include citizens in the pollution abatement efforts.

2

C&D WASTE MANAGEMENT IN NON-ATTAINMENT CITIES

- Of the 131 non-attainment cities (NACs) that have shared their city action plans on PRANA, only 35 (26 per cent) have data on C&D waste generation. Together, these cities have generated 6,563.48 tonne per day (TPD) of C&D waste. Delhi has reported the highest generation. Only eight cities have reported how much C&D waste they collect daily.

- The thumb rules for estimation of C&D waste generation need to be reviewed and updated, as there is wide variability in estimations. CSE's assessments point out that actual generation could be much higher given the status of live construction sites.

- The C&D Waste Management Rules, 2016 has given a timeline to cities to set up and operationalise C&D waste recycling plants. Of the 131 NACs, 53 have reported the status of their plants. Only 12 cities have reported at least one plant that is operational; the rest are either under construction, or proposed, or yet to be planned.

- The C&D Rules have mandated cities to notify municipal bye-laws – 17 cities have reportedly done this. Cities are also dedicating helpline numbers or developing mobile apps as part of their monitoring and collection systems.

Centre for Science and Environment (CSE) has carried out an assessment of the status and gaps in action on construction and demolition (C&D) waste management and dust mitigation strategies in construction sites to identify the pathways for further reforms in cities. This evaluation has taken an ecosystem approach and investigated different aspects of C&D waste management, including waste generation, collection, transport, processing, recycling, compliance and enforcement strategies.

The review is based on the information provided by the cities designated as non-attainment cities for not meeting national ambient air quality standards consistently under the National Clean Air Programme (NCAP). Their periodic progress reports are uploaded on the 'Portal for Regulation of Air Pollution in Non-attainment Cities' (PRANA) of the Central Pollution Control Board (CPCB). The latest set available are for the year 2021. According to it, about 131 non-attainment cities have prepared their clean air action plans and micro-action plans to control particulate pollution. These plans provide the details of implementation along with expense statements and funding requests in different sectors, including the waste sector. As the information base of these plans is not adequate or updated, efforts have been made to source additional information from district environment plans and reports of SPCBs, among others.

Additionally, deep dive field investigations have been carried out as well in selected cities to get more insights into the on-ground reality and challenges. This has helped capture the learning curve. This also brings out how nascent and variable the action is across cities.

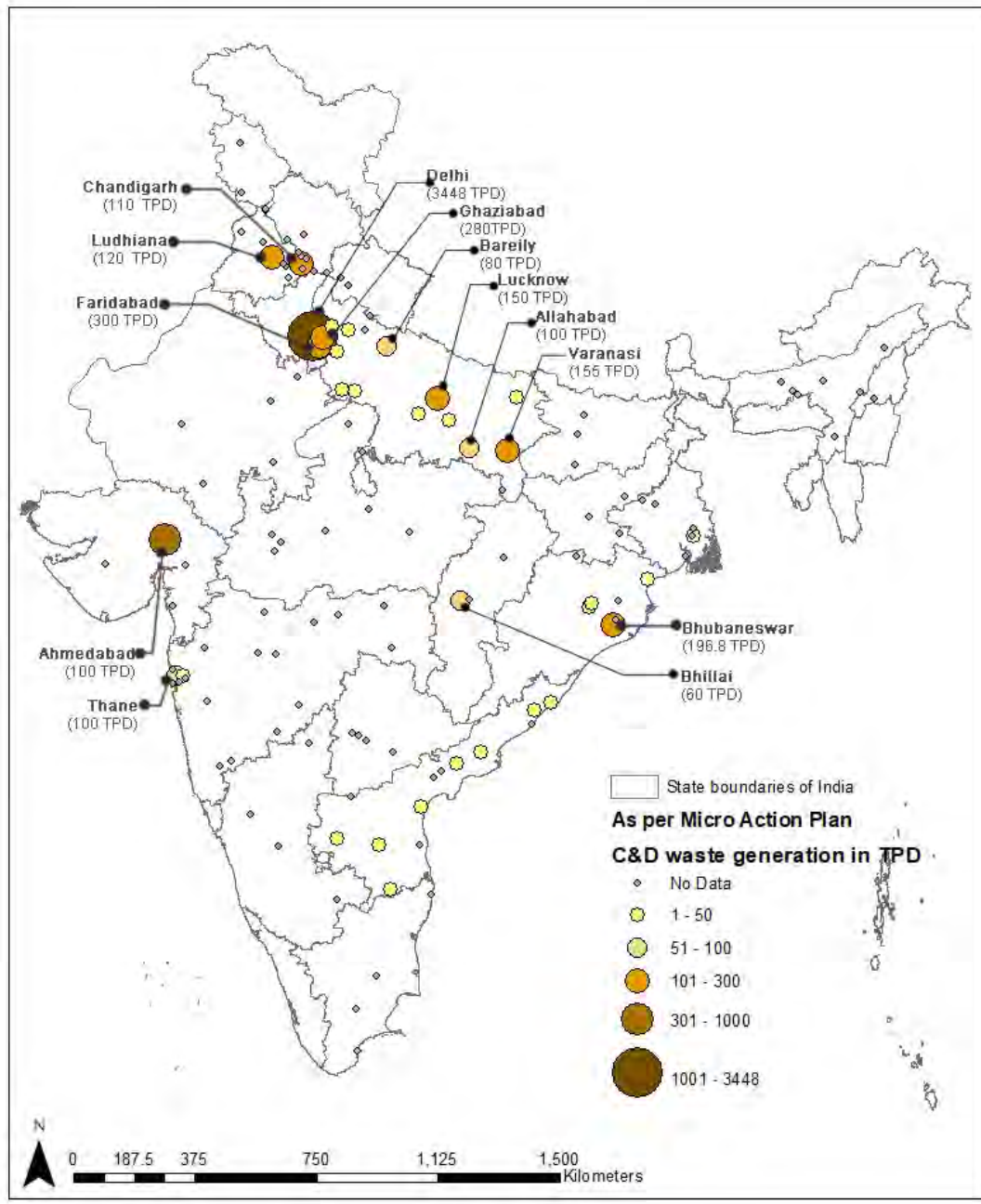
The following pages offer a snapshot of the findings with regard to the different stages of C&D waste management. This review not only helps assess the gaps in action and the inadequacy of strategies, but also identifies the strategies needed to improve the overall management of waste and provides practical guidance on implementation.

Waste generation

The data from micro-action plans in PRANA shows that only 35 cities (26 per cent of the 131 non-attainment cities that have uploaded their plans) have provided statistics on C&D waste generation. Together, these cities have generated 6,563.48 tonne per day (TPD) of C&D waste. Delhi has reported the highest generation in the country, with 3,448 TPD. This is followed by Ahmedabad (1,000 TPD), Faridabad (300 TPD), Noida (300 TPD) and Ghaziabad (280 TPD).[4]

Other cities have mainly reported their generation as below 100 TPD. A few cities such as Anpara in Uttar Pradesh and Guntur in Andhra Pradesh have reported no generation of C&D waste (see *Map 1: C&D waste generation as reported in PRANA portal of CPCB*).

Map 1: C&D waste generation as reported in PRANA portal of CPCB



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded in the official website of CPCB

There is wide variability in estimations depending on the method followed under different programmes. For example, under the Swachh Bharat Mission (SBM) 2.0 guidelines, cities are expected to apply a thumb rule of 50 gramme per capita per day to estimate their C&D waste generation as part of the city solid waste action plan. If this criteria is applied, the total generation becomes 8,176.4 TPD in 131 non-attainment cities — if only 35 cities are considered, then the generation stands at 3,052 TPD. This forms only 45.2 per cent of the actual generation reported in these cities (see *Map 2: Estimated generation of C&D waste as per SBM 2.0 guidelines*). It is quite possible that the SBM thumb rule is resulting in underestimation of C&D waste. This requires further evaluation.

The top generators — according to the SBM 2.0 estimations – are Mumbai (919.75 TPD), Delhi (817.49 TPD), Kolkata (702 TPD) and Bengaluru (426.02 TPD).[5] This is a gross underestimation compared to what has been reported by the cities. Additional assessments carried out by CSE in selected cities that are part of the NCAP list of 35 cities shows that the actual generation is expected to be much higher given the status of live construction sites. For instance, Delhi generates 3,711 TPD — more than four times the estimated quantity; Kolkata generates 1,600 TPD which is more than twice the estimate. This is as per the data collected from the ULBs. This confirms that the thumb rules for estimation of C&D waste generation need to be reviewed and updated.

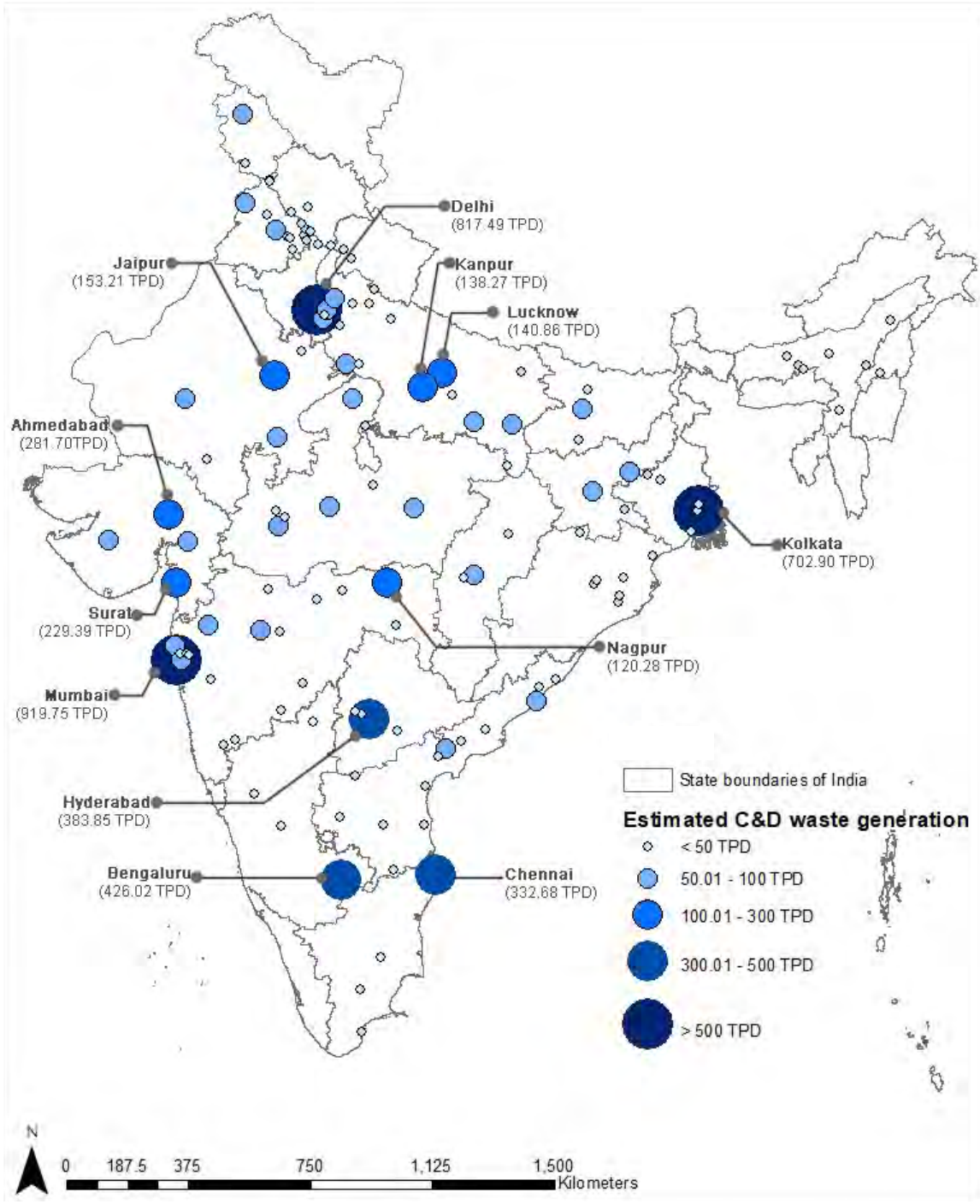
Waste collection

Information on C&D waste collection has been provided with widely varying scope — and that too, in only a limited number of cities. About eight cities have reported the tonnage of C&D waste collected daily. These include Delhi (1,770.35 TPD), Lucknow (150 TPD), Varanasi (25 TPD), Meerut (40 TPD), Agra (20 TPD), Bareilly (11 TPD), Chittoor (3 TPD) and Gajraula (0.44 TPD). The total tonnage collected is 2,019.79 TPD.[6]

Other than this, three cities have reported collection charges based on weight, and three have reported charges based on transportation. Four of the cities have reported that they impose penalties and fines, while five have said they have collection vehicles (see *Map 3: C&D waste collection in TPD*).

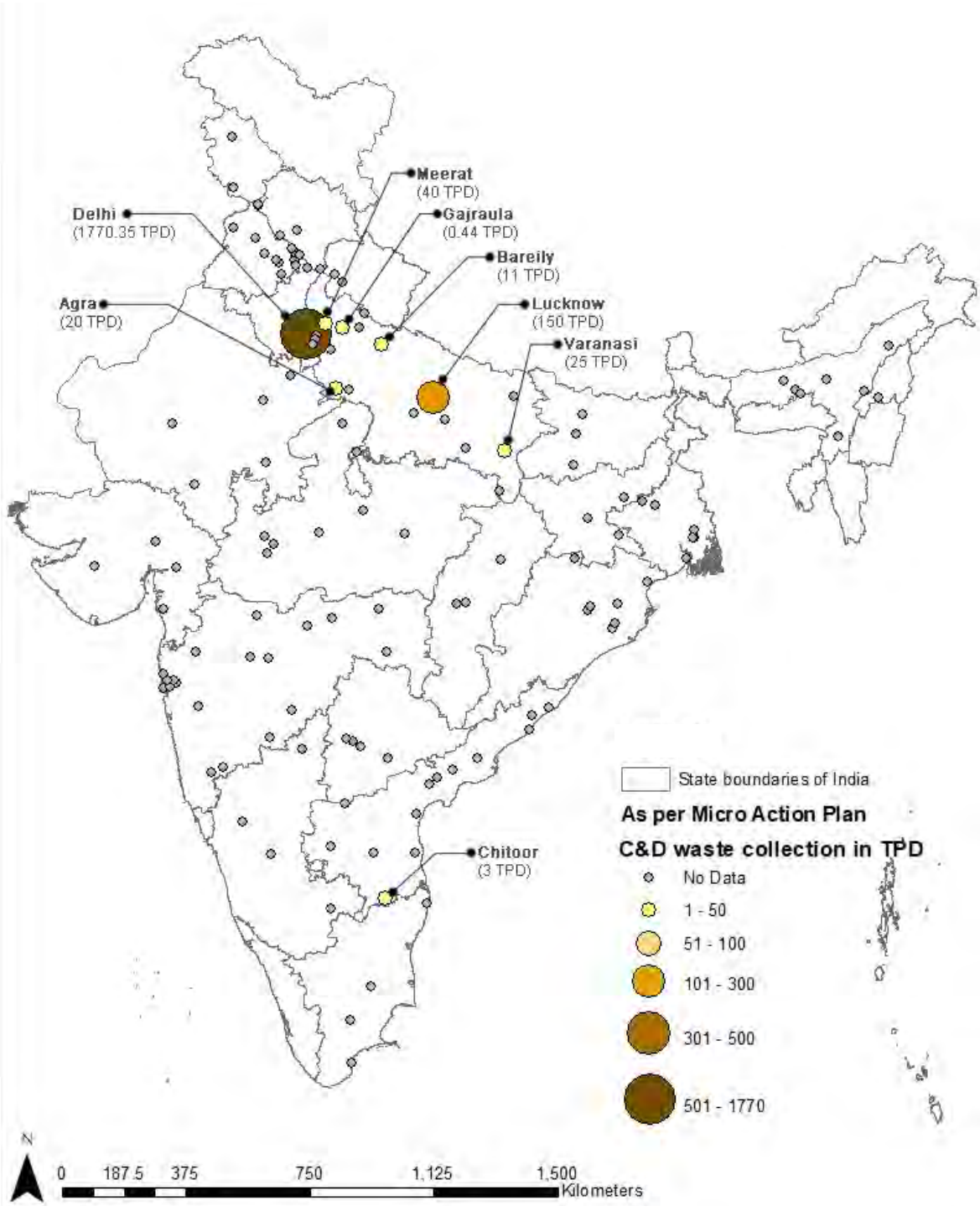
As per the data reported on PRANA, collection efficiency of most cities is less than 10 per cent. A few cities like Agra, Meerut, Gajraula, Lucknow and Chittoor claim to have achieved a collection efficiency of 100 per cent. Big generators like Delhi,

Map 2: Estimated generation of C&D waste as per SBM 2.0 guidelines



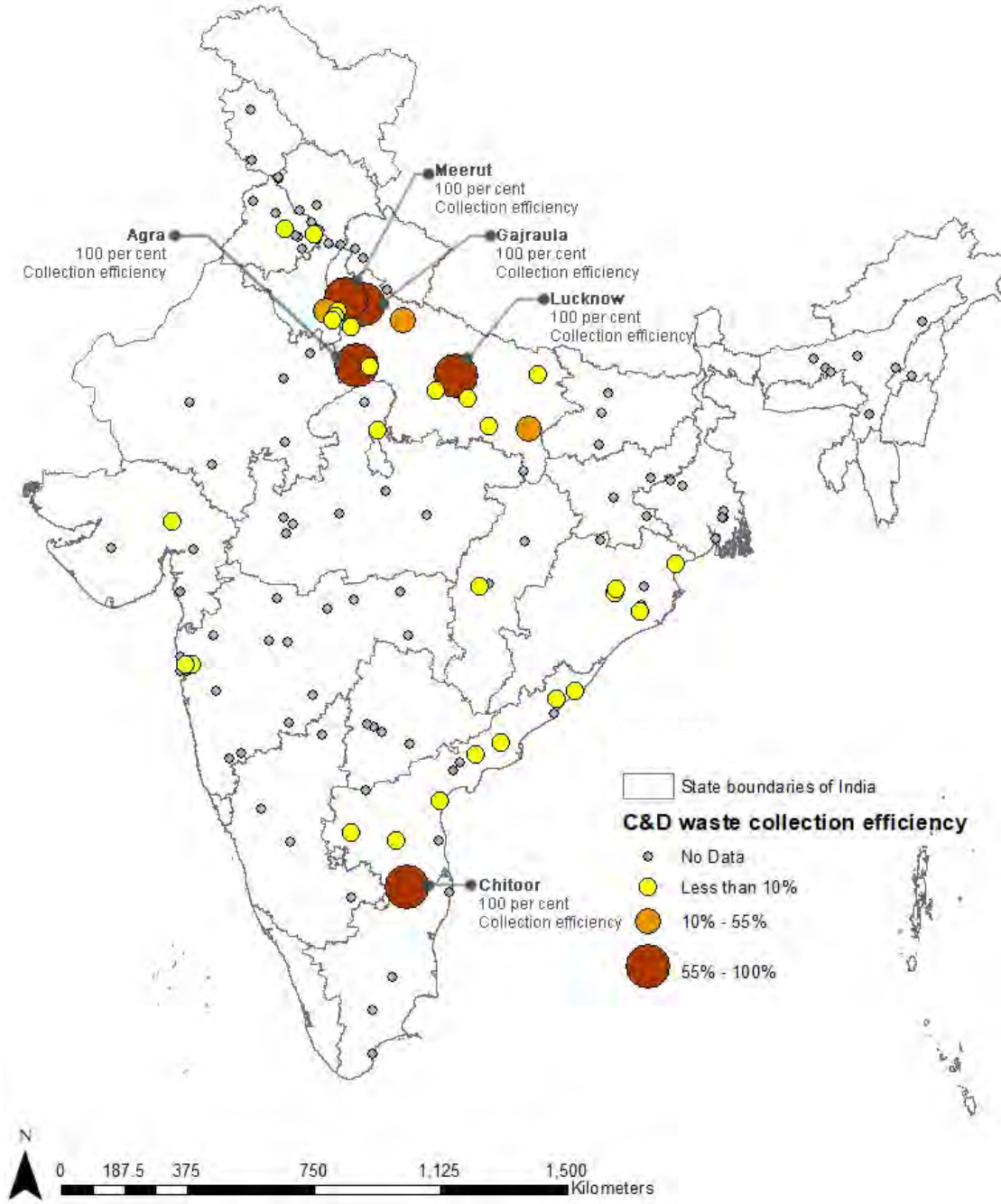
Source: Map created by CSE.

Map 3: C&D waste collection in TPD



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded in the official website of CPCB

Map 4: Collection efficiency in non-attainment cities

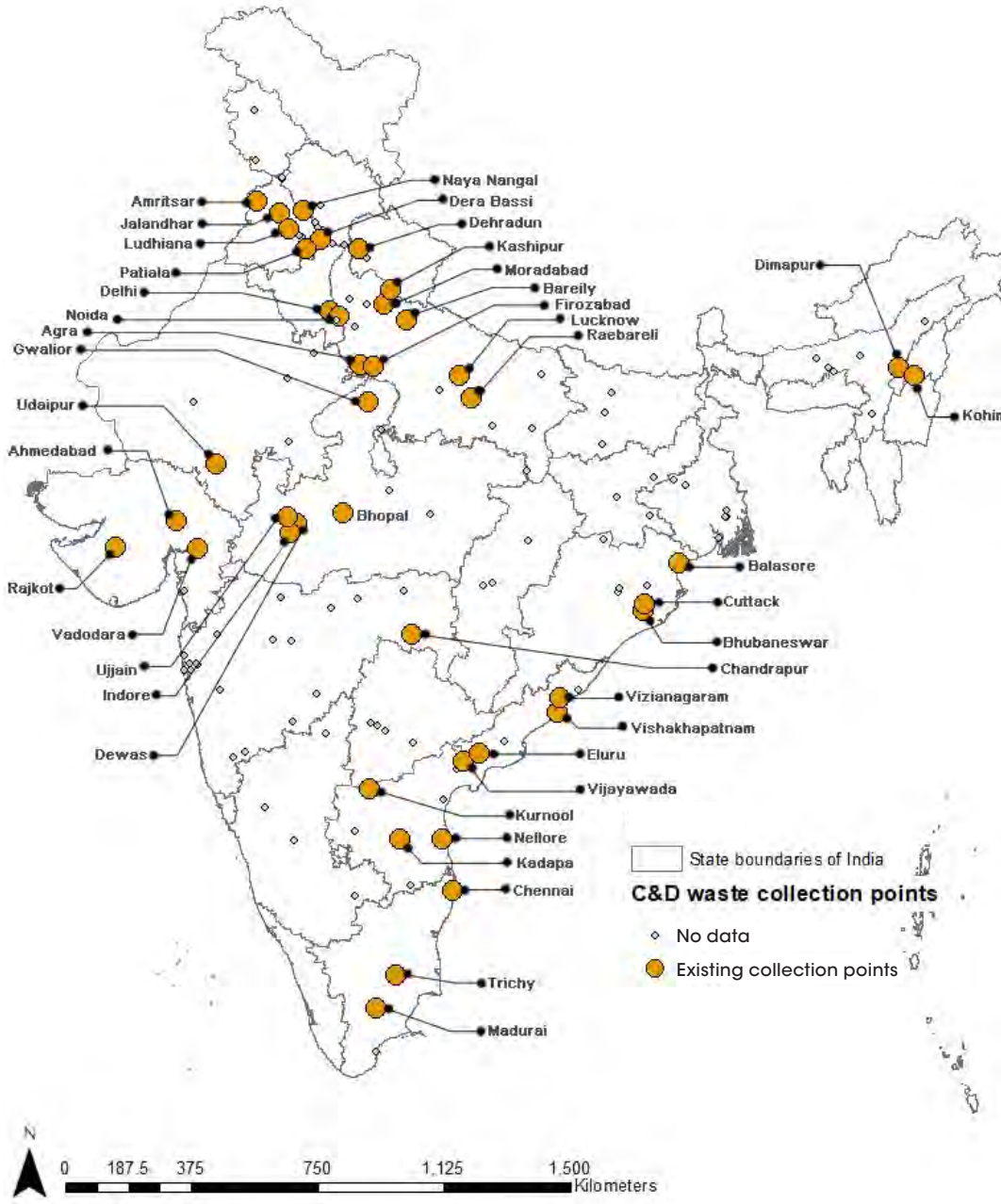


Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB

Kolkata and Mumbai have a low collection efficiency level in comparison. This means that smaller cities have a better opportunity to improve collection efficiency (see *Map 4: Collection efficiency in non-attainment cities*).

Fifty-four cities have reported that they have designated C&D waste collection stations/points. Out of these, 29 have reported the locations of these points. About nine cities have reported that they do not have collection points (see *Map 5: Dedicated C&D waste collection points in non-attainment cities*).

Map 5: Dedicated C&D waste collection points in non-attainment cities



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB

Waste treatment

The ultimate objective of C&D waste management is to process and recycle the waste to bring it back as a resource in the construction sector. The C&D Waste Management Rules, 2016 has given a timeline to cities to set up and operationalise C&D waste recycling plants. It has allowed up to 18 months to cities with million-plus population, 24 months to cities with population between one million to 0.5 million, and 36 months to cities with less than 0.5 million population.

Additionally, clean air action plans are also driving the cities to implement recycling systems. According to the micro-action plans uploaded on PRANA, 53 out of 131 cities have reported the status of their recycling plants. This includes information on whether the plant is operational, proposed, under process/construction, or yet to be planned (see *Table 1: Status of recycling plants in non-attainment cities as reported on PRANA*). To add to this data, 24 cities have reported the location of their C&D waste plants, and 20 have reported the total processing capacity.[7]

The data available on PRANA is based on the reports submitted by NACs (non-attainment cities) in 2021 – it had not been updated till the time of going to press. CSE's research shows Kolkata has set up a 1,500-TPD recycling plant which is operational. Jaipur has a 300-TPD plant which is yet to become operational. Similarly, Pune has a recycling plant with a capacity of 250 TPD and has proposed another of similar capacity. It is important for all cities to update their information on the portal.

Moving beyond PRANA data, there are 21 cities that have at least one operational recycling plant (see *Tables 2 and 3: Operational and proposed C&D waste recycling plants in cities*). These plants have a total installed recycling capacity of 13,285 TPD of C&D waste. Of these cities, three are not part of the non-attainment cities under NCAP – they are Gurugram, Greater Noida and Chennai. Delhi has the highest processing capacity of 5,150 TPD, followed by Kolkata (1,500 TPD) and Hyderabad (1,000 TPD). Nearly all 26 plants are operational; however, the

Table 1: Status of recycling plants in non-attainment cities as reported on PRANA

Status of recycling plant	Number of cities
At least one plant operational	12
Under construction/process	6
First recycling plant proposed	26
Yet to be planned	9

Source: PRANA (2021)

status of operations is unclear for the plants in Bhopal, Solapur, Indore, Bhilai and Gurugram.

There are 27 non-attainment cities that have proposed C&D waste recycling plants. While the proposed capacity is not clear for all these plants, eight cities for which information is available add up to a proposed capacity of 1,340 TPD. This is based on the data collected from the PRANA portal, detailed project reports and discussions with plant operators and ULBs.

Table 2: Operational C&D waste recycling plants in cities

S No	City	No of plants	Installed capacity (TPD)	Status of the plant	Remarks
1	Delhi	5	2000 + 1000 + 1000 + 1000 + 150	Operational	
2	Ahmedabad	1	300	Operational	
3	Surat	1	300	Operational	
4	Bhopal	1	Unclear	Unclear	
5	Jabalpur	1	50	Operational	
6	Thane	1	300	Operational	
7	Hyderabad	2	500 + 500	Operational	
8	Ghaziabad	1	400	Operational	
9	Noida	1	800	Operational	
10	Raebareli	1	5	Operational	
11	Kolkata	1	1500	Operational	500 TPD capacity for KMC and remaining for other ULBs
12	Prayagraj	1	400	Operational	
13	Solapur	1	300	Unclear	150 TPD for Solapur Municipal Corporation
14	Indore	1	100	Operational	
15	Chandigarh	1	150	Operational	Operates under capacity (20 TPD)
16	Agra	1	20	Operational	Operates under capacity (5 TPD)
17	Vijayawada	1	200	Operational	Operations on hold after working for 8 months
18	Bhilai	2	60	Unclear	
19	Gurugram	1	1000	Unclear	Not a NAC
20	Greater Noida	1	100	Operational	Not a NAC
21	Chennai	1	1000	Operational	Not a NAC
	Total	**26**	**13285**		

Source: Multiple sources. PRANA, clean air action plans and discussions with ULBs and plant operators

Table 3: Proposed C&D waste recycling plants in cities

Sl No.	City	No of plants proposed	Proposed capacity (TPD)	Status / Remarks
1	Kurnool	1	Unclear	
2	Rajahamundry / Rajamahendravaram	1	10	
3	Vishakhapatnam	1	200	On hold after operating for 8 months
4	Faridabad	1	300	
5	Bengaluru	1	500	An existing 1000 TPD is non-operational
6	Devanagre	1	Unclear	
7	Gulburga	1	Unclear	
8	Hubli Dharwad	1	Unclear	
9	Gwalior	1	Unclear	
10	Nashik	1	Unclear	
11	Navi Mumbai	1	160	
12	Ulhas Nagar	1	Unclear	
13	Vasai-Virar	1	Unclear	
14	Angul	1	Unclear	
15	Bhubaneswar	1	Unclear	
16	Cuttack	1	Unclear	
17	Rourkela	1	Unclear	
18	Talcher	1	Unclear	
19	Ludhiana	1	Unclear	
20	Patiala	1	Unclear	
21	Gorakhpur	1	Unclear	
22	Jhansi	1	Unclear	
23	Lucknow	1	150	
24	Meerut	1	10	
25	Moradabad	2	10	
26	Nagpur	1	Unclear	Under Construction
27	Tirupathy	1	Unclear	Unclear
	Total	**27**	**1340**	

Source: Multiple sources. PRANA, clean air action plans and discussions with ULBs and plant operators

Delhi has the highest number of C&D waste processing plants – seven (two of which are proposed). Hyderabad has reported four plants (two proposed), Bhilai three (one proposed) and Jabalpur two (one proposed). About eight cities from Andhra Pradesh have reported that there is no scientific processing of C&D waste, while 10 have said the C&D waste is dumped in low-lying areas and landfills and there is no formal collection system. This highlights how deficient waste management infrastructure in cities is.

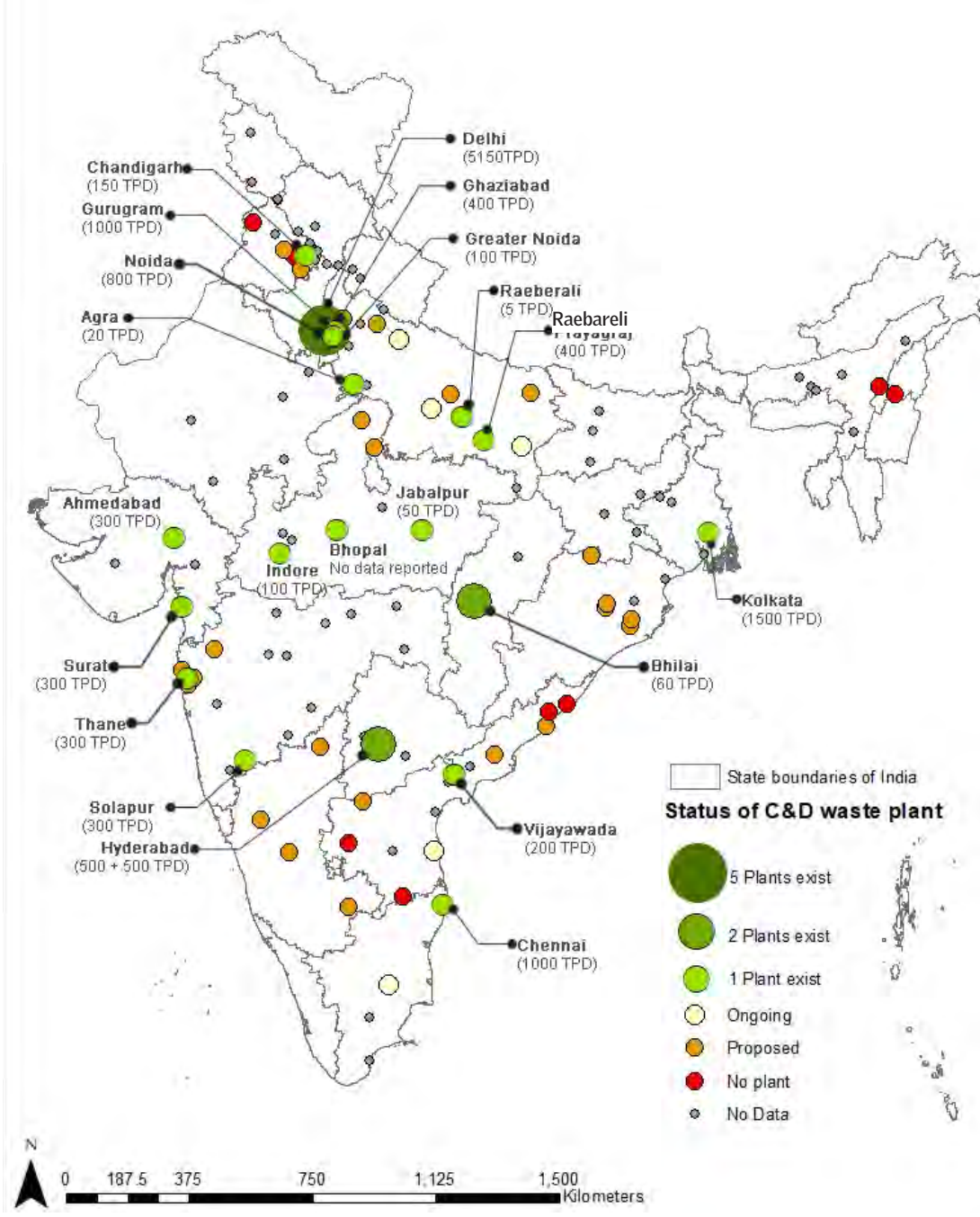
Also, going by the SBM 2.0 thumb rule, the current recycling capacity exceeds the volume of waste estimated for the cities. This once again indicates that the thumb rules for estimation itself needs to be reviewed. As cities are planning recycling infrastructure, there is enormous curiosity about the key elements of a recycling facility, including processing technologies, equipment, costing, on-site compliances and recycled products. Annexure 12 provides an overview of these elements based on a deep-dive case study (see *Map 6: City-wise status and number of recycling plants with processing capacity in TPD*).

Other than this, there are a few concerns related to technology choices, operational requirements and efficiency:

Better levels of segregation are required for efficiency: Most plant operators have reported lack of segregation during collection and transportation as a major concern. Presence of solid waste like cloth pieces, plastics, glass and other materials in the C&D waste increases processing time and resources as it requires manual separation of these items. Lack of segregation brings down the quality of the recycled C&D products — plant operators point out that the presence of concrete yields high quality recycled C&D waste products. In some cases, like in Bakkarwala in Delhi, plant operators can reject C&D waste feed if it contains more than 10 per cent of other solid waste items mixed within. Usually, about 5-6 per cent of the waste feed C&D waste recycling plants receive is made up of municipal solid waste.

Wet processing technology yields quality products, but is resource-intensive: Recycled aggregates that can replace river sand can be created only through wet processing technology. This technology does not leave behind light contaminants and fine particles. But it costs about 10-12 per cent higher than dry processing — a wet processing unit costs roughly Rs 5.5 core for 500 TPD processing capacity, while a dry crusher costs around Rs 1.5 crore for the same capacity. Further, dry processing unit fetches more revenue due to lesser electricity consumption. Wet

Map 6: City-wise status and number of recycling plants with processing capacity in TPD



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB[8]

processing requires tanks – one for water and the other for soil; which means wet processing technology requires more space as well. A separate space is also required for storing silt. Dry processing technology, on the other hand, leaves behind lesser residues.

Spillage, safety and dust are key operational challenges: Most recycling plants operate with conveyor belts that are open — there is no green cover or metal hood over the belts. Very few cities — such as Pimpri Chinchwad — have covered the conveyor belts to prevent fugitive dust emissions. Open conveyor belts lead to spillage and compromise the safety of workers. Ignorance and lack of training among workers who belong mainly to the informal sector aggravate this issue. They need to be trained regularly.

Mandate is needed for using recycled C&D waste products is crucial: Many cities do not have a mandate for reuse of C&D waste products. Regular waste feeds to processing plants — but low sales — leads to huge stockpiles of recycled products lying at the facility. Plant operators have limited site areas, and face a space crunch under these circumstances. The quality of products also gets compromised.

Waste bye-laws

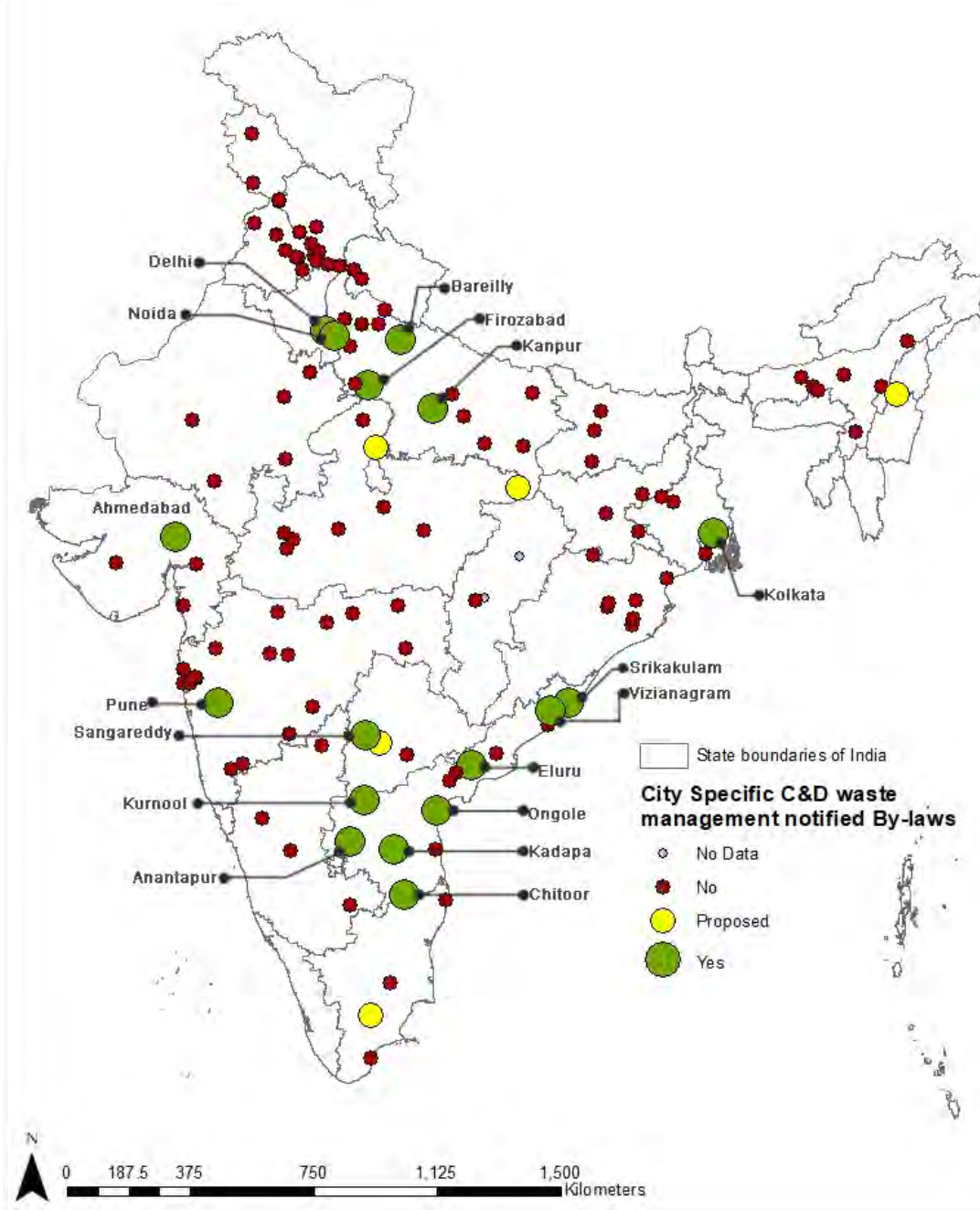
The C&D Waste Management Rules of 2016 has mandated cities to notify municipal bye-laws aligned with the provisions of the Rules to make them enforceable. Notification of bye-laws can legally force waste generators to hand over their C&D waste to ULBs or selected service providers, segregate at source into four-five streams, and prepare and submit a C&D waste management plan along with the building permission request.

According to data uploaded on PRANA, 17 cities have prepared and notified their C&D waste bye-laws (see *Map 7: Notification of C&D waste bye-laws by cities*).[8] These include cities like Delhi, Noida, Kolkata, Ahmedabad and Pune, among others; a few more – like Jhansi and Hyderabad — have proposed their bye-laws.

Helpline and mobile app

The Swachh Bharat Mission (SBM) and Swachh Survekshan are initiatives launched by the Union Ministry of Housing and Urban Affairs to encourage cities to manage their waste scientifically, achieve 100 per cent segregation and recycling, and also monitor progress. One of the key indicators of the monitoring arrangement is an on-call system for collection of C&D waste. Cities are dedicating helpline numbers or developing mobile apps as part of this system. According to

Map 7: Notification of C&D waste bye-laws by cities

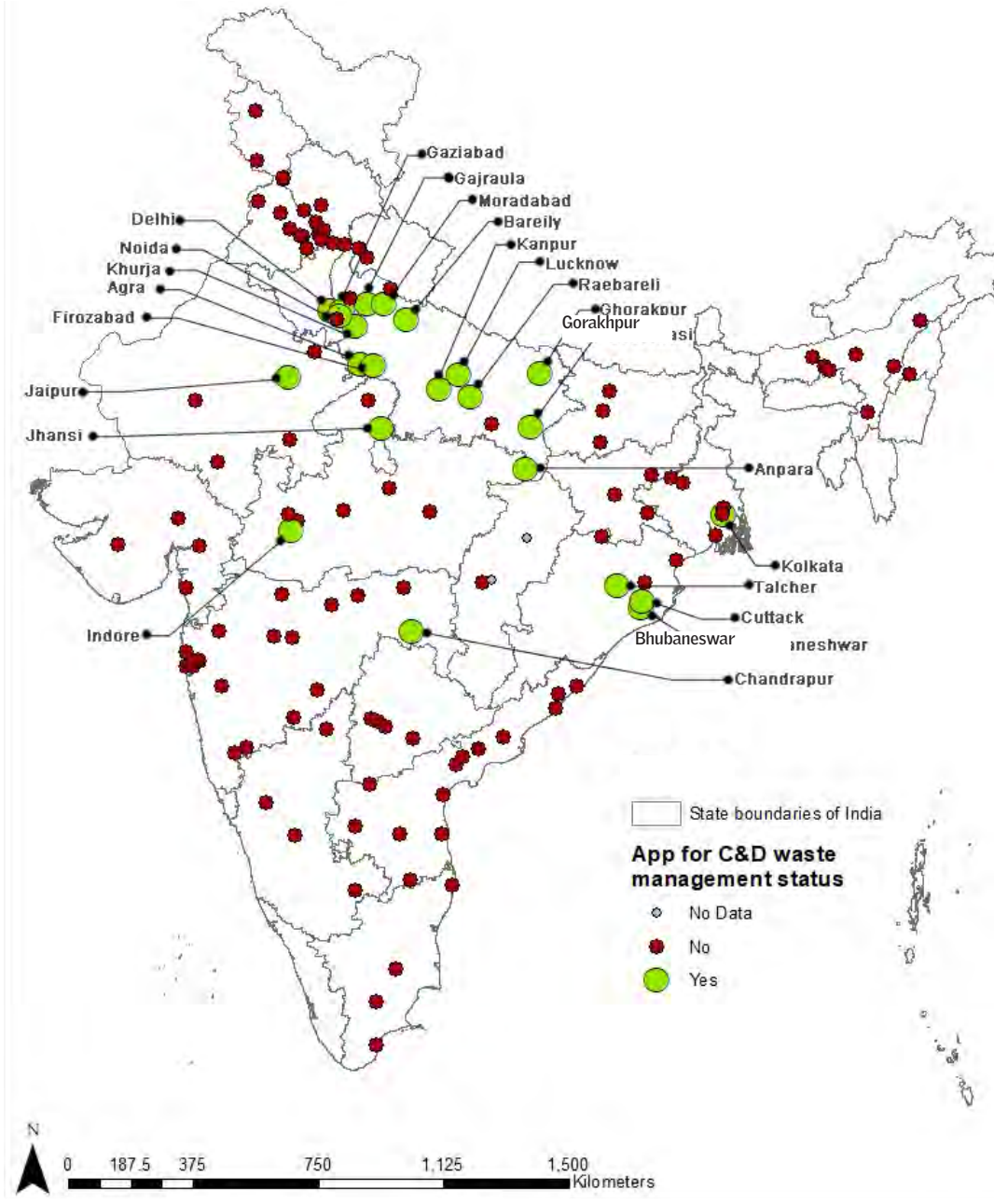


Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB[9]

data submitted on PRANA, 23 cities have developed a mobile app and 12 have notified a helpline (see *Map 8: Cities that have developed a mobile app for C&D waste collection, transportation and disposal*, and *Map 9: Cities that have a dedicated helpline for placing collection requests and complaints*).[9]

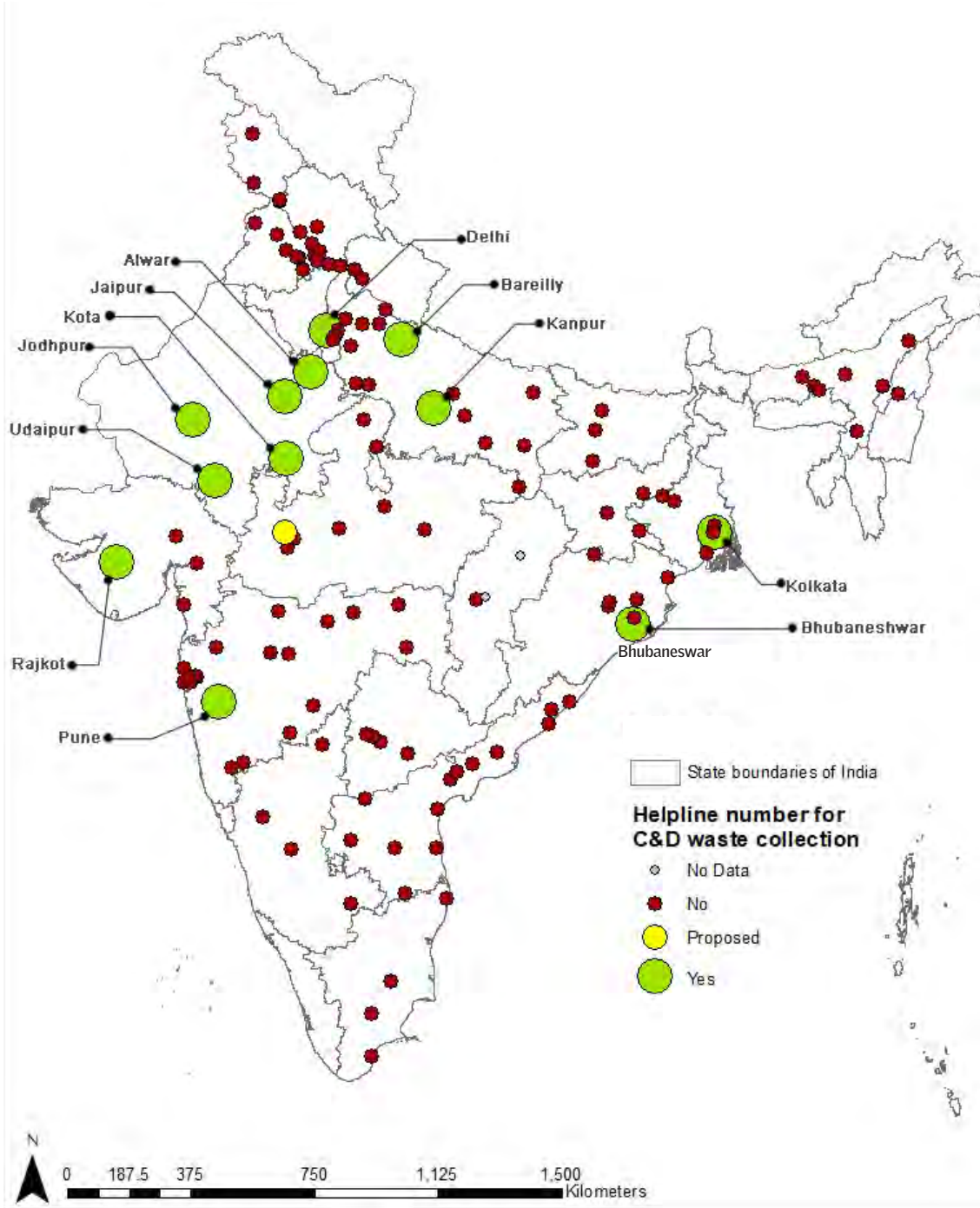
Cities that have developed a mobile app include Delhi, Noida, Jaipur, Kolkata, Bhubaneswar, Cuttack, Indore, Chandrapur, and most NACs in Uttar Pradesh. Dedicated helplines are running in Delhi, Pune, Rajkot, Kolkata, Bhubaneswar, Kanpur, Bareilly and all NACs in Rajasthan.

Map 8: Cities that have developed a mobile app for C&D waste collection, transportation and disposal



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB[10]

Map 9: Cities that have a dedicated helpline for placing collection requests and complaints



Source: Map created by CSE. Data compiled and processed from micro-action plans uploaded on the official website of CPCB[11]

3

TOWARDS AN ECOSYSTEM APPROACH

- Simply building a recycling plant will not ensure segregated collection; merely notifying bye-laws will not prevent illegal dumping. All measures need to be taken simultaneously and in equal intensity to complete the ecosystem.

- It is critical to know the volume of C&D waste in the city that needs to be managed and processed. Without it, it will be difficult to plan the recycling capacity, collection and transportation infrastructure etc.

- Cities have adopted different models of collection. What is largely common in most is the identification of bulk generators and mandating them to transport and dispose of their waste at designated sites.

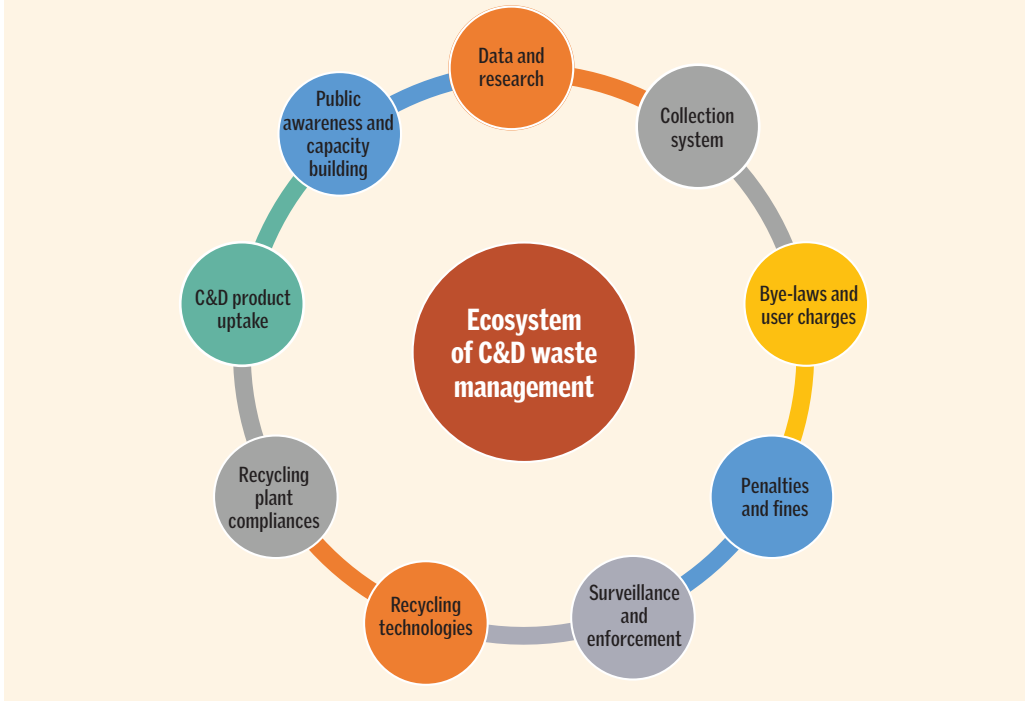
- The C&D Waste Rules ask cities to prepare and notify their C&D waste bye-laws to enable implementation of its provisions. This is important to make waste generators responsible for disposal. Only 17 cities have so far prepared and notified these bye-laws.

- Waste generators are expected to pay user charges for carting their C&D waste to a recycling plant. What cities are struggling with is managing the legacy waste, which is the ULB's responsibility. This is a costly exercise. Therefore, while cities are fixing their user charges, a parallel funding stream for legacy and unclaimed waste must be incorporated into their plans.

As more cities move towards establishing recycling plants, it is clear that they need to adopt an ecosystem approach for enabling proper C&D waste collection, transport, recycling and reuse along with dust abatement in construction activities (see *Figure 2: Key components of an ecosystem approach towards C&D waste management*). Absence of even one component of this ecosystem approach can prevent cities from optimising their strategies and achieving the desired air quality or waste management targets.

For instance, when Delhi set up its first recycling plant in 2009, it faced the problem of low to no uptake of recycled products for many years, rendering the plant financially unfeasible. Only when the Delhi government mandated replacement of 2-5 per cent of construction material with recycled C&D waste products in government projects, the situation started to change. This measure has created a demand pull for recycled products. Thus, only developing a recycling plant will not ensure proper segregated collection, and merely notifying bye-laws will not prevent illegal dumping. All measures need to be taken simultaneously and in equal intensity to complete the ecosystem.

Figure 2: Key components of an ecosystem approach towards C&D waste management



Data and research for problem assessment

CSE's engagement in different cities has revealed that ULBs often find themselves questioning the volume of C&D waste that needs to be managed. This includes both the legacy waste and the daily generation. In the absence of a formal collection system, the informal networks in cities collect, transport and dispose of the waste, mostly at unauthorised sites.

For instance, it has been reported that Gurugram has a legacy waste of nearly eight lakh tonne according to a report compiled by the Municipal Corporation of Gurugram (MCG) in 2020. Of this, 1.25 lakh was cleared by MCG during the seven months of COVID-19 lockdown in 2020; most of this was cleared off the Aravalli bio-diversity zone.[10]

Similarly, ULBs in coastal and riverine cities like Kolkata and Bhubaneswar have reported that their designated disposal sites do not receive much C&D waste as most of the waste is used for backfilling in low-lying areas and reclamation of wetlands.

Legacy waste and illegal dumping of C&D waste are big problems, especially in cities with ridges, rivers and lakes or those in eco-sensitive geographies like hilly and coastal areas. It is easy to dispose the waste in such abundant vacant spaces that are not under surveillance. As a result, the waste does not reach the designated disposal sites and the ULBs never get to know the quantum of C&D waste generation.

It is critical to know the volume of C&D waste in the city that needs to be managed and processed. Recycling capacity, collection and transportation infrastructure and humanpower are all linked with the volume of the waste. So far, ULBs have set up recycling plants with a conservative processing capacity — but this needs to be expanded if the unaccounted illegal dumping is tracked and accounted for.

Gurugram, for example, started off with a 300-TPD recycling plant that was further expanded to 1,500 TPD in less than two years. In the absence of another plant and weak enforcement, dumping in the Aravallis has continued. It has also been reported that about 2,500 tonne of fresh C&D waste is being dumped along the roadsides of this millennium city every day.[11]

There are several methods that are used globally to determine the volume of C&D waste. These methods are applicable from a project scale to a regional scale. Site

visit or direct measurement method is based on the floor area of a project, which needs to be gathered from a sample pool of developers. This makes the method time, money and energy consuming. The per-capita multiplier method depends on construction-related statistics. Estimations using geographic information system (GIS) and area-based calculation methods use demolition area data of old buildings, the accuracy of which is not high. Building information modelling (BIM) is also based on demolition data, but can offer better accuracy. While each method has its pros and cons and also a specific requirement of data, area-based calculation is the most popular method in scientific literature.[12]

When it comes to availability of construction data in India, there are several platforms that register building construction projects along with the details of their floor area and location. For instance, the Real Estate (Regulatory and Development) Act, 2016 has led to creation of online state portals. Every developer taking up construction on a more than 500 sq m plot area has to register their project on the state RERA portal. This registration provides the location and built-up area of the development.

Similarly, the Technology Information, Forecasting and Assessment Council (TIFAC) provides thumb rules for generation of C&D waste – these rules say that 50 kg of construction waste is generated for every sq m of built-up area and 300-500 kg of demolition waste per sq m.

CSE has assessed the generation of construction waste in different cities based on the data available on the RERA website (see *Table 4: Projects and estimated construction waste in selected NACs*). Kolkata with 95 registered projects is expected to produce nearly 40,000 tonne of construction waste over five years (average construction span of projects). Similarly, Noida would generate 78,000 tonne from a mere 20 projects, while Bhubaneswar will generate 46,000 tonne from 215 projects; Jaipur is expected to generate a whopping 141,000 tonne of construction waste from 167 projects.

Table 4: Projects and estimated construction waste in selected NACs

City	Number of projects	Estimated construction waste in tonne
Kolkata	95	39,368
Jaipur	167	141,074
Noida	20	78,367
Bhubaneswar	215	46,003

Source: Compiled by CSE from multiple sources

With more ULBs adopting online building permission systems, there is an opportunity to quantify the C&D waste being generated by using an area-based calculation method. There are other online portals like PARIVESH that can allow this quantification. Information on construction material sellers along with their locations, transporters hauling C&D waste materials, frequent illegal dumping points, construction hotspots etc can also enable ULBs to increase stringency in implementation of micro-action plans and monitoring.

Collection systems

Following the notification of the C&D Waste Management Rules, 2016, cities have adopted different models of collection. What is largely common in most of the cities is the identification of bulk generators — those generating more than 20 TPD or 300 tonne per project per month — and mandating these generators to transport and dispose of their waste at designated sites. For instance, Delhi has mandated bulk generators like the Delhi Metro Rail Corporation, Central Public Works Department and National Building Construction Corporation to deposit their waste directly at the recycling plant located in Burari. A processing fee of Rs 205 per tonne is paid to the plant for C&D waste that is mostly unsegregated. This model has ensured regular supply of waste feed to the plant, thus improving its economic feasibility.

The next step for cities is to set up a collection system for small generators. The different collection systems for small generators can be broadly classified into three models:

- **Building permission-linked and/or deliberate disposal:** In this model, generators pay an amount for C&D waste collection, transportation and processing at the time of seeking building permission from the ULB. For instance, Delhi charges Rs 66 per sq m of built-up area when the building developer or owner comes for building construction approval. This is a traditional system in which cities have charged 'malba fee' from building developers or owners for collection of C&D waste, at a time when the responsibility of managing C&D waste was not yet transferred to the generators. The ULB receives the fee in advance at the time of building permission and collects the waste during regular surveillance rounds.

  While this system continues to exist in many cities, new parallel systems have emerged. Delhi has designated C&D waste collection points in each ward. Generators are required to either bring their C&D waste to these points or call the local junior engineer for having the waste collected from the site.

Generators are not required to pay any charges at the time of depositing the C&D waste at the collection point. This system can be deployed both in parallel with the traditional system or as a stand-alone system. However, to encourage generators bring their waste to the collection point would require a lot of public awareness building.

Figure 3: Traditional system of 'malba fee' embedded with building permission

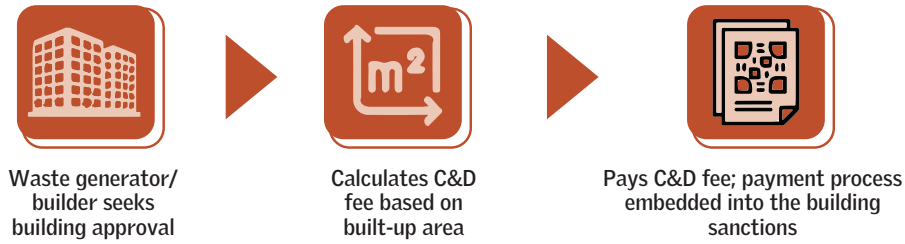


Figure 4: Designated collection points at ward or zone level

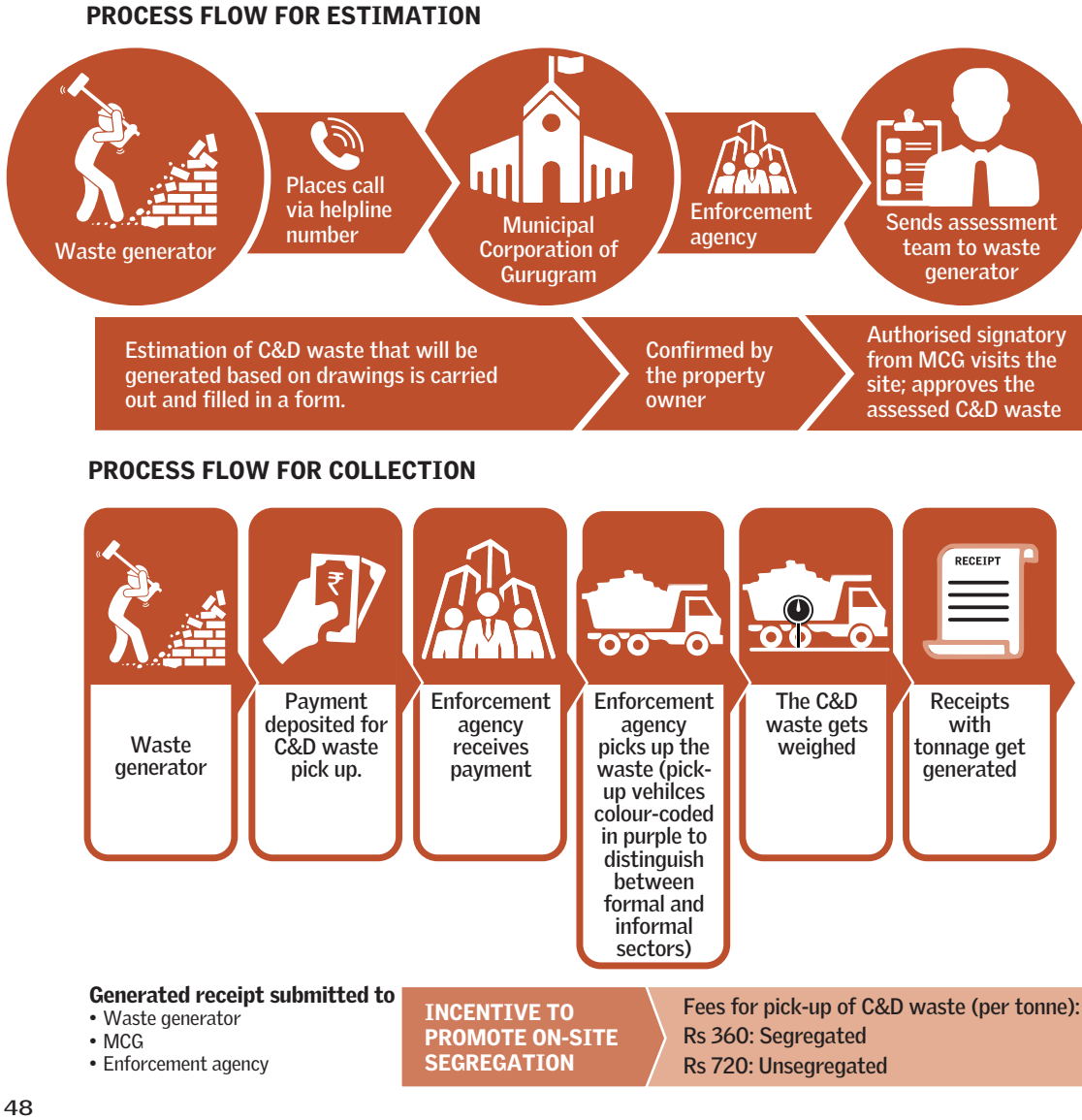
- **On-demand door-to-door model:** As per the requirements of the Swachh Survekshan initiative, the door-to-door collection model is the most popular in cities. Swachh Sarvekshan requires cities to develop a helpline to place requests for collection of C&D waste. In this model, the generator calls the ULB using the helpline number and the ULB sends a team and vehicle for collection. The vehicle weighs the collected waste and issues a payment slip for the generator as per the user fee established by the ULB. This model has been adopted by Gurugram, Ahmedabad, Pune, Pimpri-Chinchwad, Bhubaneswar, Kolkata and Jaipur, among other cities.

  Each city has moulded this collection system to suit their needs. For instance, Pune has designated 10 collection points across the city. If the volume of the waste is less than 10 tonne, generators have to bring the waste and deposit it at the collection centres. If the quantity is more, generators will need to call a toll-free number (1800-10-30222), after which the Pune Municipal Corporation will verify and lift the waste directly from the site by charging a transport and

processing fees. C&D waste generated in municipal works is to be transported to the processing plant directly by the contractor.

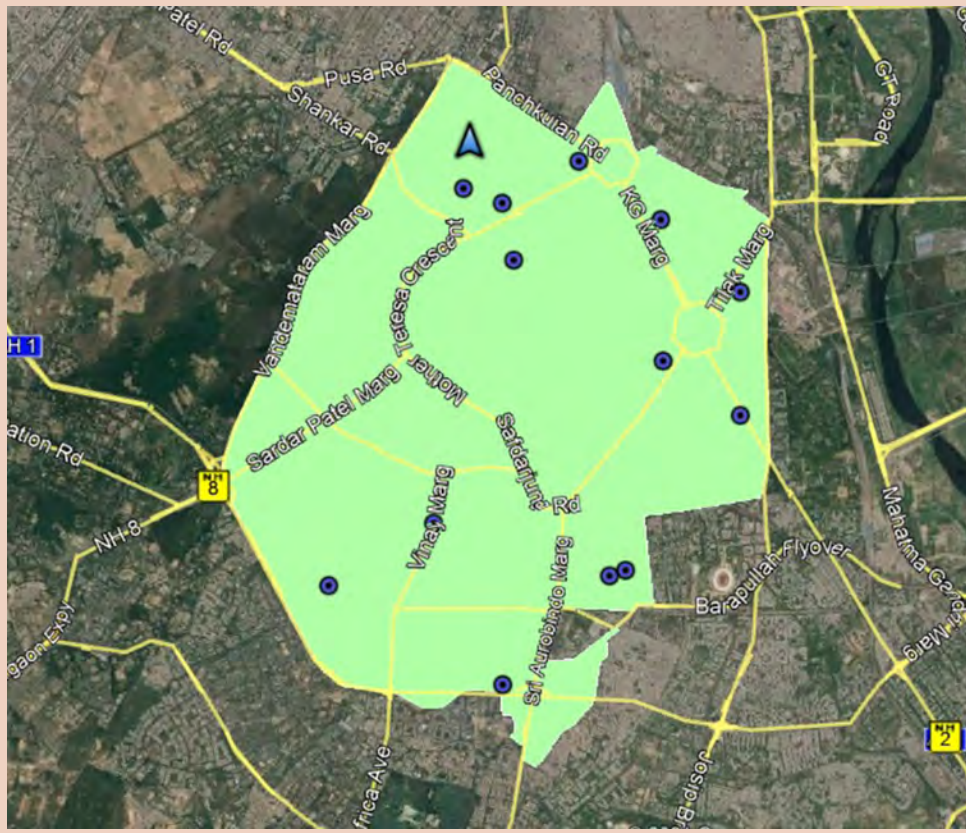
- In case of Gurugram, the Municipal Corporation of Gurugram (MCG) sends an assessment team on receiving a collection request from a generator on its helpline. The team estimates the generation of C&D waste based on the construction area involved and calculates approximate charges; this is counter-signed by the owner/generator. When the waste is actually generated, the MCG sends a collection vehicle, gets the waste weighed and issues a payment slip to the generator based on the actual weight. A pre-collection assessment enables MCG to monitor and anticipate waste from a particular area.

Figure 5: Process flow for estimation and collection of C&D waste in Gurugram



- **GPS and RFID-enabled skips and loaders (tipping fee model):** This is an emerging model in cities. For instance, the New Delhi Municipal Council (NDMC) uses a tipping fee model in which the concessionaire or service provider appointed by the ULB provides skips at identified points across the NDMC area to collect the C&D waste. Waste generators dispose of their waste

Map 10: Location of skips and transfer stations in the NDMC area, Delhi



Transfer station
C&D Waste bin / collection points
New Delhi Municipal Council area

C&D waste bin at Lodhi Colony, New Delhi

Transfer station at C-2, Pocket H, Type 2, President's Enclave, New Delhi

in these skips as and when they generate it. The concessionaire then takes the filled skip in a skip loader and takes it to a transfer station at President's Enclave; the filled skip is replaced here with an empty one. When the transfer station gets full of loaded skips, the concessionaire takes the waste to the disposal site at Shastri Park. Any unauthorisedly dumped C&D waste is also collected and taken to the transfer stations as part of the day-to-day process. The concessionaire is responsible for the upkeep of the skips as well.

- **To ensure smooth operations, the skips and skip loaders are GPS and RFID-tagged:** This enables the concessionaire to monitor the equipment, keep track of the volume of waste collected and disposed of, and of the trips made. This model uses information and communication technology and promises efficiency in operations with real time monitoring. It is suitable for small cities or cities which do not have a recycling plant. Cities that have started setting up their C&D waste collection system can also opt for this model.

Municipal bye-laws related to C&D waste

The C&D Rules provides for cities to prepare and notify their respective C&D waste bye-laws to enable implementation of its provisions. This move is important to legally bind the generators and make them responsible for proper disposal of the waste. Only 17 cities have so far prepared and notified C&D waste bye-laws, as well as penalties and fines for unauthorised disposal of the waste, as part of their larger solid waste bye-laws. For example, Kolkata has notified its solid waste bye-laws in 2020 which includes a penalty of Rs 5,000 each for "not storing and handing over C&D waste in a segregated manner" and "disposing of C&D waste in stormwater drains, roadsides, etc". This penalty compounds on repetition of the offence.

While penalties and fines are a good instrument to curb illegal disposal, C&D waste bye-laws need much more than that. People need to be informed about how to handle this new stream, which agencies are involved, their roles and responsibilities, and what kind of compliances are mandatory. Jaipur is a good example of this – the Jaipur Municipal Corporation has notified the city's C&D waste bye-laws in 2018, which detail out the duties of generators, ULBs and service providers.

According to Jaipur's bye-laws, generators are required to segregate their waste into five streams – concrete, bricks and mortar, soil, steel, wood and plastics. After segregation, they can hand over the waste to the ULB and pay user charges; bulk generators need to submit waste management plans. Duties of the ULB include preparation of a detailed city action plan; collection, transportation and disposal;

integration of C&D waste management with building permissions; surveillance and enforcement; mandating recycle and reuse in government projects; introducing incentives for use of recycled products etc. These bye-laws also mandate generators to reuse as much as 40 per cent of the waste in situ as aggregates to minimise waste generation.

There are several agencies involved in the management of C&D waste. Other than generators, ULBs and service providers, regulators (state pollution control boards) look after environmental compliances, state regional transport offices authorise vehicles hauling C&D waste, the traffic police checks plying of these vehicles and may also penalise for violations such as C&D waste being ferried uncovered (leading to dust pollution), illegal disposal, etc.

C&D waste bye-laws must detail out the duties or all the agencies involved and also the power vested with each agency in the entire process — for instance, which agency can penalise and on which violation. This is crucial to prevent overlaps and lack of coordination. Besides harmonising inter-departmental coordination, creating an overarching body that can monitor implementation, take stock from all agencies and guide them on measures to smoothen operations and clear administrative hurdles, could be very helpful.

User charges

Recycling and reuse of C&D waste is bringing new infrastructure in cities. This means there will be costs incurred to procure and operate this infrastructure. As ULBs do not possess the technical capacity and resources to manage C&D waste, they are opting for public-private partnerships. The moment a private partner or concessionaire comes into the picture, they have to achieve financial feasibility to sustain the recycling plant. This requires continuous payment of user charges against the waste received.

While it is easy to receive user charges from bulk generators, small generators are not amenable to the idea of paying for disposal of waste. Most of the illegal dumping takes place because generators try to avoid payment of user charges. This is why cities have approached the issue of notifying user charges in different ways. The erstwhile East Delhi Municipal Corporation, Jaipur and Kolkata have notified Rs 452.78 per tonne, Rs 390 per tonne and Rs 369 per tonne, respectively. This is a fixed cost model based on the tonnage of waste.

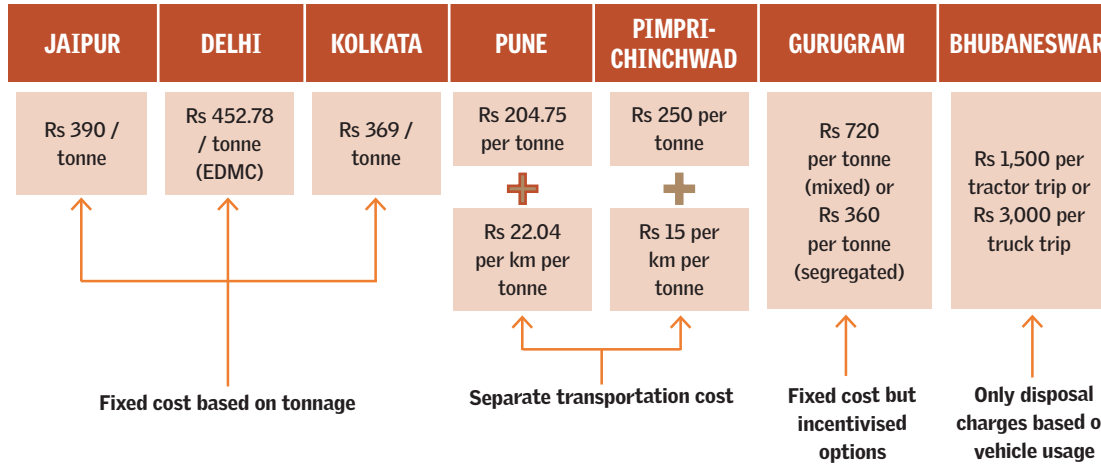
Gurugram also has a fixed cost model, but it encourages at-source segregation through incentivised user fees. It charges Rs 720 per tonne for mixed waste and

Rs 360 per tonne for segregated waste. The 2016 C&D Waste Rules provide for cities to segregate C&D waste at source into at least five streams – concrete, bricks and mortar, soil, steel, wood and plastics. Cities need to encourage at-source segregation as it increases waste reduction potential by in situ reutilisation and choice of processing technology. Segregated waste can be processed using less expensive dry technology deploying mini and mobile crushers; unsegregated waste would require cities to go for wet processing technology that involves more equipment, resources and cost.

Cities which generate relatively less waste compute the cost incurred on the basis of truck loads. Bhubaneswar, for instance, charges Rs 1,500 per tractor trip and Rs 3,000 per truck trip. Transportation is a component that can make or mar a C&D waste management project's financial feasibility. As recycling plants are often located at the periphery of a city, long distances and more number of trips mean high transportation costs, especially in big cities. Pune and Pimpri-Chinchwad have recognised this and notified user charges separately for hauling C&D waste. Pune charges Rs 204.75 per tonne and Rs 22.04 per km per tonne, whereas Pimpri-Chinchwad charges Rs 250 per tonne along with Rs 15 per km per tonne of C&D waste. This enables the ULBs to optimise their user charges effectively.

Traditionally, C&D waste has been disposed of in landfills or used for backfilling. As a result, there is a large amount of legacy C&D waste that remains to be treated and scientifically disposed of. For instance, Gurugram has about 8 lakh tonne lying along roadsides and ridge areas for years, according to a 2020 report of the MCG.

Figure 6: User charges for collection, transportation, processing and disposal of C&D waste



Source: Compiled from various sources

After a recycling plant is built, the freshly generated C&D waste is expected to be carted to it by generators after paying user charges; but the treatment of the legacy waste becomes the ULB's responsibility. This is a costly exercise: cities find it challenging to fund proper treatment of this waste due to financial limitations. Therefore, while cities are fixing their user charges, a parallel funding stream for legacy and unclaimed waste must be incorporated into their plans.

Penalties

Two applications made before the National Green Tribunal (NGT) in 2014 — application numbers 21 and 95 – have helped lay down the penalties for violations related to C&D waste and dust control compliances on site. The penalty is Rs 50,000 per default; for transportation-related violations, it is Rs 5,000 per default. Cities could include these violations and penalties in their bye-laws depending on their size and socio-economic conditions. For instance, Pimpri-Chinchwad imposes a penalty up to 10 times the cost of C&D waste transport and processing fee on illegal dumping. Illegal dumping in Pune attracts a fine of Rs 25,000 per truck. If the quantity is less, the fine would amount to Rs 1,250 per tonne. Moreover, concerned contractors/developers will be banned for one year from taking up PMC contracts if they obstruct drains and rivers.

In the case of disposal of C&D waste (or any other waste) in a water body or on roads and pavements, Kolkata imposes a fine of Rs 5,000 for the first time, followed by Rs 7,500 for second violation and Rs 10,000 for every repeated violation.

Enforcement

Cities need to establish enforcement systems specifying the non-compliances along with the system of penalties. Cities which have notified bye-laws and penalties often face humanpower crunch for enforcement. Administrative overlaps and lack of clarity about penalty powers add to the confusion and weaken enforcement.

However, cities are now earmarking dedicated resources such as on-ground teams to conduct day-to-day inspections and prosecution. For instance, Pimpri-Chinchwad has dedicated a team of four officers called the 'flying squad' for surveillance and penalisation. Gurugram has outsourced its surveillance and enforcement operations to Pragati Al Natural Resource Pvt Ltd – this has helped the city reduce instances of illegal dumping by 60 per cent.

Cities are also going ahead with a 'declaration' or 'undertaking' model. In this model, cities have created an online platform where developers have to mandatorily register any construction or demolition projects larger than 500 sq m plot area. All

ATTENTION:

MANDATORY REGISTRATION ON PORTAL BY ALL PROJECT PROPONENTS, CONTRACTORS, BUILDERS, PERSONS OR AUTHORITY UNDERTAKING CONSTRUCTION AND DEMOLITION ACTIVITY IN NATIONAL CAPITAL TERRITORY OF DELHI

Delhi pollution control committee has developed as online mechanism through a Web Portal called **"Dust Pollution Control Self Assessment" at http://dustcontroldpcc.delhi.gov.in** for self-assessment by construction agencies with respect to dust pollution in their sites in pursuance of directions dated 11.06.2021 by Commission for Air Quality Management.

The above mentioned directions envisage the following compliances by project proponents:

1. All current/upcoming projects (on plot area equal to or greater than 500 square meters) of construction and demolition for civil structures are required to mandatorily register at the web portal.
2. To self-monitor/self-audit their activities on the parameters mandated/directed for compliance and to take necessary steps, if required, to improve the status of compliance.
3. The project proponents are required to carry out self-audit/self-determination for dust control measures on the parameters provided on the Web Portal and upload a self-declaration on a fortnightly basis.
4. The provision of video fencing the remote connectivity of the projects (within the municipal area of NCR and plot area equal to or greater than 500 sqm) is part of portal.
5. Reliable low cost PM2.5 and PM10 sensors are to be installed at the project site linked to a cloud storage platform with a live Dash Board in the Web portal.

All project proponentws, contractors, builders, persons or authority undertaking construction and demolition activity in National Capital Territory of Delhi are directed to mandatorily register on the Web Portal.

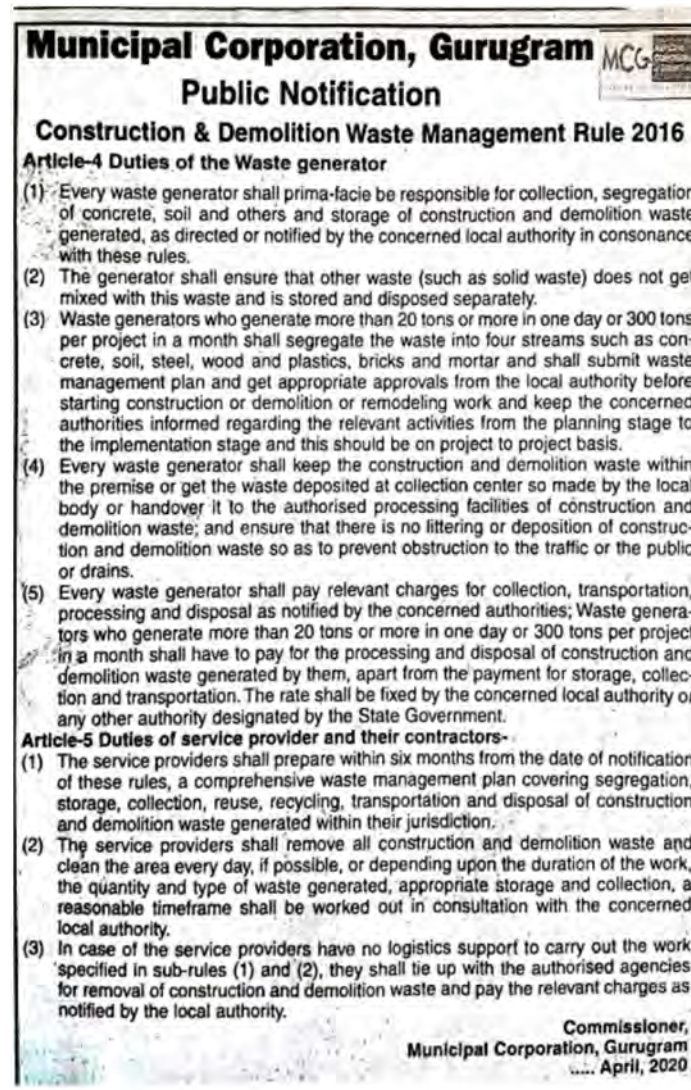
Source: DPCC

registrants have to conduct self-audits as per the provisions specified in the C&D Waste Management Rules, 2016 and the Environment (Protection) Amendment Rules, 2018. These self-audits have to be uploaded on the online platform regularly. In the case of Delhi, these audits are required to be uploaded fortnightly.

With increasing use of technology, cities are also developing video-fencing systems in which the project sites are connected remotely to a central server. With access to this server, multiple agencies can remotely monitor sites for non-compliances and issue penalties. Delhi and Kolkata are the first few cities to have developed this online platform with video fencing.

Further, Delhi has developed 586 teams under its anti-dust drive that will operate on-ground to ensure dust compliances. These teams comprise of representatives from different agencies and departments. Of this, 33 teams were contributed by the DPCC, 165 by the revenue department, 300 by the MCD, 20 by DSIDC, 14 by the Delhi Jal Board, 33 by DDA, three by the Delhi Metro Rail Corporation, six each by CPWD and PWD, one by NDMC, four by the Delhi Cantonment Board and one by NHAI. This is good example of dedicating inter-departmental resources with powers to challan for enforcement.

Public notification on C&D waste management in Gurugram



Municipal Corporation, Gurugram MCG

Public Notification

Construction & Demolition Waste Management Rule 2016

Article-4 Duties of the Waste generator

(1) Every waste generator shall prima-facie be responsible for collection, segregation of concrete, soil and others and storage of construction and demolition waste generated, as directed or notified by the concerned local authority in consonance with these rules.

(2) The generator shall ensure that other waste (such as solid waste) does not get mixed with this waste and is stored and disposed separately.

(3) Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar and shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work and keep the concerned authorities informed regarding the relevant activities from the planning stage to the implementation stage and this should be on project to project basis.

(4) Every waste generator shall keep the construction and demolition waste within the premise or get the waste deposited at collection center so made by the local body or handover it to the authorised processing facilities of construction and demolition waste; and ensure that there is no littering or deposition of construction and demolition waste so as to prevent obstruction to the traffic or the public or drains.

(5) Every waste generator shall pay relevant charges for collection, transportation, processing and disposal as notified by the concerned authorities; Waste generators who generate more than 20 tons or more in one day or 300 tons per project in a month shall have to pay for the processing and disposal of construction and demolition waste generated by them, apart from the payment for storage, collection and transportation. The rate shall be fixed by the concerned local authority or any other authority designated by the State Government.

Article-5 Duties of service provider and their contractors-

(1) The service providers shall prepare within six months from the date of notification of these rules, a comprehensive waste management plan covering segregation, storage, collection, reuse, recycling, transportation and disposal of construction and demolition waste generated within their jurisdiction.

(2) The service providers shall remove all construction and demolition waste and clean the area every day, if possible, or depending upon the duration of the work, the quantity and type of waste generated, appropriate storage and collection, a reasonable timeframe shall be worked out in consultation with the concerned local authority.

(3) In case of the service providers have no logistics support to carry out the work specified in sub-rules (1) and (2), they shall tie up with the authorised agencies for removal of construction and demolition waste and pay the relevant charges as notified by the local authority.

Commissioner,
Municipal Corporation, Gurugram
.... April, 2020

Public awareness and capacity building

Cities will find it very difficult to implement the C&D Waste Rules and dust compliances without making the general public aware, and without building capacity of the municipal staff. Currently, cities are publishing the compliance requirements in daily newspapers and installing billboards. Involving self-help groups in the collection system can guide people on the compliance requirements. This will require developing standard operating procedures and conducting training programmes for collection teams. Awareness instruments like posters, jingles and awareness campaigns organised with resident welfare associations and other civil society organisations can enable public awareness and capacity building.

4

DUST CONTROL TECHNIQUES IN THE SECTOR

- The construction sector and its related activities are potent sources of dust pollution. Guidelines for dust control are a part of many regulations in India, ranging from the Factories Act of 1948 to the C&D Waste Management Rules of 2016.

- In the absence of adequate collection points or transfer stations, C&D waste is either dumped illegally or used for backfilling. This creates pollution hotspots.

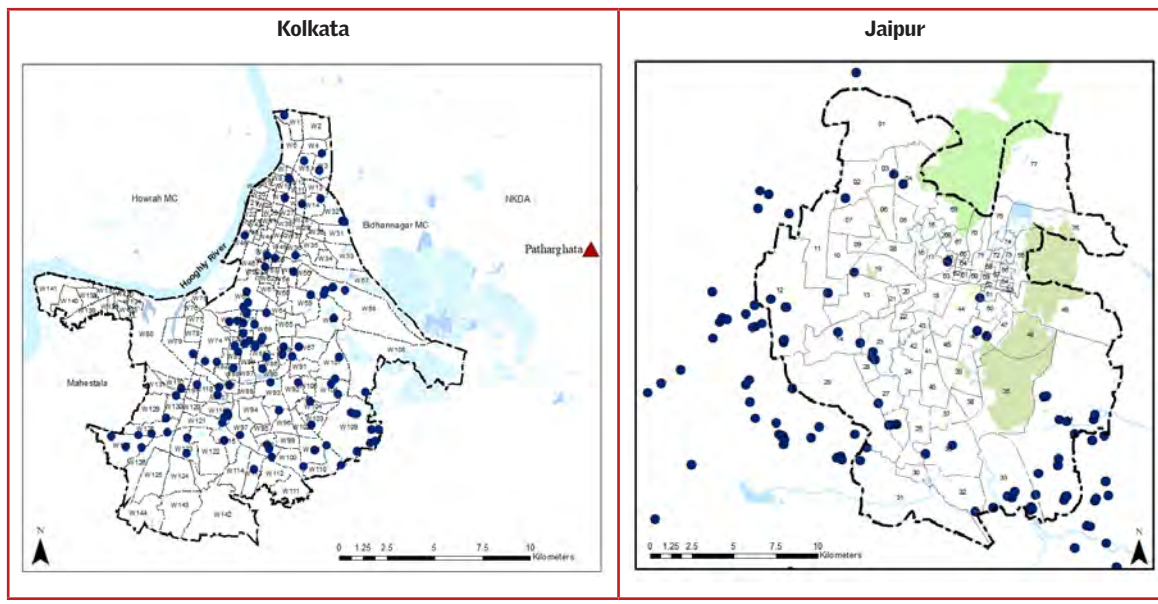
- To control dust pollution at construction sites, water sprays, wind breakers and dust suppressants can be used. Loading/unloading activities should be done on the downwind side of the storage pile. Storing areas and stockpiles should be covered and secured.

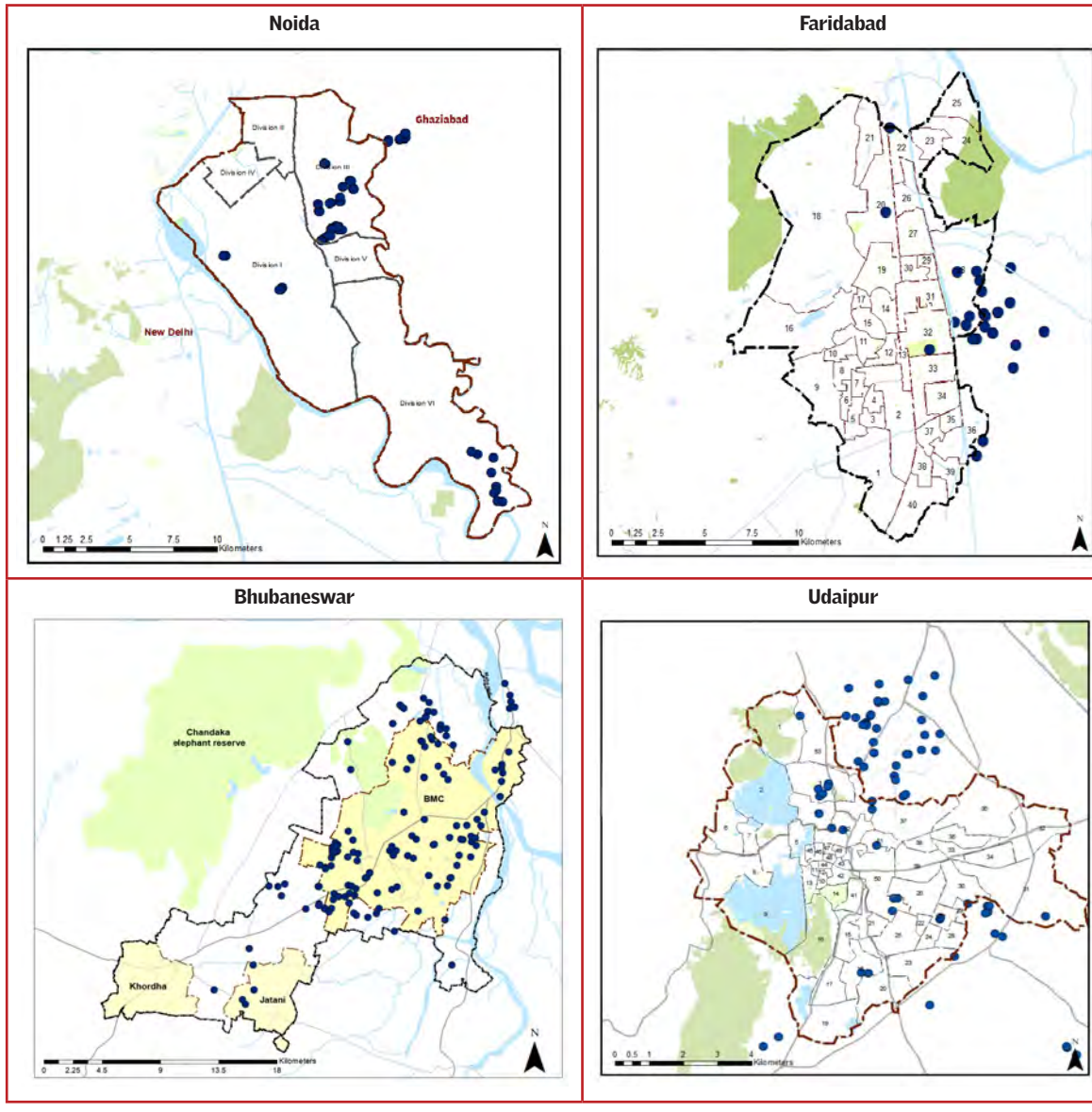
India is witnessing enormous construction activity. While the intensity of construction is already high in large cities, tiers 1 and 2 towns are seeing a massive surge as well. The RERA database of such cities reveals a considerable number of projects underway (see *Map 11: Location of projects registered with RERA in various cities*). This makes the construction sector and several segments of the construction value chain — such as building sites, material selling points, C&D waste disposal areas and processing sites and routes connecting these locations — highly potent sources of dust pollution.

CSE has mapped these segments of the construction value chain in different cities. Several examples of compliance and non-compliance have been observed. Of these, the good practices stem from the various guidelines for dust control that have been in existence for decades in India – such as those earmarked in the Factories Act, 1948 or the Environment Protection Rules, 1986. Newer regulations include the C&D Waste Management Rules, 2016; the 2017 CPCB guidelines on dust mitigation measures in handling construction materials and C&D waste; and the CPCB's Guidelines for Environmental Management of C&D Waste. The most recent mandate for dust control has come from the Environment (Protection) Amendment Rules, 2018.

Guidelines of the Council of Scientific and Industrial Research-National Environmental Engineering Research Institute (CSIR-NEERI) for control of dust pollution at construction and demolition sites and transportation of debris

Map 11: Location of projects registered with RERA in various cities





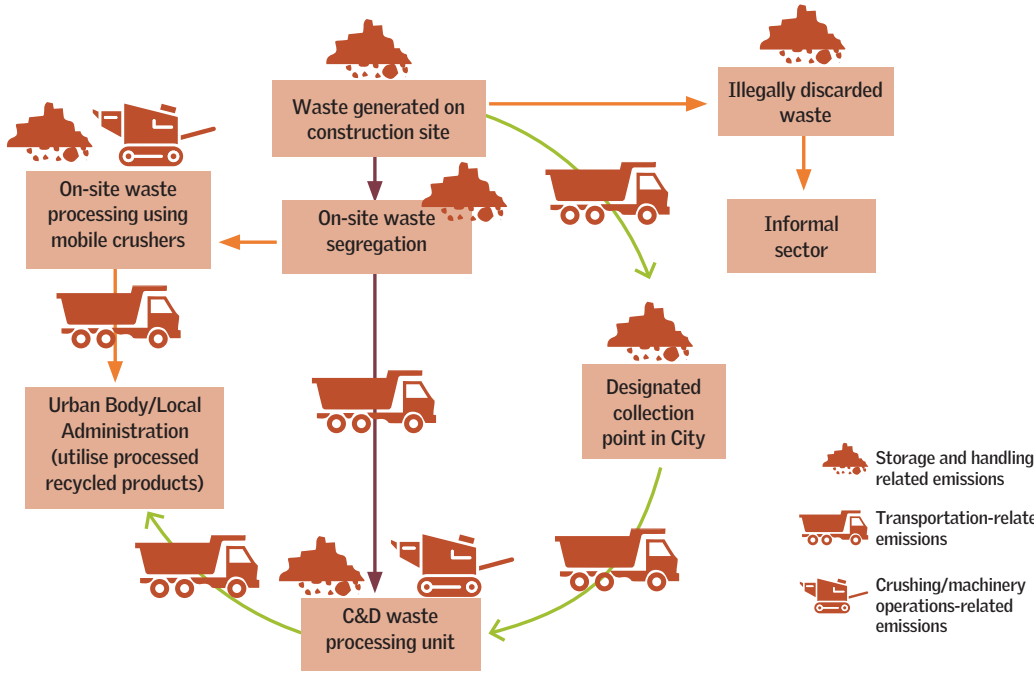
Source: Mapped by CSE from State RERA databases

and construction materials are available in the form of a guidebook.[14] Several international guidelines have also been considered in this study.[15, 16 & 17]

Collection, handling and storage of C&D waste and construction material

Handling and treatment of C&D waste involves all point, line and area sources of emissions (see *Figure 7: Emissions related to C&D waste handling*). In the absence of adequate collection points or transfer stations, C&D waste is either dumped illegally or used for backfilling. This has created pollution hotspots.

Figure 7: Sources of dust pollution in the C&D waste management loop



Source: National Resource Efficiency Policy, MOHUA

ULBs can eliminate these emissions by providing dedicated collection points or transfer stations.

The CPCB and CSIR-NEERI guidelines suggest dampening C&D waste stockpiles at collection points or transfer stations and using wind barriers to minimise fugitive dust emissions. However, such measures and techniques need to be properly designed for ensuring effectiveness.

CSE recommends minimising the drop height and emptying the container carrying C&D waste slowly. A number of other recommendations have been listed in the box on methods of controlling dust at construction sites (see page 59).

C&D waste and material transportation

Uncovered transportation of materials with silt content leads to fugitive dust emissions. Vehicular movement on unpaved staging or parking areas, material storage areas, access points, as well as haul roads and paved roadways also emits enormous amounts of dust. This makes this activity a linear source of emissions. CSE's field investigations revealed several non-compliances, especially uncovered trucks hauling C&D waste and materials.

C&D waste material transportation

Other forms of dust/particle emissions are from diesel engine exhausts, fugitive dust from loaded material, dust tracks of tyres, wearing and tearing of rubber tyres, and re-suspension of road dust (see *Figure 18: Emissions related to transportation* in and out of the site). CSE recommends that in addition to covering vehicles with non-cloth material, dust must be suppressed by sprinkling of water over the top of materials being transported, and washed or scrubbed off tyres of trucks. It is also necessary to speed up renewal of the transport fleet to ensure they meet the latest emission standards.

METHODS OF CONTROLLING DUST DURING HANDLING AND STORAGE

- C&D waste or construction materials should be emptied slowly, while keeping the receiving container close to the loader (drop height to be kept at a minimum).
- Water spray and wind breakers can be used while handling C&D waste or construction materials; wind breakers can be installed near unloading and loading points (see Figure 8).
- Dust suppressants should be applied to the top surface of the C&D waste or material stockpiles to be transported.
- C&D waste or construction materials loading and unloading activities should be confined to the downwind side (side that is protected from the wind) of the storage pile (see Figure 9).
- Areas for storing C&D waste or materials can be barricaded and demarcated with proper signage; contaminated materials should be stockpiled on an impermeable surface (see Figures 14-15).
- Dust suppressants can be used on materials in which hard crusts are formed (upon usage of dust suppressants); however, overuse should be avoided.
- Stockpiles to be securely sheeted, enclosed and kept away from the site boundary, sensitive receptors, water courses and surface drains (see Figures 10 and 11).
- Steep sloped stockpiles to be avoided — gradual slopes to be used (see Figure 12).
- Minimise excessive stockpiling of waste and materials by phasing works and scheduling transfer for recycling.
- Wind-breaks to be provided to deflect wind away from waste stockpiles (see Figure 16).

Figure 8: Use of wind breaker and water spray while handling C&D waste; wind breakers to be installed near unloading and loading points

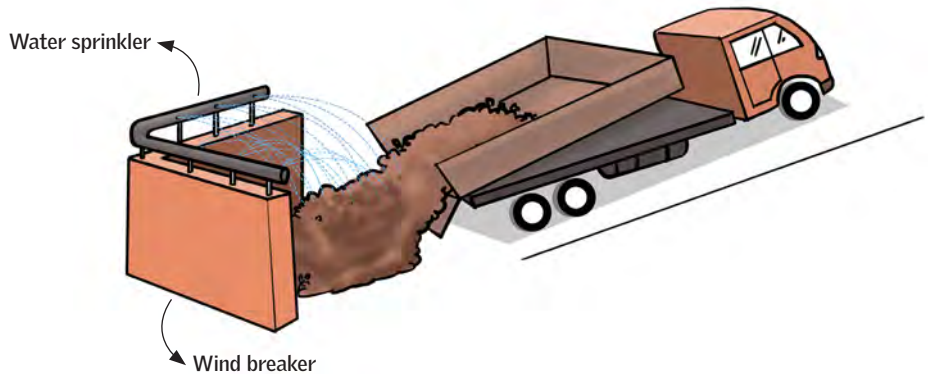


Figure 9: Material loading and unloading activities to be confined to downwind side (protected from the wind) of the storage pile

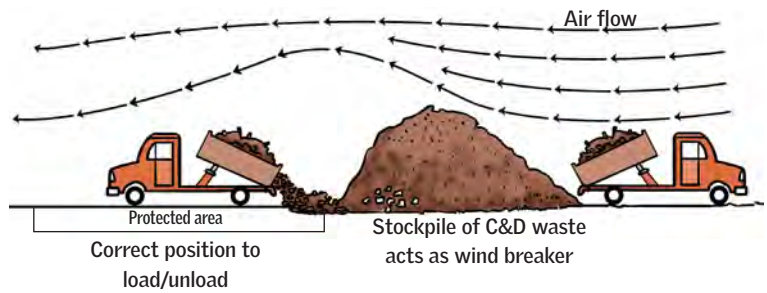


Figure 10: Stockpiles to be securely sheeted, enclosed and kept away from site boundary, sensitive receptors, water courses and surface drains

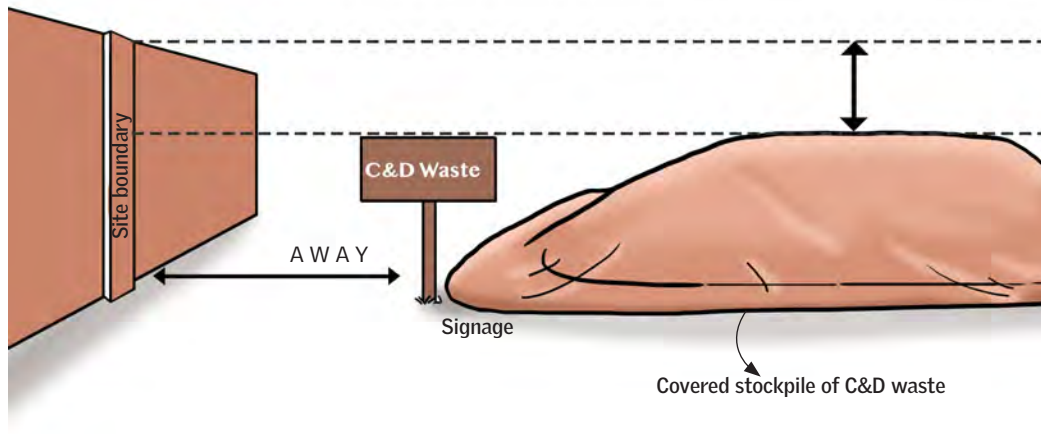


Figure 11: Improper covering of stockpile and application of dust suppressants

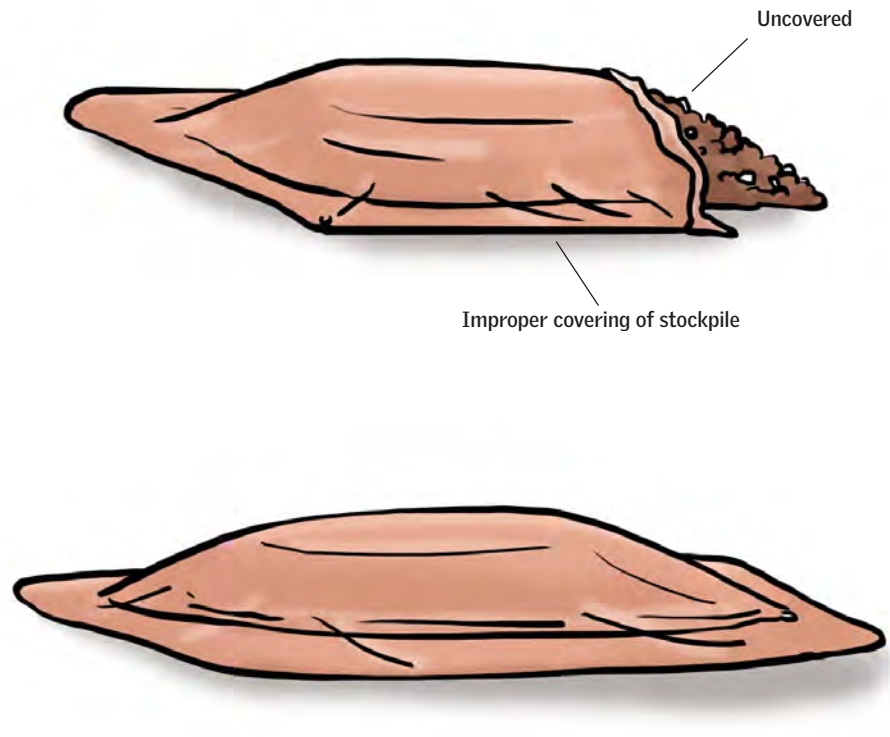


Figure 12: Steep-sloped stockpiles to be avoided; gradual slopes to be used. Stockpile height to be kept lower than that of wind breakers

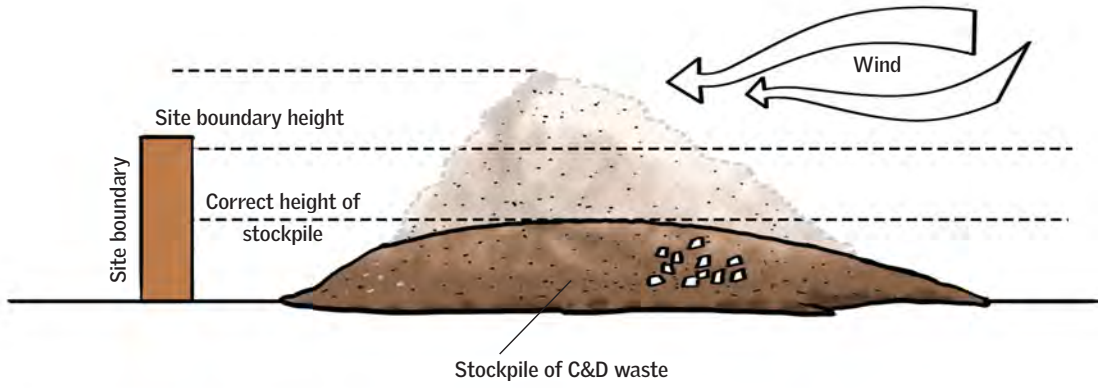
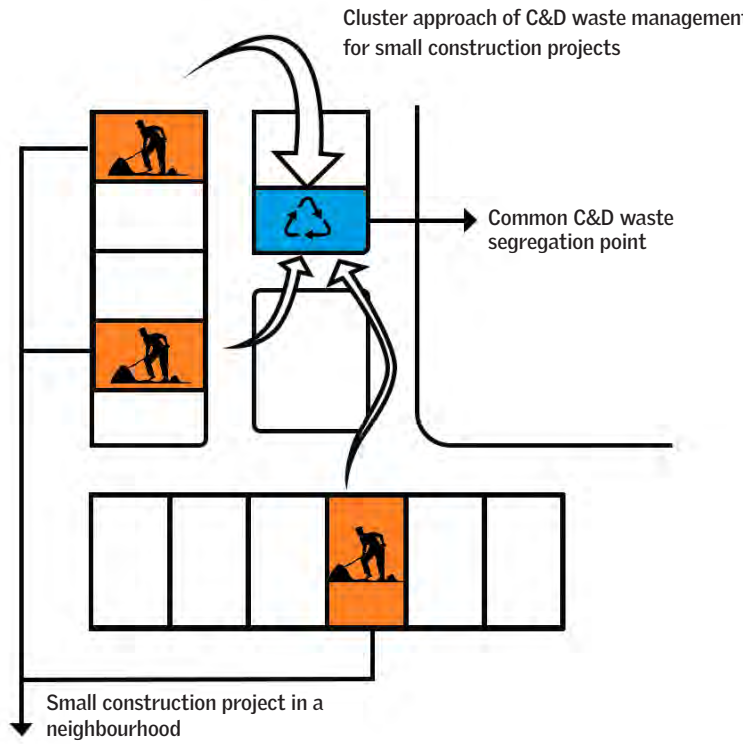


Figure 13: Waste storage points for segregation to be identified on common site for multiple small projects in vicinity of each other



Figures 14-15: Areas for storing materials and C&D waste to be barricaded and demarcated with signage; contaminated materials to be stockpiled on impermeable surface

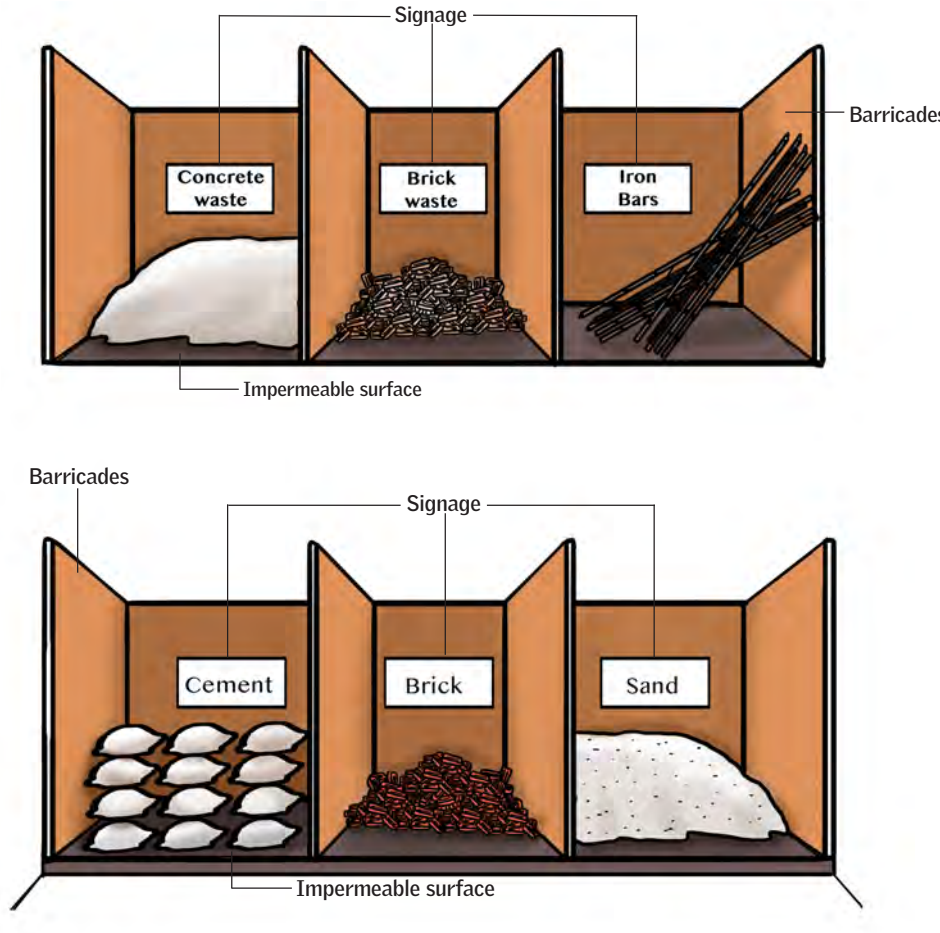


Figure 16: Wind-breaks to be provided to deflect wind away from waste stockpiles

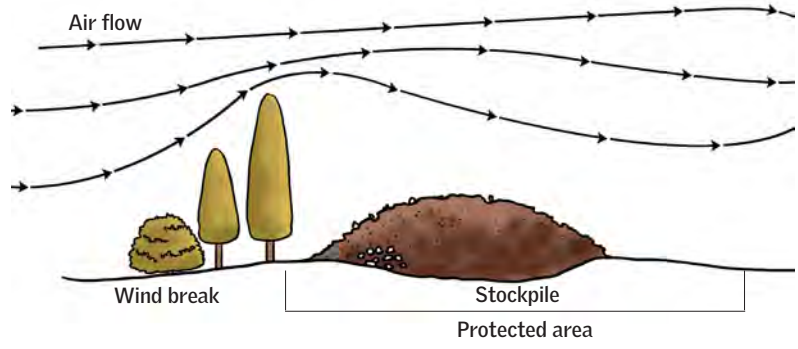
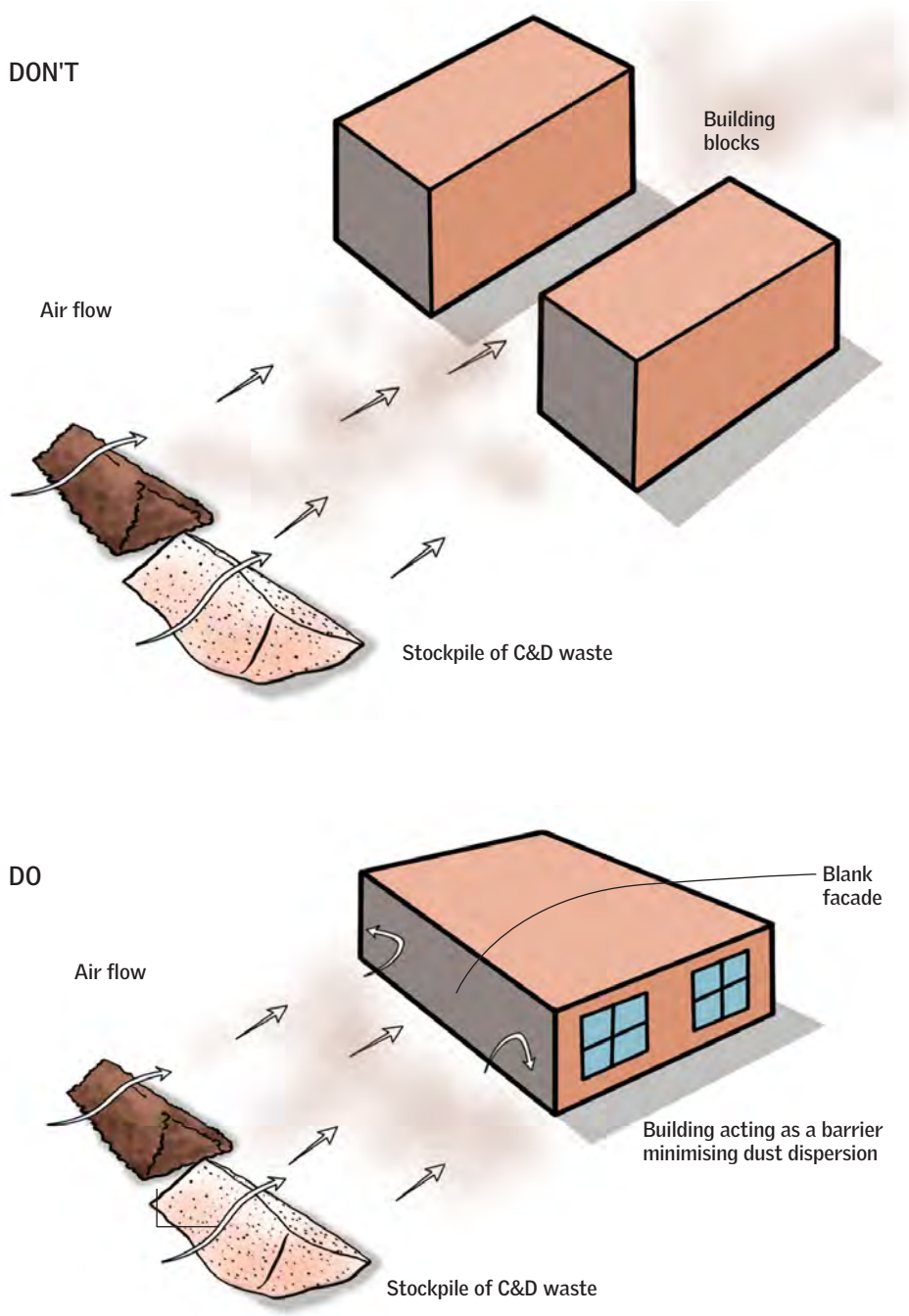


Figure 17: In transfer stations, main building to face the predominant wind direction to be used as a barrier; this facade must not have windows

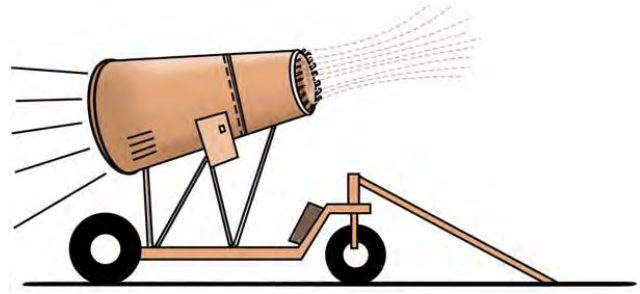


DUST RETENTION AND SUPPRESSION AT CONSTRUCTION SITES

Construction sites are crucial sources of dust pollution. If cities can arrest the rising dust emissions at construction sites, they can reduce city-wide particulate pollution substantially. A construction site mainly involves area sources of emissions. With activities like site clearing and excavation, demolition and dismantling, construction of building envelope, laying of pathways for internal circulation, surface finishing works and operation of heavy machinery, a construction site has multiple sources of dust emissions.

- Dust suppressants can be used while conducting demolition activities as per the CSIR-NEERI guidelines (2019)
- Dust mitigation practices should be a part of the environmental management plan for projects requiring environmental clearance.
- Buildings should be designed with minimum interference to natural topography to ensure minimum cut and fill.
- Wind breakers installed around the site should have a minimum height of 3 m and a maximum height of 10 m. Wind barriers should be firmly fixed to the ground.
- The windward side (side facing the predominant wind) of the windbreaker should be periodically cleaned of any accumulated material.
- Soil excavation should be practiced with proper dust mitigation measures in place.
- There should be dust barrier sheets on the scaffolding around the construction and demolition building site; all dust mitigation barriers should be displayed prominently. The sheets must be maintained free of holes or cuts (see Figure 21).
- Deconstruct instead of demolish. Undertake a pre-demolition visual assessment of recyclable content to decide on suitable demolition and deconstruction techniques to recover as much material as reasonably practical (see Figure 19).
- Appoint a C&D waste manager for the construction project responsible for implementation of waste management plans, plans for probable on-site reuse and recycling of forecasted waste (see Figure 20).
- Surfaces left exposed after completion of earthworks should be vegetated within 10 days of closure of operations.
- Dust-generating activities being conducted in enclosed spaces should include negative pressure dust collectors to reduce fugitive dust emissions.
- Fogging systems can be used in places with high levels of fugitive dust — fog droplets stick to dust particles and become heavier, thus helping them settle down (see Figure 18).
- Dust-causing construction and demolition activities must be avoided in extremely windy conditions, if possible.
- Cutting and grinding of building materials should be carried out in enclosed areas and a wet jet should be used during the process (see Figure 22).
- Water sprinklers can be used for dust suppression during crushing, grinding and other dust-causing activities.
- Fallen debris from processing should be periodically collected and put for reuse and recycling or disposal.
- Paving or blacktopping of roads within a construction site or leading to a construction site is important.
- Roads (paved and unpaved) within a construction site should be dampened by water sprinklers, preferably with the use of treated wastewater. Dust suppressants may be sprayed prior to handling of materials as per CSIR-NEERI guidelines.
- Unpaved roads should be covered with a three-four inch thick layer of material with a low silt content (such as gravel, slag, recrushed or recycled asphalt and road carpets). Vegetative cover may be used on roads with very low traffic volume (see Figure 23).
- A speed limit should be set for vehicles inside the construction site and speed limit signs (readable from both directions) should be placed; vehicles must move on designated paths in the construction site.
- Provisions for scrubbing off the dirt and mud from tyre of vehicles should be employed; devices such as wheel shakers, wheel washers and grizzlies may be used. These devices should be cleaned regularly.

Figure 18: Fogging systems to be used in places with high levels of fugitive dust – fog droplets stick to dust particles and become heavier, thus helping them settle down



Dust suppressant atomised mist

Figure 19: Deconstruct instead of demolish. Undertake a pre-demolition visual assessment of recyclable content to decide on suitable demolition and deconstruction techniques to recover as much material as reasonably practical

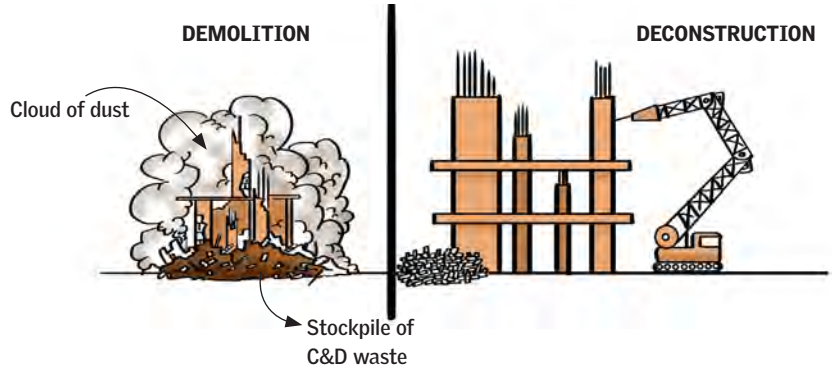
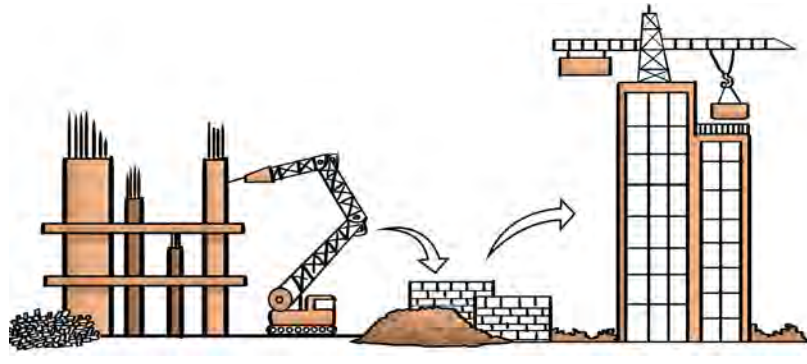


Figure 20: Plan for probable on-site reuse and recycling of forecasted waste



(1) DECONSTRUCTION (2) SEGREGATION OF C&D WASTE (3) RE-USE OF C&D WASTE

Figure 21: Dust barrier sheets to be placed on scaffolding around the building; all dust mitigation barriers to be displayed prominently. The sheets to be maintained free of holes or cuts

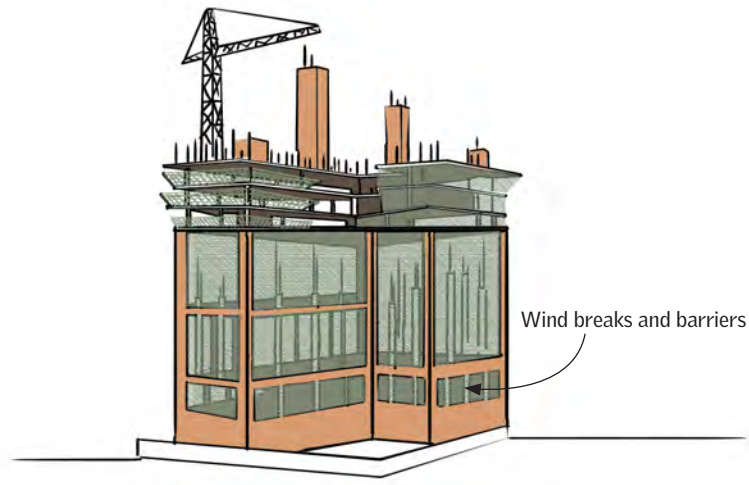


Figure 22: Cutting and grinding of building materials to be carried out in enclosed areas – wet jet to be used

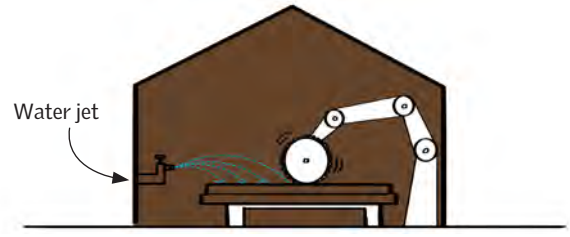


Figure 23: Unpaved roads to be covered with a 3-4 inch-thick layer of material with low silt content (like gravel or slag) – a vegetative cover may be used on very low traffic volume roads

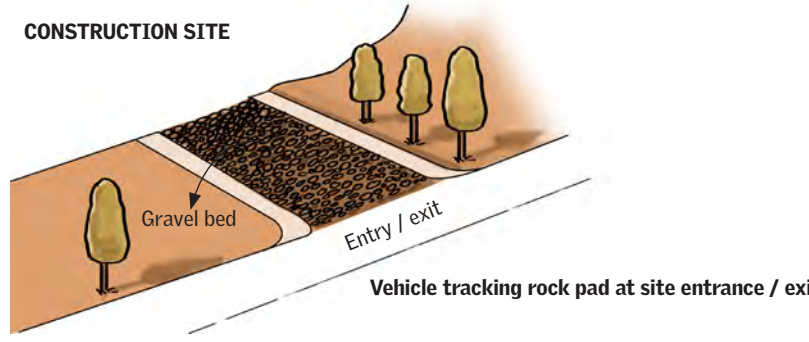


Figure 24: Disturbed areas in construction sites which remain unused for seven days or more to be stabilised to avoid dust dispersion

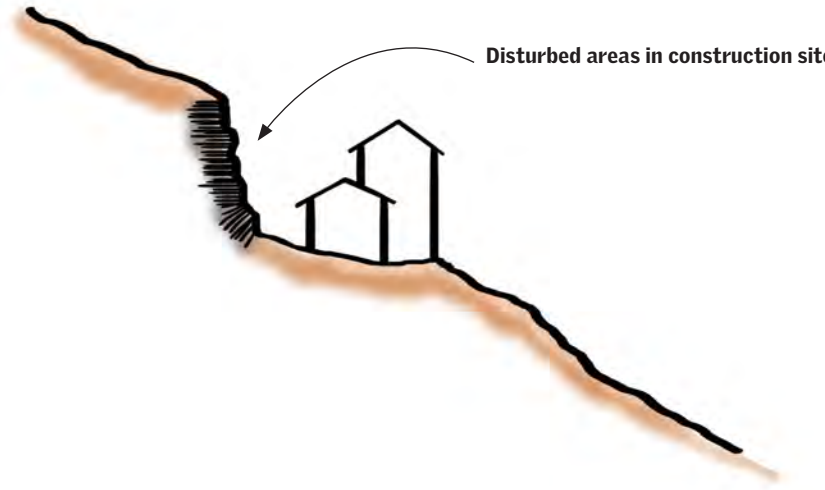
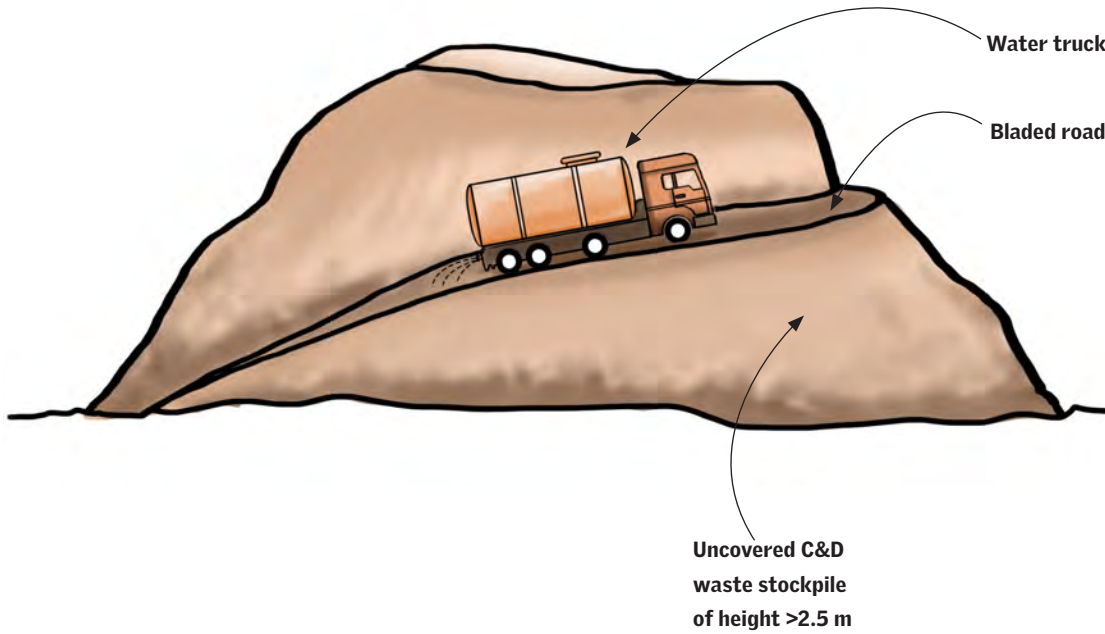


Figure 25: Uncovered storage piles over 2.5-m high to have bladed roads for access of water trucks or other dust suppressant (such as water sprinkling) system to cover the entire stockpile



METHODS OF CONTROLLING DUST DURING MATERIAL TRANSPORTATION

- Vehicles carrying construction and demolition waste should be closed on top and covered with jute, tarpaulin, plastic, etc; the cargo compartment floor should be sealed (see Figure 27).
- A gap should be maintained between the top enclosure of the container and upper surface of loaded material or waste.
- Dust suppressants should be applied to the top surface and entire surface area of the material being transported.
- C&D waste and material carrying vehicles should be equipped with GPS for rationalisation of routes to avoid sensitive receptors and residential and institutional areas, schools and hospitals (see Figure 29).
- Vehicles carrying C&D waste should be colour-coded for easy identification of authorised C&D waste transport vehicles (see Figure 28).

Guidelines for entry and exit of vehicles from C&D waste processing facilities and transfer stations

- Approach and internal roads to and inside the site should be concretised or paved to avoid dispersion of dust particles due to vehicular movement.
- Site entrances should be equipped with monitoring facilities to ensure accountability of movement of vehicles to and from the site; facility boundary should be fenced.
- Under-body wash or wheel washing facilities for C&D waste or material carrying vehicles should be installed at the entrance (see Figure 31).
- Provisions for scrubbing off dirt or mud from tyres of vehicles should be employed; devices such as wheel shakers, wheel washers and grizzlies (rough surfaced areas that scrub off dirt from tyres) can be used. These devices must be cleaned regularly (see Figure 30).
- Micro-sprinklers should be adopted during the crushing process to arrest the dispersion of micro-solid particles.
- Conveyor belts can be enclosed at least from three sides, equipped with belt wipers and cleaned periodically to get rid of residual material.
- Dust generating machinery or blasting operations should be enclosed and the ground underneath should have an impermeable surface.
- Fallen debris from processing must be periodically collected and put back into the system.
- A dust extraction hood should be installed to control dust at the C&D waste processing facility; drop height of the hopper should be kept low to minimise dust dispersal (see Figure 32).

Measures for suppression of road dust

- Vegetation should be planted on streets as per specifications mentioned in IRC:SP:119-2018.
- Bio-filtration systems can help in prevention of re-suspension of dust — these systems such as bio-planters, bio-swales and green cutters can be incorporated on streets as per specifications mentioned in IRC:SP:119-2018.
- Vehicular speed limit should be specified close to the C&D activity hotspots such as the recycling facilities etc to prevent re-suspension of dust (see Figure 36).
- Storage of C&D waste and material on streets must be prohibited; the streets next to heavy C&D activity sites should be cleaned up of dust and debris periodically.
- Roads must be designed with sufficient strength and with proper drainages in order to avoid wear, tear, potholes or deformation of the road surface (see Figure 37).

Figure 26: Emissions related to transportation in and out of the site

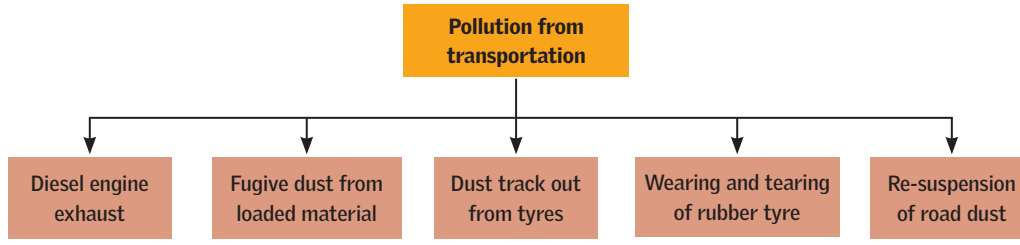


Figure 27: Vehicles carrying C&D waste to be covered from above with jute, tarpaulin, plastic, etc; cargo compartment to be sealed

Figures 28-29: C&D waste and material carrying vehicles to be equipped with GPS; vehicles carrying C&D waste to be colour-coded for easy identification

Figure 30: Provisions needed for scrubbing off dirt and mud from tyres of vehicles — devices such as wheel shakers, wheel washers and grizzlies (rough surfaced areas that scrub off dirt from tyres)

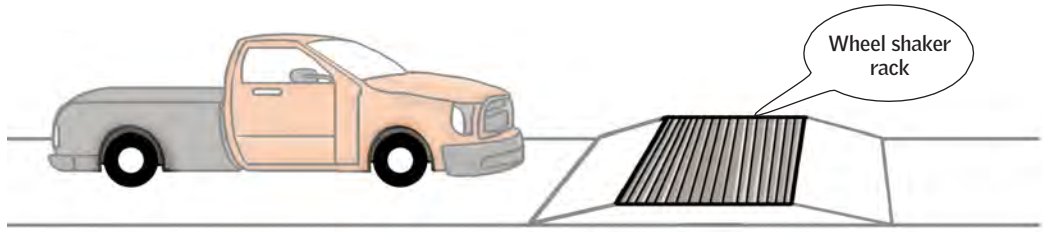
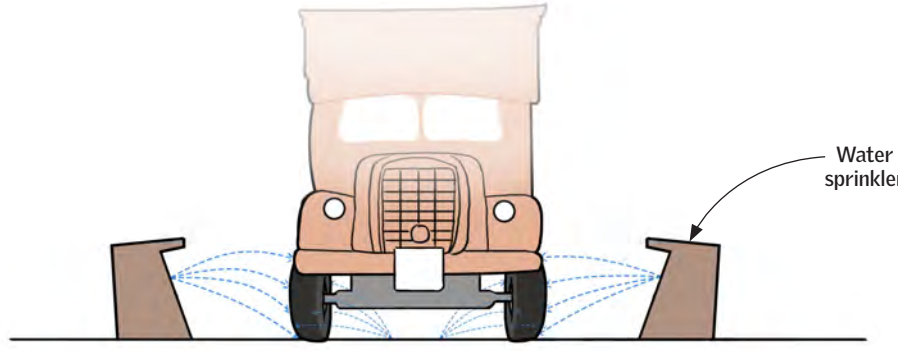


Figure 31: Under-body wash or wheel washing facilities for C&D waste or material carrying vehicles to be installed at the entrance



Washing the wheels of vehicles with dust suppressants

Figure 32: Dust extraction hood to be installed to control dust at the C&D waste processing facility — drop height of hopper to be kept low

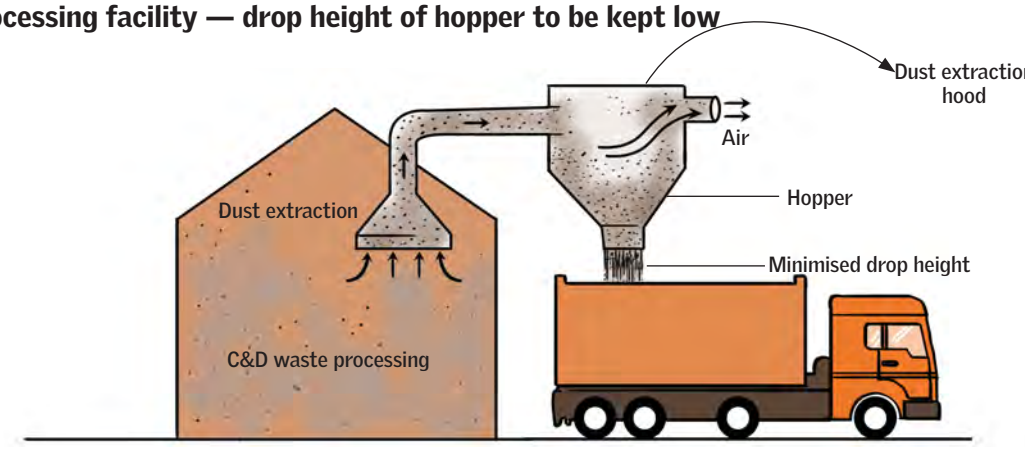
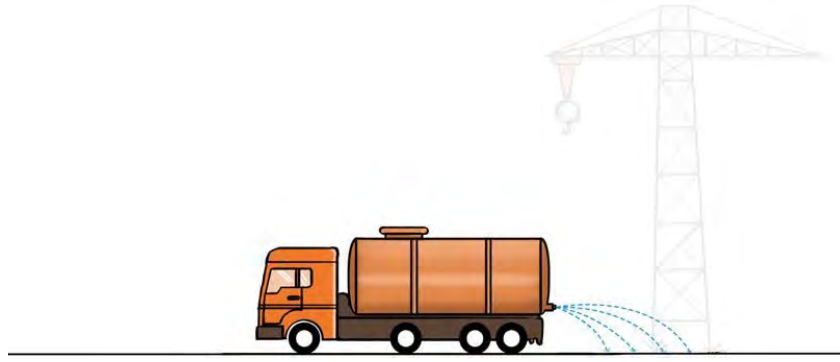


Figure 33: Dust suppressants to be applied to the top surface or entire surface area of roads (especially those that are unpaved) on which material is transported



Dust suppressants for unpaved roads

Figure 34: Vehicular speed limit to be specified close to C&D activity hotspots such as recycling facilities to prevent re-suspension of dust

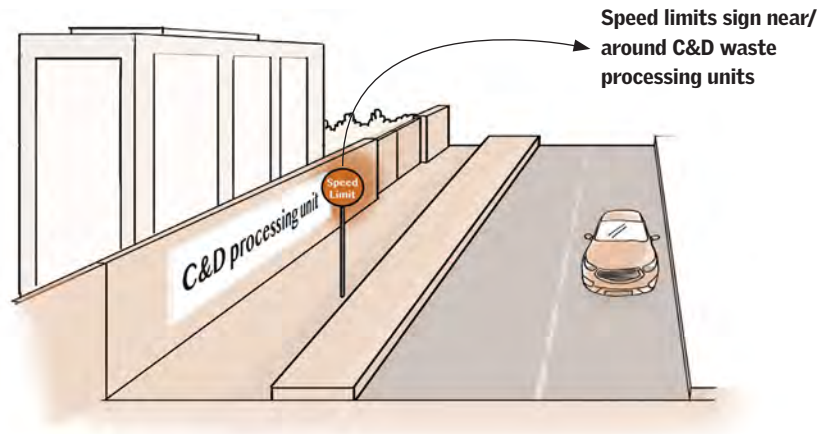


Figure 35: Roads to be designed with sufficient strength and with proper drainage in order to avoid wear, tear, potholes or deformation of the road surface

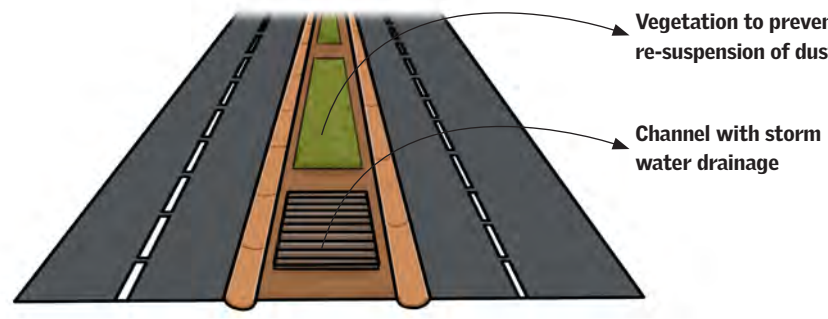
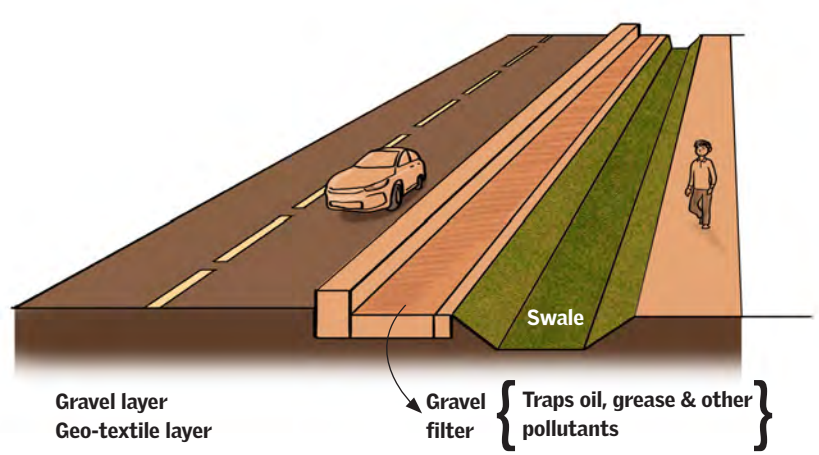


Figure 36: Bio-filtration systems can help prevent re-suspension of dust; these systems such as bio-planters, bio-swales and green cutters to be incorporated on streets



5

AN AGENDA FOR ACTION

- Adopt an ecosystem approach.
- Frame and notify bye-laws.
- Put in place an efficient collection system.
- Have clear, credible data on waste generation.
- Plan for collection and treatment infrastructure.
- Create a funding stream to manage legacy waste.
- Minimise waste and dust emissions through efficient construction management practices
- Prioritise budgets to maximise air pollution mitigation potential.
- Invest in awareness and capacity building measures.

This assessment shows that the pace of adoption of the C&D Waste Management Rules, 2016 has been slow; besides, there are gaps in implementation strategies. Every city is developing its management system in a different manner, and is facing different kinds of challenges. This section attempts to address these gaps with a view to guide cities towards a well-rounded C&D waste management system.

Adopt an ecosystem approach for C&D waste management: The current approach towards C&D waste management in cities is largely ad hoc and fragmented. For instance, a few cities are focusing on recycling plants even before notifying their bye-laws or mandating the reuse of C&D waste in construction. Other cities may have their bye-laws notified, but may not be collecting C&D waste as part of the day-to-day practice due to absence of a collection system and designated resources.

An ecosystem approach is crucial to deal with the issues linked with C&D waste management in a comprehensive manner. This approach involves addressing estimation of volume, collection systems, bye-laws with user charges, penalties and fines, surveillance and enforcement, recycling plant and associated compliances, uptake of C&D waste products, and public awareness and capacity building. Cities must prepare a dashboard/checklist for these aspects to track progress towards a complete ecosystem.

Expedite framing and notification of comprehensive bye-laws: Preparation and notification of bye-laws is a vital step in legally binding the generator to hand over C&D waste to the ULB and bring it into a formal value chain of treatment and reuse. Many cities have notified only penalties and fines as C&D waste bye-laws – which is not enough. The bye-laws must include provisions for at-source segregation, submission of a waste management plan, payment of user charges, mandatory use of recycled products and related incentives, and roles and responsibilities of different stakeholders like the ULB, service providers, state pollution control board, traffic police, etc. Cities must make all developers and waste generators liable and accountable.

Put in place a well laid out and accessible collection system: Recycling plants need continuous waste feed to make them financially feasible. Only an easily accessible collection system can ensure that. Cities must prioritise setting up a collection system instead of recycling plants. There are different systems that cities are currently putting in place, such as an on-call collection system or deliberate disposal at notified collection points. Cities are also exploring the option of linking assessment of C&D waste and its collection with building permissions as they move

towards online building permission systems. In this system, the ULB is notified of the location of the construction site, the built-up area and an estimated volume of C&D waste; this information comes from the building permission request uploaded by the beneficiary/generator. Online payment systems bring in more efficiency. Another crucial step is to identify bulk generators like the PWD, NBCC, DMRC, etc and mandate them to hand over the waste directly at the recycling plant or a notified disposal site. Cities must make all developers and waste generators liable and accountable.

Estimate the volume of C&D waste so that efficient systems can be designed: No city has got clear data on how much C&D waste is lying in the city to be processed and how much is being generated every day. As C&D waste collection is largely a residual function of solid waste collection, cities have not developed proper databases for this stream. Online platforms such as state RERA websites, PARIVESH and Delhi's online initiative under its anti-dust drive are sources that inform on the number of projects and volume of construction. These sources must be utilised by the cities to estimate waste generation. This step is crucial to plan for recycling infrastructure and prevent piecemeal augmentation of this infrastructure.

Plan for collection and treatment infrastructure: So far, cities have not planned for collection points and recycling facilities in their Master Plans. As a result, the sites that are getting identified for setting up plants and for waste collection are being selected in an ad hoc manner and not technically planned. The C&D Waste Management Rules, 2016 provide for conditions that must be followed for identification of sites for recycling. For planning collection points, width of the access roads, activities and population in the neighbourhood etc are some of the concerns that need to be considered.

According to the BMTPC's ready reckoner on C&D waste, a collection point or transfer station should cater to a radius of not more than three km. Transportation can make or mar the financial feasibility of a recycling plant – therefore, cities must minimise their transportation commitments. Decentralisation can enable this by cutting down on vehicular km travelled to a regional or centralised recycling facility and reducing empty trips. Mini, mobile and semi-mobile crushers may be utilised in a cluster approach for decentralised processing.

Adopt dynamic user charges and create a funding stream for legacy waste: Many cities are working with fixed user charges that are based on the tonnage. This method eliminates the hefty cost that is incurred due to transportation.

Especially in large cities, as the distances are long, transportation forms the biggest component of the user charges. This is why cities like Pune and Pimpri-Chinchwad are going ahead with charges that factor in the distance travelled to haul C&D waste – around Rs 22.04 per km per tonne and Rs 15 per km per tonne, respectively.

Other than this, cities must plan for a top-up in user charges to pay for treatment of legacy waste. There is tonnes of C&D waste lying in cities that are growing exponentially – Gurugram, with its eight lakh tonne of legacy waste, is a perfect example. Cities find it difficult to pay for the treatment of this waste due to the hefty costs.

Promote efficient construction management practices to minimise waste and dust emissions: There are several compliance requirements as specified by the C&D Rules of 2016 and the Environment (Protection) Amendment Rules, 2018. Besides these, there are other guidelines for dust control and safe handling of C&D waste. Cities must internalise these and make developers responsible and accountable for good construction practices and dust control. For instance, Delhi is following an approach involving self-declaration and fortnightly upload of self-audits on an online platform anchored by the Delhi Pollution Control Committee. This system was implemented as part of Delhi's anti-dust drive. Under this drive, all projects with a plot area greater than 500 sq m are required to register on the platform and take necessary steps for compliance. These projects are video-fenced with remote connectivity.

Prioritise budgets to maximise air pollution mitigation potential: Currently, budget allocation by cities in the sector is not linked with performance or assessment of mitigation potential of action. City administrations have limited understanding of infrastructure design, technology requirements, etc. Mitigation potential of the action for C&D waste management and dust control and overall greening of the construction sector is not well understood.

Priority in budget must be given to actions with high mitigation potential and long-term impact. This requires mapping of pollution generation potential of each phase of construction and demolition, material transfer, collection and recycling and the technological and infrastructure intervention needed for pollution control. While a lot of investments in mitigation measures and technologies will have to be done by construction agencies, it is necessary to map out the areas that will require public funding. ULBs will have to invest in monitoring systems and infrastructure, digital tracking and digital servers, geo-tagging and waste management sites, etc.

Currently, there is no clarity about what is fundable – as a result, fund allocation for the sector is minimal and not well rationalised.

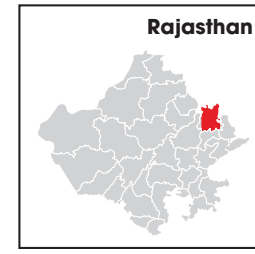
Put in place awareness and capacity building and enforcement measures: Being a relatively new waste stream, there is very little awareness about C&D waste and its management. Cities need to bring this stream to the forefront and make people aware about it – this means investment in IEC activities. ULB staff, service providers, developers and other generators need to be trained on the standard operating procedures regarding this stream, apart from its compliance requirements.

Efforts must also be made to eliminate doubts about the quality and performance of recycled C&D waste products. Demonstration visits must be organised along with training programmes. Cities have shown better enforcement when a third party is involved, as in Gurugram. Advanced solutions like video-fencing with remote connectivity – as Delhi has done – are also promising better enforcement and interdepartmental coordination. Cities that are at the planning stage of their enforcement strategy must considered these solutions. Cities can utilise funds available under programmes like 15FC and SBM 2.0 to enable this.

Annexures

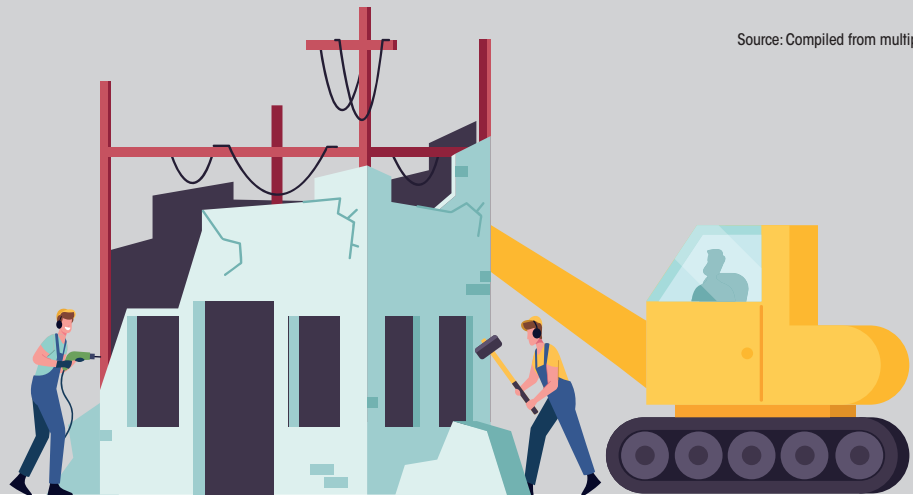
Annexures 1-11
C&D Waste Management Profiles of Selected Cities

ALWAR, Rajasthan



Area under Alwar Nagar Parishad (in sq. km)	**51.38**[1]
Number of wards	**65**[2]
Population (Census 2011)	**3,15,379**[3]
Population (2031, estimated)	**7,60,000**[4]
C&D waste generated	**5,978.34** metric tonnes in one year, according to the *Annual Report on Implementation of C&D Waste Management Rules, 2016* for 2020–21
C&D waste collected	**166 tonnes per day**
Number of intermediate storage points	**1, Ambedkar Nagar**
Number of vehicles for transportation of solid waste (including C&D waste)	**24 tractors, 2 tempos and 4 dumpers**
Vehicles for collecting only C&D waste	**1 (tractor)**

Source: Compiled from multiple sources



ALWAR has undergone rapid urbanization with pressing demands for physical infrastructure such as buildings and roads. According to the 2011 Census, Alwar's population was 0.315 million—a five-fold increase from 1961. Alwar city is part of the Delhi-NCR region and is recognized as a crucial town for the decongestion and counter-urbanization of Delhi. As per an estimate, Alwar's population is expected to reach around 0.7 million in 2031. This rise in population will lead to a greater requirement for infrastructure. This in turn will generate large quantities of C&D waste that will need to be managed.

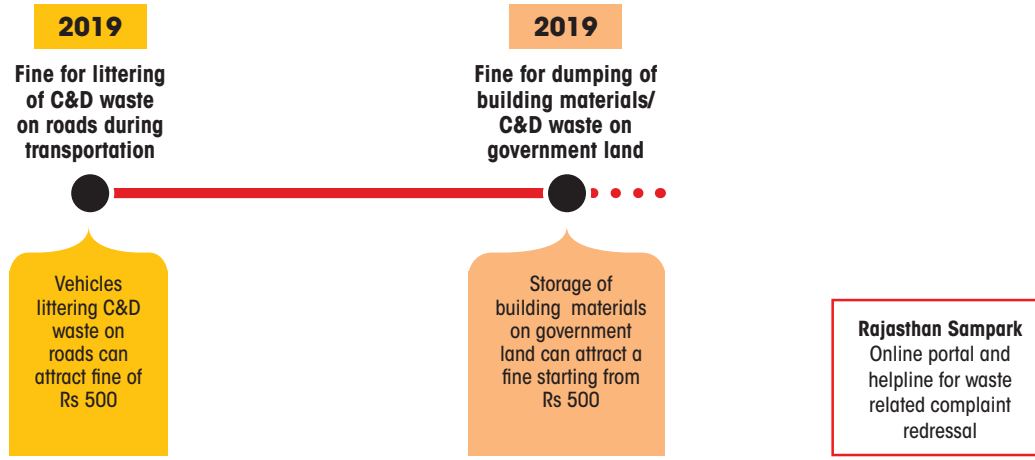
HOW IS ALWAR MANAGING ITS C&D WASTE?

In August 2021, the Rajasthan State Pollution Control Board published the *Annual Report on Implementation of C&D Waste Management Rules, 2016* for 2020–21. According to this report, Alwar Nagar Parishad had generated a total of 5,978.34 million tonne (MT) of C&D waste in one year. The Parishad collects 166 tonnes per day (TPD) of C&D waste, which is transferred to Ambedkar Nagar.

Alwar Nagar Parishad has a fleet of 24 tractors, two tempos and four dumpers that are used for hauling all municipal solid waste and C&D waste in the city—only one tractor in this fleet is designated specifically for the transportation of C&D waste. The C&D waste is lifted and transported to the transfer station at Ambedkar Nagar, from where it is taken to the final dumping yard at Agyaara Baan. The waste is currently utilized for filling low-lying areas and roads in slum areas. Currently, however, most of the C&D waste generated in the city is discarded on roads, vacant plots and green belts by the informal sector.

According to a notification by Alwar Nagar Parishad on solid waste management (SWM) bye-laws 2019, dumping construction and demolition waste on government land can now attract a fine of Rs 500 per day. The same notification also mentions that littering of C&D waste by transportation vehicles will lead to a fine of Rs 500 per day.[5]

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN ALWAR



C&D WASTE MANAGEMENT—CURRENT STATUS IN ALWAR

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆		

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆			◆			

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
◆				

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)

The city has not provided a dedicated helpline number for the collection of C&D waste. A toll-free number and a link is provided on the Nagar Parishad website through which the user can lodge their complaint/grievance on the state complaint redressal system called Rajasthan Sampark.[6]

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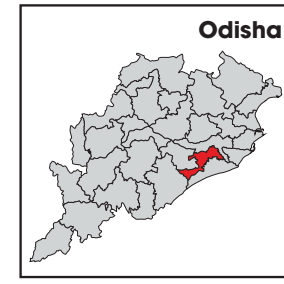
BHUBANESWAR
Odisha

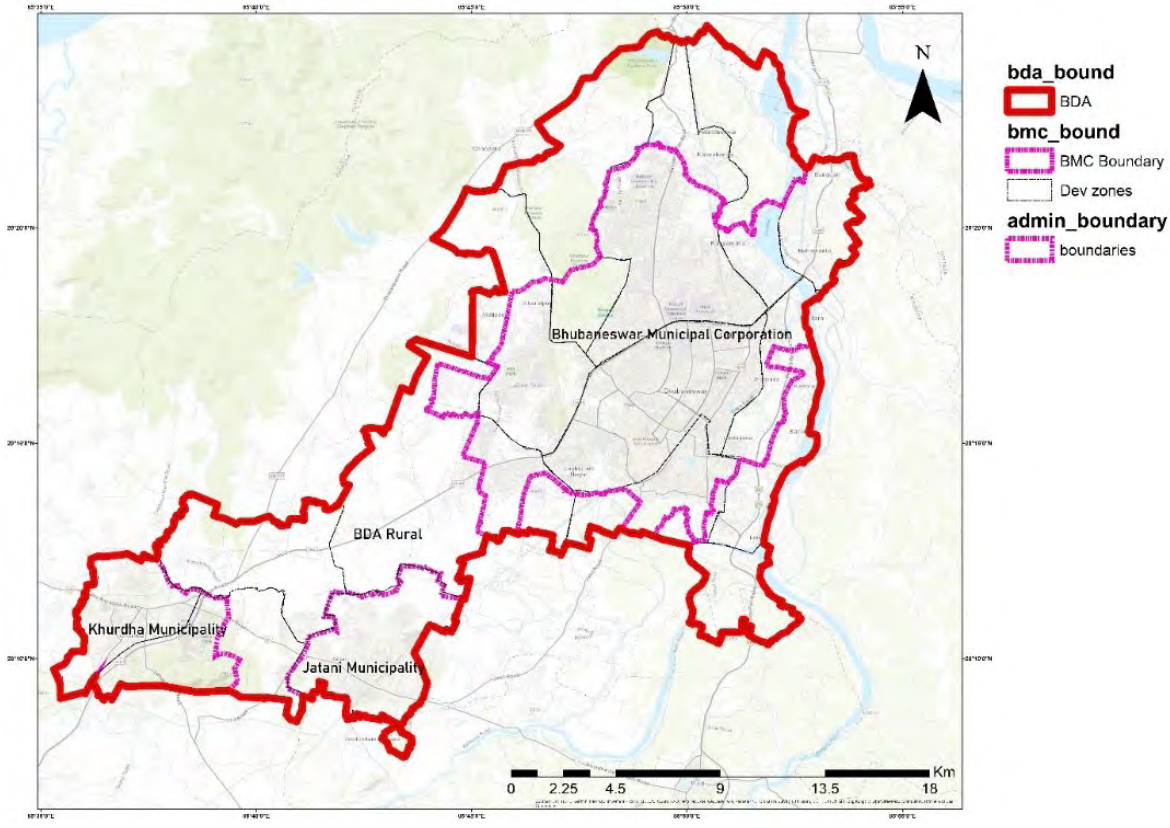


District	Khordha[1]
Area (in sq. km)	146[2] - Bhubaneswar Municipal Corporation (BMC) 419[3] - Bhubaneswar Development Plan Area (BDPA)
Number of wards	67[4] (under BMC)
Population (Census 2011)	0.84 million[5]
Projected Population (2025)	0.98 million[6]
Population density	5,759 per sq. km (within Bhubaneswar Municipal Corporation boundary)
C&D waste generation in 2021	52 tonnes per day (TPD)[7]
C&D waste processing plant	10 TPD (manual processing)
Has the city notified bye-laws?	No

Source: Compiled from multiple sources

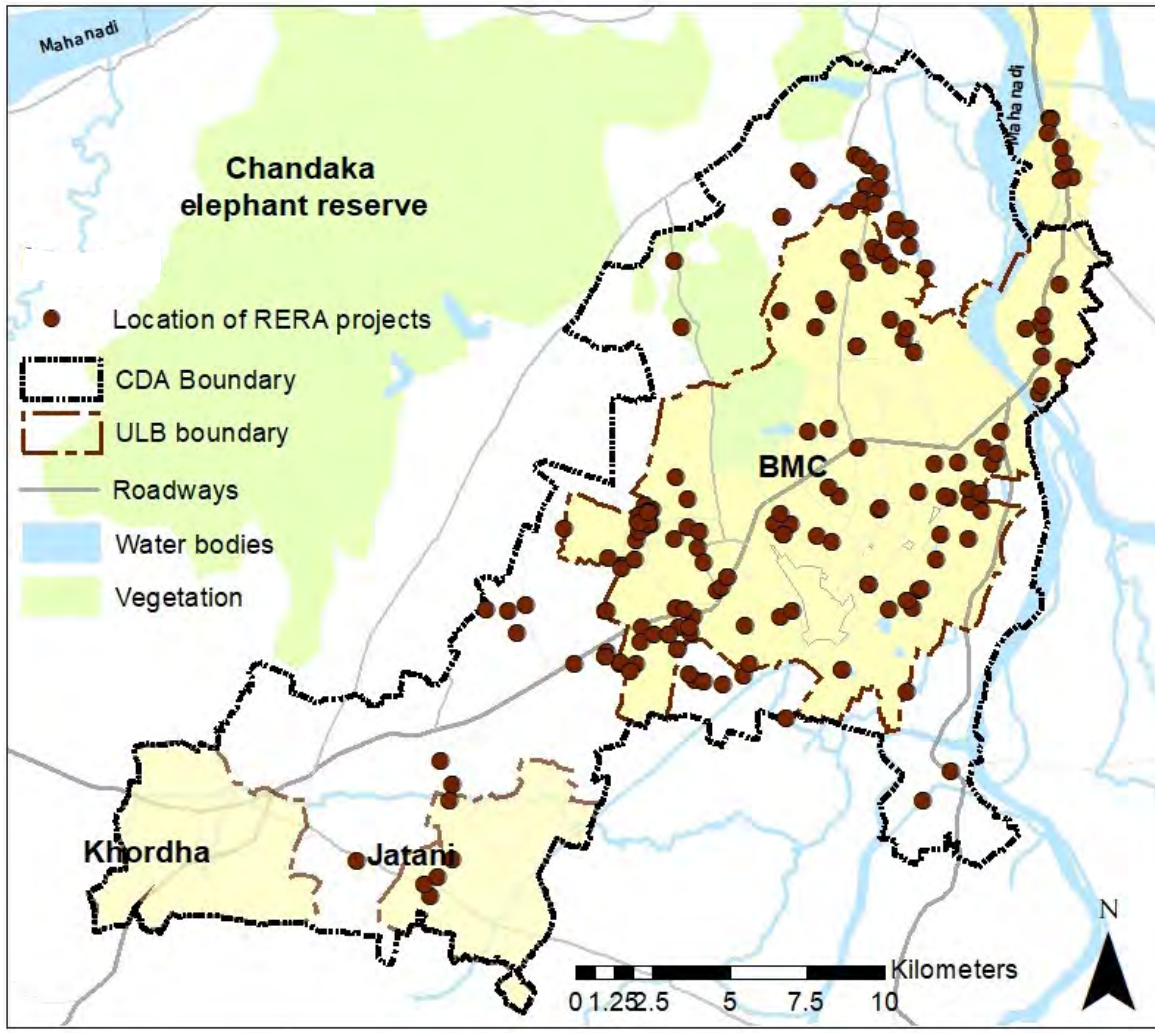
Bhubaneswar—located on the western side of the Mahanadi Delta region in coastal Odisha—is one of India's fastest developing cities. It is recognized historically and culturally as a City of Temples and is an aspiring UNESCO World Heritage City. It was ranked 1st in Government of India's Smart Cities challenge with a proposal that focuses on transit-oriented compact urban form, liveability (in terms of diverse range of housing, educational and recreational facilities) and clean environment. Bhubaneswar's infrastructure is expanding at an exponential rate to meet the demands of its increasing population due its status as the rising technical and educational hub of the east. The Bhubaneswar Municipal Corporation (BMC) area comprises 67 wards covering 146 sq. km (34.84 per cent of the total Bhubaneswar Development Plan Area [BDPA]) under the Khordha district (see *Map 1: Administrative area of BDPA*). One of the most urgent urban development issues in Bhubaneswar is the 35 per cent slum population in the city which makes affordable housing for the urban poor a most pressing need and a priority of the city administration. Demand for

MAP 1: ADMINISTRATIVE AREA OF BDPA



Source CSE

MAP 2: LOCATION OF RERA PROJECTS



Source: CSE

affordable housing, especially for rehabilitating the large slum population of the city, is driving the construction sector in the city.[8]

CONSTRUCTION ACTIVITY AND C&D WASTE VOLUME

Tremendous construction activity is going on in the area covered by the BMC due to rapid growth in the IT and education sectors. An assessment of construction projects registered on the Real Estate Regulatory Authority, Govt. of Odisha (rera.odisha.gov.in) portal has shown that nearly 46 thousand tonnes of construction waste will be generated from these projects. There are 215 projects in BMC that are registered with RERA (see *Map 2: Location of RERA projects*).

BMC will have to be prepared as this estimation includes only the projects with a plot area of 500 sqm and above and mostly residential buildings. Commercial buildings, institutional buildings, industrial buildings, small scale construction (<500 sqm plot area), construction and demolition of roads and highways will generate C&D waste much above the estimate of 46 thousand tonnes.

CURRENT SCENARIO OF C&D WASTE MANAGEMENT

BMC looks after the management of C&D waste in the city and is constantly working on enhancing the system. In May 2016, the State Pollution Control Board of Odisha mandated (via order No.7617/IND-IV-MSW-141(Pt)) all waste generators and local authorities to comply with the Construction and Demolition Waste Management Rules (2016).[9] According to the Guidelines on Environmental Management of Construction and Demolition (C&D) Wastes 2017, Bhubaneswar generated about 196.8 TPD of C&D waste in 2016.[10] That has come down over the years. As per the form III submitted by ULB to the state pollution control board, the municipality generated 52 TPD construction & demolition waste in 2021, out which 6–7 tonnes was were collected.

Penalties and fees

BMC released the user fees and penalties for various waste related activities in 2015 (via order No. 3078—XXII (L)-53/2013). The order stipulates that the fine for piling C&D waste materials on public streets is calculated based on their volume: Rs 1,500 for each tractor trip and Rs 3,000 for each truck trip.[11] In September 2021, the government had notified the urban local bodies to identify spots where C&D waste had piled up and issue notice to the owners of the waste asking them to lift it at their own cost; and in case the owners wanted it to be collected by the ULBs, required fees along with penalty (as per the quantity of waste) would be charged to the owner.[12] The three respective zonal divisional commissioners of the BMC ensure that Rs 9,500 per tipper load of C&D waste is collected from the violators. Of this, Rs 4,500 will be transportation charges per trip of the BMC owned tractor, while the remaining Rs 5,000 will be administrative charges. The major violators are bulk generators such as the East Coast Railways (ECoR), Indian Rare Earth Limited, state works departments and many central government institutions. BMC managed to collect more than Rs 56 lakh in fine from 729 violators till September 2022.[13]

Collection, transportation and disposal

BMC has made it mandatory for architects, builders, developers and contractors to submit a C&D waste management plan to get the permit for starting any construction activities.[14] According to BMC officials, BMC has an on-call collection system for C&D waste in place. For any construction, renovation and demolition activity, waste generators can call a toll-free helpline number provided on the BMC's website to request for removal of debris.[15] A public grievance portal (https://www.bhubaneswar.me) is also in place which allows citizens to report and ask for removal of construction materials and debris. On receiving a collection request, BMC's C&D waste enforcement team goes to

Figure 1: Request for removal of debris

Source: Times of India

Source: Local News article, Bhubaneswar

the site and collects the waste. Waste generators can also dump the C&D waste themselves after seeking permission from BMC.[16] C&D waste generators which generate 20 tonnes or more in a day or 300 tonnes or more in a month must submit waste management plans to the ULB before taking up any construction or demolition activity.[17]

BMC charges Rs 2,500 per trip for transportation of C&D waste. BMC's vehicle fleet comprises of tippers and JCBs hired from local contractors. The work of lifting the C&D waste in the city is also carried out by private contractors for construction sites and the charges are levied according to the weight of the debris and the number of trips made by the vehicle used for collection.

For the management of C&D waste, BMC has four enforcement teams in place—3 zonal teams (1 for each of the 3 zones) and 1 central team.[18] Each team has 8–10 people comprising of BMC members, retired army personnel, policemen and security officers. The central team is responsible for the management of C&D waste.[19] Zonal enforcement teams have 1 tipper and 1 JCB for C&D waste collection and the central enforcement team has 2 tippers and 1 JCB. When dedicated vehicles fall short, BMC hires private vehicles to haul C&D waste as per the requirements. Their role is to patrol the city daily to check for any illegal construction and stockpiles along roadsides, and issue notices and penalties for the same.[20]

The civic body has identified two low lying sites for dumping of waste and their coordinates have been hosted on the Department of Housing and Urban Development website of Odisha—2.48 acres in Pokhariput and 4 acres in Patia (see *Map 3: Location of low-lying deposition sites of C&D waste*) The collected waste at the two sites is taken to the landfill located at the outskirts of the city for disposal.

RECYCLING FACILITY

BMC has a C&D waste processing plant in Pandra, Bhubaneswar (near micro-composting

FIGURE 2: C&D WASTE OPERATIONS METHODOLOGY IN BHUBANESWAR

Places request for removal of C&D waste via

Helpline number

Online Public Grievance Portal

Bhubaneswar Municipal Corporation

Bhubaneswar.me grievance portal

Daily surveillance done by the C&D waste teams by BMC for any illegal constructions and stockpiles or construction waste on roads

BMC

3 Zonal teams
1 Central team

Depending on the zone sends team for waste collectio

Receipt given to the waste generator

Charges levied on the basis of number of trips taken by the vehicle

Picks up waste from the waste generator/ road

Waste gets dumped to

2 sites identified in Bhubaneswar- **Kargil Basti and Patia**

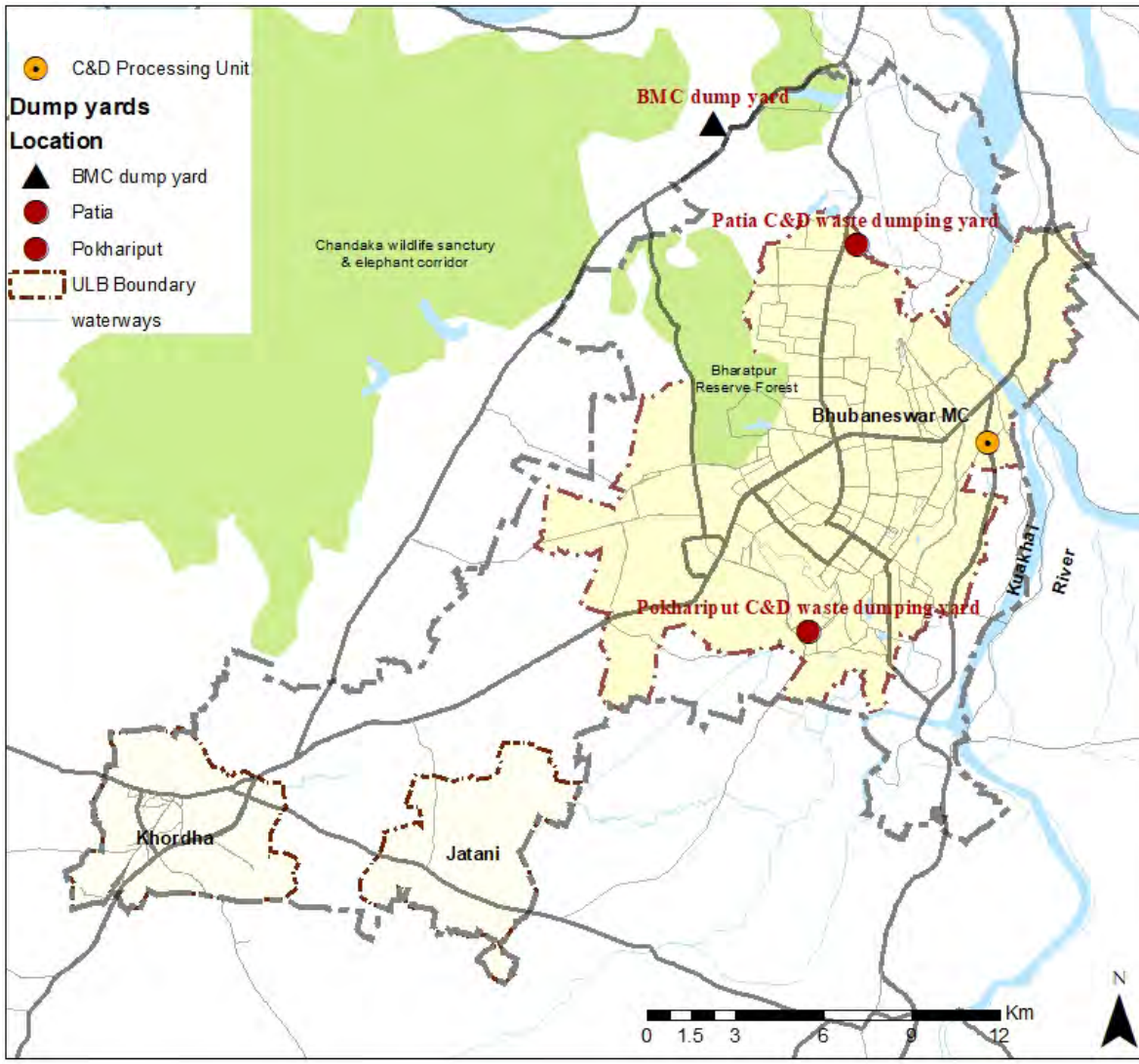
Transported to

C&D waste processing plant Pandra, Bhubaneswar

Mission Shakti SHGs are involved in segregating the waste. Waste gets processed

Waste gets crushed

MAP 3: LOCATION OF LOW-LYING DEPOSITION SITES AND PROCESSING UNIT OF C&D WASTE



Source: BMC

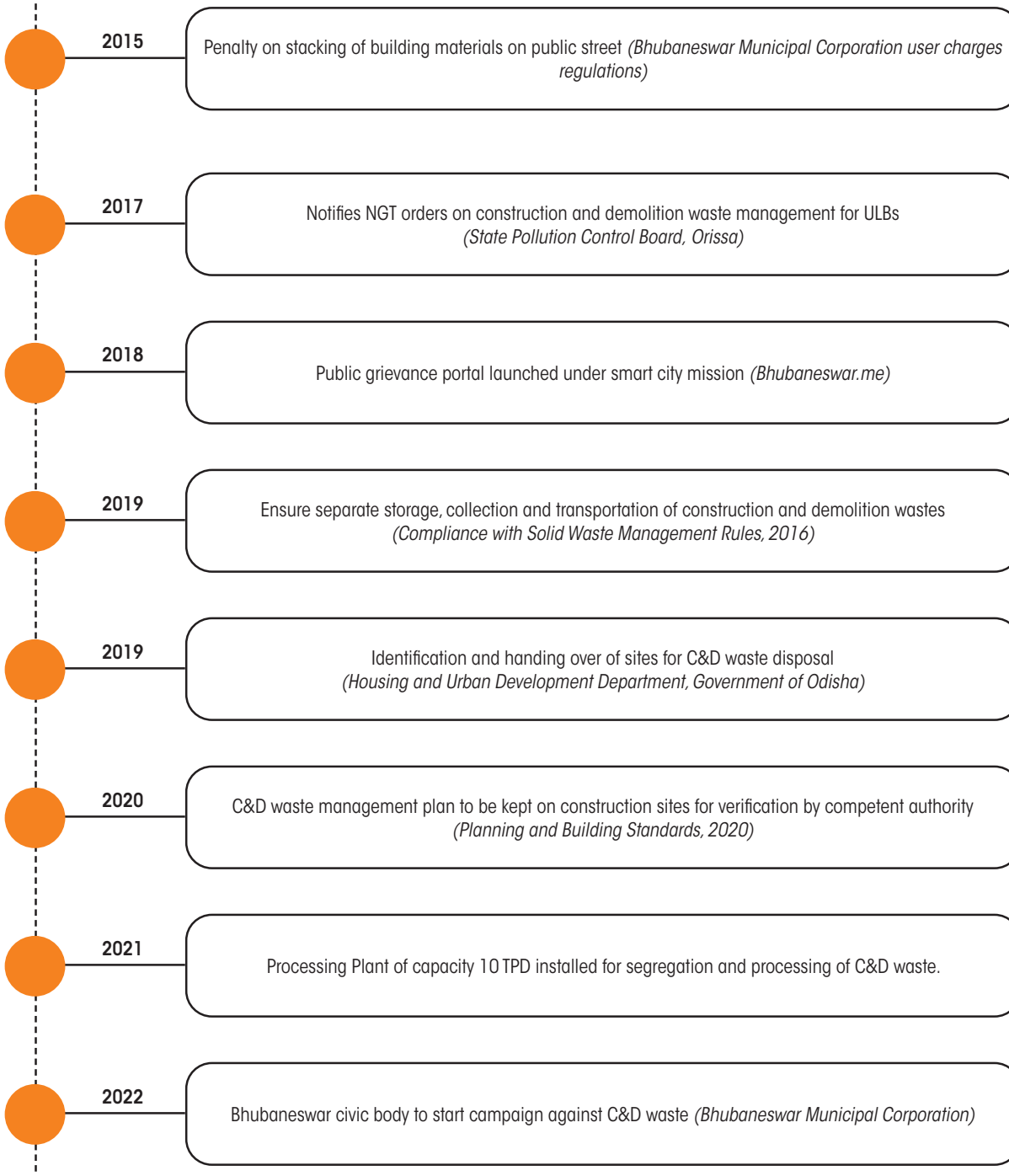
plants). It started in 2021 with a capacity of 10 TPD (see *Map 4: Location of C&D waste processing unit*). The material is crushed to form aggregates and used to produce paver blocks. The processing plant is not yet mechanized, and segregation is done manually by representatives from a local self-help group and members of Mission Shakti. BMC has floated a tender for mechanized processing which is expected to be completed by the end of the year 2022.

BMC is expanding the recycling capacity of the city. Multiple decentralized facilities (up to 5 TPD processing capacity) to be managed in partnership with the Mission Shakti Groups / transgender groups are being envisaged.[21] The members of Mission Shakti Groups / transgender groups shall collect C&D waste from waste generators and transport the same to processing facilities.[22]

BMC has initiated procurement of a C&D waste recycling plant. The city has prepared a Request for Proposal and placed it for approval from the state government.

1. Site at Kargil Basti, Pokhariput; **2.** Site at Patia

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN BHUBANESWAR



C&D WASTE MANAGEMENT—CURRENT STATUS IN BHUBANESWAR

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆		◆	◆		◆	

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
◆	◆	

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
◆		◆		

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)

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DELHI

Area (sq. km)	1,486.5[1]
Number of wards	272[2]
Population (Census 2011)	16.78 million[3]
Population (2021, estimated)	20.6 million[4]
Projected population (2041)	27.8–30.9 million[5]
C&D waste generation	3,711 tonnes per day (TPD)[6]
C&D waste recycling plants	**4 existing C&D waste recycling plants** • Jahangirpuri (Burari) – 2,000 TPD • Shastri Park – 1,000 TPD • Rani Khera (Mundka) – 1,000 TPD • Bakkarwala – 1,000 TPD **3 proposed C&D waste recycling plants** • Maidangarhi – 1,000 TPD • Jahangirpuri (Burari) – 50 TPD • Libaspur – 500 TPD

Source: Compiled from multiple sources

Delhi's infrastructure is expanding at an exponential rate to meet the demands of its increasing population. The National Capital Territory of Delhi is one of the most populous cities in the world and accounts for about 1.39 per cent of India's population. Its population density grew from 6,352 persons per sq. km in 1991 to 11,320 persons per sq. km in 2011. Meanwhile, Delhi's total population grew from 16.7 million in 2011 to an estimated 20.6 million in 2021, and it is expected to reach around 29.2 million by 2041.

Delhi has one of the largest C&D waste management systems in India with an existing capacity of processing 5,000 tonnes per day (TPD) of C&D waste and an additional proposed capacity of 1,550 TPD. According to the draft *Master Plan for Delhi 2041*, Delhi processed 1.22 million metric tonne of C&D waste (including legacy waste from previous years) in 2020–21.[7] However, just like other Indian cities, illegal dumping of C&D waste has been observed in Delhi as well, especially on the boundaries of green belts and urban forests. Besides this, Delhi also grapples with huge amounts of legacy C&D waste choking its water bodies and low-lying areas.[8]

Demolition activity near India Habitat Centre resulting in debris and fugitive dust

When it comes Delhi, the five urban local bodies (ULB) of Delhi—East Delhi Municipal Corporation (East DMC), North Delhi Municipal Corporation (North DMC), and South Delhi Municipal Corporation (South DMC), New Delhi Municipal Council (NDMC) and Delhi Cantonment Board (DCB)—have followed their own individual systems of managing C&D waste. However in May 2022, East DMC, North DMC, and South DMC were re-unified into a single entity as the Municipal Corporation of Delhi (MCD). This unification will bring about certain changes in the C&D waste management system in these three erstwhile jurisdictions. The remaining two ULBs—New Delhi Municipal Council (NDMC) and Delhi Cantonment Board (DCB)—shall continue with their current C&D waste management system.[9] Therefore, this case study largely conveys the infrastructural and administrative setups that have been operational as of May 2022.

DELHI'S SOLID WASTE BYE-LAWS 2018

Delhi notified its solid waste management bye-laws in 2018. These bye-laws lay out the provisions for C&D waste management in the

MAP 1: EXISTING AND PROPOSED C&D WASTE PROCESSING FACILITIES

Source: CSE

city and were adopted by all the ULBs.[10] The bye-laws include provisions for the collection and transportation of C&D waste and ensuring segregated storage, among other things. Failing to comply with these regulations, along with illegal dumping of C&D waste, can invite penalties of up to Rs 5,000, although these penalties varied across the different ULBs.[10] For instance, NDMC had two separate categories of penalties—residential entities pay Rs 1,000, whereas non-residential entities pay Rs 5,000 for non-compliance with the bye-laws.[11]

RECYCLING CAPACITY

Delhi's C&D waste processing capacity comprises four operational plants located in: Burari, which has a capacity of processing 2,000 TPD, and in Shastri Park, Rani Khera (Mundka) and Bakkarwala all of which have a capacity of 1,000 TPD respectively.[12] The city plans to establish three more C&D waste processing facilities in Maidangarhi (1,000 TPD), Burari (50 TPD) and Libaspur (500 TPD, which could be increased up to 2,000 TPD).[13]

UPTAKE OF RECYCLED C&D WASTE PRODUCTS

Taking into account the construction activities undertaken by all civic departments during 2020–21, the Ministry of Housing and Urban Affairs established an annual uptake target for the utilization of C&D waste based materials for government departments in Delhi. This was done with the goal of promoting the use of construction materials made from C&D waste. The recycled products made from C&D waste processing plants in Delhi are being used by various government agencies to meet these targets.

According to a notification issued in 2016

by the Department of Urban Development, Government of National Capital Territory of Delhi (GNCTD), all municipal/local government bodies in Delhi, such as the Public Works Department (PWD), Department of Irrigation and Flood Control, Delhi State Industrial and Infrastructure Development Corporation Ltd (DSIIDC), Delhi Jal Board (DJB) and other departments and organizations of GNCTD that are involved in the construction/maintenance of civic works, are required to use products recycled from C&D waste. The order mandates that these products replace two per cent of the materials used for building works and ten per cent for the materials used for road works. Further, five per cent of C&D recycled products for non-structural applications is to be mandated by the urban local bodies through modifications in bye-laws for private individuals as well.[14]

COLLECTION SYSTEM OF DIFFERENT URBAN LOCAL BODIES

Each of the five ULBs of Delhi had a different system and infrastructural capacity for the collection and transportation of C&D waste. While the steps for C&D waste management have largely been taken in a piecemeal manner, the system has been still evolving, which makes it difficult to comment on their adequacy.

A field investigation by Centre for Science and Environment (CSE) has revealed that the Delhi government is yet to create awareness around the C&D waste collection system. While most of the ULBs had designated waste collection points, these points are not well-defined, nor are their locations and details easily available to the general public. Further, these designated points were often found to be located too close to the municipal solid waste points, risking cross-contamination. This made

A C&D waste collection point in North Delhi

it difficult to store segregated C&D waste.

According to the bye-laws, bulk generators are required to take their C&D waste directly to the processing plants. However, due to lack of clarity and enforcement, bulk generators dispose of their waste, especially at night, at the collection points in order to avoid paying the necessary fees to the C&D recycling plant.

NORTH DELHI MUNICIPAL CORPORATION

According to the *Annual Report of the Delhi Pollution Control Committee, 2020–21*, the 104 wards of erstwhile North DMC had generated 1946.35 TPD of C&D waste—the highest among the five civic bodies of Delhi.[15] North DMC had designated a point in each ward for non-bulk generators to dump their C&D waste for collection.[16] This collection point and the entire collection process in the ward was overseen by a Junior Engineer (JE).

To register a complaint of illegally disposed C&D waste, a waste generator needed to call the city control room helpline number that further connected them or relayed the information to the Junior Engineer (JE). The same procedure was followed for a request for waste collection. Once the ward collection point was full, the JE would inform the Burari plant operator to send a vehicle for collecting the C&D waste and transporting it to the processing facility.

North DMC had a dedicated vehicle fleet consisting of tractor loaders and tractor trolleys that were equipped with GPS to transfer the C&D waste from designated collection points to the recycling plant. The fleet was run by the sanitation department of North DMC. As of June 2022, the collection service was free for small generators. However, bulk generators were supposed to take their C&D waste directly to the recycling plants. The North DMC charged Rs 300 per tonne from bulk generators. As of June 2022, the North Delhi Municipal Corporation was actively using the Ranikhera (1,000 TPD) C&D waste processing unit.[17]

In accordance with a plan for expanding its capacity for C&D waste processing, North DMC has allocated a 2.8 hectare plot at Libaspur, near Jahangirpuri, to a private concessionaire for designing, operating and financing a C&D waste processing facility. This facility will begin by processing 500 tonnes of waste every day, and its capacity will soon be increased to 2,000 TPD.[18] Besides this, North DMC will establish a new unit with a capacity of 50 TPD at the Burari plant by 2023.

According to the *Annual Report of the Delhi Pollution Control Committee (2020–21),* North DMC had purchased 57,756 MT of recycled C&D waste products against their target of 100,000 MT.[19]

SOUTH DELHI MUNICIPAL CORPORATION

According to the *Annual Report of the Delhi Pollution Control Committee (2020–21),* South DMC consisted of 104 wards, and generated 925 TPD of C&D waste in the financial year 2020–21. South DMC used to have 65 designated C&D waste collection points where small generators could dump their C&D waste.[20] South DMC had also been running a pilot project to provide a service where C&D waste could be collected on demand, for free. This service was provided under the Swachh Survekshan 2022 Mission. There were also provisions for citizens to get their C&D waste and debris removed by tweeting their grievances to South DMC's

official Twitter handle @OfficialSDMC. South DMC's team would reach the spot and would ensure the removal of C&D waste and debris. Through this initiative, SDMC had aimed to address grievances related to the accumulation of construction waste in a speedy manner.[21]

South DMC was in possession of a yellow-coloured vehicle fleet comprising tractor loaders and tractor trolleys equipped with GPS to transfer the C&D waste from different designated dumping points to the C&D waste recycling plant. The fleet was run by the sanitation department of South DMC.

In March 2022, South DMC had announced a tender with a project cost of Rs 700 crores for agencies to collect silt, C&D waste, and organic and other kinds of waste.[22] As of May 2022, this facility was free of cost, but only for lifting a limited amount of waste generated after repair work.[23]

As of June 2022, South DMC used the Bakkarwala (1,000 TPD) C&D waste processing unit for the disposal of C&D waste. South DMC had allocated a plot of land in Tehkhand, Okhla for the setting up of a 1,000 TPD C&D waste processing plant. According to the *Annual Report of the Delhi Pollution Control Committee (2020-21)*, South DMC had purchased 45,128 metric tonne (MT) of C&D waste recycled products against their target of 75,000 MT.[24]

EAST DELHI MUNICIPAL CORPORATION

According to the *Annual Report of the Delhi Pollution Control Committee (2020–21)*, East DMC consisted of 64 wards and generated 750–800 TPD of C&D waste in the financial year 2020–21.[25] Up until late 2021, East DMC had designated one collection point for each zone where small generators could deposit their C&D waste. In October 2021, East DMC had reduced the number of these designated points from 61 to 17 due to under-utilization.[26] This could be attributed to the high user fee (Rs 452.78 per tonne) that was charged for C&D waste collection.

Therefore, this system was short lived and in early 2022, East DMC became the first amongst the ULBs to launch an on-demand collection system for C&D waste. To avail of this service, one could call the dedicated helpline number that was available on the website.[27] East DMC imposed a fine of Rs 1,000 on residential users and Rs 5,000 on non-residential users for violating the C&D waste regulations outlined in the bye-laws.[28] A system of levying C&D waste charges on the waste generator at the time of the building approval had also been in place since 2017.[29]

East DMC had a vehicle fleet that consisted of tractor loaders and tractor trolleys equipped with GPS to transfer the C&D waste from different designated sites to the C&D waste recycling plants. The C&D waste was collected and transported by a private agency, Indo Enviro Integrated Solutions Limited.
As of June 2022, EDMC used Shastri Park (1,000 TPD) C&D waste processing unit for the treatment and disposal of C&D waste.

According to the *Annual Report of the Delhi Pollution Control Committee (2020–21),* North DMC lifted 53,697 metric tonne (MT) of recycled C&D products against their target of 50,000 MT, which was 107.39 per cent.[30]

NEW DELHI MUNICIPAL COUNCIL

According to the *Annual Report of the Delhi Pollution Control Committee (2020–21)*[31], the New Delhi Municipal Council (NDMC) generated 61.46 TPD of C&D waste in the financial year 2020–21. NDMC has demarcated 14 sites with waste collection bins in each circle of the NDMC area and uploaded their locations on the NDMC website to help citizens dispose of their waste conveniently. The list of designated points is easily available to the public and skips (metal containers for solid waste) are used as containers for C&D waste disposal. However, this system does not allow for the segregated waste to be kept separately.

NDMC also provides an on-demand service that charges a fee of Rs 440 per tonne and can be accessed through the NDMC 311 app and by calling the toll-free number 1533. NDMC charges a fine of Rs. 5,000 for violating C&D

C&D waste collection point under New Delhi Municipal Council

Source- 2 Twitter New Delhi Municipal Council

waste regulations outlined in the bye-laws.[32] A dedicated red-coloured vehicle fleet is used to collect C&D waste. There is also a system of levying charges on the waste generator at the time of acquiring building approval.

As of June 2022, the NDMC uses Shastri Park (1,000 TPD) C&D waste processing unit for processing C&D waste. According to the *Annual Report of the Delhi Pollution Control Committee (2020–21),* NDMC had used only 8,035 metric tonne (MT) of recycled C&D products against their target of 25,000 MT.[33]

DELHI CANTONMENT BOARD

According to the Annual Report of the Delhi Pollution Control Committee (2020–21), DCB generated 3.83 metric tonne (MT) of C&D waste in the years 2020–21 and disposed of it in the Shastri Park C&D waste processing plant. It set a target to collect 5,000 MT. DCB has only one designated collection point where generators deposit their C&D waste.[34] DCB does not have a dedicated helpline number for C&D waste collection or for complaints regarding illegal dumping of C&D waste.[35]

LESSONS LEARNT

Delhi has been setting up its C&D waste management system in a piecemeal manner. The Burari plant was set up with a processing capacity of 500 TPD and is now working at 2,000 TPD. Other than this, many plants are underway and in operation to cope with the increasing C&D activity and collection of C&D waste in the city. The current experience highlights the need to envision the need for infrastructure in a planned manner and estimate the generation of C&D waste at a city level. In the absence of such estimates, there is a risk of not getting the necessary or timely results. For instance, from 2009 to 2022, Delhi's processing capacity was increased multifold but it is remains inadequate. The city's formal C&D waste management system is struggling to compete with the informal sector. Due to cheaper rates, a majority of the city's population still engages the informal sector for the disposal of C&D waste. As a result, illegal dumping is rampant. With adequate processing capacity and collection systems in place, user charges can come down to the benefit of generators through economies of scale. It is equally important to educate generators regarding their duties to ensure better collection efficiency.

Other than this, Delhi's case study shows the need for creating a demand for recycled C&D waste products. The Delhi government had to mandate the use of recycled products in government and municipal contracts in order to facilitate usage and build confidence in these products due to the poor uptake of recycled products after the commissioning of the Burari plant. It has taken more than a decade to see this through. Cities that are planning a C&D waste management system must prioritize creating a demand for recycled C&D products besides setting up a recycling facility.

C&D WASTE PROCESSING PLANT AT SHASTRI PARK

The plant is spread across an area of 1 hectare and has a processing capacity of 1,000 TPD. East DMC, NDMC and Delhi Cantonment Board use this plant for processing the C&D waste that is generated within their jurisdictions. This plant only only uses wet processing systems,

Table 1: C&D waste received and processed at the facility in Shastri Park in the year 2020–21

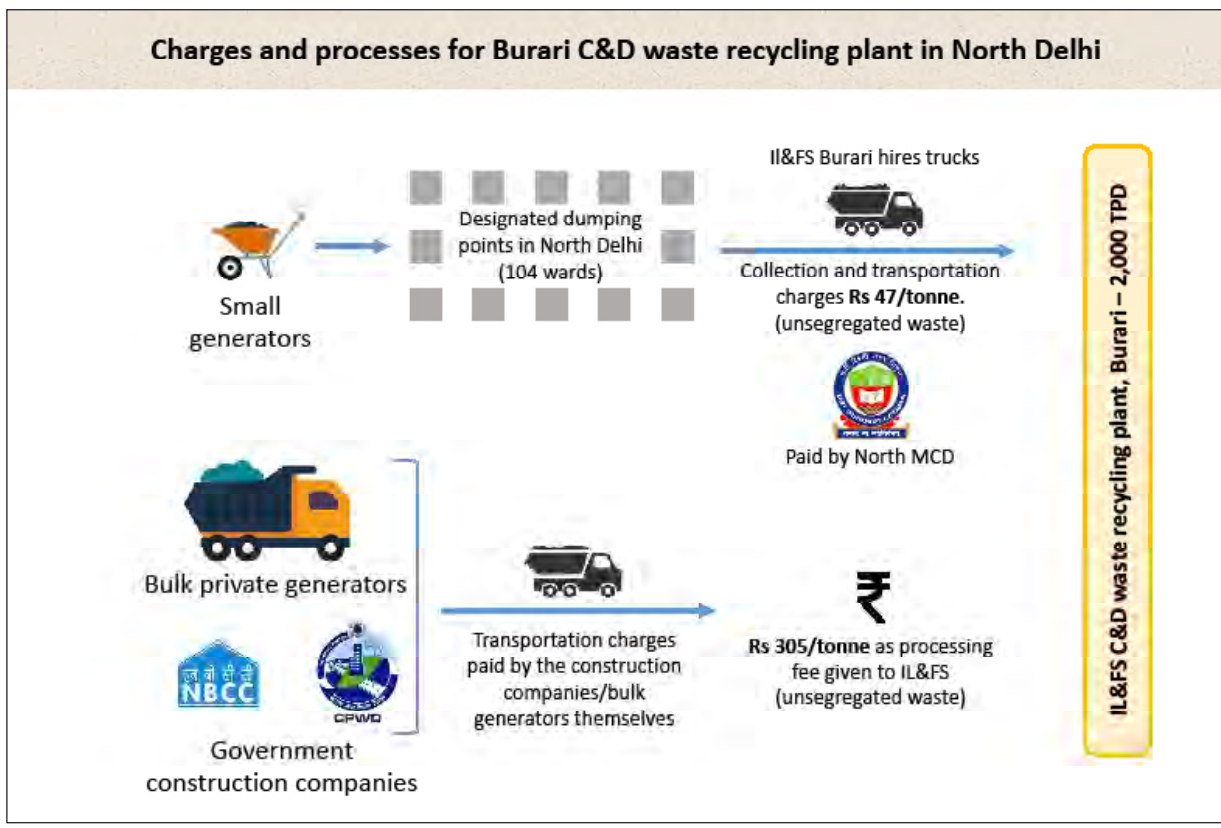
Description	Quantum (Year 2020–21)
C&D waste received products of processed / recycled C&D waste	273,673 MT
Non-structural concrete aggregate	Nil
Manufactured sand	27,041 MT
Ready-mix concrete (RMC)	Nil
Paving blocks	Nil
Granular sub-base (GSB)	44,189 MT
Soil	21,6695 MT
Cement bricks	5,456 m^3

Source- 3 Annual Report of Delhi Pollution Control Committee (2020–21)

the processing unit has washers, a screen thickener, grizzly mixers and roll mix are some of the machinery. Raw materials such as cement admixtures are used by the plant to produce the final product.[36]

PROCESSING PLANT AT BURARI

The plant has been operational since 2009 and is set up on an area of 3.4 hectares and has a capacity of 2,000 TPD. Small generators dump C&D waste at designated dumping points in North Delhi. The unsegregated waste gets picked up by the private company, Environmental Infrastructure & Services Ltd through hired vehicles. North Delhi Municipal Corporation (NDMC) pays Rs 47 per tonne as fee for the collection and transportation of waste. However, private bulk generators and government



construction agencies get the waste transported to the processing facility themselves and are charged Rs 305 per tonne for processing it. According to Mr Anil Gupta, the Executive Engineer (EE) of North DMC, the Burari plant plans to set up a new unit with a capacity of 50 TPD by the end of 2023.

The Burari C&D waste recycling plant produces aggregates of multiple sizes including fine as well as coarse materials. Moulds are used to develop recycled products such as paver blocks. Apart from these, the plant also manufactures bricks made from recycled aggregates.

The steps involved in the process are:

- The C&D waste received at the facility is first weighed at the weigh bridge with a computerized system installed near the entrance, after which an inspection of the incoming material is conducted. Records of incoming C&D waste and various products such as concrete aggregates, soil, concrete blocks, tiles, GSB and cement bricks etc. are maintained.
- The C&D waste processing facility has dry and wet processing sections. Big concrete blocks are crushed to 200–400 mm size and sent to the dry section for further crushing where aggregates of sizes 10–20mm, 3–10 mm and 3–75 mm are produced.
- Mixed C&D waste is sent to the grizzly set (filters of 200 mm size) and the material produced is sent to the Impact Crusher for a size reduction to 60 mm. Thereafter, this material is sent for wet processing where

1. Weighing bridge at Burari C&D waste recycling plant; **2.** Segregation of inerts; **3.** C&D waste processing unit at Burari C&D waste recycling plant; **4.** Aggregates of different size are received after processing

water is mixed with crushed C&D waste for producing aggregates of 60–20 mm, 20–10mm, 10–3 mm size. Hydro cyclone is used to produce sand of 3 mm–75 mm size, and a combination of silt and clay is produced at a size less than 75 mm. Filter press is used for dewatering the soil extracted from the C&D waste. Recoverables from grizzly set are sent for crushing into size of 200 mm–400 mm.

- C&D waste is sold to recyclers/scrap dealers. Whole bricks received from segregation of C&D waste is kept separately for internal use. The rejects, in the form of RDF, is sent to a waste-to-energy plant at Ghazipur (currently being operated by IL. & FS Environmental Infrastructure & Services Limited)
- The facility also has a batching plant. However, it is not operational due to less demand for Ready-Mix Concrete (RMC).
- There is a casting section where tiles, kerb stones, paver blocks, brick tiles and cement bricks (size 200 mmx 100 mm) are produced using the aggregates & sand that is produced from the C&D waste. These products also contain cement, pigments/colour & other additives.

5. Aggregates of different size are received after processing; **6.** Moulds for making pavers; **7&8.** Recycled products

Table 2: C&D waste received and processed at the facility at Burari in the year 2020–21

Description	Quantum (Year 2020–21)
C&D waste received	710,419 MT
Products made from processed/recycled C&D waste	
Non-structural concrete aggregate	146,820 MT
Manufactured sand	27,041 MT
Ready mix concrete (RMC)	Nil
Tiles	6,195 m^3
Granular sub-base (GSB)	22,756 MT
Soil	572,113 MT
Cement bricks	2,046 m^3

Source- *5 Annual Report of Delhi Pollution Control Committee (2020–21)*

C&D WASTE PROCESSING FACILITY AT DMRC SITE RANI KHERA

The plant has a processing capacity of 150 TPD of C&D waste and is spread across an area of 1.2 hectares on behalf of Delhi Metro Rail Corporation (DMRC). The capacity of this plant has been increased from 150 TPD to 1,000 TPD. It only uses wet processing systems with a computerized weigh bridge, and mostly makes fine and course aggregates by processing of C&D waste.[37] (see page 170 for detailed case study)

Table 3: C&D waste received and processed at the facility at Rani Khera in the year 2020–21

Description	Quantum (Year 2020–21)
C&D waste received	**47,660 MT**
Products of processed/recycled C&D waste	
Non-structural concrete aggregate	Nil
Manufactured sand	2,182 MT
Ready mix concrete (RMC)	Nil
Tiles	2,794 m^3
Granular sub-base (GSB)	4,744 MT
Soil	32,635 MT

Source- 6 Annual Report of Delhi Pollution Control Committee (2020–21)

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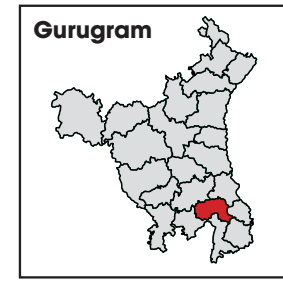
GURUGRAM
Haryana



District	Gurugram[1]
Area of the municipal corporation (sq km)	675[1]
Number of wards	35[2]
C&D waste generated in the city (TPD)	2,000
Location of the C&D waste processing plant	Sector 100, Basai
C&D waste processing plant capacity (TPD)	1,000
Has the city notified byelaws?	Yes
Number of vehicles for transportation of C&D waste	11
Number of intermediate storage-collection points	Nil
Does an app/website exist?	Yes

Source: Compiled from multiple sources

INTRODUCTION TO THE CITY

Gurugram, formerly known as Gurgaon, is located in the state of Haryana and is one of the core satellite cities in the National Capital Region. It supports the decentralisation of the national capital – in terms of industry, population and development.

The growth of the city began in the 1970s after the establishment of a manufacturing plant by Maruti Suzuki India Ltd and General Electric's operations, in collaboration with the real-estate firm Delhi Land and Finance (DLF). Gurugram eventually evolved to become the financial and industrial epicentre of Haryana and witnessed a phenomenal growth in all spheres of development, particularly in industry, in the last few decades.

A large part of the city and its infrastructure was developed by private developers; it has today become a hub of multinational companies, call centres, software companies, shopping malls and skyscrapers.[3,4] The strategic location of the city, being adjacent to the Indira Gandhi International Airport and excellent road and rail connectivity with Delhi and other states through the Delhi-Jaipur-Ahmedabad broad gauge rail link, Kundli-Manesar-Palwal expressway and the NH 8 also played a key role in the city's fast-paced development. The Municipal Corporation of Gurugram (MCG) was established in 2008 and is the civic body accountable for overseeing the development and management of the city.

Gurugram's population grew significantly by mid-1990s.[5] According to the Census, there was an increase of 44.15 per cent in the population between 1991 and 2001 and another rise of 73.96 per cent -- from 876,000 to more than 1.5 million -- between 2001 and 2011.[67] Such an increase in population has placed great demand for infrastructure and facilities, as a result of which the city continues to grow exponentially.

VOLUME OF C&D WASTE GENERATED AND THE CHALLENGES IN MANAGING IT

Gurugram generates about 2,000 tonne per day (TPD) of C&D waste, as per information shared by MCG officials with CSE researchers. The city also has about 10 lakh tonne of legacy C&D waste.

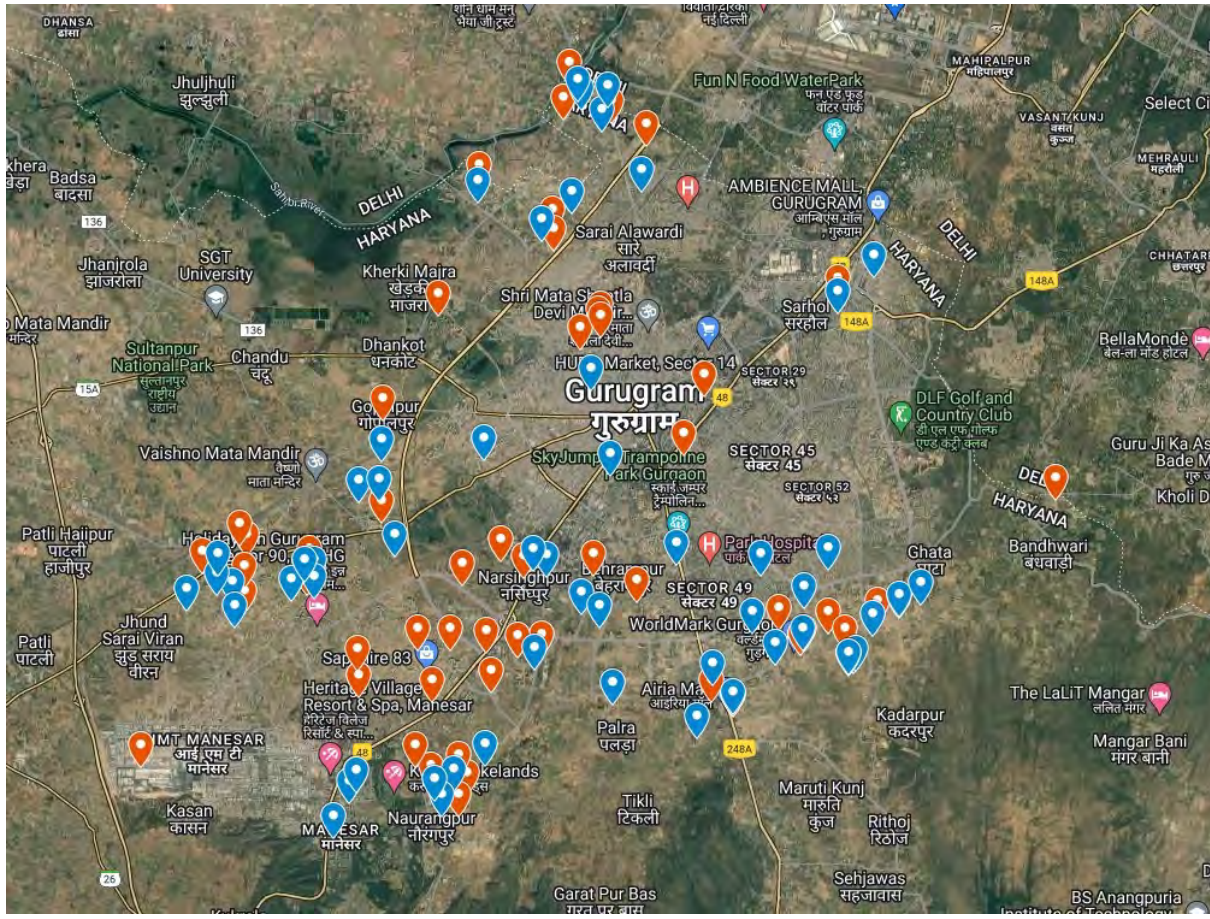
According to the Haryana RERA, over 203 projects have been registered in 2022 and 2023 alone. This denotes significant amount of construction in the city – even as the RERA registration does not include self-construction and small-scale projects (less than 500 sq m plot area) as well as the industrial, institutional and infrastructure projects.

Gurugram has major ongoing projects like the expansion of the Kundli-Manesar-Palwal Expressway and the Delhi-Mumbai Industrial Corridor,[8] and the 28.8-km-long corridor, known as 'Gurugram Metro' project[9] [10] on which construction will commence in 2023-24. Other large-scale projects include a 46 km-long Gurugram-Pataudi-Rewari highway[11] [12] (NH-352W) being developed by the National Highways Authority of India (NHAI); this is expected to be ready by 2023-end. There is also the proposed Delhi-Alwar Regional Rapid Transit System[13], a National Capital Region Transport Corporation (NCRTC) project.

Further, MCG is developing many public projects such as a commercial shop-cum-office complex, veterinary hospital, multipurpose booths and roads in sectors 33 and 35 and a cultural complex in sector 53, among others.[14]

Gurugram has topped in both housing supply

MAP 1: REGISTERED CONSTRUCTION PROJECTS IN GURUGRAM



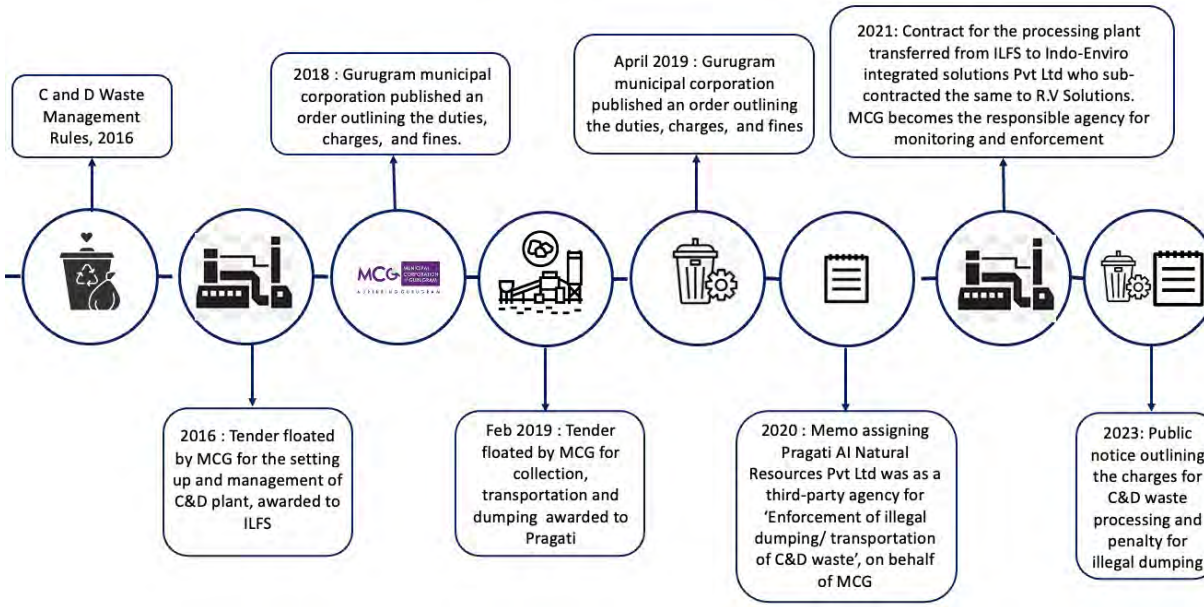
and absorption rate (used to determine how many homes are sold in a market at a particular time) in 2022 among all cities in the National Capital Region (NCR), according to a report released by Anarock, a real estate consultancy. According to the report, the city's share of sold residential units, compared to the entire stock of sold units in NCR, was 28 per cent in 2019, 31 in 2020, 39 in 2021 and 51 per cent in 2022.[15]

This demonstrates the intensity of development taking place in the city. Combined with enormous amount of legacy C&D waste, Gurugram needs to be prepared to collect and process the huge quantums of C&D waste that i is generating currently.

INFRASTRUCTURE DEVELOPMENT, POLICIES AND ACTIONS BY THE ULB

Gurugram has an operational C&D waste recycling plant. In 2016, the MCG had floated a tender for a Build-Operate-Transfer (BOT)

FIGURE 1: C&D WASTE MANAGEMENT IN GURUGRAM: A CHRONOLOGICAL RECORD



contract for a C&D processing facility. This contract was awarded to Infrastructure Leasing & Financial Services (IL&FS) for a tenure period of 20 years. The recycling plant became operational in September 2018.

Shortly after, another tender was floated for collection, transportation and dumping of C&D waste within MCG limits for a period of three years. By February 2019, Pragati AI Natural Resources Pvt Ltd was appointed to do this service. The processing rate and the annual percentage increase in tipping fee was also defined in a memo.

An order (Endst. No. MCG/ ADMC/2019/18384, dated April 2019) issued by the Commissioner of the MCG outlines the duties of waste generators, empanelled agencies, and nodal officers, the fines for illegal C&D waste dumping, and punishments. It specifies collection fees, intermediate collection locations, and the basis for C&D waste evaluation. The order also states that empanelled agencies are authorised to identify illegal dumping points, and nodal officers must prevent unauthorised transportation of C&D waste. The nodal officers are the Assistant Engineers (AEs) and Junior Engineers (JEs) who oversee the management of C&D waste. The orderwas also published in local newspapers.

In May 2020, according to a memo numbered JC(HQ)/MCG/2020/282, Pragati AI Natural Resources Pvt Ltd was appointed as a third-party agency for 'Enforcement of illegal dumping/ transportation of C&D waste'. On behalf of the MCG, Pragati was authorised to issue challans and notices to the violators of C&D waste bye-laws and impound illegal carriers of C&D waste in the city. The penalty fee was to be paid to the MCG by the violators.

The contract was transferred in 2021 to

Indo-Enviro Integrated Solutions Pvt Ltd, which sub-contracted it to R V Solutions. The MCG and the C&D waste management facility are jointly responsible for collection and transportation of the waste, and the Corporation is accountable for monitoring and enforcement. A team of MCG officials has been built up as a monitoring squad for every zone. There is an online redressal system for the public to register complaints, which can be accessed through the OneMap Gurugram website.[16]

USER CHARGES AND PENALTIES

Fees

According to the MCG order (Endst No. MCG/ADMC/2019/18384 dated 10/04/2019), C&D waste charges are paid by the generator to the MCG, which then pays it to the C&D waste processing plant. Transportation and tipping fees are decided by the plant operators, depending upon the distance.

- For MCG projects: Rs 360 charged for collection, transportation and processing (within 15 km from the project site)
- For segregated waste that is brought into the plant by the generator: Rs 205/tonne.
- For segregated C&D waste that is collected by the plant from generators: Rs 360/tonne.
- For unsegregated waste that is collected by the plant from generators: Rs 720/tonne.

Penalties

According to MCG, a penalty of Rs 10,000 is charged for illegal dumping of C&D waste. If the same defaulter and/or vehicle is found flouting the rules again, they are charged a penalty of Rs 25,000 for the second time, Rs 35,000 for the third and Rs 50,000 for the fourth time, along with a possibility of seizure of the vehicle.

For developers who do not report and/or deposit the C&D waste generated from their construction site, a penalty of 120 per cent of the processing fees for the quantity of waste generated at the rate of Rs 720/tonne is charged. The quantity of C&D waste is calculated according to the C&D waste estimation outlined in the report by TIFAC (2001)[17], which states that for every one square metre of built-up area, 50 kg of C&D waste is generated from new construction, 45 kg from renovation projects and 400 kg from demolition projects.

COLLECTION, TRANSPORTATION AND DISPOSAL OF C&D WASTE

The collection mechanism is coordinated between the MCG and the C&D plant; officials from MCG inform the plant operators about the collection points which are assigned daily. The MCG has provided a C&D waste helpline number on which the generator can call and request for collection and transportation. The generator will have to provide information regarding the quantity of waste and the location of the pick-up, after which the nodal officers shall inspect the C&D waste and estimate the quantity of it, according to the duties stated by MCG order (Endst No. MCG/ADMC/2019/18384 dated 10/04/2019).

The officers coordinate with the collection team at the plant regarding the location and priority of the waste pick-up. The collection vehicles travel to as far as 40 km from the corporation limits for collection of C&D waste. Alternatively, the waste can be brought directly to the C&D processing facility at Basai by the generator.

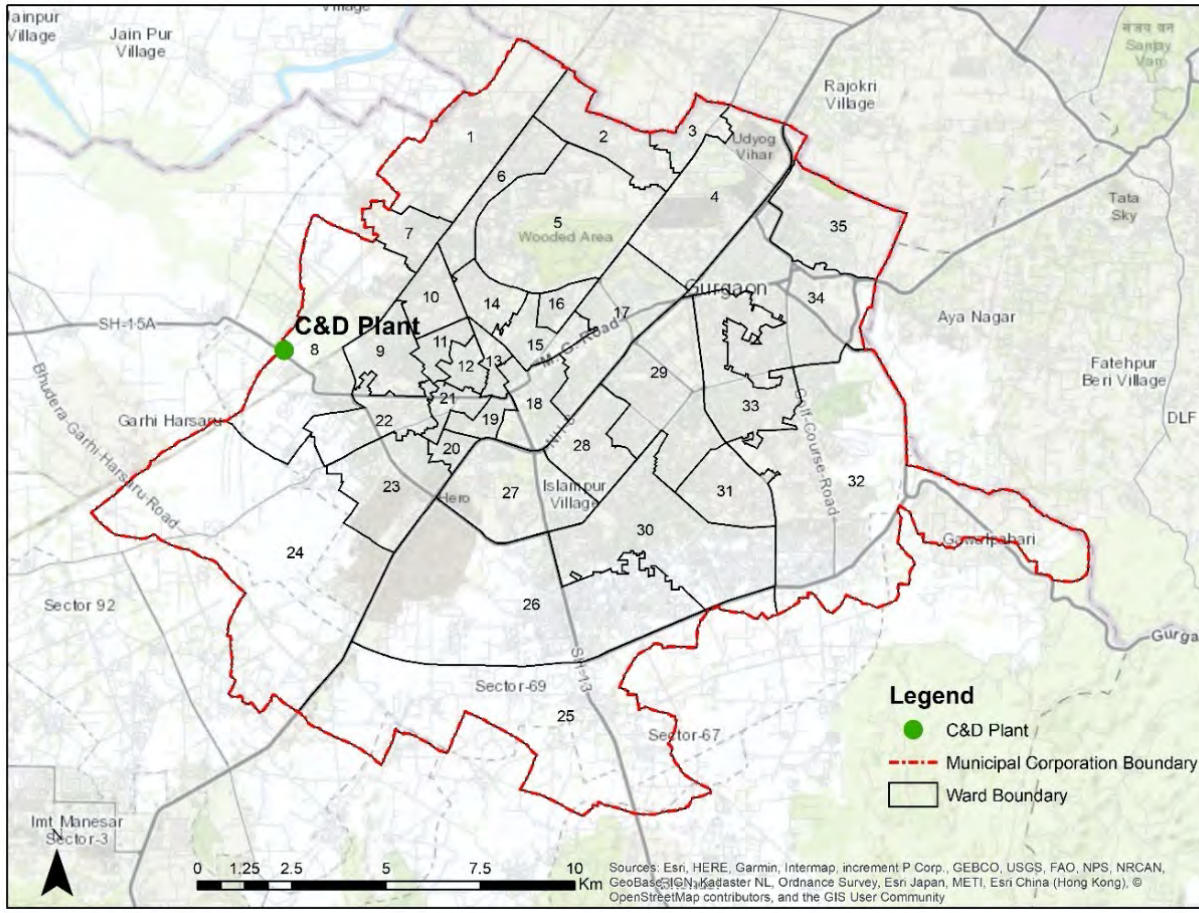
RECYCLING FACILITY

The C&D waste processing plant currently uses only dry processing technology. It is setting up a wet processing unit which is expected to begin operations by the end of 2023. The plant has a maximum capacity of 1,000 TPD and processes about 800 TPD. The plant has a fleet of 11 vehicles, including Hyva trucks and JCBs, and hires more when needed. The vehicles are not colour-coded but painted with MCG initials and are installed with GPS. They are monitored by the Corporation as well as the processing facility.

RECYCLED PRODUCTS

The facility has a concrete block making unit and an interlocking block making unit. Roughly, about 400 tonne of recycled products, mainly consisting of 10 mm, 20 mm and 40 mm aggregates, and sand dust are produced every day. These are sold as they are and used to create different recycled products such as cement blocks, kerb stones and interlocking pavers (dumbbell, milano and zigzag shaped). About 1,500-2,000 pieces of blocks sized 100 mm x 200 mm x 400 mm are produced every day, on

MAP 2: LOCATION OF C&D WASTE PROCESSING PLANT



Source: CSE

Vehicle fleet at C&D plant

Weighing bridge control room (left) Loaded truck at the weighing bridge (right)

Waste being fed into the feeding hopper (left) Manual segregation (right)

Dry processing unit (left) Anti-smog gun (right)

Financial framework of the plant	
Element	**Details**
Land	Owned by MCG. Given on lease to Indo Enviro Pvt Limited
Area of the plant	3.5 acres
Fee for land	Rs 238.2 per sq m (with an annual increase of 5% + GST)
Type of processing	Dry (wet is being installed)
Contract type	Built-Operate-Transfer – PPP model
Contract tenure	20 years
Capital cost for setting up the plant	Rs 15-16 crore (as per discussions with plant operator)
Responsibilities of plant operator	Collection and transportation (jointly with ULB) and processing
Responsibilities of ULB	Collection and transportation (jointly with plant operator), monitoring and enforcement
C&D waste generated in the city	2000 tonne per day (TPD)
C&D plant processing capacity	1000 TPD

Various processed C&D waste getting collected separately

Recycled product samples

Recycled bricks and interlocking paver tiles

an average. The processed products are tested at Sriram Labs in New Delhi, after which they are sold, mainly to local customers.

There are multiple dust mitigation measures employed in the plant – such as installation of anti-smog guns and sprinklers which are used periodically. Collection vehicles such as tractors and trucks are covered with tarpaulins or green nets while transporting C&D waste. However, there is also scope for improving some of these dust mitigation features at the plant (such as installing effective dust barriers, wheel washing facility, and planting a green belt around the edges).

CHALLENGES, ISSUES AND LESSONS LEARNT

Gurugram had started to take steps towards developing a C&D waste management ecosystem as early as 2016 by developing rules and infrastructure. The waste processing plant started its operations in 2018; a third party agency was appointed for enforcement. While this model worked effectively for the city, the developed ecosystem had to go through major transitions between 2020-2021 such as a change in the plant's ownership, its sub-leasing and termination of the third party contract. Gurugram is still trying to recover from this disruption.

Recycling plants are exposed to such operational challenges. To reduce this exposure, cities need to establish clear mandates and standard operating procedures and make the system more resilient to operational disruptions. The state government is extending capital assistance to ULBs for reforms and infrastructure – this could help safeguard C&D waste infrastructure and eco-systems.

Another issue that the plant faces is the resale of recycled products: there seems to be a lack of demand for these products. To generate this demand, use of recycled C&D waste products in construction should be made mandatory. Creating awareness on performance of recycled products and incentivisation can also add to this measure.

C&D WASTE MANAGEMENT—CURRENT STATUS IN GURUGRAM

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆		◆	◆	◆		

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
	◆	◆

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
			Phase II ◆	Phase I ◆

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)
	◆			

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JAIPUR
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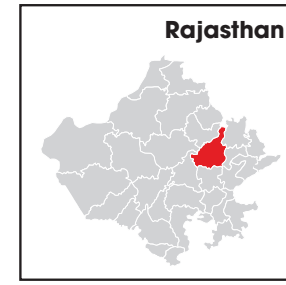
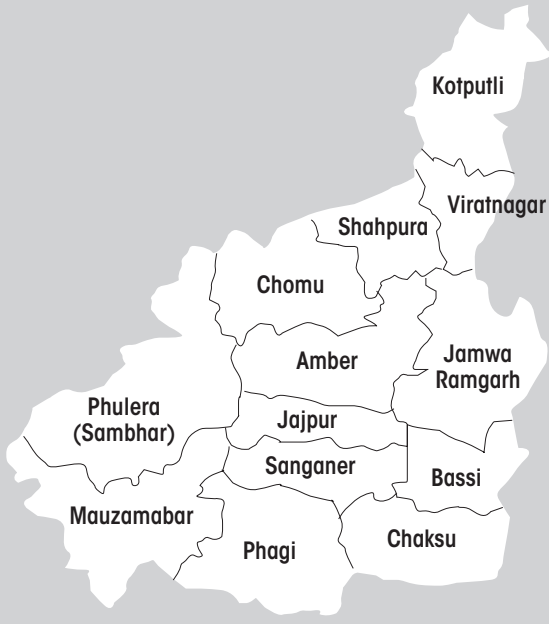




Area (sq. km)	467[1]
Number of wards	250 (150 in Greater and 100 in Heritage)[2]
Number of zones	11 (7 in Greater and 4 in Heritage)[3]
Population (Census 2011)	3.07 million[4]
Floating population	0.3 million[5]
C&D waste generated	300 tonnes per day[6]
Number of intermediate storage-collection points	11 (proposed)[7]
Status of C&D waste processing plant	Work order issued; land clearance and financial approval awaited[8]
Has the city notified bye-laws?	Yes

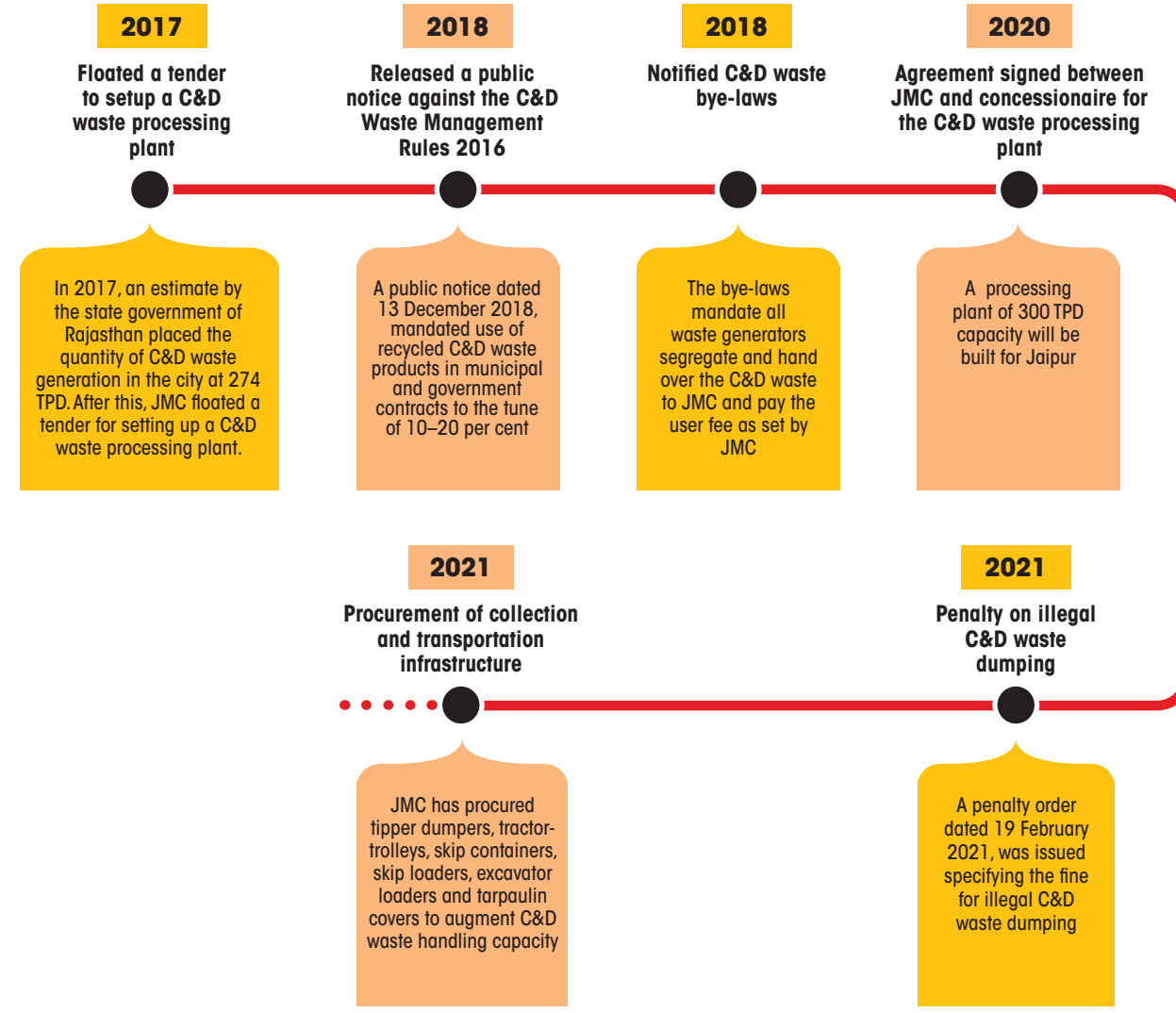
Source: Compiled from multiple sources

JAIPUR—the capital of the largest state in India—is an emerging city. It is witnessing enormous industrial activity due its close proximity to the Delhi–Mumbai Industrial Corridor. As a result, a number of new industrial areas are coming up, and the city is seeing a rise in construction activity. According to a detailed project report prepared for the setting up of a C&D waste processing plant in the city, about 300 tonnes per day (TPD) of C&D waste is anticipated from all the construction activity.[9] However, an estimation by Centre for Science and Environment (CSE) pegs the quantity of C&D waste in Jaipur at roughly 1000 TPD.[10]

CURRENT SYSTEM OF C&D WASTE MANAGEMENT

The current system of C&D waste management in Jaipur is largely run by the informal sector. Jaipur Municipal Corporation (JMC) provides

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN JAIPUR



for the collection of C&D waste through an on-call system. But under the current system, very few C&D waste generators follow this formal process. This can be attributed to a lack of awareness among the public. As a result, private contractors collect C&D waste at construction sites and dispose of it indiscriminately. A field investigation by CSE has confirmed that large quantities of C&D waste are being dumped in water bodies, and on roadsides and vacant land in the city's periphery.

The waste produced from demolition activities undertaken by citizens is taken to a sanitary landfill site by private contractors. Sanitary inspectors deployed in each ward conduct regular surveillance of illegal dumping. Based on this surveillance as well as complaints, the waste dumped illegally on roadsides and uninhabited areas is lifted by the JMC and taken to the two municipal dumpsites—Sewapura and Mathuradaspura. In December 2020, Sewapura received nearly 132 TPD, and Mathuradaspura received 147 TPD of C&D waste.

In 2019, JMC was split into two municipal bodies—Jaipur Municipal Corporation Greater and Jaipur Municipal Corporation Heritage. JMC Greater disposes of the C&D waste collected in its jurisdiction at the Sewapura site and JMC Heritage takes the waste to the Mathuradaspura site. JMC Greater has a dedicated fleet of 58 hoppers, 14 dumpers, seven tractor trolleys, seven excavator loaders and four front-end loaders. Further, JMC Greater has procured 50 skip container, two skip loaders, six dumpers, four tractor trolleys, and tarpaulin covers. These vehicles are equipped with VTS/GPS units to help track their movement.

THE TRANSFORMATION

Jaipur is one of the first few cities to prepare and notify its C&D waste bye-laws. The bye-laws, notified in 2018, addresses C&D waste in a well-rounded manner. It contains the mandate on C&D waste segregation, and lays down the duties of different stakeholders. It also contains directives on user fee, penalties, and provisions for the reutilization of C&D waste. This has laid the foundation for the city's efforts to curb illegal dumping and establish a system for the recycle and reutilisation of C&D waste.

Other than this, an order from 2018 mandates all generators to segregate and store C&D waste in their premises.[11] They must then transport the waste to a designated collection point in the zone at a later date. JMC is planning to set up one collection point in each zone. Alternatively, the generators can call JMC at the control room and get the helpline number for their zone. The Zonal Engineer then assumes the responsibility of sending a vehicle to collect the C&D waste from the generator's location.

This order also mandates the procurement of recycled C&D waste products to replace 10–20 per cent of construction materials in municipal and government contracts. This move is crucial in creating demand for recycled C&D waste products. According to the order, bulk generators are required to develop and submit a waste management plan and get approvals prior to any construction, demolition or remodelling work.

To ensure enforcement, a penalty order was released in February 2021. JMC shall penalize the C&D waste generator with Rs 1,000 per day in case of disposal of C&D waste on government land.[12]

CENTRALIZED C&D WASTE PROCESSING PLANT

In 2017, an estimate by the state government of Rajasthan placed the quantity of C&D waste generated in the city at 274 TPD. After this, JMC floated a tender for the setting up of a C&D waste processing plant. JMC has completed the procurement process for a plant with a capacity of 300 TPD. Shivalik Silica and Arghya Engineering will operate the plant through the design-build-own-operate-transfer model of project delivery. The concession period is 20 years and product recovery is estimated at 75 per cent of the input waste.

With this project, JMC is looking at three objectives:

1. Transferring the responsibility of collection, transportation and disposal, and associated costs to the C&D waste generator.
2. Reducing the amount of C&D waste that goes into the landfill.
3. Exploring and developing a market for recycled C&D waste products.

A land parcel of 3.23 hectares (8 acres) at in Langariawas has been identified for the plant. This land is part of a larger waste management cluster. This cluster comprises a sanitary landfill and a Refuse Derived Fuel (RDF) facility. While the RDF facility is awaiting closure, the sanitary landfill will receive a waste-to-energy plant. The procurement process for the plant has been finalized and closed, and the concessionaire has been selected. While the plant will process C&D waste received from the entire city, it will be administered by JMC Heritage since the site falls in their area.

The site designated for the C&D waste processing and recycling plant is about 20 km away from the city centre and roughly 30 km away from the construction hotspots that are located in the southeast and western parts of Jaipur (see Map 1: *Distance of the plant site from development clusters*). This land is currently awaiting funds from the state government, and clearance for the commencement of construction.

PROCESSING TECHNOLOGY; RECYCLE AND REUSE

According to the detailed project report prepared for the C&D waste processing plant in Jaipur, wet processing technology will be adopted to process the waste. This is mainly because the C&D waste that JMC receives is not segregated. The proposal for the plant includes jaw crushers, rolling crushers and water-based treatment systems. The plant will produce recycled C&D materials such as fine and coarse aggregates along with concrete blocks.

USER CHARGES

When the plant is operational, generators will have to pay Rs 390 per tonne for the collection, transportation and processing of C&D waste. At present, the generators generally pay a malba fee of Rs 1,000–10,000 depending on the plot size, at the time of seeking building permission. This fee is refundable if the generator lifts and disposes of the C&D waste on their own. In order to do so, a generator engages the informal sector at Rs 220 per tonne for collection, transportation and disposal of the waste. If JMC wishes to compete with this price, they will have to come up with strategies that encourage generators to hand over the C&D waste to them. For instance, subsidizing segregated C&D waste is one such strategy.

C&D WASTE MANAGEMENT—CURRENT STATUS IN JAIPUR

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	◆

Steps to curb illegal dumping

Recognize illegal C&D waste dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆			◆	◆		

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
◆		

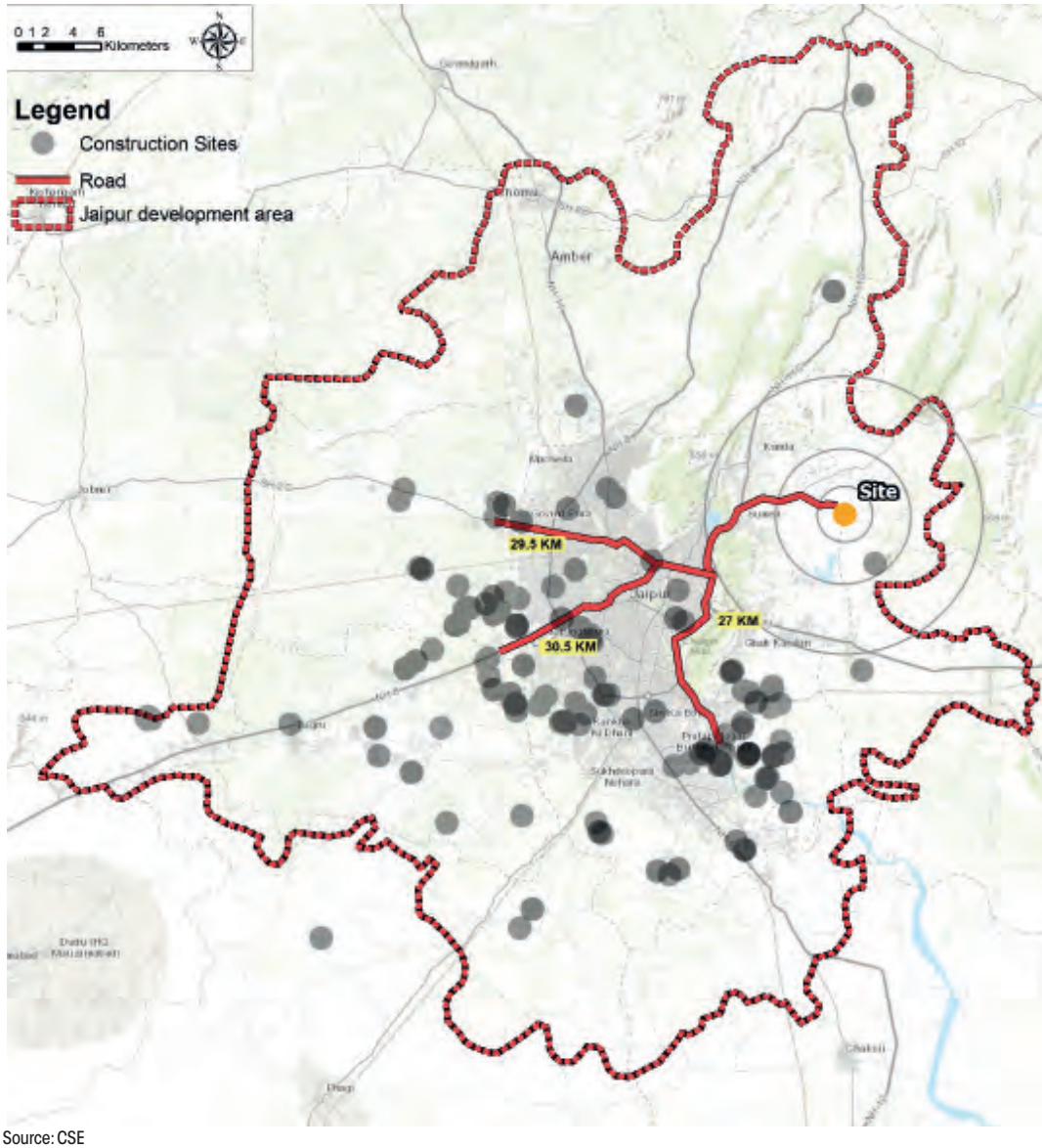
Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycling plant prepared	Floating of tender for C&D waste recycling plant	C&D waste recycling plant under-construction	C&D waste recycling plant is operational
◆	◆		◆	

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)
		◆		

MAP 1: DISTANCE OF THE PLANT SITE FROM DEVELOPMENT CLUSTERS



Source: CSE

DECENTRALIZED COLLECTION

JMC is planning to identify one dedicated C&D waste collection point in every zone. There are 11 zones in JMC area—four in JMC Heritage and seven in JMC Greater—which gives the city a total of 11 collection points. Due to constraints of space, both the municipal bodies are yet to identify the precise locations for the collection points. However, to resolve this issue and enable a more decentralised collection, JMC Greater is procuring skip loaders and skip containers to enable segregated storage and collection of C&D waste.

KEY TAKEAWAYS/LESSONS LEARNT

Ensuring that the recycling plant receives a continuous feed of waste for processing is critical for the running of a C&D waste processing plant. The tender for establishing a plant in Jaipur was floated more than once due to the uncertainty around waste feed. Establishing a collection system becomes crucial in such a scenario. By notifying its C&D waste bye-laws, Jaipur has provided the much needed mandate for this collection system. The bye-laws have legally bound generators to segregate and hand over the C&D waste to JMC and pay the relevant charges for its transportation and processing. Further, by procuring collection and transportation infrastructure such as skip containers, skip loaders, hoppers, dumpers, tractor-trolleys, etc., JMC is ensuring adequate handling capacity.

The mandate to use recycled C&D products in government and municipal contracts has taken care of the demand for these products. Such well-rounded administrative actions are fundamental to the proper management and recycling of C&D waste.

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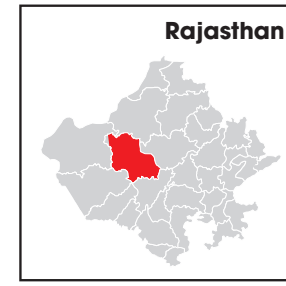
JODHPUR
Rajasthan



Area under Jodhpur Nagar Nigam (sq. km)	51.38[1]
Number of wards	160 (North: 80[2] and South: 80)[3]
Population (Census 2011)	1.03 million[4]
Population (2017)	1.18 million[5]
Current population (2021, estimated)	2.33[6]
Projected population (2031)	3.1 million[7]
C&D waste generated (2017)	95 tonnes per day[8]
Number of intermediate storage-collection points	3 • Near Central Jail • Kajri office • Pratapnagar
Number of vehicles for the transportation of C&D waste	8; (North: 4 and South: 4); one with each Chief Sanitary Inspector
C&D plant (tender to be floated again in 2022)	Plant with capacity of 100 tonnes per day

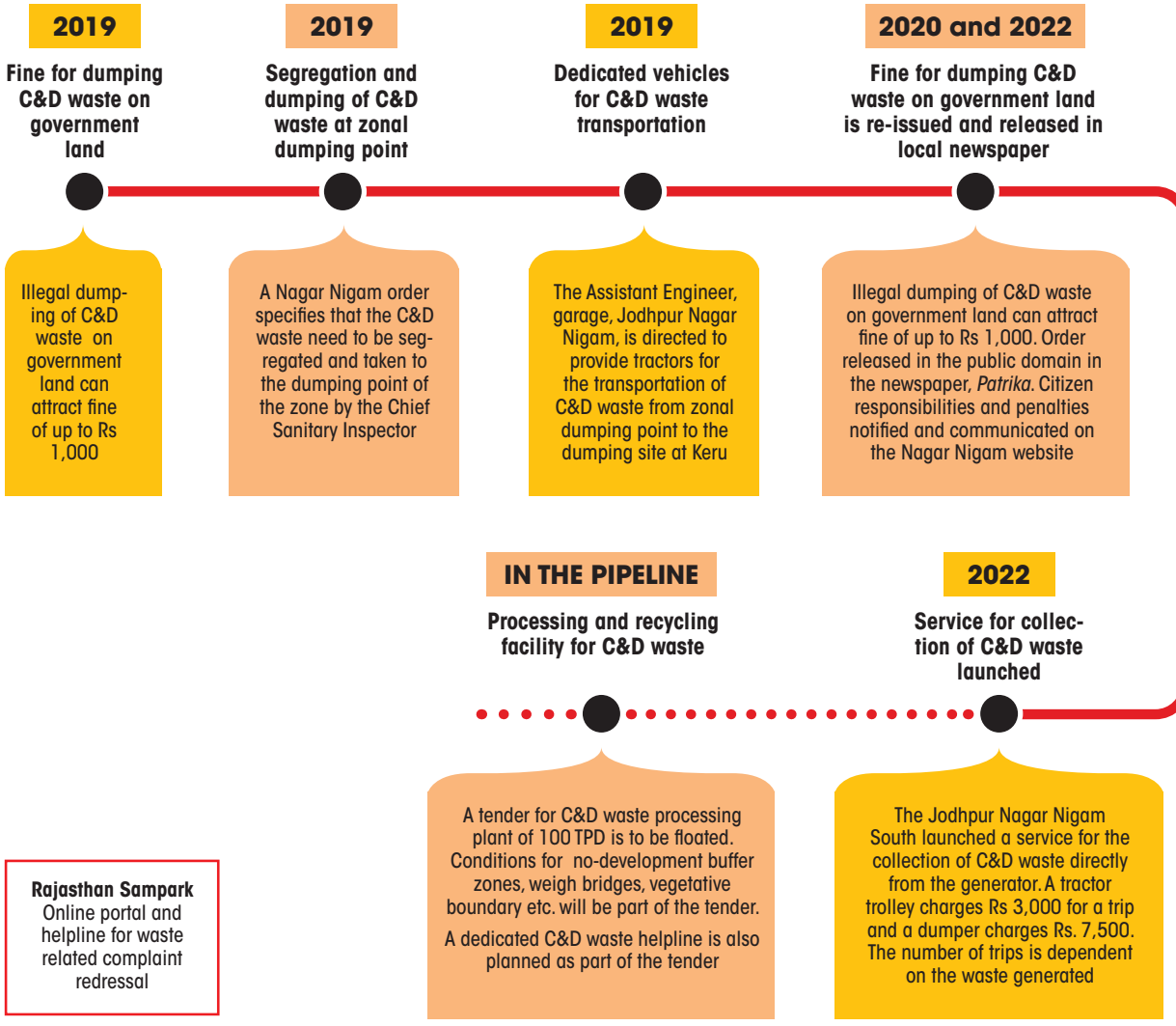
Source: Compiled from multiple sources

JODHPUR city is expanding its infrastructure at a substantial rate to support the demands of its increasing population. The population growth rate was nearly 33 per cent from 2011 to 2021 and is projected to increase at nearly the same rate over the next decade, according to the Master Development Plan 2031.[9] The rising footprint of infrastructure has also resulted in the generation of huge quantities of construction and demolition waste that needs to be managed.

HOW IS JODHPUR MANAGING ITS C&D WASTE?

In 2019, the Jodhpur Municipal Corporation South notified a fine of Rs 1,000 on the dumping of C&D waste and storage of building materials on government land. Consequently, the Chief Sanitary Inspector was given the responsibility of transporting segregated C&D waste to the dumping point of each ward. For this to be carried out, the Assistant Engineer, garage,

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN JODHPUR



Jodhpur Nagar Nigam, was directed to provide each zone with tractors for transporting waste from the zonal dumping point to the dumping site at Keru. In 2020, the penalty for illegal dumping of C&D waste on government land was notified again and published in local newspapers to increase awareness. Despite having these measures in place, Jodhpur continues to be plagued by dumping of C&D waste in both public and private land.

Currently, there are eight tractors that haul and transport C&D waste in Jodhpur. The city has three transfer stations—near Central Jail, Kajri office and in Pratapnagar. C&D waste is transported in covered vehicles and compliance checking is done at transfer stations, violation of which can result in a fine of Rs 500. It is estimated that around 45–50 tonne of C&D waste is collected and dumped every day at the Keru site.

In 2022, Jodhpur Nagar Nigam South started a service for the collection of C&D waste. The service charges Rs 3,000 per trip for a trolley truck and Rs 7,500 per trip for a dumper.

SYSTEM FOR CITIZEN COMPLAINT REDRESSAL

A citizen complaint redressal system called Rajasthan Sampark exists in the state of Rajasthan. The system consists of a state-level call centre that acts as a point of contact for citizens to reach out to the concerned government departments. The citizens can lodge their grievances against any government department/office using the portal. The complaint will then be directed to the respective office/department for redressal. C&D waste can also be reported through this system. Additionally, one can contact the Nagar Nigam South's toll-free number for C&D waste disposal.

CITY INITIATIVES IN THE PIPELINE FOR C&D WASTE MANAGEMENT

The city plans to establish a C&D waste processing facility for which the state government will be floating a request for proposal, laying down various requirements for setting up a plant. According to the request for proposal, a C&D waste processing plant with a capacity of 100 tonnes per day is to be established at Keru. Two similar tenders had been floated in the past, the latest of which was floated in December 2020. However, both these tenders failed to receive satisfactory bids.

KEY FEATURES OF C&D WASTE PROCESSING PLANT, AS MENTIONED IN THE TENDER REQUIREMENTS

- C&D waste shall be utilized in a sanitary landfill for municipal solid waste of the city.
- The processing or recycling shall be large enough to last for 20–25 years.
- The processing or recycling site shall be away from habitation clusters, forest areas, water bodies, monuments, national parks, wetlands and places of important cultural, historical or religious interest.
- A buffer zone of no-development shall be maintained around the solid waste processing and disposal facility.
- The processing or recycling site shall be fenced or hedged. It will be provided with a proper gate to monitor incoming vehicles or other modes of transportation. A digital weigh bridge will be installed at the entry (gate) to the processing facility for weighing the C&D

waste that is received by each vehicle.

- The approach and internal roads shall be paved to avoid generation of dust particles due to vehicular movement. They shall be designed in a way that ensures free movement of vehicles and other machinery.
- The weigh bridge will be equipped to measure the quantity of waste brought at the landfill site. It will be equipped with fire protection equipment and other facilities that may be required.
- The entire C&D waste processing and management system should be in compliance with C&D Waste Management Rules 2016, or the applicable rules of the state and other guidelines.

C&D WASTE RECYCLING TECHNOLOGY TO BE USED

- The concessionaire will be expected to use a combination of mechanical processes/ systems that include crushing, screening, and separation in order to maximize C&D Waste processing and ensure that not more than 20 per cent of the waste goes into the landfill site(s).
- The concessionaire shall use wet process technology to process C&D waste. This will be done in accordance with the C&D waste management and air pollution rules to minimize nuisance from excessive dust generated during the processing activity.
- The concessionaire is also responsible for establishing a research and development centre at the C&D waste processing site.

HELPLINE FOR C&D WASTE MANAGEMENT

Jodhpur Nagar Nigam South has provided helpline numbers that maybe contacted for C&D waste disposal. However, the numbers are not dedicated for C&D waste management alone.

LESSONS LEARNT

C&D processing often requires water. Since Jodhpur is situated in a water-starved region, the lack of water is a major challenge for setting up the C&D recycling plant. Setting up the plant closer to a water treatment plant could be a more feasible option than setting it up far from a water source. This would also ensure that treated water is used in C&D waste processing instead of fresh water.

C&D WASTE MANAGEMENT—CURRENT STATUS IN JODHPUR

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D waste dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆			◆			

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
	◆	

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycling plant prepared	Floating of tender for C&D waste recycling plant	C&D waste recycling plant under-construction	C&D waste recycling plant is operational
◆	◆	◆		

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)

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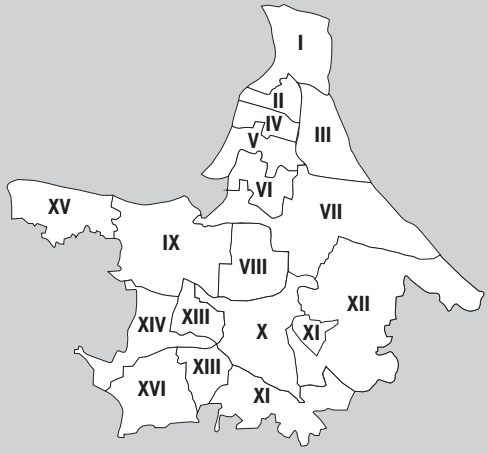
KOLKATA
West Bengal



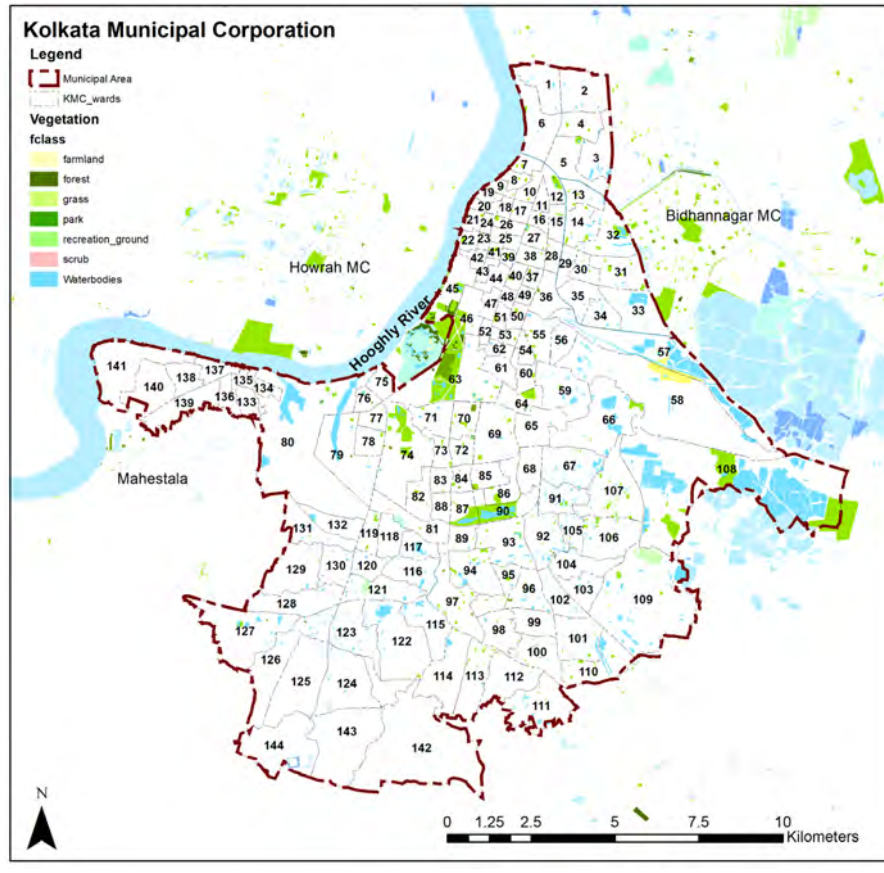
Area (sq. km)	205[1]
Number of wards	144[2] (under KMC)
Population (Census 2011)	4.5 million[3]
Population (2021, estimated)	4.63 million[4]
Projected population (2051)	28 million[5]
Floating population	6 million[6]
Population density	24,252 per sq. km[7]
C&D waste generation	1,600 tonnes per day (TPD)
Status of C&D waste processing plant	1,600 TPD at Patharghata; 500 TPD dedicated for KMC (in progress)[9]
Has the city notified bye-laws?	No

Source: Compiled from multiple sources

Kolkata—located on the eastern bank of the Hooghly River—is an educational, cultural and commercial hub of eastern India. This city is famous for its rich cultural heritage, traditions and festivals. Kolkata's infrastructure is expanding at an exponential rate to meet the demands of its increasing population. The Kolkata Municipal Corporation (KMC) area comprises 144 wards covering 205 sq. km (10.86 per cent of the total Kolkata Metropolitan Area) in the Kolkata district (see *Map 1: Municipal boundary of Kolkata Municipal Corporation with its population density*).[10]

According to the 2011 Census of India, Kolkata's population was 4.5 million—a 54.43 per cent increase from 1961. Kolkata's population is expected to reach 28 million in 2051.[11] This rise in population will lead to a greater requirement for infrastructure. This in turn will generate large quantities of construction and demolition (C&D) waste that will need to be managed.

MAP 1: MUNICIPAL BOUNDARY OF KOLKATA MUNICIPAL CORPORATION



Source: Kolkata Municipal Corporation website, generated by CSE

CURRENT SYSTEM OF C&D WASTE MANAGEMENT

Steps toward C&D waste management have begun to be taken in Kolkata. KMC notified solid waste bye-laws in 2020, which include a few provisions on C&D waste. Additionally, KMC has introduced a helpline number and a mobile app for citizens. Using the helpline, citizens can enquire about issues related to waste management and also place collection requests with the conservancy officer deputed in their respective wards. A notification dated 12.06.2020 released by KMC lays down the duties of waste generators in case of demolition. The waste generated from demolition needs to be segregated on site into concrete, steel, wood, plastics, bricks and mortar, and reused. C&D waste is to be kept within the premises and there should not be any littering which obstructs traffic, public places or drains.

The traditional practice for C&D waste management in the city largely involves transporters in the informal sector who are hired by builders to collect C&D waste. This C&D waste is either purchased by local builders for filling and land reclamation purpose or dumped indiscriminately. This indiscriminate backfilling and dumping is eating away the East Kolkata wetlands.

PENALTIES AND FEES

According to KMC solid waste bye-laws 2020, schedule B, a fine of Rs 5,000 will be levied upon all generators for not storing and delivering C&D waste after segregation. In case of disposal of C&D waste (or any other waste) in a water body, or on roads and pavements, a fine of Rs 5,000 will be levied for the first time, followed by Rs 7,500 for second violation and Rs 10,000 for every repeated violation. The user fee and fine will automatically increase at the rate of 5 per cent per year with effect from 1 January of each year.[12]

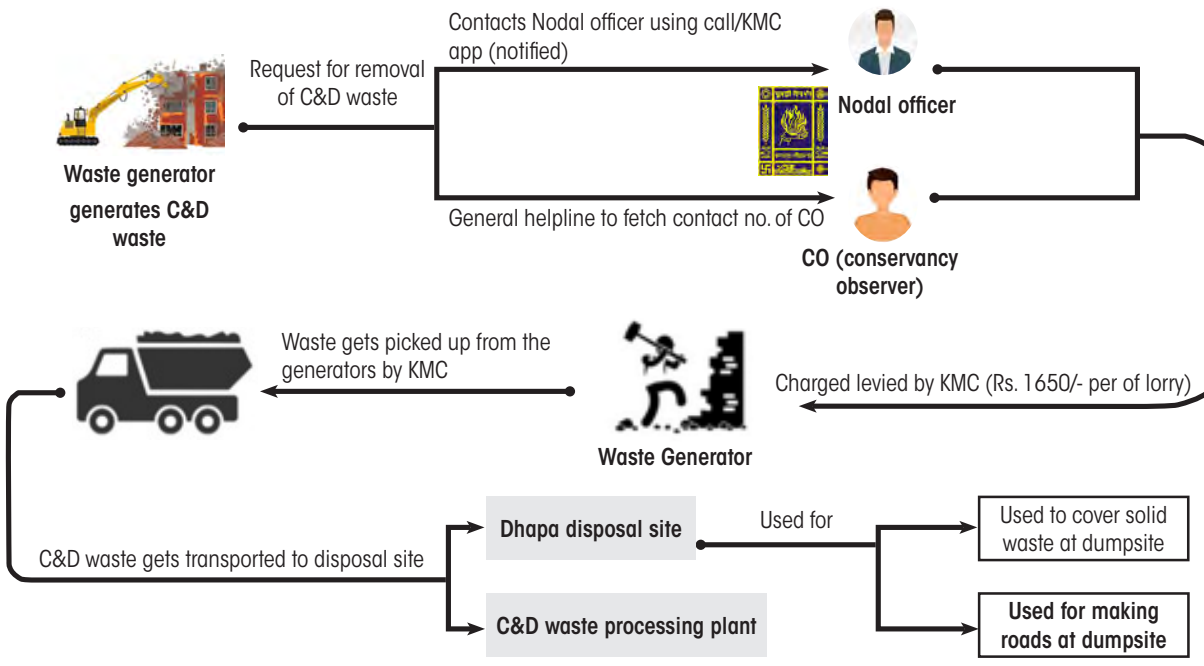
In addition to penalising for illegal dumping, KMC also levies charges for piling and dumping C&D waste in the streets during the building approval process. Kolkata Building Rules prescribe the stacking fee for building materials and C&D waste for a duration. If these materials and waste are not cleared within the given time, the waste generators are liable to pay a penalty.

COLLECTION, TRANSPORTATION AND DISPOSAL

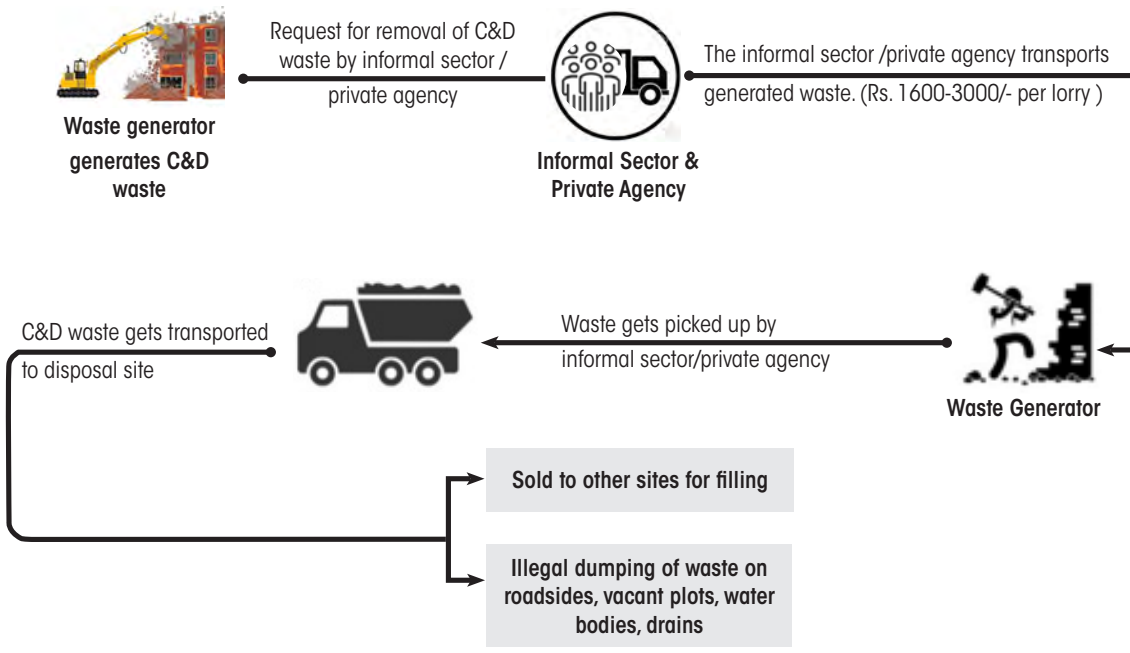
There are two systems for C&D waste collection, transportation and disposal within the boundaries of KMC. In one system, the waste generator can call on the KMC helpline and inform the conservancy officer regarding the C&D waste or visit the office for the same. The waste generator will have to pay Rs 1,650 per lorry for transportation and disposal of waste by KMC. Alternatively, the waste generator may make private arrangements for a vehicle for disposal of the waste.

The informal sector has a pivotal role in the entire chain of C&D waste management. Right from waste collection to sorting of waste—into components such as glass, plastic, steel bars, etc.—and selling it to recycling units, till the disposal of debris, the informal sector takes the lead. The charges levied by the informal sector for transportation of waste vary from Rs 1,600–3,000 per lorry. However, in this case there is no guarantee that the C&D waste is being disposed of safely at the landfill. In most cases in which

C&D WASTE DISPOSED BY KMC



WASTE GENERATOR INVOLVES INFORMAL SECTOR/PRIVATE AGENCY



the informal sector is hauling C&D waste, it is dumped illegally in drains, water bodies, forests, vacant lots or on roadsides, etc.

When KMC is involved, vehicles owned by both KMC or registered private agencies are used to collect and transport the waste. C&D waste in Kolkata is disposed of at the Dhapa landfill, which is the city's active disposal site for solid waste. At the landfill, C&D waste is mainly used for making roads for the trucks to drive on and covering the solid waste.

RECYCLING FACILITIES

Considering the large volumes anticipated due to high construction activity, KMC has procured a C&D waste recycling plant with maximum processing capacity of 1,600 TPD. Out of this, 500 TPD is dedicated to C&D waste from KMC and the remaining is dedicated to other ULBs. It is being set up in Patharghata at a 5-acre site (see *Map 2: Location of construction projects in KMC and the Patharghata plant*). As per CSE's visit in February 2023, the construction of the plant is nearly complete and is only awaiting an electric connection and roads before commencing operations. As per the information shared by KMC with CSE, operations on the same will begin in April 2023. According to the Request for Proposal, wet processing technology will be used at the facility. This centralized facility is located about 14 to 40 km from the construction hotspots in the city. This means transportation will constitute a hefty proportion of processing charges at the plant.

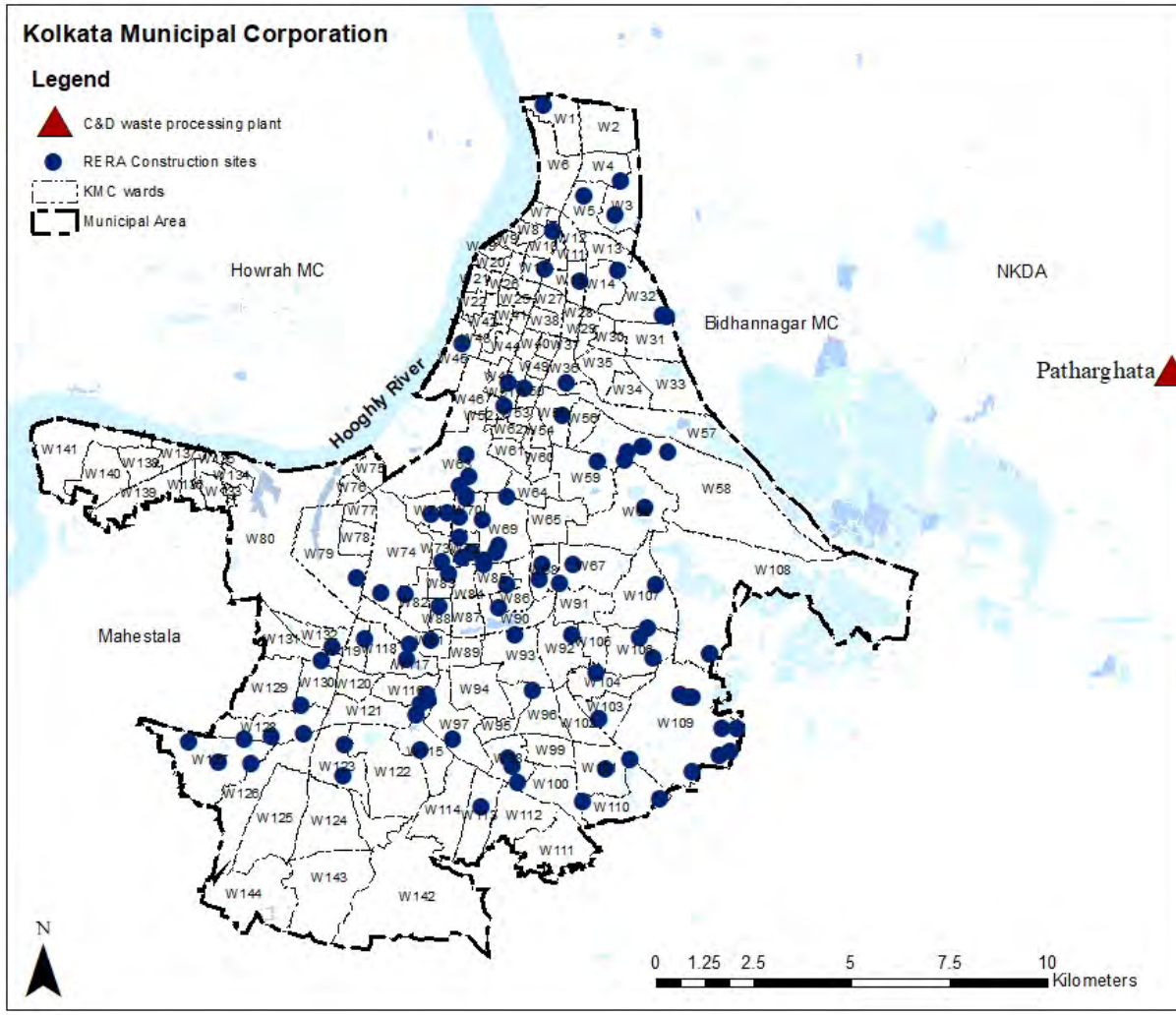
CONSTRUCTION ACTIVITY AND C&D WASTE VOLUME

Kolkata is undergoing tremendous construction activity. An assessment of construction projects registered on the West Bengal Housing Industry Regulatory Authority (WBHIRA) portal has shown that nearly 40 thousand tonnes of construction waste will be generated from these projects in the upcoming years. There were 95 projects as of November 2022 in KMC that are registered with WBHIRA (see *Map 2: Location of construction projects in KMC and the Patharghata plant*). These are all active projects which are due to be completed by 2027 as per their registration.

KMC will have to be well prepared as this estimation includes mostly residential buildings and only the projects with a plot area of 500 sqm and above. Commercial buildings, institutional buildings, industrial buildings, small scale construction (<500 sqm plot area), metro rail, roads and highways construction and demolitions will generate C&D waste much above the estimate of 40 thousand tonnes.

C&D waste processing plant

MAP 2: LOCATION OF CONSTRUCTION PROJECTS IN KMC AND THE PATHARGHATA PLANT



Source: Kolkata Municipal Corporation website and CSE

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN KOLKATA

2020

KMC solid waste bye-law notified

Vehicles littering C&D waste during transportation can attract a fine of Rs 1,000.

2022

5-acre C&D waste recycling plant set up

1,600 TPD plant at Patharghata

C&D WASTE MANAGEMENT—CURRENT STATUS IN KOLKATA

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆			◆			

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
◆		

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
◆				◆

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)

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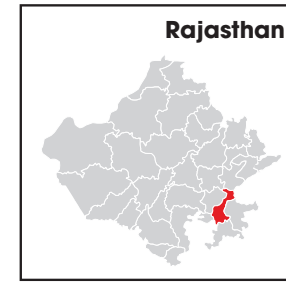
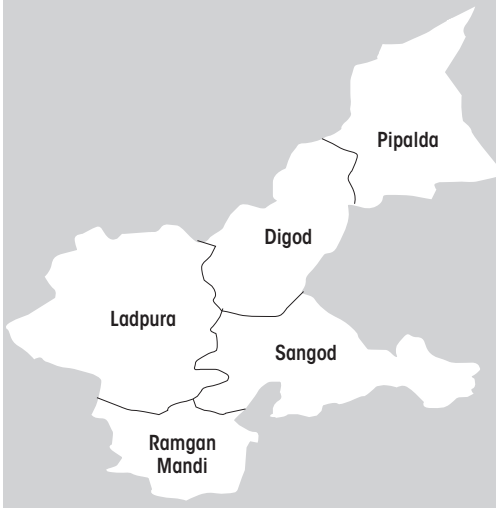
KOTA
Rajasthan





Area under Kota Nagar Nigam (sq. km)	221.36[1]
Number of wards under Kota Municipal Corporation (KMC)	150 (70 in North[2], 80 in South[3])
Population (Census 2011)	1 million (0.45 million in North, 0.54 million in South)[4]
Projected Population (2031)	1.96 million[5]
C&D waste collected by Kota Nagar Nigam	Approximately 40 tonnes per day[6]
Number of intermediate storage-collection points	2 (Planned)[7] • Bhadana • Jind Baba near Khedali Phatak
Number of vehicles for the transportation of C&D waste	8, (North Kota Nagar Nigam: 6, South Kota Nagar Nigam: 2)[8]

Source: Compiled from multiple sources

KOTA has emerged as a hub for various economic activities such as industries and educational institutions. As a result, the city has undergone rapid urbanization that has strained its physical infrastructure. According to the 2011 Census, the population of Kota has grown by 24.30 per cent from 2002 to 2011, and is estimated to have grown more than 30 per cent from 2011 to 2021.[9] This has significantly impacted the city's construction footprint. According to an estimate, the built-up area of the city has increased by 291.8 per cent in a span of 27 years (1989–2016).[9] The rise of construction activities in the city has resulted in an increase in the production of construction and demolition waste that needs to be managed in an environmentally sound manner.

HOW IS KOTA MANAGING ITS C&D WASTE?

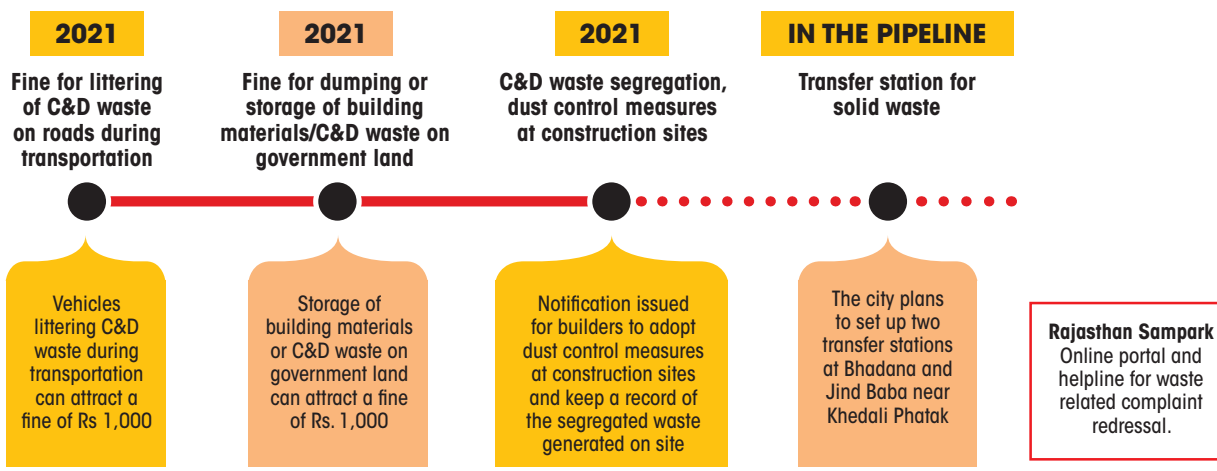
Kota has recently started taking steps towards C&D waste management. According to estimates made by the Kota Nagar Nigam, 40 tonnes of C&D waste is collected per day.

In 2021, three notifications were issued to manage this kind of waste. According to a notification issued by Kota Nagar Nigam South, dumping construction and demolition waste on government land can attract a fine of Rs 1,000 per day. The same notification also mentions that littering of construction and demolition waste by transportation vehicles will lead to a fine of Rs 1,000 per day. Kota Nagar Nigam South has also directed the construction agencies to keep a record of segregated C&D waste that is generated on site.

Currently, the Kota Nagar Nigam (North and South combined) has eight vehicles for the transportation of C&D waste—two tractor trolleys, five dumpers and one JCB. Waste generators can make a request to the municipal corporation for the removal of C&D waste from their site, and the corporation will make all the necessary arrangements. Kota Nagar Nigam North charges waste generators Rs 1,000 per tractor trolley for the collection, transportation, and disposal of C&D waste.

Although Kota does not have a dedicated

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN KOTA



C&D WASTE MANAGEMENT—CURRENT STATUS IN KOTA

◆ Yes/exists ◆ In process ◆ Partial

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D waste dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement.
◆	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆			◆			

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
	◆	

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycling plant prepared	Floating of tender for C&D waste recycling plant	C&D waste recycling plant under-construction	C&D waste recycling plant is operational
◆				

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)

helpline for C&D waste management at present, it has a grievance redressal system where complaints related to illegal C&D waste dumping can be made. This can be done through the Kota Municipal Corporation website, or by calling them on their contact number. Upon receiving a complaint made by a citizen, the corporation makes the arrangements to collect the waste. Some of it is used to fill low-lying areas and roads to meet the demand for filling materials and to reduce the burden on land. The rest of the waste ends up in a landfill. According to Nagar Nigam officials, there are plans to set up a C&D waste plant but no tender has been floated yet.

According to the District Environmental Action Plan for Kota, the city plans to develop an action plan for the management of C&D waste by setting up two transfer stations at Bhadana and Jind Baba, near Khedali Phatak.[13]

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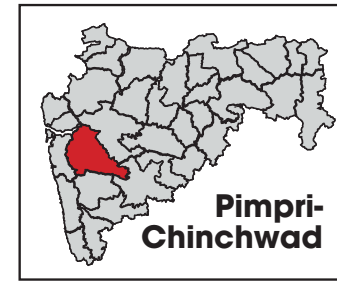
PIMPRI-CHINCHWAD
Maharashtra



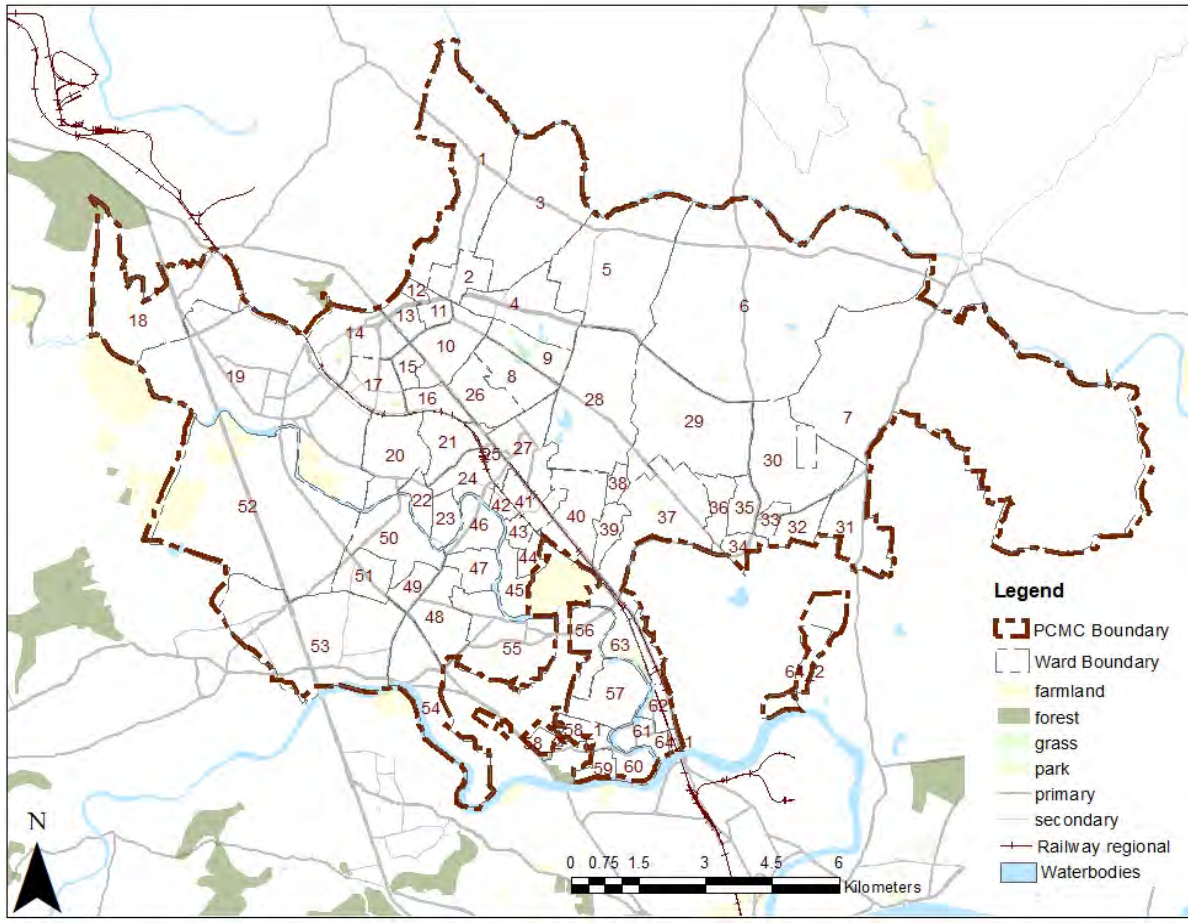
Location	150 km from Mumbai[1]
Area (sq. km)	181[2]
Number of wards	32[3]
Population (Census 2011)	1.7 million[4]
Population (2021, estimated)	2 million[5]
Population density	11,050 per sq. km
C&D waste generated	3,710 MT/year
C&D plant capacity	200 TPD
Has the city notified bye-laws?	Yes
Number of vehicles for transportation of solid waste (including C&D waste)	11 (RFID tagged vehicles)
Number of intermediate storage-collection points	8

Source: Compiled from multiple sources

The city of Pimpri-Chinchwad, governed by the Pimpri-Chinchwad Municipal Corporation (PCMC), is located 15 km north-west from the Pune city centre. It is the fifth-most populous city in Maharashtra and has long been famous for being one of the most prominent industrial destinations in the state outside Mumbai. The municipality was established in 1982 and its boundaries have been expanding over time. Currently, PCMC governs an area of 181 km^2 with a population of 1.72 million[6,7] (see *Map 1: PCMC and its ward boundaries*).

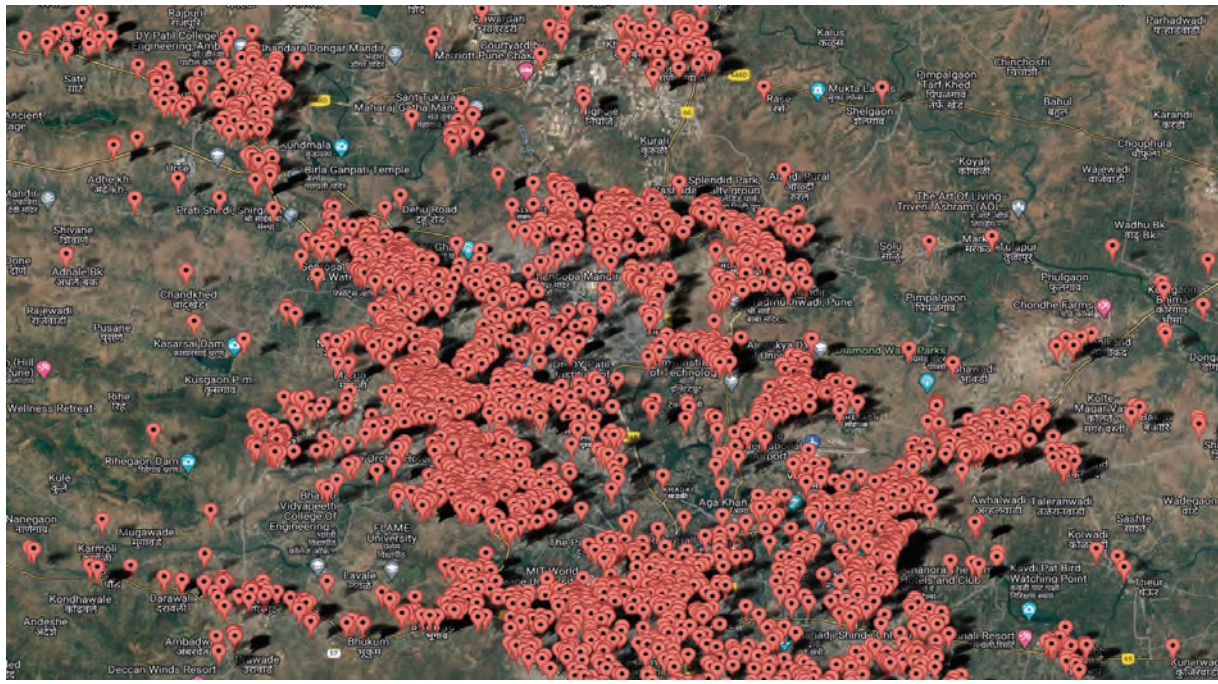
Since the formation of Maharashtra Industrial Development Corporation (MIDC) in 1962, which resulted in large-scale and continuous industrial land acquisition and consequently the demand for required support infrastructure, there has been a massive influx of several national and international automobile companies who continue to be keen on setting up manufacturing facilities and showrooms in Pimpri-Chinchwad and Pune. They form a continuous urban stretch and contain a thriving industrial belt that primarily consists of engineering and automobile industries. In

MAP 1: PCMC AND ITS WARD BOUNDARIES



Source: CSE

MAP 2: REGISTERED CONSTRUCTION PROJECTS IN PIMPRI-CHINCHWAD MUNICIPAL AREA



Source: https://maharerait.mahaonline.gov.in/GIS/default.aspx

fact, PCMC and Pune, when viewed as a unified geographical unit, make up one of India's largest industrial areas.[8]

CONSTRUCTION ACTIVITY IN THE CITY

Pimpri-Chinchwad has been growing exponentially in recent years and industrializing rapidly. Since it is part of the larger industrial belt, there is a continuous influx of investments on urban development projects (recently software and IT industries as well, along with the existing automobile industry) contributing to the city's economic growth and ultimately a rise in the housing demand in the region (see *Map 2: Registered construction projects in Pimpri-Chinchwad Municipal Area*). As of December 2022, there were 9,746 registered projects (majority in Pune and Pimpri-Chinchwad[9]) in Pune District, according to the Maharashtra RERA portal.[10]

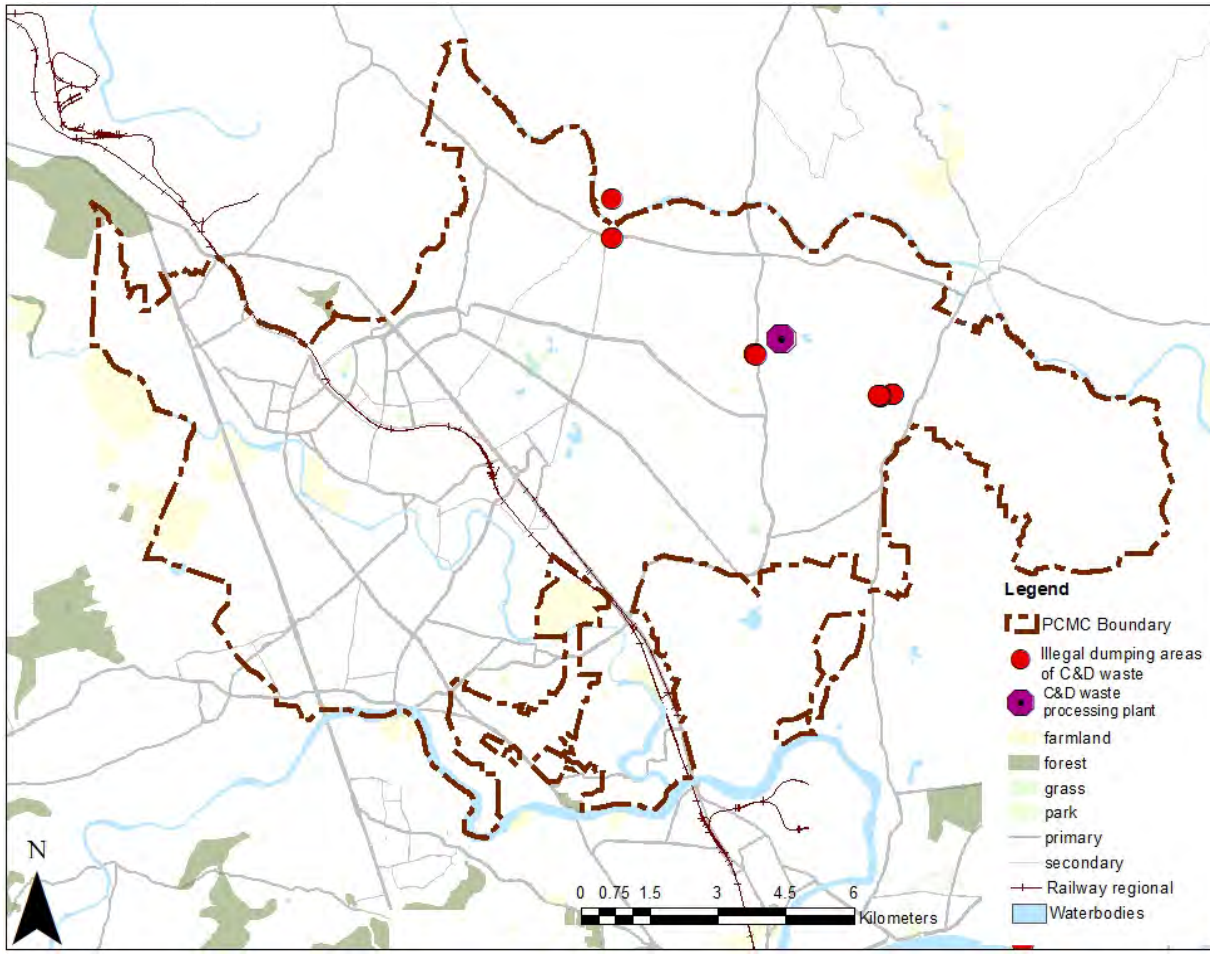
CSE's ground investigation has also revealed that even though there is a C&D waste recycling plant and notified collection points, illegal dumping is an issue in the city at large (see *Map 3: C&D plant and illegal dumping points observed in Pimpri-Chinchwad Municipal Area*). Majority of the waste is dumped on vacant plots in fringes of the city, near waterbodies and in artificial drains which leads to frequent flooding in the city as well.

CURRENT SCENARIO OF C&D WASTE MANAGEMENT

Bye-laws and mandates

PCMC has mandated all generators to submit the C&D Waste Management Plan along

MAP 3: C&D PLANT AND ILLEGAL DUMPING POINTS OBSERVED IN PIMPRI-CHINCHWAD MUNICIPAL AREA



Source: CSE

with the plan for approval of construction/demolition/renovation as per the order dated 20.11.2019. Bulk generators are required to register construction activities with the Building Permission and Unauthorised Construction Control Department at PCMC. They must contact the C&D waste recycling plant when 25 per cent of the proposed construction is complete and are advised to process 50 per cent of C&D waste generated on the site itself.

PCMC issued an order dated 02.12.2019 outlining details of the on-call waste pickup system, regulations for bulk generators, monitoring systems, and C&D processing fees and penalties. It outlines the steps to be followed by the generators for payment of fees; issue of challans; procurement of other certificates such as NOC from Building Permission and Unauthorised Construction Control Department for permitting the work to continue; payment certificate from Solid Waste Management department; and completion certificate after receiving the report of the C&D waste transferred to the Waste Processing

Plant and the certificate of use of at least 20 per cent recycled construction materials from this process.

User charges and penalties

PCMC issued an order dated 22.02.2022, stipulating charges for lifting and processing of C&D waste and the details are as follows:

Fees

- The generator must pay PCMC an amount of Rs 15 per km per tonne for transferring C&D waste to the C&D waste processing centre and Rs 250 per tonne for processing the same.
- PCMC pays the C&D plant an amount of Rs 13.5 per km per tonne for transferring C&D waste to the C&D waste processing centre and Rs 245.75 per tonne for processing the same. The waste can be brought to the plant by the developer as well, thus avoiding the transportation fees.[11]

Penalties

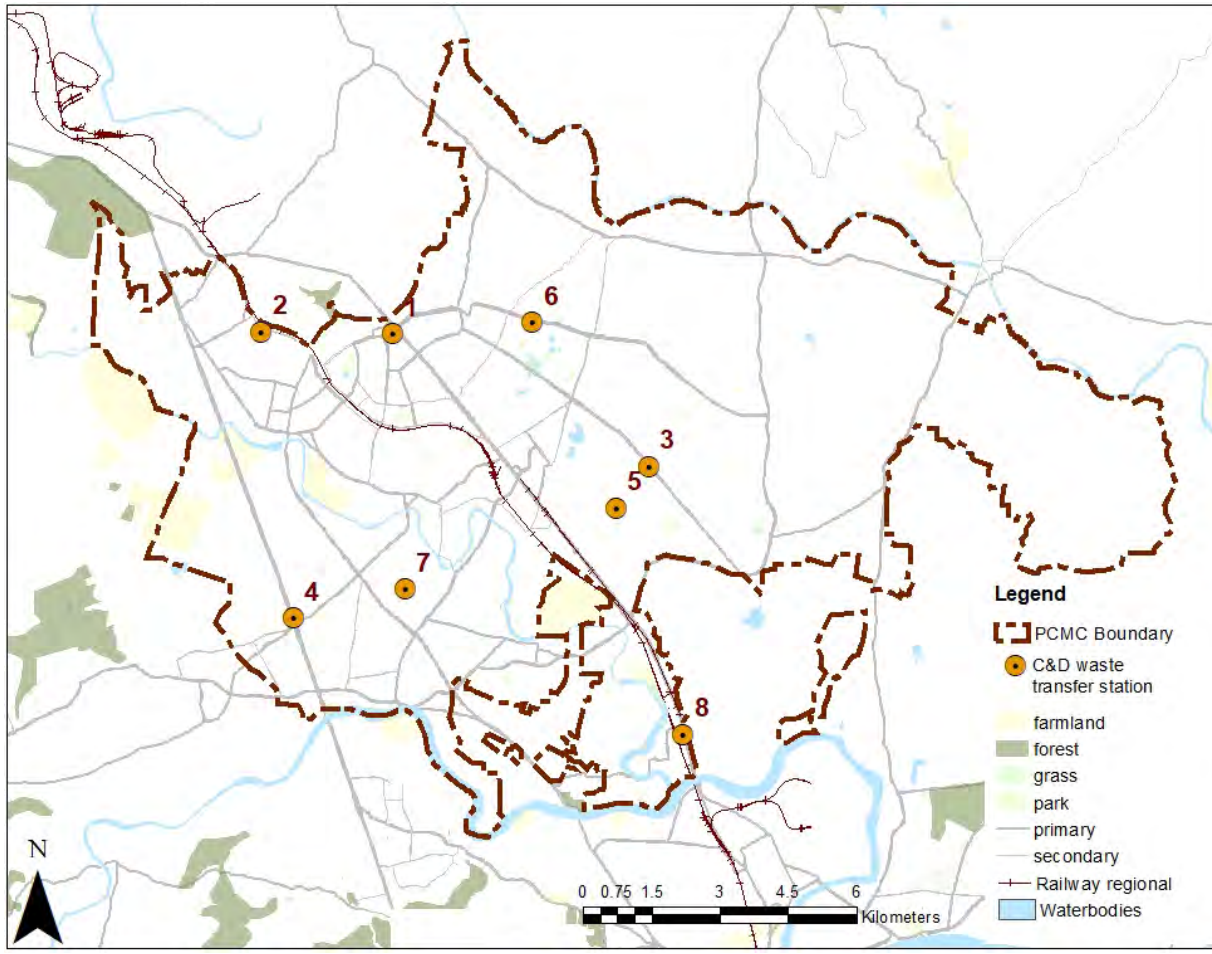
- A penalty up to 10 times the cost of C&D waste transport and processing fee can be charged against offenders by the Asst. Health officer if found to be illegally dumping C&D waste in or nearby natural water bodies like rivers, streams, streams, ponds, etc. or on roads, footpaths, and private/government open spaces in the city. There is also a provision to file a criminal case against the violators on behalf of the municipality.
- A penalty of 3 times the C&D waste processing fee could be fined for bulk generators who are not following the existing mandates.

Current system of collection, transportation and disposal of C&D waste

PCMC has different types of collection systems in place:

- **Call-based pickup:** Vehicle fleets are sent through different strategic routes each day which target multiple registered C&D sites to take waste to transfer stations. The process is the same for bulk generators and other requests for removal of C&D through the toll-free number.
- **Pickup from transfer stations:** Periodic pickups are carried out by the vehicle fleet from the designated transfer stations. PCMC has identified and allocated eight locations as transfer stations and is seeking more locations within the corporation for the same (see *Map 3: Designated C&D waste transfer stations*).
- C&D waste generated in municipal works is to be transported to the processing plant directly by the contractor or developer.
- **Pickup from illegal dumping points:** A flying squad for surveillance and monitoring of illegal C&D waste dumping has been created and is conducting patrols for the same. An online group was created for communication, management and supervision; it is overseen by assigned officers. Illegally dumped C&D waste is photographed and uploaded to the group via GPS mobile camera, along with detailed information about its quantity and location by the officers who are on patrol duty or in the monitoring squad. After getting an online approval, the assessment and validation of the same is done by the assigned officers followed by prioritization and listing for

MAP 4: DESIGNATED C&D WASTE TRANSFER STATIONS



Designated transfer stations are located near the following landmarks:

1. Nigdi police station
2. Mhaske Wasti, Ravet
3. Garbage collection centre, Gavli Matha
4. Vision mall, Wakad Highway
5. Charholi near the cemetery
6. Chowk in Spine road, near Yamuna nagar
7. Thairgaon, near cemetery
8. Dapodi, near railway station

Source: CSE

C&D WASTE MANAGEMENT—CURRENT STATUS IN PIMPRI-CHINCHWAD

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆	◆		◆	◆	◆	◆

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
◆	◆	◆

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
				◆

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)
◆	◆	◆	◆	

C&D waste recycling plant at Moshi

collection which is then carried out by the vehicle fleet from the C&D plant at Moshi.

RECYCLING FACILITY

PCMC has a C&D waste recycling plant at Moshi covering an area of 3,600 sqm. It uses both dry and wet processing technologies. Phase 1 (1,600 sqm) of this plant has been constructed and has a wet processing technology established since 2021. Phase 2 has also been proposed by PCMC. Dry processing at the plant started in 2020. Total installed capacity of the plant is 200 TPD (8-hour shifts) as of date. Collection of C&D waste, installation of weighbridges along with the necessary software for weight calculations and geotagging of transfer vehicles has been in place since 2019.

The plant works with a fleet of 11 vehicles including tippers, tractors, hook loaders, backhoe loader, dumpers and other locally hired vehicles on basis of need. The plant also has transportation municipal magistrates appointed for taking penal action for non-compliance with C&D Rules 2016.[12] The vehicles are RFID tagged and the information directly goes to the cloud storage system. The drivers are using an app developed specifically for tracking and monitoring.

Once assorted, C&D debris comprising of cement plaster, iron, etc. is brought in with GPS

3. Weigh bridge; 4. Conveyor belt

5. Wet processing technology; 6. Different materials collected seperately after processing

powered trucks and is weighed at the weighing bridges. The waste is then dumped in the yard and an initial round of segregation is done before further processing.

The processing produces recycled products such as bricks and manufactured sand of four different grades (+20mm, 20–8 mm, 8–3 mm, 3–0.075 mm), and granular sub-base (a mix of sand, gravel, crushed stone and broken rock).

The plant is equipped with good dust control practices such as covered conveyor belts, gravel paths for vehicles, water sprinklers for dust suppression and segregated storage of materials. However, the plant needs to work towards covering of material stockpiles and vehicles while hauling C&D waste and materials. The plant has been reported as operational in the MPCB final audit 2020–21.[13]

7. Processed aggregate stored on site; 8. Different types of processed re-usable aggregates

9. Partial plantation belt around the site's edge; 10. Vehicle fleet parking

LESSONS LEARNT

Pimpri-Chinchwad offers citizens and waste generators a user-friendly and easily accessible interface for placing collection requests for C&D waste and making fee payments online. Not only this, incentivization of the rate of recycled C&D products by 20 per cent from the market rate and a mandate to replace at least 20 per cent of the construction materials with recycled products in municipal works has helped build an ecosystem for reutilization of C&D waste. The recycling plant demonstrates good environmental practices and compliances such as green belt along the site boundary, covering of the conveyor belts, gravel for circulation paths and sprinkling systems for dust suppression. The plant is also equipped with software-based weighing system, RFID-tagged vehicles fleet, material testing lab, engineering store, etc.

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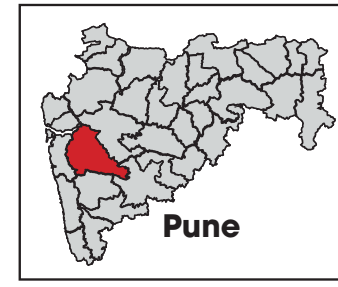
13. Ibid.

PUNE
Maharashtra



Location	154 km from Mumbai
Area (sq. km)	516.18[1]
Number of wards	58[2]
Population (Census 2011)	3.1 million[3]
Population (2021, estimated)	4.3 million[4]
Projected population (2051)	10,923,535 million[5]
Population density	8,344 people per sq. km
C&D waste generated	73,000 MT/year
C&D plant capacity	250 TPD[6]
Has the city notified bye-laws?	Yes
Number of vehicles for transportation of solid waste (including C&D waste)	40
Number of intermediate storage-collection points	10

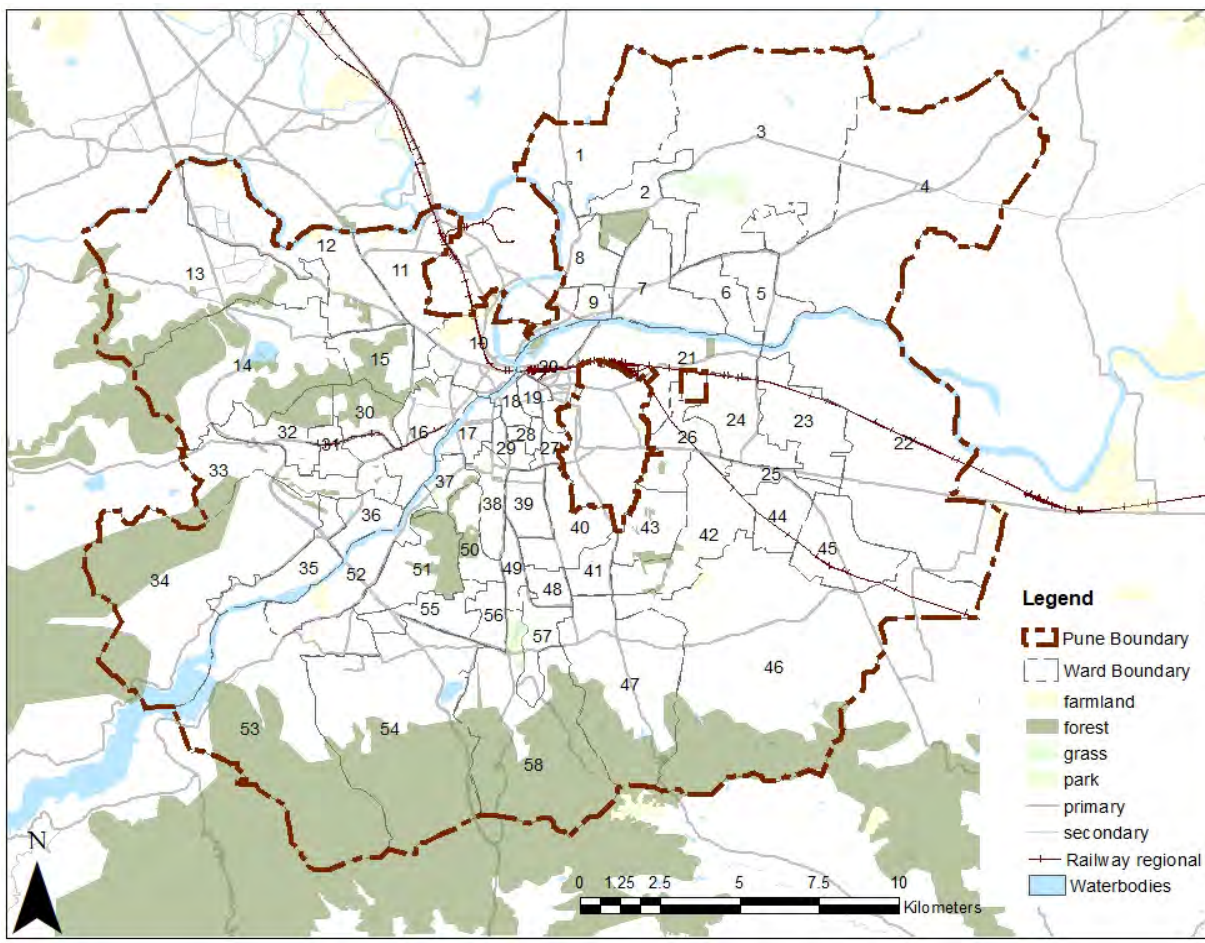
Source: Compiled from multiple sources

Pune is one of the most important industrial and educational hubs of India. Pune has also become the biggest city in Maharashtra with an area of 516.18 sq. km, surpassing Mumbai's 440 sq. km.[7] The Pune Metropolitan Region (PMR) is one the of largest metropolitan regions in the country. Due to industrial development, the region has become attractive for foreign investments. Emerging new markets, abundance of necessary natural resources, relatively mild climatic conditions throughout the year and proximity to the economic capital of the country, Mumbai, have together proven to be a blessing for this region. New businesses are being set up while old ones are expanding.[8]

SCALE OF THE PROBLEM

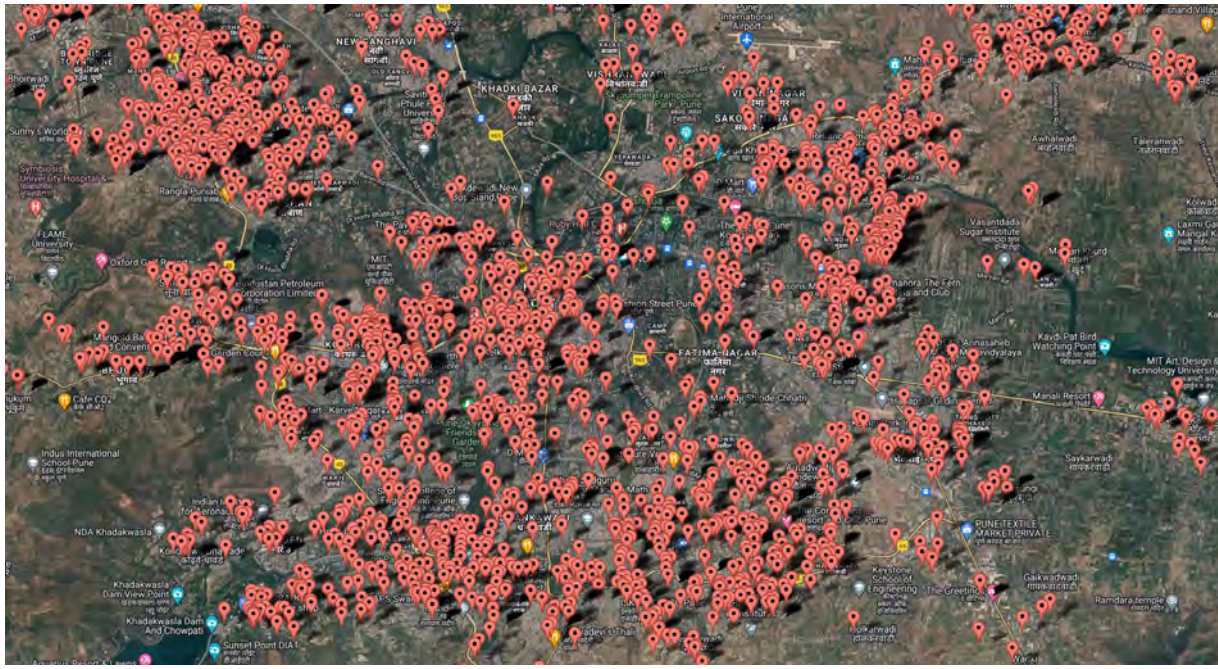
As Pune is a rapidly developing city, it is undergoing enormous construction activity and requires a system for scientific disposal of construction and demolition (C&D) waste hence generated. According to Maharasthra RERA portal of the state government, 7,651

MAP 1: PUNE MUNICIPAL CORPORATION AND WARD BOUNDARY



Source: Created by CSE

MAP 2: CONSTRUCTION PROJECTS IN PUNE URBAN AREA



Source: https://maharerait.mahaonline.gov.in/GIS/default.aspx

construction projects are registered, most of which are located in the Pune urban area (see *Map 2: Construction projects in Pune urban area*). These projects do not include roads and highways, industrial, institutional and small individual construction.

CSE's ground investigation has revealed that Pune is facing the issue of illegal dumping. A lot of C&D waste was found dumped illegally in water bodies and storm water drains, and on roadsides and vacant plots, among other places (see *Map 3: Illegal dumping points observed in Pune*). This is severely affecting the Mula-Mutha river and the ecology of the city. This behaviour can be attributed to lack of awareness among generators and the general public about C&D waste and related protocols.

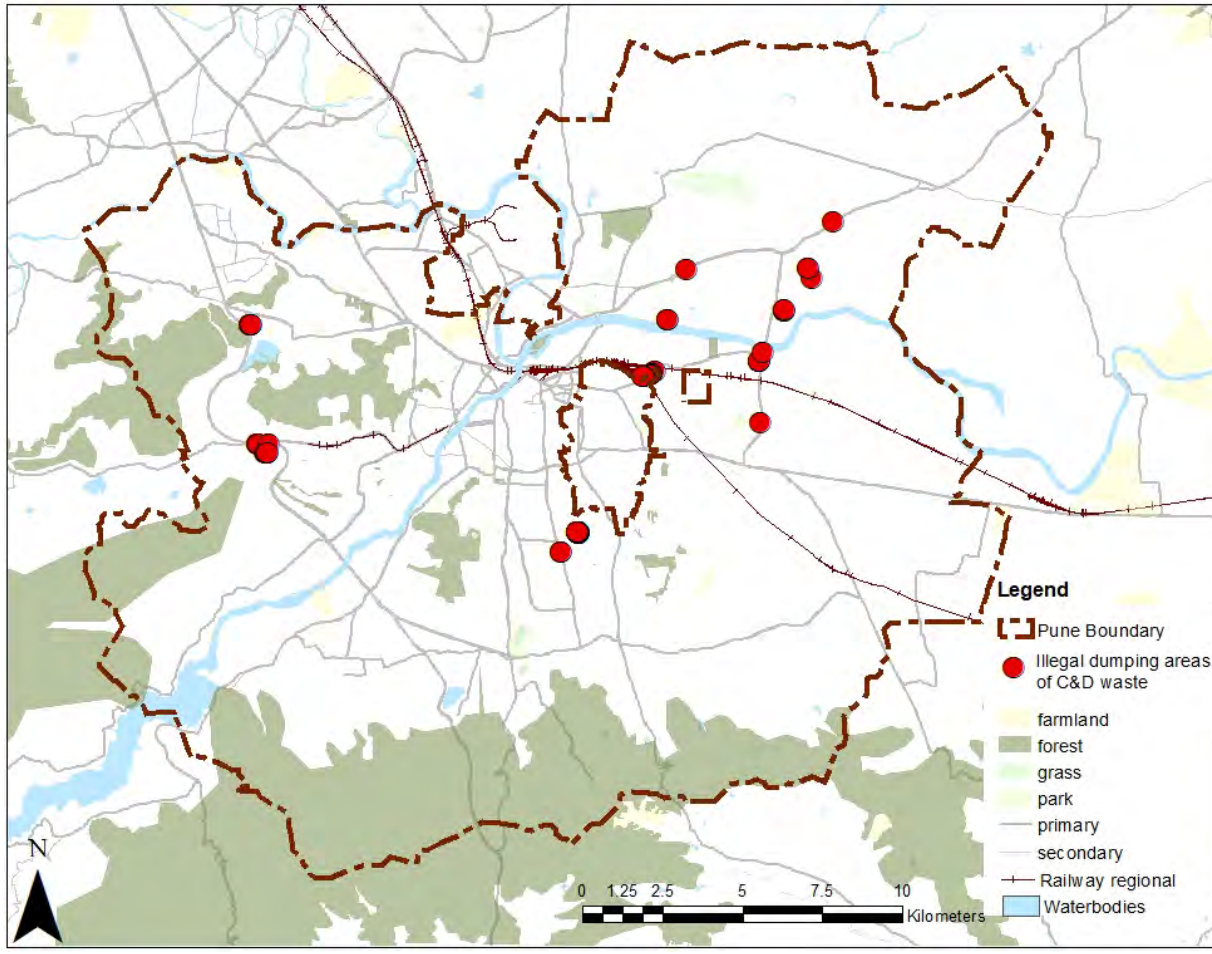
PMC has been conducting public awareness drives to inform people about scientific management of C&D waste. However, these efforts need to be increased for real impact on the ground.

CURRENT SCENARIO OF C&D WASTE MANAGEMENT

Bye-laws and mandates

Pune Municipal Corporation (PMC) has made it mandatory in its building bye-laws for developers or individuals to submit a *Construction and Demolition Waste Management Plan* along with the application for sanction of construction/internal alteration/redevelopment. After the approval of the same, a copy of the C&D waste management plan, along with the copy of the challan of payment for C&D processing fee is sent to the solid waste management department at PMC.

MAP 3: ILLEGAL DUMPING POINTS OBSERVED IN PUNE



Source: CSE

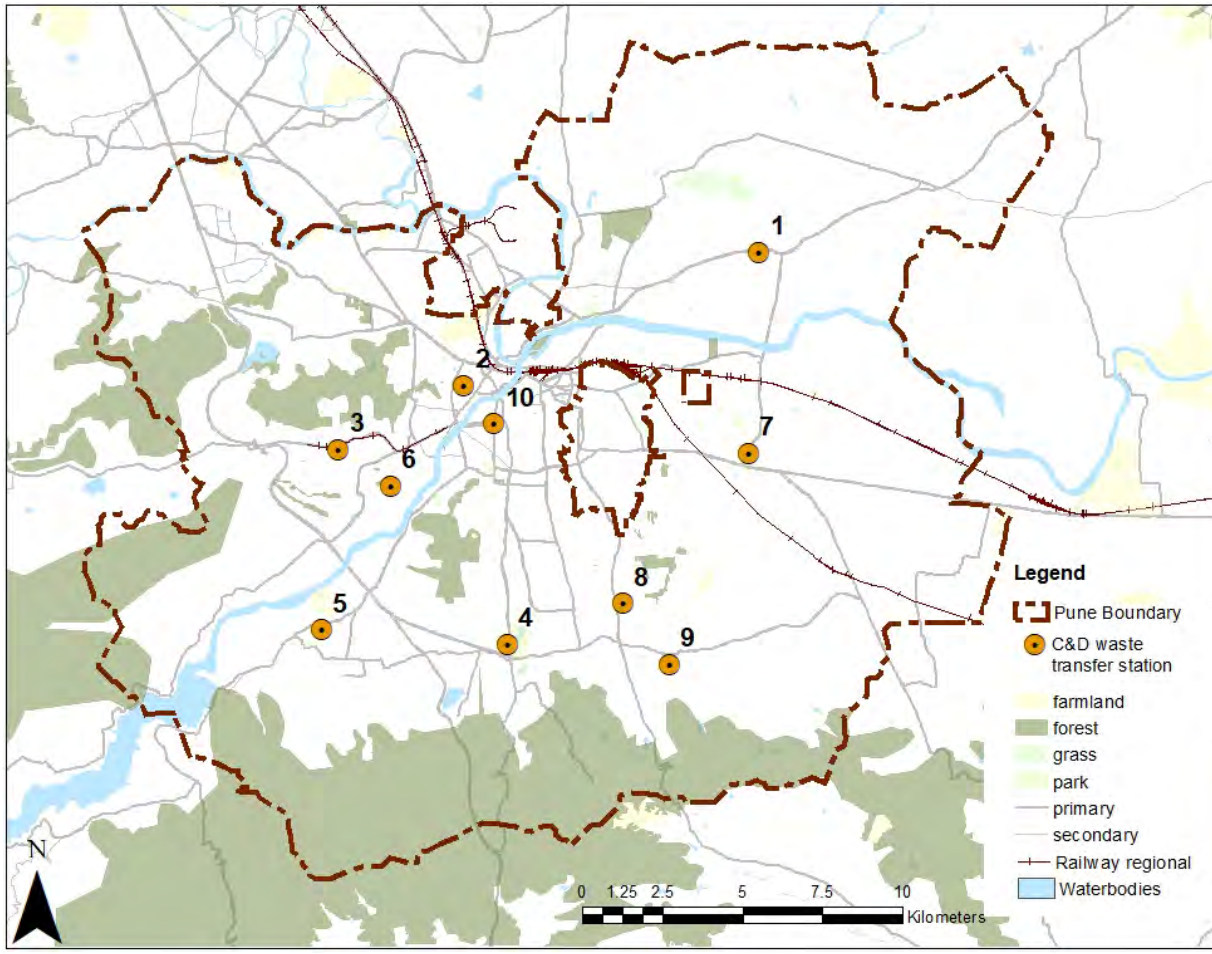
After the developer has transferred all the C&D waste to the recycling plant designated by PMC, the authorized Pune Municipal Officer of the designated area, should issue a challan to the concerned with signature and stamp stating date, vehicle number, empty and full weight of the vehicle (as per the official weighing bridge), address of the C&D waste generating site, name of the developer, etc. It is also mandatory for developers to receive and keep a payment certificate for C&D waste for records from the solid waste management department.

Bulk generators are required to register the construction with the building development department at PMC and follow the rules and mandates as mentioned in the C&D Waste Management Rules, 2016. They are required to transport the C&D waste directly to the plant at their own expense.

User charges and penalties

PMC has issued an order dated 25.01.2022 stipulating charges for lifting and processing of C&D waste. If a developer is transporting C&D

MAP 4: DESIGNATED C&D WASTE COLLECTION CENTRES



Designated transfer stations are located in the following locations:

1. Nagar road and Kharadi - Kharadi
2. Shivaji nagar-Ghole road - Vadarwadi, Gondhal chowk, Paul estate, Janwadi
3. Kothrud-Bhavdhan - Sutarwadi
4. Dhankawadi-Sahakarnagar - Ambegaon
5. Sinhagad road - Mahadevnagar, ward 34 near canal, Pharshi oil, Dattawadi, Janata vasahat
6. Warje-Karvenagar - survey number 86
7. Hadapsar - survey number 49 and 51, Kalepadal
8. Wanwadi-Ramtekadi - HM royal parking, Amenity space Kondhwa
9. Kondhwa-Yewalewadi - HM royal parking, Amenity space Kondhwa
10. Kasba-Vishrambaughwada - Dambar kothi, near Chhatrapati Shivaji Maharaj statue

Source: CSE

waste to the processing plant using their own vehicle, the charges are Rs 204.75 per tonne for processing. In case any waste generator requires transportation services as well, PMC charges Rs 22.04 per tonne per km additionally. These charges are to be paid at the ward office after weighment is done by PMC.

Illegal dumping attracts a fine of Rs 25,000 per truck. If the quantity is less, the fine would amount to Rs 1,250 per tonne. Moreover, concerned contractors/developers will be banned for one year from taking up PMC contracts if they obstruct the drains and rivers. Repeat offenders (three times) will get a case registered by the Construction Inspector/Junior Engineer, Deputy Engineer and Executive Engineer of the building department in the concerned area against them under Section 52 of the Maharashtra Regional and Town Planning Act (1996), Solid Waste Management Rules 2016 and the Environment Act.

Current system of collection, transportation and disposal

PMC has proposed 10 designated collection centres across the city for C&D waste (see *Map 4: Designated C&D waste collection centres*). The centres are awaiting administrative approval. If the volume of the waste is less than 10 tonnes, generators have to bring the waste and deposit it at the collection centres. If the quantity is more than 10 tonnes, generators will need to call the toll-free number (1800-10-30222), after which PMC will verify and lift the debris directly from the site by charging the transport and processing fees.[9]

C&D waste generated in municipal works is to be transported to the processing plant directly by the contractor. Waste generated by demolition of unauthorized structures is to be transported to the collection centres by the concerned PMC department.

1

ALL PHOTOS BY: MITASHI SINGH

1. C&D waste recycling plant at Wagholi

Untarred/Unpaved roads within the C&D plant at Wagholi

Uncovered materials

6. Weigh bridge; 7. Conveyor belt from crusher

8. Segregated aggregates: 20 mm; 9. Less than 20 mm

Precast materials made from processed waste: 10. Dividers, 11. Chambers

Bricks and tiles are created using the recycled aggregates

RECYCLING FACILITY

The C&D waste management facility at Wagholi is setup on a 2 acre plot. The plant uses dry technology to process the received C&D waste. The unclaimed and illegally dumped waste from various parts of the city is collected and brought here by PMC and bulk generators.

The plant works with about 40 vehicles (trucks, tractors, dumper placers, etc.) and has *Transportation Municipal Magistrates* appointed for taking penal action for non-compliance related to C&D waste rules.[10] The plant demonstrates several non-compliances related to C&D waste management and dust mitigation such as uncovered materials and untarred roads which can add to the fugitive dust dispersal.

There are two types of collection that are done by the vehicular fleet at the plant:

- Respective PMC ward office sends a demand notice to the plant to transfer the waste to the plant when the collection centres fills up.
- Generators (bulk) call the plant through the toll free number for collection of C&D waste from their site.

The plant uses dry processing technology which crushes the waste into different sizes of aggregates like 40mm, 20mm, 10mm and finer sizes. These recycled aggregates are used in making concrete after testing for proerties like workability, hardness, microstructure and durability.[11]

The plant produces bricks and other construction related materials, such as precast slabs, dividers, pavers, etc. However, the overall system is not working to its full potential.

LESSONS LEARNT

Transportation is a big factor or in most cases a determinant of the recyclng plant's financial feasibility. As recycling facilities are located at the edge of cities, there is a huge transportation cost attached to haul C&D waste from both construction sites or collection points within the city. Pune's model factors in this cost of transportation and charges generators dynamically for processing. A fixed processing cost model may become expensive for generators who are located in close proximity to the plant.

C&D WASTE MANAGEMENT—CURRENT STATUS IN PUNE

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
◆		

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆	◆		◆		◆	◆

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
◆	◆	

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycled plant prepared	Floating of tender for C&D waste recycled plant	C&D waste recycled plant under-construction	C&D waste recycled plant is operational
				◆

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)
◆	◆	◆		

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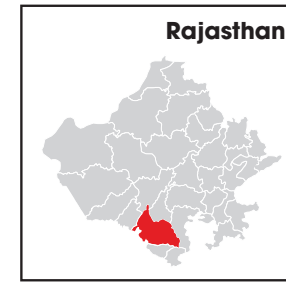
UDAIPUR
Rajasthan



Area (sq. km)	64[1]
Number of wards	70[2]
Population (Census 2011)	0.451 million[3]
Estimated current population (2021)	0.6 million[4]
Floating population	45,110[5]
C&D waste generated	5,600 metric tonnes[6]
C&D waste collected	14 tonnes per day[7]
C&D waste processing capacity	50 tonnes per day[8]
Number of intermediate storage-collection points	1
C&D waste processing plant	1 low-capacity plant is operational and there are plans to increase its capacity[9]
Has the city notified bye-laws?	No

Source: Compiled from multiple sources

UDAIPUR is a key tourist destination in Rajasthan, and tourism is the primary anchor of the city's economy. Over the past few decades, the city has also emerged as an industrial, administrative and educational hub, and has witnessed incessant construction activities.

Udaipur has been designated a 'smart city': this has led to the initiation of several infrastructure projects in and around the city. For example, a sewage network is being constructed under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). Of the over 100.22 km of sewerage pipelines planned, 84.70 km has been sanctioned.

All this has contributed to the generation of construction and demolition (C&D) waste in the city.

HOW IS UDAIPUR MANAGING ITS C&D WASTE?

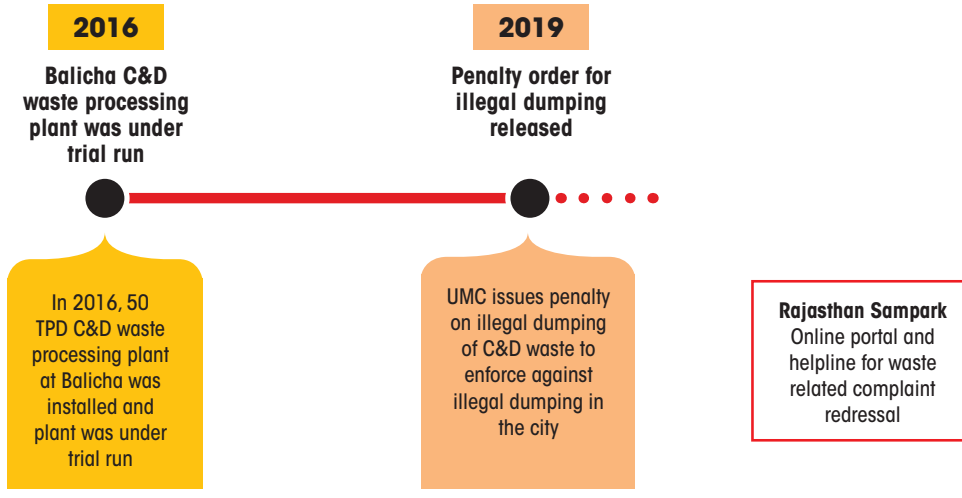
C&D waste management in Udaipur is largely run by the informal sector. In the absence of a formal collection system, waste generators have been dumping their C&D waste on vacant plots or along the roads in the city (*see Map 1: Illegal dumping spots across Udaipur*).

Currently, the city generates 180 TPD of municipal solid waste (including C&D waste), most of this gets processed through its two biomethanation plants (22 TPD), material recovery facility (30 TPD), a C&D waste plant (50 TPD) and decentralised composting initiatives.

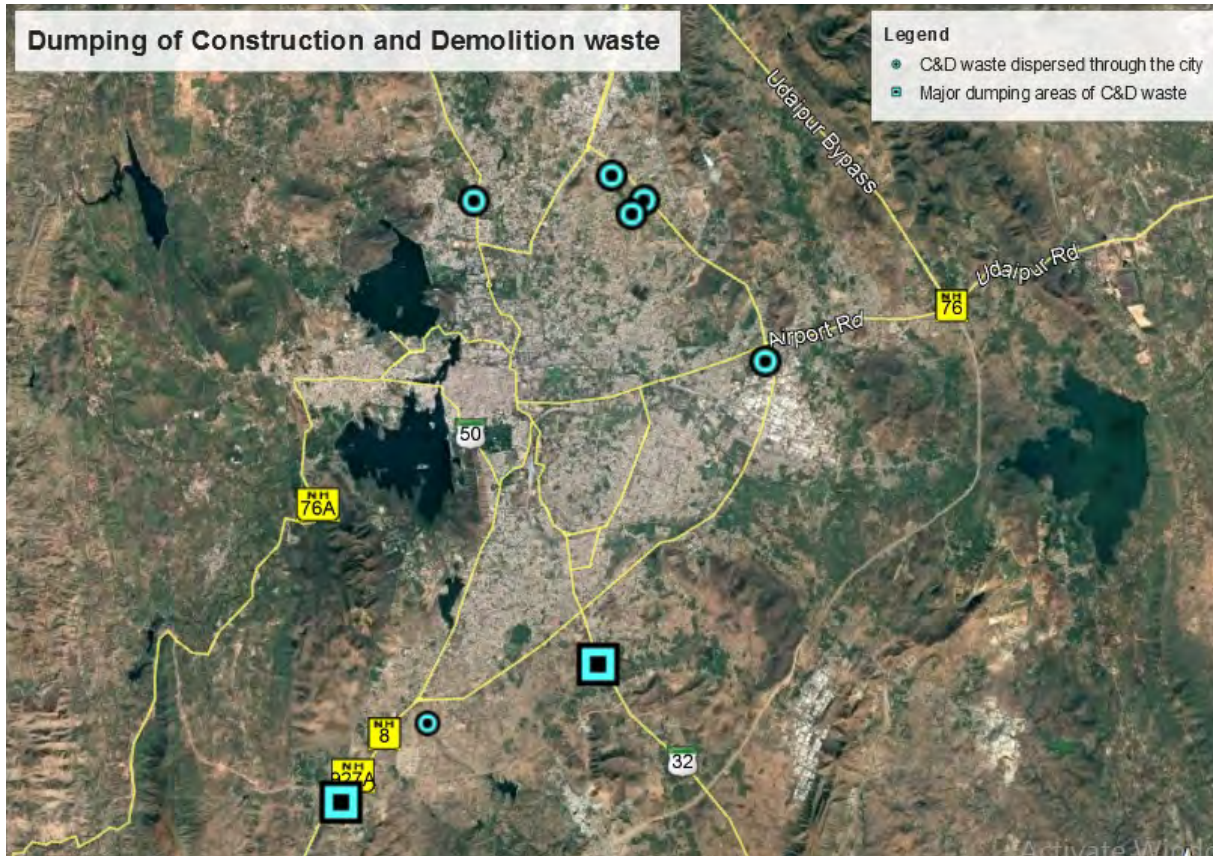
GENERATION AND COLLECTION OF C&D WASTE

In August 2021, the Rajasthan State Pollution Control Board published the *Annual Report on Implementation of C&D Waste Management Rules, 2016* for 2020–21. According to the report, Udaipur Municipal Corporation generated a total of 5,600 metric tonne (MT) of C&D waste in one year. The corporation collected nearly 14 tonne of C&D waste per day.

C&D WASTE MANAGEMENT—MAJOR MILESTONES IN UDAIPUR



MAP 1: ILLEGAL DUMPING SPOTS ACROSS UDAIPUR



Source: CSE

There are two dumping sites—at Titardih and Balicha—for solid waste, including C&D waste. However, the dumpsite at Titardih does not receive waste anymore as it is undergoing a scientific closure.The dumpsite at Balicha is also undergoing bio-remediation to be restructured into a scientific landfill.

Following an order from the Directorate of Local Bodies, Government of Rajasthan in 2019, the Udaipur Municipal Corporation (UMC) has started issuing penalties on illegal dumping of C&D waste, but people at large remain unaware.

Udaipur has also transitioned to an on-call system for the collection of C&D waste. Citizens can now file complaints with the Udaipur Municipal Corporation about unclaimed C&D waste. The UMC collects this waste which is then taken to a transfer station located at Kumharon ka Bhatta. Eventually, the waste reaches the processing plant located at Balicha, about 20 km away from the city centre.

The Balicha facility has a capacity of 50 tonnes per day (TPD). The facility was set up on a trial basis, but seeing the rampant illegal dumping in the city, the UMC is planning to increase its capacity. The facility comprises crushers that break down the mixed C&D waste into fine aggregates, coarse aggregates, bricks and blocks.

CSE PHOTO LIBRARY

Illegal dumping along the roads and vacant land in the outskirts is a common practice

The UMC is also in the process of developing and notifying C&D waste bye-laws that will lay down the duties of waste generators and allocate user charges, among other specifics. A 20-TPD collection point for C&D waste has been identified near the transfer station. The city is also aiming towards mandating the use of recycled C&D waste products in government and municipal contracts.

Udaipur's zero-landfill vision has played the role of a catalyst and pushed the city to come up with solutions for a scientific collection, transportation, treatment and disposal of different waste streams. It has enabled the city to not only reclaim valuable urban land at the dumpsites, but also rid the city of the several environmental hazards resulting from un-engineered dumpsites.

C&D WASTE MANAGEMENT—CURRENT STATUS IN UDAIPUR

◆ Yes/exists ◆ In process

Mandate

Penalty order for illegal dumping	Order to segregate C&D waste from MSW	Notification of C&D waste bye-laws
◆	◆	◆

Steps to curb illegal dumping

Recognize illegal C&D dumping sites	Surveillance system for illegal dumping	Third-party monitoring and enforcement
	◆	

Collection system

Helpline for C&D waste management	Notification of dumping points for generators	Door-to-door C&D waste collection service	Vehicle fleet for C&D waste	Fleet is GPS enabled	Issuing demolition permits	Waste assessment with building permission
◆	◆		◆			

User charges

Malba fee integrated with buildings permits	Fee for collection, transportation and/or processing	Online payment system
	◆	

Processing and disposal

C&D waste ends up in a landfill	Detailed project report for C&D waste recycling plant prepared	Floating of tender for C&D waste recycling plant	C&D waste recycling plant under-construction	C&D waste recycling plant is operational
◆				◆

Recycle and reuse

Recycling plant only produces aggregates	Plant produces recycled products for building construction	Mandatory use of recycled products	Incentives for C&D waste recycled product usage (tax rebate, etc.)	Inclusion of recycled products in Schedule of Rates (SoR)
	◆	◆		

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Annexure 12

Bakkarwala C&D Waste Recycling Plant, Delhi: An In-depth Case Study

CSE documented several recycling facilities to understand the processes and equipment used and the compliance requirements. Here is a detailed documentation of the 1,000-TPD Bakkarwala plant located in the western part of Delhi. The plant caters to the west zone and Najafgarh zone of the Municipal Corporation of Delhi (MCD).

The plant is run by a private company under a public-private partnership model. It has two types of processing units – wet and dry. The entire process at the facility can be divided into three stages — segregation, processing and manufacture of products.

Receiving waste feed

The plant receives requests for collecting and processing C&D waste from construction sites as well as from illegal dumping areas. It informs the administrative officers and engineers through a WhatsApp Group chat-based system of this collection and provides details of unclaimed and/or illegally dumped C&D waste. Once the locations and actions are prioritised, teams are sent to the sites for evaluation and collection of the waste. The plant not only caters to requests placed by the MCD, but also other administrative bodies and bulk generators such as the Public Works Department (PWD).

The plant charges a processing fee of Rs 324.5 per tonne; transportation charges are decided based on the distance. The vehicle fleet at the plant includes:

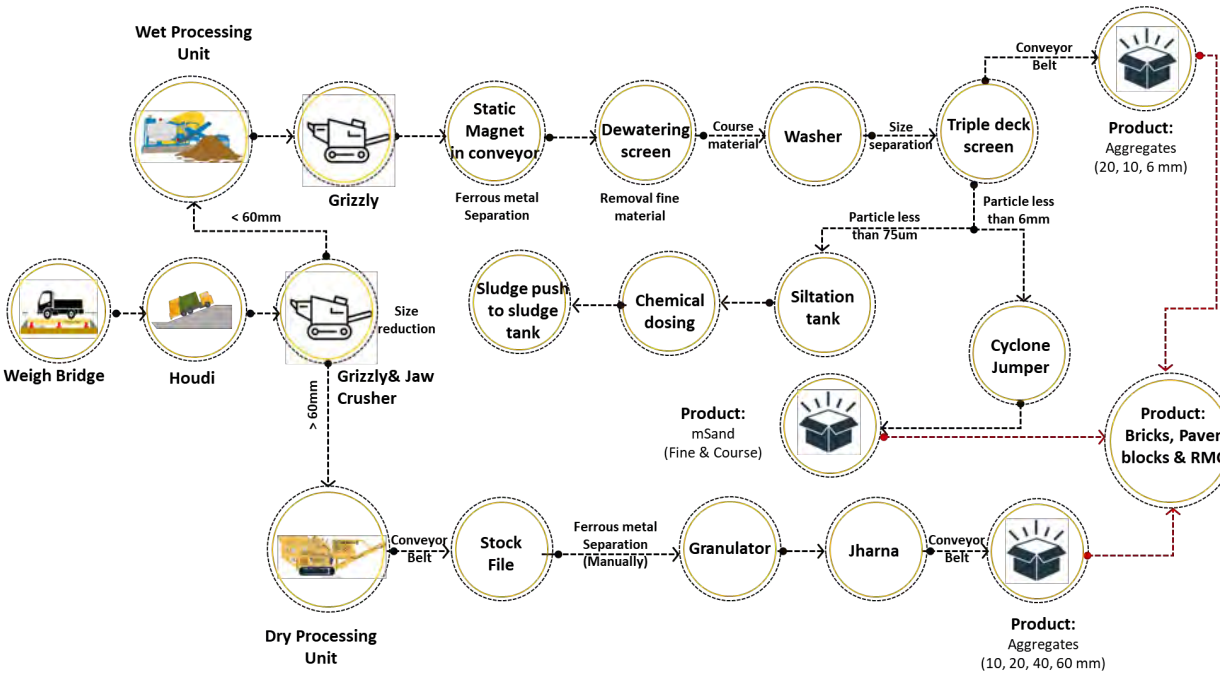
- 1 pocklain
- 2 loaders
- 4 JCBs [backhoe loaders]
- 2 forklifts
- 4 lifting cranes [hydra]

The MCD also sends private vehicles for collection as and when needed.

Vehicles bringing in the C&D waste must be RFID-tagged – waste brought in by untagged vehicles is not accepted. There are tag readers and cameras at the entrance gate as well as after the weighing ramp. Also, the plant only accepts vehicles carrying C&D waste weighing 30 tonne or less. Information related to

Figure 1: The Bakkarwala plant

Figure 2: Process flow at the Bakkarwala plant



Weight recording office (left) and weighing ramp (right)

Dumping yard: C&D waste and grizzly unit (left); mobile water sprinklers

the vehicle and time-stamps are sent directly to the MCD during entry and exit of the vehicle. Details of the load is recorded at an office next to the weighing ramp; the load is weighed during entry and again after it is dumped. The ramp is has a capacity of 50 tonne.

After the weighing ramp, there is a designated dumping yard where the C&D waste is offloaded. Manual segregation of waste is done here – the non-C&D waste such as clothes, plastics, etc is separated. Larger pieces of C&D waste are removed manually and the remaining waste is dumped into a grizzly feeder located next to the dumping yard.

Primary processing

After passing through the grizzly, the waste goes to a jaw crusher placed below the feeder; here, C&D waste pieces of sizes below 90 cm x 90 cm are crushed. The jaw crusher has a capacity of 80-100 tonne per hour, and it reduces the pieces into sizes of up to 150 mm (6 inches). The particles are then passed through vibrating screens to filter them according to their sizes. Depending on the quality of the C&D waste, the time it consumes for the process varies. Overall manual separation is done at three stages: at the dumping yard, at the first conveyor, and at the secondary processing plant.

Grizzly feeder and jaw crusher (left)

Secondary processing: Dry method

Particles over 50 mm and below 150 mm are passed through another conveyor in the Dry Processing Unit. The materials are stored in the stockpile which has a capacity of 100 MT. These particles move through the conveyor belt along which overband magnetic separators are placed at multiple points to remove the magnetic particles from the crushed waste. The waste is moved towards a granulator that processes particles up to the size of 9 inches.

For making aggregates of different sizes, the particles are converted according to requirements and transferred to the drum pulley. Those are passed through a screener and either separated or crushed again, as per need. The main products at this plant are aggregates of 40 mm, 20 mm and 10 mm. The particles are passed through a grinder if sand is to be made. This sand – also known as manufactured sand or stone dust — is mainly made of particles from red bricks and is technically a by-product of the entire crushing process.

Interior of a Dry Processing Unit: Conveyor belts moving different sized particles after screening

Transferring the material through conveyor belts for dispatch

Secondary processing: Wet method

The Wet Processing Unit is used to process C&D particles of less than 50 mm size. C&D waste is fed into the conveyor and overband magnetic separators are placed at multiple points along the conveyor belts to remove the magnetic particles from the crushed waste.

The entire wet processing system uses a fully automated Human-Machine Interface (HMI) control panel, and functions according to the requirements that is set by the operator. The fine materials are separated by the dewatering screen and the coarse material is sent for further washing. Lighter substances like plastics are then removed and send to the trash screen. All separation is done through an automatic screening system.

Depending on the size of the particles, separation takes place at the triple deck screen to separate particles of five sizes — aggregates of sizes above 20 mm, 10 mm, 6 mm, coarse sand (up to 4 mm) that is used for making M30 interlocking pavers, and fine sand that is used for mixing with cement for plastering and sludge (less than 300 micron).

The finer materials are again washed before sending them for chemical dosing to settle the clay and silt. C&D particles of size less than 6 mm but more than 75 microns are transferred to the cyclone jumper (siltation tank) – this is mainly used for separating sand and silt. The cyclone jumper produces two types of product: fine sand (less than 2.36 mm) and course sand (more than 2.36 mm). The coarse sand is used for making M30 grade paver blocks, while the fine sand is used to produce recycled bricks.

C&D waste particles less than 75 microns in size are transferred to the siltation tank. Chemical dosing of varying concentrations is done in the tank, depending on the type of silt that is required as the product (dry and wet). Floc dosing tanks are used for this chemical processing; 96 per cent of the water used in this process is recycled and reused. Water and materials pass through underground pipelines between the different units.

Particles sized 300 micron and below, which is pure silt, moves to the sludge tank. Sludge is circulated through the aqua cycle thickener so that it can move through the pipeline into the sludge pond. Sludge tanks and the chemicals in them are used to compact the waste. The waste is allowed to settle in the sludge tank for three-four days. Water is circulated to this sludge tank through an automatic pipeline; this water is recycled and sent back to the feeding plant.

Currently, the sludge is manually separated. At the time of writing this book, a filter press was being built at the plant. A filter press uses a hydraulic press to take

Conveyor belt carries pieces smaller than 60 mm after preliminary crushing

water out and make sludge cakes. This sludge can be used for making recycled building materials.

A trommel machine has also been installed at the site. It is used to dry the waste recovered from the drains. After drying the waste, the sludge is turned into silt, which is used as filling material for products.

Secondary crushing stage which prepares the waste feed for wet processing

Cone crusher unit further breaks down the particles and takes them to a dewatering screen, where coarse and fine particles are separated

Dewatering screen for removal of light materials

Filter/screen for separation (left); cyclone jumper machine (right)

Siltation tank

Sludge being poured into the siltation tank

Recycled products

The facility makes concrete bricks (230 mm X 110 mm X 75 mm), kerbstones (300 mm X 300 mm x 150 mm) and four varieties of interlocking pavers, each in three colours (grey, red and yellow):

- 'Dumbbell' block: 200 mm X 160 mm in three thicknesses: 60, 80 and 100 mm
- 'Milano' block: 270 mm X 270 mm X 60 mm
- 'Zigzag' block: 250 mm X 125 mm X 60 mm
- 'Rectangular' block: 300 mm X150 mm X 60 mm

The facility has a block making plant which makes concrete blocks of sizes 400 mm x 200 mm x 100 mm and 400 mm x 200 mm x 200 mm. A 100 cu m of mix in the block making plant produces 123 bricks of 400 mm x 200 mm x 200 mm. The components are loaded into respective moulds of the block making machine, as per demand. The plant makes about 300 to 400 blocks per day. Since this plant works with a set algorithm, the resulting blocks have consistent and of superior strength than hand-made blocks.

The blocks are stored for drying and cured for seven days. They are tested before supply at an on-site testing lab site to ensure quality of the product.

The facility also has a paver block making wing. These blocks are made in two variants – coloured and non-coloured. While non-coloured blocks are made with a coarse aggregate mix, the coloured ones require a layering of colour in the mould before pouring in the coarse aggregate mix.

The plant produces zigzag, dumbbell-shaped and Milano tiles (top, left to right), kerbstones (bottom left) and concrete blocks (bottom right)

Block making process: Pressing machine (left) and storing to rack (right)

Curing tank (left) and testing lab (Right)

Paver making process

Ready mix concrete plant

The facility has a ready-mix concrete plant which supplies concrete to large-scale projects. From making nominal concrete mixes, the plant has now advanced to making design mixes. Design mixes are different grades of concrete mixes such as M10, M20, and M30, up to M60; these are standardised for construction. Depending on the requirement of the buyer, the plant makes the concrete mix and transports it to the construction site using transit mixers (concrete carrying trucks).

During the process for making a ready mix concrete batch, materials are moved using a loader and fed into a hopper, from which it moves through the conveyor to four bins. The operator sets the options for the required type and amount of load, after which the raw materials are moved from the silos as well as from the ground to the top. Sand and aggregates are moved through the conveyor and the admixture for deciding the setting time of concrete is sent through pipelines.

The RMC plant has three 100-tonne silos – two for cement and one for fly ash. The aggregates are mixed according to requirements and controlled by an operator. One plant batch has a capacity of 1 cu m, and the transit mixers have a capacity of 7 cu m each. The mixing time for a batch is 20 seconds. Once the transit mixers are filled, the concrete is moved to the site and poured using concrete pumps, which work at a capacity of 18-30 cu m per hour.

Compliances

The plant has a green belt running along the edges of the site. Mist cannons are placed at multiple points and used periodically or at times when a large amount of waste is dumped or moved from one point to another to curb fugitive dust. Water is also sprinkled periodically on the vehicular paths to mitigate fugitive dust emissions.

The dry processing unit has wind barriers installed around it. The wet processing unit does not require wind barriers as the material is wet and does not disperse dust. The plant needs to either lay down a gravel bed or pave the vehicular paths to curb dust dispersal due to circulation of vehicles inside the site.

According to the C&D Waste Management Rules, a recycling plant should not have habitation in its surroundings. However, the Bakkarwala plant has a housing colony adjacent to it. The colony is still unoccupied; but in future, problems may crop up for its occupants in terms of noise, dust and to and fro movement of heavy vehicles. To prevent this, the plant needs to place stringent dust and noise control measures.

The costs

The cost of setting up a C&D waste management system in cities with around million population like Jabalpur, Gwalior, Ranchi, Howrah, Navi Mumbai or Jodhpur is around Rs 6.94 crore, according to a compilation from different sources.

Other than this, a 50-TPD mobile processing plant comes at a cost of Rs 10,000 per day. This includes capital expenditure, operational expenditure and interest. At a C&D waste recycling plant, cost of machinery comes to around Rs 12 lakh. Rest is the cost of day-to-day operations and interest. According to plant operators, a centralised facility smaller than 300 TPD capacity would mostly be financially unfeasible.

Costing for a few compliances is as below:

1. GPS enablement in vehicles – Rs 8,000-10,000 per vehicle for installation only; monitoring charges for the entire vehicle fleet lie around Rs 10,000 per month.
2. Tyre washing facility – Rs 2,600 per sq m for complete civil work at a regional facility
3. Wind barricading of a regional facility which includes green buffer development and boundary wall – Rs 110 per sq m + 2,590 per sq m.

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The construction sector has emerged as a significant contributor to pollution, besides being a ravenous consumer of huge amounts of material resources: construction and demolition (C&D) waste generated by this sector is rapidly swamping our cities. Understanding of this waste stream is still at a nascent stage in India — as a result, its management is not as evolved as that of other waste streams. While a policy mandate and dedicated finances are available for managing this waste, cities lack institutional preparedness. What they need is information and guidance on an eco-system approach towards managing this waste.

This report from CSE aims to provide that — it reviews the existing status and the gaps in action; offers a learning from current and emerging good practices; and identifies the way ahead.

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