

TSJ/EMD/C-28/156/2024 28 June 2024

The Member Secretary Jharkhand State Pollution Control Board T.A. Division Building, HEC Campus, Dhurwa Ranchi- 834004

Sub.: Submission of Annual Report (Form-IV) of Township, Tata Steel Limited, Jamshedpur for year 2023-24 as per Solid Waste Management Rules, 2016

Dear Sir

This has reference to captioned subject. We are submitting herewith the Annual Report on Solid Waste Management of Township, Tata Steel Limited, Jamshedpur for year 2023-24 as per Solid Waste Management Rules, 2016 for your kind consideration.

You are requested to kindly acknowledge the same and place in your records.

Thanking you Yours faithfully,

For Tata Steel Limited

Kashyg uteau

Utsav Kashyap Head Environment Clearance & Compliance (TSL)

Encl.: As above

Copy to: The Regional Officer, Jharkhand State Pollution Control Board, Regional Office-cum-Laboratory MB/15, New Housing Colony, Adityapur, Jamshedpur

TATA STEEL LIMITED

Environment Management Jamshedpur 831 001 India Mob- 8092087043 (M) e-mail utsav.kashyap@tatasteel.com Registered Office Bombay House 24 Homi Mody Street Fort Mumbai 400 001 Tel 91 22 66658282 Fax 91 22 66657724 Corporate Identity Number L27100MH1907PLC000260 Website www.tatasteel.com

Form – IV [see rules 15 (za), 24 (2)]

Format for annual report on solid waste management to be submitted by the local body

CALENDER YEAR:	DATE OF SUBMISSION OF REPORT:
2023-24	30/06/2024

1	Name of the City/Town and State	Jamshedpur, Jharkhand
2	Population	782286
3	Area in sg. kilometers	64 Sq KM
4	Name & Address of local body Telephone No.: Fax No.: E-mail:	Tata Steel Utilities & Infrastructure Services Limited (Tata Steel UISL) Sakchi Boulevard Road, Northern Town, Bistupur, PIN-831001 m.shekhawat@tatasteel.com
5	Name of officer in-charge dealing with solid waste management (SOLID WASTE MANAGEMENT) Phone No.: Fax No.: E-mail:	MANOJ SINGH SHEKHAWAT 0657-6652331/7682826457 m.shekhawat@tatasteel.com
6	Number of households in city/town Number of non-residential premises in the city Number of election/administrative wards in the city/town	Details enclosed as annexure-1 Details enclosed as annexure-1 10 nos.
7	Quantity of Solid waste (solid waste)	
	Estimated Quantity of solid waste generated in the local body area per day in metric tones	272 MT
1	Quantity of solid waste collected per day	267 MT
	Per capita waste collected per day	269 gm
-	Quantity of solid waste processed	267 MTD
	Quantity of solid waste disposed at dumpsite/landfill	61 MTD
8	Status of Solid Waste Management service	

Segregation and storage of waste at source	
Whether SOLID WASTE is stored at source in	Yes
domestic/commercial/institutional bins,	
If yes , Percentage of households practice storage of waste	98%
atsource in domestic bins	
Percentage of non-residential premises practice storage of	98%
waste at source in commercial/institutionalbins	
Percentage of households dispose or throw solidwaste	
on the streets	2%
Percentage of non-residential premises dispose of throw	
solid waste on the streets	2%
Whether solid waste is stored at source in a	
segregated form, If yes	Yes
Percentage of premises segregating the waste at	
source	>95% (Wet & Dry)
	13
Door to Door Collection of solid waste	
Whether door to door collection (D2D) of solid waste is being done in the city/town	Yes
If yes	
Number of wards covered in D2D collection of waste	At all locations which is mentioned in Annexure-I
No. of households covered	Details enclosed as annexure I
No. of non-residential premises including commercial establishments, hotels, restaurants educational institutions/office etc covered	Details enclosed as annexure I
Percentage of residential and non-residential premises covered in door to door collection through:	100%
	75%
Motorized vehicle Containerized	25%
tricycle/handcart	
Other device	0%
If not, method of primary collection adopted	NA

	Sweeping of streets					
	Length of roads, streets, lanes, bye-lanes in the city	500 Km				
	that need to be cleaned					
	Frequency of street sweeping and percentage of	Frequency	Daily	Alternate	Twice	Occasionally
	population covered			days	a	
		% of	100%	NA	NA	NA
		population		<i>k</i> .		
	Tools used	Covered				
		1.1				
	Manual sweeping			70%		
	Mechanical sweeping			30%		
	Whether long handle broom used by sanitation		Yes			
	workers	and the second second				
	Whether each sanitation worker is given handcart/tricycle for collection of waste	ing an the	Yes			
	Whether handcart/tricycle is containerized		Yes			
	Whether the collection tool synchronizes with collection/waste storage containers utilized		Yes			
	Secondary Waste Storage facilities			de la composición de		
	No. and type of waste storage depots in the city/town	Door	to Do	or collect	ion in _l	oractice
	Open waste storage sites					
	Masonry bins					
	Cement concrete cylinder bins	$\overline{V}^{*} = \frac{1}{2} \overline{\sigma} \frac{v^{*}}{v}$				
-	Dhalao/covered rooms/space					
	Covered metal/plastic containers					
	Upto 1.1 m3 bins	i - n				
	2 to 5 m3 bins	a di Altonomia Altonomia				
	Above 5 m3 containers	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				
	Bin-less city	f stillen och	I	Bin-less c	ity	
	Bin/Population ratio		0	Bin-less (city)	
	Ward wise details of waste storage depots (attach):	Waste	e is tra	nsported	to plar	nt using
	Ward No:	co	mpact	or & Hoo	k load	ers.

	Area: Population: no. of bins placed Total volume of bins placed			
	Total storage capacity of waste storage facilities in cubic meters	c 0		
	Total waste actually stored at the waste storage depots daily		0	
	Give frequency of collection of waste from the depots	Frequency	No. of bins	
	Number of bins cleared			
		Daily	100%, using compactor	
-		Alternate day	NA	
		Twice a week	NA	
	그는 것이 아이지 않는 것이 같은 것이 같은 것이 같이 많이 있다.	Once a week	NA	
		Occasionally	NA	
	Whether storage depots have facility for storage of segregated waste in green, blue and black bins	No, Waste is transpo compactors. (if yes, a bins: No. of blue bins	rted to the plant using add details)No. of green 5: No. of black bins:	
		Auto tippers transfer compactor from trans	solid waste into fer station.	
	Whether lifting of solid waste from storage depots is manual or mechanical. Give percentage (%) of Manual Lifting of solid waste	0%		
	(%) of Mechanical lifting	100%, same day static compactors transported using Hook loader & Prime movers from transfer station.		
	If mechanical – specify the method used	 D2D garbage hat directly at transf installed at differ Secondary collect compactors, hot shall transport to 	ulage vehicles unload er stations which is rent zones of city. stion vehicle i.e., ok and prime movers (Set)	
	Whether solid waste is lifted from door to door and transported to treatment plant directly in asegregated form. Yes/No (if yes, specify)	Yes, Primary vehicle to door transported station and from the transported to proc facility and dry wast centers.	s after door to transfer ere waste is essing te collection	
	Waste transportation per day		267 MT	
	Type and Number of vehicles used	Transact	d 4 Trip par day	
94.0	Animal cart		0	
	Tractors		0	
	Non Tipping		0	

	Tata Ace	106 (For D2D + Garbage haulage)			
	Dumper Placer				
	Refuse collectors	7			
	Others(tricycle)	1			
		40			
	JCB/Loader				
	Transfer Station + Compactor	5			
	Hook Loader	5 + 14			
		3 (22 Trips)			
	Frequency of transportation of waste	Frequency (%) of waste trans	sported		
		Daily – 100%			
		Alternate day			
		Twice a week			
		Once a week			
		Occasionally			
	Quantity of waste transported each day	267 MTPD			
	Percentage of total waste transported daily	100%			
	Waste Treatment Technologies used	Composting, Modular biogas & D	WCC		
	Whether solid waste is processed Yes				
	If yes, Quantity of waste processed daily	267 MTPD			
	Whether treatment is done by local body or through an agency	By Tata Steel Utilities and Infrastr Services Limited	ructure		
·	Land(s) available with the local body for waste	2.02 Hectares at Jubilee Park.			
	processing (in Hectares)	3.72 Hectares at Bara. (Proposed)			
	Land currently utilized for waste processing	Jubilee Park			
	Solid waste processing facilities in operation	CH Area Dry waste collection cen	ter		
		Uliyan Dry waste collection center	r		
		Nildih Dry waste collection center			
		Jubilee Park inside Compost proce	essing unit		
	Solid waste processing facilities under construction	Bara (Under Construction)			
	Distance of processing facilities from city/town	0, within the city			
	boundary	•			
1	Details of technologies adopted	Composting, Biomethanation & D	WCC		
	Composting	Qty. raw material			
185 - 24 - 13 1949 -		processed	160 TPD		
		Qty. final product	21 TPD		
		produced	12 700		
		Qty. sold	13 IPD		
		Quantity of residual waste	50 TPD		
		landfilled			

Bio-methanation	Qty. raw material processed Qty. final product produced Qty. sold Quantity of residual waste landfilled
Refuse Derived Fuel	Qty.raw material processed – 107 MTPD Qty. final product produced
	 – 80 MTPD Qty. sold - 5818 MT in FY-24 Quantity of residual waste landfilled - 0 MTD
Waste to Energy technology such as incineration, gasification, pyrolysis or any other technology (give detail)	Zero
 Co-processing	Qty. raw material processed
Combustible waste supplied to solid waste based power plants	5818 MT RDF Sale to cement industry
Others	Qty.
Solid waste disposal facilities	
No. of dumpsites sites available with the local body	1 – CRM Bara
No. of sanitary landfill sites available with the local body	1 – Begunadih
Area of each such sites available for waste disposal	10 acre – CRM Bara 30 acre – Begunadih
Distance of dumpsite/landfill facility from city/town	Dumpsite facility – Within city Landfill facility – 41 km
Distance from the nearest habitation	
Distance from water body	
Distance from state/national highway	
Distance from Airport	

	Distance from important religious places or historical monument	Kms
	Whether it falls in flood prone area	No
	Whether it falls in earthquake fault line area	No
	Quantity of waste landfilled each day	NA
	Whether landfill site is fenced	No
	Whether Lighting facility is available on site	No
	Whether Weigh bridge facility available	No
	Vehicles and equipments used at landfill (specify)	NA
	Manpower deployed at landfill site	Yes/No (if yes, attach details)
	Whether covering is done on daily basis	Yes/No – NA
	If not, Frequency of covering the waste deposited at the landfill	NA
	Cover material used	NA
	Whether adequate covering material is available	Yes/No
	Provisions for gas venting provided	Yes/No (if yes, attach technical data sheet)
	Provision for leachate collection	Yes/No (if yes, attach data sheet)
9.	Whether an Action Plan has been prepared for improving solid waste management practices in the city	Yes/No (if yes, attach technical data sheet)
10.	What separate provisions are made for: Dairy related activities: Slaughter houses waste: C&D waste (construction debris):	Attach details on proposal, steps taken Yes No Yes
11.	Details of Post Closure Plan	Attach Plan
12.	How many slums are identified and whether these are provided with Solid Waste Management facilities:	No (if yes, attach details)
13.	Give details of: Local body's own manpower deployed for collection including street sweeping, secondary storage, transportation, processing and disposal of waste	Drivers : 130 Helpers: 260 Supervisors: 66 Sanitary Inspector : 62 (SS) Street Sweeping : 1010

14.	Give details of:	
	Contractor/concessionaire's manpower deployed for	
	collection including street sweeping, secondary	Please find the Annexure - II
	storage, transportation, processing and disposal of	
	Waste	
15.	Mention briefly, the difficulties being experienced by	
	the local body in complying with provisions of these	Segregation of waste by citizens
	rules	
16.	Mention briefly, if any innovative idea is implemented	Decentralized system of SWM management
	to tackle a problem related to solid waste, which could	is being adopted. Capacity building like Transfer Station – 3 Nos., Compost facility
	be replicated by other local bodies	- 1 Nos., MRF - 5 Nos., Biomethantion
		plants – 3 Nos., RRR Centers, Upcycle
		center is being developed to reduced waste
		going to landfill.

Rabindra Kumar Singh General Manager (Town O&M)

Date : 27.06.2024

Place : Jamshedpur

List of services provided and Major Installations within Tata Steel Lease Hold Area for Township Operations

I. Type of services provided
1. Power Supply to Company accommodations and adjoining area.
2. Drinking Water Supply to Company accommodations and adjoining area.
3. Repair and Maintenance of roads of lease area.
4. Maintenance and operation of Sewage network of command area (Sewage
pumping stations and Sewage Treatment Plant)
5. Fleet Management Services – Maintenance of company vehicles.
6. Municipal Solid Waste Management – Collection, transportation, processing and
Disposal from township.
7. Horticulture and green cover of township.
II. Office Installations
i. Chamaria Guest House
ii. Tubes Guest House
iii. Directors Bungalow - 1
iv. Directors Bungalow - 2
v. Tata Workers Union
vi. JUSCO Shramik Union
vii. Security Training Centre.
viii. Urban Services
ix. Corporate Communication TSL
x. Centre for Excellence,
xi. JUSCO Corporate Office
xii. Town Electrical Office
xiii. Horticulture Office
xiv. ICS Centres (South Park, Central, Kadma, Sakchi, Sidhghora)
xv. Public Health Centres (RDB, NT, Kasidih, Baridih, Burma mines)
xvi. Tata Zoological Park
xvii. Public conveniences throughout township (Urinals / Public Latrines)
III. Market
i. Bistupur Market
ii. Kadma Market
iii. Sakchi Market
iv. Golmuri Market
v. Sidhghora Market
vi. Burmamines Market
vii. Kagal Nagar Market
viii. Gudri Market
ix. Airport Market

Annexure – 1

IV	RESIDENTIAL ACCOMMODATIONS									
SL.					SL.					
NO.	AREA	QTRS	FLAT	BUNG.	NO.	AREA	QTRS	FLAT	BUNG.	
1	NEW BARA FLATS		84		47	KAISER BUNG.(2 ROOMED)			16	
2	AGRICO - BARA FLATS		748		48	KAISER BUNG.(3 ROOMED)			75	
3	RN1/AGRICO	12			49	NEW TC BHA KADMA- 2 ROOMED			24	
4	M2/AGRICO	2			50	NEW TC BHA KADMA- 3 ROOMED	• •	12	37	
5	L4/AGRICO- H6/GOLMURI	1310			51	TS FLAT (OLD)		60	8	
6	L5/AGRICO	179			52	T.S.FLAT (NEW)		24		
7	L6/AGRICO	100			53	KF4 FLATS,KADMA		153		
	BARIDIH				54	BELDIH LAKE SUP.FLAT		167		
8	M.SUP.FLAT,TUBES		56		55	GPS FLATS		237		
9	BARIDIH FLATS		725		56	GREEN ENCLAVE, KADMA		181	÷. 2	
10	NEW K2 TYPE	82			57	PRAKRITI VIHAR(NOPR)		167		
11	MODIFIED NB	244			58	ULIYAN FLATS		1892		
12	TJ1/TJ2,BARIDIH	459		8	59	GREEN ENCLAVE(OPR)		70		
13	K2/TUBES BARIDIH	814			60	PRAKRITI VIHAR,KADMA	**	140		
14	L4/TUBES BARIDIH	89			61	K/K.D. TYPE		28		
15	L5 & S TYPE TUBES	67		đ	62	DINDLI ENCLAVE, KADMA	2	70		
16	L6/TUBES BARIDIH	121		5	63	K.D.FLATS, C.H.AREA	R	32		
17	NEW BARIDIH	162			64	K.D.FLATS, KADMA	1	76		
18	MODIFIED TJ TYPE, BARIDIH	35			65	KAISER FLATS, KADMA	21	8		
	BISTUPUR				66	PROF.FLATS,I.C.ROAD		152		
19	TR/BISTUPUR	206	*		67	PROF.FLATS, K.S.LINK		300		
20	L4/BISTUPUR	41	ii.		68	PROF.FLATS, FARM AREA		80		
21	L5/BISTUPUR	38			69	K.S LINK EXECUTIVE FLATS	×	24		
22	H2,H3,H4,H6,G1 & G2,BIST.	441			70	GT(ULIYAN FLAT)		90		

	1	1	1	1			1		
23	G,H1 & H5,BISTUPUR	60			71	RN1,N2,N1 & RMR,KADMA	35	ć.	
24	P & P1 BISTUPUR	27			72	M2 KADMA	96		
	BURMAMINES				73	TR INCLUDING R.D.BHATTA.	549		
25	SECURITY FLAT B.MINES		140		74	MODIFIED TR TYPE,KADMA	140		
26	S-TYPE B/MINES	162			75	L4/XN(R.D.BHATTA)T J4,BHA	975		
27	L,L3,L4 & BML,B/MINES	484			76	L5 KADMA	546		
28	H6 & BMH BURMA MINES	91			77	L6 & G5, KADMA	103		
29	BUNG. BURMA MINES	6			78	H6 KADMA	100		
	DHATKIDIH				79	PC & PCF	20		
30	DHATKIDIH FLATS		96		80	T.C. (OLD)	61		
31	PROTO TYPE FLAT		8		81	MODIFIED M-2 TYPE	8		
32	CS QUARTERS	789				SAKCHI			
	GOLMURI		251		82	SF1, SWARNAREKHA FLAT		198	
33	GF1,GF2,GF3,GF4 FLATS		80		83	SF3, BARADWARI FLAT		190	
34	GF5 FLATS		196		84	NEW SWARNREKHA FLATS		48	
35	GOLMURI FLATS - 6				85	PIPE LINE FLATS, SAKCHI		32	
	NILDIH				86	RN & N1 SAKCHI	78		
36	B TYPE BUNGALOW, NILDIH			2	87	M2/SAKCHI	110	2	
37	DS/B BUNGALOW, NILDIH			10	88	TR & SM SAKCHI	156		
38	C TYPE BUNGALOW, NILDIH			- 10	00	L,L1,L2,L3,L4,LH - SAKCHI	130		
39	DSB TYPE FLATS, NILDIH		8	21	90	SECURITY FLATS	176		
40	C_TYPE FLATS, NILDIH		32		91	H6/SAKCHI	189		
41	D TYPE FLATS, NILDIH		28		92	G4/SAKCHI	12		
42	P TYPE FLATS, NILDIH		66	U	93	MODIFIED TR TYPE SAKCHI	18		
	NORTHERN TOWN					SIDHGORA			
43	N TOWN BUNGALOW		5	199	94	NEW SR/SIDHGORA	10		-
44	VIP BUNGALOW		-	25	95	SR/SIDHGORA	14		
45	PARK ROAD OFFICERS' FLATS		48		96	X/XN-SIDHGORA	.684		
46	JUBILEE RD.OFFICERS' FLAT		C A			MODIFIED X- XN,SIDHGORA			
rU	ΤΟΤΔΙΙ	RESIDE		CCOMM	97	ONS	151	-	
	IUIALI		. I IUL A	CONTINIC	UAIL	0110	11036	7049	409

V	Work Installations							
	S.No.	Location	Premises Type					
	i	Southern STP (Kharkai) 16 MLD	D Sewage treatment plant Sewage treatment plant Sewage pumping station					
	ii	Bara Sewage Treatment Plant 45 MID						
	iii	Northern SPS (CH Area)						
	iv	Sonari SPS						
	V	Old Illivan SPS	Sewage pumping station Sewage pumping station Sewage pumping station					
	vi	New Illivan SPS						
	vii	Baradwari Sewage Dumping Station						
	viii	Burma Mines Sewage numping station	Sewage pumping station Sewage pumping station Sewage pumping station Sewage pumping station Sewage pumping station Drinking water tower Drinking water tower River water pumping station Water Treatment Plant					
	iv	Bhuivandi Sewage Dumping Station						
	v	Baridih SDS						
	vi	Swornaraltha SDS						
	AI Vii	Swallialekila SPS						
	XII	WTD Solvabia (Including Chlading)						
		Control WT						
	XIV							
	XV	Sakchi WI						
	XV1							
	XV11	Tata Nagar WT						
	XV111	Burma Mine WT						
	XIX	Sidhghora WT						
	XX.	Sonari WT						
	XX1	River Pump House						
	xxii	Dimna Filter Plant						
	xxiii	Dimna Management Development	DBGR Vehicle Maintenance Park and garden Office area					
		Centre						
	XXIV	Fleet Management						
	XXV	Horticulture Nursery						
	xxvi	Town Electric Office						
2.104	xxvii	Compost Plant - 50 TPD	Manure manufacturing					
			plant					
VI	Sonari	Airport						
VII	Hospita	als and dispensaries						
		ata Main Hospital						
	11. 1	Arrian D. J. Sonari, Kadma, Sout	h Park, Tubes, Sakchi, Sidhghora,					
		Agrico, Burmamines)	ž					
	111. Adarsh Dalal Memorial Hospital.							
	ıv. Kantilal memorial Hospital							
	v. Centre for Family Initiative							
	V1. V	eterinary Hospital						
A ZITT	V11. L	Jog Sterilization Centre						
VIII	Educat	ional Institutions						
	1. SNTI, N-Road.							
	11. Mrs. KMPM Intercollege							
	111. JUSCO School, South Park							
	IV. JUSCO School, Kadma.							
	v. Kasidih High School							
	v1. RD Tata Technical Institute, Golmuri.							
	vii. Burmamines High School							

	viii. DM Madan Girls High School	
	ix. Sakchi Girls High School	
	x. Jamshedpur Public School	
	xi. AIWC School, Old Baridih	
	xii. Tube Baridih High School.	
IX	Parks	
	i. Jublee Park	
	ii. Droabji Park	
	iii. Bistupur Postal Park	
	iv. Bhetia Park	
	v. Kagal Nagar Park	
	vi. Golmuri Park	
	vii. Agrico Park	
	viii. Nildih Park	
	ix. Tubes Guest House Park	5
Х	Playgrounds/ Golf ground/ Clubs	
	i. JRD Sports complex	
	ii. Keenan Stadium	
	iii. Mohan Ahuja Stadium	ъ. ₁ .
	iv. Gopal Maidan	
	v. Armoury Ground	
	vi. Aaam Bagan	7
	vii. Bari Maidan	
	viii. Agrico Maidan	7
	ix. G-Town Maidan	
	Golf ground	2 - 2
	x. Beldih Golf Course	
	xi. Golmuri Golf Course	, and the second s
	Clubs	
	xii. G-Town Club	
	xiii. United Club	· · · · · · · · · · · · · · · · · · ·
	xiv. Beldih Club	
	xv. Tube Makers Club	
NZT	xvi. Golmuri Club	
XI	Bustees	
	1. Gurudwara Bustee	
	11. Harijan Bustee, Dhatkhedi	
	ill. Kanikudar	
	IV. New Ranikudar	
	v. Sonali Bustee	
	vi. Kiluladin Busice	
	vii. Kullinai paua Bustee	i i
	iv Hume Pine Bustee	
	x Bhalubasha Bustee	· ·
	xi Sitaramdera Bustee	
**	vii Baridih Bustee	
	xiii Toiladungri Bustee	~
	xiv Gadabasha Rustee	
	xy East Plant Bustee	
	xvi. Namda Bustee	
	xvii Monifit Bustee	
		N. Contraction of the second sec

Contractor	Unskilled	Skilled	TATA Ace CNG	Tricycle for D2D Non accessible
			For D2D	roads
Ayur Enterprises	76.00	9.00	6.00	2.00
Ayur Enterprises	82.00	11.00	8.00	5.00
Shanti Industries	78.00	10.00	6.00	-
Shanti Industries	65.00	8.00	5.00	-
H K Singari	74.00	11.00	8.00	4.00
Frontline	49.00	6.00	4.00	1.00
Frontline	49.00	6.00	4.00	1.00
Frontline	37.00	4.00	2.00	2.00
M S Enterprises & Co.	46.00	8.00	6.00	· _
M S Enterprises & Co.	56.00	7.00	5.00	2.00
M S Enterprises & Co.	42.00	7.00	5.00	2.00
M S Enterprises & Co.	42.00	7.00	5.00	2.00
M S Brother	51.00	6.00	4.00	-
M S Brother	35.00	5.00	3.00	-
A V S Enterprises	58.00	9.00	7.00	4.00
Maa Bhagawati	33.00	4.00	2.00	2.00
T A Enterprises	42.00	6.00	4.00	2.00
K Supplier	24.00	4.00	3.00	2.00
J R Engineering Company	32.00	5.00	3.00	_
Narendra Construction	39.00	5.00	3.00	
12 Nos	1,010.00	138.00	93.00	31.00

Annexure - III

Closure and Post-Closure Maintenance Plan

Determination of the end-use of a landfill site is an essential part of the plan for landfill closure and post-closure maintenance. Some possible uses of closed landfill sites near urban centres include parks, recreational areas, golf courses, vehicle parking areas and sometimes even commercial development.

A closure and post-closure plan for landfills involves the following components:

- Plan for vegetative stabilization of the final landfill cover.
- Plan for management of surface water run-off with an effective drainage system.
- Plan for periodical inspection and maintenance of landfill cover and facilities.

POST-CLOSURE STABILISATION, OPERATION AND CARE

Long-Term Vegetative Stabilisation

If a landfill cover is intended to be used for a specific purpose e.g. park or golf course or vehicle parking area, then the cover will be stabilised in such a manner that the end-use is achieved.

However, if no specific end-use is envisaged, then long-term vegetative stabilisation will be undertaken to return the land to its original and natural vegetative landform.

Vegetation is by far the most common and usually the preferred stabilisation option after closure of landfills. If a self-perpetuating vegetative cover can be established, not only can wind and water erosion be minimized, but also the landfill can be returned to some semblance of its original appearance and land use. In favourable climates, re-vegetation may require only modest effort or may occur by natural process during a reasonably short period of time. However, in arid climates or a harsh environment, establishment of vegetation may be a lengthy, difficult and costly process.

Typically, vegetation efforts follow a series of steps. While the specific procedures are unique to each landfill and climatic regime, the following are usually representative elements of the process:

(a) Seedbed Preparation: Seedbed preparation is necessary to set the stage for establishment of the short-term community. Initial operations may include grading, furrowing, or grouping to enhance microclimate and addition of nutrients and soil amendments, if required.

(b) Short-Term Vegetation: It is common practice, in both humid and dry environments, to rely largely on grasses for the primary initial source of short-term land cover. Usually several species are included in the initial seeding mixture to increase diversity and reduce the chance of total community failure. Short-term vegetation is usually assisted by irrigation.

(c) Long-Term Vegetation: To achieved the ultimate goal of attaining a selfsustaining and stable community, a transition between short-term and longterm vegetation must occur. In some cases, this may be left to invasion by native species after short-term vegetation is assured and soil development is well under way. In other cases – for example, when irrigation has been

used temporarily to establish the short-term community – it may be necessary or desirable to enhance the natural succession process by replanting with a more diverse mix of species suited to the next stage of community succession, such as shrubs. The need for artificial enhancement of the successional process will depend on the success of previous short-term efforts and on the ultimate intended land use of the reclaimed area. All vegetation efforts, however, should work toward self-generation and minimum management in the long term.

Several factors limit the growth of plants on landfills. These include toxicity of landfill generated gases (methane and carbon dioxide) to root systems, low soil oxygen due to heavy compaction, thin cover layer inhibiting root penetration, low nutrient status of cover soil, high soil temperatures and poor soil structure. Some of these factors can be eliminated or their effect on plant growth reduced. Active gas extraction or proper use of gas barriers with venting system prevent gas migration to the root zone. Waste may be removed from certain areas to enable planting of islands of trees. By separating biodegradable waste from non-biodegradable, it may be possible to create zones free of toxic gases.

Operation after Closure The following facilities will be operated routinely after closure:

- (a) leachate management system
- (b) surface water management system
- (c) environmental monitoring system

(d) cover rehabilitation and repair system. The operating methodology will depend on the type of system adopted at the landfill.

Landfill Monitoring

Quantitative parameter to be monitored will be:

- (a) leachate quantity
- (b) gas quantity
- (c) surface water run-off quantity
- (d) cover system settlement quantities.

Qualitative parameters to be monitored will be:

- (a) leachate quality within the landfill (at the base)
- (b) leachate quality after treatment
- (c) ground water quality (up gradient and down gradient)
- (d) surface water quality at the exit of landfill
- (e) gas quality within the landfill
- (f) air quality above the landfill and at gas vents
- (g) air quality at gas control facilities.

Periodic Inspection and Maintenance

Periodic inspection and routine maintenance at a closed landfill site should be carried out for a period of 25 years after closure. The following components of a closed landfill are inspected visually after landfill closure to confirm that all functional elements are working satisfactorily. A maintenance schedule with specified reporting formats is drawn up after each inspection.

Cover System: The final cover is inspected 2 to 4 times a year (a) to check that vegetation growth is occurring satisfactorily and that plants are not showing stunted growth, (b) to detect if any erosion gullies have been formed thereby exposing the barrier layers, (c) to earmark depressions that may have developed with time and (d) to identify ponding of water on the landfill cover. At least one inspection should be carried out during or immediately after the peak of the monsoon season.

Closed landfills show significant settlement. Rectification measures must not only re-establish the initial slope of the cover (for proper surface water runoff) but must also ensure that all the components of the landfill cover system continue to perform as originally envisaged. Site managers must have sufficient equipment and funds to periodically carry out maintenance work in the form of soil filling, re-grading the cover and revegetating the landfill cap.

In areas where extensive erosion gully formation is observed, filling of cover material, regarding of cover slopes and revegetation must be routinely undertaken.

Surface Water Drainage System:

The surface water drainage system is also inspected 2 to 4 times a year (a) to identify cracks in drains due to settlements, (b) to delineate clogged drains requiring immediate clean-up and (c) to study the level of deposited soil in the storm water basin and initiate excavation measures. Broken pipes and extensively cracked drains may require replacement after filling soil beneath them to establish slopes for gravity flow. In extreme cases where longterm settlement may be excessive, it may become necessary to make sumps and operate storm water pumps for removal of accumulated water in the drainage system.

Gas and Leachate Management Systems:

Periodic inspection of the gas and leachate collection systems is undertaken to identify broken pipes, leaking gas (if any) and damaged or clogged wells/sumps. Repair work for gas and leachate management systems requires skilled manpower and should be carried out by the agencies operating the gas treatment and leachate treatment facilities. One may often have to install new gas extraction wells and leachate collection wells if the damaged/clogged facilities are inaccessible and irreparable.

Environmental Monitoring Systems:

Ground water monitoring wells, air quality monitoring systems and vadose zone monitoring instruments are periodically inspected to check that all systems are functioning satisfactorily and that well caps and sampling ports are not subjected to damage due to excessive settlement or vandalism.

Environmental monitoring systems have to be maintained during the entire post-closure period as per the requirements of the local environmental regulatory agencies. Wherever possible, monitoring instruments must be periodically recalibrated. Sampling devices must be routinely detoxified and also regularly checked for proper functioning of the opening and closing of valves or spring-loaded mechanisms.