PREFEASIBILITY REPORT

Of

Uttar Pradesh Waste Management Project
# Executive Summary

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Name of the Project</td>
<td>Uttar Pradesh Waste Management Project (UPWMP) (Integrated Common Hazardous Waste Treatment, Storage, Disposal and Recycling Facilities)</td>
</tr>
<tr>
<td>2</td>
<td>Promoters</td>
<td>Ramky Enviro Engineers Ltd.</td>
</tr>
</tbody>
</table>
| 3      | Ramky Enviro Engineers Limited Incorporation | Date of Incorporation: 28th Nov 1994  
Commencement of Business: 13th Dec 1994  
Certificate of Incorporation No: 01-18833 1994-95  
Registration With: Registrar of Companies Andhra Pradesh |
| 4      | S. No. in the Schedule             | Common Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs). Item 7(d) – Category A, all integrated facilities having incineration and landfill or incineration alone |
| 5      | New / Expansion / Modernization    | Expansion of the Existing Operational TSDF                                                                                                                                                    |
| 6      | Expansion capacity / area / length / tonnage to be handled /command area / lease area / number of wells to be drilled | Expansion treatment facilities proposed:  
Hazardous Waste: Expansion Incineration  
Bio Medical Waste: New Proposed  
E-Waste: New Proposed  
Recycling Facilities: New Proposed  
Alternative Fuel and Raw Material: New Proposed  
The project details and their capacities are given in Annexure 1 |
| 7      | Category of Project i.e. ‘A’ or ‘B’ | Category ‘A’                                                                                                                                                                                             |
| 8      | Total CHWTSDF Area                 | 12.8 ha                                                                                                                                                                                                  |
| 9      | Land Possession                    | 7.3 ha land for the project has been provided by UPPCB on lease bases. For the expansion of proposed facility 5.5 ha purchased by Ramky Enviro Engineers Ltd |
| 10     | Address of the Facility            | Plot No. 672, Kumbhi Village, Akbarpur Tehsil, Ambedkar Nagar district, Uttar Pradesh.                                                                                                                                 |
| 11     | Total Project Cost                 | Project cost is Rs. 85 Crores                                                                                                                                                                           |
11. Nearest Highway  | National Highway – 2, located 20m from the project site entrance.
13. Nearest Railway Station  | Malasa Railway Station – Approx. 8.9 km SE
14. Nearest Airport  | Kanpur Airport – Approx. 55 km E
15. Nearest village  | Guriyapur Village – Approx. 800 m E
16. National Parks  | None in within 15km radius from project site boundary.
17. Wildlife Sanctuary  | None in within 15km radius from project site boundary.
18. Major Water Bodies/Rivers  | Sengar River located approx. 125 m South from landfill
19. Name of the applicant  | Shri. Sanjiv Kumar (IWM-National Head)
                            | (Off): 040 - 23015000
                            | (Fax): 040 - 23015100
                            | e-mail: sksanjiv@ramky.com
                            | Mobile: 09810265282
20. Registered Address  | M/s. Ramky Enviro Engineers Limited
                        | Ramky Grandiose, 13th Floor, Ramky Towers Complex Gachibowli, Hyderabad – 500032
                        | Tel: 040 - 23015000
21. Address for Correspondence  | M/s. Ramky Enviro Engineers Limited
                                   | Ramky Grandiose, 13th Floor, Ramky Towers Complex Gachibowli, Hyderabad – 500032

1.0 Introduction

Uttar Pradesh waste Management project (UPWMP), a division of Ramky Enviro Engineers Limited is planning to extend the existing Common Hazardous Waste Treatment Storage and Disposal Facility (CHWTSDSF) to Integrated Common Hazardous Waste Treatment Storage and Disposal Facility (ICHWTSDSF). Existing CHWTSDSF is extended in 7.3 ha. In addition to this land 5.5 ha land is purchased by Ramky Enviro Engineers Limited to develop ICHWTSDSF. Detailed proposed capacities are given in Table no 1. The location map of the proposed project is given in Figure 1 & Topographical map given in Figure 2.
Table 1
Proposed Project Capacities

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the Facility</th>
<th>Current Capacity</th>
<th>Proposed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Secured Landfill (DLF)</td>
<td>30,000 TPA</td>
<td>1,00,000 TPA</td>
</tr>
<tr>
<td>2</td>
<td>Stabilization (LAT)</td>
<td>20,000 TPA</td>
<td>1,50,000 TPA</td>
</tr>
<tr>
<td>3</td>
<td>Incineration (INC)</td>
<td>17,280 TPA</td>
<td>17,280 TPA</td>
</tr>
<tr>
<td>4</td>
<td>Bio-Medical Waste</td>
<td></td>
<td>10 TPD</td>
</tr>
<tr>
<td>5</td>
<td>AFRF</td>
<td></td>
<td>18,000 TPA</td>
</tr>
<tr>
<td>6</td>
<td>E-Waste</td>
<td></td>
<td>8,000 TPA</td>
</tr>
<tr>
<td>7</td>
<td>Used Oil recycling</td>
<td></td>
<td>2 KLD</td>
</tr>
<tr>
<td>8</td>
<td>Spent Solvent Recycling</td>
<td></td>
<td>5 KLD</td>
</tr>
<tr>
<td>9</td>
<td>Paper Recycling</td>
<td></td>
<td>2 TPD</td>
</tr>
<tr>
<td>10</td>
<td>Plastic Recycling</td>
<td></td>
<td>2 TPD</td>
</tr>
</tbody>
</table>

Figure 1 Location Map
Figure 2 Topographical Map

Legend
- Proposed Site
- 10km Radius

Topo Map for Proposed UPWMP Project Site Kanpur

Source: SOI Toposheet Toposheet No & Yr. of Edition G44H15 - 2011
2.0 Objective of the Project

The primary objective of this project is to provide a facility which will be one stop solution for management of industrial hazardous wastes. The Integrated Common Hazardous Waste Management Facility is being proposed for Recycle / Recovery, Alternate Destruction, Treatment, Storage and Disposal of all kinds of hazardous wastes that are generated in the state of Uttar Pradesh & adjacent states. The system so designed is reliable for now and for the foreseeable future.

The overall objective encompasses the following sub-objectives:

- To ensure that the environmental impacts are minimized.
- To ensure that resource conservation is maximized.
- To ensure techno-economic feasibility of the project
- To enable Hazardous Waste Management Facility to handle the wastes in a lawful manner.
- To prevent accumulation of the wastes at points of generation.
- To establish an administrative framework and recommend the necessary infrastructure to ensure proper collection, transport, recycle, recovery, treatment, storage and disposal of the solid wastes.
- To minimize the health effects associated with solid waste handling and management activities.
- To ensure the technical reliability of the adopted technology in terms of safety, flexibility and sustainability under local conditions.
- To prevent or minimize waste generation.
- To ensure compliance with regulatory requirements at every stage of waste handling.

The outline scope of the proposed project is as mentioned below:

- Expansion of the existing operational TSDF facility
- Collection and transportation of solid hazardous waste from generating units
- Fingerprint analysis and interpretation of results in terms of its pathway of recycling / disposal.
- Carrying out Segregation, Recycling / Recovery, Treatment, Storage and Disposal of hazardous waste residues
- Monitoring (on-site) including emergency preparedness
- Reporting to regulatory authorities as needed
- Carrying out Public information and consultation
- Undertaking closure and post closure measures on exhaustion of the site capacity
- Compliance with existing state and central regulations and amendments made from time to time.
2.1 Project Proponent

Uttar Pradesh Waste Management Project, A Division of M/s Ramky Enviro Engineers Limited.

2.1.1 Ramky Group
2.1.2 Ramky Group Waste Management Division

Ramky Group’s Waste Management Division is the leader in the field of waste management in the country. Ramky has the credit and distinction of having established the first ever bio-medical waste management and hazardous waste management facilities operating on a common platform in India, providing dimension to various other similar projects in the country.

Ramky Waste Management is focused in the fields of Industrial Hazardous Waste Management, Bio-Medical Waste Management and Municipal Solid Waste Management. The group companies have the credit and distinction of having established first-of-its-kind bio-medical waste and hazardous waste management facilities operating on a common platform in the country at Hyderabad. The group today is the leader in waste management in India, with 16 bio-medical waste management facilities located at Hyderabad, Bangalore, Ludhiana, Ahmedabad, Mumbai, Chennai, Madurai, Salem, Saltora, Kalyani, Haldia, Kolkata, Mangalore and Ghaziabad. The company, today operating twelve hazardous waste management facilities established and operated under the name of

- Hyderabad Waste Management Project located at Hyderabad (Dundigal)
- Mumbai Waste Management Limited located at Mumbai (Taloja)
- West Bengal Waste Management Limited located at Haldia
- Tamil Nadu Waste Management Limited located at Chennai (Gummidipoondi)
- Uttar Pradesh Waste Management Project located at Kanpur
- Coastal Waste Management Project located at Visakhapatnam
- Rajasthan Waste Management Project located at Udaipur
- Punjab Waste Management Project located at Chandigarh (Nimbua)
- Karnataka Waste Management Project located at Bangalore (Dobaspet)
- Madhya Pradesh Waste Management Project located at Indore (Pithampur)
- Balotra Waste Management Project (Balotra)
- West Bengal Waste Management Limited located at Saltora
The bio-medical waste management facilities operated is integrated facilities catering to over 20,000 health care establishments and over 2,75,000 HCE beds. The facilities comprise of an incinerator, autoclave, shredder, landfill, transport equipment and supporting infrastructure for effective management of bio-medical wastes without any impact to the human health and environment. The company offers high quality un-interrupted services at competitive prices.

The hazardous waste management facilities in operation are integrated facilities catering to over 6000 industrial establishments and catering to over 700,000 TPA of industrial hazardous wastes. The facilities comprise of a secured landfill facility (equivalent to US-EPA, RCRA Subtitle ‘C’ requirements), a waste stabilization facility, incinerator, intractable and temporary stores, leachate treatment facility, advanced laboratory, transport equipment, administrative and other supporting infrastructure. The facilities have been rated very high by MoEF, CPCB and the State Pollution Control Boards as also by many other national / international visitors. Our facilities are serving as role models for waste management facilities in the country today.

Ramky has experience in establishment of waste management facilities with total capacity of over 700,000 TPA of hazardous waste. The company has design, detailed engineering capability for the above-mentioned capacity as proven from the established facilities. All the facilities are equipped with state of the art laboratories capable of performing comprehensive and fingerprinting analysis. The company deploys complete mechanization in collection and transportation of wastes. Ramky’s experience in MSW is also exhaustive in terms of various consultancy projects rendered for A.P. and Karnataka States in addition to the MSW management projects awarded at Haldia, Bangalore, Guwahati, Hyderabad and New Delhi.

In a society where environment stands on the top of social agenda with economic policies not tied to the same, our effort towards improvement of environment is seen as a great step towards environmental improvement projects in the country. All the waste management facilities established by the Ramky Group are operated and maintained with high priority towards environment and occupational health and safety aspects. Where possible the operations have been automated or mechanized and all the staff working with the waste are provided with adequate and suitable personnel protective equipment and regular health checkups.

2.2 Quantities of Hazardous waste

The main objective of this project is to develop a feasible expansion of Integrated Common Hazardous Waste Management Facility which will cater for the State of Uttar Pradesh & Adjacent states.
2.2.1 Hazardous wastes generated will be comprise of the following groups:

ETP sludges, Iron Sludges, Still Bottom residues and process sludges, Spent Carbon, Evaporation salts/other process salts, Incineration ash, Slags, Asbestos and glass fibers, Spent catalysts and resins, Other hazardous wastes, based on the quantities available the following general information could be inferred:

ETP sludge can go directly to landfill either directly or after stabilization.

Still bottom residues, process residues and other organic wastes can be sent for incineration including spent carbon depending on the characteristics of the impurities.

Incineration ash, slags, asbestos and glass fibers are essentially inorganic in nature and can go to landfill directly or with simple stabilization techniques.

Spent catalysts and resins would have to be characterized on a case-by-case basis to assess their nature and characteristics. However, the percentage of wastes generated through these sources is likely to be very small as most of it is taken back by the manufacturers.

Salts will have to be bagged and land filled.

Based on the above compiled information wastes have been classified by their pathway of disposal:

Wastes going to direct landfill, Wastes that require stabilization prior to landfill, Wastes requiring storage until alternate economically viable techniques are made available, Wastes requiring incineration.

3.0 Process Description
3.1 Hazardous Waste Management Facility

Collection, transportation, reception, treatment, storage, re-use, recycle, blending and disposal of industrial hazardous wastes, bio-medical waste and E-Waste generated in the state of Uttar Pradesh & adjacent states.

The proposed expansion of the project is very unique to itself. The Facility shall be the first of its kind integrated waste management facility in the Uttar Pradesh. In fact it will be a giant step in the drive towards environment protection by the state of Uttar Pradesh.

Hazardous wastes generated in the project area are expected to comprise of the following groups:

- ETP sludges
- Iron Sludges
- Still Bottom residues and process sludges
- Spent Carbon
- Evaporation salts/other process salts
Incineration ash
Slags
Asbestos and glass fibers
Spent catalysts and resins
Other hazardous wastes

Based on the quantities available the following general information could be inferred:

- ETP sludges can go directly to landfill either directly or after stabilization.
- Still bottom residues, process residues and other organic wastes can be sent for incineration including spent carbon depending on the characteristics of the impurities.
- Incineration ash, slags, asbestos and glass fibers are essentially inorganic in nature and can go to landfill directly or with simple stabilization techniques.
- Spent catalysts and resins would have to be characterized on a case-by-case basis to assess their nature and characteristics. However, the percentage of wastes generated through these sources is likely to be very small as most of it is taken back by the manufacturers.
- Salts will have to be bagged and land filled.

Based on the above compiled information wastes have been classified by their pathway of disposal:

- Wastes going to direct landfill
- Wastes that require stabilization prior to landfill
- Wastes requiring storage until alternate economically viable techniques are made available.
- Wastes requiring incineration

The following general guidelines shall relate to daily activities associated with the operations of TSDF:

The facility shall operate only during day light hours throughout the year.

The landfill will be staged in cells so that the minimum practical area of waste is exposed.

Maximum practical area of waste has the final cap in place i.e., progressive filling and capping of the landfill ensuring minimization of infiltration of wastes.

The Weight Bridge at the main entrance will record all movements and weights and receive waste tracking receipt as required by the waste manifest system.
The standpipe forming part of the leachate collection system shall be checked regularly for
the presence of leachate. Once leachate is detected it shall be regularly pumped out and
transferred to the leachate treatment facility on-site. The level of leachate in the standpipe
shall not be allowed to rise above the level of the leachate collection system.

Materials Safety Data Sheets (MSDS) for every chemical used or handled at the landfill shall
be provided on the premises.

Monitoring and auditing of the facility shall be performed on a periodic basis.

Met-station shall be installed with continuous recording system.

A security system shall be maintained to avoid trespassing and hazard to the public.

Once a waste is received at the TSDF, a sample of waste shall be collected, at the sampling
bay/temporary storage facility and shall undergo laboratory analysis based on which its
pathway of treatment/disposal shall be determined.

A waste manifest system shall be developed in accordance with the requirement of the
regulatory agencies to cover the transportation of the waste to TSDF and to provide for
record of waste manifestation. The manifest system shall include details of the waste
generator, waste transporter, quantity of waste, characteristics of waste, physical
description, consistency of waste in terms of physical state and waste category number as

Each load of waste arriving at the facility shall be located properly and logged to identify its
pathway of treatment/storage/disposal.

An inventory shall be maintained at the arrival and departure dates of waste loads in and
out of the intractable waste storage area.

3.2 Waste Disposable Operations
3.2.1 Waste Stabilization

Waste stabilization is designed to convert industrial wastes in the form of liquids, semi-
solids or reactive solids into low leachable materials that can be deposited into a secure
landfill. The stabilization operation will be carried out for all waste that requires this to
minimize their contaminant leaching potential. This will change the nature of these wastes
to a less hazardous category. Stabilization involves the immobilization of leachable
materials by fixation as non-reactive solids. The treated wastes shall be assessed for
compatibility with other wastes before being landfill and for compatibility with the HDPE
and the pipe network. The term stabilization covers a number of mechanisms including:
Immobilization / Chemical Fixation – the chemical binding of contaminants within a cementing structure to reduce the mobility or leach ability of the waste.

Encapsulation – the occlusion or entrapment of contaminant particles within a solid matrix.

Solidification – the conversion of slurries that do not readily de-water, into solids by addition of adsorption agents.

Typical reagents that would be used for the stabilization process include cement, lime, fly ash, bentonite clay, saw dust and other. Where required sodium silicate solution would be used as an additive binding agent. The reagent to be used for stabilization shall be decided depending upon the type of the waste to be stabilized, price and availability. These regents shall generally be stored in sufficient quantities. The infrastructure proposed for the stabilization unit would include:

Storage facilities for regents, Tanks/Drums for storage of reagents as required, Stabilization bins for mixing the wastes, Earth moving equipment for movement of wastes and mixing, Place for curing the treated waste, Trucks for hauling the wastes.

Treatment facility utilizes a range of techniques and processes designed to change the physical, chemical or biological characteristics of the waste. This may include changing the composition so as to neutralize the waste, to recover energy or natural resources from the waste, to render the waste non-hazardous or less hazardous, safer to transport, store, or dispose off or to reduce its volume. Typical operations at Stabilization unit are as follows:

Waste receive, Reagent addition, Mixing, Curing, Analysis of the stabilized wastes, Approval by the laboratory for disposal, Transfer of the waste materials to the truck, Disposal in the secured landfill

Application criteria: A study of the waste characteristics carried out as an integral part of the project indicates the following applicability to the process described below in Table 2

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Applicability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immobilization / Chemical Fixation</td>
<td>Heavy metal and metal plating sludge</td>
</tr>
<tr>
<td></td>
<td>Copper-chromium-arsenic wood preservative wastes</td>
</tr>
<tr>
<td></td>
<td>Mercury waste</td>
</tr>
<tr>
<td></td>
<td>Bag house dust</td>
</tr>
<tr>
<td></td>
<td>Tannery wastes</td>
</tr>
<tr>
<td></td>
<td>Spent catalysts</td>
</tr>
<tr>
<td></td>
<td>Others</td>
</tr>
</tbody>
</table>

Table 2
Stabilization Mechanism based on Waste Characteristics
### Solidification
- Effluent treatment plant sludge
- Oil and paint sludge
- Bitumen wastes
- Textile industry sludge
- Wool scouring slurry
- Others

### Encapsulation
- Aluminum powder
- Asbestos
- Filler aids
- Others

3.3 Landfill

The expansion of landfill will be designed and constructed as a secure facility to contain the waste material and any leachate, which is formed by the entrapped moisture or by infiltration of rainfall. To meet these requirements the base of the landfill has been designed as an engineered liner constructed prior to the placement of waste and also an engineered capping over the surface after completion of filling to minimize the infiltration of rainfall.

The base liner of the landfill containment system is proposed to be a double composite liner with synthetic geo-membrane plus clay. Adequate leachate collection system shall be incorporated at the base to collect and remove the leachate. These shall incorporate HDPE pipes embedded in drainage layers of sand/gravel and/or geonet/geotextile. The composite liner (Secondary liner) shall comprise of a 0.45 m thick clay compacted to a permeability less than $10^{-9}$ m/s and above this shall be a HDPE liner with permeability less than $10^{-14}$ m/s above which a complete drainage system shall be placed. Above the secondary base liner shall be placed a primary liner comprising of primarily clay layer and HDPE membrane which will prevent infiltration into the secondary layer. A leachate collection and removal system shall also be placed over the primary liner to collect and remove any leachate generated by infiltration of precipitation or by the moisture entrapped in the waste. This makes the secondary system to serve as a leak detection system and an early warning of potential future liabilities to necessitate action for remediation. Above the drainage system of the primary liner shall be placed a geo-textile filter to act as a filter/barrier between the waste and the drainage system. This entire system would make the base liner a double composite liner meeting the national laws.

Clay Liner consists of a varying proportions of hydrated aluminum silicates (e.g. kaolinite, bentonite, illite and montmorillonite) which, when properly compacted, form a soil mass with a very low hydraulic conductivity. The clay material for use as the liner at this landfill shall be analyzed and permeability testing shall be carried out to ascertain its low permeability. Design permeability of the clay liner has been fixed at $10^{-9}$ m/s and with availability of clay liner; we will be able to achieve better results than the design values.
Placement of clay liner shall be most critical in terms of its efficiency of functioning. Clay should be placed in layers not exceeding 200 mm and shall be compacted to attain the required permeability. The clay layer after attaining the 0.45m thickness should be then checked for its permeability. Further to this, clay shall be kept moist to ensure that it does not dry up and cause cracks to the lining system. To ensure this we intend to keep the clay for the purpose at +4% wet of optimum moisture content.

Synthetic Liners consists of various synthetic flexible membrane liners have been considered for use as the primary liner at the proposed landfill. Both Poly-Vinyl Chloride (PVC) and High - Density Polyethylene (HDPE) liners are generally suitable for this landfill. Tensile strength is a fundamental design consideration in order to assess the ability of the liner to resist uniaxial and biaxial strains, which occurs in the landfill. Another stress strain consideration is the coefficient of thermal expansion.

Considering various membrane properties it is decided to use HDPE liner with appropriate thickness as primary liner for the base of the landfill. HDPE was selected for the following reasons:

Adequate strength to withstand mechanical strength during construction, placement and operations.

Acceptable weathering performance.

Superior physical properties under chemical and environmental exposure to wastes

Capability to withstand the seaming process.

The hydraulic conductivity of HDPE is of the order of 0.5 \times 10^{-16} \text{ m/sec}, which is effectively impermeable. Construction of the seam welding process shall be subjected to strict QA/QC measures to ensure the integrity of the liner.

Secure Landfill is the final placement area for land fillable hazardous wastes which are treated or wastes does not require treatment. Waste directly or after treatment will be disposed in the landfill as per the laboratory advice. Waste will be spread in the landfill using heavy earth machinery and then compacted using vibro compactor. At the end of the landfill operations 10^{-15} \text{ cm soil cover is placed as a daily cover. During rainy season a flexible geo-membrane cover shall be placed over the uncapped area of the landfill minimize infiltration of rainfall into the landfill; the rain water shall be diverted to join the surface water drains. At the end of the total landfill operations the final capping shall be done using composite liner with clay and synthetic geo-membrane, with vegetative soil cover grass cover.
3.3.1 Leachate Collection/Treatment and Disposal

Leachate collection and removal provided above the geo-membrane in two layers viz., the primary and the secondary liners. The primary liner shall serve as leachate collection and removal system, while the secondary liner shall serve as leak detection system and a signal of potential liabilities in terms of environmental pollution. Leachate shall be collected by a network of lateral and header pipes embedded in a drainage layer, all of which shall eventually drain into a leachate collection sump. The collected leachate shall be transferred to a leachate treatment system.

The leachate collection system in an engineered landfill takes the form of an under-drain beneath the waste material it is required to ensure there is no more than a limited head of pressure above the base liner to cause leakage of liquid from the base of the landfill. The design maximum pressure head in the proposed landfill shall be limited to 300mm. the detailed landfill cross section is given in Figure 3.

Figure 3: Landfill Cross Section
Drainage is affected by a layer of about 300mm thick of graded sand/gravel having a high permeability. Within this layer a network of HDPE pipes are placed to collect leachate and conduct it quickly to the collection sump for removal from landfill. The pipes are typically perforated only over the upper half to allow the leachate to enter the pipe and thereafter to be contained within the pipe network system. The layout of the pipe network generally includes sufficient redundancy to ensure that if a blockage occurs somewhere in the network the leachate simply backs-up a little then flows into the system a little further up-gradient. Two layers of the leachate collection system shall be provided one over the other. Slotting area of the pipe shall be done only on the top 120 portion of the pipe and to an extent of 100 cm$^2$ per running meter of the pipe.

The key design features of the leachate collection system to be installed at the proposed landfill comprise the following:

A network of semi perforated HDPE pipes laid out directly over the primary and secondary liners and graded towards the collection sump at no less that 2% slope, with a slotting area of 100 cm$^2$ per running meter of the pipe.

A drainage layer 300mm thick of graded sand/gravel placed over the entire base of the landfill, covering the pipe network.

A geo-textile placed over the primary liner serving the purpose of filter/ barrier between the waste and the drainage media.

The pipe shall have sufficient strength to withstand the load imposed by the overlying waste and the earth moving activities associated with the placement and the compaction of the waste (Min 6 Kg/ Sq.cm).

### 3.3.2 Drainage of Surface Runoff

Network of open channels shall be designed and constructed around the landfill to intercept surface runoff of rainwater and divert it around the facility or collect it for the use at the facility or for disposal. Storm water collected on the landfill site will be directed to a first flush retention pond which shall be designed for a sufficient capacity to cover a 1 in 100 years 10 minutes storm event. In particular the storm water system will be designed and implemented to prevent surface runoff entering the landfill and thus minimizing the leachate.

### 3.3.3 Wastewater Treatment Plant

Leachate collected from Secured Landfill and other wastewater including vehicle and container washing, leachates generated at treatment, incineration, recycling plants are treated together (excluding domestic wastewater). Leachate from the landfill and all other places of generation like storage sheds, vehicle wash, and wheel wash etc., will be recycled
back into the process. The dry residue from the solar evaporation pond / incinerator will be handled as a solid waste and will be disposed in the landfill.

3.4 Incinerator

Incineration is an ultimate treatment process, applied to certain wastes that cannot be recycled, reused or safely deposited into a landfill. It is a high temperature, thermal destruction oxidation process in which hazardous wastes are converted in the presence of oxygen in air into gases and incombustible solid residue. The gases are vented into the atmosphere with cleaning as deemed necessary while the solid residue is sent to landfill for disposal. The proposed incinerator would cater for the disposal/ destruction of the following wastes:

- Spent Solvents
- Waste Oils, Oil Emulsions and Oil mixtures
- Pesticide Wastes
- Refinery Wastes
- Pharmaceutical Wastes
- Phenolic Wastes
- Grease and Wax Wastes
- Organic wastes containing halogens, sulphur, phosphorous or nitrogen compounds
- Solid materials contaminated with oils.
- Organics with high calorific value

The primary objective of this incinerator is to destroy the wastes as completely as possible, to have end products (solids and gases) that are harmless when released from the incinerator and to minimize the formation of new hazardous organic compounds. To achieve the same the incinerator is proposed with sufficient temperature, time and turbulence and in presence of excess air. Incinerator is the facility for final disposal of incinerable wastes. Wastes which are not fit for disposal in the landfill and are candidates for incineration shall be disposed in the incinerator. The wastes shall be pre-processed in case of necessary for making it uniform calorific value and maintain the norms of halogen concentrations less than 1% and all.

Wastes are fed through cart dumper and ram feeder into the rotary kiln and the hot gases are sent to the secondary combustion chamber. The residence time and the desired temperatures are maintained at both primary and secondary combustion chambers for complete combustion as per CPCB guidelines for hazardous waste incineration. The gases after complete combustion shall be sent to spray drier / evaporative cooler for cooling followed by Gas cleaning equipment.

The gases are passed through multi cyclones for removal of particulates. Then dry lime and activated carbon are injected for neutralization of acidic gases and removal of organic
constituents if any. The flue gases then passed through bag filters for complete removal particulates and then through wet alkaline scrubber for neutralization. The flue gases after completely cleaned in all respects shall be sent out through a 30 m stack. The ash generated during the combustion process and collected at the bottom of the hopper will be send to landfill facility. The typical layout of the Incinerator is shown in Figure 4 below

![Typical Layout of Incinerator](image)

**Figure 4**

Typical Layout of Incinerator

3.5 Bio Medical Waste

Growth in population, industrialization and changing life styles and food habits have brought with it various health related issues. More and more people are suffering from ailments. Alongside this is the growing awareness towards utilizing proper medical facilities. This has
created the need for a whole range of health care establishments, hospitals, clinics, laboratories which are generating "Bio-Medical Wastes" that are incompatible with the environment. These wastes need professional attention for effective management as the infectious nature of the waste can cause irreparable damage to the human health and the environment. It has become imperative to monitor and control the management and handling of these wastes.

The concern about disposal of infectious wastes generated by the hospitals is increasing rapidly due to the fear of the spread of viruses such as Acquired Immune Deficiency Syndrome (AIDS) and Hepatitis B. These wastes (bio-medical wastes generated from health care establishments) present a high risk of causing potential damage to the human health and the environment by way of spreading. To prevent the spread of such infectious wastes that finds its genesis in bio-medical wastes (from hospitals, clinics, laboratories, dispensaries etc.) a scientific approach is required. It is essential that professionally trained personnel should handle the wastes and that the wastes should be disposed scientifically.

To enable effective management and handling of the bio-medical wastes, the Ministry of Environment and Forests (MoEF) has issued regulations for the management and handling of these wastes. In response to these rules, Government and major Private Hospitals initiated their arrangements for treatment and disposal of bio-medical wastes. However, the smaller nursing homes, clinics and other similar institutions which do not have or can afford such facilities need alternate modalities and arrangements to dispose their wastes, in accordance with the Rules.

In view of the difficulties faced by private hospitals, nursing homes and clinics that could not make their own arrangements due to high cost involved in setting up treatment and disposal facilities, the need for a centralized system for treatment was felt. Consequentially, in September 2003, the Central Pollution Control Board enunciated the "Guidelines for Common Bio-Medical Waste Treatment Facility" which in addition to providing common facilities discouraged the set up of individual incineration facilities by health care establishments.

**Waste Classification and Characterization as per BMW rules**

Wastes generated by the hospitals can primarily be classified into 3 groups:

**Conventional Wastes/ Municipal Solid Wastes:** General refuse similar to the domestic/municipal solid wastes and includes artificial linens, paper, food, cans, diapers, and plastic cups. This waste is non-infectious if it is not brought in contact with the infectious wastes and properly managed.

**Hazardous Wastes:** Laboratory and Pharmaceutical Chemicals and containers including off-specification and other chemicals, alcohols, disinfectants, anti-neoplastic agents, heavy metals (e.g. Mercury), etc. These wastes are hazardous in nature and if properly segregated
and managed can be transported to hazardous waste management facility for treatment/ storage/ disposal.

**Infectious Wastes:** Commonly referred to as Clinical and pathological Wastes and include: isolation wastes (refuse associated with infectious patients), cultures and stocks of infectious agents and associated biological, human blood and blood products, pathological wastes, contaminated sharps, amputated body parts, placenta and others.

Categories of Bio Medical Waste is given in the Table 3 below

<table>
<thead>
<tr>
<th>Category</th>
<th>Type of Waste</th>
<th>Type of Bag or Container to be used</th>
<th>Treatment and Disposal options (as per Bio-Medical Waste Management Rules, 2016)</th>
</tr>
</thead>
</table>
| **Yellow** | *(a)* Human Anatomical Waste  
Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from 1971) | Yellow coloured non-chlorinated plastic bags | Incineration or Plasma Pyrolysis or deep burial |
| **Yellow** | *(b)* Animal Anatomical Waste  
Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary | | |
| **Yellow** | *(c)* Soiled Waste  
Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components. | | Incineration deep burial or Plasma Pyrolysis or  
In absence of above facilities, Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery. |
| **Yellow** | *(d)* Expired or Discarded Medicines  
Pharmaceutical waste Like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc | Yellow coloured non-chlorinated plastic bags or containers | Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature>1200°C or to common biomedical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >1200°C or Encapsulation or Plasma Pyrolysis at >1200°C. All other discarded medicines |
<table>
<thead>
<tr>
<th>Category</th>
<th>Type of Waste</th>
<th>Type of Bag or Container to be used</th>
<th>Treatment and Disposal options (as per Bio-Medical Waste Management Rules, 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(e) Chemical Waste</td>
<td>Chemicals used in production of biological and used or discarded disinfectants.</td>
<td>Yellow coloured containers or non-chlorinated plastic bags</td>
<td>Disposed of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility.</td>
</tr>
<tr>
<td>(f) Chemical Liquid Waste:</td>
<td>Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.</td>
<td>Separate collection system leading to effluent treatment system</td>
<td>After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms</td>
</tr>
<tr>
<td>(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid.</td>
<td>Non-chlorinated yellow plastic bags or suitable packing material</td>
<td>Non-chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or for energy recovery. In absence of above facilities, shredding or mutilation or combination of Sterilization and shredding. Treated waste to be sent for energy recovery or incineration or Plasma Pyrolysis.</td>
<td></td>
</tr>
<tr>
<td>(h) Microbiology, Biotechnology and other clinical laboratory waste:</td>
<td>Blood bags Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human and animal cell</td>
<td>Autoclave safe plastic bags or containers</td>
<td>Pre-treat to sterilize with non-chlorinated chemicals on-site as per National AIDS Control Organisation or World Health Organisation guidelines thereafter for Incineration.</td>
</tr>
<tr>
<td>Category</td>
<td>Type of Waste</td>
<td>Type of Bag or Container to be used</td>
<td>Treatment and Disposal options (as per Bio-Medical Waste Management Rules, 2016)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>Contaminated Waste (Recyclable)</td>
<td>Red coloured non-chlorinated plastic bags or containers</td>
<td>Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.</td>
</tr>
<tr>
<td></td>
<td>(a) Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacationers with their needles cut) and gloves.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White (Translucent)</td>
<td>Waste sharps including Metals: Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and Contaminated metal sharps</td>
<td>Puncture proof, Leak proof, tamper proof containers</td>
<td>Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete, combination of shredding cum autoclaving, and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit.</td>
</tr>
<tr>
<td>Blue</td>
<td>(a)Glassware: Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes.</td>
<td>Cardboard boxes with blue colored marking</td>
<td>Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.</td>
</tr>
<tr>
<td></td>
<td>(b)Metallic Body Implants</td>
<td>Cardboard boxes with blue colored marking</td>
<td></td>
</tr>
</tbody>
</table>

**Collection and Transportation**

Bio-medical waste will be collected from each health care establishment on a regular basis. Wastes shall be segregated as per the color coding, properly packed and placed at a secure designated point by the health care establishment from where it will be collected. Upon collection wastes shall be placed into closed containers enclosed in a containerized vehicle.
and transported to the site. The vehicles shall be dedicated for the purpose and shall adopt the conditions specified in the BMW (Management & Handling) Rules-2016.

**Bio Medical Waste Incineration**

The incinerator proposed for Hazardous waste will be used for incineration of Bio-medical Waste also, hence it is a common facility for incineration of all incinerable wastes coming to the facility.

**Autoclave**

The primary purpose of autoclave is to sterilize / disinfect the waste with steam. Micro organisms which contribute to infection do not survive beyond 80°C. However, as a precaution MoEF has stipulated a temperature of 121°C with 15psi pressure and 60 min duration to ensure distribution of temperature. At this temperature and pressure, micro organisms are completely destroyed and thus render the wastes infection free. The disinfected waste shall then be segregated into HDPE, PP, rubber, latex, glass and metal. The segregated materials shall then be shredded completing the process of disinfection and ensuring non-recycling of the waste materials for medical / food grade purposes. All the process control conditions will be as per the applicable Bio medical rules.

**Autoclave Features**

A vacuum type (programmable) autoclave which can operate at all the specifications mentioned by MoEF with a capacity to handle 2 T of medical waste per day is proposed.

The autoclave shall have continuous and automatic recording of temperature, pressure, date, time and batch of loading. Every batch shall be monitored with a strip chart recorder and once in a month the spore validation test and/or spore monitoring shall be done. Following are the key features of the proposed autoclave:

<table>
<thead>
<tr>
<th>Type: Vacuum Type, automatic with documentation.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity</strong></td>
</tr>
<tr>
<td>Temperature:</td>
</tr>
<tr>
<td>Pressure:</td>
</tr>
<tr>
<td>Time:</td>
</tr>
<tr>
<td>Automation:</td>
</tr>
<tr>
<td>Documentation/ Recording:</td>
</tr>
</tbody>
</table>
The Layout of typical autoclave process is given in **Figure 5** below

**Other Infrastructure**

**Shredder:** A mechanical shredder to make the waste unrecognizable as medical waste shall be installed with a capacity to handle about 3.3 T of medical wastes per day.

**Landfill:** The residue will be sent to secured landfill site.

**Figure 5**
*Autoclave process*

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**3.6 E Waste Recycling**

The assessment of e-waste recycling sector in India indicates that e-waste trade starts from formal dismantling sector and moves to informal recycling sector. There are no large scale organized e-waste recycling facilities in India at present except few in some states of India, while most of the e-waste recycling units are operating in un-organized sector. So, this will be an opportunity for us to serve the industries by handling their E-waste. The main objective of the proposed E-Waste facility is given below.

- To provide Safe and Secured Destruction services at project site to ensure intellectual property assurance.
- To provide innovative and pollution-free technology for recycling of E-waste.
- To provide Environmental management system and solutions.
- To recover up to 99% of total waste received
- To enhance customer service through online account access.
- To conserve natural resource & ensuring working towards global warming
- The proposed project consists of the following facilities
Prefeasibility Report for Uttar Pradesh Waste Management Project (UPWMP)

- Fully integrated state-of-art E-Waste management facility
- World class security systems
- Certified, Safe and Secured destruction services
- Comprehensive EHS practices
- Logistics, warehousing facility
- Highly skilled manpower

Methodology:

The methodology proposed to be followed at the E-Waste facility is as follows. The process flow sheet is given as Figure -6 below.

Upon client request, project management shall arrange a suitable and secured transport to collect the material from Clients premises.

Collected material shall be weighed, if desired by clients at their premises using their own weighing machine and witnessed by both parties.

Manifest to be issued by generator to transport with 6 colored copies as per HW Rules, 2008.

Delivery Order will be issued by Client prior to collection from their premises. Collected material is to be provided in good packaging condition and thereafter will be transported to the facility.

After inspection by project security guard, material shall be weighed at site weighbridge to determine the gross weight of the material and will then be sent to its warehouse for acceptance.

Goods Receive Note (GRN) for the gross weight will be issued upon receiving the material at the warehouse.

Material will then be sent for dismantling section under IDO (Internal Delivery Order) for dismantling.

Destruction process can be witnessed by Client, if required.

Upon data destruction completed, official destruction certificate will be issued to Client for records.

Dismantled material will then be sent to suitable recycling process.
Process Description:

The process involved in proposed integrated E Waste recycling facility is basically physical destruction and recovery of Platinum Group Metals (PGM's). The steps of proposed process is described in following paragraphs

The e-waste received from generator shall be stored at earmarked covered shed having concrete floor and leak proof roof. Wooden or plastic pallets shall be provided to store the waste.

Waste which may contain mainly electronic and electrical material and monitors of computer or TV’s, shall be shifted to manual dismantling section in hand trolleys

A set of 8 to 10 no. of work stations are proposed with a suction hood for any dust particle coming out of the dismantling process. A team of experts in dismantling shall be deputed for dismantling purpose with all the required tools and tackles. The tools and tackles shall be identified with best available brand to ensure optimization in working and to avoid small accidents in the process. The employees at this section shall be provided with all the required PPE’s i.e. apron, safety shoes, gloves, dust mask etc. Fire extinguishers shall be provided in the working area.

The team deputed shall dismantle all the waste articles Eg computer CPU box, hard drive, CD ROM, cables, PCB’s etc. and monitor into back cover and picture tube. The hard drive, PCB’s shall be further dismantled into components attached and naked PCB’s. Flow chart of the process is given in Figure 6

The dismantled PCB’s shall be sent for shredding followed by crushing and pulverizing. The product shall be powder of PCB from which metal and non metal part which shall be segregated by physical process. Both the products shall be stored in bags for disposal for recovery (metal part) and for making of toys and monuments (non metal part). In case the non-metal part fails to be recycled, the same shall be disposed into incinerator as this consists of residue with high C.V.

The dismantled picture tube shall send to Cathode Ray Tube (CRT) cutting m/c, which is a closed chamber attached with a hood connected to cyclone and bughouse. The CRT shall be put into the control panel connected automatic CRT cutting frame. The CRT shall be cut into two pieces i.e. front glass and funnel glass.

The glass which is free from all coating etc shall be crushed further and stored in bags to be dispatched for recycling

The components removed from PCBs shall be segregated and stored in bags for further disposal and/or reuse.

The ferrous material i.e. cabinet, body of monitor etc shall be baled and disposed for recycling
Plastic from cabinet, monitor shall be shredded in the shredder and sold out for recycling to authorized recyclers.

The chemical process for recovery of PGM shall be established during phase – II

Figure 6
E Waste proposed Flow Chart
The waste generated from above process shall be stored at earmarked area and not allow the waste to be exposed to the environment.

### 3.7 Recycling Facilities

The recycling facilities proposed for the site are:

- Spent Solvent Recycling
- Used oil recycling
- Alternative fuel recovery facility
- Waste plastic recycling
- Waste paper recycling

#### 3.7.1 Spent Solvent Recycling

Spent solvents are recovered using a distillation methodology. Following are few solvents proposed to be separated/distilled initially:

- Isopropyl alcohol
- Butanol
- Dimethyl formamide
- Toluene and
- Ortho dichloro benzene
- Storage of spent solvents

The waste solvent shall be received in drums (MS/Plastic) and shall be stored in shed which will be provided with garland drain, fire hydrant system, lined floor etc.

The drums shall be stacked as per the best practices. The leakages shall be avoided at any point of time.

A separate storage shed sized 35 X 40 m is proposed adjacent to facility to store the solvent drums.

The stacking of drums shall be in the manner that mixing of solvent drums shall be avoided at maximum extent.

Distillation process is suitable for the recovery of many spent solvents. Distillation can be a batch or continuous operation. It is proposed to adopt batch process in the proposed facility. The process involves pre-treatment of neutralization and separation of spent solvent feed mixture in a Reactor. After layer separation, the spent solvent mixture will be sent to distillation still connected to distillation column. The solvent mixture is heated by steam and the distillation column will be under total reflux for a specific period. Fractionation of solvent takes place solvent / water as the case may be are separated initially under atmospheric pressure and later under vacuum (if required). Distilled solvents are analyzed, stored and recycled, liquid effluent mostly condensate will be recycled back into system and
solid residue sent for incineration / landfill. Steam for heating will be donor from the boiler. The process diagram of the solvent recovery is depicted below:

**Process Description:**

Distillation can be a batch or continuous operation. It is proposed to adopt batch process in the proposed facility. The process involves pre-treatment of neutralization and separation of spent solvent feed mixture in a Reactor. After layer separation, the spent solvent mixture will be sent to distillation still connected to distillation column. The solvent mixture is heated by steam and the distillation column will be under total reflux for a specific period. Fractionation of solvent takes place solvent / water as the case may be are separated initially under atmospheric pressure and later under vacuum (if required). Distilled solvents are analyzed, stored and recycled, liquid effluent mostly condensate will be recycled back into system and solid residue sent for incineration / landfill. Steam for heating will be donor from the boiler. **Figure 7** below shows the Flow Chart of Spent Solvent Recovery.
3.7.2 Used Oil Recycling

Used oil is termed as hazardous. Lube oil does not wear out with use it only gets contaminated with water, carbon and fuel etc. that means used oil when it is ready for rejection can be re-used.

The methods of disposal being followed are Dumping, Burning or Reprocessing. The Used / Waste Oil generated are not easily biologically degradable. Therefore, dumping of Used / Waste oil is harmful to environment.

Burning of Used / Waste Oil is not desirable for the following reasons:

- Waste Fuel Oil contains substantial quantity of water that will prevent proper burning of fuel and lead to generation of carbon monoxide.

- The Used Oil (used lubricants, Transformer oils etc), they may contain chemicals, metallic compounds, Polychlorinated Biphenyl (PCBs) etc which when burned will release gas to the atmosphere. Therefore, burning of used / Waste Oil should not be encouraged.

- The other option is Repressing. Improper reprocessing methods can lead to generation of waste which is even more hazardous than Used / Waste Oil.

Therefore, reprocessing should be allowed only with approved methods. Reprocessing of Used / Waste will not only be a solution for disposal of waste but it will have tremendous economic advantage.

The process diagram of the waste/used oil recycling plant will be as below in Figure 8 below.

**Figure 8 Used Oil Recycling**
3.7.3 Alternative Fuel Recovery

Alternative fuel platforms will be developed with in an area of 25 x 50 m as below:

<table>
<thead>
<tr>
<th>&quot;S&quot; Type</th>
<th>&quot;L&quot; Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Fuel Preparation Facility</td>
<td>Alternative fuel preparation Facility</td>
</tr>
</tbody>
</table>

‘L’ Type Alternative Fuels Area:

‘L’ Type Alternative Fuels are basically Liquid Type Incinerable Waste which are more than 2500 Kcal.

- Common Neutralization Tank to maintain pH level 7
- 25 KL Mixing Tank with Cooling Coil and External Jacket to control the heat for Exothermic Liquid Waste
- 25 KL Mixing Tank for the Non-Exothermic Liquid Waste
- Agitator set up made by Stainless Steel Pump

‘S’ Type Alternative Fuels Area:

‘S’ Type Alternative Fuels are basically Solid Type Incinerable Waste which are more than 2500 Kcal

- Common Neutralization Tank to maintain pH level 7
- Mixing pit of 5 x 5 m
- Jaw mixer for premixing of the solid and semisolid Waste.
- Blender

Solid blend is prepared through mixing in an appropriate quantity of solid/semi solid waste with binders. The first step of preparing solid blend is to selection of waste.

The segregation of waste according to their pH & calorific value helps in it. Source materials for solid substitute fuel include Paint Sludge, Oily Filter Cake, Spent Carbon, Organic waste, Tarry waste, Biomass, Resin, Distillation Residues, Grease, ETP sludge, and alumina sludge etc.

Assortment of waste is done according blending norms.

A general waste selection criteria for high calorific value fuel is Low moisture content, High LOI & TOC, High calorific value, Good compressibility, Less ash content, Non toxic, Less
pollutant, Sustainable combustion. Schematic Diagram for the Alternative Fuel Recovery is shown in Figure 9.

**Figure 9**
Alternative fuel recovery

3.7.4 Waste Plastic Recycling

Plastics are an arbitrary group of artificial materials, generally of synthetic organic origin, which at some stage in manufacture are in plastic condition during which they are shaped, often with aid of heat and pressure.

**Understanding the definition:**

Arbitrary Group: There is no code or specification with which a material must comply in order to be called a plastic. For example, synthetic rubber fulfills all the conditions laid down in the above-mentioned definition yet it is not included in the list of plastics.

Artificial materials: Material made by compounding, different from naturally occurring materials such as wood, sandstone or metals.

Generally of Synthetic organic origin: In organic compounds the principle element is carbon. Most of the plastics are made of simple organic chemicals raw materials. Certain naturally existing organics such as bitumen, casein or cellulose are also employed for the manufacture of plastics.

Plastics undergo permanent deformation under stress. During some stage of its manufacture they are truly plastic and capable of being shaped. At ordinary temperatures plastic items are not plastic but solid like.

Plastics are shaped by means of heat and pressure in a mould. Process is called moulding.
3.7.5 Waste Paper Recycling

Waste Paper recycling is the process of converting waste into new paper products. The process of paper recycling involves mixing used paper with water and chemicals to break it down. It is then chopped up and heated, which breaks it down further into strands of cellulose, a type of organic plant material; this resulting mixture is called pulp, or slurry. It is strained through screens, which remove any glue or plastic that may still be in the mixture then cleaned, de-inked, bleached, and mixed with water. Then it can be made into new paper. The same fibers can be recycled about seven times, but they get shorter every time and eventually are strained out.

To start the paper recycling process, the waste paper needs to be sorted, such as by newsprint, computer paper, magazine paper etc, as different types of paper are treated differently during the paper recycling process to make different types of recycled paper products. For example, finer paper with multi-colored ink would require additional processing. Effort is taken to ensure that the waste paper is free of any pins, clips, staples etc.

The major process involved in waste paper recycling is as follows

- Pulping
- Pulp screening and cleaning
- Deinking
- Refining, color stripping, bleaching
- Paper making

Process Description

**Pulping:** During this stage of the paper recycling process, the sorted paper is usually soaked in huge pulpers, which contain water and chemicals. The pulper shreds the paper up into smaller pieces. The heating of the paper mixture also breaks the paper down more quickly into the paper fibers. The paper mixtures turns into a mushy mix, known as a pulp.

**Pulp screening and cleaning:** The pulp is forced through screens with holes of various shapes and sizes to remove small contaminants such as bits of plastic and globs of glue. In addition, the pulp may also be spun around in large cone-shaped cylinders. Heavy contaminants (eg. staples) are thrown out of the cone via centripetal forces, while lighter contaminants collect in the center of the cone and are removed.

**Deinking:** The next stage in the paper recycling process involves deinking – removing the ink from the paper fibers of the waste paper. Sticky materials (referred to as “stickies”) like glue residue and adhesives are also removed at this stage. Deinking is achieved by a combination of mechanical action (eg. shredding) as well as chemical means (eg. additional of chemicals). Small particles of ink are rinsed from the pulp with water, while larger particles and “stickies” are removed with air bubbles in a process known as flotation.
With flotation, the paper pulp is fed into a flotation cell, where air and soap-like chemicals called surfactants are injected into the pulp. The surfactants cause the ink and "stickies" to dislodge from the pulp and stick to the air bubbles as they float to the surface of the mixture. The inky air bubbles create froth which is then removed, leaving the clean pulp behind.

Refining, color stripping, bleaching: During refining, the pulp is beaten to make the recycled fibers swell, as well as to separate the individual fibers to facilitate paper making. If the recovered paper is colored (e.g. color printed paper), color stripping chemicals are added to remove the dyes from the paper. From this processing, brown paper is obtained. If white recycled paper is to be produced, the pulp would need to be bleached with hydrogen peroxide, chlorine dioxide, or oxygen to make it whiter and brighter.

**Paper Making:** In the last stage of the paper recycling process, the cleaned up pulp is ready to be made into recycled paper. The recycled fiber can be used alone, or blended with new wood fibers (i.e. virgin fibers) to give it extra strength or smoothness. The pulp is mixed with water and chemicals, such that the pulp is 99.5% water. This watery pulp mixture then enters the head box of a paper making machine, and is sprayed in a continuous jet onto a huge wire mesh-like screen moving very quickly through the paper machine. On the screen, water starts to drain from the pulp, and the recycled fibers begin to bond together to form a watery sheet. The sheet then moves rapidly through a series of felt-covered press rollers which squeeze out more water from the pulp. Schematic diagram of paper recovery is shown below in **Figure 10** below.

**Figure 10**

*Flow Chart of Wastepaper Recycling*