Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

TOWARDS LAKSHYA ZERO DUMPSITE

Collection of Case Studies

Swachh Bharat Mission Urban 2.0

Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

TOWARDS LAKSHYA
ZERO DUMPSITE

Collection of Case Studies

Swachh Bharat Mission Urban 2.0

Message

Shri. Manoj Joshi
Secretary,
Ministry of Housing
and Urban Affairs
Government of India

I am pleased that the GIZ India, in collaboration with the Ministry of Housing and Urban Affairs, has brought out a compilation of best practices entitled ***'Towards Lakshya Zero Dumpsite- A collection of case studies'*** on the subject of remediation of dumpsites and reclamation of land.

The 'Swachh Bharat Mission-Urban 2.0' (SBM-U 2.0) was launched on 1st October 2021 with a goal to make cities Garbage-Free and achieve 100% processing of waste. One of the specific objectives of the mission is to ensure that ***'all legacy dumpsites are remediated, and land will be recovered'***

The Municipal Solid Waste Management Rules, 2016 have mandated the cities to clear legacy waste dumpsites and stop usage of existing dumpsites. The need of accelerating of remediation of legacy wastes is also directed by hon'ble National Green Tribunal (NGT). Administrative and regulatory drive notwithstanding, legacy waste dumpsite remediation continues to be a challenge in most of urban India. Various aspects starting from procurement methodologies to the processing and disposal of excavated material continue to pose challenges in the remediation value chain.

Of all the stakeholders involved in remediation, it is the Urban Local Bodies (ULBs) who have the most crucial role as implementing agencies. This compilation of best practices constitutes a useful resource book as it focuses on ULB-specific actionable points covering all stages of the remediation process from planning, technology, contracting, execution, finance and monitoring. There is much to learn from the experience of cities that have carried out successful remediation projects and are in the process of reclamation of dumpsite land.

I am sure this "Towards Lakshya Zero Dumpsite- collection of case studies" prepared by GIZ India, under German Development Cooperation project "Cities Combatting Plastic Entering Marine Environment (CCP-ME)" will serve as a guiding document to all the city administrators.

Message

Dr. Steffen Koch
Minister,
Head of Department
for Economic and
Global Affairs
Embassy of Germany,
New Delhi

Swachh Bharat Mission - Urban 2.0 is bringing a paradigm shift in terms of changing behaviours. Indian government aims to achieve “Lakshya Zero Dumpsite” to deal with the legacy waste garbage hills which entraps around 1.6 million metric tonnes of legacy waste, occupying 15000 acres of valuable land in more than 3000 dumpsites across cities.

It gives me immense pleasure to bring to you the developed document “Towards Lakshya Zero Dumpsite- collection of case studies” prepared by the Ministry of Housing and Urban Affairs with support of the German Government. This support is extended under project “Cities Combating Plastic Entering Marine Environment” and funded by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety And Consumer Protection (BMUV), Government of Germany. Getting implemented by GIZ India, as a part of Indo-German cooperation. We have continued to support India in making cities green and sustainable for close to 70 years now and will continue to do so in the future.

This document talks about experiences of twelve cities of varying size and geographies who have already undertaken dumpsite remediation and moved ahead in becoming Garbage free cities. This will serve as a guidance document for other cities in the country and help them learn, plan better and achieving the countries vision of SBM 2.0, making cities Garbage free.

I congratulate Indian Government for bringing out this case study document which will help other cities in successfully replicating legacy waste remediation. I also wish Indian cities all the best in their endeavors to achieve zero garbage going to landfills.

Acknowledgement

Vaishali Nandan
Project Head,
Cities Combating Plastics Entering Marine Environment
GIZ India

Urban dumping sites were always an eyesore. However, in recent times they also increasingly become environmental hazard. Many dumpsites are also close to water bodies (rivers, lakes and seas) further adding to the problem of marine litter. It is hoped that this compilation of case studies on achievement of cities on urban solid waste dumpsite remediation will prove to be an inspiration to other cities in the country. It was with this vision of the Hon'ble Prime Minister and the guidance provided by Ms Roopa Mishra, Joint secretary SBM U-2.0, MoHUA that the document was initiated. We would like to thank her for this constant support.

We wish to express our sincere thanks to Sh. Binay Jha, Director – SBM U- 2.0 at MoHUA for playing a catalytic role for pushing and ensuring information from the cities included in this study.

We are also thankful to Ms. Ritu Maheshwari IAS, CEO- NOIDA and entire engineering team of NOIDA for facilitating site visits by GIZ team.

We also wish to convey our thanks to Sh. Sandeep Sharma from East Delhi MC; the city teams of who shared the relevant information and field data during interaction calls and meetings. We also thank team members of SBM Project Monitoring Unit for support and guidance provided during the documentation process.

We wish to express sincere thanks to Ms Seema Awasthi, ICUC consultants and Mr. Nagesh, Director, Zigma Global Enviro Solutions Pvt Ltd for providing relevant information from many of the sites.

Last, but not the least, we also thank all authors whose work have been cited here in this document.

Table of Contents

Executive Summary

With growing population, urbanization and changing lifestyles in Indian cities, waste management has become a challenge, requiring utmost attention. India is generating close to 54 million tonnes of Municipal solid waste every year and only 73 percent of this waste is getting treated, remaining being disposed of to dumpsites of sanitary landfills. The focus of cities was earlier towards improving collection and diversion of waste towards disposal, which was majorly changed with Swachh Bharat Mission 1.0 in 2014 and thereafter Solid waste Management Rules 2016, which emphasized towards zero waste to landfill approach.

Valuable urban land resources measuring an approximate area of 15,000 acres has been lost till date due to continuous dumping. Disposal sites are breeding ground for various pathogens, can cause landfill leachate seep into the surface and groundwater or lead to the production of the greenhouse gasses (methane and carbon dioxide), and even cause air pollution due to dust emissions and dumpsite fires. Also, windblown litter can enter the marine environment through these sites, overall threatening the environment. Clearing these mountains of years-old waste is critical to not just transforming the urban landscape of the country, but also addressing the issue of public health and environmental concerns. As many dumpsites are located close to water bodies, solid waste can easily find its way into the marine systems, which in turn can carry the pollutants for long distances, ultimately ending up as environmental and health hazard for humans, animals and nature far beyond the borders of said disposal sites.

At present, there are only limited resources for upgrading or replacing these dumpsites and, equally, the owner ULBs have limited funds and technical competence to operate and maintain these dumpsites. Thus, to support dumpsite remediation, among others, Swachh Bharat Mission-Urban 2.0 (SBM-U 2.0) was launched by the Hon'ble Prime Minister on 1st October, 2021, with the vision of creating Garbage Free Cities by 2026. Towards this end, one of the major objectives under the Mission is 'Lakshya Zero' Dumpsite to remediate 16 crore metric tonnes (MT) of legacy waste dumpsites occupying nearly 15,000 acres (6070 Ha) of city land.

In line with the objective to help cities and states learn from the experiences of other cities who have already completed or are in process of completing remediation and provide aggregated knowledge and learning on legacy waste reclamation this document "Towards Lakshya Zero Dumpsite- collection of case studies" has been compiled. It provides insights from twelve cities of varied sizes and geographies to help understand specific challenges and processes followed for achieving legacy waste disposal and site reclamation.

State, City	Dumpsite name	Population	Acres of land reclaimed /under remediation (acre)	Amount of legacy waste recovered/ to be recovered (MT)	Unit Rate (INR)
Andhra Pradesh, Tirupati	Ramapuram site	2,87,482	25.26	2,15,520	911/MT
Andhra Pradesh, Vijayawada	Ajith Singh Nagar Dump Yard	10,34,388	44.31	3,05,898	842/MT
Chandigarh, Chandigarh	Daddumajra	16,00,000	20	5,00,000	600/MT
Delhi, East Delhi	Ghazipur	48,60,000 (2021)	0 (ongoing)	9,00,000	306/MT
Gujarat, Surat	Khajod	44,67,797	151	25,00,000	166/cum
Gujarat, Vadodara	Atladara	16,70,806	19	3,75,000	887/MT
	Makarpura		12 (ongoing)	4,00,000	882/MT
Madhya Pradesh, Bhopal	Bhanpur	19, 38,251	21.03 of 39	1,60,626	378/cum
Madhya Pradesh, Indore	Deoguradiya	19,64,000	100	15,00,000	450/MT
Maharashtra, Nagpur	Bhandewadi dump yard site A	24,00,000	25	10,00,000	788/MT
	Bhandewadi dump yard site B		8	6,00,000	1015/MT
Maharashtra, Nashik	Khatprakalp	14,86,053	6	1,90,000	180/MT
Tamil Nadu, Tiruchirappalli	Ariyamanglam	9,16,857	39	5,00,000	684/cum
Uttar Pradesh, Noida	Noida Sec 54	6,50,000	4	27,165	1193/MT
	Noida Sec 145		6.2	5,13,813	986/MT
	Noida Sec 145 A		4.49 of 13.73 (ongoing)	3,72,447	986/MT

To address the issues pertaining to lack of understanding of various pre-requisite factors, prior to planning and implementation of dumpsite remediation, this document also discusses the contractual and technical procedures of legacy waste remediation by cities, along with the monitoring mechanisms adopted and key takeaways, on how to extract resources and put them back to circular economy.

This would help and guide other ULBs in the country to plan their dumpsite remediation in a more robust, systematic and structured manner.

Introduction

Solid Waste Management Rules 2016 stipulate under Rule 15. The local authorities and Panchayats shall “investigate and analyze all old open dumpsites and existing operational dumpsites for their potential for bio-mining and remediation and wheresoever feasible, take necessary actions to bio-mine or remediate the sites; in absence of potential of bio-mining and remediation of dumpsites, they shall be scientifically capped as per landfill capping norms to prevent further damage to the environment”.

Further, National Green Tribunal (NGT) under its Order in OA 519/2019 made an observation “where bio-mining and remediation is possible, both ex-situ and in-situ, such options can be exercised, which is not only environmentally safe but cost effective. There may be hardly any situation when remediation is not possible. The option of capping of legacy wastes, which has huge environmental and health consequences, is no option at all, except for inert waste, which again is to be disposed in a scientific secured landfill”.

Swachh Bharat Mission-Urban 2.0 (SBM-U 2.0) was launched by the Hon’ble Prime Minister on 1st October, 2021, with the vision of creating Garbage Free Cities by 2026. Towards this end, one of the major objectives is ‘Lakshya Zero’ Dumpsite to remediate 16 crore metric tonnes of legacy waste occupying nearly 15,000 acres of city land, founded on a strong political will and support for cities to undertake remediation of old dumpsites.

> **“The goal of the ‘Swachh Bharat Mission Urban 2.0’ is to make a garbage - free city, a city completely free of garbage.”**
>
> Shri Narendra Modi, Prime Minister of India.

As on date, India generates more than 148620 Tonnes per day of municipal solid waste out of which more than 108760 Tonnes per day is processed. Door to door collection is done in 88180 wards out of which 90.8% wards give segregated waste (MoHUA 2022). In the past dumping of mixed MSW was a major practice in urban areas, as well as the easiest low cost option. With SBM in 2014 and SWM Rules 2016 coming into force, focus of cities got shifted towards segregation, segregated collection, and processing of waste- targeting zero waste to landfills. Old dumpsites pose a major threat to the environment and have been a persistent source of environmental pollution in respective cities, where they are located. These have also become a single spot prime source of GHG emissions, i.e. methane, amounting to 15.83 million tonnes CO_2 Eq (Ministry of Environment Forest and Climate Change, 2021). Clearing these mountains of years-old waste is critical to not just transforming the urban landscape of the country, but also for addressing the issue of public health and environmental concerns. It further helps recover the recyclables and combustibles and put them back into circular economy loops.

With the aim to help cities which are either in process of either implementing remediation projects or planning to start such remediation projects, this document “Lakshya Zero Dumpsite: A compilation of case studies” has been prepared. Fifteen cases have been captured under this document, to help cities in better planning and in successful implementation of dumpsite remediation and help the country achieve “Lakshya Zero Dumpsite”.

Legacy Waste Dumpsites and Marine Pollution

Disposal sites and legacy waste are an increasingly severe issues in India, especially with regard to the marine environment. Since the 1970s, the common practice had been the uncontrolled dumping of municipal solid waste in sanitary landfills or at dumping sites. (Central Pollution Control Board 2019). With an overall Municipal Solid Waste (MSW) generation of around 60 million tonnes a year from urban areas, and plastic waste generation of around 9.5 million tonnes a year, urban centres and cities are faced with the challenge of ever-growing mountains of legacy waste (Pandey and Manuja 2020). This is grave, as such disposal sites are breeding grounds for various pathogens, can cause landfill leachate seep into the surface and groundwater or lead to the production of the greenhouse gasses (methane and carbon dioxide), and even cause air pollution due to dust emissions and dumpsite fires. Additionally, windblown litter can enter the marine environment through these sites, overall threatening the environment. This pollution of soil, water and air is especially the case in large cities, where dumpsites take up endlessly growing areas of land filled with mixed waste just outside the city borders (Central Pollution Control Board 2019).

However, while people living nearby these sites are especially vulnerable to the adverse impacts, the proximity of such areas to the marine environment causes the negative effects to be more intense and widely spread into the country and oceans. This is an issue that is often considered insufficiently (Naveen, Sumalatha and Malik 2018). Through many dumpsites located close to water bodies (lakes, rivers, seas and oceans), solid waste can easily find its way into the marine systems, which in turn can carry the pollutants for long distances, ultimately ending up as environmental and health hazard for humans, animals and nature far beyond the borders of said disposal sites.

Studies in the past also indicate that 80 percent of marine litter in oceans originate from land-based activities (Kapinga and Chung 2020) and around 3/4th of this is due to unmanaged waste from cities (Kumar, et al. 2020). The Ganga and Brahmaputra riverine system is also amongst the top 10 most polluting systems in the world contributing to marine litter (Krishna 2019). The severity of this aspect becomes even more prominent, when looking at the large cities of India having existing disposal sites. From 74 sites surrounding 54 cities (including Port Blair), only 16 have more than 1000 m distance to water bodies, be it, sea, rivers, lakes, ponds, or drains. Only 4 of them are more than 3000 m away. Instead, most disposal sites are situated in only a couple of 100 m distance, 15 even below 100 m, going as less as being only 20 m away from respective water bodies. (See Figure below). As a consequence, not only citizens living in close proximity are being affected, but also people, environment and ecosystem further away. Thus, solid waste, such as plastics, as well as various other contaminants can easily enter and pollute the marine environment, posing immediate threat for the water quality and in turn the health of people and animals who make use of the natural resources, both, near and far from these disposal sites.

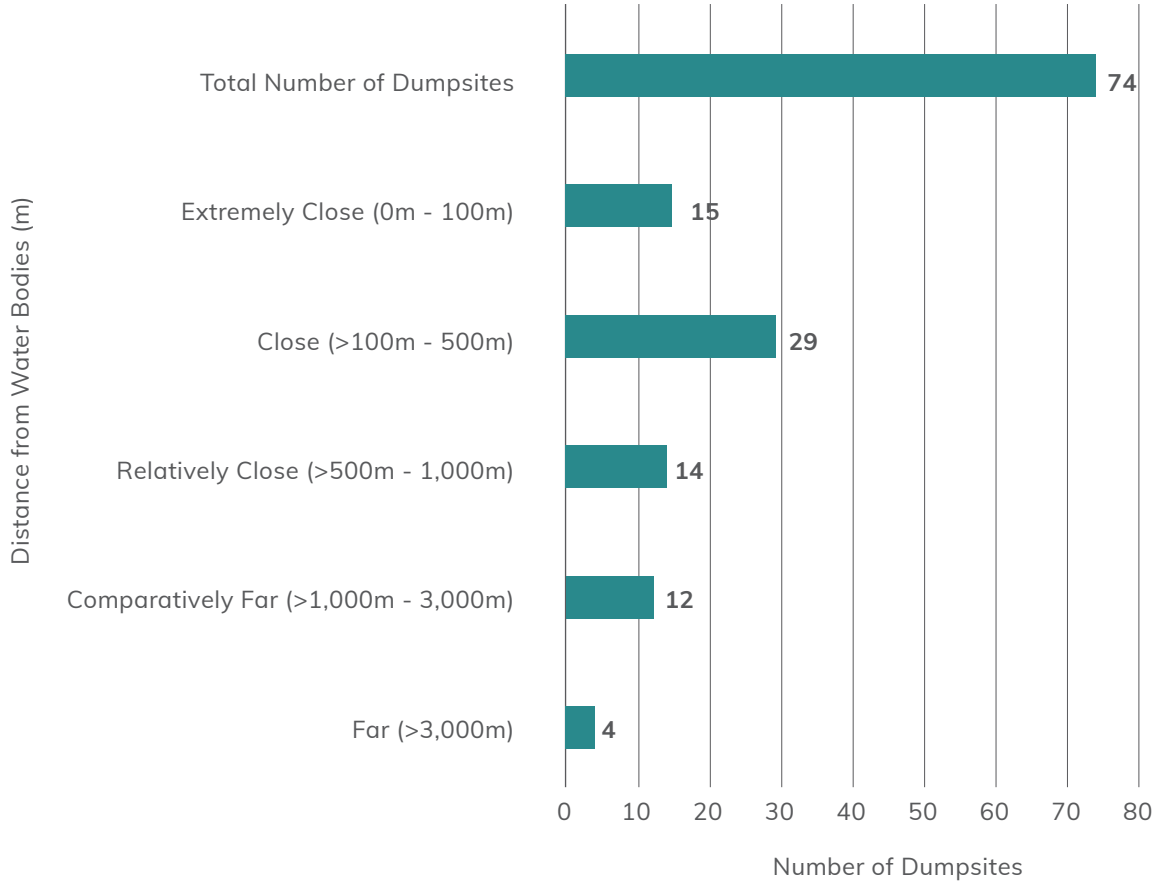


Figure 1: Distance of dumpsites from water bodies, GIZ, 2022

Source: GIZ, 2022*

Considering the risks posed by such dumpsites, it is important to search for solutions and counteractions, and preventing the adverse effects of these places from spreading. Thus SBM 2.0 was launched in October 2021 with a special focus on making cities garbage free and achieving "Lakshya Zero Dumpsite" (ET Government 2021). On February 19th, 2022, Prime Minister Narendra Modi announced that the government will increase its efforts to free many of India's urban areas from such landfills, and transforming them into green areas instead (NDTV 2022). While in any case such a legacy waste remediation is an important step, getting rid of dumpsites that are close to any type of water body is overall priority and to be considered primarily. Only then, marine pollution through leakage into the water bodies can be avoided, as well as the concomitant negative consequences. Thus, India has set targets to achieve reclamation of legacy waste dumpsites by the year 2026 and make cities garbage free (Ministry of Housing & Urban Affairs 2022). This case study document has been compiled with the objective to help cities and states learn from the experiences of other cities which have already completed remediation. It provides insights from more than a dozen cities of varied sizes and geographies to help understand specific challenges and processes followed for achieving legacy waste disposal and site reclamation. It also discusses the procedure of legacy waste stabilisation followed during remediation as well as monitoring mechanisms adopted, for cities to take up remediation of legacy waste dumpsites in their own areas.

* As per analysis carried out by GIZ

Landfill Sites and Dumpsites in Cities with Population of One Million and above

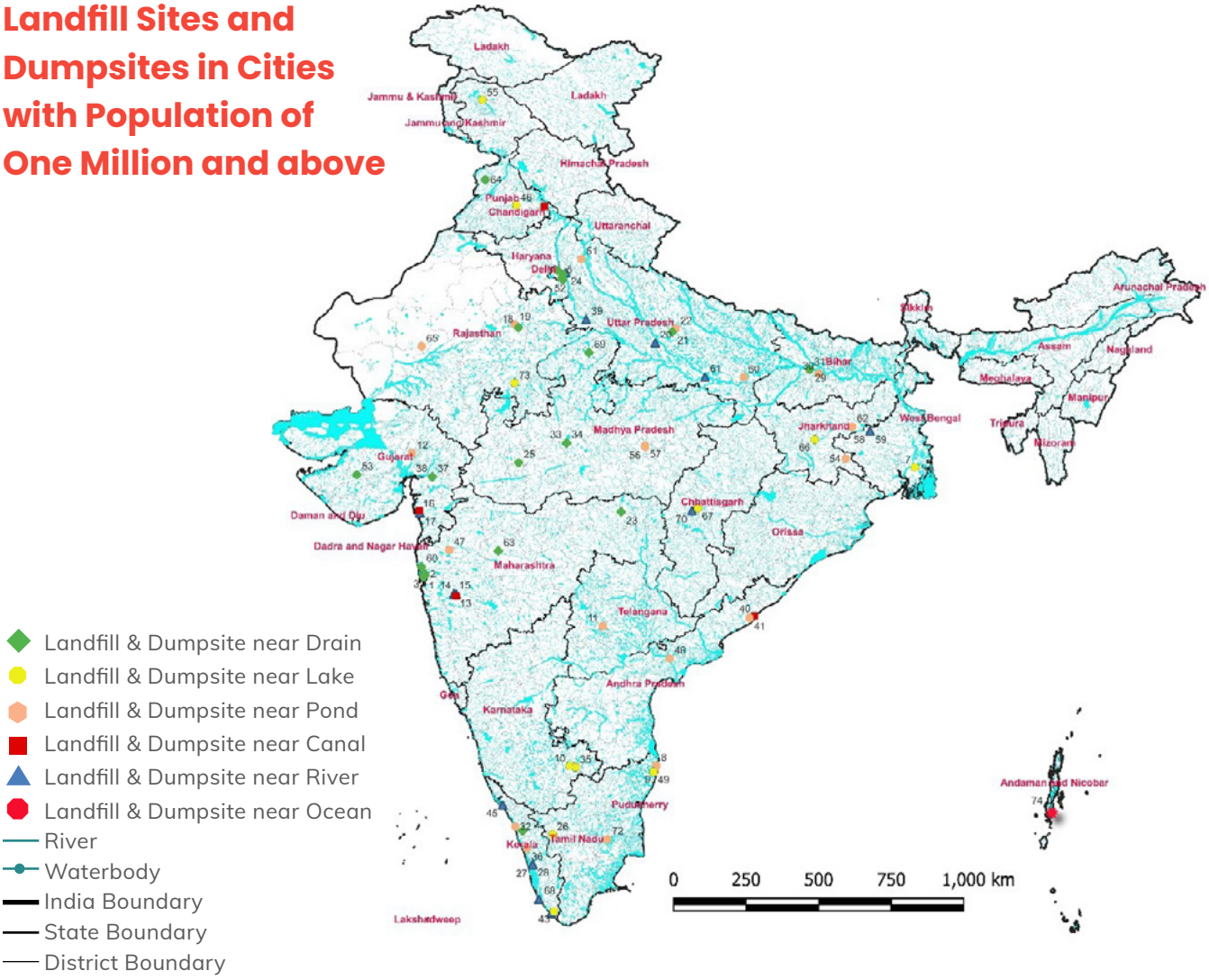


Figure 2: Map showing Water body and disposal site linkages for million plus cities, GIZ 2022

Name of Landfill/ Dumpsites	Water Bodies	Approx Distance (meter)
Deonar Dumping Ground	Drain	120
Mulund Waste Gound	Drain	251
Kanjurmarg Dumping Site	Drain	442
Gazipur	Drain	222
Okhla	Drain	1222
Bhalswa	Drain	80
Dhapa Garbage Ground	Jheel	90
Kodungaiyur	Pond	119

Name of Landfill/ Dumpsites	Water Bodies	Approx Distance (meter)
Perungudi	Kaaria Kulam	1110
Mavallipura Landfill Site	Lake	214
Jawahar Nagar Dumping Yard	Pond	258
Pirana Landfill	Pond	1170
Uruli Devachi	Canal	1580
Manjari garbage dumping	Mula Mutha River	1100
Phursuing	Mula Mutha River	110

Name of Landfill/ Dumpsites	Water Bodies	Approx Distance (meter)
SMC Garbage Dump	Canal	650
Khajod	River	730
Kuda Kachra Mount	Drain	1700
Sitapura dumping ground	Pond	3970
Panki Open Dump Site	Pandu River	379
Shivri	Drain	3560
Ghaila Village	Pond	245
Bhandewadi Dump Yard	Drain	1490
Pratap Vihar	Hindon River	352
Devguradia	Drain	2400
Vellalore	Vellalore lake	1890
Brahmapuram	Kadambrayar River	144
Kalamassery	Kadambrayar River	613
Dumping Ground Patliputra	Drain	45
Solid Waste Landfill Area Khusrupur	Chakchanda Talab	280
Ram ChakBairya	Pond	685
Njeliyanparamba	Areekkulam Pond	344
Bhanpur Landfill Site	Drain	141
Adampur Chhawni Dump Yard	Drain	170
Mundur Dump Yard	Gunduru Lake	1024
Laloor	Ambadi Kulam	528
Garbage Dumping Ground	Drain	174
Jambuva	Drain	53
Kuberpur	Yamuna River	917
Dump Yard	Canal	600
G V M C Dump Yard	Pond	965
Theruvushala	Drain	1330
Vilappilsala	Lake	399
Erumakuzhi , near chala market	killi River	540
Chelora	Kaanaam River	570

Name of Landfill/ Dumpsites	Water Bodies	Approx Distance (meter)
Alamgir	Lake	130
KhatPrakalp	Pond	338
Dump Yard	Kanuru Cheruvu	160
Vellakal	Vadakkupattu lake	344
Saraiyyabasti	Saranganath Kund	719
Ganwri Village	Pond	523
Manohar Lal Khattar Dumping Ground	Drain	109
Nakrawadi	Drain	364
Bara	Pond	150
Saidpora Achan	Anchar lake	800
Ranital	Rani Taal Pond	40
Kathonda	Pond	1240
Kalipahadi	Nunia river	240
Samdihi	Nunia river	70
Vvcmc Dumping Ground	Drain	395
Baswar	Yamuna River	713
Matkudiya	Karmik Nagar Talab	490
Madki Naregaon Village	Drain	3420
Bhagtanwala	Drain	730
Keru	Pond	6000
Jhiri village	Lake	752
Sarona	Lake	900
Kureepiza	River	73
Site In Gwalior-shivpuri Road	Drain	4000
Jamul	Tandula River	501
Dadu Majra	Canal	90
Ariyamangalam	Tangeswari Nagar Pond	725
Nanta Trenching Ground	Jheel	135
Port Blair City Garbage Dump Yard	Andaman Sea	100

BHOPAL

Location	Bhanpur Dumpsite, Bhopal
Project Started	January 2018
Project completed	June 2021 (for closure) and another 5 years for monitoring (ongoing)
Area covered by waste	37 acres
Production started	2018
Total contracted waste	11,10,0000 cum
Total project cost	Cost for remediation, land reclamation and scientific closure is INR 42 cr. and O&M cost for 5 years post closure is INR 10 cr.
Cost per tonne	INR 378 / cum for capping and closure
Execution model	PPP

Reclaimed area	21.07 of 37 acres 57% of the land was reclaimed and rest was capped
Value of recovered land	Rs 380 crores
Products utilized	Combustible fraction to waste to energy units, inerts for capping and closure, Bioearth for urban gardening/ used as capping material at site itself.

The Story

Bhopal city is the heartland of Madhya Pradesh. Surrounded by lakes and hills, the city is famous for its natural surroundings. The district of Bhopal has maximum height of 505 meters above mean sea level and minimum 180 meters. It receives an average annual rainfall of 992 mm. There are 85 wards in the Urban Local Body of Bhopal spread over an area of 413 sq km.

The population of the city, according to 2011 census, was 19,38,251. The total waste generation, amounted to approximately 1000 TPD which composed of 57.83% biodegradables, 30.95% non-biodegradables and 11.22% inert fractions. The current door-to-door collection efficiency of waste is reported at 100%, with segregated waste collection. Mixed waste (750 TPD) was disposed at Bhanpur dumpsite from 1980 till year 2017. Accumulated waste was estimated to be 11,10,000 cum and had a height of approx. 10 m.

Background

- Bhopal generates approx. 1000 TPD of MSW on daily basis. Bhanpur dumpsite was unpleasant from environmental as well as aesthetic point of view. Total area of dumpsite was 37 acres. Actual accumulated waste was found to be about 1112715 cum. It was proposed to cap an area of 16 acres and reclaim 21.03 acres of land. Since this was an uncontrolled waste dumping site (unlined) which has received waste for 40 years, issues like Contamination of soil, groundwater, ambient air quality were a threat to nearby residents. Bad odour from site, was also a pain for residents during rainy season, based upon the prevailing local wind direction.

- Bid was allotted on volume basis and third-party consultant was hired by BMC for successful management and monitoring of work.

- The remediation work was completed on 08 June 2021. Total waste processed (Remediation) was 1,60,626 MT and output in terms of combustible fraction is 19000 MT, soil enricher quantity was 63220 MT, Stones/ C&D waste quantity was 1606 MT, while the Moisture reduction was 44800 MT & inert quantity was estimated at 32000 MT.

- The site had a 600 TPD processing plant, 50 TPD leachate treatment plant, gas collection and dispersion system, landfill liners on capped area and green belt developed.

- Currently, city waste is segregated and waste rejects are disposed at a scientific landfill named Aadhampur, located in the outskirts of the city. This is equipped to handle mixed waste received from city as well as processed legacy waste.

Execution Method and Contractual Agreement

Waste characterization study and lab tests were conducted at site. Project was designed for 3 years for execution and closure and 15 years for post-closure monitoring.

There were 3 stages:

(1) Survey and planning

(2) Remediation of legacy waste &

(3) Scientific Closure. Topographical survey and borehole investigation were also conducted, and contract was awarded on volumetric basis.

- Project was completed within the timeline and operator worked in adherence to timeline and used appropriate equipment.

- As per the contract the bidder was required to carry out the remediation activity to utilise the maximum quantity of the accumulated waste at the site through a suitable processing method.

- The remaining waste and the rejects from the remediation activity were transported in an optimized manner at one place to reclaim at least 15 acres of land and then cap the relocated and compacted waste as per provisions of MSW rules 2016

- The closed site was to be maintained by the bidder for the next 15 years, post closure as per SWM rules 2016.

- The contractor was responsible in case of any penalty issued by GOI agency relevant to non-compliance of prevalent rules relevant to the project by the Concessionaire, the said penalty was to be paid by the Concessionaire and mitigation activity was to be immediately executed without any failure.

- The contractor was responsible for undertaking various tests for the project as per the standards prescribed under SWM Rules and Bureau of Indian Standards.

- The activities executed at Bhanpur dumping site included planning of work to undertake biomining of legacy waste (dumpsite remediation) at the dumpsite, to come out with 21 acres of recovered land and 16 acres of scientifically capped site with provision for monitoring landfill gas emission and leachate treatment.

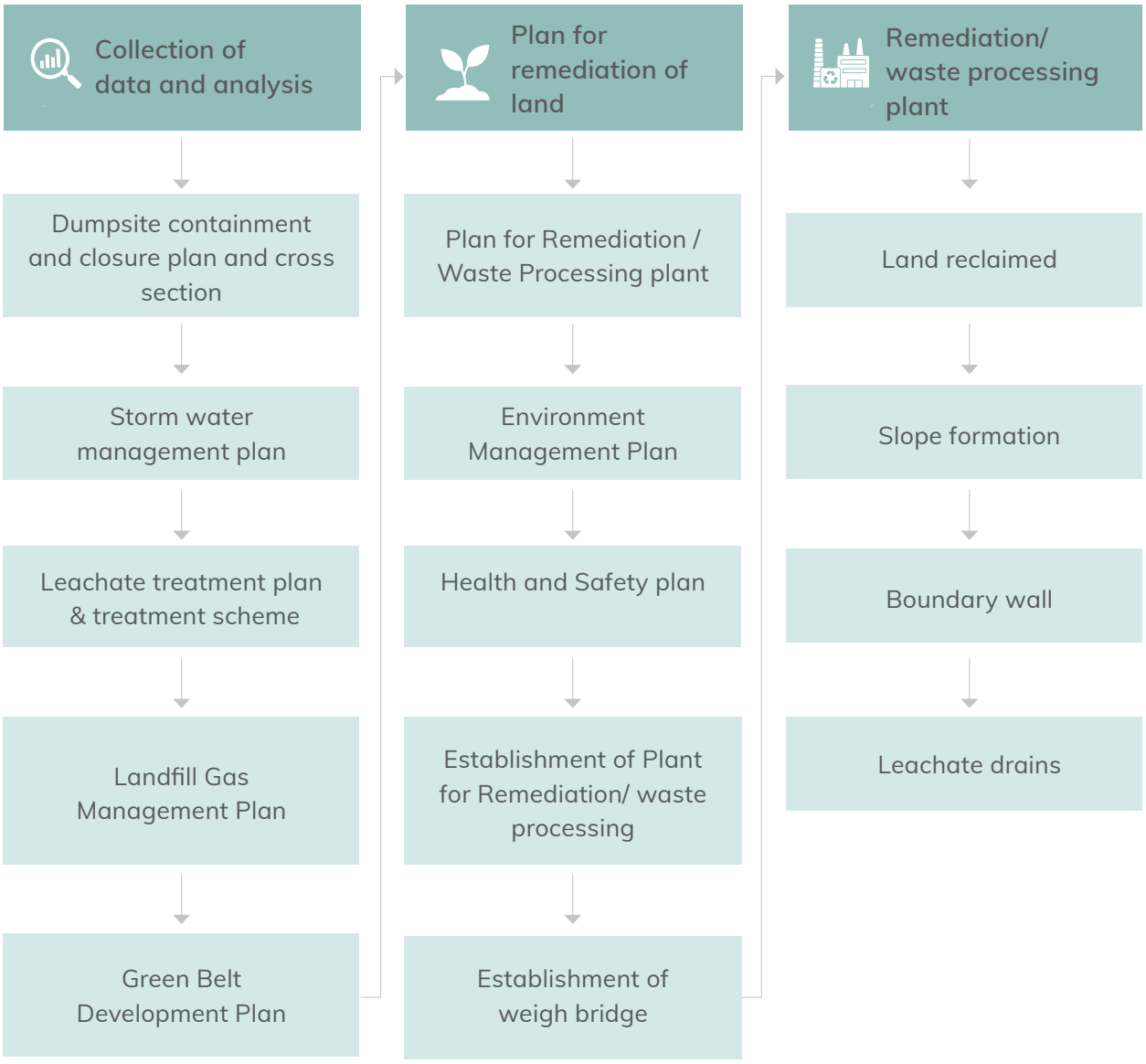
- The activities also included Remediation/ Biomining and Reclamation of land; Closure of dumpsite; and Post-closure Environment plan.

- A contractor was appointed on 3rd January 2018 to conduct the remediation activities and scientific closure within 3 years via public private partnership (PPP) arrangement. The chronology of project activities is presented below.

Figure 3: Picture before remediation

Figure 4: Dumpsite view, post remediation

Flow of dumpsite remediation work undertaken at Bhopal



Monitoring and Mechanism

To technically support the reclamation work, ULB had engaged Independent Engineer, for overall monitoring and environmental management of the project. All compliances required as per CPCB guidelines and related testing were regularly conducted.

Remediation Technique

- Mechanical biomining was done through poclain and excavators. Inoculum was used for stabilization and making open windrows and segregation through trommel.
- As part of process of remediation, heaps of waste were processed with added bio-culture and were left for 27 days for achieving biological stabilization. The processed, waste was thereafter passed through 3 sets of trommels for segregation. These included, 75mm, 50mm, and 8 mm screens.
- The outputs from screening units comprised of Inerts and fines, combustible fraction (Refuse derived fuel (RDF)) and soil enricher (Biosoil). Combustible fraction was sent out to waste to energy units for energy recovery, while inerts were used for capping and closure, and soil enricher was sold out for urban gardening or was used as capping material at site itself.
- The next process at the site was Bio-capping and closure: of 16-acre land parcel. Under the bio-capping process, after digging land, a layer of HDPE liner was placed. Waste was refilled with a trapezoidal structure imparting strength and stability to backfilled waste.
- The top layer was covered with geo membrane, soil and planted with grass. Leachate generated is collected via peripheral network of pipes and treated in a leachate treatment plant. This land is now developed into a green area.
- The capital cost for remediation, land reclamation and scientific closure was INR 42 cr. and O&M cost for 5 years post closure is INR 10 cr.
- BMC got 21 acres of land parcel (~ 57%) free from waste and land is ready to use for commercial purposes. Estimated value of reclaimed land is 380 crores. For fresh waste generated during the tenure New SLF was developed at Adampur Chawani.

Figure 5: Tromell system installed at Bhanpur Dumpsite in 2019

Challenges

01 Site was fully closed with controlled access, adequate space was made available by the ULB for storage of excavated material, technical guidance was provided by the PMC, hence there were less operational challenges.

02 ULB had also partially arranged for the funds on its own and also got support from the state government through SBM funds, hence city did not face any challenge.

Land Recovery & Utilization

- Overall, 57% of land could be remediated and low value materials were routed towards utilisation for energy recovery. The construction demolition waste/ inerts extracted were used thereby for the cover materials for the remaining land parcel at site itself.

- BMC claims that uncontrolled dumping has now stopped and city is only sending process rejects for dumping to SLF. Environmental quality has started improving and project has also reduced possible GHG emissions from site along with employment generation during all phases of dumpsite remediation.

Figure 6: RDF processed at Bhanpur site for further utilisation and energy recovery

Takeaways

- City showcased a sound model, whereby 57% of land area was recovered and contractor is responsible for 5 years extensive monitoring of the capped site.
- Since the work was relatively new, a project monitoring agency was hired by BMC to assist in technical aspects as well as help in monitoring.
- After reclamation of land, a boundary wall was created along the capped site, to resist any kind of slope failure.
- Execution was on time and since the recovered portion of materials were to be utilised for capping. Recovered combustible materials were linked with cement kilns.
- The reclaimed land is planned to be utilised for interstate bus terminal.

CHANDIGARH

Location	Dadumajra Dumpsite, Sector 38 – Dadumajra Labour Colony
Project Started	October 2019
Project completed	March 2023 (ongoing)
Area covered by waste	20 acres
Production started	Not Available
Total contracted waste	3,75,000MT
Total project cost	INR 33 crores
Cost per tonne	660
Execution model	On weight basis
Reclaimed area	8 acres (ongoing) 100 % to be remediated

Value of recovered land	Not Available
Products utilized	Contractor responsible to appropriately dispose all retrieved material

The Story

One of the earliest planned cities in the country, Chandigarh is a city, district and union territory serving as a joint capital for Punjab and Haryana. The metropolitan area of Chandigarh, Mohali and Panchkula collectively forms a Tricity, with a combined population of over 16,00,000.

Known globally for its architecture and urban design, Chandigarh is a dynamic urban agglomeration with one of the highest Human Development Index in India.

On account of increased urbanization, waste generation in the Municipal Corporation of Chandigarh (MCC) area has risen from around 250 MT/d in 2010 to around 550 TPD, presently from the 26 municipal wards of Chandigarh encompassing 56 residential sectors, markets area and 41 urban slums.

Dadumajra, the only designated dump yard in Chandigarh and was operational for over 40 years. Mining has been ongoing since 2012 at the Dadumajra site.

Background

Operational from 1970 through 2012, the Dadumajra dumpsite is the only designated dumpsite in Chandigarh. As most of the waste processing plants of the city are undergoing upgradation, most of the generated dry waste is disposed in the landfill. The Dadumajra site is spread across 45.11 acres. Out of this, an area of 20 acres was taken up for remediation in the first phase. The city was being adversely impacted by the dumpsite and constantly faced bad odour, environmental impact, health concerns and aesthetics which led to the city taking up remediation. The Dadumajra dumpsite also has an 8 acres SLF 8 acres for upcoming SLF and 7 acres of vacant land. The total waste disposed off at the site nearly amounted to 5 lakh MT and had an average height of 10 mts. The Municipal solid waste from Chandigarh city comprises plastics and polythene (7%), clothes (4%), paper (6%), wood/organic/vegetables (52%), glass (1%), inerts (21%), rubber/leather (0.8%) and miscellaneous waste (3%) (CPCB, 2010). The densities of solid is estimated to be 550 kg/m^3 for Chandigarh (Rana, Ganguly and Gupta 2015). Apart from municipal wards, residential sectors, market areas and urban slums, the dumpsite also received waste from the rural habitations of the Union Territory of Chandigarh.

Execution Method and Contractual Arrangement

The contracting process for the dumpsite remediation started in 2019, which was relatively new. As a result, there were very few contractors working in the area and MSW processing and hazardous waste processing firms were allowed to participate in the tendering process.

The contract was awarded to a private waste management operator. The estimated cost for dumpsite remediation was 660 INR/MT excluding GST and the total cost of the project was estimated to be INR 33 Crores (29 crores excluding GST). A tender for approximately 500,000 metric tonnes was awarded for remediation, to be completed by March 2023.

The contractor was responsible for setting up processing facility to dispose of about 500,000 MT legacy waste from the Dadumajra Dumping Ground (DMDG) through scientific processing within 540 days from the appointed date. This included the procurement of suitable and adequate number of heavy earth moving machinery, equipment, vehicles, and treatment technology (two sets of screening system). The materials recovered from the legacy waste, comprised of 68% biosoil, 14% C&D, 16% RDF and 2% recyclables like steel, wood, leather etc.

The contractor was responsible for carrying out contour survey and waste component analysis for effective planning. Additionally the contractor was responsible for all requisite permissions and was required to appropriately dispose of the residue/ rejects and fines generated or recovered during the process.

The provisions under the key bidding parameters included payment on weighment basis on per metric tonne processed, with key SLA's like non-compliance of SWM rules, delays in commencement, tampered weight

bridges, malfunction and technical problems in weighment systems. Though the contract stipulated timeframes for rectifying these issues it also included provisions for stipulated penalties beyond the timeframes.

Monitoring Mechanism

For ease of operations and monitoring, the entire area of existing dump site was divided into 20m x 20m grids. Mining of existing dump was done grid-wise as per the action plan submitted by the Concessionaire and as approved by the Chandigarh Smart City Limited (CSCL). This plan is reviewed periodically and is subject to changes according to local circumstances.

The Plant has a Consent To Operate and Consent To Establish, from the Chandigarh Pollution Control Committee (CPCC) and follow all environmental norms for barricading (5 m wall + 6mgl sheet barricade) and sprinkling. To suppress dust, shades were constructed over the trommel lines. The plant also has a leachate treatment plant, where leachate is treated and then sent for further treatment with sewage.

Though, no hazardous waste was obtained while remediating the dumpsite, a Toxic Characteristic Leachate Procedure (TCLP) test were conducted every three months to check the suitability of disposing Biosoil (inerts) in low lying areas.

The mass balance was also mapped, by tracking weighed fractions leaving the site with the weight of materials processed.

The ground water was tested continually, through the tube wells.

A Project Monitoring Committee (PMC)was established. The Chandigarh Smart City Limited site engineer along with the municipal staff (SDO, Site engineers) were taken on deputation and continuously monitored the work progress.

For better monitoring, CCTV cameras were installed throughout the site. All vehicles on site are RFID enabled and the weigh bridges are fully automated.

All records are reviewed every day and the PMC, CMC and Contractors site engineers sign off on the records at the end of every day.

The second phase of remediation 7.7 lakh tonnes will be done, reclaiming an additional 8 acres of land at Dadumajra.

Remediation Technique

- The contractor was responsible to deploy suitable and adequate number of heavy earth moving machinery, equipment, vehicles, and treatment technology.
- For continuous and reliable operations of the entire system, the concessionaire installed three sets of screening systems to turn 800-900 MT/day, this was transferred to windrows bio-culture solution was sprayed. Post this the material was shifted to processing unit lines for its treatment and segregation.
- Each set of trommel consisted of 75mm and 16mm trommels. Each fraction also underwent air density separation. Two additional movable lines were also setup to increase the capacity to efficiently collect the end product, i.e., refuse derived fuel (RDF), construction and demolition (C&D) waste and fines (bio-soil) etc.
- The generated RDF was disposed at a nearby cement plant and the C&D waste was directed to the C&D waste plant of Municipal Corporation of Chandigarh(MCC). The fines were used as inert material to fill up the low-lying areas etc.

- The remediation site is in proximity to neighbouring residential areas. A boundary wall of 5mts was built and above it 6mts high GI sheets were installed. The purpose of this barrier was to restrict flies and dust from entering residential pockets. Water was sprinkled continuously and cannon sprinklers were used to suppress the dust arising from the remediation site, on windy days.

Challenges

01 Disposing off RDF (combustible fraction) proved to be a challenge. A moisture level of 13% was pre-determined for the segregated RDF fraction. The process was unable to maintain and achieve this level consistently.

02 The contractor had identified cement plants in Himachal Pradesh to dispose of the RDF. A price of INR 800/tonne was agreed upon with Geocycle (third party) and the transportation was included in the scope of the contract. Geocycle sought pre shredded material. However, due to the lack of a pre-shredder on site, minimal quantity of undersized material could be disposed.

03 Of the total RDF generated (65000MT), only 23000 MT could be disposed by the contractor. Amounting to the total land reclaimed being only 8 acres despite 422000 MT waste being remediated.

04 The quality of RDF was also an issue, as the process is moisture sensitive. Vehicles were stopped at cement plant and were not allowed to unload. Due to mismatches, transportation of material was challenging.

05 The trommel capacity was impacted, on account of high moisture content and the winter season. Beyond 8-10% moisture content of legacy waste, trommels got choked. Similarly in winters since stabilization time increases, it slowed down the overall reclamation process.

06 Infrastructural challenges also persisted, due to non-availability of power and approach road. The power line came from 3kms away and installation took time delaying the overall process.

07 Fluctuating fuel prices were also a challenge as the contractor was responsible for disposing RDF by traveling for long distances.The extra transportation cost was to be borne by contractor.

08 Covid 19 restriction led to delays in the process, as laborers were not allowed to work during lockdown.

09 Presently, dry waste from city, is not processed as the processing plant is not operational. This creates another waste pile in the city with fresh waste being constantly deposited.

10 During RDF tests at the cement plants, mud was also an issue. The city thus suggested to the contractor install a shredder for the second phase of operations.

11 Heavy vehicles cannot ply in daytime. Special permission was taken to allow them to operate.

Land Recovery & Utilization

- The entire land of about 20 acres was to be reclaimed for future use for scientific waste treatment and disposal. Till now 4.22 lakh MT of waste has been reclaimed and only 8 acres of land is remediated as site is being used to store RDF currently.
- The C&D waste recovered was sent to a state of art processing facility to be made into paver blocks and bricks.
- The large quantity of biosoil recovered was used in the southern part of the city for the development of a green belt.
- The recovered RDF was sent to Darlaghat, Himachal Pradesh as well as to the Sonipat JBM waste to energy plant.
- The city also plans to remediate another 8 acres of land that has close to 7 lakh MT of waste. Thus overall, 28 acres of land will be available and will be utilized for waste management purposes.

Figure 7: Aerial view of Dadumajra Dumpsite

Takeaways

- Implications of environmental factors such as moisture, and weather conditions (monsoon, winter, windy weather). That remediation process is moisture sensitive and may be delayed on account of weather conditions. Thus must be factored into the process of remediation.

- Mismatched quantities of combustible fractions(RDF)coupled with the demand of nearby processing/recovery units, makes proper disposal challenging and decreases land recovered.

- Barricading walls and shades were helpful in suppressing dust and improved the aesthetics while the work was underway.

- With appropriate testing and monitoring, the recovered Bioearth was utilized to develop green cover in the city.

EAST DELHI

Location	East Delhi
Project Started	December 2019
Project completed	2024 (Ongoing)
Area covered by waste	70 acres (14,00,00,000 MT)
Production started	Not Available
Total contracted waste	900000 MT recovered. Another tender for 50, 00, 000 MT to be remediated in next 3 years
Total project cost	Not Available
Cost per tonne	INR 306
Execution model	Rental model- ULB is responsible for disposal of recovered materials outside the site.
Reclaimed area	Nil (work is in progress). Height reduced by 12 mts in some stretches.
Value of recovered land	Not Available
Products utilized	Combustibles were then sent to waste to energy plant and inerts were used for filling embankments and low-lying areas.

The Story

Delhi is divided into five different local municipal corporations, East Delhi Municipal Corporation (EDMC) being one of them. EDMC span upto 125 km^2 area, having an average population density of about 31,608 persons/km^2.

EDMC is further divided into 64 wards spread in 2 zones: Shahdara North (200 colonies) and Shahdara South (269 colonies). The projected population in EDMC area for years 2021 is 48.6 lakh generating about 2600 MT (average) of MSW.

A waste to energy plant was commissioned in November 2016 at Ghazipur site in EDMC area with capacity to handle 1300 Metric Tonnes per day (MTPD) MSW and generate 12 MW power.

EDMC has only one dumpsite for disposal of its waste, which is the Ghazipur disposal site, operating since 1984 and has exhausted its designed space capacity in 2002.

Background

The disposal site located at Ghazipur spreads over an area of approximately 70 acres (with max height 65 mts) and receives on an average of 2000 MT of Municipal Solid Waste (MSW) daily as on date. The dumpsite is in operations since 1984 and had completed its designed air space capacity in year 2002 itself. Since the city had no other land for dumping waste, they continued disposing at the same site.

It is located at a junction of Delhi and Uttar Pradesh state and is in close proximity with East Delhi, Noida and Ghaziabad, posing serious issues with respect to environment, economic, and social developments. At some sides, slope of the dumpsite is very steep (60-70 degrees) and posed a danger to humans, animals and establishments around it. The site has no leachate collection and treatment mechanism neither any mechanism to tap the generated landfill gas.

Ghazipur dumpsite had approximately 140 million MT legacy waste (based on estimates by EDMC)[1], which consists of a significant fraction of biodegradable components (mixed waste getting dumped) with high moisture content (Babbar, Verma and Mehmood 2017).

Due to these emerging issues and notice by NGT, EDMC started remediation of legacy waste at Ghazipur through trommels w.e.f. December 2019, with a target to clear 140 MT legacy waste by 2024.

Execution Method and Contractual Agreement

- The contract given by EDMC was based on a fixed rate contract at Rs 306/tonne of waste processed (fixed by all 3 ULBs of Delhi). Contractor was liable to excavate and lift materials till site of screening/sorting (within dumpsite transportation) and take the materials after sorting to various material category stacks at the site itself. EDMC is responsible for transporting these recovered materials to other disposal/ recovery units, through its contracts/agreements.

- The present contract targets around 6000 Tonnes/month with a penalty clause for non-performance by concessionaire. The initial machinery was put in with a capacity to handle 200 tonnes per day of waste per machine. About 18 such machines are operational now. Eight new machines (four pairs) are to be installed with a capacity to handle 800 tonnes per day each and these machines will also have shredders with it, to provide RDF which is more acceptable in market for energy recovery.

- Combustibles were then sent to waste to energy plant and inerts were used for filling embankments and low-lying areas.

Figure 8: View of Ghazipur Dumpsite with remediation in progress

[1] *Presentation by EDMC to MoHUA on dumpsite remediation*

Monitoring Mechanism

CPCB guidelines and MoHUA advisory have been followed for executing the remediation work. Materials recovered were tested at frequency of once per month for establishing its suitability for use/ disposal in low lying areas and embankments.

Remediation Technique

- The present contractor deployed excavator, Trommel, Hyva trucks, and conveyor belts for segregating stabilized materials and in-site transportations.
- Windrows are made and for stabilization of waste, EDMC is spraying microorganism solution and allowing waste to stand for a stabilization period. The generated leachate is also sprayed back on to the stabilization face to increase the stabilization process.
- EDMC has been doing two screenings of 30mm and 6 mm, but it was observed that by removing less than 6 mm fraction the binding nature of material is reduced and it was not easily taken up for filling and embankment. Less than 6mm material was used specifically for parts after mixing with good earth.
- Materials recovered from remediation are checked every month for presence of harmful chemicals, in line with its usage.
- EDMC is responsible for transporting these recovered materials to other disposal/ recovery units, through its contracts/ agreements.

Challenges

01 EDMC roughly gets 20% RDF, 20% C&D waste and remaining fines / inerts from the processing of recovered material. The current capacity of processing units at the city is not enough to take up the RDF as well as inert fraction for disposal.

02 It plans to complete 25% remediation by June 2022, 50% of remediation by December 2023, and complete remediation by December 2024, subject to availability of alternate site for fresh waste processing by DDA.

03 The amount of fresh waste getting disposed to the Ghazipur site has not stopped, due to unavailable land for establishing processing facility for this waste.

04 Daily fresh waste management at Ghazipur has also been receiving a set-back due to poor functioning of Ghazipur WTE project. On an estimate with about 1300 TPD and more MSW getting to Ghazipur site, more than 11 Lakh tonnes of fresh waste has been received, rather remediation of only 9 lakh tonnes of material has been achieved.

05 Another challenge faced is the easy offtake of the recovered materials. The waste to energy plant has only been able to take up on an average 120 tonnes per day of RDF (from remediation site) and there are limitations with the quality of materials as well.

06 Placement of machines at locations which are stable and does not pose risk for operations was a challenge. Gradually 18 machines were deployed and height has been reduced at certain peaks.

07 Stability of slopes while dumping waste is important to avoid any future slope failure risk. EDMC has been suppressing dust using sprinklers and fog cannon machines, at a frequency of every hour.

08 EDMC also finds it difficult to transport materials outside the city as their vehicles attracts a green cess for again entering the city. It has been requesting a waiver for green cess for its remediation transportation, for easy uptake by neighbouring areas.

09 The corporation faces financial crunch and has asked for more funds from SBM 2.0 for the dumpsite remediation and waste processing facility. An organisation has also been formed with NTPC to establish a processing unit, but due to non-availability of land this has not yet mobilised.

10 Movement of RDF to far off distance is a challenge due to transportation costs to such large distances. These materials are to be transported either to Madhya Pradesh or Rajasthan for disposal.

11 C&D waste recovered from remediation site is expected to be about 2000-3000 TPD soon, similarly RDF will be in same range. But the city is finding it difficult for uptake by users at the same pace. The existing facilities are way under capacity to absorb these shock loads, intended till 2024 (deadline for remediation).

12 Lastly, there have been delays in execution due to COVID 19 lockdowns and ban on construction/demolition activities by Commission for Air Quality Management (CAQM) for pollution mitigation.

13 EDMC found it difficult to dispose the processed material at the pace with which it is recovered from site.

Land Recovery & Utilization

- The reclaimed land is to be utilized for establishing processing plant for the city.
- Since December 2019, around 9 Lakh Tonnes of legacy waste has been processed, therefore dumpsite height has been reduced by 12-16 meters at certain stretches.
- Inert fraction has been disposal at - NHAI site Meethapur, NTPC Eco Park and some low-lying areas with over one Lakh MT of RDF utilized in Ghazipur WtE Plant.

Takeaways

- Capacities of machines installed earlier was quite less in beginning (@200MT/d), which now are procured at 800- 1000 MT/day. It is important that state of art machines are procured.
- Through the cost for remediation is fixed, but appropriate linkages of recovered material and timely offtake is a challenge. This further leads to delay of work by contractors due to space crunch. Planning and market demand plays a major role in timely completion.

INDORE

Location	Devguradia Dumpsite
Project Started	2016
Project completed	2019
Area covered by waste	100 acres
Production started	2016
Total contracted waste	15,00,000 Metric Tonne
Total project cost	INR 16 Crores (for renting machines and manpower)
Cost per tonne	660/MT
Execution model	Not Available
Reclaimed area	Not Available
Value of recovered land	300 plus crore INR
Products utilized	Completely in the scope of the ULB

The Story

One of the most populous cities of Madhya Pradesh, Indore serves as a commercial capital for the state. Indore is the largest city located in Madhya Pradesh and lies on the southern edge within the tributaries Saraswati and Khan of the Shipra River. Indore has the highest elevation among major cities of Central India. It has a population of 19.64 lakhs (census 2011).

In 2014 the annual Swachh Survekshan Survey conducted by the MoHUA ranked Indore at 149th position. However, in 2017 Indore

secured the first rank in the Swachh Survekshan and has continued to do so for five consecutive years.

The city generates around 1100 tonnes of waste daily. Out of which biodegradable waste accounts for 600TPD and non-biodegradable waste to 500 TPD.

The Devguradia dumpsite in Indore is one of the oldest and has attracted attention from local media and residents for its adverse impact of the environment and city life.

Remediation of the Devguradia site was undertaken in 2016 and was completed in three phases.

Background

The Devguradia dumpsite has legacy waste from over 60 years amounting to over 15 lakh metric tonnes. The site spans 139 acres of which 39 acres was demarcated as area for solid waste processing (organic waste treatment-BioCNG, C&D waste processing and dry waste MRF and Sanitary landfill). For years the Devguradia site emitted foul odour, caused fires and polluted the city of Indore. The waste dump at Devguradia was large and distinctly visible to visitors and city dwellers. A few years before, a Public Interest Litigation (PIL) was filed in the Madhya Pradesh High Court to remove the dumpsite. In case of a fire in the dumpsite, it used to require 15 days to be managed and often impacted the city adversely.

Thus in 2016, the ULB decided to remediate the legacy waste at the Devguradia site.

After a preliminary pilot testing and the approval of the ULB, the remediation process started. The entire site of Devguradia was divided into 20 sectors and the quantity of waste to be remediated was determined based on the contouring of the area. The remediation work was taken up in three phases, with the first two phase 1 serving as pilots.

Execution Method and Contractual Arrangement

The Indore municipal corporation (IMC) formulated an implementation plan that comprised of three steps. The third and main step in the plan was Remediation of Legacy Waste.

Based on the Solid Waste Management Rules 2016, the IMC sought to determine the feasibility of Remediation of legacy waste and an action plan consisting of 3 phases was formulated. The first phase and second phase were rolled out to test the waters, the third phase was initiated after having empirical proof to indicate the success of the first phase. All this work was carried out between 2016-2019.

This was approved by the Mayor, and IMC utilized its own funds to remediate the waste. No outside funding was required.

The model adopted included pilot testing in 2016 with 0.5 lakh metric tonne remediation in phase I with a rental model. Followed by 1.5 lakh metric tonne with a contract model in 2017 (with machines and operators by contractor, for completing remediation and disposal by ULB) and then for 13 lakh tonnes with a rental model till 2019 in phase III.

The expenses incurred by the ULB for remediation was nearly INR 450/MT in 2016 for remediation work. However, the ULB estimated this to cost close to INR 600/MT including the cost for disposal.

Under the rental model, trommels were hired on rent and operated 24x7 to achieve remediation. Around 20 trommel sets were procured in Phase III (one set for each sector within the 100-acre site). The Indore Municipal Corporation outsourced the operators for the reclamation work on a contract basis. Machines including dumpers, JCB, and poclain machines were provided by the ULB for local transportation.

The IMC required many heavy machineries and decided to rent trommels, screens, excavators, and backhoe loaders. These machines were operated by utilizing IMC resources.

City fabricators were also approached to supply machines for segregating materials (trommel). A total of 6-7 contractors supplied trommels for segregation, on rent to IMC. One platform had 2 trommels each.

An RFP was floated to allow waste management firms to participate in the contracting process. There was a meeting and briefing for contractors to help understand the project better. Mostly, solid waste processing firms participated in this process.

A rental model was preferred as there were fewer agencies otherwise. The first phase recovered one acre of land and trees were planted in the recovered area. This further motivated the IMC to work ahead.

The phase three process duration was estimated to be 6 months. However, on account of site conditions, the process took 8-9 months to complete.

For execution, authorities deployed 10 trommels, 15 horizontal screens, 50 excavators and loaders. Additionally, 200 workers were deployed for this task.

Monitoring Mechanism

A team, headed by the Commissioner of Indore Municipal Corporation monitored the progress of the project daily.

For better monitoring, 30 CCTV cameras were installed all across the site to oversee activities and keep records.

IMC was responsible for monitoring. A team of sub-engineers, supported by 2 sanitary inspectors worked on each trommel in shifts of 8 hours. There were three people per sector for each set of trommel. All officials on site were connected by a network of walkie-talkies. This contributed to the monitoring mechanism and also promoted responsible behaviour.

Logbooks were maintained to record fuel consumption.

A SPCB team frequently visited the site to monitor environmental parameters. No third party was involved.

The Impact Assessment was done later by a consultant hired by the ULB.

Remediation Technique

IMC conducted surveys to identify the areas that would be fit (certain geophysical, geochemical, and biological characteristics) to carry out the remediation process. Further surveys were conducted to map out an efficient action plan.

Contouring and topological surveys were conducted using Total Station and Differential Geographical Positioning System (DGPS) to determine the quantity of the waste to be remediated in 2 months' time. Parcels of the site were labelled as locations A, B, C and D

Table 1: CONTOUR SURVEY RESULTS

Location	Area (sq.m)	Average Height of waste (metre)	Quantity (MT)
A	846450	4.50	3,80,925
B	49186	6.50	2,14,790
C	66493	5.10	3,39,114
D	73089	6.36	4,64,846
		Total	14,99,675 (15,00,000)

SOURCE "Indore 2021: Remediation of all identified dumpsites no legacy waste/zero landfill city

Out of the 15 lakhs MT of the overall quantity of MSW, it was decided that 50,000 MT would be remedied in the first phase.

Before starting the remediation of waste, it is imperative to excavate or bio-mine legacy waste. The waste is excavated by loosening it to make windrows, allowing the waste to decompose without odour when sprayed with bio-culture. The excavation was done by using a JCB excavator, sieving, segregation, and baling methods.

The dusty top layer (materials in active biological state), was stabilized using herbal or biological culture (composting bio-cultures). Doing so reduced the volume of waste by 40%.

Long spike harrows operating in cross directions were used to rake the garbage and remove recyclables from it regularly.

The recyclables recovered were sent to the Material Recovery Facility (MRF) which is located adjacent to the remediation unit.

The third phase made use of trommels and associated machinery. Powerful fans (air density separator) were attached to each trommel at the reject conveyors to blow out the plastic fractions. Machines were used to remove the dust from recovered waste, and after cleaning the recovered recyclables like glass metal, cloth, plastic, etc., were sold to ragpickers and scrap dealers for recycling. The IMC deployed machines on rent.

Stones, bricks, and ceramics were sent to the construction and demolition waste plant where they were processed and re-used, or to the low-lying areas for filling and roads. The inert rejects were weighed and sent to a secured scientific landfill within the disposal site.

The fine soil recovered after segregation was transferred to existing gardens or to create new gardens in the region. The stabilised soil was mixed with good earth and utilised further.

Challenges

01 One of the primary challenges in the process of remediation was the outsourcing of manpower to work on site. There were over 200 people from IMC continuously monitoring the work.

02 Monitoring was a critical component of the remediation process. Especially to effectively implement a rental model. Regular monitoring was a challenge on account of the staff falling ill because of the site conditions. The machines were operational 24x7.

03 After excavation, concrete platforms were built to enable vehicle movement and the setting up of machinery. Movement of vehicles was also a concern due to site conditions.

04 Obtaining an electric connection was challenging and required the efforts and cooperation of various departments and the entire ULB to procure.

05 Identifying contractors was a challenge as the work was relatively new. A Request For Proposal was developed, and the bidding parameters established, ensuring that waste management firms could also participate. Meetings were called to motivate contractors to take part.

06 There was a need to appropriately link the disposed RDF to cement plants. Additionally, leather was available in large quantities. Only appropriate linkages could help in proper disposal.

Land Recovery & Utilization

- IMC built an urban forest with 60,000 saplings. This would help reduce Green House Gas Emissions, soil pollution, and groundwater contamination. It also increased the real estate value of the reclaimed land and benefited the citizens of Indore by eliminating dump fires, leachate generation, and foul odour from the dumpsite.

- The remediation unit, weighbridges, MRF centres, all were located within the site to reduce unnecessary transportation and ensure an easy and economical clean-up. Moreover, this ensured that life outside the site was not disrupted by the constant movement of trucks in and out of the site.

Figure 9: The Devguradia site before remediation.

Figure 10: The Devguradia site after remediation.

Takeaways

- The rental model adopted in Indore, ensured low cost of operations for the city. However, the monitoring process was resource intensive.

- Appropriate linkages for all recovered fractions was not possible. As a result, 10% of the rejects were sent to the SLF.

- The recovered Bio earth was utilized as a top cover on site. It was also used for plantation to develop an urban forest

NAGPUR

Location	Bhandewadi Dumpsite A	Bhandewadi Dumpsite B
Project Started	August 2019	January 2022
Project completed	December 2022 (ongoing)	August 2023 (ongoing)
Area covered by waste	25 acres	29 acre
Production started	October 2019	February 2022
Total contracted waste	10,00,000 MT	6,00,000 MT (13-14 lakh MT to be awarded in next phase)
Total project cost	INR 78.8 Crores	INR 60.90 Crores
Cost per tonne	INR 788	INR 1015
Execution model	PPP model with 100% recovery of land	
Reclaimed area	Ongoing	Ongoing
Value of recovered land	Not Available	Not Available
Products utilized	All recovered material to be disposed appropriately by the contractor	

The Story

Nagpur, in Maharashtra lies at the center of the country with the “Zero Mile Marker” indicating the geographical center of India.

Nagpur’s population was 24 lakhs (Census 2011) and is currently estimated to be approximately 30 lakhs.

The Nagpur Municipal Corporation (NMC) currently generates an average of 1100-1200 TPD of waste, with an average per capita generation of 444 grams per person per day. The Swachh Survekshan 2021 ranked Nagpur 23rd among the cities with a population over 10 lakhs.

The Bhandewadi dumpsite is an open dumpsite located 10 kms from the city center.

Background

The Bhandewadi dumpsite spans over 54 acres and receives waste from various parts of the city. The site was divided into 2 sites – site A dumpsite with 10 lakh MT legacy waste (25 acres) and site B which is also a sanitary landfill with 20 lakh MT waste.

The site is surrounded by habitation on three sides (east, north, and west), a sewage treatment plant to the southeast, and a composting and RDF plant to the south. Bhandewadi dumpsite has been in operation since 1968 and has been earmarked as a compost yard in all the development plans for the city since then.

The remediation work was awarded to a private contractor in two phases on basis of waste tonnage processed. The work included complete remediation of Nagpur Bhandewadi dumpsite (in 2018) which is 5.65m in average height (Site A) and Nagpur smart city site –which was 6.27 mts average heigh (site B) which is a sanitary landfill site. The amount of work awarded for site B was only 6 lakh MT. The remaining waste of 13-14 lakh MT at site B is under clearance stage, as NMC has sent the proposal to state for clearance and necessary approvals.

Execution Method and Contractual Arrangement

The contract for remediation of legacy waste at Bhandewadi was awarded to a private contractor under the Engineering, Procurement and Construction (EPC) mode, based on weight of material processed. The work order was awarded in two phases.

The contractor was required to set up processing facilities to dispose off the existing MSW from the Bhandewadi sites through scientific processing in accordance with SWM Rules 2016 and other applicable rules and norms as amended from time to time.

The contractor was also responsible for disposal of all aggregates which included loading and transportation of such aggregates till disposal.

The recovered material was required to be utilized or disposed strictly in adherence to SWM Rules 2016 and land recovery is the ultimate goal of the project.

A contour survey is conducted every month for monitoring volumetric reduction of the existing dump. Monthly payment to the contractor is based on weighment of net quantity of input waste processed from site A and site B (supported by contour survey reports). Almost 8.75 lakh MT is already remediated at site A and the remaining is planned to be complete by December 2022. Site B will be completed by August 2023.

The contractor was required to set up and operate the treatment plant for effluents.

Contractor was solely responsible to dispose of the rejects/inerts generated during the process.

The contractor was responsible to get all required permissions/NOCs from various authorities like Maharashtra Pollution Control Board (MPCB), in order to process existing MSW dumped at Bhandewadi.

Monitoring Mechanism

For each month, the payment was released only after the contract was adhered to and approved by the third-party agency.

Every month, payment to the contractor was based on the weighing of net quantity of input waste processed from the designated

sites. Additionally, for fractions, certificates for appropriate forward linkages were required to be furnished to the competent authority.

The monitoring mechanism also included automated updation of weight and availability on an online platform (SCADA system) and environmental monitoring conducted by MPSPCB monthly.

For better monitoring, CCTV surveillance with data storage for the entire contract duration (High-Definition IP based cameras in adequate numbers (as directed by NMC) and VTS was functional.

A detailed record of all the material going out was maintained.

Remediation Technique

Nagpur Municipal Corporation's (NMC) contractor started processing legacy waste using remediation/ bio-mining technology at the existing dumpsite.

A total of 311 windrows of five to six feet in height were created from approximately 600,000 tonnes of garbage. The process involved bio-mining of waste, followed by segregation, and harrowing of waste and spraying of bio cultures to accelerate degradation.

According to the NMC officials, the process was successful in reducing the height of the existing dumpsite. The process adopted was:

Pre-assessment and Stabilization: In this stage, the dumpsite was primarily assessed for its topography, geography, height, density of waste using a drone-based contour survey where a 3D map of the same was obtained. This helped the contractor to understand the methodology that can be adopted for stabilization, leachate management and channelization for collection, fire management and rag pickers management

A baseline study was conducted which included testing all the parameters required for ground water, surface water, soil, leachate, air quality etc., to understand the level of contamination and damage due to the dumpsite. A waste characterization study was conducted parallelly based on numerous samples collected at various locations of the dumpsite.

A strategy was derived for carrying out stabilization of waste, using equisized windrows. The idea was to give maximum exposure to the waste to initiate the degradation process. The windrows were turned a minimum three times at an interval of every 5 days. During this tenure the bio-culture and deodorizer was continuously sprayed using a tractor mounted industrial sprayer. Once at least 75% germination was obtained, the waste was marked fit for processing.

Processing and Segregation: Based on the waste characterization study, the machines were decided for screening, based on weight and size of the material. The machines would include blade drum trommels with anti-clogging devices, combustible separators, air density separators, suction devices and disc screen separators. Refinement trommels, over band magnetic separators, hopper, blowers and belt conveyors of various width and lengths were also included.

The suction and blower mechanism at each of the trommel allowed the air density separation and hence good quality RDF was available.

Appropriate Disposal of aggregates: All the aggregates generated were channelized either for recycling, upcycling, or re-purposing based

on the adherence to the SWM Rules 2016, CPCB and NGT Guidelines. There were four basic category of aggregates that were generated, namely: Coarse Soil and Stones; Fine Soil (soil enricher); Segregated Combustible Fractions and Recyclable. Fine soil was directed to the Horticulture Department, combustible fraction was sent to cement industries and stones and inerts were for low lying areas. The inerts were disposed in low lying areas and abandoned mines outside the city.

The data shared for material diversion is from the duration of 01 January 22 till 30 March 22 and the average daily values have been reported. The details are as follows:

Table 2: Data on different outputs from remediation site

S. No.	Aggregates	Quantity (in MT) (Site B) (1 Jan 2022– 30 March 2022)	Quantity (in MT) (Site A) (01 October 2019 till 30 March 2022)
1	**RDF**	6,399.82	66,066.62
2	**Soil**	26,731.79	2,84,049.31
3	**Stones**	14,538.79	2,78,196.30
4	**Others- Recyclables**	79.81	207.92
5	**Wood Aggregates**	30.61	2.50
6	**Ferrous Aggregates**	5.86	20.37
7	**Stainless Steel Aggregates**	0.78	2.61
8	**Footwear Aggregates**	24.24	12.73
9	**Glass Aggregates**	9.03	1.05
10	**Plastic Aggregates**	4.20	1.05
11	**Tyre Aggregates**	5.09	13.32
		47,750.21	**6,28,520.15**

According to the table, 85% of material recovered from site B was inert, while the dry fractions with combustible values are found to be only 13%, which was diverted to Ambuja Cement facility located at Chandrapur, at a distance of 120 km.

Challenges

01 As the area was larger than 50 acres, maintaining and controlling the dust level for the reclaimed area was a challenge.

02 During harsh summers, the area would become highly prone to fires. To manage this, the site staff would continuously take rounds to identify potential fire hazards.

03 During COVID-19, IEC, provision for separate transportation and adequate meals ensured that the site was shut down only for 30 days.

At the Bhandewadi site A –

01 The contractor had to form two separate access roads to differentiate between vehicles dumping fresh waste and bio-mining vehicles.

Bhandewadi Dumpyard Bio Mining Project

ZIGMA
Global Environ
Private Limited

Ticket Number
55774

Ticket Date
03-04-22

Material
MSW

Vehicle No.
MH 40 BL 3486

Supplier
NMC

Material	Gross weight	Tare Weight	Net Weight
MSW	21,635.00	9,595.00	12,040.00

Empty
Date 03-04-22
Time 12:06:20

Loaded
Date 03-04-22
Time 12:00:49




Source: https://nagpur.zigma.global.in/dashboard/day_wise_report_list_print.php?id=63487

02 Due to large quantities of incoming fresh waste, there was no separate place available for pre-stabilization. Lack of adequate space within the dumpsite to set-up the plant was a challenge.

03 As the waste was stored inside the disposal site and there was a continuous influx of fresh waste, odour management became a challenge.

04 The material was deposited in an SLF, which resulted in increased leachate outflow.

05 The method adopted required the contractor to segregate 250mm stones and process.

At the Bhandewadi site B-

01 The remediation plant could only be set-up once the contractor had cleared out the existing waste.

02 The delay in obtaining a power connection, as previously, the connection was privatized but then the Electricity Board took over.

Land Recovery & Utilization

The total area to be reclaimed is 25 acres for site A and 04 acres for site B. The recovered materials are appropriately linked by the contractor. Combustibles are linked for energy recovery, inerts are disposed in low lying areas / abandoned mines outside the city, and bio earth is mixed with good earth and used for green belt development.

Figure 11: Ariel view of project-A Before and after Remediation at Nagpur

Takeaways

- Influx of fresh waste daily hinders with the process of remediation. It is important that site undergoing remediation should not receive any fresh waste. If fresh waste comes in keep routes and areas separate.
- Complete remediation is possible provided materials recovered are of acceptable quality and appropriately linked with markets.
- Taking up remediation work in phases, provides an opportunity for the city to gain experience and improve processes and management practices.
- Online monitoring with SCADA systems is beneficial for monitoring agency as well as the working agency.
- Environmental monitoring is done in accordance with SWM Rules and CPCB and MSPCB guidelines

NASHIK

Location	Khatprakalp, Nashik
Project Started	June 2017
Project completed	January 2018
Area covered by waste	6 acres
Production started	2017
Total contracted waste	1,90,000 Metric Tonnes
Total project cost	INR 3.4 Cr (1.50 Cr for machinery +Rs 1.9 Cr on diesel)
Cost per tonne	Rs 180
Execution model	On weight basis- as part of waste management contract for city

Reclaimed area	6 acres
Value of recovered land	Not Available
Products utilized	Recyclables taken by rag pickers; soil was used for capping at Sanitary Landfill, debris/inerts were used for filling low lying areas, combustibles had no taker were disposed in SLF

The Story

Nashik is an ancient holy city located on the banks of Godavari River in Maharashtra. It covers an area of 264.23 sq.km and lies 584 mts above mean sea level.

The city is known as the “Wine capital of India” as about 90% of all wine produced in India comes from the Nashik Valley.

It is a pilgrim centre known for its historical importance and the heritage manifested in various religious occasions at Ramkund and Godavari Ghats. Various aspects of its physical heritage include Godavari River and its awe-inspiring banks in the heart of city. Dadasaheb Phalke memorial at foothills of Buddha caves, Mangi-tungi near Jain temple, Lasalgaon, Asia’s largest wholesale market for onion.

According to 2011 census, the population of Nashik city was 1,486,053 and Nashik Municipal Corporation is generating around 650-680 TPD MSW. City is the pioneer to start door to door collection under project name of “Ghantagadi” in year 1996-97.

Background

Nashik Municipal Cooperation dumpsite ‘Khatprakalp’ has been operating since 2003 and receiving waste /rejects close to 65MTPD. The legacy waste spread across the area of 6.5 acres was around 1,90,000 Metric Tonnes with 15 meters average height. This legacy disposal site was part of total land area of 82 acres which is utilised for integrated waste processing, mechanical composting, RDF making, briquetting, new scientific landfill, leachate treatment plant and dead animal incinerator.

The problem of soil pollution, water pollution and air pollution due to the legacy waste dumpsite were key issues. The site was close to caves which are trekking points and tourist attractions. There were issues pertaining to odour at the tourist spots.

The contract was awarded under PPP arrangement for shifting materials after remediation to another parcel and capping it.

Thereafter, 6 acres of land was recovered with about 1,90,000 metric tonnes of waste being remediated.

Remediation project was given as a part of solid waste management contract (30 year) to contracting agency as a PPP arrangement. Recovered recyclables were handed over to ragpickers for recycling, inerts were disposed in low-lying area and other recovered materials were disposed in portion of SLF and capped.

Execution Method and Contractual Agreement

- Nashik Municipal Corporation had awarded PPP contract on waste management to Nashik Waste Management Pvt. Ltd for 30 years period. Remediation work was part of the same contract to be completed within 2 years. Overall tipping fee is around INR 650 per tonne. The project involved 100% reclamation of legacy waste site. City estimates the cost for only dumpsite remediation to be around 150-180 Rs/tonne (2017-18).

- The complete site of 82 acres was divided in 04 phases: A, B, C & D. where A&B are pockets of scientific landfill and C&D were pockets of site to be remediated.

- The scope of the work was to remediate, and shift processed legacy waste from pocket C&D to pocket A&B. Further, dozing & compacting of the shifted waste was done at A&B as per the drawing & instruction of our supervisor at site. A&B were further capped and closed.

- The contract was based on a weight basis, at a lumpsum price and a penalty of 10% was to be levied in case of delay. Looking at the deviation and increased quantity of waste being remediated, a small value

contract was awarded for additional shifting of materials.

- Remediation was completed in the year 2017-18 within a tenure of 8 months.
- The actual cost for remediation was about Rs.1.50 Cr for machinery and Rs 1.9 Cr was spent on diesel which was spent by the NWMPL (Nashik Waste Management Private Limited) and 6 acres valuable land was recovered.
- The contract also provided additional cost of Diesel consumed, which was 70,418 liters of diesel for processing 1.9 lakh metric tonnes of waste.

Figure 12: Nashik disposal site before remediation

Figure 13: Nashik disposal site during remediation

Monitoring Mechanism

The remediation and capping of the legacy waste were carried out as per CPCB guidelines.

Agency people were there to do monitoring. 2-3 Junior Engineers with 1 Superintending Engineer and 1 bio technologist were appointed. Even director waste management used to take regular monitoring rounds.

CCTV surveillance was done, vehicles were tracked through RFID and GPS.

After biomining & caping the pollution level has fallen extremely low. City carried out water sampling at 4 borewells every year before and after monsoon. It has recorded improved ground water quality after remediation.

Remediation Technique

- Technology used for excavation, stabilization of materials using effective microorganism solution (stabilising agents), and processing of legacy waste through screening -Mechanical segregation. Materials were further loaded in trucks and weighed before being disposed/recycled.
- The remediation process used excavators, hywas, dumpers, dozer, screening equipments, weigh bridge during the process. The screens used were 75mm in size and 3# screens were used.
- Recovered recyclables were taken by rag pickers; recovered soil (21890 cubic meter) was used for capping at Sanitary Landfill (part C&D); debris/inerts were used for filling low lying areas; remaining materials put in to SLF which were capped.

- The leachate was collected via drains, constructed along this SLF and is further treated in leachate treatment plant & treated leachate was reused for windrow composting & gardening.

- Disposal and processing of fresh waste during the period of remediation was done in the processing plant itself.

Challenges

01 Being part of PPP tender no major infrastructural, financial, or contractual challenges were observed. Also, no socio-political oppositions were faced.

02 Operation was only possible during dry season and during monsoon the process was affected by the rain & moisture. Hence, the work was planned in a way to start from June 2017 till January 2018.

03 As Nashik does not have cement industry in vicinity of 300-400 kms to use recovered dry waste, and transportation cost for shifting these materials to cement plants were on very high side, city had disposed this in adjoining SLF.

04 Since the site was old, it had very little or no compostable matter.

Land Recovery & Utilization

- Total Land recovered in the process was 6 acres which was completely cleared. The output in terms of materials recovered was about 197000 MT which included soil, combustibles, debris, metals, inserts, plastic, and other recyclables etc. The disposal mechanism for the rejects was into the nearby SLF which were later capped scientifically.

- The recovered land parcel is getting utilised for screening and processing C&D waste and during non-rainy days, this site is also used for making compost, via windrow composting.

Takeaways

- The strategy used for environmental management was to complete the work in a single phase and dispose of material recovered immediately and the remaining material got disposed of at space between two other landfills which were scientifically capped afterwards.

- The work of remediation was part of overall waste management contract awarded to a contractor engaged for 30 years.

- Materials were not linked as alternate fuel to recover heat energy as the cost for transporting materials were high. However, city has dumped these materials appropriately in adjoining SLF.

- Recovered inters and biosoil were utilized by city itself for capping the adjoining SLF.

NOIDA

Location	Sector 54, Noida	Sector 145, Noida
Project Started	Dec 2018	August 2019- (site A) August 2020 (Site B)
Project completed	June 2019	July 2020 (site A) Ongoing (Site B)
Area covered by waste	4 acres of land remediated	6.2 acres of land remediated (Site A), 4.49 of 13.73 acres remediated- ongoing (Site B)
Production started	December 2018	August 2019 (site A) 2020(site B)
Total contracted waste	27,165 tonnes	87,000 (site A) + 372500 (site B)
Total project cost	17.9 Cr INR	49.3 Cr INR
Cost per tonne	Rs 1193	Rs 986

Execution model	PPP contract based on weight of waste processed	PPP contract based on weight of waste processed
Reclaimed area	4 acres	6.2 acres (Site A), 4.49 of 13.73 acres ongoing (Site B)
Value of recovered land	Not Available	Not Available
Products utilized	RDF Sent to Cement Industries, Bio earth to Horticulture Department, C&D waste to filling low lying areas	RDF Sent to Cement Industries, Soil and C&D waste for levelling low lying areas

The Story

Noida, short for New Okhla Industrial Development Authority, is a planned city in the state of Uttar Pradesh. Noida is a world class

industrial hub connected to Delhi and is part of the National Capital Region (NCR) of India.

Home for close to 650,000 people, around 600 tonnes of municipal solid waste is produced in Noida daily. This volume is an increasing pressure to the city's dumpsites which still has 1.68 lakh tonnes of legacy waste awaiting treatment.

One of the key requirements for the contractors was the adoption of mobile solutions for easy scalability and replicability. The plan for remediation started from December 2017, when Noida Municipal Corporation (NMC) took decision for remediation and undertook technical presentations. Part of the land reclaimed in sector 54 is now developed into a park with lake for recreational purposes. Site at sector 145 will also be used for creating green areas.

Background

The city has two dumping grounds, one at sector 54 Noida, and the second at sector 145 Noida. The average height of these dumping grounds is 6.8 meters at sector 54 and 6.9 – 7.1 meters at sector 145. Constraint of land availability, environmental and health risks led to urgent clearance of dumpsite for inert disposal. Noida decided to clear the dumpsites at sector 54 and sector 145 through scientific processing in an environmentally sound manner.

Execution Method and Contractual Agreement

Procurement model indicated to achieve 100 % reclamation of land, with contractor being responsible for appropriate transport and disposal of recovered materials. Also using a system which was modular and mobile.

Payments were linked with weight of materials entering processing stream after stabilisation and contractor had to establish systems for robust monitoring and measurement, such as weigh bridge with CCTV surveillance and online monitoring through SCADA system. NMC and Contractor had access to an online portal where day wise data was recorded. The dashboards were useful in showcasing progress of work. The concessionaire had to carry out contour survey every month for monitoring volumetric reduction of existing dump.

The legacy waste material recovered from the dumpsite and converted into a resource material was owned by the contractor and they were allowed to sell or use it for any civil infrastructure purpose subject to achievement of compliant norms as laid down by the Centre/ State Government.

Materials were transported to appropriate disposal sites including cement plants, horticulture department, and low-lying areas.

The RFP also demanded that the contractor caters to fresh waste along with the legacy waste.

	Sector 54 dumpsite	Sector 145 dumpsite
Waste Remediated/ Project Timeline	27,165 MT remediated in 6 Months	4,59,500 MT remediated within 15 Months. 168000 MT more to be remediated (ongoing)
Delay in monsoon	Covered up by running plant for 22 hrs/day	
Issues with setting up of Plant	Land was compacted by use of the C&D waste.	
Environmental Impact mitigation	On a continuous basis	
Moisture and odour control	Use of sprinklers, water cannon guns, and deodorizers are being used.	

Monitoring Mechanism

Contract was on weight basis and contractor had to establish systems and processed for robust monitoring and measurement.

Figure 14: Noida sector 54 disposal site before and after remediation

It was ensured that the payment was released only after the same was adhered to and approved by the third-party agency monthly before the bills were raised. The primary condition was that the contractor must adhere to all the rules, laws and guidelines as prescribed.

The contractor had to carry out contour survey every month for monitoring volumetric reduction of existing dump and contour survey reports were submitted along with every monthly bill clearly showing monthly volumetric reduction.

Payment was made to the contractor every month based on weighment of net quantity of input waste processed from designated sites. Monitoring was done via online portal (SCADA). CCTV footages and dashboards were, useful in showcasing progress of work.

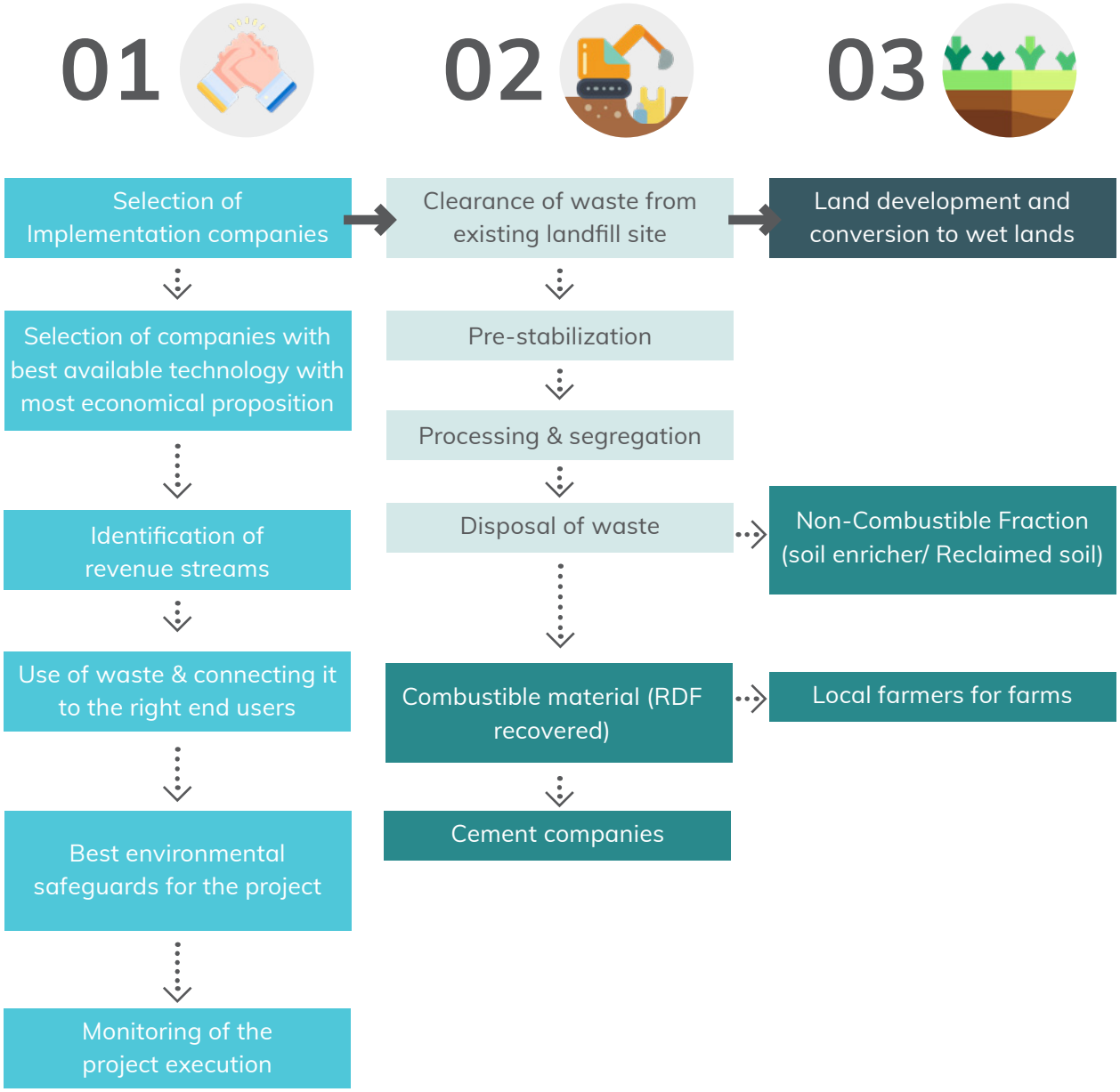
With regards to various fractions, certificates for appropriate forward linkages were required to be furnished to the competent authority.

Remediation Technique

- The projects are managed by a private contractor as a PPP contract.
- The dumpsite was primarily assessed for its topography, geography, height and density of waste. The objective was to determine the most suitable methodology for stabilization, leachate management and channelization for collection, fire management and rag pickers management.
- Further, a baseline study was conducted which covered testing all the parameters required for ground water, surface water, soil, leachate, air quality etc. to understand

the level of contamination and environmental damage. A waste characterization study was conducted parallelly based on numerous samples collected at various locations of the dumpsite.

- Based on the assessment results, a strategy was derived for carrying out stabilization of waste, using equisized windrows, allowing maximum exposure to the waste to initiate the degradation process.
- After a sequence of turnings and treatment with bio-culture and de-odouriser, the windrows were converted into cones which further eases the degradation process and keeps the waste ready for processing. The material was marked as fit for processing once observed as stable (absence of odour, dryness of the material, non-formation of steam etc.

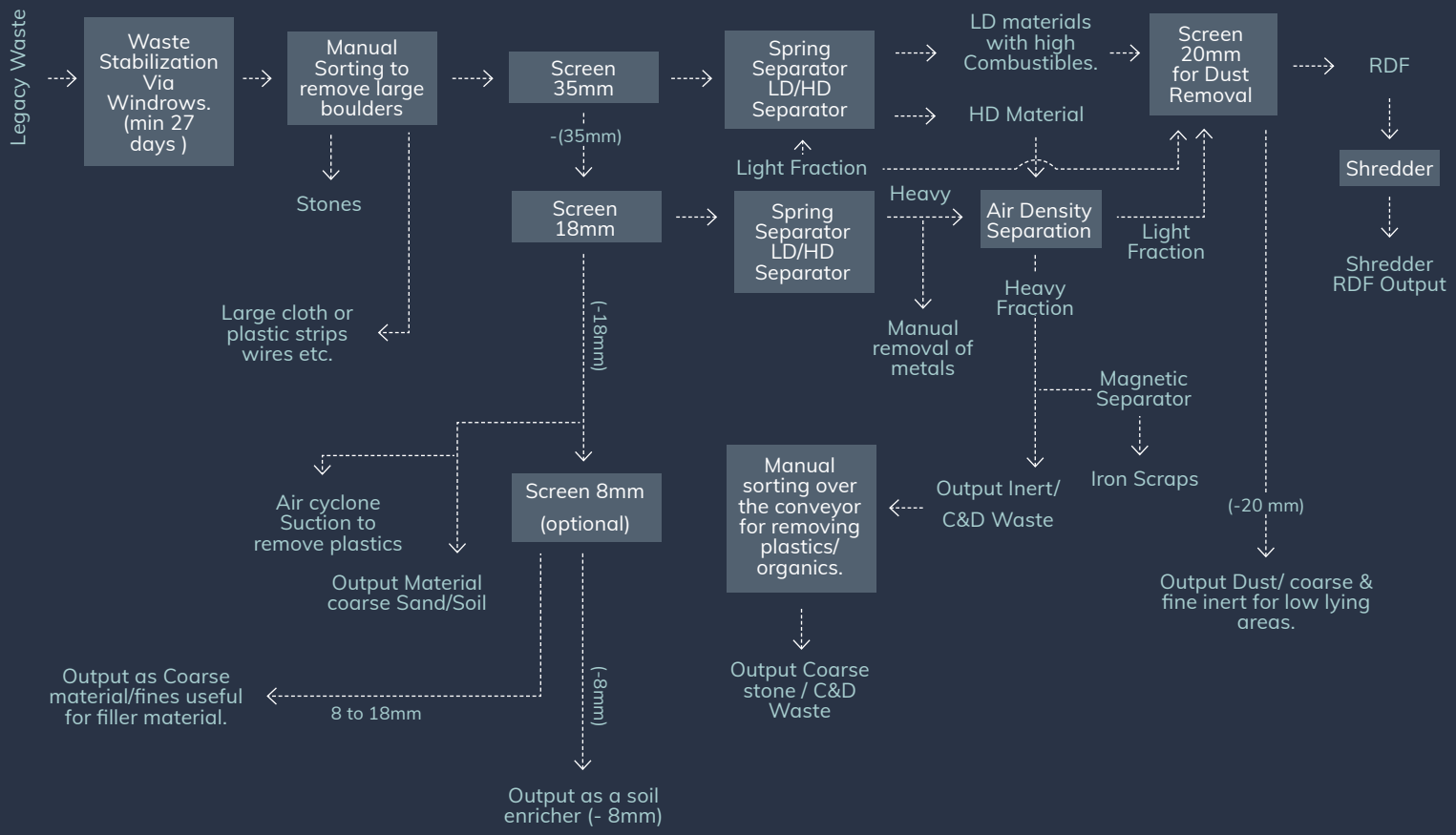


Segregation

- The waste characterization study and the quality of aggregates were the two key parameters for determining the necessary machines for screening. The quality of aggregates plays a paramount role ensuring that they are of acceptable quality when they are used for recycling or upcycling. The 8mm less fraction is mostly bio earth which is high in stabilised organic content, and can be mixed with good earth and used for horticulture (non-edible) activities. Removing the 8mm less fraction reduces the content of organics in less than 18mm fraction from roughly 18% to 8%, enhancing the acceptability of this fraction for filling in low lying area.
- The suction and blower mechanism at each of the trommel allows air density separation and hence RDF of good quality is segregated.

Appropriate Disposal of aggregates

- The aggregates generated from this process were of four basic categories: Coarse Soil and Stones; Fine Soil (soil enricher); Segregated Combustible Fractions and Recyclable. Fine soil being sent to horticulture department, combustible fraction sent to cement industries and stones and Inerts for low lying areas. Finally, all was channelized either for reuse, recycling, upcycling, or re-purposing[2].



- With regards to monitoring of the various fractions, certificates for appropriate forward linkages were required to be furnished to the competent authority.
- The only form of rejects that are generated from the process were the domestic bio-medical waste (like syringes, thermometers, medicine bottles, test tubes etc.) and domestic hazardous waste (like tube light remains, battery cells, CRT etc.). Both these were channelized to authorized handlers based on the quantity collected at various intervals.

Challenges

01 Challenges such as proximity to habitation was leading to tress passing and security issues in sector 54 dumpsite.

02 The plant was required to be setup in a low-lying area about 2 meters above the normal ground level to avoid flooding.

03 The remote location of dumpsite in sector 145, led to lack of access during monsoon, power cuts, installation of DG sets for backup were required leading to increasing operation cost.

Table 3: Details of aggregates recovered from legacy waste remediation sites in Noida

S. No.	Aggregates	Disposal Details 22.08.2019 to 15.08.2020	Disposal Details 16.08.2020 to 30.03.2022	Disposal Details 07.12.2018 to 26.06.219
		Quantity (in MT) from Sector 145 (B)	Quantity (in MT) sector 145 (A)	Quantity (in MT) Sector 54
1	RDF	12,838.91	1,16,967.03	15,498.26
2	Soil	61,798.94	1,93,701.79	10,319.25
3	Stones	12,393.77	61,320.74	1,347.58
4	Others- Recyclables	3.50	458.43	27,165.09
5	Wood Aggregates	1.14	222.46	
6	Ferrous Aggregates		224.16	
7	Stainless Steel Aggregates	0.83	7.48	
8	Glass Aggregates		4.33	
9	Footwear Aggregates	-	-	
10	Plastic Aggregates	0.25	-	
11	Tyre Aggregates	-	-	
12	Aluminium	1.28	-	
		87,035.12	3,72,447.99	27,165
				4,86,648

[2] based on the adherence to the SWM Rules 2016, CPCB Guidelines and NGT directions

04 At sector 145 the soil in Noida is extremely fine and the roads are not paved. This posed a huge challenge in terms of dust control. This is was because Noida comes under Delhi NCR region with huge focus on air quality management. Thus water cannons had to be installed for management of air quality.

05 The only form of rejects generated from the process were the domestic bio-medical waste (like syringes, thermometers, medicine bottles, test tubes etc.) and domestic hazardous waste (like tube light remains, battery cells, CRT etc.). Both these were channelized to authorized handlers based on the quantity collected at various intervals.

06 During COVID lockdown, protocol was followed by creating awareness, nutrition rich food, separate transportation and appropriate IEC ensured just 30 days shutdown during the period.

07 In addition, heavy fog during winter made it difficult to transfer waste from the dumpsite to the hopper due to poor visibility. Hence material was brought and stored near the hopper during noon for the plant to function throughout the day.

Land Recovery & Utilization

For Sector 54 dumpsite:

- 4 acres of land remediated with overall improvement in hygiene, environmental conditions and job creation.
- 15,500 MT RDF sent to Cement Industries, 10,300 MT Bio Earth sent to Horticulture Department for Plantation Activities, 1,350 MT of C&D waste recovered and sent for disposal in low lying areas.
- This restoration exercise was an example of conversion of Wasteland to Wetland.
- The project got awarded under the Smart City Mission Awards 2020.

For Sector 145 dumpsite:

- 10.69 of 19.93 acres (ongoing work) of land remediated with overall improvement in hygiene, environmental conditions and job creation.
- Reclamation of Site A has been completed and handed over by the contractor to the Authority.
- 129800 MT RDF Sent to Cement Industries.
- 255500 MT Soil used for levelling low lying and abandoned area.
- 73714 MT of C&D Waste recovered and sent for disposal in low lying areas.
- 925 MT of other recyclables recovered.

Takeaways

- Reclamation of complete site is possible with appropriate mechanisms for recovery of materials in line with market demand.
- Machineries can be placed on elevated ground to avoid flooding in work area during monsoon.
- Procurement model indicated can be used to achieve 100 % reclamation of land, with contractor being responsible for appropriate transport and disposal of recovered materials. Also establishing system which is modular and mobile.
- Systems like power backup and approach road have to be considered by ULB while planning operations. The machineries can be run in 2 or even 3 shifts if required.
- Water cannon and sprinkling at site can help manage dust suspension.
- Regular monitoring help identifying sites for landfill fires, and air flow were cut using Inerts over such pockets.
- Online portal installed by contractor provided better monitoring with online access to records and dashboard (showcasing progress).
- Financing was not a constraint and SBM funds supported the city in successfully executing remediation.
- Heavy fog during winter made is extremely difficult to transfer waste from the dumpsite to the hopper due to poor visibility-hence, material was brought and stored near the hopper during noon time so that the plant can run throughout the day.
- The project enabled the conversion of wasteland to wetland at site 1, as it was previously an oxidation pond of the city sewage treatment plant. Although restoration exercise is still in process to turn wetland into a basin to recharge water table, the efforts from the municipality brought significant improvement in health, hygiene and environmental conditions of the area. For the achieved results, the project was awarded under the Smart City Mission Awards 2020.

SURAT

Location	Khajod Open Dumpsite
Project Started	December 2016
Project completed	December 2017
Area covered by waste	151.2 acres
Production started	Not Available
Total contracted waste	25,00,000MT
Total project cost	Not Available
Cost per cum	Rs. 166 (for screening and shifting)
Execution model	Item Rate Based
Reclaimed area	60% recovered + 40% capped and reused
Value of recovered land	Not Available
Products utilized	100% with the ULB

The Story

One of the fastest growing cities, Surat is located in the western part of the country. The city has a growing population on account of intra and interstate migration and is spread across an area of 326 Km^2.

Surat has a population of around 44,67,797 people as per Census 2011 and generates around 2000 Metric Tonnes of municipal solid waste every day, of which 60% is organics.

The Khajod site, an open dumpsite was operational from 2002. In 2016, with the release of the SWM rules, Surat undertook remediation for the Khajod site, becoming one of the first 20 cities in the country to carry out dumpsite remediation.

Surat utilized its reclaimed area from the Khajod site for recreational activities, sports and a golf course.

Background

The Khajod dumpsite in Surat had been operational for over three decades and over 1000 MT of waste was deposited at the site per day. In 2016, after the SWM Rules were announced, Surat being one of the top 20 cities under the Swachh Bharat Mission, undertook the remediation project for the Khajod site. With 150 acres (612000 m^2) area, the site had around 25,00,000 MT of solid waste. The dumpsite also received other waste as a consequences of disasters, such as floods. The site also comprised of processing and disposal facilities with sanitary landfill cells along with a large open dumping area. The site is just 0.7kms away from the nearest surface water body and a kilometer away from the nearest habitation.

The Khajod site had been receiving waste since 2002 and the total volume of waste was 37,18,856 cum, spread over 6,11,741 sq mt.

The tender for the remediation project was awarded to an agency experienced in DPR preparation and execution under the Swachh Bharat Mission. Sixty percent of this was financed by the SBM.

The city of Surat has a centralised processing unit with a capacity to handle 1600 TPD at composting facility as well as RDF making facility. Other than this city has 300 TPD C&D waste procesing unit, 100 TPD plastic processing unit and 5 TPD e-waste processing facility and 50 TPD biogas unit.

Execution Method and Contractual Arrangement

For the Khajod dumpsite remediation project, a MoHUA panelled consultant was contracted. Preliminary analysis to undertake remediation was carried out first in 2015. Subsequently, a detailed project report for remediation work was prepared in December 2016.

Contour mapping was done to analyze the volume of waste to be remediated.

The contract was awarded on a per unit rate basis. The cost per unit of excavation, processing, and transportation to other pockets at the site was INR 166 per cum. Additionally, there was a separate unit rate for capping, gas collection, leachate collection, and geotextile liners.

The work under the contract included stabilisation and shifting of material and capping of the site area to be utilized for recreational activities. The contracted agency for the remediation project was required to have experience in both earth works and HDPE liners.

Of the 10 pockets of the Khajod dumpsite, six pockets were reclaimed for Diamond City residential space and the capped area is used for recreational activities and has facilities for mini golf, badminton, parks and other social activities.

The capped site has both a gas collection and leachate collection system.

Monitoring Mechanism

The city appointed an environmental monitoring agency to carry out regular testing (20 sample tests in a year), with a minimum frequency of once per month and the intermediate testing done as per requirement. The agency was responsible for monitoring air, water and soil at the site.

Additionally, the ULB appointed a project monitoring agency to quantify and evaluate the work and check progress and invoicing.

A Third-party government agency was also hired to assist and aid the city on technical matters. This was an academic institute responsible for regular site visits (4-5 times a month) with Surat Municipal Corporation (SMC) officials. Their role was to guide SMC and its contractor on the ongoing remediation and reclamation work.

SMC also conducted a fortnightly meeting involving all stakeholders to resolve any conflict and to update on relevant matters.

There is regular environmental monitoring at the Khajod site. Since 2017, no instance of landfill fire has been reported.

Remediation Technique

- The remediation technique used for the Khajod dumpsite included screening of materials and moving them to designated pockets which were to be capped.
- The concept was to have a gabion wall around the capped area, which retained the recovered materials. The items on unit rates were waste screening and shifting, HDPE liners, Gabion wall, Grass for top cover, leachate well and gas collection network.
- The total site area was divided into 10 pockets. Remediation using effective microorganism solution, soft turning was done to stabilize materials in pockets 1-6. After stabilization, materials were screened (using a 60mm trommel) and shifted to pockets 7-10 which were planned to be capped.
- The entire process took 1 – 1.25 years to complete. During this time soil underneath the excavated area was tested regularly and the recovered fine earth and inerts were used for capping the four pockets of the site.
- Fresh waste generated during this time was sent to a processing plant and the rejects were sent to a sanitary landfill parcel within the Khajod site. The SLF on site will be functional for around four more years.

Challenges

01 The absence of cement industries around the dumpsite. The nearest cement plant was approximately 650 kms away. Transporting the RDF generated was not a viable option. A large quantity of RDF was baled and stored. Local industries with boilers were unable to utilise the recovered RDF.

02 Bio Earth (solid enricher) constituted 10-20% of the recovered material.

03 On account of Surat's extensive textile industry, the trommels of the unit were clogged with threads and increased the need and cost of maintenance.

04 The site had high tension electricity wires over it. To navigate through this, the dumpsite was divided into two pockets to ensure the height of the waste dump was as per the norms

of the state DISCOM and safe from the wires. A path of 26m width was cleared for this purpose.

05 There was some resistance against the reclamation work, from local city residents. Due to this, the site work was delayed by 3 months and resumed only after NGT's directives for the work.

06 No material was sent out of the site after remediation. The lack of energy and economic linkages made it difficult to transport combustible faction to cement plants.

Land Recovery & Utilization

- The remediated area is 612000 m^2.
- Capped area was used to make a golf course and is being utilized for recreational activities and sports.

Takeaways

- Lack of linkages with allied industries significantly impacts the re-purposing of recovered material. In this case, many combustibles had to be baled and stored on site as there were no linkages.
- A gabion wall around the capped area ensures no sliding post capping.
- Stabilization and compaction (using sheep foot rollers), to achieve desired levels, as per the contour. Soil was used along with sheep foot rollers to achieve the levels.
- The impact of prevalent industries of the city on the remediation process – owing to the extensive textile industry in Surat, the trommels would get clogged with rags. Shredders were installed. However, sometimes when the material recovered was primarily textiles, it was disposed without screening.
- Since this was new work, an agency for technical assistance was on board, along with a project monitoring agency.
- The work was awarded on a unit rate basis and was a joint venture.
- The MSWM manual 2016 of MoHUA and CPHEEO manual was used to lay the drainage and gas collection layer at the capped site.

TIRUCHIRAPPALLI

Location	Tiruchirappalli (Dumpsite: Ariyamanglam)
Project Started	April 2019
Project completed	Ongoing
Area covered by waste	39 acres (Total dumpsite 47.5 acres)
Production started	August 2019
Total contracted waste	760,000 cum (500,000 metric tonnes).
Total project cost	INR 52 Cr -Phase 1
Cost per tonne	684 INR
Execution model	Based on volume of waste processed. Contractor liable for 100% land recovery and appropriate disposal.

Reclaimed area	39 acres (26 acres recovered till date). Phase II (under tendering stage) with remaining 8 acres of land.
Value of recovered land	Not Available
Products utilized	Recyclables were sold, combustible fractions sent to cement kilns and stones used to fill low-lying areas, and solids used for afforestation.

The Story

Tiruchirappalli (or Trichy) Corporation has 65 wards with a total area of 167.23 sq. kms. City generates around 435 MT of MSW every day. Around 60% of it is biodegradable waste such as food waste and vegetable waste, with the rest being non-biodegradable waste like plastic and packaging.

The dumpsite in Trichy named Ariyamanglam (47.5 acres) was started in year 1967. The site was surrounded by residential and industrial areas and also experienced fires due to landfill gas emissions.

In year 2019 Trichy Corporation decided to take up remediation of first phase 39 acres and contract was awarded based on volumetric basis. A third-party consultant was also hired for conducting monthly surveys and verifying bills of contractor. The work has led to recovery of 26 acres till now. Second phase of remediation with 3.34 lakh cum will cater to remaining 8 acres of land (under tendering stage).

Background

The Ariyamanglam dumpsite in Trichy was started in the year 1967. Around 7,60,000 cum (500,000 metric tonnes) of waste were expected to be on the dumpsite as legacy waste (average height 6.1 meters) spread across an area of 47.5 acres. The waste dumped in 84% of the area varied from 5 to 11 m height

The site experienced fires due to landfill gases and posed challenge to nearby residential and industrial areas. Tiruchirappalli Corporation decided to bio-mine and clear the entire waste and to recover the total land of the dumpsite. A consultant was appointed by Tiruchirappalli Corporation for the preparation of the detailed project report. The entire dumpsite was surveyed and topographical survey report was prepared. The remediation work was bifurcated in 2 phases. First phase with 39 acres land area (with average height 6.1 meters) and second phase with around 8 acres of land area. The site had an adverse impact on the socioeconomics and health of the city population residing nearby.

The remediation work at Trichy dumpsite for first phase was awarded to a private contractor in April 2019, to be completed by March 2022. The total cost for remediation work for phase 1 was estimated to be INR 52 Cr. Phase II with 3.34 lakh cum will cater to the remaining 8 acres of land.

Execution Method and Contractual Agreement

Work awarded on volumetric basis to process 7.6 lakh cum of waste in two years-(phase I). The contractor was responsible for processing, transporting, and appropriately disposing of recovered materials. The project contractor/ operator was responsible for obtaining all statutory clearances, permission, licenses, and authorizations necessary for the Project at their Cost. The contractor was required to have technology flexible enough to augment the capacity and accommodate environment-friendly changes to be imposed by governing authority

The contractor/operator is required to process not less than 1500 cubic meters per day for 8 hours x 2 shifts per day and segregate the recyclable material and the enriched soil, debris like stone, and shredding the remaining matter mixed with plastic, etc.

The capacity of units installed by the contractor is around 1000-1500 TPD of legacy waste processing, which employs around 120 people for the task. The final material cannot be kept for more than one month within the premises.

Environmental monitoring was done using SWM Rules and CPCB guidelines. The contractor had installed an ERP system for online monitoring along with CCTV surveillance.

Monitoring Mechanism

Contour survey of the site is done every month (using total station) by appointed third party on basis of which payments are processed. A well-equipped laboratory for monitoring and analysis of environmental parameters for air quality, meteorology, water, wastewater, noise, groundwater, etc based on the overall monitoring requirements was set up by the contractor at the site.

The contractor has been monitoring various environmental paraments through its well-established site laboratory complying with the environmental standards by CPCB/NGT requirements.

Contractor also has an online SCADA-based platform that allows real-time monitoring and data recordings for its users. A third party (educational institute) was hired to monitor the performance of work by the contractor and submission of the monthly report, verifying the work done. The cost of the third party for 2 years was INR 20 lakhs. The monitoring agency used to take levels along with the contractor for avoiding any discrepancy.

Remediation Technique

The remediation methodology adopted at Trichy followed three steps:

Pre-assessment and stabilization:

Primary assessment of the site was carried out using a drone-based contour survey where a 3D map was obtained. Baseline assessments for testing various parameters of groundwater, surface water, soil, leachate, and air quality were conducted to assess the damages and utilization of land as well as treatment (for strategizing a remediation plan) undertaken.

Processing and segregation:

The machines for screening were decided based on waste characterization study, the weight and size of the material to be screened as well as output capacity requirements. The machines included blade drum trommels with anti-clogging devices, combustible separators, air density separators, suction devices, disc screen separators, refinement trommels, over band magnetic separators, hopper, blowers, and belt conveyors of various widths and lengths. The equipment and material flow is regularly monitored and modified based on waste characteristics and output requirements.

Figure 15: Areal view of dumpsite before and during remediation at Trichy

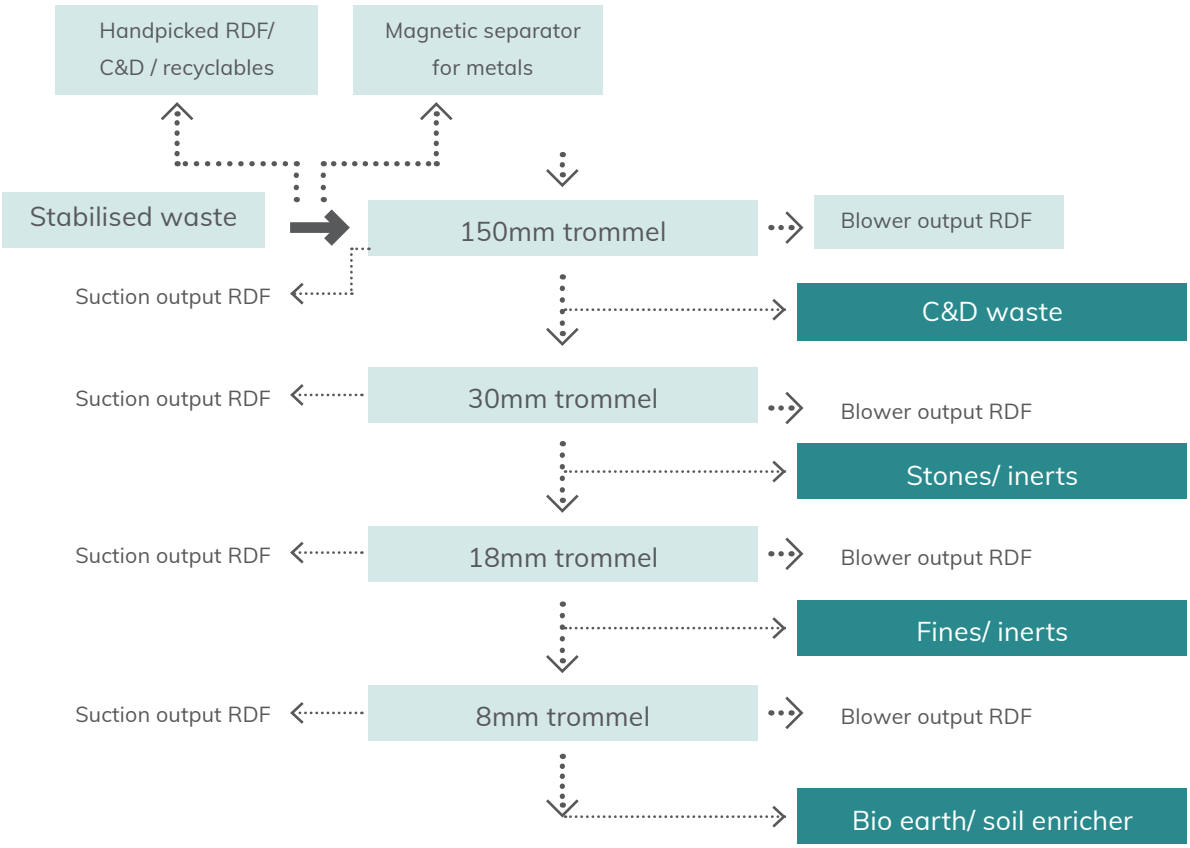


Figure 16: Methodology for Remediation process at Trichy

Responsible disposal of recovered materials:

The outputs from the remediation site from January 2020 to March 2022 was about 494978 MT and included combustible fractions (83,010 MT), soils (2,64,032 MT) , stones (1,46,974 MT) , and other recyclables (963 MT). The recyclables were sold to recyclers, combustible fractions were sent out to cement kilns for energy recovery, stones were used for filling low-lying areas and enriched earth was used for afforestation in horticulture. It was ensured that all the aggregates that are generated are channelized either for recycling, upcycling, or re-purposing and all this is based on the adherence to the SWM Rules 2016, CPCB guidelines and NGT requirements

Challenges

01 The dumpsite was in proximity to the residential area and industries adjoining the site which led to operational challenges. This was overcome with targeted IEC for neighboring residents.

02 The high groundwater levels posed a challenge for stabilisation and moisture control in the waste. As a result, the time required for stabilization was given as 70-90 days (instead of min 27 days). Which leads to the accumulation of large quantities of waste at the site. As an outcome, the number of excavators was doubled to take care of turning of this material.

03 Currently Trichy site has a processing capacity of 60,000 tonnes per month with 2 plants. This was only possible due to the large area of the site. Heavy rains also add to the issues at the site.

04 Delay in providing a power connection led to delays in starting the execution work.

05 The payment was made based on the cubic meter which according to the contractor made it extremely difficult for the contractor to ascertain the density of the waste.

06 The volumetric basis of the contract created challenges that led to regular discussions among all parties to avoid any conflict. The payment linking with a volumetric basis prevented the contractor from of starting remediation at all portions of the site.

07 With the formation of windrows (for stabilization), waste was spread, and volumes were increased on the top layer. On conducting the contour mapping this did not show any progress of work, as materials were agitated and bulked by the contractor, thus creating pressure for the contractor to speed up the works (which is mostly biological stabilization and not in hands of the contractor) as payments were linked with volume of waste processed.

08 Safety concerns were a challenge due to high fire-prone area during extreme summers due to heat and sun radiations on combustible materials. This was managed with increased vigilance using manpower who did regular rounds to identify potential fire hazards before they spread widely. The fires if found were suppressed with excavators and inert materials. Infrared cameras attached to phone devices are also being used.

Land Recovery & Utilization

- 26 acres of land (out of 39 acres) have been cleared till now. Remediation work is still in progress. Reclaimed land is proposed to be used for creating an Urban Forest for not less than 7 Years, thereafter land may be utilized for Revenue generation aspects such as commercial complex, integrated market etc.

- The recyclables were sold to recyclers, combustible fractions were sent out to cement kilns for energy recovery and stones were used for filling low-lying areas, and enriched earth were used for afforestation in horticulture.

Takeaways

- Volumetric basis contract, along with third party monitoring provided confidence to ULB to execute remediation work. This also led contractor to speed up the stabilization and processing at site.

- Moisture content was a barrier as stabilization time had to be increased to three times. Contractor started by making windrows all over so the processing work can be executed smoothly.

- All materials were appropriately linked, and this was possible due to appropriate segregation and marketing of recovered products. 100% of land is getting remediated.

- IEC proved to be beneficial in making nearby residents understand the work and allowing contractor to work smoothly at site.

- Need to monitor the waste characterisation and flow of material through the equipment for maximum output.

TIRUPATI

Location	Tirupati (Dumpsite located at Ramapuram)
Project Started	April 2019
Project completed	March 2021
Area covered by waste	25.26 Acres
Production started	August 2019
Total contracted waste	2,15,520 MT
Total project cost	18.64 Cr INR
Cost per tonne	Rs.911
Execution model	PPP Model with 100% land reclamation on basis of weight processed
Reclaimed area	25 Acres
Value of recovered land	Not Available

Products utilized	100%- all recovered materials are to be disposed of appropriately by the contractor.

The Story

Tirupati is a city in the Indian state of Andhra Pradesh, home to the important Hindu shrine of Tirumala Venkateswara Temple and other historic temples and is referred to as the “Spiritual Capital of Andhra Pradesh”.

The Tirupati Municipal Corporation (TMC) spread is around 27.44Sq Kms and includes 50 Wards. According to the 2011 census, the City’s population is around 2,87,482. This is now estimated to be around 4,24,286 in 2022. The city has 50 election wards sub-divided into 372 micro pockets for better management, each having 300-350 households.

Tirupati is known as the spiritual center of Andhra Pradesh with about daily 75,000 pilgrims visiting Tirumala for the darshan of Lord Venkateshwara. It was named the “Best Heritage City” for the year 2012-13 by the Ministry of Tourism.

Presently every day more than 229 metric tonnes of solid waste are generated in the city. This comprises of 120 MT wet waste, 52 MT of dry waste, 1 MT of domestic hazardous waste, 31 MT of residual and inert waste, and 25 MT of C&D waste.

After the segregation of garbage, civic body authorities were transferring the garbage from secondary collection points to the Ramapuram dumping yard located 25 km from the city. This created agitation in the people of Ramapuram and surrounding villagers who have been opposing the garbage dumping near the village. Therefore, the city started construction of a solid waste management plant near Thukivakam village with Smart City funds and remediation work at Ramapuram was initiated.

Background

The dumpsite was located at Ramapuram reached heights in range of 1.39mts – 1.93mts. Dump was scattered randomly on the valley and on the sides of the road (1.15 Km stretch). The dump yard was divided into three zones. Zone 1 was on the right side of the road; a low-lying valley filled with solid waste. Zones 2 & Zone 3 were located on the left side of the road while entering the dump yard.

During rain the leachate started impacting the settlements around it following which there was an agitation by villagers.

Contract was awarded for reclaiming 25 acres of land with 2.04 lakh metric tonnes (272550 cum) of waste through PPP arrangement on basis of weight of materials processed.

The remediation started in April 2019 and was completed in March 2021.

Execution Method and Contractual Agreement

- A pilot remediation was carried out at the dumpsite by Waste Management Solutions in the year 2017-2018 to remediate about 50,000 MT of legacy waste.

- Tirupati Smart City Corporation Limited (TSCCL) and Tirupati Municipal Corporation invited tenders for “Solid Waste Management Project – Remediation of Existing MSW Dumpsite at Ramapuram through Bio-Mining Process under implementation of the Smart City Mission in Tirupati”. A private party was awarded the project for remediation of about 200,000 MT waste in a span of 36 months on basis of “DESIGN-BUILD- OPERATE” (DBO) system.

- The project would involve design, erection, operation and maintenance of the Bio-mining plant with an ultimate aim to reclaim the existing land in a scientific manner.

- As per the physical characterization of waste, around 37.6% of the waste was compostable in nature (can be decomposed into soil on application of specific inoculants). About 17% of the waste was combustible in nature (can be recovered and utilized in the Waste to Energy Plant). Rest 43% of the waste was inert in nature and could be disposed at low-lying areas.

- The work envisaged an economically viable and environmentally sustainable method in 25.26 acres, TSCCL intended to reclaim at-least 90% of the total dumpsite area. Though, contractor was able to reclaim 100% land.

- Contractor was responsible to do complete remediation and linkage of materials for appropriate disposal. The contractor was also responsible to conduct appropriate IEC for nearby residents and city citizens, for ensuring free flow of information.

Monitoring Mechanism

- Regular monitoring of the site with CCTV cameras was in place along with SCADA system for online monitoring, which was regularly updated and provided access (reports) to clients (internal to company and external agencies). This was available along with online weigh slip generation mechanism. Records could even be assessed later at any point in time.

- The contractor had to monitor groundwater quality, surface water quality, work zone air quality, ambient air quality, and soil within the site as well as in surrounding villages from authorized laboratories/ agencies and submit the report on monthly basis. This was part of the environmental monitoring plan(EMP)developed for remediation work.

- Monthly Health check-ups for the Plant workers were done.

- Green Belt have been developed which are protecting the Fauna & Flora of the Area.

- Environmental management cell was also set up to implement EMP and ensure compliance with applicable rules and regulations, looking after regular operation and maintenance of pollution control devices. This cell also reviewed and interpreted monitored results and suggested corrective measures while maintaining a logbook of public complaints and the action taken.

Remediation Technique

The remediation methodology adopted at Tirupati followed three steps:

Pre-assessment and stabilization:

In this step, historical and indiscriminately dumped waste was stabilized by converting it into windrows and spraying it with de odourizer and bio culture (made moisture free, odour free and pathogens free). This was done for atleast 25 days. This made it ready for the next process of segregation.

Processing and segregation:

Based on the waste characterization study, and the weight and size of the material the machines were decided for screening based on the weight and size of the material (4 sets of trommels). The ultimate purpose was to ensure that the required capacity per tonne was always achieved based on the choice of machines. Input mixed historical waste was fed into SUPEX Trommel Screens which very efficiently classified the material into combustible and non-combustible fractions (inerts). The non-combustible fraction were then passed through a transfer conveyor in turn transferring it again to soil and other separator, segregating stones from the soil. The soil thus obtained could be further screened to obtain finer organic matter fraction (< 4mm) which is called Bio-earth. The combustible fraction is passed through combustible separator which tries to segregate any non-combustible fraction that would still be present.. The further segregated

non-combustible fraction is then passed on to a transfer conveyor which is fitted with their patented finger screen which automatically handpicks the combustible fraction which was left out of the non-combustible fraction. All the SCF is further transferred to the RDF Processing facility for converting to RDF. The RDF was then supplied to ACC Limited – Chandrapur (562 km from plant), Zuari Cement – Yerraguntla (185 km from Plant), Bharathi Cements – Kadapa (175 km from the plant). For the overall processing the machines included were blade drum trommels with anti-clogging devices, combustible separators, air density separators, suction devices, disc screen separators, refinement trommels, over band magnetic separators, hopper, blowers, and belt conveyors of various width and lengths. Automatic inline baling system was also provided for fast operations.

Responsible disposal of recovered materials:

The outputs from remediation were majorly combustible fraction, soil, and stones. All the aggregates generated were channelized either for recycling or upcycling. This was all based on the adherence to the SWM Rules 2016, CPCB guidelines and NGT requirements.

Figure 17: Ariel view of dumpsite at Tirupati before and after remediation

Challenges

01 The site was in a valley and hence during monsoons, the water from the hills used to gush down to the plant.

02 The site was remotely located and hence manpower availability was a challenge.

03 Lack of infrastructure at the remote location made it extremely difficult to get a power connection.

04 Local agitation was there initially. IEC activities were conducted which made people understand the benefits of the project and created support.

05 The trommels choked very frequently due to the materials. Therefore, all trommels were provided with anticlogging & disc screen separators.

Land Recovery & Utilization

- Remediation and Biomining project remediated 25 acres of existing dumping yard and reclaimed it for use by TMC.
- Four basic categories of aggregates that were generated and disposed of properly by the contractor were:

    1. **Coarse Soil and Stones (Inert)- (28,958 MT)** Was used for road construction, road embankments, filling up low-lying areas predominantly besides highways and houses, with proper MoUs with the landowners.
    2. **Fine Soil- (1,60,384 MT)** Was used for afforestation, the top layer of reclaimed land, and nurseries ensuring it will be used only for farming nonfood crops.
    3. **Segregated Combustible Fractions- (25,951 MT)** Was converted into Refuse Derived Fuel using a series of machines and supplied to the cement plants to be co-processed in their cement kilns as an alternate fuel.
    4. **Recyclables- (227.57 MT)** Mostly included metal scraps, stainless steel scraps, recyclable plastics, tires, and glass. All these were channelized through traders or direct recyclers for recycling applications.

- TMC along with the contractor identified old and abandoned stone quarries near the site for filling up with recovered C&D waste and inerts. This helped them reclaim around 10 acres of land that was left unutilised. The plantation is carried out over this area thus increasing green cover.
- The land property value of the nearby area has increased drastically, converting many non-agriculture land pockets into plots.
- City is now converting the recovered land into green space.

Takeaways

- Contract was awarded for reclaiming 25 acres of land with 2.04 lakh metric tonnes (272550 cum) of waste through PPP arrangement on basis of the weight of materials processed. This was done after conducting a pilot for 50000 MT.

- Recovered materials were appropriately linked through contractor to reclaim 100% of the land under legacy waste. Even other abandoned mines were refilled and 10 acres of land has been reclaimed at such sites.

- Isolated location of the site and public agitation were the challenges, which were overcome by spreading awareness among citizens and hiring people from nearby areas. Indicating key role of IEC.

- A performance bank guarantee of 5% value was required by the ULB from the contractor for releasing funds.

- Regular environmental monitoring was conducted at a frequency of once every month. Online monitoring was done using SCADA system and CCTV cameras, which proved to be successful.

VADODARA

Location	Atladara dumping ground, Mujmahuda, Vadodara	346, Makarpura, Vadodara
Project Started	October 2017	July 2021
Project completed	February 2021	Feb 2023 – In progress 200000MT legacy waste processed, till date
Area covered by waste	19 acres	12 acres
Production started	16th July 2018	10th February 2021
Total contracted waste	3,75,000MT	4,00,000MT
Total project cost	INR 33.26 Crores	INR 33.68 Crores
Cost per ton	887	842
Execution model	PPP Model	PPP Model

Reclaimed area	17 acres + 2 acres compost unit	2 acres, till date
Value of recovered land	INR 125 Crores (Approximately)	Not Available
Products utilized	All recovered material to be disposed appropriately by the contractor	

The Story

The Story presents details of remediation work in Vadodara (Baroda), the second largest city in the state of Gujarat spread across an area of 220 sq. km. and located on Banks of Vishwamitri river. The city houses over 22 lakh citizens according to estimations (census 2011 population: 16,70,806)

The city is divided in 18 administrative wards and the total waste generation is approximately 1050 TPD (Gujarat Pollution Control Board, 2020-2021).

Two legacy waste dumpsites Atladara (19 acres) and Makarpura (12 acres) were 100% remediated, as these posed challenges for environment and health of city residents.

The ULB demonstrated that a project of this magnitude can be executed flawlessly with focused emphasis on Testing, Traceability, Technology and Transparency of excavated materials.

The reclaimed land at Atladara is being used for setting up of Construction and Demolition waste management facility and Plastic Waste Processing facility. Afforestation is being carried out in remaining parts of the reclaimed land. The Makarpura site, after remediation will be used to set up a sanitary landfill to dispose rejects from processing facilities

Background

The imminent impacts of the accumulated legacy waste on the environment, and the health of citizens residing in nearby areas pushed the officials at VMC to take steps to efficiently manage the dumpsite. Atladara site's proximity to Vishwamitra river was also a grave cause of environmental concern, leading to leachate access to river water, resulting into its pollution.

Based on these factors, In 2017, the city planned to cap the Atladara site. The idea of remediation for the Atladara site came from a webinars organised by the Ministry of Housing and Urban Affairs (MoHUA) which introduced this concept to the city administration.

Furthermore, the SWM Rules of 2016, NGT directions, SPCB pressure and the SBM support were among the key drivers for the city to take-up the remediation project.

City was unclear of the strategy and had called for expression of interest. MoHUA empanelled consultant was hired for evaluation of tenders and strategy to clear complete site was adopted.

The complete mobilization of plant, manpower, earthmovers, and responsible disposal of aggregates and other excavated waste streams were carried out by the contractor with proper parameters provided and third- party inspection from the side of VMC. Testing (for toxic limit) at Atladara were conducted every fortnight to check quality of recovered inerts and soil enricher for disposal.

Execution Method and Contractual Arrangement

The contract was awarded to a private party based on a well-designed Terms of Reference by the ULB. The TOR included third-party monitoring, with an emphasis on 'Testing, Traceability, Technology, and Transparency'. The contractor was responsible for 100% reclamation of land and disposal of all recovered material appropriately.

For regular monitoring of the site, CCTV cameras were installed. The contractor also established a Supervisory Control and Data Acquisition (SCADA) system which was regularly updated and provided access to clients (internal to company and external agencies)

Monitoring and Mechanism

- Regular monitoring of the site with CCTV cameras was put in place. The contractor also had established an ERP system which was regularly updated and provided access to clients (internal to company and external agencies). This helped to monitor quantities of waste reclaimed and make related payment computations.

- The contractor had to monitor ground water quality, work zone air quality and ambient air quality monitoring within the site from authorized laboratories/ agencies and submit the report on monthly basis.

- The project demonstrated importance of well-structured Terms of reference and third party monitoring, with an emphasis on 'Testing, Traceability, Technology, and Transparency.

Remediation Technique

Phases of Execution

The Atladara Dumpsite was divided in 4 zones for the process of remediation. The zoning of dumpsite was beneficial for planning the movement of vehicles and machinery, as well as creating space for processing of excavated matter. Zone 3 occupied the largest piece of land, around 6.5 Acres, followed by zone 4 occupying 5.5 acres.

Pre-assessment and Stabilization

The dumpsite was assessed, and baseline study was conducted for its topography, height, waste density using a drone-based contour survey (3D map), ground water, surface water, soil, leachate, air quality etc.

Methodology included stabilization, leachate management and channelization for collection, Fire management and Rag pickers management.

A waste characterization study was conducted parallelly based on numerous samples collected at various locations of the dumpsite.

Processing and Segregation

Based on the waste characterization study, and the weight and size of material, the machines were finalized for screening. The ultimate purpose was to ensure that the required capacity of equipment in terms of total daily loading estimates was always achieved. The machines included blade drum trommels with anti-clogging devices, combustible separators, air density separators, suction devices, disc screen separators. Refinement trommels, over band magnetic separators, hopper, blowers and belt conveyors of various width and lengths were also used. The configuration and type of machinery used depended on the waste characterization and was regularly updated based on the characteristics of waste.

The quality of aggregates generated, determines its viability for further recycling, upcycling, or repurposing and needs to be of good quality for appropriate linkages.

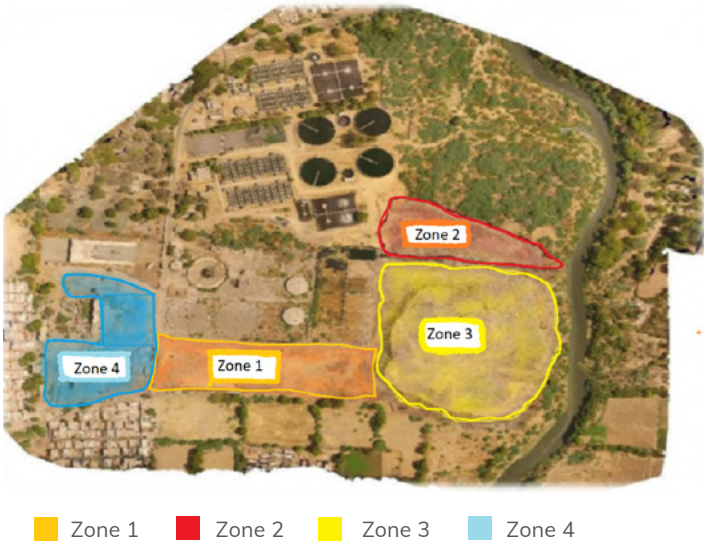
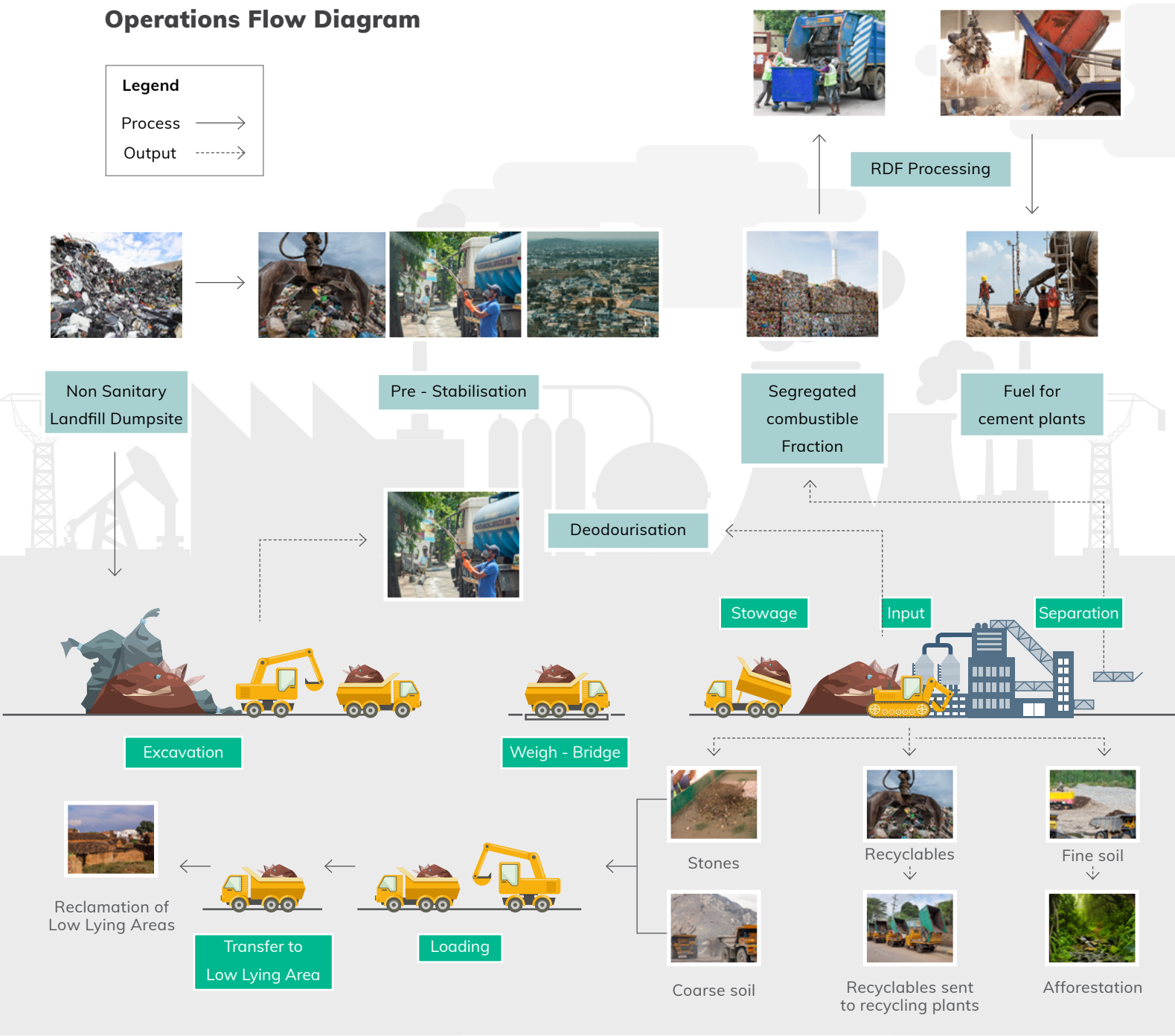


Figure 18: Zoning of Atladara Dumpsite for execution

Operations Flow Diagram



Appropriate Disposal of aggregates

It was ensured that all the aggregates that are generated were channelized either for recycling, upcycling, or re-purposing and all this based on the adherence to the SWM Rules 2016, CPCB and NGT Guidelines.

Details of recovered materials

Atladara site 01.07.2018 to 28.02.2021
Quantity (in MT)

324057.27	**44.94**
Inerts	Wood
80163.35	**32.59**
RDF	Iron Scrap
1.03	**3.98**
Plastic	S. Steel
35.08	**0.67**
Tyre	Aluminium
-	**-**
OBMS	Glass

4,04,338.90
Total

Makarpura Disposal Details from
01.02.2021 to 27.05.2022 Quantity (in MT)

1,57,245.56	**146.28**
Inerts	Wood
38,328.88	**-**
RDF	Iron Scrap
11.88	**3.78**
Plastic	S. Steel
32.77	**0.05**
Tyre	Aluminium
22.86	**5.38**
OBMS	Glass

1,95,797.44
Total

Challenges

01 The Atladara remediation plant was setup on the banks of River Vishwamitri, it was prone to risk of flooding during monsoons. So, the legacy waste remediation plant was setup by raising the ground level by 2 meters to avoid flooding of plant area during monsoons.

02 The Makarpura site was below HT power lines. Directions provided by SPCB and local DISCOM were followed and height of waste below the HT line was kept low as a safety factor.

03 The Atladara dumpsite had a huge influx of fresh waste at the time of bio-mining making it difficult for separate waste handling. No separate place was available for pre-stabilisation due to influx of fresh waste. The landfill phase 1, 2 and processing had same entry gate. Hence a separate access road was formed by contractor to separate fresh waste dumping vehicles and bio-mining vehicles.

04 Odour management was a huge challenge as there was huge influx of fresh waste at the same time.

05 Acquiring an electric connection to start the remediation project was a challenge.

06 Disposal of RDF due to non-proximity of industries that utilise RDF was also a challenging factor.

Land Recovery & Utilization

- With clearing of the Atladara dumpsite, about 37,316 Metric Tons of Refuse Derived Fuel (RDF) generated from the process was used to replace coal in cement kilns thus saving 15,672 metric tons of carbon dioxide emissions[3]. The reclaimed land is being used for setting up of Construction and Demolition waste management facility and Plastic Waste Processing facility. Afforestation has been carried out on parts of the reclaimed land.

- The Makarpura site is reclaimed to make way for a Sanitary landfill which will be utilized to dump inerts generated from the fresh waste processing facility.

Figure 19: Aerial view of Atladara Dumpsite before remediation

Figure 20: Aerial view of Atladara Dumpsite after remediation

[3]According to studies carried out by VMC in 2020

Takeaways

- Complete remediation of dumpsite is possible with appropriate linkage of recovered recyclable materials.

- Estimates of waste quantity was 3-3.5 lakh tonnes. Later this figure was 4.31 lakh tonnes, as per actuals. The impact of waste density on quantification must be factored in.

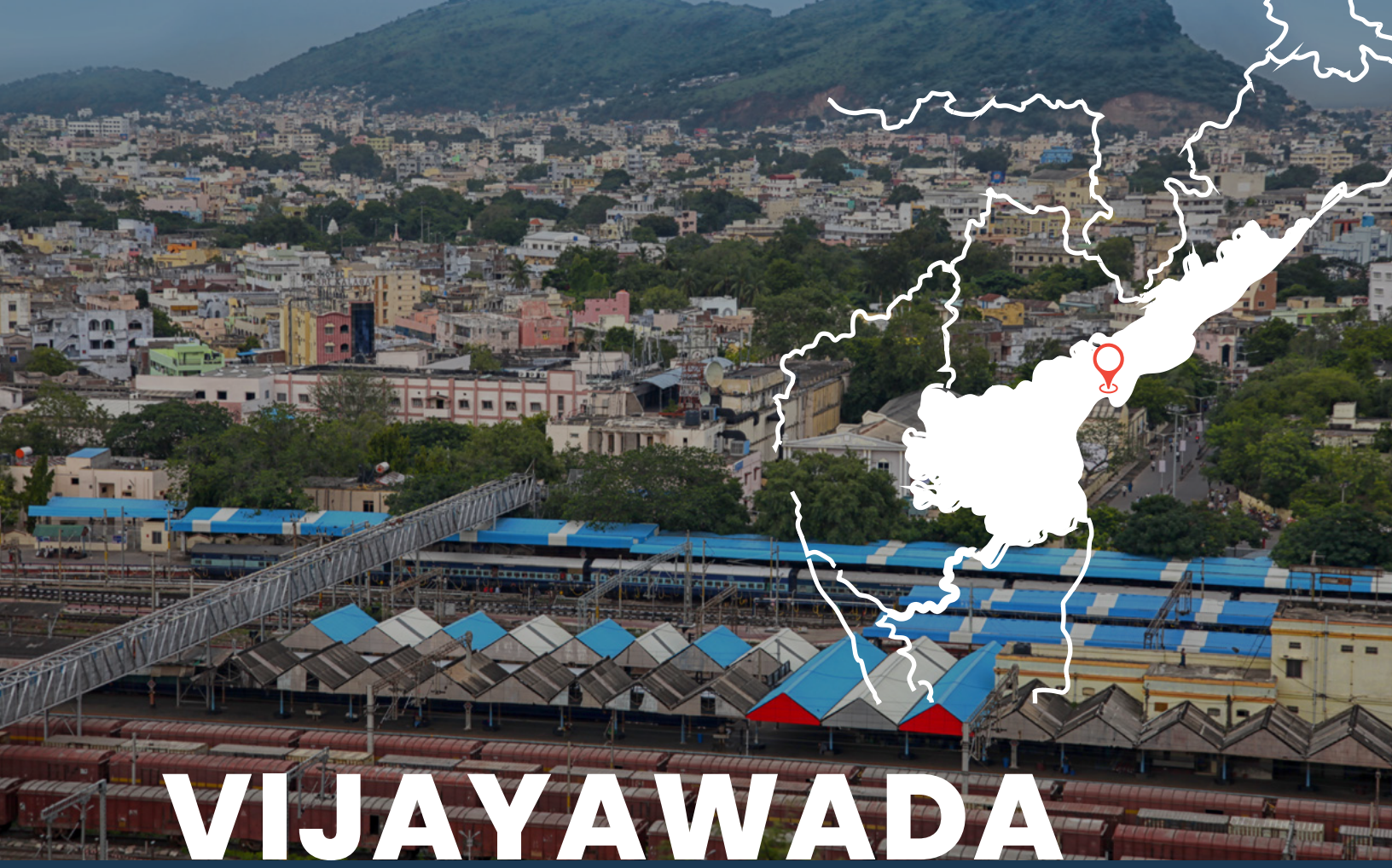
- Regular meeting of committee involving various stakeholders can facilitate understanding of work and lead to smooth and timebound execution. (Periodic discussions with different departments enabled the provision of electric connection to start the project).

- In case of unavailability of high mobilization advances, it is advised to secure a bank guarantee from the contractor.

- The quality of aggregates is critical for its use in recycling, upcycling or re-purposing.

- Biomedical waste can be linked through cities to BMW management units.

- RDF can be used as fuel by cement units, contractors need to oversee transportation and quality control.



VIJAYAWADA

Location	Vijayawada (Ajith Singh Nagar dump site)
Project Started	September 2017
Project completed	July 2020
Area covered by waste	44.31 Acres
Production started	July 2018
Total contracted waste	3,05,898 Tonnes
Total project cost	25.75 Cr INR
Cost per tonne	INR 842
Execution model	PPP contractor was responsible to remediate and recover 100% land, with appropriate material linkages

Reclaimed area	44.31 acres
Value of recovered land	Not Available
Products utilized	Through contractor the combustible fractions were sent to cement industry, sand & stone were used for filling low lying areas. Rubber, glass and other recyclables recovered were sent for recycling.

The Story

Vijayawada is a city on the banks of the Krishna River, in the state of Andhra Pradesh. The city is one of the major trading and business centres of the state and hence, it is also known as “The Business Capital of Andhra Pradesh”.

As per 2011 census, the city had an urban population of 10,34,358 residing over an area of 61.88 sq. km. The city is divided into 64 electoral wards. The total waste generated is around 550 TPD, out of which, approximately 48.2% is wet waste and remaining as dry waste.

The city is processing 240 metric tons of wet waste and 229 metric tons of dry waste and the rest of the waste i.e., 81 metric tonnes is sent it to the landfill site for final disposal situated at Pathapadu (area 2.75 Acres at Pathapadu village which is 20 kms away from Vijayawada city). The dumpsite taken up for remediation is located at Ajith singh Nagar and has legacy waste of 30 years. This was posing environmental and health issues for the residents of city.

Background

The Ajith Singh Nagar dumpsite had a legacy waste spread across an area of 44.31 Acres and had 3,05,898 Tons of waste dumped (with average height of 2-3 mts).

In the past at the time of landfill fires, smoke exhausts got spread due to strong down-winds throughout residential areas. This caused respiratory sicknesses among the general public. Foul odour of the waste dumps along wind direction to the colonies was also a persisting nuisance. The dumpsite had started impacting the groundwater due to leachate generated from dumpsite. People got sick and started moving out of the place. This forced migration also raised the importance of remediation of the dumpsite.

The Vijayawada Municipal Corporation (VMC) entered into a “DESIGN-BUILD OPERATE” (DBO) contract with a Private Service Provider to implement the project “Remediation of Ajith Singh Nagar dump site through Bio- mining process in VMC”. The payments were linked on a weighment basis, whereby the weight of materials was recorded based on a digital weighment equipment. The contractor was paid a tipping fee based upon per metric tons of waste remediated by contractor. The treatment quantity was estimated to be 3,05,000 metric tons of waste. During the process, the combustible fractions were sent to the cement industry, and sand & stone were used for filling low-lying areas. Recovered Rubber, glass, and other recyclables were sent for recycling. This entire disposal was the responsibility of the contractor.

Procurement methodology and contract design

- The contract was awarded to be completed in a single phase at a rate contract of INR 842 per ton of waste processed (recorded based on a digital weight basis). Whereby contractor was responsible for complete remediation of 44.31 acres and appropriately dispose recovered materials.

- The project would involve the design, construction, operation, and maintenance of the bio-mining and reclamation of the existing solid waste dump site in the said process in a scientific manner.

- The contractor was responsible for setting up of daily sorting and segregation targets with flexible sorting systems; mechanism for handing over recovered hazardous, Biomedical and C&D waste; mechanism for stabilization and separation of city compost was also contractors responsibility, to reclaim ground to its natural ground level, transport and store inert and compost materials and dispose RDF appropriately.

- The contract terms were to clear the existing legacy waste in a scientific manner as per CPCB norms and handover the clear site to Vijayawada Municipal Corporation.

Figure 23: Aerial view of Ajith Singh Nagar Dumpsite before and after remediation

Remediation Technique

The remediation methodology adopted at Vijayawada followed three steps:

Pre-assessment and stabilization:

Under the first step primary assessment of the site was carried out using a drone-based contour survey, where a 3D map was obtained. A baseline assessment for testing various parameters of groundwater, surface water, soil, leachate, and air quality were conducted to assess the damage done due to dumping and utilization of land and its treatment. These samples were collected from various locations on the existing dumpsite.

These tests and primary assessment help in strategizing a remediation plan. Windrows were formed and stabilized using inoculum (microbial solution) for minimum 27 of days and thereafter they were checked for complete stabilization.

Processing and segregation:

Based on the waste characterization study, weight and size of the material, and output capacity requirements the machines configuration were decided for screening. The machines included were blade drum trommels with anti-clogging devices, combustible separators, air density separators, suction devices, disc screen separators, refinement trommels, over band magnetic separators, hopper, blowers, and belt conveyors of various widths and lengths. The flow sheet was regularly changed, based on waste characteristics and output requirements. The quality of aggregates played a paramount role in ensuring that they were of acceptable quality when used for recycling, upcycling, or re-purposing.

Responsible disposal of recovered materials:

It was ensured that all the aggregates that are generated are channelized either for recycling, upcycling, or re-purposing and all this was based on the adherence to the SWM Rules 2016, CPCB, and NGT Guidelines.

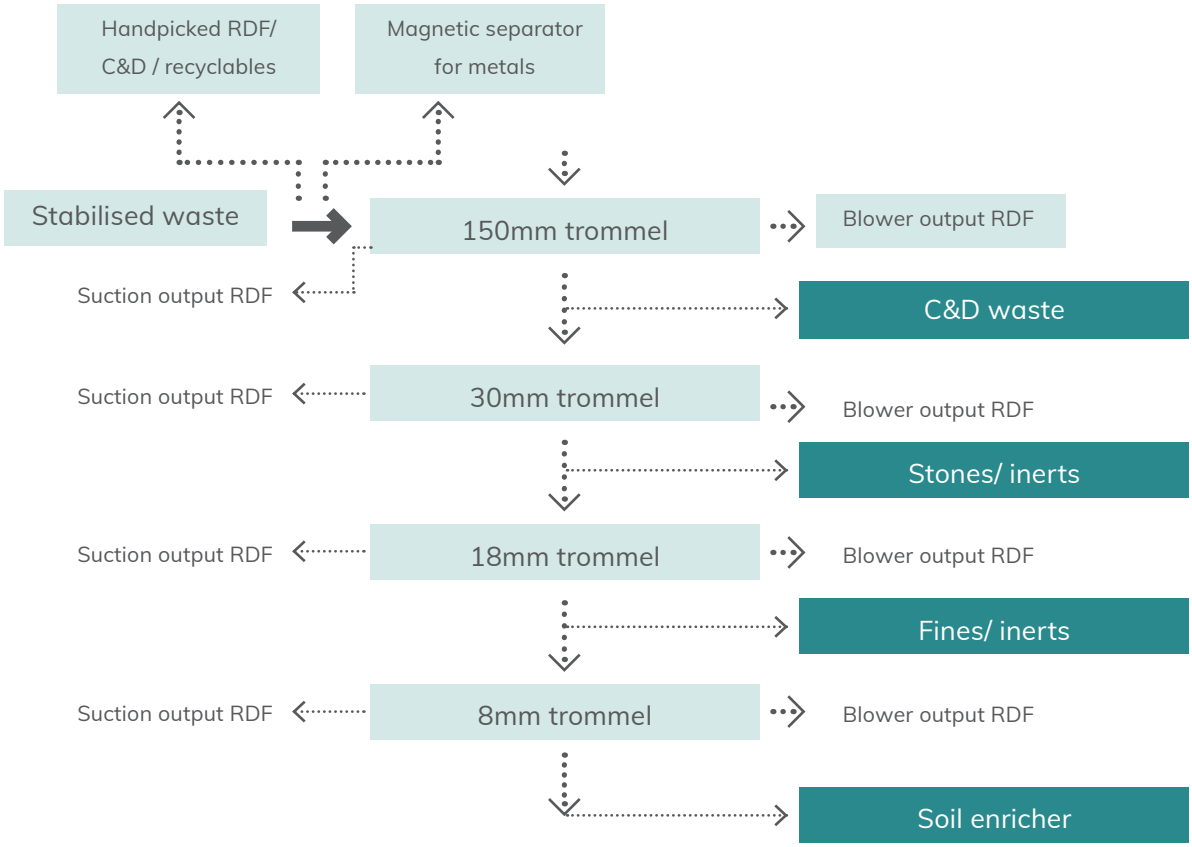


Figure 24: Process flow diagram of remediation work carried out at Vijayawada

Challenges

01 One of the challenges was regarding heavy rains that the area was receiving. The site was in a low-lying area and hence during monsoons, there was a huge stagnation of water, which had to be physically pumped out each time there were monsoons. The site encountered three cyclones during its term, during which-all emergency protocols were maintained to get the plant back on track.

02 The Second challenge was the availability of stabilized land for installing the machinery. With appropriate planning during the initial phase of the work, a stable piece of land was identified for working.

03 The third issue was that the site had proximity to habitation. As a result, strong IECs were planned in the area for making people aware of the work the contractar is taking up and the outcomes people will see. Some other remediation works, and outcomes were also shared with residents during the discussion.

Land Recovery & Utilization

- Metals, Plastics, Glass, Tires, Stones, Stainless steel, Soil, and combustibles were recovered from the remediation. Around 44 Acres of land was reclaimed, and the site was proposed for the construction of houses and parks.

- The reclaimed site had enabled the construction of 1500 apartments all under the Slum rehabilitation program. A part of the reclaimed site has been converted into a construction and demolition waste processing facility and another part into a children park.

- During the process, the combustible fractions (47212 MT) were sent to cement industry, sand & stone (69870 MT) were used for filling low lying areas. Rubber, glass, and other recyclables (276 MT) recovered were sent for recycling. Soil recovered (1,01,651 MT) was channelized and utilized for horticulture purposes to maintain green belt

Monitoring and Mechanism

- Environmental parameters were monitored at a frequency of once per month

- Soil and groundwater baseline was established to evaluate post biomining and remediation performance.

- All State pollution control board's norms are being observed. The site is being monitored through CCTV cameras and the dashboard (SCADA system) is updated from time to time. The quantity is also weighed using digital scales

Takeaways

- Complete remediation of site with appropriate linkages of recovered materials is possible, with appropriate stabilisation, sorting and screening mechanism.

- Planning is an important step, and issues like flooding, possible public agitation etc can be addressed through appropriate arrangements.

- Online monitoring system (SCADA system) with monthly bill arrangements on weight of waste processed proved smooth in execution of the work.

www.sbmurban.org