Template/Pro forma for Submission

NMHS-FINAL TECHNICAL REPORT (FTR)

Demand-Driven Action Research Project Grant

NMHS Reference No.:	**KU/NMHS/MG/2016/002 /8603/007**	**Date of Submission:**	0 1 0 9 2 0 2 0 **d d m m y y y y**

PROJECT TITLE (IN CAPITAL)

ENVIRONMENTALLY SUSTAINABLE SMART SYNTHESIS OF CARBON NANO MATERIAL ALONG WITH THE PRODUCTION OF HIGH VALUE ADDED FUEL AND ADDITIVES FOR THE CONCRETE MIXTURE FROM WASTE PLASTIC, A HAZARDOUS WASTE AROUND THE HIMALAYAN REGION

Project Duration: 1st April 2016 to 31st March 2020

Submitted to:

Er. Kireet Kumar, Scientist 'G' and Nodal Officer, NMHS-PMU
National Mission on Himalayan Studies, GBPNIHESD HQs
Ministry of Environment, Forest & Climate Change (MoEF&CC), New Delhi
E-mail: nmhspmu2016@gmail.com; kireet@gbpihed.nic.in; subratabose@nic.in

Submitted by:

Dr. Nanda Gopal Sahoo (Professor)
In- charge PRS-Nanoscience & Nanotechnology Centre
Department of Chemistry, Kumaun University, Nainital
Contact No:9149135437, E-mail: ngsahoo@yahoo.co.in

NMHS-Final Technical Report (FTR) template

Demand-Driven Action Research Project

DSL: Date of Sanction Letter

3	1	0	3	**2**	**0**	**1**	**6**
d	d	m	m	y	y	y	y

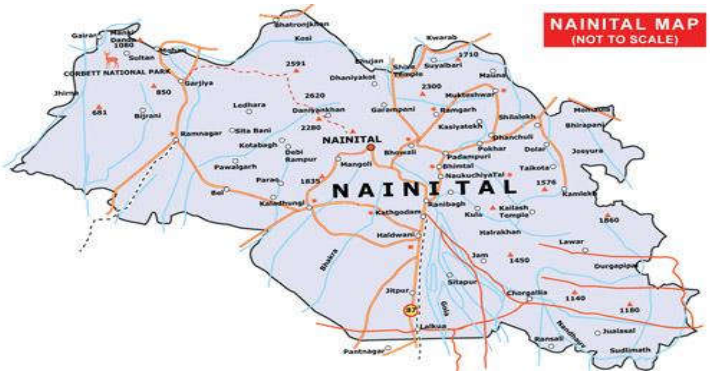
DPC: Date of Project Completion

3	1	0	3	**2**	**0**	**2**	**0**
d	d	m	m	y	y	y	y

Part A: Project Summary Report

1. Project Description

i.	Project Reference No.	KU/NMHS/MG/2016/002 /8603/007
ii.	Type of Project	Medium Grant
iii.	Project Title	ENVIRONMENTALLY SUSTAINABLE SMART SYNTHESIS OF CARBON NANO MATERIAL ALONG WITH THE PRODUCTION OF HIGH VALUE ADDED FUEL AND ADDITIVES FOR THE CONCRETE MIXTURE FROM WASTE PLASTIC, A HAZARDOUS WASTE AROUND THE HIMALAYAN REGION
iv.	State under which Project is Sanctioned	Uttrakhand

v.	Project Sites (IHR States covered) (Maps to be attached)	
vi.	Scale of Project Operation	Regional
vii.	Total Budget/ Outlay of the Project	1.98000 + 0.27088(one year extension) = 2.25088 (in Cr)
viii.	Lead Agency	Kumaun University Nainital, Uttrakhand, India
	Principal Investigator (PI)	Prof. Nanda Gopal Sahoo, PRS-NSNT Departement of Chemistry Kumaun University Nainital, Uttrakhand, India.
	Co-Principal Investigator (Co-PI)	(i) Prof. A.B.Melkani, Head Department of Chemistry, DSB Campus, Kumaun University, Nainital (ii) Prof. S.P.S. Bisht, Department of Zoology, DSB Campus, Kumaun University, Nainital (iii) Dr. Mahendra Rana, Department of Pharmacy, Bhimtal Campus, Kumaun University, Nainital
ix.	Project Implementing Partners	Kumaun University Nainital, Uttrakhand, India Progank Society Nainital

	Key Persons / Point of Contacts with Contact Details, Ph. No, E-mail	Prof. Nanda Gopal Sahoo PRS-NSNT Centre, Department of Chemistry Kumaun University Nainital, Uttrakhand, India. Mobile No +919149135437 Email- ngsahoo@yahoo.co.in

2. Project Outcome

2.1. Abstract (not more than 500 words) [it should include background of the study, aim, objectives, methodology, approach, results, conclusion and recommendations).

Through this project, we have developed and implemented unique process to control and convert the waste plastic into value added products such as graphene and fuels. The graphene nanosheets obtained from the waste plastic have many advantages because it further can be used for many applications such as fabrication of graphene based electrode for supercapacitor, solar cell and water purification as well as in development of high standard concrete mixtures etc. The very first year of the projects started with appointment of the project staff, followed by literature review, collection of the waste plastic and its categorization along with conduction of several awareness programs. Further, as we knew the plastic contains carbonic structure which leads up the possibility to convert it into structural allotrope of carbon. Our method to produce graphene from waste plastic is a very cost effective and environment friendly route for solving the problems related to plastic pollution. Thus in depth the waste plastic was collected, segregated, chopped and finally processed through two step high temperature catalytic pyrolysis. For such high temperature catalytic pyrolysis process, the establishment of **SWAYAMBHU-WRM-2021** i.e. waste recycling machine was done in the very next phases which work on the two step pyrolysis approaches. The impactful objectives of the project included the collection of required raw materials in the form of waste plastic, conduction of knowledgeable awareness programs and seminars, synthesis of graphene, production of value added fuels, and their characterization. Further the value added nanomaterials such as graphene nanosheets were utilized in concrete mixture, water purification and supercapacitors application. The expertise of the work was explored in various national and international stages that include publications of research articles in different journals, filling of patents, presenting the work in various conferences (National and International). At the conclusive point, we obtained the graphene nanosheets from plastics waste which was further characterized through various characterization techniques such as RAMAN, FT-IR, XRD, TEM, SEM/EDX, TGA. In addition, optimization and characterization of waste plastic obtained fuels has been done during this project work, which was obtained as the secondary product. While their calorific values were characterized and evaluated by Bomb Calorimeter. During this project, we developed graphene nanosheets as the additives for the making of high standard concrete with tremendously enhanced strength and lifetime of cementing concrete. In addition, we have also used the synthesized graphene nanosheets for the fabrication of supercapacitor and evaluated their electrochemical performance as well as used for fuel cell and solar cell applications. The very last phase awareness campaign has been conducted successfully along with various knowledgeable workshops. We have published **16** research articles including two book chapters so far in reputed international journals, while **41** research articles were presented in national and international conferences.

Prof. Nanda Gopal Sahoo was awarded by **8th National Award for Technology Innovation from Ministry of Chemicals and Fertilizers, Department of Chemicals and Petrochemicals, Govt. of India, in 2018.** Research students also received many young scientist awards on this work. We have successfully filled two patents in Indian Patent Office New Delhi, and we have also successfully transferred our technology of bulk production of graphene from waste plastic to industry (i.e. HEXORP PVT. Limited) through NRDC and Ministry of Environment, Forest and Climate Changes.

Recommendations:

1. The waste recycling machines WRM-2021 need to be installed in the entire IHR regions of India.

2. The communication linkages need to be made in order to create more awareness among the common people of the society.

2.2. Objective-wise Major Achievements

S. No.	Objectives	Major achievements (in bullets points)

	To synthesis Graphene from the plastic waste for the energy and biomedical applications and to develop new cheaper and greener techniques for the mass production of Graphene from plastic waste.	• The SWAYAMBHU WRM-2021 has been established at centre • The production and characterisation of graphene nanosheets have been done successfully • Prof. Nanda Gopal Sahoo was awarded by 8th National Award for Technology Innovation from Ministry of Chemicals and Fertilizers, Department of Chemicals and Petrochemicals, Govt. of India, in 2018. • The technology of mass production of graphene from waste plastic has been successfully transferred to HEXORP LTD. PVT. • Total 16 research articles have been published so far in different international journals and two patents were filled and were published online.
	Conversion and collection of the fuel from the plastic waste for the automobile and other similar industrial applications using the same, by using specially design multipurpose incinerator (furnace)	• The conversion of fuels from waste plastics has been done. • In addition, purification of fuels through fractional distillation has been done. • Through this process, we are getting the 25-40% of fuel which depends upon types of plastics and catalyst used during the process.
	As the secondary stage plastic (semi liquid plastic) to be utilized for making additives for high standard concrete	• We have successfully enhanced the strength of concrete mixture by using the synthesized graphene nanosheets and tested it through 1000 kN Universal Testing Machine (UTM) which showed 43% enhancement in mechanical and 30% enhancement in tensile strength.

	To conduct the awareness programs at the various region of project site to aware the community of that site about the hazardous effect of plastics by NGO	• We have conducted more than 20 awareness programs in the duration of this project at different areas of IHR.
	Graphene for the energy application (Extension period)	• We have used the synthesized graphene nanosheets for the fabrication of high performance supercapacitor. In addition, this graphene nanosheets also used for the fabrication of solar cells. • Through this, we have achieved the highest capacitance of 377 F/g.

2.3. Outputs in terms of Quantifiable Deliverables*

S. No.	Quantifiable Deliverables*	Monitoring Indicators*	Quantified Output/ Outcome achieved	Deviations made, if any, and Reason thereof:
1.	The collection of the waste plastic and its categorization. Conduction of awareness programs and establishment waste recycling machine.	The segregation should be done at the time of waste collection as the machine dos not have segregation unit.	SWAYAMBHU-WRM-2021, fabricated and established. More than 20 awareness campaigns have been conducted on different location of the state.	NA
2.	Production of carbon nanomaterials such as	Instrument needed to be	The production of graphene was	NA

	graphene and value added fuel from the waste plastic.	handled carefully.	successfully achieved along with fuels.	
3.	Characterization of graphene by advanced spectroscopic and microscopic techniques.	Graphene should be washed by double distilled water and should be oven dried before performing any characterizations.	The spectroscopic and microscopic characterization such as RAMAN, FTIR, XRD, TEM, SEM/EDX, TGA has been done for the qualitative verification of graphene.	NA
4.	Characterization of value added fuels.	Needs to be handled more carefully as they are readily inflammable. Before processing fuel should be distilled if requirement are for any specific kind of fuel.	The calorific values of fuels were tested through Bomb Calorimeter	NA
5.	Development of nano reinforced cementing concrete mixture along with its characterization.	In order to make proper concrete with high strength, we need to follow Indian concrete Mixture guidelines of Civil Engineering	While for cementing mixture Universal Testing Machine (UTM) data wads followed the result showed excellent enhancement in compression and	NA

		Department of India.	tensile strength of concrete materials.	
6.	Development of graphene based electrode for supercapacitors application.	Electrochemical studies are performed on two electrode system can also be done on three electrode system or by varying the electrolyte for better performance.	Electrochemical performance testing of developed electrode has been done and reported with 377 F/g capacitance.	NA

(*) As stated in the Sanction Letter issued by the NMHS-PMU.

2.4. Strategic Steps with respect to Outcomes (in bullets)

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document
1.	New Methodology developed:	• Two • We have successfully developed the process for the mass scale synthesis of graphene from waste plastic. • We have also developed the process for the synthesis of potassium doped graphene oxide sheets from agriculture waste.	Patent filed: 1. N. G. Sahoo, Sandeep, M. Karakoti, V.D.Punetha, "A process of manufacturing Graphene", Application No. 201611016081. 2. N.G. Sahoo, C. Tewari, S. Pande, M. Karakoti, S. Dhali, H. Tewari, G. Tatrari, A.B. Melkani, "Hydro-Solvo-Thermal Graphene Oxide Synthesis Method", Application No. *202011011434*. (See appendix II)

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document
2.	New Models/ Process/ Strategy developed:	We have developed the process for the mass synthesis of graphene with cost friendly and environment friendly manner also utilised the graphene into concrete materials, supercapacitors and water purification technology. We have also developed the process for the synthesis of potassium doped graphene oxide sheets from agriculture waste.	Kindly see section 4.1 of Final Technical Details Part B. For more details the filed Patent can be followed. 1. N. G. Sahoo, Sandeep, M. Karakoti, V.D.Punetha, "A process of manufacturing Graphene", Application No. 201611016081. 2. N.G. Sahoo, C. Tewari, S. Pande, M. Karakoti, S. Dhali, H. Tewari, G. Tatrari, A.B. Melkani, "Hydro-Solvo-Thermal Graphene Oxide Synthesis Method", Application No. *202011011434*.
3.	New Species identified:	NA	NA

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document
4.	New Database established:	12-15% graphene was produced form utilizing waste plastic and 25-40% fuels were obtained varying with type of plastic used.	(See appendix II) Pandey, S., Karakoti, M., Dhali, S., Karki, N., SanthiBhushan, B., Tewari, C., Rana, S., Srivastava, A., Melkani, A.B. and Sahoo, N.G., 2019. Bulk synthesis of graphene nanosheets from plastic waste: An invincible method of solid waste management for better tomorrow. Waste management, 88, pp.48-55. (I.F. 5.431)
5.	New Patent, if any:		

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document
	• Filed (Indian/ International)	2 Indian	N. G. Sahoo, Sandeep, M. Karakoti, V.D.Punetha, "A process of manufacturing Graphene", Application No. 201611016081. Nanda Gopal Sahoo**,** Chetna Tewari, **Sandeep Pandey**, Manoj Karakoti, Sunil Dhali, Himani Tewari, Gaurav Tatrari, Anand B Melkani, "Hydro-Solvo-Thermal Graphene Oxide Synthesis Method", Application No. 202011011434. Publication Date: 27-03-2020. (See appendix II)
	• Granted (Indian/ International)		

S. No.	Particulars	Number and Brief Details	Details of Attachment/ Supporting Document
	• Technology Transfer(if any)	1	Transferred to HEXORP PVT. LTD. See appendix II
6.	Others (if any):	NA	NA

3. Technological Intervention

S. No.	Type of Intervention	Brief Narration on the interventions	Unit Details (No. of villagers benefited / Area Developed)
1.	Development and deployment of indigenous technology	We showed new routes for the conversion of waste plastic into advance carbon based materials by concise utilisation of nanotechnology.	We have covered different IHR sites especially of Nainital district, conducting awareness campaign including Ramnager, Garampani, and Haldwani etc. While some awareness campaigns connecting the society have been conducted in various other districts of the IHR such as in Pithoragarh districts and Bageshwar district.

2.	Diffusion of High-end Technology in the region	Nanotechnology that has been followed during project, hopefully it will also continue to benefit the society in coming future.	The city of lakes Nainital has been benefitted the most with our technology so far.
3.	Induction of New Technology in the region	The SWAYAMBHU WRM-2021 is nano technological innovation which does not have any harmful consequences to the environment and ecology, beside that it has several crucial direct benefits to the society.	NA
4.	Publication of Technological / Process Manuals	Two Indian patents were filled and 16 articles relating to the research have been published so far in different international journals so far during this project.	NA

	Others (if any)	Successfully transferred our technology to industry HEXORP PVT. LTD.	NA

4. New Data Generated over the Baseline Data

S. No.	New Data Details	Status of Existing Baseline	Additionally and Utilisation New data
1.	Graphene from waste plastic	12-15 wt% of graphene was obtained	The percentage can be enhanced utilizing kind of plastic, temperature, pressure and catalyst used
2.	Value added fuels from waste plastic	25-40% of crude oil can be obtained other than graphene and gases depending upon kind of plastics.	The percentage can be enhanced utilizing kind of plastic, temperature, pressure and catalyst used
3.	Highly compressive and tensile cementing concrete materials	43% enhanced compression strength and 30% enhanced tensile strength have been obtained.	The developed extra strengthen concrete can be used for building purpose.
4.	Electrode materials for supercapacitors	377 F/G specific capacitance was reported for graphene based supercapacitors.	The supercapacitors can be made by using the material.

5. Demonstrative Skill Development and Capacity Building/ Manpower Trained

S. No.	Type of Activities	Details with number	Activity Intended for	Participants/Trained			
				SC	ST	Woman	Total

1.	Workshops	2	Plastic pollution and graphene	NA	NA	NA	500
2.	On Field Trainings	2	Plastic pollution	NA	NA	NA	300
3.	Skill Development	5	Innovation in nanotechnology	NA	NA	50%	500
4.	Academic Supports	NA	NA	NA	NA	NA	NA
	Others (if any)	NA	NA	NA	NA	NA	NA

6. Linkages with Regional & National Priorities (SDGs, INDC, etc)/ Collaborations

S. No.	Linkages /collaborations	Details	No. of Publications/ Events Held	Beneficiaries
1.	Sustainable Development Goal (SDG)	The methodology of waste plastic to graphene nanosheets followed during this project was very sustainable as it has very low budget processing and easy access of the raw material.	Two scientific workshops were conducted for the demonstration of our technology to the inspire students.	Society and students

2.	Climate Change/INDC targets	This project not only eliminates the problem of waste plastic pollution beautifully without producing any harmful effects to the environment. The greener methodology along with production of advanced products such as graphene and fuels, defines the worth of this project regarding to the climatic changes.	One article was published in international journals of waste management having impact factor of 5.8.	Global society
3.	International Commitments	'Save earth and say no to plastic' such campaigns are highlighted by our project.	We have successfully conducted international conference for the demonstration of our expertise on the topic ICEFN & SEM 2019.	Research scholars, students, teachers and scientists
4.	Bilateral engagements	NA	NA	NA

5.	National Policies	The project was sincere effort to follow some missions of GOI, such as **'Clean India mission'**, '**Say no to single used plastic'** etc.	We have conducted more than 15 awareness campaigns to create awareness among local and region population.	Society (local and national)
6.	Others collaborations	NA	NA	NA

7. Project Stakeholders/ Beneficiaries and Impacts

S. No.	Stakeholders	Support Activities	Impacts
1.	Gram Panchayats	The gram panchayats were exclusively affected by then project as we have conducted various awareness workshops in rular areas to implement our knowledge and aware the villagers.	Fruitful results can be expected in near future.
2.	Govt Departments (Agriculture/ Forest)	The forests and biodiversity is directly influenced by positive correlation of our project to the human society.	Various animals and plants can be saved from their extinction due to waste plastic pollution.
3.	Villagers	The livelihood options of several villagers were enhanced by directly inclusion of the project to the society. This worked exclusively in the way to their benefits.	The economical boost might be expected if the project will be implemented at mass scale by government.
4.	SC Community	Directly connects to the each poor population of the society.	Betterment can be expected in near future.

5.	ST Community	Directly connects to the each poor population of the society.	Betterment can be expected in near future.
6.	Women Group	Directly connects the gender equality of the huge proportion of the rular society.	Improvement expected in near future.
	Others (if any)	NA	NA

8. Financial Summary (Cumulative)

S. No.	Financial Position/Budget Head	Funds Received	Expenditure/ Utilized	% of Total cost
I.	Salaries/Manpower cost	39,55,059.00	37,55,156.00	94.95
II.	Travel	7,21,120.00	7,99,295.00	110.84
III.	Expendables &Consumables	20,00,000.00	25,99,541.00	129.97
IV.	Contingencies	5,05,559.00	9,00,000.00	178.02
V.	Activities & Other Project cost	20,000,00.00	25,99,741.00	129.98
VI.	Institutional Charges		5,00,000.00	--
VII.	Equipments	1,09,00000.00	1,09,04,416.00	100.04
	Total	2,00,81,738.00	2,20,58,149.00	109.08
	Interest earned	5,09,172.00		
	Grand Total	2,05,90,910.00		

* Please attach the consolidated and audited Utilization Certificate (UC) and Year wise Statement of Expenditure (SE) separately, ref. **Annexure I.**

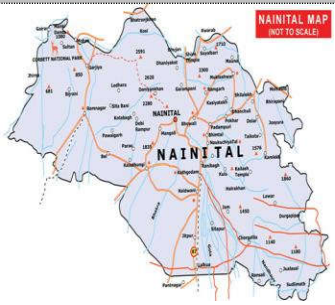
9. Major Equipment/ Peripherals Procured under the Project** (if any)

S. No.	Name of Equipments	Cost (INR)	Utilisation of the Equipment after project

1.	Swayambhu WRM-2021	64,00,000.00	For recycling of waste plastic into graphene, value added fuels and natural household gases.
2.	TGA-DSC	34,01,239.00	To check the thermogravimetric stability of obtained material./ To check the dispersion behaviours of obtained material.
4.	OVEN	98,775.00	Heating
5.	UTM	3,04,500.00	For compression and tensile strength testing
6.	BOMB CALORIMETRE	2,80,152.00	To check and identify the Calorific values of fuel.
7.	SONICATOR	99,500.00	To ultrasonic mixing of any solution or mixture.
8	DIGITAL VISCOSITY METER	3,20,250.00	To check the viscosity of fuels.

Details should be provided in details **(ref **Annexure III &IV).**

10. Quantification of Overall Project Progress

S. No.	Parameters	Total (Numeric)	Details of Attachments/ Supporting Documents
1.	IHR States Covered	01	
2.	Project Site/ Field Stations Developed	01	
3.	New Methods/ Modeling Developed	02	 

4.	No. of Trainings arranged	02	
5.	No of beneficiaries attended trainings	NA	NA
6.	Scientific Manpower Developed (Phd /M.Sc./JRF/SRF/ RA):	10	See Annexure V
7.	SC stakeholders benefited	NA	NA
8.	ST stakeholders benefited	NA	NA
9.	Women Empowered	07	Neema Pandey Himani Tewari Seema Bhandari Monika Matiyani Neha Karki Chetna Tewari Anita Rana
10.	No of Workshops Arranged along with level of participation	02	DST INSPIRE Camp, B.Tech student from Graphic Era University and for students of Sainik School, Nainital.
11.	On-field Demonstration Models initiated	02	We have successfully synthesised the graphene nanosheets from waste plastic, which has been demonstrated for the dye removal and water

			purification applications.
12.	Livelihood Options promoted	02	The livelihood options of waste plastic collectors and regional waste plastic cleaners, sellers and rular population have been increased direct inclusion of this project to the society.
13.	Technical/ Training Manuals prepared	02	We have trained various students via conduction of international conference and different innovative workshops.
14.	Processing Units established	01	
15.	No of Species Collected	NA	NA
16.	New Species identified	NA	NA
17.	New Database generated (Types):	Graphene Value added fuels Extra strengthen concrete mixture Supercapacitor electrode	See section 4 of Final technical Report Part B. See appendix II
	Others (if any)	NA	NA

11. Knowledge Products (KPs) and Publications

S. No.	Knowledge Products (KPs)/ Publication	Number		Total Impact Factor	Remarks/ Enclosures
		National	International		

S. No.	Knowledge Products (KPs)/ Publication	Number		Total Impact Factor	Remarks/ Enclosures
		National	International		
1.	Journal Research Articles/ Special Issue:		14	2.5	All the papers Are published in international journals (See appendix II)
2.	Book Chapter(s)/ Books:		2	NA	See appendix II
3.	Technical Reports		1	NA	NA
4.	Training Manual (Skill Development/ Capacity Building)		14	NA	See appendix II
5.	Papers presented in Conferences/Seminars		41	NA	NA
6.	Policy Drafts/Papers		5	NA	NA
7.	Others:		NA	NA	NA

*Please append the list of KPs/ publications (with impact factor and further details) with due Acknowledgement to NMHS.

12.1. Success Model(s)/ Best Practice(s) under the Project:

Parameters	**Description**	**Details of Attached supporting documents**

(1) Adaptability of the Technology:	The technology of mass production of graphene and value added fuels from waste plastic and its further utilization into concrete mixture and energy applications can be adapted for the good of society. It will not only turn on the '**trash to treasure'** aspect of technology but also the easy and low budget costing adaptability enhances its candidature for upgradation of Himalayan region to other parts of India.	Nanda Gopal Sahoo, **Sandeep,** Manoj Karakoti and Vinay Deep Punetha; "A Process of Manufacturing Graphene", Patent Application No.: 201611016081. For document kindly see: (See appendix II)

(2) Acceptability (interest of the local people):	• Due to low cost processing of **SWAYAMBHU WRM-2021** it can work as the economy booster that will ultimately connect to the livelihood options of local peoples of the Himalayan region. • Thus the technology is very acceptable and interesting for the society as nanotechnology and its implementation are still very new to India.	Pandey, S., Karakoti, M., Dhali, S., Karki, N., SanthiBhushan, B., Tewari, C., Rana, S., Srivastava, A., Melkani, A.B. and Sahoo, N.G., 2019. Bulk synthesis of graphene nanosheets from plastic waste: An invincible method of solid waste management for better tomorrow. Waste management, 88, pp.48-55. (I.F. 5.431) For document kindly see: (Annexure II)
(3) Improvement in Ecological Variables:	The technology is boosting the ground level feeders of the society by providing them an option to create their financial wealth.	Kindly see technology transfer documents. For document kindly see: (Annexure II)
(4) Baseline Data and Comparison with the Controlled Data:	See Final Technical Report Part B	See Final Technical Report Part B

(5) Outcomes of the Scientific Publications, Knowledge Products:	16 research papers which include two book chapters have been published so far in international journals in the duration of this project. While our expertise was expressed by us in 41 national or international level conferences along with this we have filled two patents and both were published online.	See Final Technical Report Part B For document kindly see: (Annexure II)

12.2. Recommendation on Utility of Project Findings, Replicability and Exit Strategy

Particulars	Recommendations
Utility of the Project Findings:	The findings of this project are very useful in socio-economic aspects of Himalayan region and to control the problems related to waste plastic and its distribution in different region of Himalayas. The production of graphene not only controls the waste plastic problems but also it provides the necessary livelihood option to the rular societies of the Himalayan region. While the alternate production of the fuels and highly strengthen concrete mixture is excellent boost for other infrastructural developments and related technologies.
Replicability of Project:	The project can be implemented as mass scale by projecting SWAYAMBHU WRM -2021 at various locations of India to control the waste plastic situation. It will also provide the livelihood option to the Himalayan people along with neat and clean environment.

Exit Strategy:	The fruitful outcomes of the project will be helpful into withdrawal the plastic based problem and will result it into the value added products. Due to drastic reach of plastics over the huge range of IHR, thus in near future it can change the ecologies and biological divergence of the IHR. In this regards, all the IHR regions must have well organized system to reduce the presence of plastics in the environment. This project was a beautiful demonstration of waste upcycling into value added products which can enhance the livelihood options of the regional people.

Forwarded

विभागाध्यक्ष
रसायन विज्ञान विभाग
कुमायूँ विश्व विद्यालय नैनीताल

(Dr. Nanda Gopal Sahoo)
(PROJECT PROPONENT/ COORDINATOR)
Department of Chemistry
D.S.B. Campus, Nainital
(Signed and Stamped)

(HEAD OF THE INSTITUTION)

Forwarded

21.08.2020

Dean
Faculty of Science
Kumaun University
Nainital

Registrar
Kumaun University
NAINITAL.
(Signed and Stamped)

Place: Nainital

Date: 20/08/2020