International Symposium on Marine Design and Construction 2019
(SMDC 2019)

RIVER TRASH CLEANER.

Mr. M Upendra[a], Ms. T. Hadassah[b],Dr. Bh.Nagesh[c], Prof. (Dr.) I.N. NiranjanKumar[d]
[a,] *Engineering Director & Co-Founder of Highsea Naval Architects LLC, Texas, USA.*
[b,] *Research Scholar in Marine Engineering Department, Andhra University, Visakhapatnam, INDIA.*
[c,] *Visiting Professor in Marine Engineering Department, Andhra University, Visakhapatnam, INDIA.*
[d,] *Director, Indian Maritime University, Visakhapatnam Campus.*

ABSTRACT
With the increase in global plastic pollution in rivers/lakes which is adversely affecting the human and aquatic life. In this paper we present the design and analysis of Zero emission River Trash Cleaner (z-RTC) which is a electrically operated self-propelled floater with trash collecting arms and trash processing plant on the floater. The z-RTC collects the trash and the processing plant on the floater separates the plastic from the trash. The design and analysis of the z-RTC covers the general arrangement, stability, hydrodynamics and structural analysis. The collected plastic will be converted to lubricant oils by having an on-site pyrolysis plant. The last section of the paper discusses about the benefits and cost estimation of z-RTC.

1 INTRODUCTION

1.1 PROBLEM OF WATER TRASH IN INDIA

Indian cities are among the largest garbage generators in the world, producing about 62 million tonnes of waste every year. Only about 82% of it is collected and only about 28% of it treated and processed. Most goes into landfills, open dump sites or just left on the ground, often clogging rivers and drains.

The solid waste is swept into surrounding water bodies such as the Ganga and her tributaries, either purposely by people or by heavy rains during the monsoon season. In waters, large biodegradable waste take a lot of the oxygen from the water to decompose, leading to illness of fish and other aquatic creatures.

Many cities along the Ganga and her tributaries do not have any sort of solid waste management system, and if they do, they are not sufficient to handle the amount that is produced each day. Another huge problem, is a lack of education and environmental awareness among the ordinary people. People have nowhere to put their garbage, so they inevitably throw it into the surrounding environment, being completely unaware of the consequences, or they burn the trash (which releases harmful chemicals into the atmosphere).
The need to find acceptable, sustainable and environmentally-friendly solutions for the treatment of all solid waste is urgent.

NOMENCLATURE
RTC River Trash Cleaner

1.2 NAMAMI GANGA PROGRAM

The Government of India has created a taskforce to address the problem of river trash, especially in the

Ganga River and its tributaries. This resulted in the creation of a Namami Ganga Program. The objectives of this project are being achieved by focusing on six different projects:

1. Creating Sewerage Capacity
2. Creating River-Front Development
3. River Surface Cleaning
4. Bio-Diversity Conservation
5. Afforestation
6. Public Awareness.

1.3 RIVER SURFACE CLEANING: IMPLEMENTATION, APPROACH AND METHODOLOGY

“River Surface Cleaning” is one of the several programs being implemented as part of the Ganga Namami Program. Currently, this program is implemented at 11 locations along the Ganges. The idea behind this program is to employ RTCs (boats/vessels outfitted with equipment capable of picking up the floating trash) and speed up the cleaning process. Several vessels can be utilized simultaneously to make the process efficient and benefit from the common operations that are part of this overall process.

Our methodology would include putting into service one or more of our RTCs designed for this purpose, collecting and processing the trash once the vessel storage space is filled, and emptying the trash at

predetermined locations (if these do not exist already at site). The process would be complete once the trash containers on land are emptied and hauled away to one of the nearby land-fills to further process the trash (this currently is beyond the scope of this project).

2 THE GANGA RTC PROJECT

2.1 PROJECT OBJECTIVES:

The principal aim of this project is to create a new design for a system that is effective and efficient in cleaning up the trash floating on rivers and inland waterways, with objectives as follows:

1) To compare the proposed design of trash collecting system by performing engineering design methods
2) To design intended system for actual operations
3) To test the design by inputting real time data
4) To commission and install the final designed vessel at the project site

By utilizing the above design steps and imposing few more design conditions as indicated in section 3.2, and through an iterative process, a RTC similar to the one shown in Figure 1 was obtained.

2.2 PROJECT SCOPE AND MAP:

The scope of the project consists of:

a) River surface cleaning of identified areas along the length of the Ganges. These areas would be defined by parameters that include:
- Length of coastline and direction from a set landmark, and the width of river to be traversed
- A given landlocked water body
- Coverage of surface based on the duration the RTC is operated on a given day.

b) Collection and pooling of trash at given locations.

c) Hauling and further treatment of solid waste where necessary.

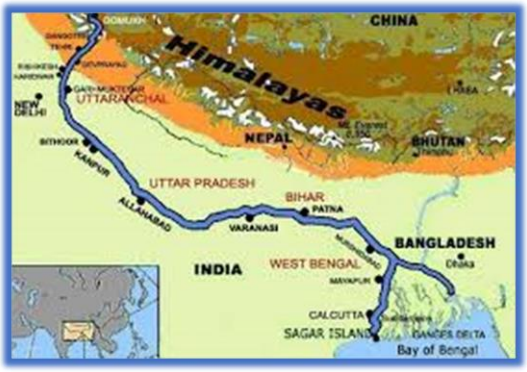
A daily charter rate for the RTC along with the costs required to operate based on duration or service area (in acres) is attached in the appendix. A map of the river Ganga and its tributaries is shown in the figure above. The expected project area would span the areas covered by the river or its tributaries.

3 PROPOSED RIVER TRASH CLEANER

3.1 DESIGN METHODOLOGY

The design is based on a system design engineering and analysis approach. While giving due regard to the importance of the system design procedure, the methodology also draws on reliability study where the process will enhance the dependency on the system applied adequately in removing trash from inland waterways.

Particular attention was paid to present design of boats,



since it is the most crucial phase in determining the overall configuration and because of its importance in concurrent engineering. The information obtained can be further analysed for improving the design of trash collecting system for rivers and inland waterways.

3.2 RTC DESIGN AND CAPACITY

The RTC is designed with the following objectives:

- Rapidly collect and dispose off the waste at regular points on the shore along the course.
- Environmentally safe technology to solve the world's ever increasing water trash problem.
- Vessels storage area to be at least 14,000 lbs or 800 cubic feet of material.
- Logs and items of up to 60 inches in diameter are easily conveyed and stored.
- Based on an operating width of 15 ft and the vessels max. Steady speed of 6 knots, a water surface area of approx. 530,000 SQFT (approx. 12 acres) would be swept up by the RTC in an hour.

This vessel designed to meet the above objectives also has several advantages including:

- The mobility on water and over land make it easily transportable to several locations
- The RTC can be put into operation immediately upon launch, thereby maximizing productivity and providing immediate results.
- Low running costs.
- Minimum downtime
- Excellent and safe operator control
- A machine capable of recovering floating and half-submerged trash of various kinds
- Minimal environmental impact
- Ease of mobility, launch and recovery

The vessel is also equipped with the following supporting equipment for ease of use and increased productivity:

- Shore Conveyors – These help in transfer of material from vessel to the shore.
- Tilt-Deck Trailers – Launch and retrieve vessel and transportation
- Power-packs: Hydraulic power for conveyors
- Trailer-Conveyors : Dual function of trailer and conveyerized dumpster

Fig1: Typical RTC (Trash Capacity 14,000 lbs)

3.3 REGULATORY FRAMEWORK

Some of the important laws and regulations that are applicable to the environmental and social aspects of the program that is being implemented are given below:

- Environmental Protection Act, 1986 – To protect and improve overall environment.
- Coastal Regulation Zone (CRZ) Notification, 1991 – Protection of fragile coastal belt.
- Municipal Wastes Management Rules, 2000 – To manage collection, transportation, segregation, treatment and disposal of solid wastes.
- Water Prevention and Control of Pollution Act, 1974 – To control water pollution by controlling discharge of pollutants as per the prescribed standards.

3.4 PROJECT COST

A preliminary cost estimate for this project is shown in the table below. The cost includes work performed for the engineering design, development and manufacture of the vessel intended for the purpose of this project.

	River Trash Cleaner Construction Cost	
S.no	**Description**	**Cost (INR.)**
1	Preliminary Engineering	401,205
2	Basic Design and Engineering	2,942,500
3	Construction Cost	
	Hull Construction	12,037,500
	Engine and Machinery	1,872,500
	Outfit	3,878,750
4	On-board Skimming equipment	1,765,500
5	Additional Supporting equipment	668,750
	Shore Conveyors	
	Tilt Deck Trailers	
	Power Packs	
	Trailer Conveyors	
6	Sea trail and testing	866,700
7	Government / Classification Approvals	1,177,000
8	Transportation	615,250
9	Commissioning and Installation	535,000
	Total Construction Cost	**26,760,700**

The operating costs for chartering the vessel for a period of one month (operating 10 hours a day, 5 days a week) is shown below:

Operating Costs (per month)		
S.no	**Description**	**Cost (INR.)**
1	Crew Wages & Insurance	
	Vessel Operator (1)	150,000
	Collection Crew (2)	130,000
	Insurance	63,000
2	Fuel and Supplies	
	Engine Oil (@60 LBS per day)	88,000
	Lub oil (40 gallons per day)	30,000
	Freshwater	12,000
	Maintenance	45,000
	Total Operating Cost, 30 day period	**518,000**

3.5 SOCIO-ECONOMIC BENEFITS

There are multiple social and economic benefits once this project is approved and executed.

- The ganga river that is presently polluted and covered by trash in various locations would be cleaned and

would be considered less of a health hazard for families to live near the banks of the river

- The land that is close to the river can be used for residential development and newer communities can occupy and take responsibility to keep their surroundings clean
- People living in coastal areas would begin to take responsibility to keep the environment and the waters that they utilize for drinking or transport to keep it clean.

4 OPERATION AND MAINTAINENCE

4.1 OPERATIONS

The RTC comes equipped with the following:

- A complete Hydraulic System for all skimming, load handling, and propulsion functions, with variable speed control at the operator's finger tips.
- An Air Cooled Diesel Hydraulic Power Unit, placed into a noise proofed, lockable engine room.
- Lockable Hydraulic Oil Tank, Filtration, Hydraulic Oil Cooler, Hydraulic Directional Valves.
- Stainless Steel Hydraulic Cylinder Rods.
- Operator's platform with a seat and console with engine controls monitoring system including warning lights, tachometer and hour meter, and hydraulic controls with pressure gauge.
- Conveyor Belt System made of heavy duty Stainless Steel supported by UHMD plastic tracks and interchangeable floors.
- Articulated RTC Wings
- Front Conveyor with adjustable depth setting and cleats mounted to belts.
- Storage Conveyor with load indexing and height adjustable discharge
- Twin Pontoon Steel Hull “hydro-dynamically” shaped, including multiple compartments, inner ribbing, tie and lift cleats, drains and vents, anti-skid deck, bottom skids, rub rails, gunnels.
- Two independent, bi-directional Hydraulic Propulsion Units with variable speed controls, bronze propellers, stainless steel shafts, drop arms, and hydraulic connections, as well as tunnel guards, and power tilt.
- Railings and Guards
- Stainless Steel Fasteners
- Marine Coating, following sandblast preparation, includes priming and finishing coats. Standard colors are Safety Orange and Blue.
- Fire extinguishers, life jacket and life ring with 45 Ft. (13.5M) of rope
- Operators Manual, Parts Catalog and One Year Warranty with Option to extend up to 5 years.

The RTC cleans up floating debris from harbors, rivers and other waterways making them safe for public use and consumption. With their twin catamaran hulls, the RTCs easily retrieve a wide variety of manmade and organic floating debris including litter, old tires, plastics, leaves, timber, branches, logs to name a few.

As unwanted debris is collected, it is conveyed on board and stored in a storage hold area. Complete instrumentation and hydrostatic hydraulics enable a single operator to manage all functions of the RTC without coming into direct contact with the refuse. The adjustable collection flares enable the operator to clean out even tight corners.

4.2 MAINTENANCE

The RTC has been designed to use standard equipment for which the parts are available worldwide. The power source is a Kubota V 1500 cc water cooled diesel engine. A full maintenance manual would be provided along with the RTC.

The RTC is an extremely reliable vessel. However, as with any hard-working machine, it will require regular maintenance to ensure its smooth and reliable operation.

The RTC is delivered with a full set of serviceable spares for the first two years of operation. One or more mechanics would be trained in the maintenance and if need be a service technician from the Company would be available for to make sure the equipment is maintained in tip-top order.

5 PROJECT MANAGEMENT

5.1 COMPANY MANAGEMENT

The company would manage the project by adhering to its predefined timeline, scope, and budget. Project tasks would include:

- Status reporting:
  Tracks task and financial progress in addition to risks and issues, jointly reviewed on a weekly basis.
- Project Plan:
  Updated on a weekly basis based on team progress.
- Change Control:

Assesses impact of any project changes on project timeline, scope, and budget.
Formal change order documentation requires signoff before work can be performed.

- Readiness:
  Utilize customer readiness scorecard throughout project to assess progress.
- Checkpoint:
  Review progress, confirm milestones reached, and review future work at the conclusion of each project phase.

An approximate duration and delivery date for the above described RTC is 6 months and Dec 15, 2018. These dates are subject to change based on regulatory approvals and how quickly the GOI can place a PO for our product.

5.2 SCHEDULING AND TIMING

	2018					
	July	Aug	Sept	Oct	Nov	Dec
Concept Study and Development						
Design and Engineering						
Construction						
Commissioning and Installation						

5.3 RISK IMPACT AND MITIGATION

Probability of Occurrences			**Catastrophic**	**Critical**	**Moderate**	**Minor**	**Negligible**
Definition	**Meaning**	**Value**	**(A)**	**(B)**	**(C)**	**(D)**	**(E)**
Frequent	Occurs frequently Will be continuously experienced	**5**	**5A**	**5B**	**5C**	**5D**	**5E**
Likely	Occur less frequently if process is corrected Issues identified with minimal audit activity Process performance	**4**	**4A**	**4B**	**4C**	**4D**	**4E**
Occasional	Occurs sporadically Potential issues discovered during focused review.	**3**	**3A**	**3B**	**3C**	**3D**	**3E**
Seldom	Unlikely to occur Minimal issue identification during focused review	**2**	**2A**	**2B**	**2C**	**2D**	**2E**
Improbable	Highly unlikely to occur	**1**	**1A**	**1B**	**1C**	**1D**	**1E**

With reference to the above chart, the following steps are taken to mitigate some of the major risks identified so far in this project.

i. Engineering and Development
Rating: 2D
Mitigation: Company has experienced personnel and has worked on many similar challenging projects in the past (please see appendix)

ii. Financial
Rating: 2E
Mitigation: The project is well funded by external agencies that worked with this team on prior occasions.

iii. Construction
Rating: 3D

Mitigation: Our company has professional tie-ups with reputed shipyards and boat builders that have delivered similar products in the past (please see appendix)

5.4 MONITORING FRAMEWORK

The work that is carried out would be monitored by employing modern sampling techniques and third party inspections. Some of the testing that would be done to ensure quality service include:

1) Water quality monitoring at regular intervals and locations
2) Submission of project progress reports to intergovernmental agencies as needed
3) Continuous evaluation and improvement steps to achieve project goals

6 CONCLUSIONS

The waterways and rivers in India are at high risk of further pollution if proper steps to remedy are not undertaken. The introduction of one or more RTCs to accomplish the project objectives is of utmost need. Considering the complexities of the issues facing the

Ganga River and its cleanliness, the RTC designed by Highsea Naval Architects would provide a quick and reliable solution. Henceforth, HSNA requests that this proposal presented here be given the highest priority and looks forward for the earliest approval.

7 APPENDIX

7.1 RTC SPECIFICATIONS

Model: 105A2**, Cost:** Rs2.68 CR

Hull dimensions		
Length	35 FT	
Beam	12 FT 8 IN	
Depth	12 FT 4IN	
Draft, fully loaded	8 FT 2 IN	
Operating Dimensions		
Length	45 FT	
Width	15 FT	
Height	14 FT	
Pick-up Capacity		
Width	15 FT	
Depth	2 FT 4 IN	
Storage Capacity		
Weight	14,000 LBS	
Volume	800 CU FT	
Propulsion		
Type	2 hydraulically driven, independent and bi-directional variable speed	
Travel speed	Max 6 knots	
Hydraulic System		
Pumps	2 hydrostatic pumps and one variable piston pump	
Reservoir	150 Gallons	

Model: 105A2**, Cost:** Rs2.68 CR		
Controls	Electro-Proportional	
Electrical System		
Voltage	12 V DC	
Additional Options		
Air Conditioner/Heater	VHF Radio	
Anti-Foul Paint Below WL	Search Light	
RTC Wash Pump		
Note: All dimensions and weights are NET, not including Options. Length is maximum, fully extended. Lead time for delivery is 6 months after issue of PO.		

8 REFERENCES

1. **MARPOL Annex V.**
2. "Design and Fabrication of River Cleaning Machine" by Saifali Sayyad, Adarsh Dorlikar, Sneha Ratnaparkhi, Nikhil Tonge, Tanvi Bhagat, Prof.Mahesh N. Buradkar, published in International Research Journal of Engineering and Technology (IRJET), p-ISSN: 2395-0072, e-ISSN: 2395-0056, Volume: 06, Issue: 05, May 2019.
3. "Remote Operated Floating River Cleaning Machine" by Shrutika Pawar, Sunita Shinde, Jyoti Fatangare, Suyanka Thorat, Vijaykumar published in International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 06 Issue: 04, Apr 2019.
4. "Design And Fabrication Of River Cleaning" by Machine Sheikh Md Shahid Md Rafique, Dr. Akash Langde, published in IJSART, ISSN [ONLINE]: 2395-1052, Volume 3 Issue 11 – NOVEMBER 2017.
5. "Design and fabrication of River Waste Cleaning Machine" by Mr. P. M. Sirsat , Dr. I. A. Khan , Mr. P. V. Jadhav , Mr. P. T. Date, published in International Conference on Science and Engineering for Sustainable Development (ICSESD-2017) (www.jit.org.in), International Journal of Civil, Mechanical and Energy Science (IJCMES), Special Issue-1, ISSN: 2455-5304.
6. "Design and Analysis of River Water Cleaning Machine" by Madhavi N.Wagh, Kashinath Munde, published in July 2018 IJSDR, Volume 3, Issue 7, ISSN: 2455-2631.
7. "STUDY OF RIVER HARVESTING & TRASH CLEANING MACHINE" by Rajendra Patil, Rahul Itnare, Sagar Ahirrao, Amol Jadhav, Ajay Dhumal, published in International Conference on Emerging Trends in Engineering and Management Research-16,ISBN:9788193207475, www.conferenceworld.in, 23rd March 2016.
8. "Design and Fabrication of Project on Water Bodies Cleaning Robot" by Raj Vaibhav Tiwari, Aditya Maheshwari, Dr. M.C. Srivastava, Ashwini Sharma published in International Journal of Engineering and Management Research Page Number: 15-17, ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962, Volume-8, Issue-3, June 2018.
9. "REVIEW OF RIVER CLEANING SYSTEM" by Mr.Abhijeet Ballade, Mr.Vishal Garde, Mr.Akash Lahane, Mr.Pranav Bub, published in International Journal of Innovations in Engineering Sciences and Technology: Mech, vol. 3, issue.1, pp. 20-23, http://www.ijiest.org, ISSN: 2454-8324

9 AUTHORS BIOGRAPHY

Mr. M. Upendra holds the current position of Engineering Director and Co-Founder of Highsea Naval Architects LLC, Texas, USA. And has 10 years of experience in Ship Design and Construction with Bachelors of Engineering in Naval Architecture from Andhra University and a Masters Degree in Naval

Ms. T. Hadassah is a Fulltime Research Scholar in Andhra University, Marine Engineering Department.

Dr. Bh. Nagesh holds the current position of Vice President (Design) of ABG Shipyard Limited. He has been involved in many private and Government projects involving in quality oriented FSO & FPSO & ship Designs and Offshore Structural & piping designs, Construction Supervision etc., assimilating

changes in technology and customer requirements. He has excellent skills in Riser Analysis, Pipe Stress Analysis and Pipe Surge Analysis. He is a good ship and offshore machinery & piping design engineer and has sound knowledge in structural designs of all shipboard machinery, HVAC and Piping designs.

Prof. (Dr.) I.N. Niranjan Kumar is presently holding the position of the Director of Indian Maritime University for its Vizag campus. He was a very senior most Professor of the Department of Marine Engineering, Andhra University College of Engineering, Andhra University. He has been teaching various courses at the graduate and postgraduate level for the last more than two decades. Currently he is involved in many research projects, and specializes in the areas of Thermodynamics and Heat Transfer subjects and related research activities. He is also the Chairman Board of Studies in Andhra University and member in various selection committees.