HETERO LABS LIMITED (UNIT-III)
S.No. 120 & 128, 150 (PART), 150/1, 151/2, 158/1,
N.Narasapuram (Village),
Nallamattipalem (V), Nakkapalli (Mandal),
Anakapalli (Dist) - 531 081., A.P., INDIA.
Tel : +91 891 2877900, Fax: +91 891 2877933
CIN: U24110AP1989PLC009723

27th May 2024

Letter NO: HLL-III/EHS/MoEF&CC/2024-25/02

Joint Director (S)
Integrated Regional Office (IRO),
Ministry of Environment, Forest & Climate Change,
Green House complex, Gopala Reddy Road,
Vijayawada - 520010,
Andhra Pradesh.

Dear Sir,

Sub : Submission of six-monthly compliance report of CRZ Clearance issued to M/s Hetero Labs Ltd, Unit-III Nakkapalli, Visakhapatnam –Regarding

Ref : CRZ Clearance vide Letter No: 11-54/2006-IA.III dated 04th January 2007

With reference to the above, please find enclosed six-monthly compliance report of CRZ clearance of M/s Hetero Labs Ltd, Unit-III for the period **1st October 2023 to 31st March 2024** with all necessary enclosures for your kind information and perusal.

You are requested to kindly acknowledge the receipt.

Thanking you,

Yours faithfully,
For Hetero Labs Ltd, Unit-III

S. Kullayi Reddy
Associate Vice President -EHS

Enclosures : As above

COMPLIANCE TO THE CONDITIONS OF CRZ CLEARANCE VIDE LETTER NO. 11-54/2006-IA.III DATED 04TH JANUARY 2007

COMPLIANCE PERIOD: 1ST OCTOBER 2023 TO 31ST MARCH 2024

S.NO	CONDITION	COMPLIANCE
Section- A (Specific conditions)		
i	All the conditions stipulated by environment department, Government of Andhra Pradesh as contained in their letter No. 3013/SADA/2006, dated 14.09.2006 should be effectively implemented. The project shall be implemented in such a manner that there is no damage whatsoever to the mangroves/other sensitive coastal ecosystems. If any damage to mangroves is anticipated/ envisaged as a result of project activities, then the clearance now being accorded shall stand cancelled and the proponents may seek fresh approval from the ministry.	**Complied.** The industry has implemented all the conditions in letter No. 3013/SADA/2006, dated 14.09.2006 issued by the Environment Department, Gove of Andhra Pradesh. Copy of the compliance report is enclosed as **Annexure-I.** There are no mangroves and other sensitive ecological issues in the project area.
ii	All the conditions stipulated by Andhra Pradesh pollution control board vide their order No. 137/PCB/RO-VSP/CFE/HO/2006- 476, dated 22.06.2006 should be effectively implemented.	**Complying.** The industry has complied with all the conditions given in the CFE order No. 137/PCB/RO-VSP/CFE/HO/2006- 476, dated 22.06.2006 issued by APPCB. Copy of the compliance report is enclosed as **Annexure-II.**
iii	A continuous and comprehensive post-project marine quality-monitoring programme should be taken up. This should include monitoring of water quality, sediment quality and biological characteristics covered in the EIA studies.	**Complied.** The industry has been conducting the "post-project marine quality monitoring" through National Institute of Oceanography regularly and the reports are being submitted to the RO, MoEF&CC along with six monthly compliance reports. The monitoring programme is inclusive of monitoring of water quality, sediment quality and biological characteristics covered in the EIA studies. Copy of the latest monitoring report is enclosed as **Annexure-III.**
iv	It should be ensured that no activities are taken up in the forest area till necessary forest clearance is obtained and furnished to this ministry. Adequate measures for compensatory afforestation must be taken accordingly.	**Not Applicable.** There is no forest land in the project area and hence not obtained the approval from forest department.
v	It shall be ensured that there is no displacement of people, house or fishing activity as a result of the project.	**Please refer below:** There are no villages, habitation or houses in the project area and hence there is no displacement of people as a result of the project.
vi	It shall be ensured that due to the project, there is no adverse impact on the drainage of the area and recharge of groundwater. No groundwater should be tapped in the	**Complied.** The project is for laying of pipeline for disposal of treated effluent into Sea through

	project area falling in coastal regulation zone.	marine outfall. Hence there is no adverse impact on the drainage of the area and recharge of groundwater. No groundwater is being tapped in the project area falling in coastal regulation zone.
vii	The project proponent must ensure that the effluents/ liquid waste discharged are as per the standards laid down by the Andhra Pradesh Pollution Control Board.	**Complied.** The industry is disposing the treated effluent into sea through marine disposal in the presence of APPCB officials after meeting the standards laid down by the Board. Online Effluent Monitoring System (OCEMS) is installed and connected to both APPCB & CPCB websites.
viii	The camps of labour shall be kept outside the coastal regulations zone area. Proper arrangements for cooking fuel shall be made for the labour during construction phase so as to ensure that mangroves are not cut/ destroyed for this purpose.	**Please Refer Below:** There were no labour camps for the execution of the project and there are no mangroves in the project area.
ix	The entire stretch of the pipelines shall be buried underground except at the booster pumping station, which will be properly fenced, and the station would be manned round the clock. The buried lines will be protected with anticorrosive Coaltar based coating. The coating will be tested in accordance with prescribed standards.	**Please refer below:** The MOC of the pipeline used for the project is HDPE and hence no coaltar coating is required. The pipelines are buried underground at a safer depth all along the pipeline route. No booster pump is installed in the pipeline routing.
x	Markers shall be installed at every 30m to indicate the position of the line. Regular patrolling of the pipeline needs to be done. This will help in identifying any activity that have the potential to cause pipeline damage or to identify small leaks whose effects are too small to be detected by instrument.	**Complied.** The entire pipeline is passing through the land of Hetero and regular patrolling is being carried along the pipeline to check the condition of pipeline. Pipeline is crossing the creek and one village public road where pipeline has been buried at safe depth and display boards have been installed at the crossing of creek & Road. Photographs of the display Boards are enclosed as **Annexure-IV.**
xi	There should be display boards at critical locations along the pipeline viz. road/rail/river crossings giving emergency instructions as well as contact details of M/s. Hetero Labs Limited. This will ensure prompt information regarding location of accident during any emergency. Emergency information board should contain emergency instructions in addition to contact details.	**Complied.** Indication Boards are installed at the crossing of creek & Road. The photographs of the display boards are enclosed as **Annexure-IV.** The concerned personnel of the Environment Department are doing the surveillance rounds and they are having the contact details of the concerned personnel to inform about the leakages.
xii	All issues raised in the public hearing conducted for the project on 16.02.2006 should be comprehensively addressed.	**Complied.** The issues raised in the public hearing dated 16/02/2006 have been addressed and fulfilled.

Section-B (General Conditions)		
i	Construction of the proposed structures should be undertaken meticulously confirming to the existing central/local rules and regulations. All the construction designs/drawings relating to the proposed constructions activities must have approvals of the concerned state government department/ Agencies.	**Please refer below:** There are no construction activities along the pipeline project except excavation for laying the pipeline.
ii	The project authorities should take appropriate community development and welfare measures for the villagers in the vicinity of the project site, including drinking water facilities. A separate fund should be allocated for this purpose.	**Complying.** The industry is carrying several community development and welfare measures for the villagers in the vicinity of the project site, including drinking water facilities. Separate budget is being allocated for the CSR activities. Copy of the CSR activities taken up by the industry is enclosed as **Annexure -V.**
iii	To meet the emergency situation, appropriate firefighting system should be installed. Appropriate arrangements for uninterrupted power supply to the environment protection equipment and continuous water supply for the firefighting system should be made.	**Please refer below:** There is no scope of fire in the project area as the project is only laying of pipeline. There is no chance of fire in the project. However, the industry has installed appropriate firefighting facilities to the entire facility.
iv	A separate Environment Management Cell with suitably qualified staff to carry out various environment related functions should be set up under the charge of a Senior Executive who will report directly to the Chief Executive of the Company.	**Complied.** Separate Environment Management cell has been set up to carry out the functions related to Environment. The environment department is headed by Associate Vice President and supported by qualified staff of 70 people.
v	The funds earmarked for environment protection measures should be maintained in a separate account and there should be no diversion of these funds for any other purpose. A year wise expenditure on environment safeguards should be reported to this Ministry's Regional Office at Bangalore.	**Complied.** The funds earmarked for environment are being spent for environment protection only. Year wise expenditure on safeguards will be submitted to the Ministry's Regional Office.
vi	Full support should be extended to the officers of this Ministry's Regional Office at Banglore and the officers of the Central and State Pollution control Board by the project proponents during their inspection for monitoring purposes, by furnishing full details and action plans including the action taken reports in respect of mitigative measures and other environmental protection activities.	**Complying.** The industry is extending its full support and furnishing all the details & action plans including the action taken reports in respect of mitigative measures and other environmental protection activities to the officers of this Ministry's Regional Office and the officers of the Central and State Pollution control Board during their inspections for monitoring purpose.
vii	In case of deviation or alternation in the project including the implementing agency, a fresh reference should be made to this Ministry for modification in the clearance	**Noted and agreed upon.**

	conditions or imposition of new one for ensuring environmental projection. The project proponents should be responsible for implementing the suggested safeguard measures.	
viii	The Ministry reserves the right to revoke this clearance, if any of the conditions stipulate are not complied with to the satisfaction of this Ministry.	**Noted and agreed upon.**
ix	This Ministry or any other competent authority may stipulate any other additional conditions subsequently, if a deemed necessary, for environmental protection, which shall be complied with.	**Noted and agreed upon.**
x	A copy of the clearance letter shall be marked to the concerned Panchayat / local NGO, if any, from whom any suggestion / representation has been received while processing the proposal	**Complied.** Copy of the clearance letter has been submitted to the Panchayat.
xi	State Pollution Control Board / Committee should display a copy of the clearance letter at the District Industries Center and Collector's Office / Tahsildar's Office for 30 days	---
xii	The project proponent should advertise at least in two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned informing that the project has been accorded environmental clearance and copies of clearance letters are available with the Andhra Pradesh State Pollution Control Board and may also be seen at website of the Ministry of Environment and Forests at http//www.envfor.nic.in/.	**Complied.** The industry has advertised regarding the clearance in two local newspapers after obtaining the clearance.
xiii	The project proponents should inform Regional Office, Banglore as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of start of work.	**Not Applicable.** Own funds are being utilised for the project.
xiv	The project proponent will obtain the Forest clearance for the land passing through the Reserved Forest area before commencement of the project activities in forest area	**Not Applicable.** There is no reserve forest area along the pipeline routing. The entire pipeline is passing through the Company's land.
xv	So as the maintain ecological features and avoid damage to the ecosystem, movement of vehicles in the Inter Tidal Zone shall be restricted to the minimum.	**Complied.** There is no vehicle movement in the Inter Tidal Zone for laying the pipeline.
xvi	Budgetary break up for Environmental Management Plan for the project to be mentioned.	The budget for the Environmental Management Plan is common for the entire facility.

HETERO LABS LTD, UNIT-III

Compliance to the conditions of conditions in letter issued by the Environment Department, Govt. of Andhra Pradesh vide letter No. 3013/SADA/2006, dated 14.09.2006.

S.NO	CONDITION	COMPLIANCE
I	The proposed pipeline shall conform to the norms prescribe the CRZ notification issued by the Ministry of Environment and Forest, Government of India S.O.No. 114(E), dated 19-02-1991.	**Complied.** The pipeline has been laid as per the norms prescribe in the CRZ notification issued by the Ministry of Environment and Forest, Government of India.
II	No activity on ground shall be undertaken without obtaining environmental clearance from the Ministry of Environment and Forest, Government of India as per S.O.No. 114(E), dated 19-02-1991 and the amendments issued thereof.	**Complied.** All works have been carried after getting the Environmental Clearance from MoEF&CC.
III	The industry shall be discharges the treated effluents into the sea through a submarine outfall as recommended by the National Institute of Oceanography.	**Complying.** The industry is discharging the treated effluents into the Sea through the submarine outfall (Diffusers) as recommended by the National Institute of Oceanography.
IV	The industry shall draw the water from Yeleru Left Bank Canal and other surface water sources. The tapping of the ground water shall be taken up only in the cases of outages or exigencies.	**Complying.** The industry is using water from the Sea water desalination plant installed and not drawing any surface or Ground water for the industrial usage**.**
V	The standards stipulated by the Andhra Pradesh Pollution Control Board/The Central Pollution Board/any other statutory body for marine discharge of treated effluents should be followed.	**Complying.** The industry is meeting the standards stipulated by the Andhra Pradesh Pollution Control Board/The Central Pollution Board for the marine discharge of treated effluents and disposing the treated effluents in presence of APPCB officials after meeting the standards. OCEMS have been installed and connected to both APPCB & CPCB websites.
VI	The Efficiency of diffuser should be monitor regularly to ensure proper dilution of effluents. The EIA Report provides for 216 times dilution level based on the discharge point suggested by National Institute of Oceanography (NIO). the industry shall ensure to conduct toxicity experiment at salinity levels prevailing at the discharge point and furnish the report to the Authority as part of post monitoring programme.	**Complying.** The dilution at the disposal point has been checked through NIO and found it is as per the design. The industry is carrying the post project marine monitoring studies regularly and submitting the reports to APPCB and MoEF&CC along with six monthly compliance reports.
VII	The industry shall undertake afforestation of lands along the coast using suitable local species to serve as shelter belt and wind breaks to ensure protection of interior areas.	**Complied.** The industry has developed green belt in an area of 24 acres along the coast with multiple species.

VIII	The industry should collect monthly samples of effluent near the marine outfall diffuser and submit the results to the APPCB for the purpose of verification of all parameters and compare results with the standard fixed in the case of other chemical and pharmaceutical industries.	**Complied.** APPCB is collecting the samples from Guard ponds regularly and disposing the treated effluents in presence of APPCB officials after meeting the standards. Industry is getting the post project marine monitoring studies regularly to check the marine environment around the outfall point.
IX	The chemical and toxicological studies at the sources of treated effluent shall be carried out and tested as per the norms/ standards, to assess its suitability for disposal into the sea. The industry shall also explore the possibility of adopting latest technology to minimize the discharge of effluent into the sea by recovery and reuse of effluents to attain zero discharge levels of effluent in future.	**Complied.** The industry is regularly testing the Chemical & toxicological studies at Guard ponds and submitting the reports to APPCB. The disposal of treated effluent is being done in presence of APPCB officials after meeting the standards prescribed by the Board. The industry is exploring the possibilities for recycling the wastewater to the maximum possible extent and till data industry has taken following measures for recycling of wastewater: ➢ Domestic wastewater is being treated in STP and recycling back for gardening and green belt development. ➢ Recycling part of treated effluent for Cooling Tower make up in ETP area. ➢ Using freshwater RO reject for ash quenching purpose and for detoxification of containers & container liners. ➢ Contaminated steam condensate is being treated in Condensate treatment & polishing plant and recycling back to Boiler.
X	Monitoring of marine environment at the marine outfall point (diffusion point) and its surroundings, so as to assess the adverse impact on marine life over an area of 2 X 2 Sq. Km. Since it involves discharge of effluents containing various chemical components, some of the dominant organisms in the area of discharge may be affected. The toxicity of the effluents before release need to confirm bioassay test prescribed by the central pollution control board (CPCB) and further the toxicity of the effluent be released into the sea is to be measured at 30-32 ppt i.e ambient environmental condition. Bioassay tests shall be perform periodically and post	**Complied.** The industry is regularly monitoring the Marine environment in 5 Km radius of marine outfall point through National Institute of Oceanography for sea water quality, Sediment analysis, Toxicological studies, Heavy metals etc.. The reports are being submitted to APPCB and MoEF&CC along with six monthly compliance reports.

	project monitoring to know the cumulative effects on the marine environment because of industrial development in the surrounding areas.	
XI	All safety measures shall be incorporated to avoid any possible accidents and adequate safety measures shall be taken to prevent leakage of wastewater into surrounding areas.	**Complied.** The industry has taken all safety measures for preventing leakage of wastewater into surrounding areas by way of regular surveillance rounds, Regular maintenance of pipeline, markings at critical locations etc.
XII	The proposed pipeline shall be aligned in such a way to provide free movement of trawlers and other mechanized boats. There shall not be any obstruction to fishing activity.	**Complied.** The pipeline has been laid as per the recommendations of NIO and is completely buried in the Seabed. It is not obstructing free movement of trawlers and other mechanized boats.
XIII	There shall not be any obstruction to the public using the beachfront.	**Complied.** The pipeline has been buried at a very safer depth and hence there is no obstruction to the public using beachfront.
XIV	The firm shall submit the detailed drawings of pipeline along with location map to the scale, duly marking the part of the proposed pipeline in the CRZ map. Necessary details pertaining to excavation through various zones and other relevant information shall be furnished for the purpose of record.	**Complied.** Submitted detailed drawings of pipeline along with location map to the scale, duly marking the proposed pipeline in the CRZ map to MoEF&CC and APCZMA.
XV	The firm shall incorporate plans for maintenance of marine ecology in the Environment Management Plan for implementation after approval form the competent authority. All precautionary measures needed to maintain the fragile ecology of coastal zone and surrounding shall be incorporated in Environment Management Plan.	**Complied.** The monitoring Marine Ecology is an integral part of Environmental Management Plan of the Industry.
XVI	Full cooperation shall be extended to all inspecting authorities/ organizations such as APPCB, APSADA, CPCB and local Environment Protection Organization.	**Being Complied.** The industry is extending its full cooperation to all inspecting authorities/ organizations such as APPCB, APSADA, CPCB and local Environment Protection Organization

For Hetero Labs Ltd, Unit-III

28/05/2024

S. Kullayi Reddy

Associate Vice President -EHS

COMPLIANCE TO THE CONDITIONS OF CONSENT FOR ESTABLISHMENT VIDE ORDER NO: 137/PCB/VSP/RO-VSP/CFE/HO/2006-476 DATED 22/06/2006.

S.NO	CONDITION	COMPLIANCE
SCHEDULE-A		
1	Progress on implementation of the project shall be reported to the regional office, Visakhapatnam, A.P Pollution control board once in six months.	**Complied.**
2	Separate energy meters shall be provided for Effluent Treatment Plant and air pollution control equipment's to record energy consumed.	**Complying.** The industry has installed energy meters in ETP, and three Continuous Ambient Air Quality Monitoring Stations are Installed and are directly connected to CPCB & APPCB.
3	The proponent shall obtain consents for operation from APPCB, as required under Sec. 25/26 of the water (p&c of P) act, 1974 and under Sec. 21/22 of the Air (P&C of P) act, 1981, before commencement of the activity.	**Complied.** The industry has obtained consents for operation from APPCB, and the CFO Copy is enclosed as **Annexure-A.**
4	Notwithstanding anything contained in this conditional letter or consent, the board hereby reserves its right and power under Sec.27(2) of water (prevention and control pollution) Act, 1974 and under sec.21(4) of air (prevention and control of pollution) act, 1981 to review any or all the conditions imposed herein and to make such alternation as deemed fit and stipulated any additional conditions by the board.	**Noted and Agreed Upon**
5	The consent of the board shall be exhibited in the factory premises at a conspicuous place for the information of the inspecting officers of different departments.	**Complied.** The industry has placed Consent Boards within the Site.
6	Compensation is to be paid for any environmental damage caused by it, as fixed by the collector and district magistrate as civil liability.	**Noted and Agreed Upon.**
7	Floor washing shall be admitted into the effluent collection system only and shall not be allowed to find their way in storm drains or open areas. The industry shall maintain a good house keeping. All pipe walls, sewers, drains shall be leak proof. Dyke walls shall constructed around storage of chemicals.	**Complying.** The industry has Constructed Dyke walls around the storage of chemicals, and maintaining proper Housekeeping with leak proof systems.
8	Rainwater harvesting structure shall be established on the plant site. The proponent shall ensure that effluent shall not enter the rainwater harvesting structure.	**Complying.** The industry is having rainwater harvesting systems and properly designed to prevent effluent intrusion.

<table>
<tr><td>9</td><td>The rules and regulations notified by ministry of law in justice, GOI regarding the public liability insurance act, 1991 shall be followed.</td><td>Noted And agreed Upon.</td></tr>
<tr><td>10</td><td>This order is valid for period of Five years from the date of issue</td><td>Noted and Agreed Upon.</td></tr>
<tr><td colspan="3">SCHEDULE- B</td></tr>
<tr><td colspan="2">WATER</td><td></td></tr>
<tr><td>1</td><td>The source of water is Yeluru left bank canal/ bore wells and the maximum permitted water consumption is 236.75KLD. the industry shall use surface water to the maximum extent to avoid sea water intrusion into the ground water</td><td>Complying.

The water consumption for the industry is supplied by M/s. Hetero Infrastructure SEZ Ltd. and the source of water is Sea.</td></tr>
<tr><td>2</td><td>The effluent treatment plant and multiple effective evaporation system shall be constructed and be commissioned, and air pollution control equipment shall be installed along with the commissioning of the activity. All the units of ETP shall be impervious to prevent groundwater pollution.</td><td>Complying.

The industry is having Effluent Treatment Plant with multiple effective evaporation system in M/s. Hetero Infrastructure SEZ Ltd. and is not polluting Groundwater.
The industry has also installed 3 No Continuous Ambient Air Quality Monitoring Stations which are directly connected to CPCB & APPCB.
The Layout of CAAQMS is enclosed as Annexure-B.</td></tr>
<tr><td>3</td><td>The trade effluents shall be treated to the marine water standards, and domestic effluent shall be treated to the on land for the irrigation standard’s, stipulated under environmental protection rules,1986, notified and published by MoEF, Government of India as specified in Schedule VI wide G.S.R (422E), Dt. 19.05.1993 and its amendments thereof.</td><td>Complying.

The industry is treating effluent under CPCB Standards for both HTDS & LTDS.

The Monitoring report on Treated Effluent is enclosed as Annexure-C.</td></tr>
<tr><td>4</td><td>The maximum wastewater generation (KLD) from M/s. Hetero Labs Ltd. Unit –V shall not exceed the following:
<table>
<tr><th>S.No</th><th>Unit</th><th>Quantity(KLD)</th></tr>
<tr><td>1</td><td>Process effluents</td><td>46.7</td></tr>
<tr><td>2</td><td>Boiler Blowdown</td><td>9</td></tr>
<tr><td>3</td><td>Cooling tower Blowdown</td><td>10</td></tr>
<tr><td>4</td><td>Washings</td><td>30</td></tr>
<tr><td>5</td><td>RO Rejects</td><td>86.78</td></tr>
<tr><td></td><td>total trade effluents</td><td>182.48</td></tr>
<tr><td>6</td><td>Domestic effluent</td><td>25</td></tr>
<tr><td></td><td>Grand Total</td><td>207.48</td></tr>
</table></td><td>Complying.

The wastewater generation is within the Consent</td></tr>
<tr><td>5</td><td>The trade effluent generated from this plant shall be treated along with trade effluents from other three units i.e M/s. Hetero Drugs Ltd., Unit-IX, M/s Cirex Pharmaceuticals Unit-II, M/s. Symed Labs, Unit-IV. The domestic effluent generated from this unit shall be treated along with the domestic effluent generated from other three units. By ETP and STP shall be located within the</td><td>Complying.

The industry is treating the effluents of all units in CETP of M/s Hetero Infrastructure SEZ Ltd.</td></tr>
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<td>premises of M/s Hetero Drugs Ltd, Unit-IX. The treatment and disposal of effluent shall be as following:
<table>
<tr><th>Source</th><th>Treatment</th><th>Mode of Final Disposal</th><th>Standards to be Complied</th></tr>
<tr><td><u>Stream-I</u>

High TDS & high COD process effluents</td><td>ETP for stream-I followed by multiple effect evaporation system</td><td>Condensate to ETP Stream-II. Evaporation salts to TSDF</td><td>--</td></tr>
<tr><td><u>Stream-II</u>
Low TDS Low COD Effluents from washing and utilities condesate</td><td>ETP for Stream-II</td><td>Marine disposal through submerged marine outfall. ETP sludge to TSDF</td><td>Marine Discharge Standards</td></tr>
<tr><td><u>Stream-III</u>
RO rejects</td><td>Sand and granular activated filter</td><td>Mixed with treated effluent and disposed through submerged marine outfall.</td><td>Marine Discharge Standards</td></tr>
<tr><td><u>Stream-IV</u>
Domestic</td><td>STP</td><td>Green belt development</td><td>Onland for irrigation standards</td></tr>
</table>
</td>
<td></td>
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<tr>
<td>6</td>
<td>All the ETP units except effluent collection tanks shall be constructed above the ground level.</td>
<td>Complied.

All the tanks in the industry are constructed above the Ground Level.</td>
</tr>
<tr>
<td>7</td>
<td>Separate meters with necessary pipelines shall be provided for assessing the quantity of water used for each of the purposes mentioned below:
a) Industrial cooling, boiler feed.
b) Domestic purposes.
c) Processing, whereby water gets polluted and pollutants are easily biodegradable.
d) Processing, whereby water gets polluted and pollutants are not easily biodegradable.</td>
<td>Complied.

The industry has installed separate digital flowmeters for the pipelines which are connected to APPCB Website.</td>
</tr>
<tr>
<td>8</td>
<td>The proponent shall comply with the following for controlling air pollution
<table>
<tr><th>S.NO</th><th>Details of Stack</th><th>Stack-I</th><th>Stack-II</th></tr>
<tr><td>a)</td><td>Attached to:</td><td>Coal fired boiler</td><td>DG Sets</td></tr>
<tr><td>b)</td><td>Capacity</td><td>10 TPH</td><td>2 * 500KVA</td></tr>
<tr><td>c)</td><td>Fuel</td><td>Coal – 50 TPD</td><td>Diesel</td></tr>
<tr><td>d)</td><td>Stack height</td><td>41m</td><td>5.0m (above roof level)</td></tr>
<tr><td>e)</td><td>Pollution control equipment</td><td>Bag filter</td><td>Acoustic enclosure</td></tr>
<tr><td>f)</td><td>Standards to be complied</td><td>SPM-115mg/Nm^3</td><td>--</td></tr>
</table>
<table>
<tr><th>Process emission</th><th>Control</th></tr>
<tr><td>HCL&SO2</td><td>Two stage scrubbers</td></tr>
<tr><td>Hydrogen and oxygen</td><td>Let out into atmosphere</td></tr>
</table>
<table>
<tr><th>Fugitive emission</th><th>Control</th></tr>
<tr><td>Solvent emissions</td><td>Vents to be connected to boiler as committed vide lr. Dt.09-06-2006</td></tr>
</table>
</td>
<td>Complying.</td>
</tr>
</table>

<table>
<tr><td>9</td><td>In monitoring air quality, volatile organic compounds (VOC) should also be included.</td><td>Complied.

The industry is including volatile organic compounds (VOC) in monthly monitoring reports.</td></tr>
<tr><td>10</td><td>Vent condensers shall be provided in series to reactors, distillation columns, dryers and centrifuges to condensate the emissions.</td><td>Complied.

The industry connected reactors, distillation columns, dryers and centrifuges to vent Condensers in order to trap emissions.</td></tr>
<tr><td>11</td><td>A sampling port with removable dummy of not less than 15cm diameter of the stack from the nearest constraint such as bends etc. A platform with suitable ladder shall be provided below 1 meter of sampling port to accommodate three persons with instruments. A 15 AMP 250V plug point shall be provided on the platform.</td><td>Please Refer Below:

Boilers are installed in the premises of M/s Hetero Infrastructure SEZ Ltd and sampling ports are provided as per the standards of the Boards.</td></tr>
<tr><td>12</td><td>The generator shall be installed in a closed area with acoustic, enclosure ad slencer and suitable noise absorption systems. The ambient noise level shall not exceed 75Db(A) during day time and 70Db(A) during night time.</td><td>Complying.

The industry has installed generator in a closed area where Ambient Air Quality and Noise levels are being monitored by MoEF & NABL accredited third party agencies.
Latest Analysis reports are attached as Annexure -D for your kind perusal.</td></tr>
<tr><td colspan="2">SOLID WASTE</td><td></td></tr>
<tr><td>13</td><td>The proponent shall comply with the following:
<table>
<tr><th>S.no</th><th>Description</th><th>Quantity</th><th>Method of Disposal</th></tr>
<tr><td>1</td><td>Coal Ash from Boiler</td><td>20MT/ Day</td><td>Brick Manufracturers</td></tr>
<tr><td>2</td><td>Solid waste from Process</td><td>1508.55Kg/ Day</td><td>TSDF</td></tr>
<tr><td>3</td><td>Waste Oil</td><td>500 L/Year</td><td>Authorized Recyclers</td></tr>
<tr><td>4</td><td>Used Batteries</td><td>10No.s/Year</td><td>Authorized Recyclers</td></tr>
<tr><td>5</td><td>Solvent Residue</td><td>1641 Kg/Day</td><td>TSDF</td></tr>
</table></td><td>Complying.</td></tr>
<tr><td>14</td><td>The activated carbon shall be disposed off to TSDF. Palladium carbon used in Hydrogenation reaction shall be sent for recycle and reuse.</td><td>Complying.

The industry is sending Spent Carbon to TSDF through APEMCL website.</td></tr>
<tr><td>15</td><td>The following rules and regulations notified by the MoEF & GOI shall be implemented:
a) Hazardous Waste (management & Handling), Rules, 1989.
b) Manufacture, storage and import off hazardous chemicals rules, 1989</td><td>Complying.

The industry is following all the rules and regulations notified by the MoEF & GOI</td></tr>
<tr><td>16</td><td>Green belt of width 50m shall be developed along with the boundary of the industry. Green belt development shall be</td><td>Complying.

The industry has developed more than 33% of Green belt in its entire site.</td></tr>
</table>

	started along with the construction activity.	
17	Appropriate risk assessment with disaster management plan shall be submitted to the board within the period of three months.	**Complying.**
18	The procurement of intermediates shall be done from organizations holding appropriate concent and authorization from the concerned State pollution control board. Copies of all manifests shall be submitted to the board.	**Complying.** The industry is having Consent to Authorization from APPCB. The latest CFO copy is enclosed as **Annexure-E.**
19	The proponent shall provide revised calculations with material balance for recovery and losses of solvents to air, water and residues.	**Complied.** The industry has submitted revised calculations with material balance for recovery and losses of solvents to air, water and residues in EMP along with CFO application.
20	The storage yards for the solvents and chemicals shall be relocated at a safe place from the indicated sites on the layout, such that minimum greenbelt of 50m is provided.	**Complying.**
21	A well structured environment management cell with appropriate laboratory facilities shall be created for environmental monitoring and operation, and maintenance of ETP and STP.	**Complying.** The industry has a well-qualified and experienced staff in environment management cell for environmental monitoring and operation, and maintenance of ETP and STP
22	The industry shall comply with CREP recommendations with respect to bulk drug industries.	**Noted and will comply.**
23	The proponent shall obtain clearance from Central Ground Water Authority to draw ground water.	**Not Applicable.** The industry is not drawing groundwater.
24	The recommendations/ commitments made during the public hearing held on 16.02.2006 at the revenue divisional office premises, Narsipatnam, Visakhapatnam shall explicitly be followed from pollution control point of view.	**Complied.**
25	The proponent shall not undertake any activity without obtaining environmental clearance from MoEF, Govt. of India as per MoEF, Govt. of India notification No. S.O.60(E) Dt. 27.01.94 and the amendments issued thereof.	**Noted and agreed upon.**

ANDHRA PRADESH POLLUTION CONTROL BOARD
PARYAVARAN BHAVAN, A-3, INDUSTRIAL ESTATE,
SANATHNAGAR, HYDERABAD - 500 018.

Phone: 040-23887500
Fax: 040- 23815631
Grams : Kalusya Nivarana
Website :www.appcb.org

CONSENT & AUTHORISATION ORDER
BY REGISTERED POST WITH ACKNOWLEDGEMENT DUE

Consent Order No : APPCB/VSP/RO-VSP/HO/40/HO/2008 2283 **Date: 02.02.2008**

(Consent Order for Existing/New or altered discharge of sewage and/or trade effluents/outlet under Section 25/26 of the Water (Prevention & Control of Pollution) Act,1974 and amendments thereof, Operation of the plant under section 21 of Air (Prevention & Control of Pollution) Act 1981 and amendments thereof and Authorisation / Renewal of Authorisation under Rule 5 of the Hazardous Wastes (Management & Handling) Rules 1989 & Amendment Rules).

CONSENT is hereby granted under section 25/26 of the Water (Prevention & Control of Pollution) Act, 1974, under section 21 of Air (Prevention & Control of Pollution) Act 1981 and Authorisation under the provisions of HW (M & H) Rules (hereinafter referred to as 'the Acts', 'the Rules') and the rules and orders made thereunder to

M/s. Hetero Labs Ltd., Unit-III,
(Formerly M/s. Hetero Labs Ltd., (Unit-V)),
Sy.No. 119, 126, 120, 125 part, 138 part,
N.Narasapuram (V),
Nakkapalli (M),
Visakhapatnam District.
Email: contact@heterodrugs.com

(hereinafter referred to as 'the Applicant') authorizing to operate the industrial plant to discharge the effluents from the outlets and the quantity of Emissions per hour from the chimneys as detailed below.

i) Out lets for discharge of effluents:

Outlet No.	Outlet Description	Max Daily Discharge (KLD)	Point of Disposal
1.	Process effluents after treatment	95.7 KLD	Into sea
2.	RO Rejects	86.78 KLD	Into sea
3.	Domestic effluents	25 KLD	Septic tank followed by soak pit

ii) Emissions from chimneys:

Chimney No.	Description of Chimney	Quantity of Emissions in m3/hr. at peak flow
1	Attached to 20 TPH coal fired boiler *	
2	Attached to process vents DG Set 1000 KVA	
3	Attached to process vents	

*** The steam shall be utilized for both the units i.e., M/s. Hetero Drugs Ltd., (Unit – VI & M/s Hetero Lab Ltd., (Unit- III)**

III) HAZARDOUS WASTE AUTHORISATION (FORM – II) [See Rule 3(C) & 5 (5)]

1. Number of Authorisation and date of issue - APPCB/VSP/VSP/138/HWM, Dt:02/02/2008.
2. The Director (Operations), M/s Hetero Labs Ltd (Unit – III), (formerly M/s Hetero Labs Ltd (Unit – V)) is hereby granted an authorization to operate a facility for collection, reception, storage, treatment, transport and disposal of Hazardous Wastes namely:

S.No	Name of the Hazardous waste	*Stream*	Quantity of Hazardous waste.	Disposal Option.
1.	Forced Evaporation System Salts.	34.3 of Schedule – I	2.5 TPD.	Sent to TSDF, Parawada, Visakhapatnam District
2.	ETP Sludge	34.3 of Schedule – I	0.125 TPD.	

3.	Solvent Residues	26.1 of Schedule-I	**1.64 TPD.**	**Sent for incineration.**
4.	Spent Carbon.	28.2 of Schedule – I	**0.5 TPD.**	**Sent to Cement units / Sent for incineration**
5.	Used Lead Acid Batteries	22 of Schedule – IV	**5 No's/ year**	Given back to manufactures or dealer on buy back basis.
6.	Waste Oils	5.1 of Schedule – I	**500 Ltrs/year.**	**Reprocessors / Recyclers authorised by APPCB.**

on their premises located at Sy.No. 125, 119/1, 119/2, Neelakonda Narsapuram (V), Nakkapalle (M), Visakhapatnam District.

This consent order is valid for manufacture of the following products along with quantities only.

Group - I		
S.No	**Description**	**Capacity (MT/day)**
1	Lamivudine	0.30 MT/day
2	Nevirapine	0.75 MT/day
3	Saquinavir Mesylate	0.30 MT/day
4	Simvastatin	0.35 MT/day
5	Stavudine	0.30 MT/day
	Total	**2.0 MT/day**

Group II		
S.No	**Description**	**Capacity (MT/day)**
1	Benzepril HCl	0.20 MT/day
2	Efavirenz	0.50 MT/day
3	Ezetimibe	0.25 MT/day
4	Pioglitazone	0.20 MT/day
5	Terbinafine HCl	0.30 MT/day
6	Tioconazole	0.25 MT/day
7	Zidovudine	0.30 MT/day
	Total	**2.0 MT/day**
Group III		
S.No	**Description**	**Capacity (MT/day)**
1	Capecitabine	0.25 MT/day
2	Duloxetine	0.20 MT/day
3	Escitalopram Oxalate	0.20 MT/day
4	Irbesartan	0.30 MT/day
5	Levetiracetam	0.35 MT/day
6	Losartan Potassium	0.20 MT/day
7	Rupatadine	0.20 MT/day
8	Valsartan	0.30 MT/day
	Total	**2.0 MT/day**

Only one group shall be manufactured at a time. The industry shall surrender the CFE obtained vide order dt.03.09.2005 for manufacturing intermediates and shall out source first stages of Group – I products i.e., the first stages of Group – I shall not be manufactured, as committed vide lr.dt.09.06.2006

By-products

S.No	Name of Byproduct	Quantity
1	Methanol	272.5 Kgs/day
2	Sodium borate	221.5 Kgs/day
3	Salicylic acid	192.6 Kgs/day
4	Imidazole	136 Kgs/day

5	Acetic acid	36.5 Kgs/day
6	Sodium Bromide	165.25 Kgs/day
7	Benzoic acid	178.8 Kgs/day
8	N-methylpyrrolidine	132.5 Kgs/day
9	t-BuCl	40 Kgs/day
10	Toluene	119.5 Kgs/day
12	Methane Sulfonic acid	280.6 Kgs/day
13	Sodium acetate	114.4 Kgs/day
14	Ethyl iodide	104 Kgs/day

This order is subject to the provisions of `the Acts' and the Rules' and orders made thereunder and further subject to the terms and conditions incorporated in the schedule A, B & C enclosed to this order.

This combined order of consent & Hazardous Waste Authorisation shall be valid for a period ending with the **31st day of May 2008.**

Sd/-
MEMBER SECRETARY

To

M/s Hetero Labs Ltd., (Unit-III),
(Formerly M/s. Hetero Labs Ltd., (Unit-V)),
Sy.No. 119, 126, 120, 125 part, 138 part,
N.Narasapuram (V),
Nakkapalli (M),
Visakhapatnam District.

// T.C.F.B.O //

Joint Chief Environmental Engineer (CFO)

SCHEDULE – A

1. The applicant shall make applications for renewal of Consent (under Water and Air Acts) and Authorisation under HWM Rules **at least 60 days before the date of expiry of this order,** along with prescribed fee under Water and Air Acts for obtaining Consent & HW Authorisation of the Board.
2. The industry shall immediately submit the revised application for consent to this Board in the event of any change in the raw material used, processes employed, quantity of trade effluents & quantity of emissions etc.
3. a) All the fugitive emissions shall be controlled with proper measures.
   b)The applicant shall also install the equipment such as wind speed recorder, wind direction recorder.
4. The applicant shall not change or alter either the quality or the quantity or the rate of the discharge or the route of discharge and shall not change or alter either the prescribed quality or the rate of emission without the previous written permission of the Board.
5. The applicant shall, not later than 30 days from the date of issue of this consent order, certify in writing to the Board that the applicant has installed or provided for an alternative electric power source sufficient to operate all facilities installed by the applicant, to comply with the terms and conditions of this consent. In absence of alternative electric power source sufficient to operate all facilities installed by the applicant, to comply with the terms and conditions of this consent, production shall be stopped.
6. Any up-set condition in any plant/plants of the industry, which result in, increased effluent discharge and/ or violation of standards stipulated in this order **or** the emission of any Air Pollutant into the environment in excess of the standards laid down by the Board, occurs or is apprehended to occur due to accident, or other unforeseen act or event, the person-in-charge of the premises, from where such discharge / emission occurs or is apprehended to occur shall forthwith intimate the fact of such occurrence or the apprehension of such occurrence to this Board, by fax / email under intimation to the Collector and District Magistrate.
7. In case of such episodal discharges / emissions mentioned in item 6 above, the industry should take immediate action to bring down the discharge / emission below the limits prescribed in this order.
8. A good house keeping shall be maintained both within the factory and in the premises. All hoods, pipes, valves, sewers and drains shall be leak proof. Floor washings shall be admitted into the effluent collection system only and shall not be allowed to find their way into storm drains or open areas.
9. a)The industry shall carryout analysis of waste water discharges or emissions through chimneys, for the parameters mentioned in Schedule – B of this order at regular intervals.
   b)The industry shall maintain following records to accessible to the Board, whenever required.
   1. Analysis reports of waste water/ emissions.
   2. Log book for operation of pollution control systems.
   3. Inspection book
10. The applicant shall set up THREE Ambient Air Quality Monitoring Stations for continuous recording of relevant critical parameters mentioned in Schedule - B as per the CPCB guidelines and submit monthly reports.
11. Separate power connection with energy meter shall be provided for the Pollution Control Equipments and record of power consumption and chemicals consumption for the operation of pollution control equipment shall be maintained separately.
12. The applicant shall comply with the directives/orders issued by the Board in this order and at all subsequent times without any negligence on his part. The applicant shall be liable for such legal action against him as per provisions of the Law/Act in case if non-compliance of any order/directive issued at any time and/or violation of the terms and conditions of this consent order.
13. The applicant shall furnish to the visiting officer and / or the Board any information regarding the construction, installation or operation of the effluent treatment system / air pollution control equipment / secured storage area of Hazardous Waste and such other particulars as may be pertinent for preventing and controlling pollution.
14. The industry is liable to pay compensation for any environmental damage caused by it, as fixed by the Collector and District Magistrate as Civil liability.
15. All the rules & regulations notified by Ministry of Environment and Forests, Government of India in respect of management, handling, transportation and storage of hazardous chemicals and wastes shall be followed.
16. All the rules & regulations notified by Ministry of Law and Justice, Government of India regarding Public Liability Insurance Act, 1991 shall be followed.
17. The occupier shall educate the workers and nearby public of possible accidents and remedial measures.
18. For any accident or spillage of hazardous wastes causing damage to the Environment, the occupier or the transporter as the case shall be held responsible.

19. In case of closure of industry, the un-used/not consumed raw materials falling under the category of Hazardous Chemicals and mentioned in Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 and Amendment Rules, 2003 shall be removed and sold to other units within 90 days from the date of closure to prevent any possibility of occurrence of an accident. In case the above hazardous chemicals have lost their properties originally acquired, then they shall be treated, as Hazardous Waste and they should be disposed off only to the agencies authorized by APPCB in a safe manner.
20. The occupier shall prepare/update Emergency preparedness plan for safe handling of hazardous waste from time to time and submit the same to APPCB. Emergency preparedness plan must be implemented immediately whenever there is fire, explosion or release of hazardous waste or hazardous waste constituents, which could endanger to human health or environment.
21. Packaging, labeling and transportation of Hazardous Wastes shall be in accordance with the provisions of the rules issued by the Central Govt. under the Motor Vehicles Act, 1988 and other guidelines issued from time to time. The packaging and labeling shall be based on the composition and hazardous constituent of the waste, however all Hazardous Waste containers should be provided with a general label.
22. The driver who transports Hazardous Waste should be well acquainted about the procedure to be followed in case of an emergency during transit. The transporter shall carry a Transport Emergency (TREM) Card (as given in the guidelines for management and handling of hazardous wastes) duly filled by the Hazardous Waste generator.
23. Containers / Container Liners of Hazardous Chemicals and Hazardous Wastes should be thoroughly detoxified before selling to the agencies authorized by APPCB. Proper records, specific to each Hazardous Chemical / Hazardous Waste containers / Container Liners should be maintained in the following way:
    I) Number of containers received.
    II) Date and method of detoxification.
    III) Name of agencies to whom containers were sold with quantities.
    IV) Transportation particulars.
24. No Hazardous Wastes shall be mixed with any other wastes or shall be discharged to a common, other internal, external sewerage or other drainage system without prior approval of APPCB.
25. If HDPE bags are used for storing Hazardous Wastes, it should be ensured that they are perfectly sealed mechanically or double hot sealed. If MS/HDPE bags or drums are used for storing Hazardous Wastes, these drums / bags should be ensured that they are perfectly sealed.
26. The person authorised shall not rent, lend, sell, transfer their industrial premises without obtaining prior permission of the State Pollution Control Board.
27. Any unauthorised change in personnel, equipment as working condition as mentioned in the application by the person authorized shall constitute a breach of his authorisation.
28. The industry shall comply with the provisions of Batteries (Management & Handling) Rules, 2001.
29. The industry shall put up two sign boards (6x4 ft. each) at publicly visible places at the main gate. The first sign board shall provide information on specific conditions of CFO and Hazardous Waste Authorisation. The second sign board shall display online data on quantity and nature of hazardous chemicals being used in the plant, as well as water, air emissions and solid waste generated within the factory premises.
30. The applicant shall exhibit the Consent & HW Authorisation order of the Board in the factory premises at a prominent place for the information of the inspecting officers of the different departments.
31. Not withstanding anything contained in this conditional letter or consent, the Board hereby reserves the right and powers under Section 27(2) of the Water (Prevention & Control of Pollution) Act, 1974 and its amendments thereof and under Section 21 of the Air (Prevention & Control of Pollution) Act, 1981 and its amendments thereof to review any and/or all the conditions imposed herein above and to make such variations as deemed fit for the purpose of the Acts by the Board.
32. The authorisation issued under Hazardous Waste (Management and Handling) Rules, 1989 and its amendments thereof, shall comply with the provision of the Environment (Protection) Act, 1986.

Sd/-
MEMBER SECRETARY

SCHEDULE - B

Special Conditions

1. The effluent discharged shall not contain constituents in excess of the tolerance limits mentioned below.

Outlet	Parameter	Limiting Standards
1 & 2	pH	6.50 – 8.50
	Chromium Hexavelent	0.10 mg/l
	Lead	0.10 mg/l
	Total Suspended Solids	100 mg/l
	Phenols	1.00 mg/l
	Cyanides as CN	0.10 mg/l
	Chemical Oxygen Demand	250 mg/l
	Biochemical Oxygen Demand	100 mg/l
	Sulphide (as S)	2.00 mg/l

2. The industry shall take steps to reduce water consumption to the extent possible and consumption shall NOT exceed the quantities mentioned below:

S.No	Purpose	Quantity
1.	Process water	55.21 KLD
2.	Boiler Feed	27 KLD
3	Cooling Tower	24 KLD
4	Domestic	25 KLD
5	Washings	30 KLD
6	Additional water to RO	86.78 KLD
	Total	**247.99 KLD**

3. The industry shall file the water cess returns in Form-I as required under section (5) of Water (Prevention and Control of Pollution) Cess Act, 1977 on or before the 5th of every calendar month, showing the quantity of water consumed in the previous month along with water meter readings. The industry shall remit water cess as per the assessment orders as and when issued by Board.
4. The emissions shall not contain constituents in excess of the prescribed limits mentioned below.

Chimney No.	Parameter	Emission Standards
1 & 2	SPM	115 mg/Nm^3
3	HCL	35 mg/Nm^3

5. The industry shall comply with ambient air quality standards of TSPM - 200 µg/m^3 ; RSPM - 100 µg/m^3; SO_2 - 80 µg/m^3; NO_x - 80 µg/m^3.

Noise Levels: Day time (6 AM to 10 PM) - 75 dB (A)
Night time (10 PM to 6 AM) - 70 dB (A).

6. The industry shall not increase the capacity beyond the permitted capacity mentioned in this order, without obtaining CFE/CFO of the Board.
7. The industry shall install full-fledged ETP for the complete capacity as per the CFE order dt. 22.06.2006 for the waste water quantities mentioned in this order and submit the compliance report to RO, Visakhapatnam within four months.
8. The industry shall construct four guard ponds each with two days capacity to receive the ETP effluent before it is pumped for marine disposal. Only three guard ponds shall be operational at a time and one will be kept empty in reserve to receive the effluent in case of system failure indicated by bio-monitoring. The guard pond shall be constructed with appropriate lining and leak-proof construction specified for this purpose and the compliance report shall be submitted to RO, Visakhapatnam within three months.
9. The Industry shall regularly monitor the effluent quality before discharging into the sea. It is to be discharged into sea only if it meets Board Standard otherwise the effluent shall pump back to ETP for further treatment to meet the Board Standards.
10. The Industry shall carry out the post project marine environment Impact Assessment Study by NIO due to discharge of effluents into sea by the industry for every 3 months and submit report to Board Office.
11. The industry shall segregate the effluent streams as per the CFE order dt.22.06.2006.
12. The industry shall install bag filter to the 20 TPH boiler and the boiler shall be operated only after installation of the bag filter.

13. **The steam requirement shall be met from the 20 TPH boiler installed at M/s. Hetero Labs Ltd., (Unit-III) and in no case additional boiler shall be installed and any action of the Board under relevant sections, will be irrespective of usage of the 20 TPH common boiler.**
14. The industry shall install separate water meters with totaliser at different sections and at ETP outlet and at marine outfall.
15. The industry shall install separate energy meter and hour meter to the marine outfall pump.
16. The industry shall develop a minimum of 50 mtrs width green belt as per CFE order dt.22.06.2006.
17. The industry shall complete ETP control room before starting the production.
18. The industry shall not cause any smell nuisance to the surroundings.
19. The Industry shall maintain the compliance of conditions stipulated in the CFE order 22.06.2006.
20. The Industry shall maintain the compliance of conditions stipulated in the EC order dated 22.09.2006.

Sd/-
MEMBER SECRETARY

SCHEDULE - C
[See rule 3(c) and 5(5)
[CONDITIONS OF AUTHORISATION FOR OCCUPIER OR OPERATOR HANDLING HAZARDOUS WASTES]

1. The industry shall implement waste minimization and cleaner production practices.
2. The industry shall recover the spent solvents to the tune of atleast 95% with in the premises.
3. The industry shall dispose / sell the hazardous wastes to only Reprocessors / recyclers authorized by State Pollution Control Boards. They shall verify the authorization of the Board given to the Reprocessors / recyclers before disposing their wastes.
4. The industry shall not store the hazardous waste in their premises more than 90 days from the date of generation.
5. The industry has to improve house keeping at the storage area of the solid waste.
6. The industry shall take all practical steps to avoid any spillage of effluents, waste oil hazardous chemicals & hazardous wastes on land.
7. The industry shall maintain 6 copy manifest system for transportation of waste generated and a copy shall be submitted to Board Office and concerned Regional Office.
8. The industry shall store the hazardous waste on a raised platform under a shed till it is lifted to M/s. HWMP, Dundigal, Rangareddy District.
9. The Industry shall not dispose Waste oils/ Non-ferrous metal scrap / Used lead acid batteries and Spent Solvents / Spent acids to the traders. The same shall be disposed off only through authorised Re-cyclers/Re-processors.
10. The Industry shall maintain the quantity of incinerable waste, land disposal waste and recyclable waste generated with in the premises and details of disposal.
11. The Industry shall collect all the used Containers & Container Liners used for storing of Hazardous Waste and Chemicals at a designated place.
12. The industry shall provide necessary detoxification facility for each of the different category of used containers based on the requirement and inform the Board, the detoxification methods being adopted with in a week to the concerned Regional Office, with a copy marked to Board Office.
13. Detoxification of the containers and container liners shall be carried out in a separate designated place and the waste thus generated shall be treated and the Hazardous Waste generated shall be disposed as per the HW authorisation conditions.

14. Records shall be maintained in Form as annexed indicating number of containers and container liners, method of detoxification carried out, details of disposal of wastes collected during detoxification, details of disposal of detoxified containers and container liners clearly indicating the agencies to whom it is disposed.
15. The detoxified containers and container liners shall be collected and stored in a separate designated place. Before disposal, the Industry shall inform the concerned Regional Office atleast 15 days in advance, about the number of containers proposed to be disposed and the agencies to whom they are being disposed. The Officials of Regional Office may inspect the detoxified containers and verify the detoxification status and the number of containers before their disposal from the industrial premises.
16. The Industry shall maintain good house keeping & maintain proper records for Hazardous Wastes stated in Authorisation (FORM-III).
17. The unit shall submit the condition wise compliance report of the conditions stipulated in Schedule B & Schedule C of this order on half yearly basis to Board Office, Hyderabad and concerned Regional Office.

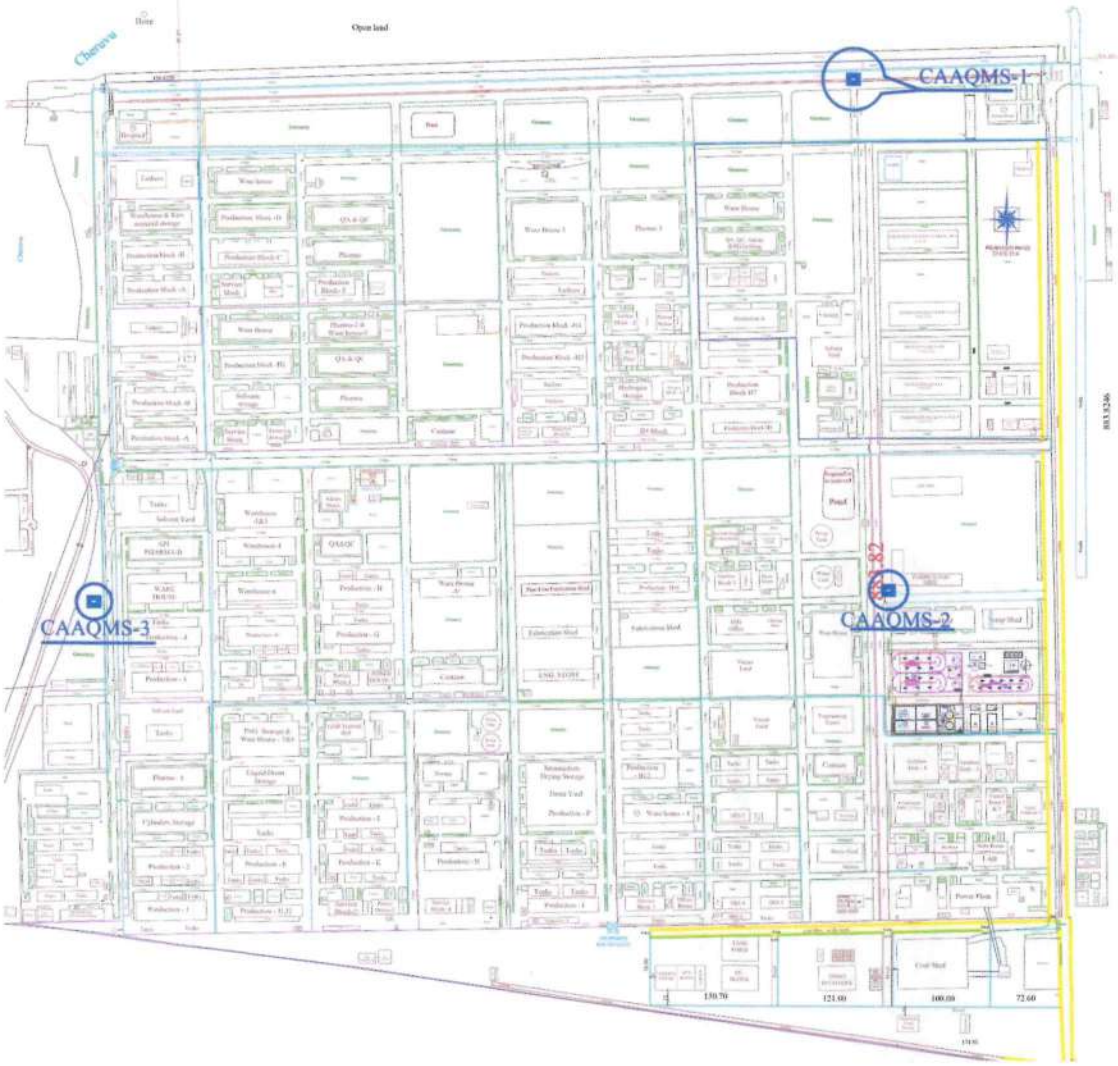
Sd/-
MEMBER SECRETARY

To
M/s Hetero Labs Ltd., Unit-III,
(Formerly M/s. Hetero Labs Ltd., (Unit-V),
Sy.No. 119, 126, 120, 125 part, 138 part,
N.Narasapuram (V),
Nakkapalli (M),
Visakhapatnam District.

// T.C.P.B.O //

Joint Chief Environmental Engineer (CFO)

CAAQMS LOCATIONS



SV ENVIRO LABS & CONSULTANTS Environmental
Engineers & Consultants in Pollution Control
Enviro House,B-1, Block - B, IDA
Autonagar, Visakhapatnam
Phone: 9440338628
Email:info@svenvirolabs.com
(Recognized by GOI, Ministry of Environment & Forests)
(An ISO 9001 Certified and NABET Accredited for EIA)

Ref Code	:	SVELC/HISEZL/23-04/001	**Date : 25-04-2023**
Name and Address	:	**M/s. HETERO INFRASTRUCTURE SEZ LIMITED,** N.Narasapuram Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	:	Effluent Analysis	
Source of Collection	:	ETP OUTLET	
Sample Code	:	SVELC/23/EFF/0377	
Date of Collection	:	15-04-2023	
Date of Receipt	:	15-04-2023	

TEST REPORT

S No	Parameter	Unit	Result	Method	Standard
1	pH	-	7.29	APHA 4500-H+B, 23rd Ed,2017	5.5-9.0
2	Suspended Solids, SS	mg/l	18.0	APHA 2540-D, 23rd Ed,2017	100
3	Total Dissolved Solids, TDS	mg/l	1357	APHA,2540-C,23rd Ed, 2017	-
4	Chemical Oxygen Demand(COD)	mg/l	162	APHA 5220-B, 23rd Ed,2017	250
5	BOD 3d 27°C	mg/l	58.0	IS 3025 Part 44	100
6	Chlorides as Cl^-	mg/l	378	APHA,4500-Cl B,23rd Ed, 2017	1000
7	Oil & Grease	mg/l	1.9	APHA,5520-D,5-38,23rd Ed, 2017	10
8	Sulphide as S	mg/l	0.21	APHA,4500S^2 D, 23rd Ed,2017	2.0
9	Phenolic compounds (C_6H_5OH)	mg/l	0.06	APHA,5530-C, 23rd Ed,2017	1.0
10	Cyanide as CN	mg/l	BDL	APHA,4500-CN^- E , 23rd Ed,2017	0.2
11	Hexavalent chromium as Cr^{+6}	mg/l	BDL	APHA,3500-Cr B , 23rd Ed,2017	0.1
12	Lead as Pb	mg/l	BDL	APHA,3120-B , 23rd Ed,2017	0.1

Note: BDL denotes Below Detectable Level

ANALYZED BY

SV ENVIRO LABS & CONSULTANTS

SV ENVIRO LABS & CONSULTANTS

Environmental Engineers & Consultants in Pollution Control

Enviro House,B-1, Block - B, IDA
Autonagar,Visakhapatnam
Phone: 9440338628
Email:info@svenvirolabs.com
(Recognized by GOI, Ministry of Environment & Forests)
(An ISO 9001 Certified and NABET Accredited for EIA)

Ref Code	: SVELC/HLL3/23-04/001	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Ambient Air Quality	
Source of Collection	: Near Canteen Area	
Sample Code	: SVELC/23/AAQ/0379	
Date and Time of Start	: 15-04-2023 12:00 hr	
Duration of Sampling	: 24 Hours	
Atmosphere Condition	: CLEAR SKY	

TEST REPORT

S.NO	PARAMETER	UNIT	RESULT	METHOD	NAAQ STANDARD
1	Particulate Matter – PM_{10}	$\mu g/m^3$	61.8	IS : 5182 – P-23	100
2	Particulate Matter – $PM_{2.5}$	$\mu g/m^3$	23.7	IS : 5182 – P-24	60
3	Sulphur Dioxide – SO_2	$\mu g/m^3$	13.6	IS : 5182 – P-2	80
4	Oxides of Nitrogen – NO_X	$\mu g/m^3$	12.4	IS : 5182 – P-6	80

ANALYZED BY

SV ENVIRO LABS & CONSULTANTS

SV ENVIRO LABS & CONSULTANTS

Environmental Engineers & Consultants in Pollution Control
Enviro House,B-1, Block - B, IDA
Autonagar,Visakhapatnam
Phone: 9440338628
Email:info@svenvirolabs.com
(Recognized by GOI, Ministry of Environment & Forests)
(An ISO 9001 Certified and NABET Accredited for EIA)

Ref Code	: SVELC/HLL3/23-04/002	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Ambient Air Quality	
Source of Collection	: Near Production Area (Block-A)	
Sample Code	: SVELC/23/AAQ/0380	
Date and Time of Start	: 15-04-2023 12:15 hr	
Duration of Sampling	: 24 Hours	
Atmosphere Condition	: CLEAR SKY	

TEST REPORT

S.NO	PARAMETER	UNIT	RESULT	METHOD	NAAQ STANDARD
1	Particulate Matter – PM_{10}	$\mu g/m^3$	64.0	IS : 5182 – P-23	100
2	Particulate Matter – $PM_{2.5}$	$\mu g/m^3$	24.3	IS : 5182 – P-24	60
3	Sulphur Dioxide – SO_2	$\mu g/m^3$	13.8	IS : 5182 – P-2	80
4	Oxides of Nitrogen – NO_X	$\mu g/m^3$	11.9	IS : 5182 – P-6	80

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Environmental Engineers & Consultants in Pollution Control
Enviro House,B-1, Block - B, IDA
Autonagar,Visakhapatnam
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Ref Code	: SVELC/HLL3/23-04/003	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Ambient Air Quality	
Source of Collection	: Near Production Block	
Sample Code	: SVELC/23/AAQ/0381	
Date and Time of Start	: 15-04-2023 12:30 hr	
Duration of Sampling	: 24 Hours	
Atmosphere Condition	: CLEAR SKY	

TEST REPORT

S.NO	PARAMETER	UNIT	RESULT	METHOD	NAAQ STANDARD
1	Particulate Matter – PM_{10}	$\mu g/m^3$	65.7	IS : 5182 – P-23	100
2	Particulate Matter – $PM_{2.5}$	$\mu g/m^3$	25.0	IS : 5182 – P-24	60
3	Sulphur Dioxide – SO_2	$\mu g/m^3$	15.6	IS : 5182 – P-2	80
4	Oxides of Nitrogen – NO_X	$\mu g/m^3$	13.8	IS : 5182 – P-6	80

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Environmental Engineers & Consultants in Pollution Control
Enviro House,B-1, Block - B, IDA
Autonagar,Visakhapatnam
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Ref Code	: SVELC/HLL3/23-04/004	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Effluent Analysis	
Source of Collection	: ETP INLET	
Sample Code	: SVELC/23/EFF/0382	
Date of Collection	: 15-04-2023	
Date of Receipt	: 15-04-2023	

TEST REPORT

S No	Parameter	Unit	Result	Method
1	pH	-	7.68	APHA 4500-H+B, 23rd
2	Suspended Solids – SS	mg/l	189	APHA 2540-D, 23rd Ed,2017
3	Total Dissolved Solids – TDS	mg/l	13931	APHA,2540-C,23rd Ed, 2017
4	Chemical Oxygen Demand – COD	mg/l	11764	APHA 5220-B, 23rd Ed,2017
5	BOD 3d 27°C	mg/l	4682	IS 3025 Part 44
6	Chlorides as Cl^-	mg/l	3127	APHA,4500-Cl B,23rd Ed, 2017
7	Oil & Grease	mg/l	6.9	APHA,5520-D,5-38,23rd Ed, 2017
8	Sulphide as S	mg/l	8.93	APHA,4500S^2 D, 23rd Ed,2017
9	Phenolic Compounds (C_6H_5OH)	mg/l	0.34	APHA,5530-C, 23rd Ed,2017
10	Cyanide as CN	mg/l	BDL	APHA,4500-CN^- E , 23rd Ed,2017
11	Hexavalent Chromium as Cr^{+6}	mg/l	BDL	APHA,3500-Cr B , 23rd Ed,2017
12	Lead as Pb	mg/l	BDL	APHA,3120-B , 23rd Ed,2017

Note: BDL denotes Below Detectable Level

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Ref Code	:	SVELC/HLL3/23-04/005	**Date : 25-04-2023**
Name and Address	:	**M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	:	Stack Monitoring	
Source of Collection	:	725 KVA Generator	
Sample Code	:	SVELC/23/SE/0383	
Date and Time of Start	:	15-04-2023 13:15 hr	
Duration of Sampling	:	30 MINS	

TEST REPORT

STACK DETAILS

S No	Description	Unit	Result
1	Pitot Coefficient	-	0.87
2	Specific Gravity of Fluid	-	1.0
3	Temperature @ DGM	°C	33
4	Stack Temperature	°C	157
5	Nozzle diameter	mm	10
6	Exit Velocity	m/sec	14.1
7	Fuel Used	-	HSD

EMISSION DATA

S.No	Parameter	Unit	Result	Method	Standard
1	Particulate Matter – PM	mg/nm^3	66.8	IS:11255 – P-1	115
2	Sulphur Dioxide – SO_2	mg/nm^3	30.7	IS:11255 – P-2	-
3	Oxides of Nitrogen – NO_x	mg/nm^3	49.0	IS:11255 – P-7	-

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SV ENVIRO LABS & CONSULTANTS Environmental
Engineers & Consultants In Pollution Control
Enviro House,B-1, Block - B, IDA
Autonagar,Visakhapatnam
Phone: 9440338628
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Ref Code	: SVELC/HLL3/23-04/006	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Stack Monitoring	
Source of Collection	: 1165 KVA DG SET - I	
Sample Code	: SVELC/23/SE/0384	
Date and Time of Start	: 15-04-2023 14:00 Hr	
Duration of Sampling	: 30 MINS	

TEST REPORT

STACK DETAILS

S No	Description	Unit	Result
1	Pitot Coefficient	-	0.87
2	Specific Gravity of Fluid	-	1.0
3	Temperature @ DGM	°C	33
4	Stack Temperature	°C	191
5	Nozzle Diameter	mm	10
6	Exit Velocity	m/sec	16.2
7	Duration of Sampling	minutes	30
8	Fuel Used	-	HSD

EMISSION DATA

S.No	Parameter	Unit	Result	Method	Standard
1	Particulate Matter – PM	mg/nm^3	73.5	IS:11255 – P-1	115
2	Sulphur Dioxide – SO_2	mg/nm^3	48.2	IS:11255 – P-2	-
3	Oxides of Nitrogen – NO_x	mg/nm^3	64.1	IS:11255 – P-7	-

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SV ENVIRO LABS & CONSULTANTS Environmental
Engineers & Consultants in Pollution Control
Enviro House,B-1, Block - B, IDA
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Ref Code	:	SVELC/HLL3/23-04/007	**Date : 25-04-2023**
Name and Address	:	**M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	:	Stack Monitoring	
Source of Collection	:	1165 KVA DG SET - II	
Sample Code	:	SVELC/23/SE/0385	
Date and Time of Start	:	15-04-2023 14:45 Hr	
Duration of Sampling	:	30 MINS	

TEST REPORT

STACK DETAILS

S.No	Description	Unit	Result
1	Pitot Coefficient	-	0.87
2	Specific Gravity of Fluid	-	1.0
3	Temperature @ DGM	°C	33
4	Stack Temperature	°C	219
5	Nozzle Diameter	mm	10
6	Exit Velocity	m/sec	16.9
7	Duration of sampling	minutes	30
7	Fuel Used	-	HSD

EMISSION DATA

S.No	Parameter	Unit	Result	Method	Standard
1	Particulate Matter – PM	mg/nm^3	74.6	IS:11255 – P-1	115
2	Sulphur Dioxide – SO_2	mg/nm^3	42.3	IS:11255 – P-2	-
3	Oxides of Nitrogen – NO_x	mg/nm^3	63.7	IS:11255 – P-7	-

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Enviro House,,B-1, Block - B, IDA
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Phone: 9440338628
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Ref Code	: SVELC/HLL3/23-04/008	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Stack Monitoring	
Source of Collection	: 2030 KVA Generator - I	
Sample Code	: SVELC/23/SE/0386	
Date and Time of Start	: 15-04-2023 15:30 hr	
Duration of Sampling	: 30 MINS	

TEST REPORT

STACK DETAILS

S No	Description	Unit	Result
1	Pitot Coefficient	-	0.87
2	Specific Gravity of Fluid	-	1.0
4	Temperature @ DGM	°C	32
5	Stack Temperature	°C	235
6	Nozzle Diameter	mm	10
7	Exit Velocity	m/sec	18.5
8	Fuel Used	-	HSD

EMISSION DATA

S.No	Parameter	Unit	Result	Method	Standard
1	Particulate matter – PM	mg/nm^3	77.5	IS:11255 – P-1	115
2	Sulphur Dioxide – SO_2	mg/nm^3	44.8	IS:11255 – P-2	-
3	Oxides of Nitrogen – NO_x	mg/nm^3	69.7	IS:11255 – P-7	-

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Ref Code	: SVELC/HLL3/23-04/09	**Date : 25-04-2023**
Name and Address	: **M/s. HETERO LABS LIMITED (UNIT-III)** Nallamatipalem Village, Nakkapally Mandal, Visakhapatnam (Dt).	
Sample Particulars	: Stack Monitoring	
Source of Collection	: 2030 KVA Generator - II	
Sample Code	: SVELC/23/SE/0387	
Date and Time of Start	: 15-04-2023 16:15 hr	
Duration of Sampling	: 30 MINS	

TEST REPORT

STACK DETAILS

S No	Description	Unit	Result
1	Pitot Coefficient	-	0.87
2	Specific Gravity of Fluid	-	1.0
4	Temperature @ DGM	°C	32
5	Stack Temperature	°C	231
6	Nozzle Diameter	mm	10
7	Exit Velocity	m/sec	18.1
8	Fuel Used	-	HSD

EMISSION DATA

S.No	Parameter	Unit	Result	Method	Standard
1	Particulate Matter – PM	mg/nm^3	78.2	IS:11255 – P-1	115
2	Sulphur Dioxide – SO_2	mg/nm^3	44.9	IS:11255 – P-2	-
3	Oxides of Nitrogen – NO_x	mg/nm^3	65.4	IS:11255 – P-7	-

ANALYZED BY

SV ENVIRO LABS & CONSULTANTS

ANDHRA PRADESH POLLUTION CONTROL BOARD
D.No.33-26-14D/2, Near Sunrise Hospital, Pushpa Hotel Centre,
Chalamavari Street, Kasturibaipet, Vijayawada – 520 010
Phone. No.0866-2436217, Website : https://pcb.ap.gov.in

RED CATEGORY

RENEWAL OF CONSENT TO OPERATE & AUTHORISATION ORDER

Consent Order No : APPCB/VSP/ CFO/HO/137/2017- Dt. 10/02/2023

CONSENT is hereby granted for Operation under section 25/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21/22 of Air (Prevention & Control of Pollution) Act 1981 and amendments thereof and Authorisation under Rule 6 of the Hazardous & Other Wastes (Management and Transboundary Movement) Rules, 2016 and the rules and orders made there under (hereinafter referred to as 'the Acts', 'the Rules') to:

M/s. Hetero Labs Ltd., Unit-III,
Sy.No. 119,126,120,125(part),138(part),150,151/1, 151/2(part),158/1,
N.Narasapuram (V), Nakkapalli (M),
Visakhapatnam District-531081
Email: KullayiReddy.S@heterodrugs.com

(Hereinafter referred to as 'the Applicant') authorizing to operate the industrial plant to discharge the effluents from the outlets and the quantity of emissions per hour from the chimneys as detailed below:

i) Out lets for discharge of effluents:*

Outlet No.	Outlet Description	Max Daily Discharge KLD	Point of Disposal
1.	**High TDS & High C O D :** Process & Washings	261	Shall be treated in Stripper, MEE & ATFD at CETP, M/s. Hetero Infrastructure, SEZ for treatment.
2.	**Low TDS & Low COD** Cooling tower blow down – 32KLD	32	Shall be sent to biological ETP of M/s. Hetero Infrastructure Ltd., Hetero SEZ for further treatment and disposal.
3.	Domestic effluents	60	Shall be sent to Common STP located at M/s. Hetero Infrastructure Ltd., SEZ for further treatment.

***The above effluents shall be routed through M/s. APEMC.**

ii) Emissions from chimneys:

Chimney No.	Description of Chimney	Quantity of Emissions in m3/hr. at peak flow
1	Attached to 2x2030 KVA, 2x1165 KVA & 1x725 KVA D.G.Sets	--
2	Process emissions	--

***The required steam shall be met from the existing coal fired boilers at M/s. Hetero Infrastructure Ltd., in N.Narsapuram, Ch. Lakshmipuram, Rajaihpet, Pedda Teernala & (V), Nakkapalli (M), Visakhapatnam District.**

iii) HAZARDOUS WASTE AUTHORISATION (FORM – II) [See Rule 6 (2)]:*

M/s. Hetero Labs Ltd., Unit – III, Sy.no. 119,126,120,125(part),138(part),150,151/1, 151/2(part),158/1, N. Narsapuram (V), Nakkapalli (M), Visakhapatnam District., is hereby granted an authorization to operate a facility for collection, reception, storage, treatment, transport and disposal of Hazardous Wastes namely:

- **HAZARDOUS WASTES WITH DISPOSAL OPTIONS:***

S. No.	Name of the Hazardous Waste	Stream	Quantity of Hazardous Waste	Disposal Option
1.	Organic Waste	28.1 of Schedule – I	12.793 TPD	Shall be sent to Authorised Cement plants for co-processing / TSDF, Parawada, Visakhapatnam
2.	Spent Carbon	28.3 of Schedule- I	2.036 TPD	
3.	Process inorganic waste	28.1 of Schedule – I	2.479 TPD	Shall be sent to TSDF, Parawada, Visakhapatnam District through M/s. Hetero Infrastructure Ltd., Hetero SEZ
4.	Expired or damaged Raw materials	28.5 of Schedule – I	0. 2 TPD	Shall be sent to TSDF, Parwada Visakhapatnam or shall be sent to Cement industries along with Other wastes for Co-processing depending on the characteristics of the material
5.	Damaged or Expired products (Intermediates/API)	28.5 of Schedule – I	0.2 TPD	Shall be sent to the Cement industries for usage as alternate fuel in the kiln along with Organic Residue (or) TSDF, Parwada Visakhapatnam
6.	Used PPEs & Other General waste	33.2 of Schedule – I	0.5 TPD	Shall be sent to Cement Industries or to TSDF.

- **HAZARDOUS WASTES WITH RECYCLING OPTIONS:***

S. No.	Name of the Hazardous Waste	Stream	Quantity of Hazardous Waste	Disposal Option
1.	Container & Container liners of Hazardous waste & Hazardous chemicals	33.1 of Schedule – I	2600 Nos/month.	After complete detoxification shall be disposed to outside agencies / to TSDF for detoxification for disposal.

2.	LDPE liner	33.1 of Schedule – I	500 Kg/day	
3.	Used /Waste Oils	5.1 of Schedule – I	180 Lit/Month	Shall be sent to Authosed reprocessors recyclers.
4.	Spent solvents	28.6 of Schedule-I	204.7 KLD	Shall be recovered and recycled within industry premises or to authoried SRS units.
5.	Recovered solvents	28.6 of Schedule-I	195.1 KLD	Shall be recycled withi the industry or sold to utside parties.

***The above wastes shall be routed through M/s. APEMC.**

Non- Hazardous / Other wastes:

S. No.	Name of the Waste	Quantity of Waste	Disposal Option
1.	Lead Batteries	20 No/Month	To be sent to supplier or Manfacturer on Buy back basis
2.	e-waste	50 Kg/day	To be sent to Authorized E – waste facility
3.	Electrical Waste	50 Kg/day	

This consent order is valid for the following products along with quantities indicated only:

S. No	Product Name	Production (Kg/day)	No. of stages	Key starting Raw material	Quantity of KSM (Kg/day)
GROUP –A (REGULAR PRODUCTS)					
1	Abacavir sulphate	166.67	II	Vinecelactam	133.33
2	Capecitabine	133.33	V	D-Ribose	193.94
3	Cefidinir	166.67	IV	(2)-Ethyl 2-(2-aminothiazol-4-yl)-2-(hydroxyimine) acetate	148.81
4	Cefixime Trihydrate	1000	V	T-phenyl acetamido-3-methyl chlorocephosporonic acid,4-methoxy benzyl ester	1562.5
5	Cefoxitin Sodium	333.33	IV	7-(2-Thienyl)acetamidocephalosporinic acid sodium salt	1111.11
6	Cefpodoxime Proxetil	666.67	IV	Deacetyl-7-Aminocephlosporamic Acid(D-7ACA)	606.06
7	Cefuroxime Axetil	666.67	III	Deacetoxy-7 amino cephlosporanic acid (D-7ACA)	416.67
8	Citicoline Sodium	100	III	Oxalic acid	100
9	Darunavir	250	II	(3as,4s,6ar)-a-methoxy tetrahydro furo(3,,4-b)furan-2(3H)-one	333.33

10	Dolutegravir Sodium	167	II	Methyl-4-methoxy acetoacetate	166.67
11	Domperidone IP	166.67	I	5-chloro-1-(piperidin4-yl)-1,3-dihydro-2H-benzimidazol-2-one	183.33
12	Efavirenz	333.33	I	4-chloro-2-Trifluoro Acetyl anailineHydro chloride hydrate	333.33
13	Fluconazole	166.67	III	1,3-difluro benzene	146.2
14	Folic acid	100	II	4-Nitrobenzoic acid	83.33
15	Gliclazide	166.67	III	cyclo pentane-y2-Di carboxylic acid	208.33
16	Hydralazine Hydrochloride	200	III	1-Phthalazione	222.22
17	Irbesartan	166.67	II	1-Aminocyclopentane acetamide	76.8
18	Lamivudine	2333.33	III	5-Chloro-1,3-oxathiolane-2-carboxylic acid-(1R,2S,5R) menthyl ester	5065.04
19	Levetiracetam	1500	I	(S)-2-Amino butyramide. Hydrochloride	1575
20	Losartan Potassium	866.67	V	Valeronitrile	260
21	Nevirapine	1000	II	2-Chloro-N-(2-chloro-4-methyl-3-pyridinyl)-3-pyridine carboxamide	1538.46
22	Omeprazole	166.67	I	5-Methoxy-2-[[4-methoxy-3,5-dimethyl-2-pyridinyl)-methyl] thio]-1H-benzimidazole	226.67
23	Pamidronate sodium	166.67	I	Beta alanine	96.3
24	Phenyl Ephrine.HCL	166.67	IV	3-Hydroxy Acetophenone	357.14
25	Pioglitazone Hydrochloride	166.67	V	5-Ethyl-2-pyridine Ethanol	137.63
26	Quetiapine fumerate	333.33	III	11-Chloro dibenzo-(1,4) -thiazepine	295.14
27	Ritonavir	100	III	(2S,3S,5S)-2-Amino-3-hydroxy-5-(t-butyloxycarbonylamino)-1,6-diphenyl hexane	80.81
28	Rosiglitazone maleate	166.67	III	2-Chloropyridine	65.23
29	Rosuavstatin calcium	100	VI	Tertiary butyl-2[(4R,6S)-6-(acetoxymethyl)-2,2-dimethyl-1,3-dioxan-4-yl]acetic acid	149
30	Telmisartan	100	III	2-N-Propyl-4-methyl-6-(1-methyl benzimidazole-2-yl)benzimidazole	74.07
31	Tenofovir Disproxilfumerate	666.67	I	Adenine	261.44

32	Terbinafine HCL	166.67	I	N-methyl-1-naphalene methane amine hydrochloride	128.21
33	Tranexamic acid	100	III	4-cyanobenzylamine hydrochloride	81.3
34	Valsartan	500	II	L-Valinemetyl ester hydrochloride	375
35	Zidovudine	1166.67	II	Thymidine	791

S. No.	Product Name	Production per Day (Kg)	No.of Stages	Key Raw Material	Qty of KSM (Kgs/day)
GROUP –B (CAMPAIGN PRODUCTS)					
1	Acyclovir	33.33	I	Guanine	25
2	Alendronate Sodium Trihydrate	3.33	I	4-Amino butyric acid	1.63
3	Alfuzosin Hydrochloride	26.67	I	N-Methyl-N'-(amino-6,7-dimethoxy-2-quinozolinyl)1-3-propanediamine Hydrochloride	38.1
4	AliskirenHemifumarate	6.67	I	tert-Butyl (1S,3S)-3-(3-(3-methoxypropoxy)-4-methoxy benzyl)-1-((4S)-tetrahydro-4-isopropyl-5-oxofuran-2-yl)-4-methylpentylcarbamate	8.89
5	Amlodipine Besylate	25	I	Phthalimido Amlodipine	31.86
6	Anastrozole	1	I	1, 2, 4-triazole	0.79
7	Aripiprazole	33.33	III	7-hydro-3,4-di hydro carbostyril	22.22
8	Atazanavir Sulphate	33.33	IV	4-Formyl phenyl boric acid	16.67
9	Atomoxetine HCL	33.33	IV	Acetophenone	30.87
10	Atorvastatin Calcium Trihydrate	33.33	I	4R-Cis)-1,1-Dimethylethyl-6-2-[-(4-Fluorophenyl)-5-(1-Methylethyl)-3-phenyl-4-[(phenylamino-carbonyl]-1H-pyrrol-1-yl]ethyl-2,2-dimethyl-1,3-dioxane-4-acetate	40
11	Benazepril HCL	3.33	II	R-2 Hydroxy-4-phenyl-butanoic acid ethyl ester	1.67

12	Benfotiamine	66.67	III	Thiamine Hcl	66.67
13	Bicalutamide	66.67	II	4-Amino-2-Trifluoror methyl benzonitrile	55.56
14	Butenafine Hydrochloride	0.67	I	1-(Bromomethyl)-4-tert-butylbenzene	0.46
15	candesartan cilexetil	16.67	II	Candesartan	25.01
16	Cefditoren pivoxil	66.67	V	7-phenyl acetamido-3-chloro methyl-cephalosporinicacid-para-methoxy benzyl ester(GCLE)	111.11
17	Cilazapril Monohydrate	3.33	VIII	L-Glutamic acid	3.33
18	Cilostazol	25	I	5-(4-Chlorobutyl)-1-cyclohexyl-1H-tetrazole	23.75
19	Citalopram Hydrobromide	66.67	II	5-Cyanophthalide	41.3
20	Clopidogrel Hydrogen Sulfate	26.67	I	Methyl(+)-alpha-amino(2-chlorophenyl)acetate tartaric acid salt	55.87
21	Daclatasvir	13.33	IV	1,1'-([1,1'-Biphenyl]-4,4'-diyl)bis(2-bromoethan-1-one	15.33
22	Deflazacort	1.67	I	6b-Acetyl-5-hydroxy-4a, 6a, 8-trimethyl-4a,4b,5,6, 6a,6b,7,8,9a,10,10a,10b,11,12-tetradecahydro-9-oxa-7-aza-pentaleno[2,1-a]phenanthren-2-one	2.19
23	Desloratadine	1.67	I	4-(8-chloro-5,6-dihydro-11H-benzo[5,6] cyclohe ptal[1,2-b]pyridin-11-ylidene)-1- piperidine carboxylic acid ethyl ester	2.47
24	Didanosine	3.33	III	Inosine	3.33

25	Dorzolamide HCl	5	I	(±)-Trans-5,6-dihydro-4 H-4-Ethyl amino-6-meth ylthieno[2,3-b] thiopyran-2-sulfonamide -7,7-dioxide	11.22
26	Duloxetine HCL	25	IV	2-Acetylthiophene	41.95
27	Eletripton	16.67	IV	D-protine	20.81
28	Emtricitabine	33.33	III	L-Tartaric acid	39.33
29	Eplerenone	1.67	I	7-Methylhydrogen 17alp ha-hydroxy-3-oxapregne -4,9(11)-diene-7-alpha, 21-dicarboxylate, gamm a-lactone	2.07
30	Eprosartan Mesylat e	16.67	IV	p-toluic acid	18.34
31	Erlotinib Hydrochlor ide	16.67	V	3,4-Dihydroxy Benzoic a cid	10.42
32	Escitalopram Oxala te	16.67	III	Tetra hydrafuran	69.33
33	Esomeprazole Meg nesium	33.33	I	(±) Omeprazole	92.26
34	Etoricoxib	25	II	1-(6-methylpyridin-3-yl)- 2[4-(methylsulfonyl)phen yl]ethane	25
35	Ezetimibe	16.67	III	Glutaric an hydride	16.67
36	Famciclovir	26.67	I	1,3-propanediol, 2-[2-(2- Amino-9H-purin-9-yl)eth yl]	25.64
37	Febuxostat	16.67	I	Ethyl-2(3-cyano-4-Isobut oxyphenyl)-4methylthioz ole-5-carboxylate	16.67
38	Fosamprenavir Cal cium	66.67	I	Benzyl N-[(2R,3S)-3-ami no-2 hydroxy-4-phenylb utyl]-N- (2-methylpropyl) carbamate	54.22

39	Fosinopril Sodium	33.33	VII	Trans-4-hydroxy-L-proline	74.67
40	Glimpiride	26.67	I	4-[2-(3-ethyl-4-methyl-2-oxo-3-pyrroline-1-carboxamido) ethyl]benzene sulfonamide	28.99
41	Indinavir	16.67	II	[2R-[3(S*)1(2S*,3R*)]]2-Benzyl-1-(2,2-dimethyl-2,3,3a,8a-tetrahydro- 8H-indeno[1,2-d]oxazol-3-yl)-3-(2-oxiranyl)-1-propanone	10.79
42	Itraconazole	25	I	2,4-dihydro-4-[4-[4-4 methoxy phenyl]-1piperazinyl]phenyl]-2-(1-methylpropyl)-3-H-1,2,4-triazol-3-one	50
43	Lacosamide	33.33	II	D-Serine	19.38
44	Lansoprazole	33.33	I	3-Methyl-4-[((2,2,2-trifluoroethoxy-2-pyridinyl)methyl)-thio]1H-Benzimidazole	
45	Ledipasvir Premix IH	16.67	II	Tert-Butyl-6-(5-(7-Bromo-9,9-difluoro-9H fluoren-2-yl)-1H-Imidazol-2-yl)-5-Azaspiro[2,4]Heptane-S-carboxylate	13.33
46	Letrozole Intermediate	33.33	II	4-Bromo methyl benzonitrile	106.67
47	Levo Milnacipran	16.67	I	R-Epichlorohydrin	16.67
48	Levofloxacin	25	I	Ethyl 9,10-difluoro-2 ,3-dihydro-3-(S) -methyl-7 -oxo-7H-pyrido[1,2,3-de]-1,4-benzoxazine-6-carboxylate	26.19
49	Lisinopril Dihydrate	20	II	(S)-1-[N2-(1-ethoxy carbonyl-3-phenylpropyl)-N6-trifluoroacetyl-L-lysyl]-L-proline	31.85
50	Lopinavir	66.67	VI	(2S)-2Amino-3phenyl propinoic acid	66.67
51	Loratadine	6.67	V	3-(2-(3-chloro phenyl ethyl pyride	6.84
52	Maraviroc	16.67	VI	Natropinonehcl	16.67

53	Methyl Cobalamin	16.67	I	Cyanocobalmine	16.67
54	Mifepristone	3.33	I	3,3-(ethylenedioxy)-17(beta)-(propyn-1-yl)-5(alpha), 10(alpha) -epoxyseter-9(11)-en-17-beta-ol	3.89
55	Miglitol	1.67	I	6-Desoxy-6-[formyl(2-hydroxyethyl)amino]-L-sorbose	2.45
56	Milnacipran	16.67	I	2-(Chloromethyl)oxiane	16.67
57	Milnacipran HCL	1.67	I	N,N-Diethyl-2-((1,3-dioxoisoindolin-2-yl)-methyl-1-phenyl cyclopropane carboamide	2.71
58	Montelukast sodium	25	I	2-[2-[3(S)-[3-[2-(7-chloro-2-quinolinyl)-ethyl]phenyl]-3-hydroxy propyl]phenyl-2-propanol	28.85
59	Moxifloxacin	26.67	I	Ethyl-1-cyclopropyl-6,7-difluoro-1,4-dihydro-8-methoxy-4-oxo-quinoline-3-carboxylate	27.45
60	Moxonidine	16.67	I	4,6-dichloro-2-methyl-5-pyrimidine	18.67
61	Nadifloxacin	0.67	I	5-Bromo-6-fluoro-2-methyl-1,2,3,4-tetrahydroquinoline	0.63
62	Nelfinavir	3.33	I	(3S, 4aS, 8aS)-N-(1, 1-Dimethylethyl) decahydro-2-[(2R, 3R)-2-hydroxy-3-amino]-4-(phenylthio) butyl]-3-isoquinolinecarboxamide benzoic acid	3.85
63	Olanzapine	33.33	I	4-Amino-2-methyl-10H-thieno[2,3-b][1,5]-benzodiazepine hydrochloride salt	79.37
64	Osaltamivir phosphate	25	X	Sicmic acid	27.78
65	Ozagrel HCL	3.33	I	Ethyl-3-[4-(bromomethyl)phenylprop-2-enoate	4.44
66	Pantoprazole Sodium	25	III	5-[Difluoromethoxy)-1H-benzimidazole-2-thiol	16.13
67	Perindopril	16.67	VI	Valeryl chloride	67.67

68	Phthalazinone	33.33	II	Phthalimide	65.27
69	Posaconazole	33.33	I	N-{4-[4-(4-Hydroxy-phenyl)-piperazin-1-yl]-phenyl}-carbamic acid phenyl ester	28.89
70	Rabeprazole Sodium	25	II	4-(3-methoxypropoxy)-3-methyl-2-chloromethyl-pyridine hydrochloride	25.58
71	Raltegravir	50	I	5-methyl-1,3,4-oxadiazole- 2-carbonyl chloride	21.15
72	Ramipril	33.33	I	Benzyl(cis,endo)-octahydrocyclo penta(b)pyrrole-2(s)-carboxylate hydro chloride	33.33
73	Ranolazine di HCL	16.67	I	N-(2,6-Dimethylphenyl)-1-piperazineacetamide	10.32
74	Rasagiline Mesylate	3.33	I	(R)-(+)-Aminoindan hydrochloride	2.96
75	Residronate Sodium	3.33	I	2-(3-pyridyl)acetic acid	1.95
76	Rifaximin	33.33	I	Rifamycin-D	33.33
77	Roflumilast	3.33	I	4-Difluoromethoxy-3-hydroxy benzaldehyde	3.33
78	Rufinamide	20	IV	2,6-difluoro benzoic acid	22.6
79	Rupatadine fumarate	3.33	I	Loratadine	3.4
80	Sequinavir Mesylate	26.67	V	Methanol	105.61
81	Sertaconazole	16.67	I	3-(Bromomethyl)-7-chloro Benzo(b) Thiophene	16.67
82	Sertraline HCL	25	III	4-(3,4-Dichlorophenyl)-3,4-dihydro-N-methyl-1(2H)-Naphthalenimine	28.41
83	Simvastatin	66.67	V	Lovastatin	87.72
84	Sofosbuvir	50	IV	(2R,3R,4R)-3-(Benzoyloxy-4-f;luoro-4-methyl-5-oxotetra hydro-furan-2-yl) methyl benzoate	87.72
85	Stavudine	16.67	III	5-Methyluridine	16.67

86	Sumatriptan Succinate	3.33	I	N-methyl-3-(2-chloroethyl)-1H-indole-5-methanesulfonamide	3.03
87	Tazarotene	1.67	I	6-Ethynyl-4,4-Dimethylthiochroman	1.15
88	Tegaserod Maleate	1.67	I	Hydrazinecarbo thioamide	0.55
89	Temozolomide	2.67	II	5-amino-1h-imidazole-4-carboxamide hcl	1.78
90	Tiagabine	23.33	I	4-Bromo-1,1-bis(3-methyl-2-thienyl)-1-butene	25.28
91	Tioconazole	26.67	IV	2-Chloro-3-(bromomethyl)thiophene	18.67
92	Topiramate	16.67	I	2,3,4,5-bis-O-(1-methylidene)-beta-D-fructopyranose	18.52
93	Torsemide	2.67	I	4-[(3-Methylphenyl)amino]-3-pyridinesulfonamide	2.22
94	Valacyclovir	50	II	2-(Acetylamino)-1,9-dihydro-9-[[2-(acetyloxy)ethoxy] methyl]-6H-purin-6-one	74.16
95	Velpatasvir	16.67	IV	9- Bromo-3-(2-bromoacetyl)-10,11-di hydro-5H-di benzo[c,g] chromen-8 (9H)-one	35.61
96	Venilafaxine	16.67	II	2-(4-Methoxyphenyl)acetonitrile	0.99
97	Voriconazole	27.33	I	6-Ethyl-5-fluoro-4-chloropyrimidine	0.54
98	Voglibose	1.66	II	Voliolamine	3.33
99	Zonisamide	33.33	I	1,2-Benzisoxazole-3-acetic acid	4.66
100	Validation batches for samples purpose	100	--	--	--

*** The total production of the industry shall be 13,000 Kg/day (i.e., 11,816.67 Kg/day from 15 No. of products out of 35 regular products and 1183.33 Kg/day from 27 No. products out of 99 campaign products.) at any point of time**

This order is subject to the provisions of `the Acts' and the Rules' and orders made thereunder and further subject to the terms and conditions incorporated in the schedule A, B & C enclosed to this order.

This combined order of Consent to operate & Hazardous Waste Authorisation shall be valid for a period ending with the **31st day of March, 2023.**

PRAVIN KUMAR IAS, MS(PK), O/o MEMBER SECRETARY-APPCB

To

M/s. Hetero Labs Ltd., Unit-III,
Sy.no. 119,126,120,125(part),138(part),150,151/1, 151/2(part),158/1,
N.Narasapuram (V), Nakkapalli (M),
Visakhapatnam District-531081

Copy to:

1. The JCEE, Zonal Office, **Visakhapatnam** for information and necessary action.
2. The EE, Regional Office, **Visakhapatnam** for information and necessary action.

SCHEDULE-A

1. Any up-set condition in any industrial plant / activity of the industry, which result in, increased effluent / emission discharge and/ or violation of standards stipulated in this order shall be informed to this Board, under intimation to the Collector and District Magistrate and take immediate action to bring down the discharge / emission below the limits.
2. The industry should carryout analysis of waste water discharges or emissions through chimneys for the parameters mentioned in this order on quarterly basis and submit to the Board.
3. Notwithstanding anything contained in this consent order, the Board hereby reserves the right and powers to review / revoke any and/or all the conditions imposed herein above and to make such variations as deemed fit for the purpose of the Acts by the Board.
4. The industry shall ensure that there shall not be any change in the process technology, source & composition of raw materials and scope of working without prior approval from the Board.
5. The applicant shall submit Environment statement in Form V before 30th September every year as per Rule No.14 of E(P) Rules, 1986 & amendments thereof.
6. The applicant should make applications through Online for renewal of Consent (under Water and Air Acts) and Authorization under HWM Rules at least 120 days before the date of expiry of this order, along with prescribed fee under Water and Air Acts and detailed compliance of CFO conditions for obtaining Consent & HW Authorization of the Board.
7. The industry should immediately submit the revised application for consent to this Board in the event of any change in the raw material used, processes employed, quantity of trade effluents & quantity of emissions. Any change in

the management shall be informed to the Board. The person authorized should not let out the premises / lend / sell / transfer their industrial premises without obtaining prior permission of the State Pollution Control Board.

8. Any person aggrieved by an order made by the State Board under Section 25, Section 26, Section 27 of Water Act, 1974 or Section 21 of Air Act, 1981 may within thirty days from the date on which the order is communicated to him, prefer an appeal as per Andhra Pradesh Water Rules, 1976 and Air Rules 1982, to Appellate authority constituted under Section 28 of the Water(Prevention and Control of Pollution) Act, 1974 and Section 31 of the Air(Prevention and Control of Pollution) Act, 1981.
9. The industry shall be liable to pay Environmental Compensation / Other Environmental Taxes, if any environmental damage caused to the surroundings, as fixed by the Collector & District Magistrate or any other competent authority as per the Rules in vogue.
10. The industry may explore the possibility of tapping the solar energy for their energy requirements.
11. The industry should educate the workers and nearby public of possible accidents and remedial measures.

S C H E D U L E - B

The industry shall comply with the following conditions:

1. The industry shall connect online pH meters to the scrubbers to APPCB website by 28.02.2023;
2. The industry shall install dedicated multi stage scrubbers to the process vents and report the compliance Office, Visakhapatnam by 31.03.2023.
3. The industry shall strictly comply with the directions the Hon`ble NGT issued if any in O.A.No. 23 of 2022 filed against M/s Hetero Infrastructure SEZ Ltd

WATER POLLUTION:

4. The LTDS effluents sent to CETP of M/s. Hetero Infrastructure SEZ Ltd., shall not contain constituents in excess of the tolerance limits mentioned below:

Outlet	Parameter	Concentration in mg/l
2	pH	6.50 – 8.50
	Temperature ^{o}C	<45^{o}c
	TDS	15,000 mg/l
	TSS	600 mg/l
	BOD	3,000 mg/l
	COD	15,000 mg/l
	Oil and Grease	20 mg/l
	Chromium Hexavalent (as Cr+6)	2 mg/l
	Chromium (total) (as Cr)	2 mg/l
	Ammonical Nitrogen (as N)	30 mg/l
	Cynide (as CN)	0.20 mg/l
	Lead (as Pb)	1 mg/l
	Nickel (as Ni)	3 mg/l
	Zinc (as Zn)	15 mg/l
	Arsenic (as As)	0.20 mg/l

	Mercury (as Hg)	0.01 mg/l

(The industry shall segregate the HTDS & LTDS effluent streams and the effluents which are not meeting the above standards shall be treated as HTDS effluents and shall be sent to MEE of M/s. Hetero Infrastructure SEZ Ltd., for evaporation)

5. The source of water is Hetero SEZ & Sea water Desalination plant. The following is the permitted water consumption:

Sl. No.	**Purpose**	**Quantity (KLD)**
1	Process & Washings	261.0
2	Cooling Tower makeup	161.0
3	Domestic	70.0
	Total	**492.0**

Separate meters with necessary pipe-line shall be maintained for assessing the quantity of water used for each of the purposes mentioned above purpose.

6. The industry shall maintain separate water meter for assessing the quantity of water used for different sections.
7. The industry shall maintain Electro Magnetic flow meters with totalizers for each stream effluents as stipulated to measure the quantity of effluents generation for each stream wise and transporting to HIL – SEZ.
8. The industry shall segregate the cyanide bearing and heavy metal bearing effluent separately and shall send it to the CETP of SEZ by following manifest system for separate treatment. They shall not mix it either in the LTDS effluent or HTDS effluents.
9. The LTDS and HTDS effluents shall be stored in above ground collection tanks separately.
10. The industry shall maintain tank in tank for collection of effluent and washings from production blocks. Free space shall be maintained around the tank in tank to observe leakages if any.
11. The industry shall maintain proper manifest system for effluent transported to HIL and maintain records for quantity of High TDS and Low TDS effluents sent to HIL.
12. Effluents shall not be discharged onland or any water bodies or aquifers under any circumstances. Floor washings shall be admitted into effluent collection system only and shall not be allowed to find their way into storm water drains or open areas.
13. The industry shall provide containers detoxification facility. Container & Container liners shall be detoxified at the specified covered platform with dyke walls and the wash wastewater shall be routed to low TDS collection tank.
14. The industry shall maintain web camera and flow meters provided for HTDS & LTDS pumped to CETP properly and same connected to CPCB & APPCB servers, as per CPCB directions dt. 05.02.2014 / 02.03.2015.
15. Rain water shall not be allowed to mix with either trade or domestic effluents.

Industry shall maintain storm water drains, properly.

AIR POLLUTION:

16. The emissions shall not contain constituents in excess of the prescribed limits mentioned below:

Chimney No.	**Parameter**	**Emission Standards (**mg/Nm3**)**
2	HCl	35
	NH3	30
	Sulphuric acid mist	50
	Chlorine	15
Tank farm vents	HCl	35
	NH3	30
	Chlorine	15
	Benzene	5
	Toluene	100
	Acetonitrile	1000
	Dichloromethane	200
	Xylene	100
	Acetone	2000

17. The industry shall comply with emission limits for DG sets of capacity upto 800 KW as per the Notification G.S.R.520 (E), dated 01.07.2003 under the Environment (Protection) Amendment Rules, 2003 and G.S.R.448(E), dated 12.07.2004 under the Environment (Protection) Second Amendment Rules, 2004. In case of DG sets of capacity more than 800 KW shall comply with emission limits as per the Notification G.S.R.489 (E), dated 09.07.2002 at serial no.96, under the Environment (Protection) Act, 1986.
18. The industry shall comply with ambient air quality standards of PM10 (Particulate Matter size less than 10mg) - 100 mg/ m^3; $PM_{2.5}$ (Particulate Matter size less than 2.5 mg) - 60 mg/ m^3; SO_2 - 80 mg/ m^3; NO_x - 80 mg/m^3, outside the factory premises at the periphery of the industry.
    Standards for other parameters as mentioned in the National Ambient Air Quality Standards CPCB Notification No.B-29016/20/90/PCI-I, dated 18.11.2009

    Noise Levels: Day time (6 AM to 10 PM) - 75 dB (A)
    Night time (10 PM to 6 AM) - 70 dB (A).

19. The industry shall maintain multi stage scrubbers to the process vents to control the process emissions. The industry shall maintain online pH measuring system to the scrubbers to treat the process emissions and same connected to APPCB website. Scrubbed liquid shall be recycled as far as possible and finally sent to CETP of HIL – SEZ for further treatment.
20. The evaporation losses in solvents shall be controlled by taking suitable measures, which include:

    i. Chilled brine circulation to effectively reduce the solvent losses into the

atmosphere.

ii. Transfer of solvents by using pumps and closed conveyance instead of manual handling.
iii. Closed centrifuges be used due to which solvent losses are reduced drastically.
iv. The reactor vents connected with primary & secondary condensers to catch the solvent vapours.
v. All the solvent storage tanks are connected with vent condensers / Nitrogen blanketing system to prevent solvent vapours.

21. The HIL shall maintain 3 CAAQM stations to measure VOC, SPM, SO2, NOX, CO within HIL complex and maintain link to APPCB website.
22. The industry shall not use odour causing substances such as Mercaptan or cause odour nuisance in the surroundings.
23. The industry shall provide VOC meters with real time data transmission facility through internet of things (IoT) and link to the servers of APPCB.

GENERAL:

24. The industry shall not manufacture new products and not exceed the consented capacity without CFE/CFO of the Board.
25. The effluent discharged and emissions shall comply with the tolerance limits mentioned in MoEF notification dated 09.07.2009 prescribed for Pharmaceutical (Manufacturing and Formulation) industry and G.S.R. 541(E) dt. 06.08.2021 for Bulk Drug and Formulation (Pharmaceutical).
26. The drums containing chemicals / solvents shall be stored under a roof on elevated platform with a provision to collect leakages / spillages in the collection pit.
27. The industry shall maintain the following records and the same shall be made available to the inspection officials of the Board:
    a. Daily production details, RG-I records and Central Excise Returns.
    b. Quantity of Effluents generated, evaporated and reused, disposed to Sea.
    c. Log Books for pollution control systems.
    d. Hazarodus waste generated and disposed.
28. Under no circumstances, the industry shall burn the hazardous waste along with other wastes.
29. The industry shall maintain a minimum green belt area of 33% of total area with native species.
30. The industry shall comply with the SoP issued by CPCB for Solvent Recovery units dated 22.03.2021. The total cumulative losses of solvents shall not be more than 5% of the solvent on annual basis from storage inventory.
31. The industry shall comply with SoPs issued by CPCB time to time for all the wastes.
32. The industry shall maintain valid PLI policy which includes Environmental Relief Fund (ERF) and submit copy to RO, Visakhapatnam on yearly base.
33. The industry shall comply with the Regulation of Persistent Organic Pollutants Rules,2018 notified by the MOEF&CC Notification vide G.S.R. 207 (E) dated 30.05.2018. As per the notification, the following 7 chemicals are prohibited to

manufacturer, trade, use, import and export:

i. Chlordecone,
ii. Hexabromobiphenyl,
iii. Hexabromodiphenyl ether and heptabromodiphenyl ether (commercial octa-BDE),
iv. Tetrabromodiphenyl ether and pentabromodiphenyl ether (commercial penta-BDE),
v. Pentachlorobenzene,
vi. Hexabromocyclododecane and
vii. Hexachlorobutadine.

34. The industry shall submit the information regarding usage of Ozone Depleting Substance once in six months to the Board.
35. The industry shall install digital display boards at publicly visible places at the main gate indicating the products manufactured Vs permitted quantities, Treated effluent concentrations Vs discharge standards, Stack emission & AAQ concentrations Vs standards, hazardous waste generation, disposed, stock Vs permitted quantities and validity of CTO; and exhibit the CTO order at a prominent place in the factory premises, as per Hon'ble Supreme Court order.
36. The industry shall submit Half yearly compliance reports to all the stipulated conditions in Environmental Clearance (EC), Consent to Establishment (CTE) and Consent to Operation (CTO) through website i.e., https://pcb.ap.gov.in by 1st of January and 1st July of every year. The first half yearly compliance reports shall be furnished by the industry and second half yearly compliance reports shall be the audited through MoEF&CC recognized and National Accreditation Board for Laboratory Testing (NABL) accredited third party.
37. Any other directions / circulars / notices issued by CPCB, MoEF&CC and APPCB shall be followed from time to time.
38. The conditions are stipulated without prejudice to the rights and contentions of this Board in any Hon'ble Court of Law.

Special conditions:

39. The industry shall posses a valid NOC issued by the Andhra Pradesh State Disaster Response and Fire Service Dept., (APSDRFSD) at concerned Regional Office, APPCB.
40. The industry shall prepare a safety report and carry out an independent safety audit report of the respective industrial activities including chemical storages / isolated storages by an expert not associated with such industrial activity as required under Rule 10 of MSIHC Rules, 1989 and get it approved by the Factories Dept., and submit the compliance along with copy of the safety report, safety audit report and safety certificate at concerned Regional Office, APPCB.
41. The industry shall extend training to the working personnel for the prevention of accidents and necessary antidotes to ensure safety, as per the MSIHC Rules, 1989.
42. The industry shall carryout calibration of safety equipment and leak detection systems at regular intervals and shall certify the same with the Factories Department. That certified copy shall be submitted to the APPCB, Regional Office.

43. The industry shall install fluorescent Wind Vane at the highest point in the industry premises.
44. The industry shall submit Risk analysis and risk assessment covering worst scenario clearly describing impact within the industry premises and outside the industry premises and emergency response system.
45. The industry shall submit the copy of the safety audit report and On-Site / Off Site Emergency Plans as applicable after being certified by the Factories Department to the APPCB, Regional Office from time to time, if the storage quantity of hazardous chemicals is equal to or, in excess of the threshold quantities specified in schedule 2 & 3 of MSIHC Rules, 1989.

SCHEDULE – C

[See rule 6(2)]

[CONDITIONS OF AUTHORISATION FOR OCCUPIER OR OPERATOR HANDLING HAZARDOUS WASTES]

1. The authorised person shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.
2. The authorisation shall be produced for inspection at the request of an officer authorised by the State Pollution Control Board.
3. The person authorised shall not rent, lend, sell, transfer or otherwise transport the hazardous and other wastes except what is permitted through this authorisation.
4. Any unauthorised change in personnel, equipment or working conditions as mentioned in the application by the person authorised shall constitute a breach of his authorisation.
5. The person authorised shall implement Emergency Response Procedure (ERP) for which this authorisation is being granted considering all site specific possible scenarios such as spillages, leakages, fire etc. and their possible impacts and also carry out mock drill in this regard at regular interval of time;
6. The person authorised shall comply with the provisions outlined in the Central Pollution Control Board guidelines on “Implementing Liabilities for Environmental Damages due to Handling and Disposal of Hazardous Waste and Penalty”.
7. It is the duty of the authorised person to take prior permission of the State Pollution Control Board to close down the facility.
8. An application for the renewal of an authorisation shall be made as laid down under these Rules.
9. Any other conditions for compliance as per the Guidelines issued by the Ministry of Environment, Forest and Climate Change or Central Pollution Control Board from time to time.

Specific Conditions:

10. The industry shall comply with the provisions of HWM Rules, 2016 in terms of interstate transport of Hazardous Waste and manifest document prescribed Under Rule 18 and 19 of the HWM Rules, 2016.
11. The industry shall not store hazardous waste for more than 90 days as per the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.

12. The industry shall store Used / Waste Oil and Used Lead Acid Batteries in a secured way in their premises till its disposal to the manufacturers / dealers on buyback basis.
13. The industry shall transport the hazardous waste to cement industries only through vehicle fitted with GPS tracking system.
14. The industry shall maintain 7 copy manifest system for transportation of waste generated and a copy shall be submitted to concerned Regional Office of APPCB. The driver who transports Hazardous Waste should be well acquainted about the procedure to be followed in case of an emergency during transit. The transporter should carry a Transport Emergency (TREM) Card.
15. The industry shall maintain proper records for Hazardous and Other Wastes stated in Authorisation in Form-3 i.e., quantity of Incinerable waste, land disposal waste, recyclable waste etc., and file annual returns in Form-4 as per Rule 20 (2) of the Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.

PRAVIN KUMAR IAS, MS(PK), O/o MEMBER SECRETARY-APPCB

To
M/s. Hetero Labs Ltd., Unit-III,
Sy.no. 119,126,120,125(part),138(part),150,151/1, 151/2(part),158/1,
N.Narasapuram (V), Nakkapalli (M),
Visakhapatnam District-531081

ANNEXURE-III

Restricted distribution

NIO/SP- 04/2023
(SSP-3462)

Monitoring Study around the marine outfall point of Hetero Infrastructure SEZ Ltd. in the coastal waters off Nallamattipalem

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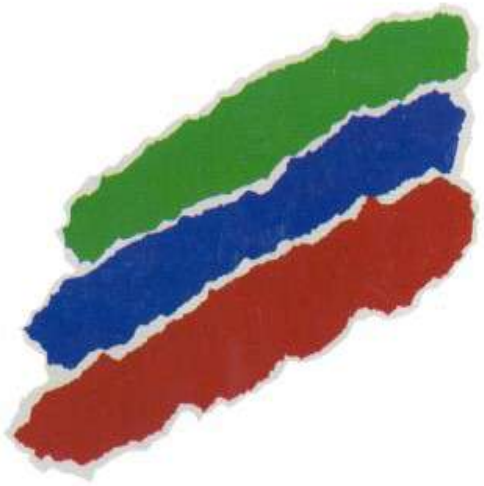

February 2023

सीएसआईआर – राष्ट्रीयसमुद्रविज्ञानसंस्थान
CSIR-NATIONAL INSTITUTE OF OCEANOGRAPHY
(वैज्ञानिकतथाऔद्योगिकअनुसंधानपरिषद)
(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)
दोना पावला, गोवा भारत / **DONA PAULA, GOA - 403004**
India
फ़ोन/Tel : 91(0)832-2450450/ 2450327
फैक्स /**Fax: 91(0)832-2450602**
इ-मेल/e-mail : ocean@nio.org
http:// www.nio.org

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February 2023

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PR E F A C E

M/s. Hetero Infrastructure SEZ limited, Rajayyapeta village, Nakkapalli Mandal, Visakhapatnam district approached CSIR-National Institute of Oceanography (CSIR-NIO), Regional Centre at Visakhapatnam to carry out the post project monitoring of marine environment at its marine outfall point (MOP) to know the impacts, if any on the ecology, water and sediment quality due to the release of treated effluent from Hetero chemical complex. In this connection, CSIR-NIO received a service order (No. 4900198745) from Hetero Infrastructure SEZ Limited on 29th April 2022. CSIR-NIO conducted a field campaign on 7th May 2022 in the marine outfall region of M/s Hetero Chemical Complex for *in-situ* observations and sample collection for the comprehensive study on water quality, biological, microbiological and sediment characteristics of the region. The following studies were carried out:

- Monitoring of physico-chemical, biological, micro-biological and sedimentological parameters in the marine environment to assess the present status of marine ecology.
- Toxicological studies to know the survival rate of the test species with the treated effluent from the guard pond of M/s Hetero Infrastructure SEZ Limited.

This report describes the results of the above studies and provides recommendations to M/s Hetero Infrastructure SEZ limited to maintain the sea water quality and health of the ecosystem in the coastal waters off Rajayyapeta.

Station: Visakhapatnam (**M S KRISHNA**)

Date: 06.02.2023 (Project Leader)

List of Contributors to the project

Scientist-In-Charge

Shri. G. P. S. Murty

Project Leader

Dr. M. Sri Rama Krishna

Data Collection, Processing & Analysis

Physico-chemical studies	*Biological studies*
Dr. V.V.S.S. Sarma	Dr. T.N.R. Srinivas
Dr. M. Sri Rama Krishna	Dr. L. Jagadeesan
Mr. R. Gangadhar Raju	Ms. M. Sravani
Mr. K. Suresh Kumar	Mr. Joseph Ignitious
Mr. I Dhanunjaya Rao	
Mr. Dipin Ghosh	
Mr. Shirish Varshishth	
Mr. M. Sree Lakshmi	

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Executive Summary

CSIR-National Institute of Oceanography (CSIR-NIO) received a work order from M/s Hetero Infrastructure SEZ Limited to conduct post project monitoring study of the marine environment around its marine outfall point (MOP) in the coastal waters of Rajayyapeta. Accordingly, CSIR-NIO carried out a field campaign in the coastal waters off Rajayyapeta on 7th May 2022 for *in-situ* observations and sample collection for physico-chemical, biological, microbiological and sedimentological parameters. Eco-toxicology (bioassay) test was conducted for four days on the treated effluent collected directly from the guard pond of M/s Hetero Infrastructure SEZ Limited using zebra fish following CPCB norms. The salient features of our investigations in this study are given below.

- ✓ The range of values observed for temperatures and salinities of the study region is normal and consistent with coastal waters of east coast of India.
- ✓ The range of concentrations observed for chemical parameters such as dissolved inorganic nutrients (nitrite, nitrate, phosphate and silicate) is normal and is concurrent with the coastal waters along the east coast of India.
- ✓ The range of values observed for pH and total suspended matter in the study region is normal and are well within the values reported for coastal waters of east coast of India. However, the range of total petroleum hydrocarbons (TPHC) found in the surface and bottom waters of this study (10.0-22.1 µg/L and 2.1-37.4 µg/L, respectively) are relatively higher than those found in the previous monitoring study conducted in this region in 2017 (1.3-10.5 µg/L and 1.7-4.7 µg/L, respectively), indicating that there is a slight increase in recent years in the TPHC input from local sources into the coastal waters of Rajayyapeta.

- ✓ Mean dissolved oxygen (DO) concentrations in the surface (6.1±0.2 mg/L) and bottom (5.8±0.5 mg/L) waters of the study region are well above the threshold limit of DO concentrations for good quality of seawater (5.0 mg/L), indicating that coastal waters of this region are healthy with respect to DO concentrations.

- ✓ Mean values of biochemical oxygen demand for three days (BOD_3) in the surface and bottom waters of this study (1.9±0.7 mg/L and 2.1±1.0 mg/L, respectively) are well within the reported BOD_3 values for east Indian coastal waters. The BOD_3 values found in this study indicate that there is no significant pollution of labile organic matter from external sources in this region during the study period.

- ✓ Phytoplankton biomass, in terms of Chlorophyll-a (chl-a), varied from 0.23 to 0.56 mg/m^3 (mean: 0.37 mg/m^3) and it is considerably lower than those found in this region in 2017 monitoring study (1.2 to 7.44 mg/m^3). Mean phytoplankton abundances found in the surface and bottom waters of this study (4646 Nos./L and 5675 Nos./L, respectively) are considerably lower than those reported in the previous monitoring study conducted in this region in 2017 (10860 Nos./L and 10698 Nos./L, respectively), indicating that decreased primary production in the study region when compared to 2017. However, phytoplankton diversity increased as the range of number of phytoplankton genera recorded in surface waters of this study (15-27) is considerably higher than those reported in 2017 (12-19). Though the diatoms are the most predominant contributors to the total phytoplankton abundance, their mean contribution to the total phytoplankton decreased to ~60% in this study compared to ~97% in 2017. On other hand, dinoflagellate contribution increased from ~4% in 2017 to ~23% in the present study. Cynobacterial contribution to the total phytoplankton abundance is 4.2% only. Dominant and consistently occurring species were *Chaetoceros sp., Skeletonema sp., Rhizosolenia sp., Cyclotella sp., Nitschia sp.,*

Navicula sp., Ceratium sp., Gymnodinium sp., Trichodesmium sp., Cyanobacteria*, Thalassiothrix sp*., etc.

✓ Meso-zooplankton abundance in the present study (mean: 395 Nos./m^3) is less than one-fourth of the zooplankton abundance reported in previous monitoring study (1776 Nos./m^3) conducted in this region in 2017. Copepods are predominant in the total zooplankton abundance, with a mean contribution of 89.2% (range: 79.5-94.3%). Chaetognatha contributes from 0.7% to 9.4% (mean: 3.4%) to the total zooplankton abundance. Decapod larve are the third dominant groups in the total zooplankton abundance, with a mean contribution of 1.8% (range: 0.4-4.9%). The lowest abundant groups that contribute <1% to the total zooplankton abundance are Bivalve larvae (mean: 0.8%), Cladocerans (mean: 0.6%) and Thaliacea (0.4%).

✓ The range of macro faunal density found in this study (2650 to 3200 ind/m^2) is comparable to those found in surface sediments of east coast of India. A total of 20 fauna was found and is dominated by families of Polychaeta, with a mean contribution of ~68.3% to the total abundance. In particular *Nephteidae, Orbinidae, Eunicidae, Tereellidae, Opheliidae, Nereidae* and *Spionidae* families are common in all stations. The second largest group was Arthropoda and it was dominated by Amphipoda and Isopoda. Sipancula and Nematoda were present at all the stations. The wet weight of biomass was in the range of 4.05 to 11.27 g/m^2. The meiofauna represent the intermediate size group among the benthos. A total of 7 taxa were identified in the study area and the meio fauna was dominated by nematode, harpacticoid copepod, polychaeta, turbellaria, foraminifera, ostracoda and nauplii of crustacean group.

✓ The range of TVC found in the surface (2.9-24.6 x 10^3 CFU/mL) and bottom (0.9-34.8 x 10^3 CFU/mL) waters of this study are comparable with those

reported in the previous monitoring study conducted in this region in 2017 (5.6-13.6x10^3 CFU/mL and 3.2-33.0 x10^3 CFU/mL, respectively). However, total coliform counts in this study (1.4-8.4 x10^3 CFU/mL in surface and 0.01-10.0 x10^3 CFU/ mL in bottom water) are considerably higher than those reported in the previous monitoring study conducted in 2017 (0.3-0.8 x10^3 CFU/ mL and 0.2-1.2 x10^3 CFU/ mL, respectively). The range of *Escherichia coli* like organisms (ECLO) found in this study (NG to 3.2 x10^3 CFU/ mL and NG to 3.1 x10^3 CFU/ mL, respectively) is comparable with those found in the previous monitoring study conducted in 2017 (1.5-3.7 x10^3 CFU/ mL and 0.7-7.4 x10^3 CFU/ mL, respectively). The *Enterococcus faecalis* like organism counts were NG to 22.9 x10^3 CFU/ mL in surface water and NG to 1.6 x10^3 CFU mL in bottom water. The *Vibrio* like organism (VLO) counts were NG to 3.0 x10^1 CFU/ mL in surface water and NG to 1.0 x10^1 CFU/ mL in bottom water. *Vibrio cholerae* like organism (VCLO) counts were NG to 3.0 x10^1 CFU/ mL in surface water and NG to 1.0 x10^1 CFU/ mL in bottom water. There is no growth of *Vibrio parahaemolyticus* like organism (VPLO) in both surface and bottom waters.

- ✓ ECLO and EFLO counts were observed in most of the stations which showed the influence of anthropogenic activities such as domestic and industrial discharge, recreational activities, open defecation in coastal (beach) regions (in villages), fisherman activities etc. The counts were higher than the reported from the coastal waters and as per standards of coastal recreational waters. VLO and VCLO counts were observed only in two stations out of the 12 stations sampled in the coastal waters off Rajayyapeta.
- ✓ Eco-toxicology (bioassay) test was conducted for four days (96 hrs) on the treated effluent collected from M/s Hetero Infrastructure SEZ Limited using zebra

fish. During the test period of 96 hours, no mortality was observed in the control treatment and the effluent concentrations of 10%, 20% and 30%. The effluent of 50% concentrations recorded 5% mortality during the last 24 hours. Whereas, 60% effluent concentration recorded 5% mortality during the last 48 hours. The 90% effluent recorded 10% mortality while the 100% effluent recorded 25% mortality during the test time of 96 hours. These results indicate that the treated effluent collected from the guard pond of M/s Hetero Infrastructure SEZ Limited did not fulfill the CPCB norms for the bio-assay test, i.e., 90% of survival of zebra fish in 100% of treated effluent after the test time of 96 hours.

- ✓ Based on the median lethal concentrations (LC_{50}), the acute toxicity unit (TUa) of the treated effluent of M/s Hetero Infrastructure SEZ Limited was determined as 0.56 (range: 0.35 to 0.71) for zebra fish. Therefore, the quality of the treated effluent from M/s Hetero Infrastructure SEZ Limited is graded as Limited Toxic (TUa: <1).
- ✓ Based on the results of investigations carried out in the coastal waters of Rajayyapeta (large variability in the abundances of phytoplankton and zooplankton), it is recommended to carry out yearly monitoring study in the coastal waters of Rajayyapeta for next couple of years
- ✓ Based on the observations and eco-toxicology test results, it is recommended to prevent the extensive growth of algae in guard ponds of the industry in eco-friendly manner to improve the quality of treated effluent in order to comply with the CPCB norms of bioassay test for the treated effluent.

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Chapter 1
INTRODUCTION

1.1 Background information

M/s. Hetero Infrastructure SEZ Limited is a bulk drugs manufacturing company situated at Rajayyapeta village in Nakkapalli Mandal of Visakhapatnam District, Andhra Pradesh (Fig. 1.1). This plant is producing bulk drugs and their intermediates for the past few years. The industry is discharging the treated effluents into the sea through a marine disoposal pipeline at a distance of 980 m from the coast, a safe disposal point for quick dispersion, as recommended by the National Institute of Oceanography in their Rapid Marine Environmental Impact Assessment report of 2006. As per the conditions of Environmental Clearance (EC) issued by MoEF&CC, Govt. of India and consent for operation issued by APPCB, the industry is carrying regular post-project monitoring studies in the marine environment and bioassay tests for the treated effluents as a mandatory for a coastal based industry. Accordingly, CSIR-National Institute of Oceanography (CSIR-NIO), Regional Centre, Visakhapatnam has carried out post project monitoring studies in 2010, 2012, 2014 and 2017 to know the impacts if any due to the discharge of treated effluents on the seawater quality and health of the ecosystem. As part of the post project monitoring of the marine environment, once again M/s Hetero Infrastructure SEZ Limited approached CSIR-NIO, Regional Centre, Visakhapatnam for these studies to know the cumulative effects, if any, on the ecology, water quality and sediment quality due to the discharge of treated effluents into the marine environment in April 2022. After examining the proposal, CSIR-NIO agreed to carry out the study to generate one time site-specific data on oceanographic parameters and bioassay studies on the treated effluents as part of the post project monitoring.

Fig. 1.1.: Hetero chemical complex

1.2 Objectives and scope of the Study

The generation of site-specific environmental data base is a prerequisite for the assessment of probable impact of any coastal based industry. The main objective of the study is to understand the cumulative impact, if any, on the ecosystem in the coastal waters off Rajayyapeta due to the release of treated effluent from M/s Hetero Infrastructure SEZ Limited. Hence, the scope of the present study includes the generation of reliable data, at least one time, in respect of physico-chemical, biological, micro biological and sedimentological parameters to understand the water quality and sediment quality at and around the marine out fall point (MOP; discharge point) covering 12 stations. Since the toxicological studies are important to assess the survival rate of test species in the treated effluent, the scope of the work also includes to carry out the bioassay test for four days (96 hours) on the treated effluent collected from the guard pond of M/s Hetero Infrastructure SEZ Limited using pink zebra fish as test species. The results of the monitoring study

conducted in the coastal waters off Rajayyapeta on 7th May 2022 and the toxicological studies conducted on the treated effluent are given in this report.

1.3 Company Profile

M/s Hetero Infrastructure SEZ Limited is a Bulk Drug Manufacturing Complex with four units situated at N. Narasapuram, Nakkapalli Mandal, Visakhapatnam district of Andhra Pradesh. Out of four units, one unit is in the non-Special Economic Zone (SEZ) and the other three units are in the SEZ. M/s Hetero-Infrastructure SEZ Ltd is providing utilities & common facilities like Water, Steam, Effluent Treatment, Sewage Treatment, Scrap Yard, Hazardous waste handling etc. to all the manufacturing units located in this area.

The industrial estate is situated in Sy. Nos: 215, 286/1, 286/2, 283/1 in Ch. Laxmipuram village, 312/1 to 312/5, 312/10 to 312/12, 313/1 to 313/7 of Rajayyapeta village, 19(part) in Peda Teenarla village, 117/1 to 117/3, 119/1, 119/2, 120/1, 120/2, 125, 126, 129/1 to 129/9, 138, 142, 150, 215, N. Narsapuram village, Nakkapalli Mandal, Visakhapatnam District spread over an area of 139.856 ha. The various units which are working at present are as below:

- Hetero Labs Limited, Unit-III (Non SEZ)
- Hetero Drugs Limited, Unit-IX (SEZ)
- Hetero Labs Limited, Unit-IX (SEZ)
- Honour Lab Ltd, Unit-III
- Hetero Infrastructure SEZ Ltd (common facilities)

The Hetero complex (Fig. 1.2) is surrounded by open lands & salt lake in the south direction, open lands in the east direction, open lands in north direction and road connecting Upamaka village with Rajayyapeta village in the West direction, The NH 16 is in the north direction at a distance of 4 km, the nearest railway station is located at

Narsipatnam at a distance of 9 km in the north direction. The nearest airport is located at a distance of 70 km in the north east direction at Visakhapatnam. The Bay of Bengal is in the south eastern direction of the site at a distance of 1.2km. The area is drained by the Varaha River in the northern direction up to a distance of 13km, and the Tandava River in the south west direction at a distance of 14km.

Fig. 1.2: Synoptic view of the Hetero Complex

The capital cost of the project is Rs 1500 Crores. The SEZ is designed on the basis of required infrastructure for pharmaceutical manufacturing facilities like, road, storm water network, common utilities, storage facilities for raw materials, solvents, parking areas, pollution control facilities etc.

The water requirement of the project is being met with the sea water desalination plants (Fig. 1.3) installed in the premises of Hetero Infrastructure SEZ Ltd. Vermi Compost and sewage treatment plants (Figs. 1.4 and 1.5) are provided to treat the waste water and effluent treatment plant, containing different stages of treatment (Figs. 1.6 to

1.11) for industrial waste water. Water conservation measures were incorporated in the plumbing designs. Water recycling / reuse were adopted by way of using treated sewage for green belt development. The storm water from the site is collected in a storage tank and the same is reused for various purposes (as and when required), while the over flow is let out into the natural drain adjacent to the site. The required power is drawn from the AP TRANSCO and adopted energy efficient design for lighting and utility systems to optimize the energy requirement. Construction material was drawn from local sources. The industry installed a 6.1 MW Captive power plant for the generation of power and uses power from Hetero Wind Power.

Amenities and utilities:

A number of amenities and utilities were implemented during the operation phase to provide common infrastructure and pollution control facilities.

Fig. 1.3: Desalination plant in the Hetero Premises

Fig. 1.4: Vermi Compost Plant

Fig. 1.5: Sewage Treatment Plant (STP)

Fig. 1.6: Stripper and MEE (I & II)

Fig. 1.7: ATFD Connected to MEE I & II

Fig. 1.8: HTDS Tanks covered with Hoods and connected to Scrubbers

Fig. 1.9: Biological system for LTDS & Condensate of MEE & ATFD

Fig. 1.10: Guard ponds for storage of treated Effluent

Fig. 1.11: Aeration tanks

Baseline environment:

The baseline environment of the project impact areas (PIA) spread over 25km radius from the site was studied for air, water, soil, noise, ecological and social economic status. The baseline status is found to be within the prescribed limits in all respects except the noise levels which are found to be above the prescribed limits during day time in the PIA.

1.4 Major Products:

Table 1.1: Hetero Labs Limited (UNIT – III) – regular products

S. No	Name of the Product	Quantity (Kg/Day)
1	Abacavir sulphate	166.67
2	Capecitabine	133.33
3	Cefidinir	166.67
4	Cefixime Trihydrate	1000
5	Cefoxitin Sodium	333.33
6	Cefpodoxime Proxetil	666.67
7	Cefuroxime Axetil	666.67
8	Citicoline Sodium	100
9	Darunavir	250
10	Dolutegravir Sodium	167
11	Domperidone	166.67
12	Efavirenz	333.33
13	Fluconazole	166.67
14	Folic acid	100
15	Gliclazide	166.67
16	Hydralazine Hydrochloride	200
17	Irbesartan	166.67
18	Lamivudine	2333.33
19	Levetiracetam	1500
20	Losartan Potassium	866.67
21	Nevirapine	1000
22	Omeprazole	166.67
23	Pamidronate sodium	166.67
24	Phenylephrine.HCl	166.67
25	Pioglitazone Hydrochloride	166.67
26	Quetiapine fumarate	333.33
27	Ritonavir	100
28	Rosiglitazone maleate	166.67

29	Rosuvastatin calcium	100
30	Telmisartan	100
31	Tenofovir Disproxil fumerate	666.67
32	Terbinafine HCl	166.67
33	Tranexamic acid	100
34	Valsartan	500
35	Zidovudine	1166.67
Total Production capacity worst case scenario		**11816.67 Kg/day**

Table 1.2: Hetero Labs Limited (UNIT – III) – Campaign Products

S.No	Name of the Product	Quantity (Kg/Day)
1	Acyclovir	33.33
2	Alendronate Sodium Trihydrate	3.33
3	Alfuzosin Hydrochloride	26.67
4	Aliskiren Hemifumarate	6.67
5	Amlodipine Besylate	25
6	Anastrozole	1
7	Aripiprazole	33.33
8	Atazanavir Sulphate	33.33
9	Atomoxetine HCl	33.33
10	Atorvastatin Calcium Trihydrate	33.33
11	Benazepril HCl	3.33
12	Benfotiamine	66.67
13	Bicalutamide	66.67
14	Butenafine Hydrochloride	0.67
15	candesartan cilexetil	16.67
16	Cefditoren pivoxil	66.67
17	Cilazapril Monohydrate	3.33
18	Cilostazol	25
19	Citalopram Hydrobromide	66.67
20	Clopidogrel Hydrogen Sulfate	26.67
21	Daclatasvir	13.33
22	Deflazacort	1.67
23	Desloratadine	1.67
24	Didanosine	3.33
25	Dorzolamide HCl	5
26	Duloxetine HCl	25
27	Eletripton	16.67
28	Emtricitabine	33.33
29	Eplerenone	1.67
30	Eprosartan Mesylate	16.67
31	Erlotinib Hydrochloride	16.67

32	Escitalopram Oxalate	16.67
33	Esomeprazole Megnesium	33.33
34	Etoricoxib	25
35	Ezetimibe	16.67
36	Famciclovir	26.67
37	Febuxostat	16.67
38	Fosamprenavir Calcium	66.67
39	Fosinopril Sodium	33.33
40	Glimpiride	26.67
41	Indinavir	16.67
42	Itraconazole	25
43	Lacosamide	33.33
44	Lansoprazole	33.33
45	Ledipasvir Premix	16.67
46	Letrozole Intermediate	33.33
47	Levo Milnacipran	16.67
48	Levofloxacin	25
49	Lisinopril Dihydrate	20
50	Lopinavir	66.67
51	Loratadine	6.67
52	Maraviroc	16.67
53	Methyl Cobalamin	16.67
54	Mifepristone	3.33
55	Miglitol	1.67
56	Milnacipran	16.67
57	Milnacipran HCl	1.67
58	Montelukast sodium	25
59	Moxifloxacin	26.67
60	Moxonidine	16.67
61	Nadifloxacin	0.67
62	Nelfinavir	3.33
63	Olanzapine	33.33
64	Oseltamivir phosphate	25
65	Ozagrel HCl	3.33
66	Pantoprazole Sodium	25
67	Perindopril	16.67
68	Phthalazinone	33.33
69	Posaconazole	33.33
70	Rabeprazole Sodium	25
71	Raltegravir	50
72	Ramipril	33.33
73	Ranolazine di HCl	16.67
74	Rasagiline Mesylate	3.33
75	Residronate Sodium	3.33
76	Rifaximin	33.33
77	Roflumilast	3.33
78	Rufinamide	20

79	Rupatadine fumarate	3.33
80	Sequinavir Mesylate	26.67
81	Sertaconazole	16.67
82	Sertraline HCl	25
83	Simvastatin	66.67
84	Sofosbuvir	50
85	Stavudine	16.67
86	Sumatriptan Succinate	3.33
87	Tazarotene	1.67
88	Tegaserod Maleate	1.67
89	Temozolomide	2.67
90	Tiagabine	23.33
91	Tioconazole	26.67
92	Topiramate	16.67
93	Torsemide	2.67
94	Valacyclovir	50
95	Velpatasvir	16.67
96	Venlafaxine	16.67
97	Voriconazole	27.33
98	Zonisamide	33.33
99	Voglibose	1.66
Total Production capacity worst case scenario		**1183.33 Kg/day**

The total Production Capacity Per Month is 390T

Table 1.3: Hetero Labs Limited (UNIT – IX) – Regular Products

S.No	Name of the Product	Quantity (Kg/Day)
1	Abacavir Sulphate	333.34
2	Atorvastatin Calcium	333.33
3	Darunavir	333.33
4	Dextromethorphan	333.33
5	Diltiazem	150
6	Dolutegravir Sodium	666.67
7	Efavirenz	666.67
8	Emtricitabine	333.33
9	Irbesartan	100
10	Lamivudine	3333.34
11	Levetiracetam	1333.34
12	Lopinavir	166.7
13	Losartan potassium	666.7
14	Naproxen	100
15	Nevirapine	500
16	Olmesartan	333.34
17	Quetiapine Hemifumerate	333.34

18	Stavudine	1000
19	Telmisartan	666.67
20	Tenofovir disproxil fumerate	666.67
21	Trazodone	333.34
22	Valsartan	666.67
23	Zidovudine	666.67
	Total Production capacity worst case scenario	**7666.69Kg/Day**

Table 1.4: Hetero Labs Limited (UNIT – IX) – Campaign Products

S.No	Name of the Product	Quantity Kg/Day
1	Aripiprazole	16.67
2	Atazanavir Sulphate	33.34
3	Atomoxetine HCL	33.34
4	Butenafine HCL	16.66
5	Candesartan CilexetilL	33.34
6	Cilazapril Monohydrate	16.67
7	Desloratadine	16.67
8	Didanosine	8.33
9	Entacapone	33.34
10	Escitalopram Oxalate	33.34
11	Etoricoxib	100
12	Etravin	8.33
13	Ezitamibe	33.34
14	Finasteride	20
15	Fosampravior	10
16	Hydralazine HCL	20
17	Levodopa	100
18	Loratadine	33.34
19	Merviroc	33.34
20	Milanacipron	8.33
21	Moxanidine	0.033
22	Nelfinavir Mesylate	8.3
23	Osaltavir Phosphate	100
24	Pioglitazone HCL	66.67
25	Ramipril	33.34
26	Rilpivirine	8.33
27	Ritonavir	66.67
28	Saquanavir Mesylate	8.33
29	Simvastatin	33.34
30	Spironolactone	33.34
31	Terbinafine	200
32	Toresemide	33.34
33	Verapamil	66.67

34	Voricanazole	16.66
35	Zonisamide	66.67
Total Production capacity worst case scenario		**866.7Kg/Day**

Table 1.5: Hetero Drugs Limited (UNIT – IX) – Regular Products

S.No	Name of the Product	Qty per Day in Kgs
1	Acyclovir	333.33
2	Bupropion	500
3	Celecoxib	333.33
4	Citaloparm hydro bromide	133.33
5	Diclofenac Diethyl amine	333.33
6	Diclofenac Potassium	333.33
7	Diclofenac Sodium	800
8	Diolat-12	150
9	Divalproex sodium	333.33
10	Esomeprazole Magnesium Di Hydrate	133.33
11	EsomeprazoleMagnesium Tri Hydrate	233.33
12	Fenofibrate	333.33
13	Fexofenadine	300
14	Gabapentine	400
15	Metaxalone	166.67
16	Nabimitone	100
17	Pregabalin	200
18	RitanovirPremix Amorphous &Form)	666.67
19	Sevelamer Carbonate	100
20	Sertraline HCl Form-I & II	600
21	Topiramate	200
Total Production capacity worst case scenario		**3166.66Kg/day**

Table 1.6: Hetero Drugs Limited (UNIT – IX) – Campaign Products

S.No	Name of the Product	Quantity per day (in Kgs)
1	Carbidopa	20
2	Cinacalcet	16.66
3	Dabigatran Etexilate Mesylate	33.33
4	Eletripan Hydrobromide	16.67
5	Febuxostat	33.33
6	Fesoterodine	6.67
7	Ivacaftor(Premix)	10
8	Lacosamide	50
9	Levodopa	33.33
10	Lopinavir	66.67
11	Lurasidone	40
12	Mamantine HCL	33.33

13	Mexiletine Hydrochloride	80
14	Mirabegron Alpha	20
15	Mirabegron Beta	33.33
16	Pitavastatin	16.67
17	Prasugrel Hydrochloride	17
18	Relaxifene Hydro chloride	33.33
19	Risidronate Sodium	16.67
20	Rilpivirine Hydrochloride	16.67
21	Rivastigmine Base	50
22	Rizatriptan	16.67
23	Rosuvastin	50
24	Rufinamide Premix	30
25	Rufinamide	33.33
26	Silodosin	6.67
27	Sodium Zirconium Cyclosilicate	50
28	Valgaciclovir	33.33
29	Zafirlukast (Amorphous)	10
30	Zolmitriptan	10
31	2-Acetoxy ethyl acetoxymethylethe	2000
32	Validation batches for Samples	100
Total Production capacity worst case scenario		**366.66Kg/day**

Table 1.7: Effluent generation per day

S. No.	Unit	HTDS & HCOD (KLD)	LTDS & LCOD (KLD)	RO Rejects (KLD)	Domestic (KLD)	Total Effluent Generation (KLD)
1	HDL - IX	62.16	2.5		25	89.66
2	HLL - IX	101.1	4		25	130.1
3	HLL - III	261	32		60	353
4	Honour	30.87	5.35		10	46.22
5	Hetero Infra	--	35.504	30	8	73.504
Total		**455.7**	**79.354**	**30**	**128**	**692.484**

Table 1.8: Water Consumption as per Consents

S. No.	Unit	PURPOSE (KLPD)				Total Water Consumption (KLPD)
		Process & washings	Cooling	Domestic	Additional Water to RO	
1	HDL - IX	62.79	50	25	0	137.79
2	HLL - IX	101.13	70	25	0	246.13

3	HLL-III	261	161	70	0	492
4	Honour	32.23	80	10	0	122.23
5	Hetero Infra	--	--	10	107	447

Table 1.9: Details of boilers

S. No.	Capacity
1	20 TPH
2	1x 45 TPH
3	1 x 20 TPH
4	1x 12 TPH

1.5 Green Belt Development

Green belt is recommended as one of the major components of the Environmental Management Plan. The existing industry has green belt and the management emphasizes the development of further greening of the site to enhance environmental quality through mitigation of fugitive emissions, attenuation of noise levels, balancing eco-environment, consumption of treated effluent, prevention of soil erosion, and creation of the aesthetic environment. The greenbelt is in an area of 124.5 acres. The enhancement of the green belt involved the plantation of small species. Proper attention and management are being taken up by the firm to maintain the survival rate of the planted species. For plantation of the small plants digging pits are very important for preparing the soil environment near the roots of the plants. The size of the pit will be optimum enough to supply required nutrients to the roots of the plant. The usual method is to dig a pit of required size three to four months before planting of the species, which is generally done at the break of the monsoon. The pits of 45 cm x 45 cm x 45 cm size in the case of hardier spices like Eucalyptus, Shisham, Acacia etc., but larger pit size is preferred for fruit yielding trees like mango, Jamun etc. 1m x 1m x 1m pits may be used for plantation of other trees. The

soils of the plant side will be mixed with 1/3 farmyard manure before refilling about a week prior to planting.

M/s. Hetero Labs Ltd. units are having good environment management plan and made this as part of their corporate policies. The firm has considered Safety, Health and Environmental protection as an integral part of their business. As a part of the environmental management plan the firm established and developed a green belt in and around each block of the plant (Figs. 1.13 to1.18).

Fig. 1.12: Green Belt inside the factory

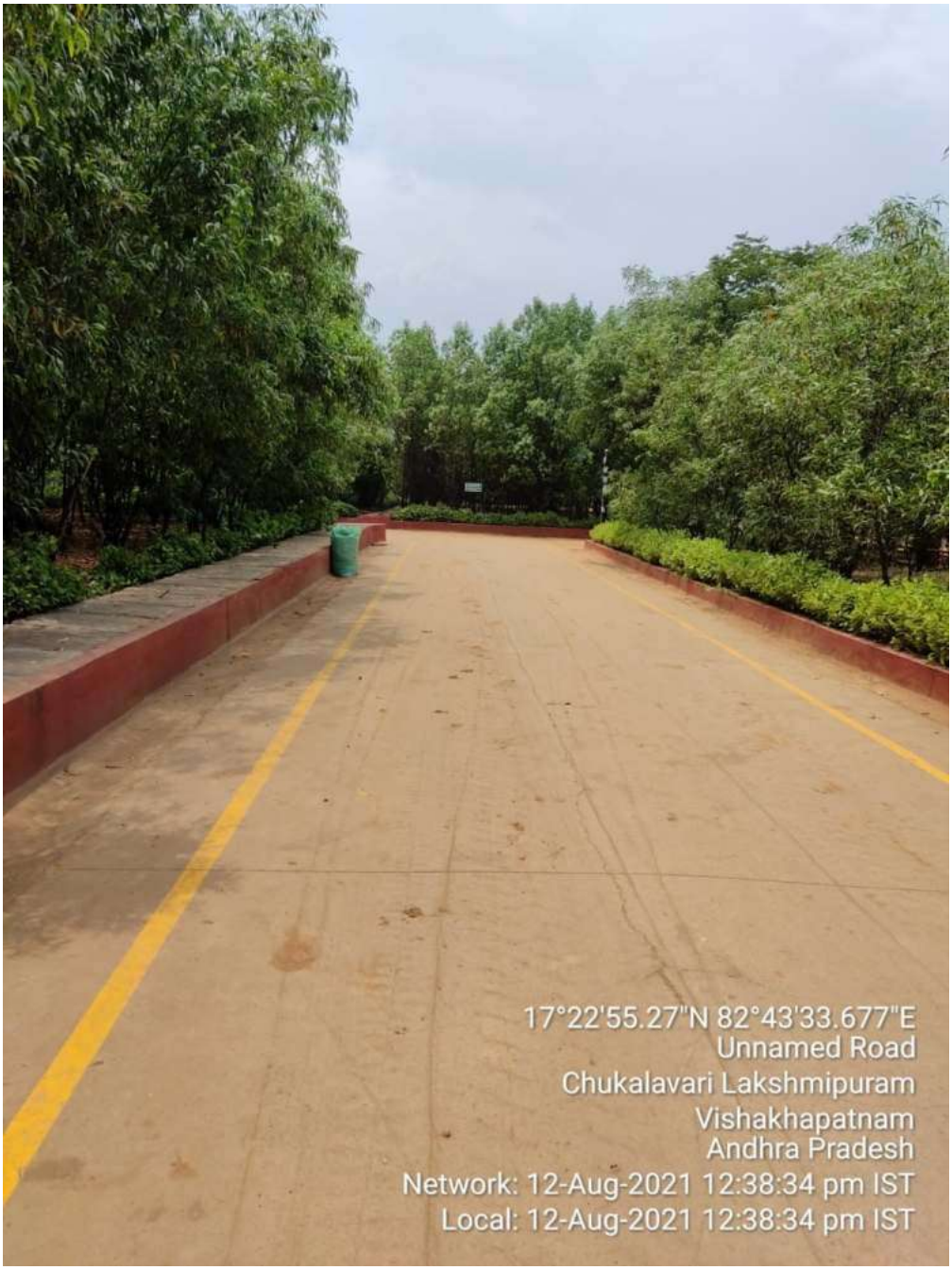

Fig. 1.13: Green Belt within the factory

Fig. 1.14: Green Belt in ETP area

Fig. 1.15: RCC Road connected to Boilers with Green Belt

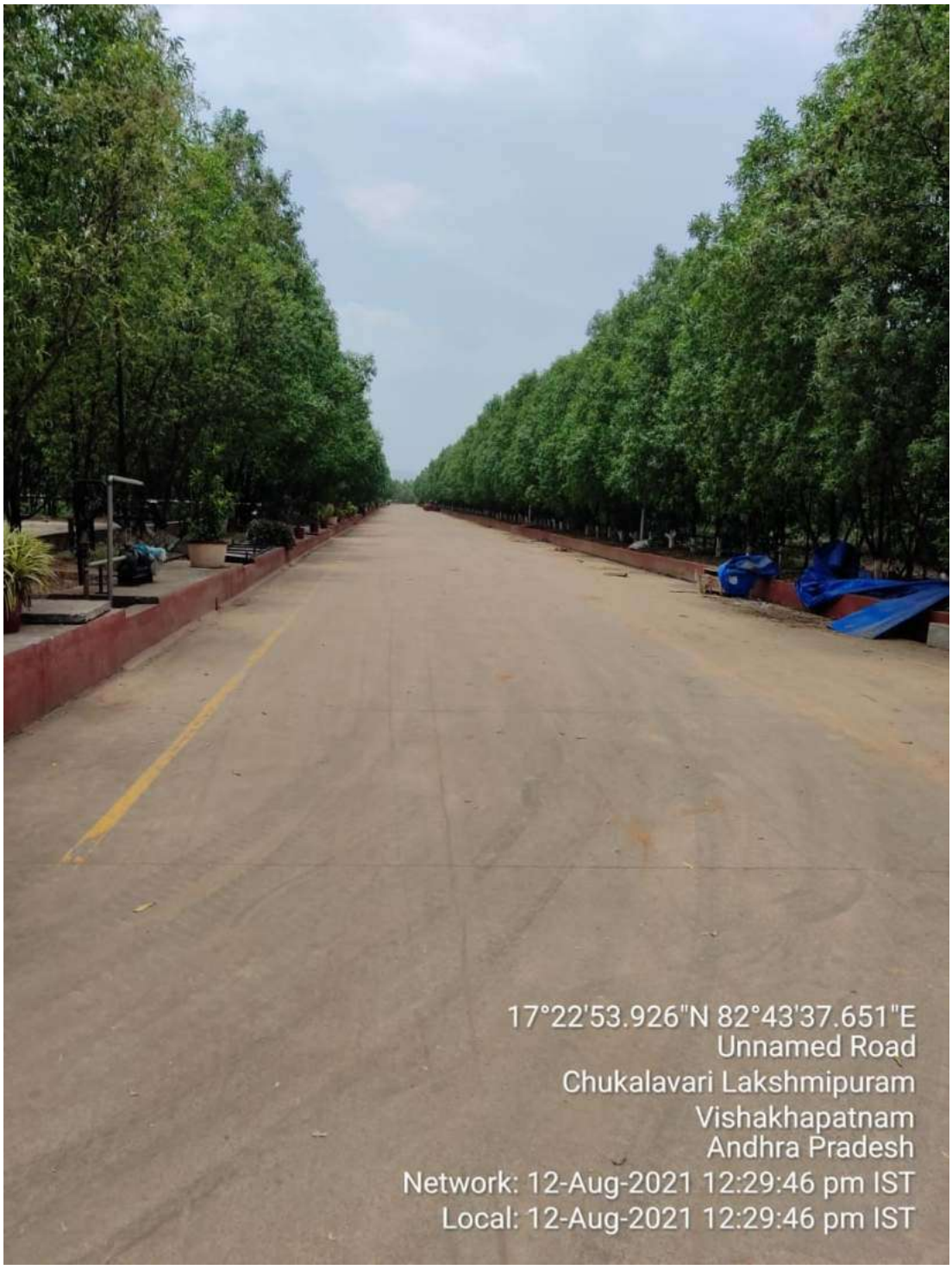

Fig. 1.16: Green Belt in the Hetero premises

Fig. 1.17: Green Belt inside the company

Chapter 2

SAMPLING AND METHODS

1.1. Sample collection

A field campaign for in-situ observations and sample collection in the coastal waters of Nallamattipalem was conducted on 7th May 2022 on a mechanized fishing boat. Samples for physico-chemical, biological, microbiological and sedimentological parameters were collected at selected 12 stations following Paris Commission Guidelines. Stations were fixed in all four directions with a distance of 0.5 km, 1.0 km and 2.0 km from the marine outfall point (MOP) (Fig. 2.1; Table 2.1). Details of the station locations such as latitude, longitude and water column depth were provided in Table 2.1. Treated effluent was collected directly from the guard pond of M/s Hetero Chemical Complex to conduct bio-assay (eco-toxicity) tests and to examine the concentration levels of heavy metals in the treated effluent

A Niskin water sampler (10L, plate. 2.1) was used to collect water samples from surface and near bottom in coastal waters off Nallamattipalem at all stations shown in Figure 2.1. Water samples were collected in pre-cleaned glass/plastic bottles as soon as the water sampler was brought onto the deck (Plates 2.2 and 2.3). The samples in duplicate were fixed immediately for dissolved oxygen (DO) after collection on deck. Samples for phytoplankton were collected in narrow mouth self-sealed 1 litre PVC bottles and added Lugols Iodine (10%) solution as a preservative. Phytoplankton samples were collected in both surface and bottom waters at each station. Meso zooplankton from the surface waters was collected by towing the bongo net fixed with a flow meter. Zooplankton samples collected in the bucket that was fixed at the end of the bongo net were removed and transferred the sampled into a PVC jar as depicted in plates 2.4 and 2.5. The volume of

water filtered through the bongo net was calculated from the flow meter reading. Formalin was added as a preservative to the zooplankton sample and brought to the shore laboratory for further analysis. Surface sediment collected using Van Veen grab sampler (Plate 2.6) and sieved for benthic organisms through the benthic sieve (Plate 2.7). Benthic organisms (both macro and meio-fauna) were separated from surface sediment by washing the sediment sample on the benthic sieve with a gentle flow of water to remove clay and silt particles. Benthic organisms retained on the sieve were transferred to a PVC jar and added Rose Bengal as a preservative. Collection and laboratory analysis of phytoplankton, zooplankton and benthic fauna were given in the methodology section (Section 2.2.2).

For Biochemical Oxygen Demand (BOD) samples were collected in air-tight glass bottles and kept in the BOD incubator for five days. After five days, samples were fixed with Winklers A and B reagents for the determination of DO in the sample. Samples for dissolved inorganic nutrients were collected in plastic bottles and kept frozen until the samples reached the shore laboratory. Samples were preserved in a -20^{o}C deep freezer at the shore laboratory until the analysis is performed. Standard methods have been employed to analyse chemical constituents in seawater samples collected for this study. The collection of water samples from Niskin sampler was shown in plates 2.2 and 2.3, and towing of zooplankton (bongo) net and collection of zooplankton sample from net-bucket were shown in plates 2.4 and 2.5. Surface sediments were collected using Van Veen grab sampler (Plate 2.6) and benthic organisms from surface sediment were separated using benthic sieve (Plate 2.7).

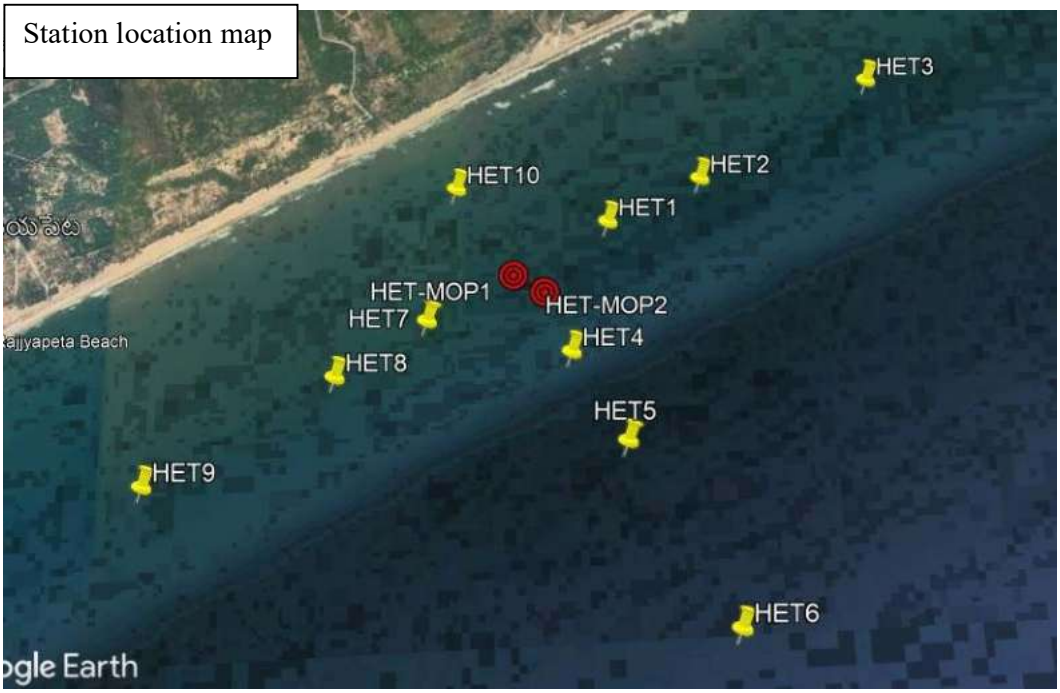

Fig. 2.1: A map showing station locations in the study area, i.e. coastal waters off Nallamattipalem. Red circles show the MOPs of M/s Hetero Chemical Complex. Yellow pins show the stations fixed in all four directions of the MOP with distances of 0.5 km, 1.0 km and 2.0 km from MOP.

Plate. 2.1: Niskin sampler (10L) used for collection of water samples

Plate 2.2: Collection of samples onboard fishing trawler

Plate 2.3: Collection of waters samples from Niskin sampler

Plate: 2.4: Towing of bongo net in surface waters for zooplankton and removal of bucket from bongo net to collect zooplankton sample

Plate: 2.5: Collection of zooplankton sample

Plate 2.6: Van Veen grab sampler

Plate 2.7: Benthic sieve

Table 2.1: Sampling locations in coastal waters off Rajayyapeta

Station Name	Latitude (′′N)	Longitude (′′E)
HET 1	17°21'13.56"N	82°44'45.84"E
HET 2	17°21'20.16"N	82°45'1.44"E
HET 3	17°21'35.94"N	82°45'30.66"E
HET 4	17°20'52.56"N	82°44'39.18"E
HET 5	17°20'38.22"N	82°44'47.58"E
HET 6	17°20'9.72"N	82°45'3.48"E
HET 7	17°20'58.62"N	82°44'16.02"E
HET 8	17°20'50.34"N	82°44'1.26"E
HET 9	17°20'34.86"N	82°43'31.44"E
HET 10	17°21'20.28"N	82°44'21.00"E
Hetero- MOP1	17°21'7.00"N	82°44'31.00"E
Hetero- MOP2	17°21'04.0"N	82°44'36.0"E

Table 2.2: Names of scientific and technical personnel participated in the field campaign

S. No.	Name of Personnel	Designation
1	Dr. TNR Srinivas	Senior Scientist
2	Mr. I Dhanunjaya Rao	Project Associate
3	Mr. Shrish Vashishth	Project Associate
4	Mr. Joseph Ignitiuous	Project Associate

2.2. Methodology

2.2.1. Physico-chemical characteristics

The Physico-chemical parameters were analysed through the standard procedures following Carrit and Carpenter (1966), Grashoff (1974), Suzuki and Ishimaru (1990) and

Grassoff et al. (1992). The detailed methodology of each parameter is given below, and the instruments used in this study were given in Table 2.3. Temperature and salinity were obtained from CTD (SBE-19plus; Sea-Bird Electronics, USA) profiler.

a) pH

pH of the seawater sample collected in air-tight glass bottle (60ml) was measured using a Metrohm pH analyzer (Titrando 865). Standard buffer solutions (Merck, Germany) were used for calibration of the instrument. Based on the repeated analysis of aliquots of standards and samples, the precision of the analysis for pH is 0.002 units.

b) Dissolved Oxygen (DO)

Winkler's method was adopted for the determination of DO concentrations. A measured volume of water sample was fixed immediately after collection with the reagents Winkler's A (manganous chloride) and Winkler's B (alkaline potassium iodide). Standard titration with sodium thiosulphate (standardized with potassium Iodate, KIO_3) was adopted for the analysis purpose. Concentration of DO was expressed in mg/l. The precision of analysis, expressed as standard deviation with this method was ±0.07%.

c) Biochemical Oxygen Demand (BOD)

Samples for the determination of biochemical oxygen demand were collected in triplicate. The dissolved oxygen concentration was determined using one of the triplicate samples according to Winkler's method, as detailed above. The remaining bottles were kept in the BOD incubator for three days at 20ºC. Dissolved oxygen in these samples was determined after fixing the samples on completion of three days of incubation. BOD_3 was computed from the initial DO concentrations and expressed in mg/l.

d) Ammonium - Nitrogen (NH_4^+ - N)

Ammonical - Nitrogen in seawater samples was determined with the indophenol blue method using trione. Care was taken for the analysis of ammonium and ammonia free distilled water was used for analysis to avoid any contamination as ammonia is highly soluble in water. The absorbance of the coloured complex was measured at 630 nm in Spectrophotometer against a standard. NH_4 - N is expressed in µmol/l and the precision of analysis, in terms of standard deviation, is ±0.02 µM

e) Nitrite - Nitrogen (NO_2^- - N)

Nitrite was determined by the method of Bend Schneider and Robinson whereby the nitrite in the water sample was diazotised with sulphanilamide and coupling with N-1-Naphthyl ethylene diamine dihydrochloride. The absorbance of the resultant azo-dye was measured at 543 nm against a standard solution. Concentrations of NO_2^- - N in seawater is expressed in µmol/l.

f) Nitrate - Nitrogen (NO_3^- - N)

Nitrate in the seawater sample was first reduced to nitrite using heterogeneous reduction by passing the buffered seawater samples through an amalgamated cadmium column and the resultant nitrite was determined as above. The measured absorbance was due to initial nitrite present in the sample and nitrite obtained by reduction of nitrate in the sample. Necessary correction was therefore applied for any nitrite initially present in the sample. Concentrations of NO_3^- - N in seawater were expressed in µmol/l. The precision of analysis for both nitrite and nitrate, in terms of standard deviation, is ±0.02 µmol/l

g) Phosphate - Phosphorus (PO_4^{3-} -P)

Inorganic phosphate was measured by the method of Murphy and Riley in which the samples were made to react with acidified molybdate reagent and then reduced using ascorbic acid. The absorbance of the resultant phosphorous molybdenum blue complex was measured at 880 nm against a standard. Concentrations of PO_4^{3-}- P in seawater were expressed in µmol/l. The precision of analysis, in terms of standard deviation, is ±0.01 µmol/l

h) Silicate - Silicon (SiO_4^{2-} - Si)

Silicate - silicon was also estimated by reaction with acid - molybdate and ascorbic acid in the presence of oxalic acid. The interference of phosphate is prevented by addition of oxalic acid. The absorbance of the resultant silico - molybdenum blue complex was measured at 810 nm in Spectrophotometer against a standard. Concentration of SiO_4^{2-}- Si in seawater was expressed in µmol/l. The precision of analysis, expressed as standard deviation, is ±0.02 µmol/l

i) Total Phosphorus (TP)

The seawater sample was autoclaved with alkaline potassium persulphate in a closed bottle. The solution was neutralized and then estimated for phosphate as described above for phosphate – phosphorous. The total phosphorus is expressed in µmol/l.

µmol/l. The precision of analysis, expressed as standard deviation, is ±0.02 µmol/l

j) Total nitrogen (TN)

Aliquot of the seawater samples were analyzed for total nitrogen (TN) on TOC and TN analyzer (Elementar).

k) Total suspended matter (TSM)

One litre of seawater sample was filtered through a pre-weighed Polycarbonate filter (0.22 µm; Millipore) and after filtration the filter was dried for about 2 days at 60°C. The dried filter was weighed and noted down the reading. The filter was dried again and took the weight measurement. This procedure was continued until the weight loss of the filter due to drying is zero. The weight of the material retained on the filter was considered as TSM concentration and was expressed as mg/L.

l) Petroleum Hydrocarbons (PHC)

Total petroleum hydrocarbons (TPHC) concentrations in seawater samples were determined by a standard liquid-liquid extraction method (LLE, EPA method 3510) (Morries, 2013; Ahmed et al., 2015) using Ultra Violet Spectrofluorometric (UVF) detection technique (Greason, 2009) which is more efficient and reliable for TPHC determination in water samples (Adeniji et al., 2017). Seawater sample (500ml) was extracted with HPLC grade n-hexane (20ml) three times and the combined extract was dried over anhydrous sodium sulphate to remove moisture content. Fluorescence of the extract was measured at an emission wave length of 360 nm (excitation wave length 310 nm) using spectrofluorometer (Cary Eclipse, Varian). Blanks prepared by following the same procedure which was employed for sample collection were used to correct the fluorescence of the samples. PHC concentrations in seawater were calculated from the multi-point calibration established by chrysene as a standard. Results of TPHC concentrations in seawater samples are expressed as chrysene equivalents. Repeated analysis of aliquots of samples and standards yielded ±4% of the precision for the TPHC measurements.

2.2.2. Biological Characteristics

All analyses were conducted as per the NIO methodology manual for biological parameters, an in-house compilation based on internationally used published methods

a) Phytoplankton

1-2 litre of the water samples were collected with the help of a Niskin sampler from the surface and bottom. The collected samples were preserved with lugols iodine (10%) and few drops of 2.5 % buffered formalin. In the laboratory, phytoplankton samples were allowed to settle for 24-48 hrs. in one litre measuring jars. After the gravity settlement, the samples were concentrated into 10ml from which 1ml samples were taken and phytoplankton cells were enumerated using a Sedgwick Rafter counting chamber following a standard protocol (UNESCO, 1978). Phytoplankton cells were identified into the genus/species levels using the Olympus inverted microscope (model: IX 71) with the aid of standard taxonomic literatures of Diatoms, Dinoflagellates and Blue-green algae (Subrahmanyam, 1946).

b) Zooplankton

Zooplankton samples were collected through horizontal hauls of HT net (49.5 cm diameter and 200 µm mesh) attached with the calibrated digital flow meter to measure the amount of water filtered through the net. At each station, the net was operated for 5 minutes as shown in Plate 2.4 and the sample remained in the bucket (Plate 2.5) after filtering the seawater through the 200 µm mesh was collected in a pre-cleaned PVC bottle. The excess waters were removed using bolting paper. Zooplankton biomass was measured through the displacement method (Postel et al., 2000). After the biomass measurements, zooplankton samples were preserved in 4-5% buffered formaldehyde for further analysis. In the laboratory, 25-50% of subsamples were taken using Folsom's

plankton splitter the subsamples were analyzed in detailed for quantitative analysis. Zooplankton samples were sorted into group levels using the standard literatures of the Conway et al., 2000 and their abundances were represented in m^3.

c) Benthos

Samples for benthos i.e., bottom living organisms, were collected using a Van Veen grab (Plate 2.6), covering an area of $0.04m^2$ and a penetration depth of 10 cm. Biota (organisms) contained in the sediment were separated by wet sieving (Plate 2.7).

(i) **Meio-fauna**

Sub-samples for meiofauna were collected from the Van Veen grab using a hand core (3 cm diameter) and preserved in formalin-Rose Bengal solution. Samples were passed through a set of two sieves; 0.5 mm and 0.045 mm mesh sieve. The material retained on the finer mesh was used for the analysis of meiofauna. All organisms were sorted and counted under binocular stereoscope microscope in the laboratory. An average of three replicates was taken for the population count and expressed as number per 10 cm^2.

(ii) **Macro fauna**

The sediment samples for macro fauna was washed through a 0.5 mm mesh size sieve and the retained samples were preserved in 10% seawater formalin containing Rose-Bengal stain. In the laboratory, the macro faunal samples were again washed through 0.5 mm mesh sieve in running water to clear adhering sediments. All stained animals were picked and preserved in 5% formaldehyde. Later organisms were sorted and counted group wise under a stereoscope zoom binocular microscope. Wet weight of major macro faunal taxa was recorded on a single pan balance. Fauna was identified as far as possible.

2.2.3. Microbiological parameters

About 100 ml of the sample was sub-sampled into a pre-sterilized bottle for bacterial analysis. All samples were collected with precautions required for microbiological analysis.

Sample serially diluted to 3 times of 10^{-1} to 10^{-3} with sterile salt water. Heterotrophic bacterial counts were determined using R2A agar. Around 100 µl of each serially diluted water samples is plated on R2A agar plates and spread with sterile glass rod and incubated at 37 ^{o}C for 48-72 hours. The colonies formed on the plates are counted using the colony counter and represented as a number of colony forming units (CFU) per ml of water sample after considering dilution factor. Total coliform counts were obtained by plating water samples on MacConkey agar. The colonies formed on the plates are counted using the colony counter and represented as number of colony forming units per ml of water sample after considering the dilution factor. The colonies of pink-red colour and with bile precipitate are counted as ECLO on MacConkey agar plates. The colonies of colourless to pale pink are counted as EFLO on MacConkey agar plates. PALO counts were obtained by plating water samples on Cetrimide agar. The colonies exhibiting fluorescence at 250nm and a blue green pigmentation are considered PALO. VLO counts were obtained by plating water samples on TCBS agar. The colonies formed on the TCBS agar plates are counted as VLO. The colonies of yellow colour are counted as VCLO on TCBS agar plates. The colonies of bluish-green colour are counted as VPLO on TCBS agar plates.

Table 2.3: List of instruments used for this study

S. No.	Name of the instrument	Make & Model	Parameter
1.	CTD Profiler	Sea-Bird Electronics, USA, SBE-19 plus	Temperature and salinity
2.	pH meter	Metrohm, Switzerland Titrando 830	pH
3.	DO titrator	Titrando 835; Metrohm, Switzerland	DO and BOD
4.	Spectrophotometer	Shimadzu, UV-1800	Ammonium
5.	Spectrofluorometer	Turner Designs	Chlorophyll-*a*.
7.	BOD incubator	Tempo Instrument Pvt. Ltd.; TI 500	BOD (incubation)
8.	Auto Analyzer	Skalar, The Netherlands	Nitrite, nitrate, phosphate, silicate
9.	Diaphragm pumps	KNF and Merk Millipore	Separation of particulate matter
10.	Flow Cam	Fluid Imaging Technologies, VSIV	Phytoplankton and Zooplankton
11.	Fluorescence microscope	Olympus (BX51), Nikon (Eclipse80i)	Phytoplankton and Bacteria
12.	Inverted microscope	Olympus, IX 71	Zooplankton
13.	Stereo zoom microscope	Nikon (SMZ 25)	Benthic organisms
14	Precision balance	Sartorius, Cubis	Total suspended matter

2.2.4. Bio-assay (toxicity) test

Discharges into the aquatic environment of contaminated wastewater from various industries represent a major source of aquatic pollution. Aquatic organisms are exposed to a number of pollutants emanating from various types of industries. Concern for the impact of chemical pollution on the quality of aquatic ecosystems has stimulated over 30 years of research on the biological effects of pollutants. Quantifying the ecotoxicological effects of pollutants is critical to the protection of aquatic ecosystems. Determination of water quality criteria for aquatic life is similar to the solving of most biological problems in which experimental data are obtained under controlled laboratory conditions in order to predict effects that might occur under natural conditions.

Physico-chemical parameters are generally used for the evaluation of effluent quality. However, monitoring of these parameters alone cannot provide a measurable quantity in the toxicity assessment. Furthermore, in some cases, the quality of waste water in terms of physico-chemical parameters may conform to the permissible limits, and the wastewater may be toxic to the aquatic flora and fauna. Therefore, toxicity evaluation through bioassays forms an important and cost-effective tool in wastewater quality monitoring programmes.

Acute toxicity tests (bioassays) are generally performed to evaluate the toxicant and other materials used in the coastal environment to determine the relative sensitivity of different living organisms and permissible effluent discharge dose. It is a procedure in which the responses of aquatic organisms are used to detect or measure the presence or effect of one or more substances, in a particular ecosystem. Median lethal concentration (LC_{50}) of a toxicant is the concentration that results in the mortality of a specified portion of the population within a definite period of time. Median lethal concentration (LC_{50}) of a toxicant in an environmental medium which results in 50% mortality of test organisms within a definite period of exposure periods (such as 24 hrs, 48 hrs, 72 hrs and 96 hrs) is called LC_{50}. The LC_{50} values in turn represent the median lethal concentration or median tolerance limit.

In this study, Acute toxicity tests conducted on treated effluents were carried out using Whole Effluent Toxicity (WET) methods of USEPA to assess the potential toxicity of effluents using the zebrafish specimens of 30-35mm in length as test species, as suggested by central pollution control board (CPCB). The results of these tests can be used for a variety of functions including resource consent monitoring and compliance, toxicity identification evaluations and evaluation of effluent treatment processes. WET tests were

performed to determine the actual impacts of effluents on organisms residing in receiving waters where the effluents were discharged.

2.2.4.1 Whole Effluent Toxicity (WET) Testing

The establishment of toxicity-based limits relies on the use of standardized laboratory toxicity tests that can assess the potential effect of effluents on aquatic life in the receiving system. Since effluents often contain complex mixtures of chemicals that are poorly characterized, a suite of acute and chronic toxicity tests (termed whole effluent toxicity, or WET, testing) is used to measure the aggregate toxicity of chemicals in an effluent (US-EPA, 1991). Whole Effluent Toxicity (WET) testing is a term used to describe the adverse effects or toxicity to a population of aquatic organisms caused by exposure to an effluent. This toxicity can be experimentally determined in the laboratory by exposing sensitive organisms to effluents using WET tests. Responses assessed usually include survival, growth, and/or reproduction. This type of test can be used to evaluate the toxicity of effluents, storm-water, or ambient surface waters. WET testing is used to assess and regulate the combined effects of all constituents of a complex effluent rather than the conventional methods of controlling the toxicity of single chemicals or constituents.

WET testing exposes laboratory populations of aquatic organisms such as fish, invertebrates, and algae to diluted and undiluted effluent samples under controlled conditions in order to estimate the environmental toxicity of that sample. The information is used to prevent the discharge of toxic amounts of pollutants to surface waters. The standardized procedures of WET tests allow one to determine the actual environmental exposure of aquatic life to effluent or ambient water without knowledge of the chemical, physical, and biological characteristics of that discharge or ambient water. Whole Effluent Toxicity (WET) testing is an important component of the US Environmental Protection

Agency's (USEPA's) integrated approach for detecting and addressing toxicity in surface waters.

Aquatic test organisms are placed in test containers that usually contain a series of concentrations of a sample. Tests usually include 100% sample and sample mixed with various amounts of dilution water (control water containing no sample) to form a series of sample dilutions. Observations of the organism's response, such as mortality, are made at specific time intervals. The duration of the test ranges from periods as short as 40 minutes up to 7 days depending on the organisms used and whether acute or chronic effects are of interest. At the end of the test, the results are used to estimate the toxicity of the sample. Control survival must be 90% or greater for an acceptable test. The test "passes" if survival in the control and effluent concentration equals or exceeds 90%. The test "fails" if survival in the effluent is less than 90%, and is significantly different from control survival (which must be 90% or greater), as determined by hypothesis testing.

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2.2.4.2 Test Species

Acute toxicity test (bioassays) of treated effluent was carried out using the locally available zebrafish specimens of 30-35mm in length as test organisms, as suggested by CPCB (method IS:6582-1971).

Zebrafish (Danio Rerio, F. Hamilton, 1822)

The fish species selected for bioassay experiments were zebra fish, *disambiguation* (Danio rerio). The taxonomic position of the test species is given below:

Phylum: Chordata
Class: Actinopterygli
Order: Cypriniformes
Family: Cyprinidae
Subfamily: Danioninae
Genus: *Danio*
Species: *D. rerio*

The test organism selected for toxicity tests was freshwater fish belonging to the minnow family, Cyprinidae, often called as tropical fish. It is a vertebrate model organism that is widely used in scientific research. This fish is also largely available in private ponds in different varieties. Zebra fish of pink variant was used in this study for bio-assay test on treated effluent.

Plate 2.8: Zebrafish (*Danio rerio*)

A large number (~6000) of healthy zebra fish of pink variety were procured from local commercial sources (Visakhapatnam) and transported to the Laboratory of CSIR-National Institute of Oceanography (CSIR-NIO), Regional Centre, Visakhapatnam in oxygenated polythene bags. After the arrival to the Laboratory, zebrafish were acclimatized by keeping them in large tanks with continuous aeration for a minimum period of two weeks before being subjected to bioassay experiments.

During the acclimatization period, zebra fish were fed with artificial pellet feed twice a day. Before the start of bioassay experiments, the length of the test animals was observed and found to be having a length in the range of 30-35 mm. Physico-chemical parameters of seawater in the acclimation tanks fell within the recommended optimum

levels for the rearing of zebrafish: water temperature, (30.3±0.5 ºC), dissolved oxygen (6.8±0.2 mg/l), pH (7.6±0.2) and NH_3/NH_4 (<0.5 mg/l).

2.2.4.3 Experimental Set-up

Ground water was used throughout the experiment for the acclimatization of fish, control tank and as diluent. All the experiments were conducted at room temperature of 28 °C, with a maximum day and night variation of 2 °C. No Feed was given to test animals 48 hrs prior to the experiments or during the experiments. Different concentrations of test solutions of effluent were chosen for the following sets of experiments, under slow continuous aeration. Dissolved oxygen in the experimental and control tanks was always maintained at >5 mg/l throughout the exposure study using artificial aeration. Each set of experiment was accompanied by a Control with three replicates. Appropriate volumes of effluent concentration prepared as above were added to containers tanks containing zebrafish (*Danio rerio*) of the pink variety.

The test containers were inspected at regular intervals for recording mortality at different exposure periods of 1 hr, 6 hrs, 12 hrs and 24 hrs during the first day of the experiment followed by every 12 hrs till completion of the experiment (i.e., 96 hrs) for calculating the LC_{50} values. The dead organisms were removed immediately from tanks in order to avoid any type of bacterial contamination. Records were also maintained for any abnormal behaviour of the test animals. At the end of each test, the organisms were transferred to a clean tank for observing their recovery. The average percent mortality recorded at different test solutions in triplicate test containers during the four exposure periods was determined. The median lethal concentration (LC_{50}) values in the percentage of toxicant for zebra fish exposed to different concentrations of effluent were calculated based on the mortality rates.

2.2.4.4. Data analysis

Mortality of test organisms for different effluent samples over different exposure periods are presented in the Results Section. The mortality values of different effluent water samples for different exposure periods (24 hrs, 48 hrs, 72 hrs and 96 hrs) were calculated following the method of log-probit transformation for time and dose-mortality curves suggested by Finney's method (1971) using LDP line software (http://embakr.tripod.com/ldpline).

Table 2.4: Summary of conditions and acceptability criteria for WET acute Toxicity Test with zebra fish as test species

Type	Comment
Test condition	Static non-renewal
Test duration	96 hrs
Temperature	>28 °C
Photoperiod	12 hrs light: 12 hrs dark
Test chamber size	25 Litres
Age of test organisms	30 Day Post Larvae
No. organisms per test chamber	30 animals
No. replicate chambers per concentration	Three
Feeding	None
Test solution aeration	Yes, >5 mg l^{-1}
Dilution water	Groundwater
Test concentrations	07 effluent concentrations and a control
Dilution series	Effluents: ±0.5 dilution series
Endpoint	Effluents: Mortality
Sample volume	Nil
Test acceptability criterion	90% survival in 100% effluent after 96 hrs

2.2.4.5 Acute Toxicity of treated effluents with a WET test

Acute toxicity of treated effluents with whole effluent toxicity test expressed in terms of median lethal concentrations (LC_{50}) was evaluated by subjecting the acclimatized zebra fish of pink variety exposed to four exposure periods (24 hrs; 48 hrs; 72 hrs and 96 hrs) with seven different concentrations (% v/v) of effluent test solutions. Experiments were conducted under static conditions and all experimental tanks had a triplicate and each experimental set included a Control (0%). The average percent mortality recorded at different test solutions in triplicate test containers during the four exposure periods was determined.

Data on average mortality of test animals (in percentage) in different test concentrations of treated effluent collected from M/s Hetero Infrastructure SEZ Limited over four exposure periods is presented in Table 3.23. The median lethal concentration (LC_{50}) of treated effluent to test species at different exposure periods is shown in Table 3.24. No mortality was observed in control treatment during the exposure period of 96 hrs.

Chapter 3

RESULTS AND DISCUSSION

3.1. Physico-chemical characteristics

Physical parameters such as salinity and temperature in the surface and bottom waters of the station locations were provided in Table 3.1. The results of biogeochemical parameters such as pH and Chlorophyll-*a* were provided in Table 3.2, while the concentrations of dissolved inorganic nutrients were given in Table 3.4.

Temperature ranged from 29.14 to 29.98 ºC in the surface and from 28.96 to 29.66ºC in the bottom waters of the study region (Table 3.1), with mean values of 29.59±0.23 ºC and 29.25±0.18 ºC, respectively, during the sampling period.

Table 3.1: Temperature (ºC) and salinity in the surface (SUR) and bottom (BOT) waters at the sampling stations in the study region

Station Name	Depth (m)	Temperature		Salinity	
		SUR	BOT	SUR	BOT
H1	13.7	29.98	29.20	33.43	33.38
H2	14	29.81	29.24	33.40	33.42
H3	14.1	29.75	29.29	33.40	33.38
MOP1	13.2	29.73	29.27	33.43	33.40
MOP2	14	29.63	29.38	33.45	33.37
H4	14.6	29.62	29.22	33.03	33.40
H5	17.1	29.70	28.99	33.43	33.47
H6	18.8	29.54	28.96	33.69	33.43
H7	13.1	29.14	29.36	33.69	33.40
H8	13.4	29.36	29.31	33.50	33.40
H9	13.5	29.39	29.15	33.56	33.43
H10	8.5	29.46	29.66	33.18	33.41

Sea surface salinity in the study region varied from 33.03 to 33.69 PSU (Table 3.1), with a mean salinity of 33.43±0.18 PSU. In the bottom waters, salinity ranged between 33.37 and 33.47 PSU (Table 3.1), with a mean salinity of 33.41±0.034 PSU during the study period. The range of salinity values observed in this study are close to those reported previously from this region during April-May.

pH of the study region ranged from 8.18 to 8.28 in the surface and from 7.77 to 8.28 in the bottom (Table 3.2; Fig. 3.1), with mean values of 8.24±0.03 and 8.21±0.14, respectively. These values are concurrent with the range of pH values observed in the coastal waters off Visakhapatnam and Kakinada in the western coastal Bay of Bengal. However, the pH values found in this study are higher when compared to the pH values reported from this region in 2017 (7.4-8.0 and 7.5-8.0 in the surface and bottom waters, respectively). Phytoplankton biomass, expressed in terms of Chlorophyll-*a* (Chl-*a*) concentration, ranged from 0.23 mg/m^3 to 0.42 mg/m^3 in the surface and from 0.31 mg/m^3 to 0.56 mg/m^3 (Table 3.2; Fig. 3.1) in the bottom waters during the study period. Mean Chl-*a* concentrations in the study region are 0.32±0.1 mg/m^3 in the surface and 0.41±0.1 mg/m^3 in the bottom waters. The Chl-*a* values found in this study are remarkably lower than those reported in 2018 from this region both in surface (range: 2.43-7.44 mg/m^3) and in the bottom waters (range: 1.2-5.86 mg/m^3). The range and mean concentrations of Chl-*a* found in this study are considerably lower than those values observed in the coastal waters off Kakinada and Yanam, and in the nearby coastal location in the western coastal Bay of Bengal. Considerably lower phytoplankton biomass (Chl-*a*) in this study may be due to either lower biological production and/or higher grazing pressure.

Table 3.2: pH and Chlorophyll-*a* in the surface (SUR) and bottom (BOT) waters at the sampling stations.

Station Name	Depth (m)	pH		Chl-*a* (mg/m^3)	
		SUR	BOT	SUR	BOT
H1	13.7	8.235	8.256	0.24	0.36
H2	14	8.281	8.228	0.28	0.56
H3	14.1	8.271	8.234	0.36	0.45
MOP1	13.2	8.247	7.769	0.25	0.31
MOP2	14	8.24	8.286	0.23	0.32
H4	14.6	8.27	8.244	0.33	0.32
H5	17.1	---	8.242	0.34	0.42
H6	18.8	8.23	8.238	0.36	0.43
H7	13.1	8.284	8.23	0.42	0.42
H8	13.4	8.245	8.283	0.31	0.38
H9	13.5	8.186	8.283	0.32	0.47
H10	8.5	8.221	8.257	-	-

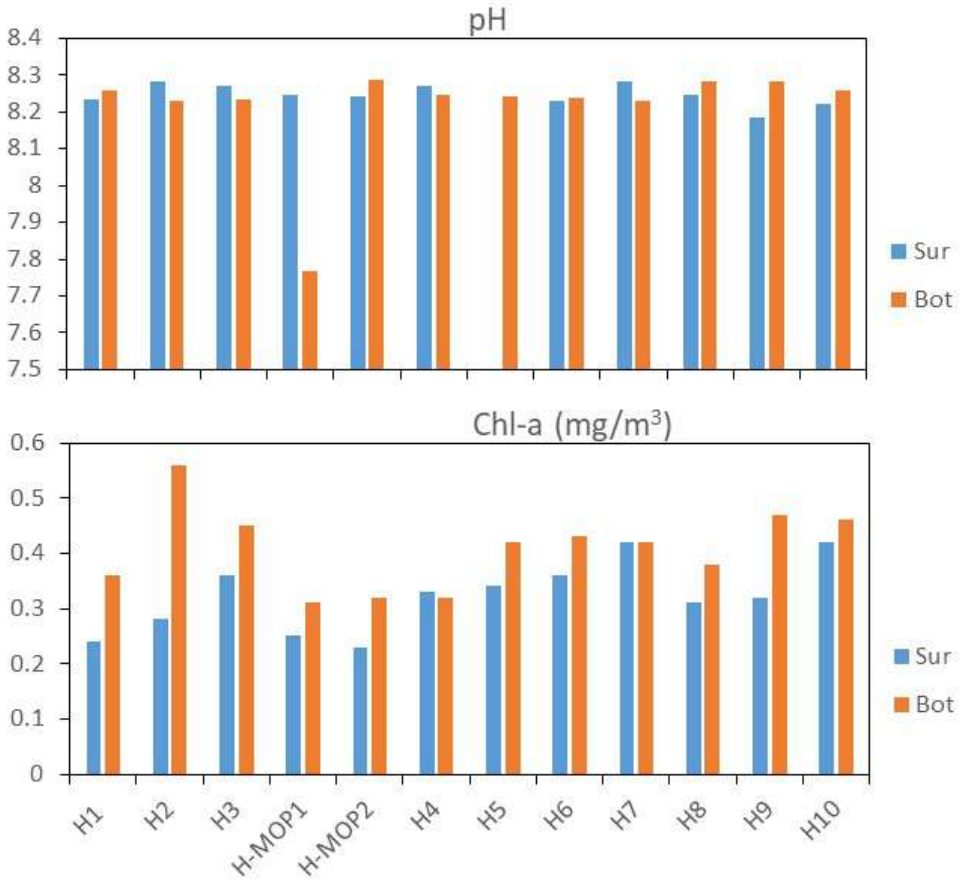


Fig 3.1: Spatial variability of (a) pH and (b) chlorophyll-a (mg/m^3) in the coastal waters off Rajayyapeta during the study period

Dissolved oxygen (DO) concentrations varied from 5.6 to 6.4 mg/L in the surface and from 4.6 to 6.3 mg/L in the bottom waters of the study region (Table 3.3; Fig. 3.2). The mean DO concentrations were 6.1±0.2 mg/L and 5.8±0.5 mg/L in the surface and bottom waters, respectively. DO concentrations found in this study are considerably higher than those found in both surface and bottom waters of this region in 2017 (2.7 – 6.0 mg/L and 3.3-5.9 mg/L, respectively). The DO concentrations found in this study are relatively higher than those found during 2010, 2014 and 2017 monitoring studies conducted in this region and more or less similar to those found during 2007 and 2012 monitoring studies conducted in this region. No significant deviation in DO concentration was found at the

MOP locations compared to the nearby locations around the MOPs in the coastal waters of Rajayyapeta. The mean DO concentrations observed in the surface (6.1±0.2 mg/L) and bottom (5.8±0.5 mg/L) waters of the study region are above the thresh hold limit of 5.0 mg/L for healthy coastal waters. Nevertheless, the observed DO concentrations in this study are comparable to or slightly higher than those reported in the base line data (EIA report of this project) of this region, indicating that no significant change in the DO concentrations of the marine environment. Biochemical oxygen demand for three days (BOD_3) ranged from 0.6 to 3.2 mg/L in the surface and from 0.8 to 4.1 mg/L in the bottom waters during the study period (Table 3.3; Fig. 3.2). The range of BOD_3 values found in this study is relatively higher than the range of values reported from this region in 2017 (0.4-2.75 mg/L and 0.3-2.10 mg/L in the surface and bottom waters, respectively), indicating that increased input of biodegradable organic matter from local sources to this coastal region in recent years. However, mean BOD_3 values in the surface and bottom waters of this study (1.9±0.7 mg/L and 2.1±1.0 mg/L, respectively) indicates no significant pollution of organic matter in this region during the study period.

Concentrations of dissolved inorganic nutrients such as phosphate, silicate, nitrite, and nitrate in the surface and bottom waters of the study region were given in Table 3.4 and Fig. 3.3. Phosphate concentrations ranged from 0.2 to 0.9 µM in the surface and from 0.2 to 1.1 µM in the bottom waters (Table 3.4), with mean phosphate concentrations of 0.5±0.2 µM and 0.5±0.3 µM, respectively. Phosphate concentrations found in this study are slightly lower than those reported in 2017 from this region in both surface (range: 0.45 to 1.39 µM) and bottom (range: 0.85 to 1.47 µM) waters. Dissolved inorganic silicate concentrations during the study period ranged from 6.7 to 28.0 µM and from 4.6 to 25.9 µM in the surface and bottom waters (Table 3.4), with mean silicate concentrations of 13.4±5.8 µM and 13.5±5.9 µM, respectively. In contrast to that of phosphate, silicate

concentrations are relatively higher than those observed from this region in 2017 both in the surface (range: 4.9-8.9 µM) and bottom (range: 7.4 – 15.5 µM) waters.

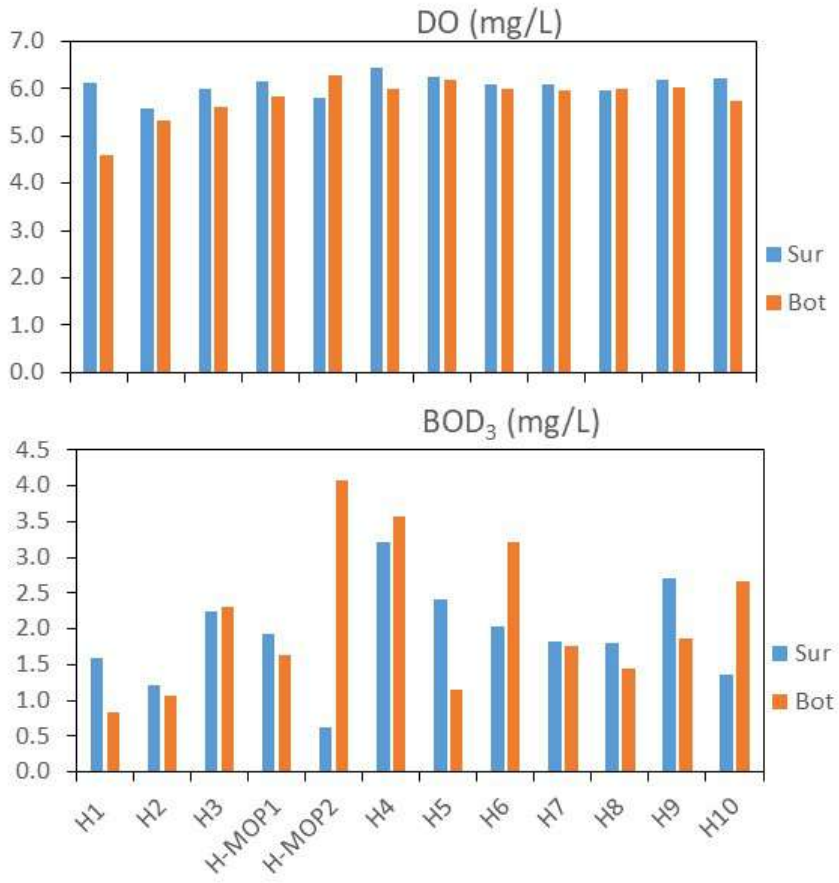


Fig. 3.2: Spatial variability of DO and BOD at various stations in the surface and bottom waters of the study region

Nitrite concentrations varied between 0.02 and 0.52 µM in the surface (mean: 0.13±0.1 µM) waters and between ND and 0.78 µM (mean: 0.23±0.2µM)) in the bottom waters. The range of nitrite concentrations observed in this study in the surface (0.02-0.52 µM) and bottom (ND-0.78 µM) waters are close to the range of values observed in 2017 from this region (0.1-0.6 µM and 0.1-0.5 µM in the surface and bottom waters, respectively). Nitrate concentrations ranged from 8.1 to 23.4 µM in the surface, with a mean nitrate concentration of 15.6±5.1 µM. These concentrations are remarkably higher than those observed in surface waters of this region in 2017 (range: 1.5 – 4.5 µM),

whereas, in the bottom waters nitrate concentrations ranged from 5.7 to 19.9 µM, with a mean concentration of 13.0±4.4 µM. Similar to that of the surface waters, bottom waters of this study also recorded significantly higher nitrate concentration compared to those observed in the bottom waters of this region in 2017 (range: 1.5 – 3.8 µM) Both silicate and nitrate concentrations in this study are higher than those reported in 2017 from this region, whereas phosphate concentrations in this study are slightly lower than those reported in 2017 from this region. Nevertheless, nitrate concentrations in this study are relatively higher than those found in this region in 2017 and in coastal waters of the western coastal Bay of Bengal, indicating increased input of nitrate from local sources to this coastal region in recent years.

Table 3.3: Dissolved oxygen (DO; mg/L) and biochemical oxygen demand for three days (BOD_3; mg/L)) in the surface (SUR) and bottom (BOT) waters at the sampling stations.

Station	DO (mg/L)		BOD_3 (mg/L)	
Name	SUR	BOT	SUR	BOT
H1	6.1	4.6	1.6	0.8
H2	5.6	5.3	1.2	1.1
H3	6.0	5.6	2.2	2.3
MOP1	6.2	5.8	1.9	1.6
MOP2	5.8	6.3	0.6	4.1
H4	6.4	6.0	3.2	3.6
H5	6.3	6.2	2.4	1.1
H6	6.1	6.0	2.0	3.2
H7	6.1	5.9	1.8	1.8
H8	5.9	6.0	1.8	1.5
H9	6.2	6.0	2.7	1.9
H10	6.2	5.7	1.3	2.7

Table 3.4: Dissolved inorganic phosphate (µM), silicate (µM), nitrite (µM) and nitrate (µM) concentrations in the surface (SUR) and bottom (BOT) waters at the sampling stations.

Station	Phosphate		Silicate		Nitrite		Nitrate	
	SUR	BOT	SUR	BOT	SUR	BOT	SUR	BOT
H1	0.5	0.3	8.3	11.5	0.06	0.08	11.9	9.1
H2	0.7	0.3	14.8	14.3	0.04	0.06	11.6	19.4
H3	0.3	0.4	28.0	13.2	0.52	0.56	12.7	17.2
MOP1	0.8	1.1	6.7	25.9	0.20	0.78	8.1	5.7
MOP2	0.2	0.3	14.3	15.5	0.26	0.20	22.2	8.8
H4	0.3	0.2	12.6	9.5	0.06	0.26	23.4	9.7
H5	0.5	0.7	11.5	17.8	0.06	0.14	17.9	19.9
H6	0.9	0.5	10.5	9.5	0.20	0.14	14.6	14.0
H7	0.3	0.2	16.8	0.6	0.12	0.12	10.3	14.3
H8	0.4	0.5	18.1	8.0	0.04	0.02	21.4	10.8
H9	0.4	0.6	7.9	18.8	0.02	0.18	19.6	12.5
H10	0.7	0.8	11.2	4.6	0.02	ND	13.9	14.5

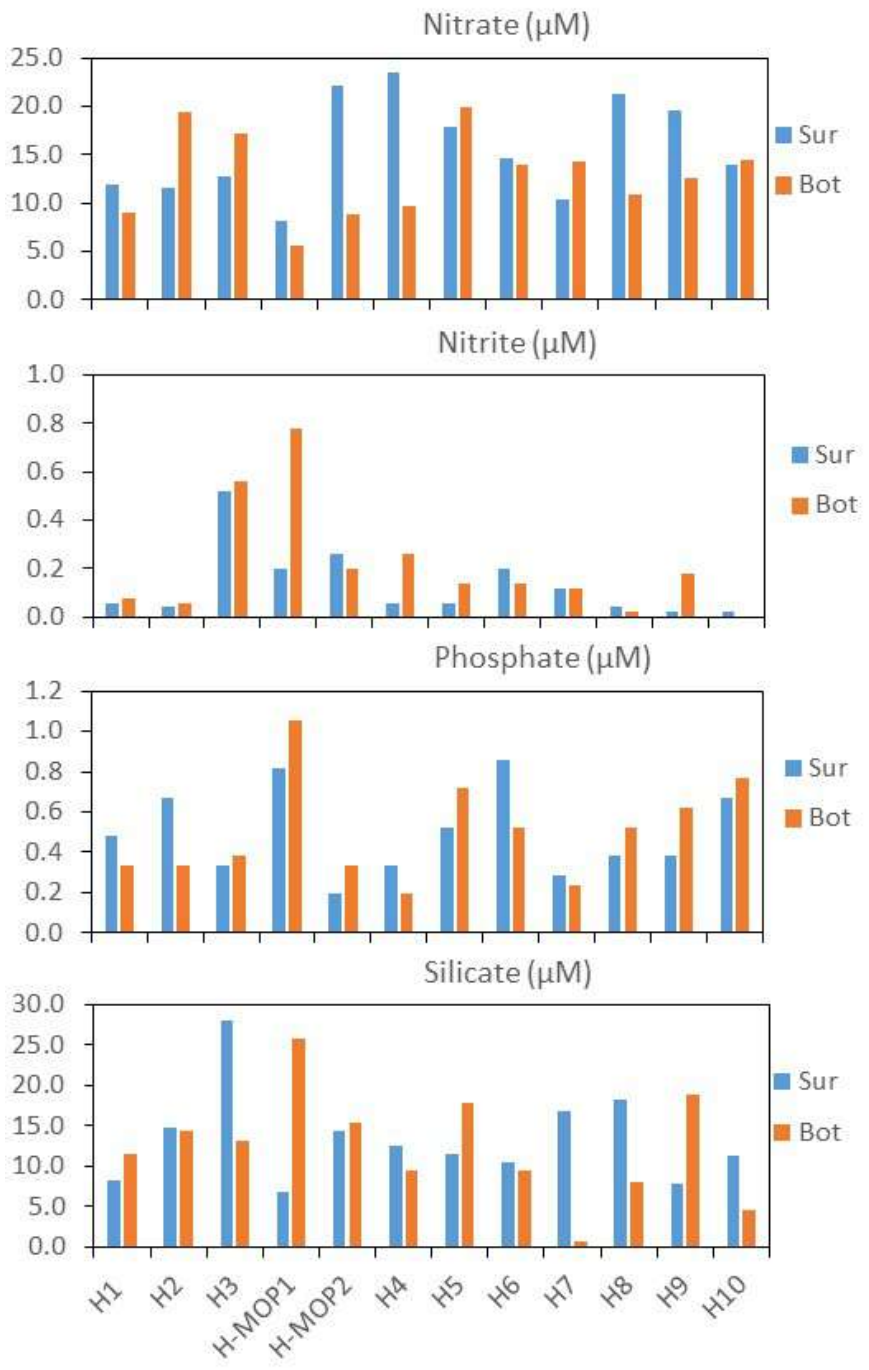


Fig 3.3: Spatial variability of dissolved inorganic nutrients (a) nitrate (µM), (b) nitrite (µM), (c) phosphate (µM) and (d) silicate (µM) in the coastal waters off Rajayyapeta during the study period

Total suspended matter (TSM) concentrations ranged from 20 to 52.3 mg/L (Table 3.5), with a mean value of 33.1±11.5 mg/L in the surface waters of the study region. Bottom

waters recorded TSM concentrations between 24 and 51.8 mg/L (mean: 35.4±8.6 mg/L) during the study period. Both surface and bottom waters recorded similar mean TSM concentrations. TSM concentrations found in this study (range: 20–52.3 mg/L; mean: 34.2 mg/L) are consistent with the range of values reported in the previous monitoring studies conducted in this region during 2010, 2014 and 2017, whereas, relatively higher when compared to the values reported during 2007 and 2012 monitoring studies conducted in this region. Total petroleum hydrocarbon (TPHC) concentrations varied from 10.0 to 22.1 µg/L in the surface waters (Table 3.5), with a mean concentration in the study region of 14.9±4.0 µg/L. In the bottom waters, TPHC concentrations varied broadly from as low as 2.1 µg/L to as high as 37.4 µg/L (Table 3.5), with a mean concentration of 16.0±10.2 µg/L. Compared to the TPHC concentrations reported in the previous monitoring study conducted in this region in 2017 (1.3-10.5 µg/L and 1.7-4.7 µg/L in the surface and bottom waters, respectively), TPHC concentrations found in this study (10.0-22.1 µg/L and 2.1-37.4 µg/L, respectively) are relatively higher, indicating a slight increase in the TPHC input from local sources into the coastal waters of Rajayyapeta in recent years. Overall, the concentrations of physico-chemical parameters found in this study are within the range of values reported from the coastal Bay of Bengal.

Table 3.5: Total suspended matter (mg/L) and total petroleum hydrocarbon (TPHC) concentrations in the surface (SUR) and bottom (BOT) waters at the sampling stations.

Station	TSM (mg/L)		TPHC (µg/L)	
	SUR	BOT	SUR	BOT
H1	21.3	37.7	22.1	15.0
H2	20.0	24.0	10.9	---

H3	27.2	29.6	13.7	16.1
MOP1	34.0	30.8	10.0	31.1
MOP2	31.2	35.0	14.2	14.0
H4	21.8	33.0	14.8	17.4
H5	25.8	25.2	18.0	2.1
H6	26.3	32.3	13.7	6.6
H7	52.3	51.8	21.4	12.8
H8	50.5	49.5	12.1	9.5
H9	44.5	41.0	16.7	37.4
H10	42.3	34.3	11.1	14.0

Table 3.6: Comparison of chemical constituents in the coastal waters off Rajayyapeta during different monitoring studies

Parameter	2007	2010	2012	2014	2017	2022
DO (mg/L)	5.1-6.7	3.2-5.6	5.6-7.6	2.3-5.2	2.7-6.0	4.6-6.4
BOD_5 (mg/L)	0.29-1.16	0.13-1.5	0.3-4.3	0.4-2.75	0.3-2.1	0.6-4.1
pH	7.9-8.1	8.0-8.1	8.1-8.2	7.4-8.0	7.4-8.0	7.77-8.29
TSM (mg/L)	10.6-35.2	34.2-69.6	19.0-32.8	16.4-48.8	16.8-45.6	20.0-52.3
NO_2—N (µM)	0.04-0.31	0.1-0.74	0.04-0.49	0.58-1.27	0.11-0.61	ND – 0.78
NO_3—N (µM)					1.5-4.5	5.7-23.4
PO_4^{3-}—P (µM)	0.3-1.4	0.1-1.1	0.9-2.5	1.4-4.4	0.5-1.6	0.2-1.1
SiO_4^{2-}—Si (µM)	0.8-5.6	0.7-7.2	3.6-13.6	10.3-14.5	5.0-15.6	4.6-28.0

3.2 Biological Characteristics

4.2.1 Chlorophyll-*a*:

Chlorophyll *a* pigment in surface water ranged between 0.2 mg/m^3 and 0.4 mg/m^3 in the surface and between 0.3 mg/m^3 and 0.6 mg/m^3 in the bottom waters, with mean concentrations of 0.32±0.1 mg/m^3 and 0.41±0.1 mg/m^3, respectively (Table 3.2). The range of Chl-*a* concentrations found in this study is similar when compared to the Chl-*a* concentrations observed in the coastal waters off Kakinada and Yanam, east coast of India.

4.2.2. Phytoplankton

The detailed results of phytoplankton cell count in surface waters of the study region at all stations are given in (Table 3.9). Phytoplankton abundance in surface waters varied from as low as 3200 Nos./L to as high as 6200 Nos./L, with a mean abundance of 4646 Nos./L. The range of phytoplankton abundance found in this study is considerably lower than the range of phytoplankton abundance reported from this region in the year 2017 (range: 5430 – 15390 Nos./L; mean: 10860 Nos./L; Table 3.7). A total of 29 phytoplankton genera were recorded (Table 3.9) in this study. The number of genera recorded at various stations ranged from 15-27 which is relatively higher than the range of genera reported (12-19) in the previous monitoring study conducted in this region in 2017. Predominant species groups and their contribution to the total phytoplankton abundance were shown in Fig. 3.4. Diatoms are the most predominant in the total phytoplankton abundance at all stations (Fig. 3.5). Diatom contribution to the total phytoplankton varied from 53.3% to 76.7% (Table 3.10), with a mean contribution of 61.7% to the total phytoplankton abundance. The contribution of diatoms to the total phytoplankton in this study is relatively lower when compared to those reported in 2017 from this region. Contribution from dinoflagellates to the total phytoplankton abundance ranged from 16.3% to 27.9 %, with an average contribution of 20.8% which is significantly higher than

those reported in 2017 from this region (3.8%). Cynobacteria appeared in all stations, except at MOP1 station, and its contribution to the total phytoplankton abundance varied from 1.5% to 8.5% only (mean: 4.2%). Average contribution of different phytoplankton groups to the total phytoplankton abundance was shown in Fig. 3.5. Dominant and consistently occurring species were Chaetoceros sp., Skeletonema sp., Rhizosolenia sp., Cyclotella sp., Nitschia sp., Navicula sp., Ceratium sp., Gymnodinium sp., Trichodesmium sp., Cyanobacteria, Thalassiothrix sp., etc. The species present in samples but in low abundances were *Coscinodiscus sp., Pinnularia sp., Cochlodinium sp., Chroococcus sp.* etc.

Phytoplankton abundance in bottom waters varied from as low as 4100 Nos./L to as high as 7200 Nos./L, with a mean abundance of 5675 No./L (Table 3.11) and it is exceptionally lower than those reported in 2017 monitoring study conducted in this region (5820-18480 Nos./L; mean: 10698 Nos./L). Phytoplankton abundance in the bottom waters (mean: 5675 Nos./L) is more or less similar compared to that of the surface waters (4646 Nos./L) of the study region. In this study, a total of 29 phytoplankton genera were recorded in the bottom waters (Table 3.11) with a range of 14-24, and it is comparable with the range of genera reported in the previous monitoring study conducted in this region in 2017 (15-22). Predominant species groups and their contribution to the total phytoplankton abundance was shown in Fig. 3.6. Diatoms are the most dominant taxa followed by dinoflagellates at all stations (Table 3.12). Diatoms contribution to total phytoplankton abundance ranged from 32.4% to 70.8%, with a mean contribution of 56.8% (Table 3.12; Fig. 3.7) and it is considerably lower than those found in 2018 in this region (mean: 89.1%).

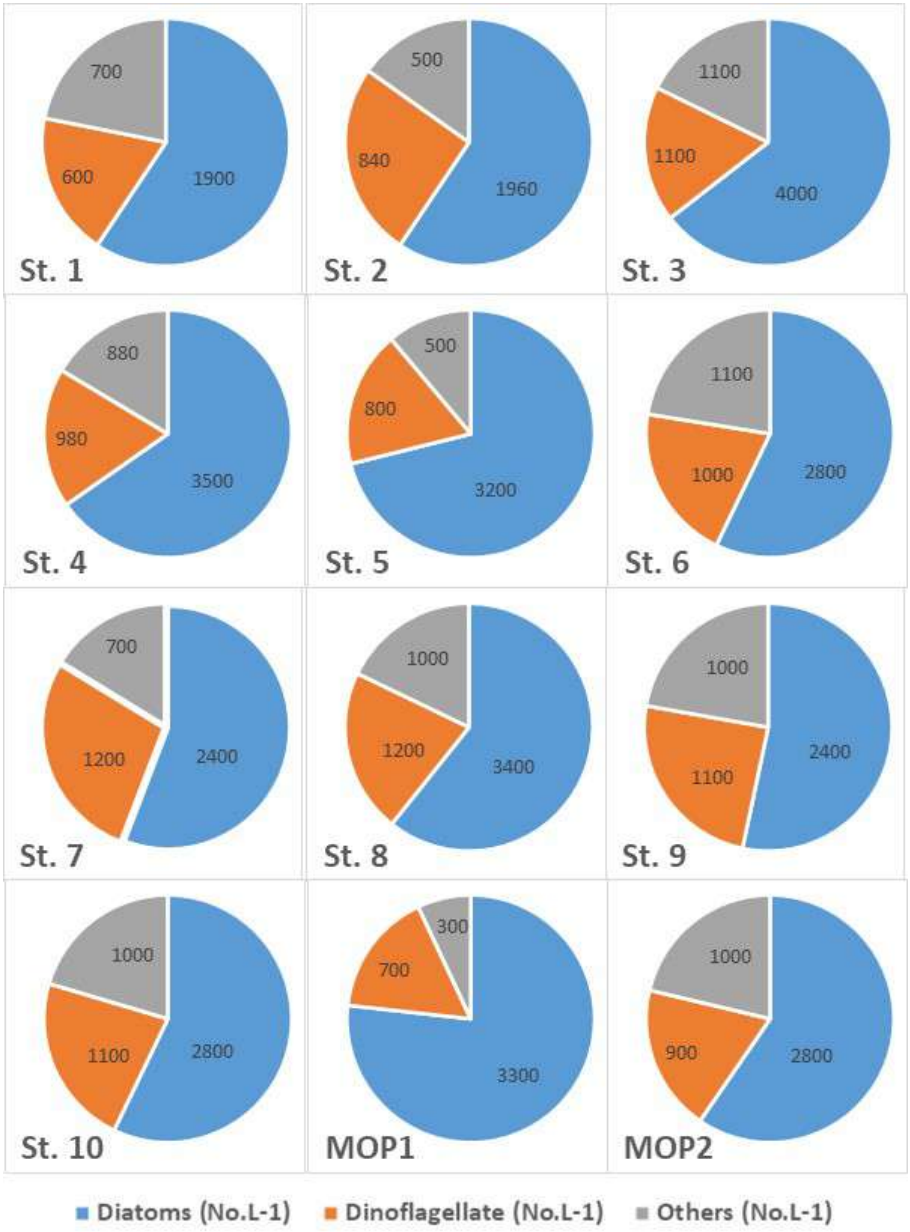


Fig. 3.4: Abundance (No/L) of diatoms and dinoflagellates in the total phytoplankton in the surface waters of the study region

Dinoflagellate's contribution to total phytoplankton abundance varied from as low as 16.7% to 39.7%, with a mean contribution of 25.0% and it is considerably higher than those reported in 2018 (range: 1.5%-5.8%, mean: 4.0%). Cynobacteria contribution to the total phytoplankton is minor as was observed in the surface waters. Compared to surface

waters, dinoflagellate's contribution to the total phytoplankton abundance was slightly higher in the bottom waters. Predominant species present in bottom waters are *Skeletonema* sp., Rhizosolenia sp., Nitschia sp., Chaetoceros sp., Cyclotella sp., Thalassiosira sp., Cymbella sp., Peridinium sp., Gymnodinium sp., Cochlodinium sp. The average contribution of diatoms and dinoflagellates to the total phytoplankton in the bottom waters was shown in Fig. 3.7

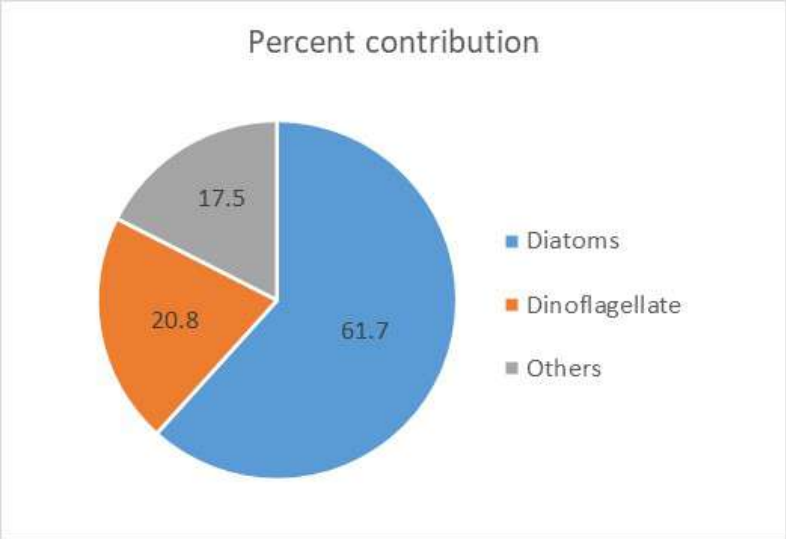


Fig. 3.5: Percent contribution of diatoms and dinoflagellates to the total phytoplankton abundance in the surface waters of the study region

Table 3.7: Comparison of the range of No. of phytoplankton genera and phytoplankton abundance (No./L) during different monitoring studies

Year	No. of Genera (range)		Cell counts (Nos./L)	
	Surface	Bottom	Surface	Bottom
2012	11-17	7-14	200-4800	100-2900
2014	6-20	7-13	2400-16600	3600-18000
2017	12-19	15-22	5430-15390	5820-18330
2022	15-27	14-24	3200-6200	4100-7200

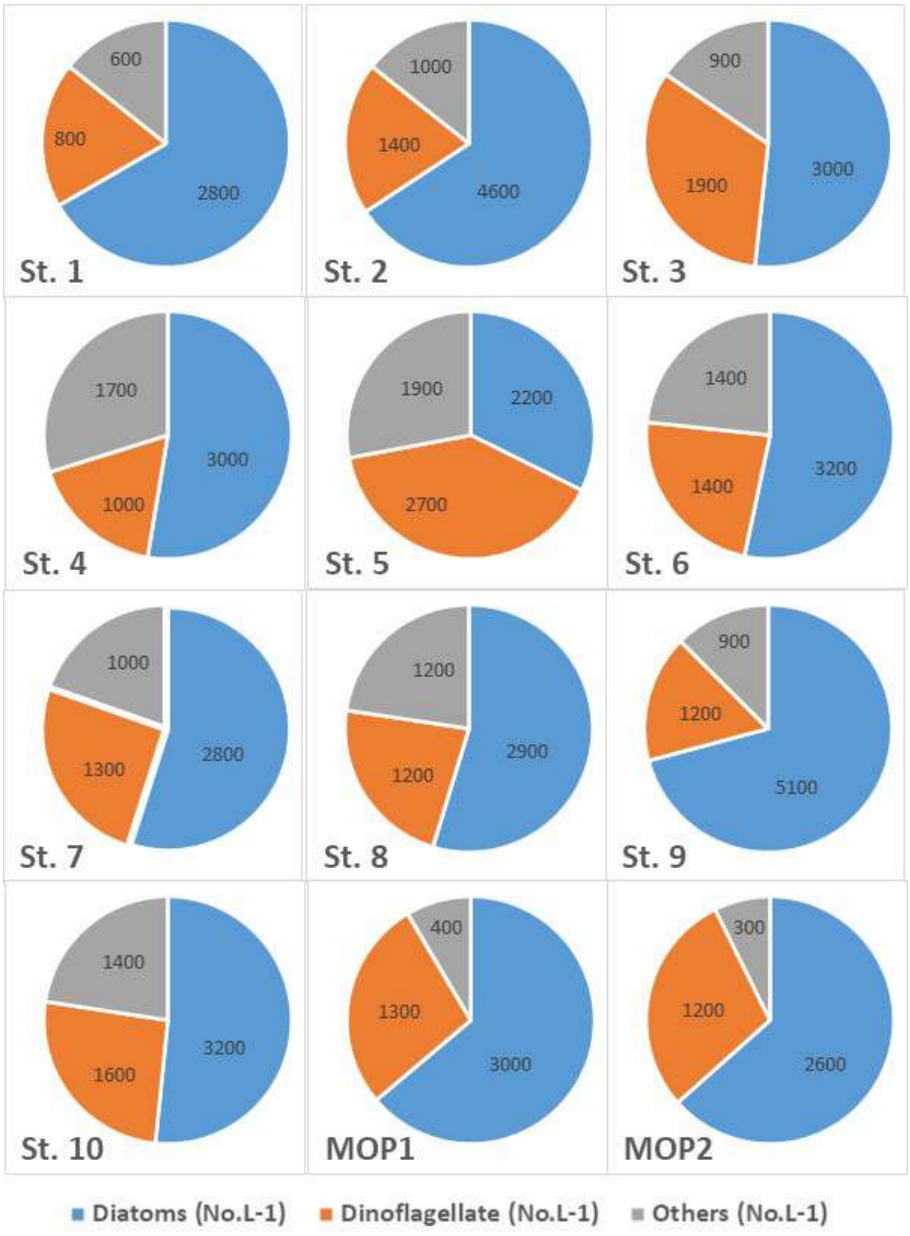


Fig. 3.6: Abundance (No/L) of diatoms and dinoflagellates in the total phytoplankton in the bottom waters of the study region

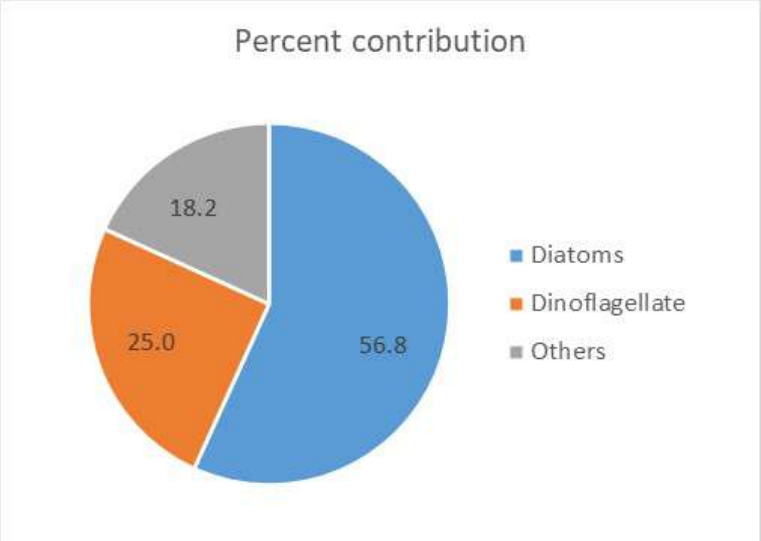


Fig. 3.7: Percent contribution of diatoms and dinoflagellates to the total phytoplankton abundance in the bottom waters of the study region

4.2.3. Zooplankton

The secondary production is the standing stock of zooplankton which feeds on phytoplankton. The seasonal average of zooplankton biomass for the Bay of Bengal (BoB) is 0.43 ml/m^3 in pre-monsoon, 0.24 ml/m^3 in monsoon and 0.99 ml/m^3 in post-monsoon season (Desai & Bhargava, 1998). According to Goswami (1999), the standing stock biomass (ml/m^3) of zooplankton in the Bay of Bengal shows wide variation in space and time in the shelf as well as in the oceanic ecosystems.

Meso-zooplankton abundance in the present study ranged from 208 to 552 No./m^3 with a mean abundance of 395 No./m^3 (Table 3.13; Fig. 3.8). The zooplankton abundance found in this study is considerably lower than the abundance of zooplankton reported in 2017 from this region (range: 500 to 3239 No./m^3; mean: 1776 No./m^3). Also, the range and mean values of zooplankton abundance found in this study are significantly lower than those reported in the coastal waters off Kakinada. However, zooplankton abundance found

in this study is considerably higher than those reported in the previous monitoring studies conducted in this region during 2012 (57 No./m^3) and 2014 (98 No./m^3). These results indicate that zooplankton productivity has decreased in the present study region during recent years. Altogether 17 faunal groups were found in the study region. Copepods are predominant in the total zooplankton abundance (Table 3.14; Fig. 3.9) with a mean contribution of 89.2% (range: 79.5%–94.3%) (Table 3.14). Chaetognatha is the second dominant group that contributes 0.7% to 9.4% to the total zooplankton abundance, with a mean contribution of 3.4% (Table 3.14). Decapod larvae are the third dominant groups in the total zooplankton abundance, with a mean contribution of 1.8% (range: 0.4% to 4.9%) (Table 3.14). The zooplankton groups that contribute >1% to the total zooplankton abundance are Appendicularians (mean: 1.6%). The lowest abundant groups that contribute <1% to the total zooplankton abundance are Bivalve larvae (mean: 0.8%), Cladocerans (mean: 0.6%) and Thaliacea (0.4%).

Table 3.8: Comparison of the range and mean of zooplankton abundance (No./m^3) during different monitoring studies.

Year	Zooplankton abundance (No./m^3)	
	range	mean
2012	24-132	57
2014	34-169	98
2017	500-3239	1776
2022	208-552	395

Table 3.9: Phytoplankton abundance (No./L) at the sampling stations in the surface waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP1	MOP2
Diatoms												
Chaetoceros sp.,	200	200	200	100	0	100	0	100	300	100	100	100
Skeletonema sp.,	200	100	2000	600	400	200	100	100	200	200	800	900
Rhizosolenia sp.,	400	200	0	200	200	400	400	200	300	100	500	300
Coscinodiscus sp.,	0	0	0	100	0	100	0	0	100	200	300	0
Cyclotella sp.,	200	160	200	400	600	200	400	300	0	0	400	200
Thalassiosira sp.,	100	100	0	200	200	100	200	200	400	100	100	200
Hemidiscus sp.,	0	0	0	100	100	200	400	400	200	400	0	200
Leptocylindrus sp.,	0	0	100	100	0	0	0	100	0	100	0	0
Pleurosigma sp.,	100	100	100	100	200	100	200	200	0	0	0	0
Pinnularia sp.,	0	100	0	0	0	0	0	100	0	100	0	0
Striatella sp.,	0	100	200	100	0	0	0	100	0	200	0	100
Nitschia sp.,	200	200	200	200	600	400	300	400	400	600	600	300
Synedra sp.,	100	100	0	100	200	200	0	100	0	100	0	0
Cymbella sp.,	0	100	0	300	200	200	100	200	300	100	100	200
Navicula sp.,	200	200	200	400	200	100	200	400	0	100	300	0
Thalassiothrix sp.,	100	200	800	400	200	100	0	100	0	0	100	100
Amphiprora sp.,	100	100	0	100	100	400	100	400	200	400	0	200
Dinoflagellate												
Prorocentrum sp.,	0	200	200	100	100	100	0	100	200	100	100	200
Ceratium sp.,	300	100	300	200	300	200	100	200	300	200	300	100
Peridinium sp.,	0	0	200	100	100	100	400	400	0	100	0	0
Gymnodinium sp.,	300	100	100	200	200	200	400	100	300	200	0	400
Noctiluca sp.,	0	40	0	100	0	0	0	0	0	100	0	0
Protoperidinium sp.,	0	100	100	80	100	200	200	100	0	100	0	100
Dinophysis sp.,	0	100	100	100	0	100	0	0	0	100	0	0

Cochlodinium sp.,	0	0	0	40	0	0	100	200	300	0	300	100
Podolampas sp.,	0	200	100	60	0	100	0	100	0	200	0	0
Cyanobacteria	100	100	100	80	100	200	100	400	200	400	0	400
Chroococcus	0	0	0	0	0	0	0	0	0	0	200	0
Trichodesmium sp.,	600	400	1000	800	400	900	600	600	800	600	100	600
Total Abundance (No.L-1)	**3200**	**3300**	**6200**	**5360**	**4500**	**4900**	**4300**	**5600**	**4500**	**4900**	**4300**	**4700**

Table 3.10: Percent contribution of diatoms and dinoflagellates to the total phytoplankton abundance at the sampling stations in surface waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP1	MOP2
Diatoms	59.4	59.4	64.5	65.3	71.1	57.1	55.8	60.7	53.3	57.1	76.7	59.6
Dinoflagellate	18.8	25.5	17.7	18.3	17.8	20.4	27.9	21.4	24.4	22.4	16.3	19.1
Others	21.9	15.2	17.7	16.4	11.1	22.4	16.3	17.9	22.2	20.4	7.0	21.3

Table 3.11: Phytoplankton abundance (No./L) at the sampling stations in the bottom waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP1	MOP2
Diatoms												
Chaetoceros sp.,	200	100	200	100	100	200	100	200	100	200	200	200
Skeletonema sp.,	600	1600	600	400	100	400	100	300	1600	400	400	600
Rhizosolenia sp.,	400	400	0	200	200	200	400	200	200	600	200	0
Coscinodiscus sp.,	0	200	200	100	200	200	200	400	300	100	0	0
Cyclotella sp.,	200	300	300	400	400	400	600	100	400	400	400	200
Thalassiosira sp.,	200	100	100	0	600	200	100	200	400	0	300	0
Hemidiscus sp.,	0	0	200	200	0	0	0	0	0	0	0	200
Leptocylindrus sp.,	0	200	100	100	0	100	200	0	600	200	400	200
Pleurosigma sp.,	100	200	200	100	200	400	0	100	400	0	0	0
Pinnularia sp.,	0	0	0		0	0	200	100	0	100	200	0
Striatella sp.,	0	100	200	0	0	0	0		0	200	0	200
Nitschia sp.,	600	200	200	600	200	600	200	400	400	200	400	800
Synedra sp.,	0	0	0	100	0	200	200	200	200	100	0	0
Cymbella sp.,	200	0	0	0	0	100	0	100	0	0	200	100
Navicula sp.,	200	200	200	400	200	100	0	200	200	400	0	0
Thalassiothrix sp.,	0	800	400	100	0	0	400	300	100	200	200	100
Amphiprora sp.,	100	200	100	200	0	100	100	100	200	100	100	0
Dinoflagellate												
Prorocentrum sp.,	0	200	100	100	100	200	0	200	0	600	200	200
Ceratium sp.,	0	300	400	100	600	400	200	400	600	400	200	200
Peridinium sp.,	200	200	200	200	800	100	0	100	0	0	0	0
Gymnodinium sp.,	200	200	1000	200	600	200	800	200	600	200	200	400
Noctiluca sp.,	0	0	0	0	100	100	0	0	0	100	0	200
Protoperidinium sp.,	0	0	200	100	200	100	200	200	0	100	200	0
Dinophysis sp.,	0	100	0	0	0	100	0	100	0	100	300	100
Cochlodinium sp.,	400	200	0	200	200	200	0	0	0	0	0	0

Podolampas sp.,	0	200	0	100	100	0	100	0	0	100	200	100
Cyanobacteria	0	0	100	100	100	200	400	200	200	400	100	100
Chroococcus	0	0	0	0	0		0	100	100	200	100	0
Trichodesmium sp.,	600	1000	800	1600	1800	1200	600	900	600	800	200	200
Total Abundance (No.L-1)	**4200**	**7000**	**5800**	**5700**	**6800**	**6000**	**5100**	**5300**	**7200**	**6200**	**4700**	**4100**

Table 3.12: Percent contribution of diatoms and dinoflagellates to the total phytoplankton abundance at the sampling stations in bottom waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP1	MOP2
Diatoms	66.7	65.7	51.7	52.6	32.4	53.3	54.9	54.7	70.8	51.6	63.8	63.4
Dinoflagellate	19.0	20.0	32.8	17.5	39.7	23.3	25.5	22.6	16.7	25.8	27.7	29.3
Others	14.3	14.3	15.5	29.8	27.9	23.3	19.6	22.6	12.5	22.6	8.5	7.3

Table 3.13: Total zooplankton abundance (No./m^3) at the sampling stations in the surface waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP 1	MOP 2
Hydromedusae	0.7	0.1	0	0.2	0.3	0.1	0	1.1	1.7	1.8	0.2	0.4
Siphonophore	0.2	0.7	0.5	0.1	0.4	0.4	0.4	2.1	0	1.6	0.4	1.2
Ctenophora	0.3	0.7	0.1	1.7	0.4	0.4	0.8	1.7	1.3	1.6	0.4	0.6
Chaetognatha	7.5	20.4	18.3	12.9	9.1	6.6	9.16	2.5	35.41	8.3	28.7	4.2
Copepods	326	404	388	359	322	390	442	333	493	374	258	165
Cladocerans	4.2	6.12	0.8	1.6	1.4	0.4	0.8	0.7	0.1	0.4	3.2	4.1
Ostracods	0.2	0.3	0.7	0.1	0.4	0.6	0.9	0.6	0.2	0.3	0.1	0.8
Lucifers	1.3	8.6	1.3	1.7	1.3	2	3.4	1.9	1.6	1.6	3.2	1.4
Thaliacea	1.1	0.7	0.9	0.8	0.8	0.7	0.7	0.4	0.6	0.6	3.12	5.1
Appendicularians	11.2	2.1	1.9	16.6	7.5	2	12.5	4.6	4.3	9.1	0.6	4.1
Polychaete larvae	0.8	0	0.4	0	0.8	0.4	0	0	0	0	0	3.2
Decapod larvae	6.2	8.1	6.4	7.1	9.3	6.4	8.7	5.8	2	1.7	4.1	10.1
Bivalve larvae	5.8	0	4.2	0	6.4	1.2	0	8.5	0.8	0.8	2.3	3.1
Gastropod larvae	0.4	0	0	0.9	0	0	3.1	0	4.3	0	0	4.1
Fish Eggs	0.2	0.3	0.4	0.4	1.1	1.6	1.6	2.5	6.6	1.1	0.1	0.1
Fish larvae	0	1.3	0	0.6	0.8	0.7	0.1	0.3	0	0.4	0.1	0.2
Total (No./m^3)	**366**	**454**	**423**	**404**	**362**	**414**	**484**	**366**	**552**	**403**	**304**	**208**

Table 3.14: Percent contribution of various groups to the total zooplankton abundance at different sampling stations in the surface waters of the study region

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	MOP 1	MOP 2
copepods	89	89	92	89	89	94	91	91	89	93	85	80
appendicularians	3.1	0.5	0.4	4.1	2.1	0.5	2.6	1.3	0.8	2.3	0.2	2.0
Decapod larvae	1.7	1.8	1.5	1.8	2.6	1.5	1.8	1.6	0.4	0.4	1.3	4.9
Bivalve larvae	1.6	0.0	1.0	0.0	1.8	0.3	0.0	2.3	0.1	0.2	0.8	1.5
Chaetognatha	2.0	4.5	4.3	3.2	2.5	1.6	1.9	0.7	6.4	2.1	9.4	2.0
Cladocerans	1.1	1.3	0.2	0.4	0.4	0.1	0.2	0.2	0.0	0.1	1.1	2.0
Thaliacea	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	1.0	2.5
Appendicularians	3.1	0.5	0.4	4.1	2.1	0.5	2.6	1.3	0.8	2.3	0.2	2.0

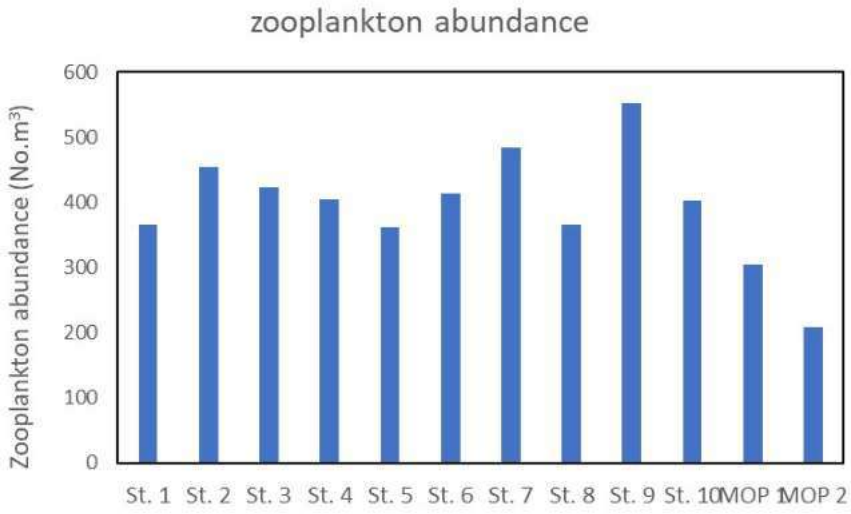


Fig. 3.8: Abundance (No/m^3) of zooplankton in surface waters of the study region

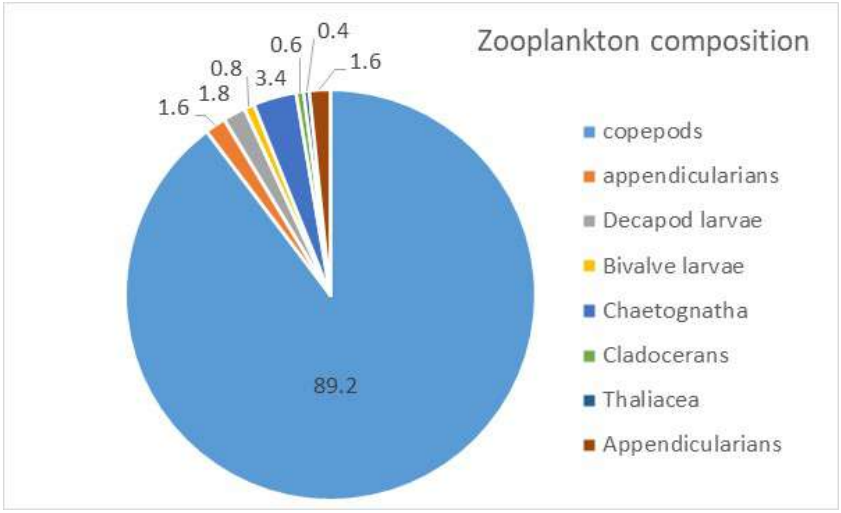


Fig. 3.9: Percent contribution of various groups to the total zooplankton abundance at different stations in the study region

3.2.3. Benthos

Benthos, the seafloor biota, contributes substantially to the secondary production of potential and sustainability of demersal or near bottom living fishable resources. The distribution of biomass production of benthos in the seas surrounding India is reported by

Parulekar et al (1982). A number of comparative studies on benthos of various ecosystems of the seas around India are available and a resume of published results on the standing crop and production of benthos from Bay of Bengal are given in Table 3.15.

Table 3.15: Reported standing crop and production of benthos in the Bay of Bengal

	REGION	BAY OF BENGAL
Biomass (g/m^2)	**Shelf**	<0.1-98.8 (4.9)
	Slope	0.1-60.2 (4.6)
	Deep	0.1-5.2. (2.3)
Productivity ($gC/m^2/y$)	Shelf	0.6-3.1 (1.2)
	Slope	0.1-2.4 (0.8)
	Deep	0.4-1.0 (0.8)

4.2.4.1. Macro and meiofauna:

Benthic macro fauna is basically comprised of sedentary and sessile organisms, dominated by polychaete worms and Arthropods. The macro faunal density of the study area ranged from 1950 to 3500 No./m^2 (Table 3.16; Fig. 3.10). The macrofaunal density range found in this study is slightly lower than those reported in a previous monitoring study conducted in this region in 2017 (900-4650 No./m^2), but higher than those reported in 2012 (400-2575 No./m^2) and comparable with those reported in 2014 (125-3325 No./m^2) from this region (Table 3.16). A total of 27 fauna were found in this study (Table 3.17). Contribution from various groups to the macrofaunal density ranged from 1.6% to 48.2% (Table 3.18). The fauna was dominated by families of polychaeta and their contribution was in the range of 16.1% - 48.2%, with a mean contribution of 30.6% to that of the total abundance (Figs. 3.11 and 3.12). Foraminifera is the second largest group that was contributed to total density of macrofauna and its contribution ranged from 17.9% to

37.7%, with a mean contribution of 24.1% (Fig. 3.12). Mollusca is the third largest group in the total macrofauna and it contributes 22.6% (range: 8.9% to 37.3%) to the total density of the macrofauna in the study region (Fig. 3.12).

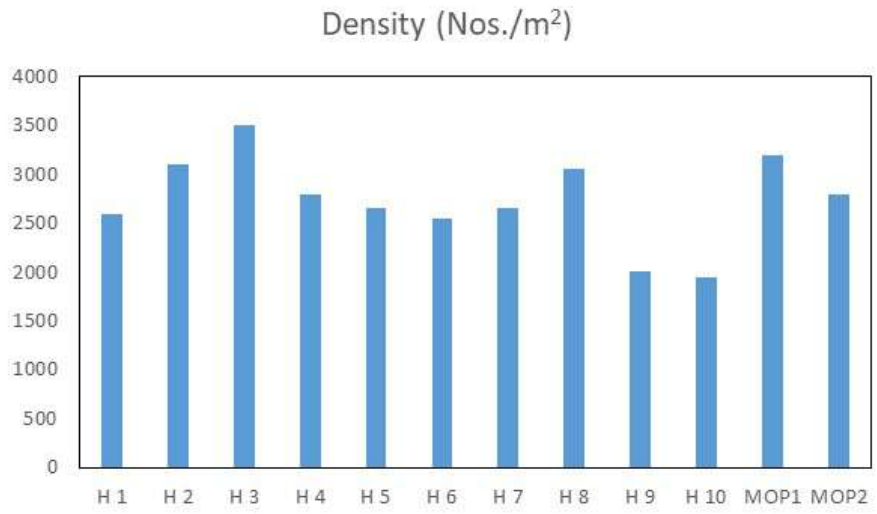


Fig. 3.10: Density of macrofauna in the surface sediments at different stations in the study region

The macro faunal density of the study area found in various previous monitoring studies was given in Table 3.16 and compared with the macro faunal density found in this study.

Table 3.16: Comparison of macrofaunal density in the study region during monitoring studies conducted in different years

Year of monitoring	Macrofaunal density (No./m^2)
2012	400 - 2575
2014	125 - 3325
2017	900 - 4650
2022 (This study)	1950 - 3500

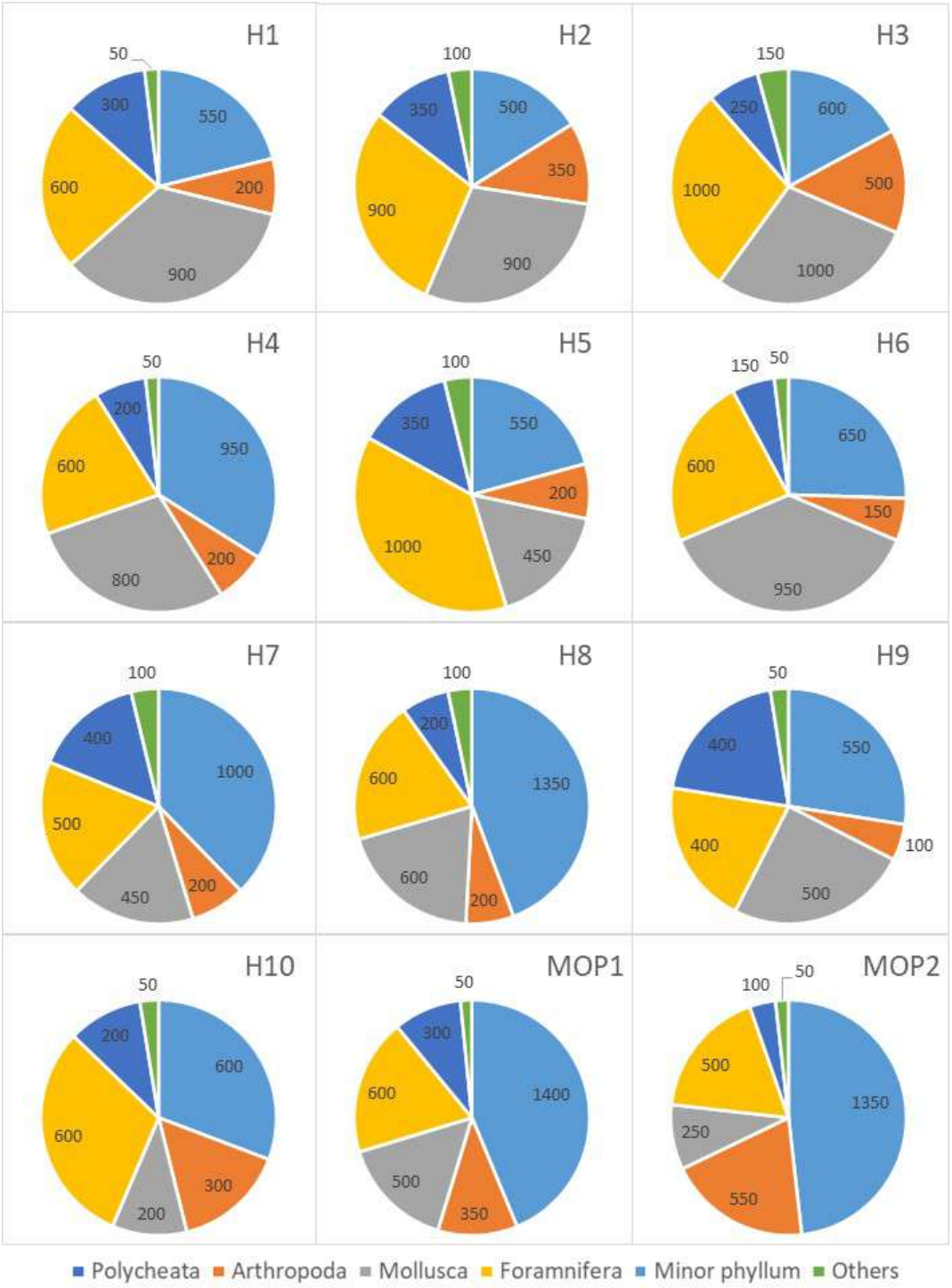


Fig. 3.11: Abundance of various groups (No./m^2) contributed to the total macrofaunal density in the surface sediments at different stations in the study region

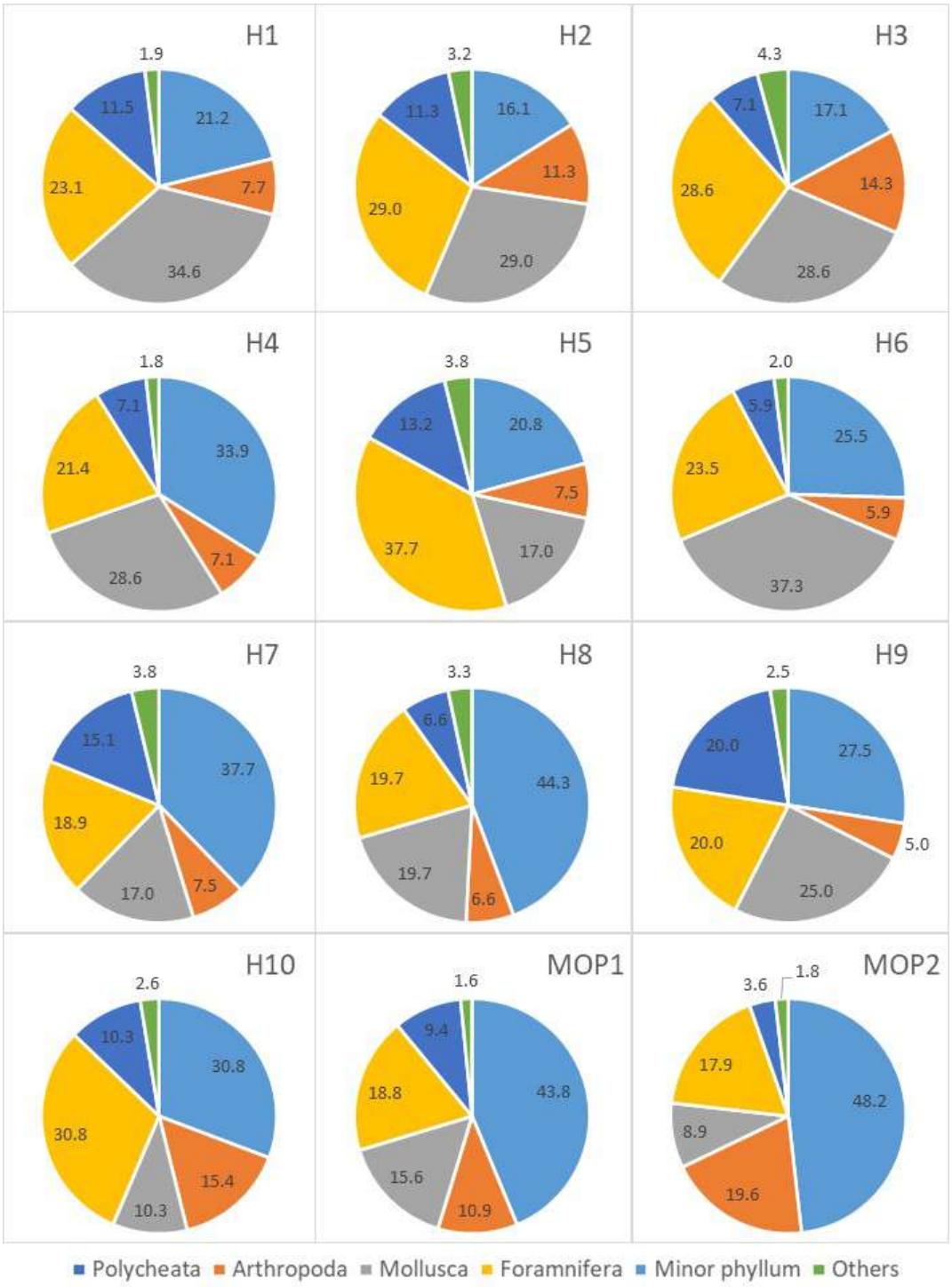


Fig. 3.12: Percent contribution of polychaeta, arthropoda, Mollusca, foraminifera, minor phylum and others to the total macrofaunal density in the surface sediments at different stations in the study region

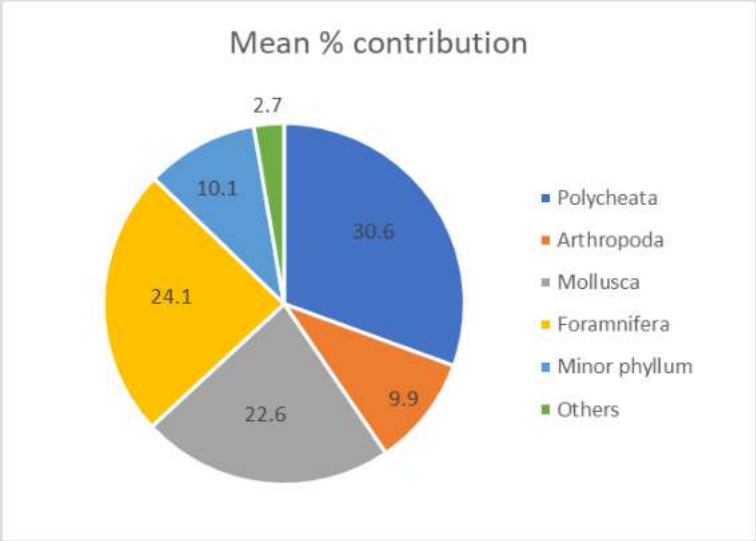


Fig. 3.13: Mean percent contribution of polychaeta, arthropoda, Mollusca, foraminifera, minor phylum and others to the total macrofaunal density in the surface sediments of the study region

The abundance of meio fauna varied from 346 No./10cm^2 to 870 No./10cm^2, with an average abundance of 539 No./10cm^2. Mean abundance of various meio faunal groups is shown in Fig. 3.14 and their percent contributions are shown in Fig. 3.15. The range of values of meio faunal density found in this study is slightly lower than those observed in a previous monitoring study conducted in this region in 2017 (416-1006 No./10cm^2) Abundance of Nematoda in this study varied from 100 to 291 No./10cm^2 (mean: 186.6 No./10cm^2) and this range is also comparatively lower than those reported in the 2017 monitoring study (311-710 No./10cm^2). Although, Nematoda are the major contributors to the total meio fauna abundance their contribution is lower in this study (34.6%) compared to the previous monitoring study (>80%), indicating increased biodiversity. Foraminiera is the second largest contributors with an average contribution of 16.6 % to the total meio faunal density. Turbellaria is the third largest contributor with a mean contribution of 8.1%. A total of 11 meio faunal groups were found in this study.

Fig. 3.14: Mean abundance of various groups of meio-fauna in the surface sediments of the study region

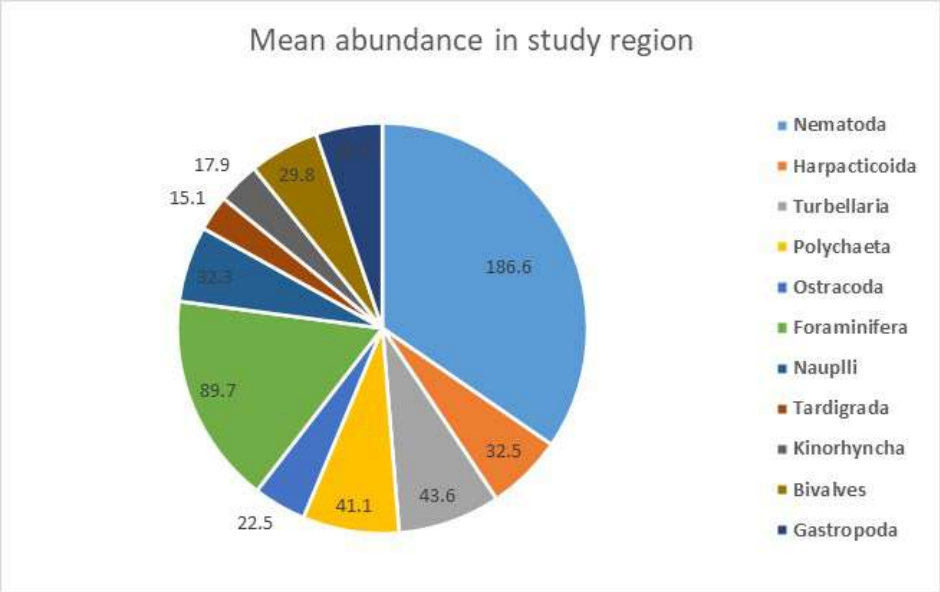


Fig. 3.15: Mean percent contribution of various groups to the total meio-faunal density in the surface sediments of the study region

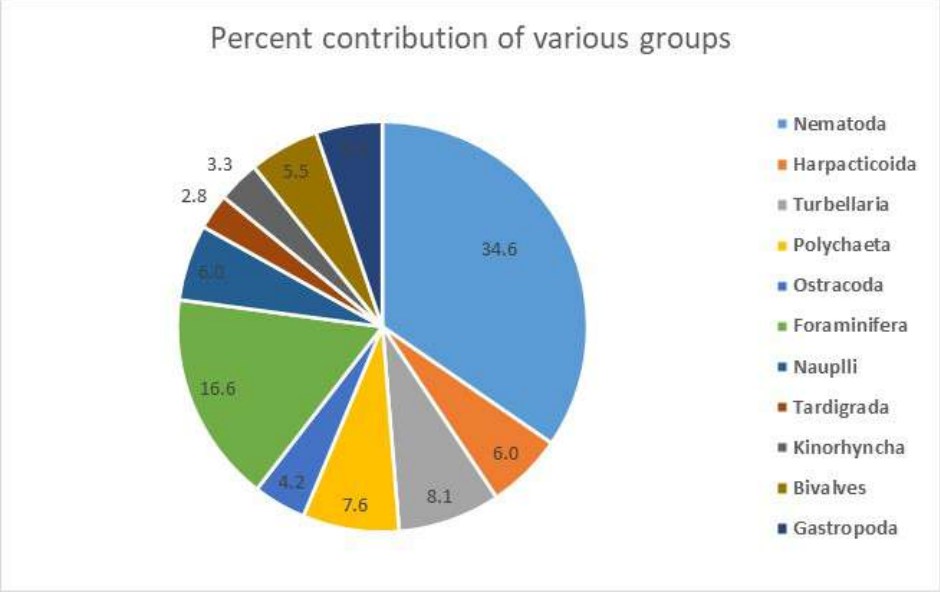


Table 3.17: Macrobenthos abundances (No/m^2) in surface sediments of the study region

SI.NO	Taxa	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H-MOP	H13
						Polychaeta							
1	Nephtyidae sp.	50	50	0	100	50	50	200	100	0	200	200	200
2	Orbinidae sp.	0	0	0	50	0	0	0	50	0	0	0	0
3	Spionidae sp.	50	50	50	100	0	50	100	100	50	100	0	100
4	Opheliidae sp.	0	50	0	100	0	0	100	100	100	0	0	0
5	Glyceridae sp.	50	0	100	0	100	50	50	50	50	50	400	400
6	Nereidae sp.	50	50	0	100	0	0	0	0	0	0	0	0
7	Pilardigae sp.	0	50	0	50	50	0	50	100	50	0	0	200
8	Aphroditidae sp.	100	0	0	0	0	100	0	200	0	0	0	0
9	Cossuridae sp.	0	0	0	0	0	100	100	0	50	50	100	0
10	Cirratulidae sp.	50	0	100	100	0	0	100	200	100	0	0	200
11	Terebellidae sp.	0	0	50	0	0	0	0	0	0	0	200	0
12	Syllidae sp.	50	50	0	50	100	0	100	50	50	0	0	0
13	Maldanidae sp.	0	0	0	0	0	50	50	0	50	50	0	0
14	Capitellidae sp.	0	0	50	0	0	50	0	0	0	0	200	100

15	Pisionidae sp.	50	50	0	200	200	50	0	100	0	0	0	0
16	Eunicidae sp.	50	50	50	0	0	0	0	0	0	100	0	50
17	Sabellidae sp.	0	0	0	0	0	50	50	200	50	0	200	0
18	Unidentified	50	100	200	100	50	100	100	100	0	50	100	100
	Arthropoda												
19	Amphipoda sp.	50	150	300	100	100	100	100	50	50	150	50	300
20	Tanaidacea	100	200	100	50	50	50	100	150	50	100	300	200
21	Isopoda sp.	50	0	50	0	50	0	0	0	0	50	0	50
22	Cumacean sp.	0	0	50	50	0	0	0	0	0	0	0	0
	Mollusca												
23	Gastropoda	500	400	600	200	250	450	250	200	200	100	300	100
24	Bivalvia	400	500	400	600	200	500	200	400	300	100	200	150
25	Foramnifera	600	900	1000	600	1000	600	500	600	400	600	600	500
	Minor phyllum												
25	Sipunculus	100	50	150	100	50	50	100	0	100	100	0	0
26	Nematoda	200	300	100	100	300	100	300	200	300	100	300	100
27	others	50	100	150	50	100	50	100	100	50	50	50	50
	Density no/m²	**2600**	**3100**	**3500**	**2800**	**2650**	**2550**	**2650**	**3050**	**2000**	**1950**	**3200**	**2800**

Table 3.18: Percent contribution of various groups to the total macrobenthos abundances (No/m^2) in surface sediments of the study region.

SI.NO	Taxa	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	HMOP	H13	Mean
1	Nephtyidae sp.	21.2	16.1	17.1	33.9	20.8	25.5	37.7	44.3	27.5	30.8	43.8	48.2	**30.6**
2	Orbinidae sp.	7.7	11.3	14.3	7.1	7.5	5.9	7.5	6.6	5.0	15.4	10.9	19.6	**9.9**
3	Spionidae sp.	34.6	29.0	28.6	28.6	17.0	37.3	17.0	19.7	25.0	10.3	15.6	8.9	**22.6**
4	Opheliidae sp.	23.1	29.0	28.6	21.4	37.7	23.5	18.9	19.7	20.0	30.8	18.8	17.9	**24.1**
5	Glyceridae sp.	11.5	11.3	7.1	7.1	13.2	5.9	15.1	6.6	20.0	10.3	9.4	3.6	**10.1**
6	Nereidae sp.	1.9	3.2	4.3	1.8	3.8	2.0	3.8	3.3	2.5	2.6	1.6	1.8	**2.7**

3.3 Microbiological parameters

Certain aquatic microbes serve as excellent indicators of pollution. Microbes, in particular, bacteria react quickly to changes in environmental conditions. An assessment of the microbial activity is possible by the determination of the microbial biomass (total viable count). Therefore, the total viable counts imply an indirect measure of *in situ* activity in contrast to several specific indicator microbes, and this has been used as one of the principal criteria of pollution in natural water. Besides the pollution indicator bacteria such as total coliforms (TC), *Escherichia coli* like organisms (ECLO) and *Enterococcus faecalis* like organisms (EFLO) occurring in the coastal waters have also been included. These indicator bacteria will presumably show that sewage discharge with human faecal matter is present, which also indicates the possible presence of pathogenic bacteria in the water samples. Apart from that some pathogenic bacteria such as *Vibro cholerae* like organisms (VLO) and *Vibro parahaemolyticus* like organisms (VPLO) abundance was also studied. Water samples from the surface and bottom were collected at each station with the help of a Niskin sampler. All the samples were stored in ice immediately after collection and transferred to the laboratory for the enumeration of different groups of bacteria. Standard microbiological methods were followed for dilution, spread plating and incubation.

Seawater samples collected from the study area were analyzed for the following microbiological parameters:

1. Total viable count (TVC) – R2A Agar seawater medium,
2. Total Coliform (TC) – Mac Conkey's Agar,
3. *Escherichia coli* like organisms (ECLO) – Hichrome Universal Agar,
4. *Enterococcus faecalis* like organisms (EFLO) – Hichrome Universal Agar,
5. *Vibro* like organisms (VLO) – TCBS Agar,

6. *Vibrio cholerae* like organisms (VCLO) – TCBS Agar,
7. *Vibrio parahaemolyticus* like organisms (VPLO) – TCBS Agar,

The counts of different groups of bacteria recorded in the water column are presented in Table 3.19. The values of TVC in the surface water were in the range of 2.9 to 24.6 x 10^3 CFU/ml. The values for the bottom water were 0.9 to 34.8 x 10^3 CFU/ml. These counts are comparable with those reported in the previous monitoring study conducted in this region in 2017 (5.6-13.6x10^3 CFU/ml and 3.2-33.0 x10^3 CFU/ml in surface and bottom waters, respectively). The total Coliform count was 1.4 to 8.4 x10^3 CFU/ml in surface water and 0.01 to 10.0 x10^3 CFU/ml in bottom water. The coliform count found in this study are considerably higher than those reported in the previous monitoring study conducted in this region in 2017 (0.3-0.8 x10^3 CFU/ml and 0.2-1.2 x10^3 CFU/ml in the surface and bottom waters, respectively). Similarly, the *Escherichia coli* like organism (ECLO) counts were NG to 3.2 x10^3 CFU/ml in surface water and NG to 3.1 x10^3 CFU/ml in bottom water. The range of ECLO found in this study is comparable with those found in the previous monitoring study conducted in this region in 2017 (1.5-3.7 x10^3 CFU/ml and 0.7-7.4 x10^3 CFU/ml in the surface and bottom waters, respectively). The *Enterococcus faecalis* like organism counts were NG to 22.9 x10^3 CFU/ml in surface water and NG to 1.6 x10^3 CFU/ml in bottom water. The *Vibrio* like organism (VLO) counts were NG to 3.0 x10^1 CFU/ml in surface water and NG to 1.0 x10^1 CFU/ml in bottom water. Similarly, the *Vibrio cholerae* like organism (VCLO) counts were NG to 3.0 x10^1 CFU/ml in surface water and NG to 1.0 x10^1 CFU/ml in bottom water. There is no growth of *Vibrio parahaemolyticus* like organism (VPLO) in both surface and bottom waters.

Wide variation in TVC is observed spatially both in surface and bottom waters. ECLO and EFLO counts were observed in most of the stations and were high in the few

samples but a large variation was observed, which showed the influence of anthropogenic activities such as domestic and industrial discharge, recreational activities, open defecation in coastal (beach) regions (in villages), fisherman activities etc. The counts were higher than the reported from the coastal waters and as per standards of coastal recreational waters. VLO and VCLO counts were observed only in two stations out of the 12 stations sampled in the coastal waters off Rajayyapeta.

Table 3.19: Abundance (CFU/ml) of various bacterial populations in the water column of the study region

Station	Depth	TVC ($x10^3$)	TC ($x10^3$)	ECLO ($x10^3$)	EFLO ($x10^3$)	VLO ($x10^1$)	VCLO ($x10^1$)	VPLO ($x10^3$)
HET1	**SUR**	8.8 [3]	4.0	0.7	1.2	3.0	3.0	NG
	BOT	21.6	9.0	2.4	NG	NG	NG	NG
HET 2	**SUR**	15.2	5.6	1.6	0.2	NG	NG	NG
	BOT	5.6	6.2	NG	1.1	NG	NG	NG
HET 3	**SUR**	8.3	8.0	2.9	0.1	NG	NG	NG
	BOT	3.4	9.5	3.1	0.1	NG	NG	NG
HET 4	**SUR**	3.4	2.0	0.1	0.2	NG	NG	NG
	BOT	34.8	10.0	NG	0.2	NG	NG	NG
HET 5	**SUR**	11.8	7.2	NG	22.9	NG	NG	NG
	BOT	20.4	1.5	NG	0.1	NG	NG	NG
HET 6	**SUR**	12.2	6.0	1.5	0.5	NG	NG	NG
	BOT	18.0	9.0	NG	1.6	NG	NG	NG
HET7	**SUR**	15.6	7.5	1.9	0.3	NG	NG	NG
	BOT	3.1	0.4	NG	NG	1.0	1.0	NG
HET 8	**SUR**	4.8	5.7	1.8	NG	NG	NG	NG
	BOT	8.8	3.0	NG	0.1	NG	NG	NG
HET 9	**SUR**	2.9	8.4	3.2	8.4	NG	NG	NG
	BOT	0.9	1.7	0.4	NG	NG	NG	NG
HET 10	**SUR**	11.4	1.4	0.4	NG	NG	NG	NG
	BOT	5.1	1.1	0.1	0.1	NG	NG	NG
MOP1	**SUR**	18.6	6.9	1.2	0.6	NG	NG	NG
	BOT	3.1	0.01	NG	NG	NG	NG	NG
MOP2	**SUR**	24.6	3.0	0.8	0.1	NG	NG	NG
	BOT	4.0	1.5	0.3	0.1	NG	NG	NG

TVC	Total Viable Count
TC	Total Coliform Count
ECLO	*Escherichia coli* like organism Count
EFLO	*Enterococcus faecalis* like organism Count
VLO	*Vibrio* like organism Count
VCLO	*Vibrio cholerae* like organism Count
VPLO	*Vibrio parahaemolyticus* like organism Count
NG	No Growth

3.4.1 Eco-toxicity of treated effluent

The toxicity of the effluents can be evaluated by employing several tests. Bioassay is one of the important tests among them and it is used to test the sensitivity of the organisms on exposure to a toxicant. Bioassay is defined as the test in which a living tissue, organism or group of organisms are used as a reagent for the determination of the potency of any physiologically active substance of unknown activity. In this experiment, a test species either a larva or adult is exposed to different concentrations of toxicant in a given time in order to know the nature and degree of response. During acute toxicity experiments, the tolerance response of the organism is evaluated by exposing it to the specified toxicant for a short period of time. In general, the level of tolerance of any organism to the toxicant is observed for a period of 96 hrs. in acute toxicity experiments. Static bioassay is widely used as a short-term response experiment for acute toxicity experiments and this is one of the best methods to provide the results very fast and accurately. In this experiment, the response of a toxicant to the organism is measured in terms of mortality or lethality.

The physico chemical characteristics of the treated effluent collected from M/s Hetero Infrastructure SEZ Limited are given in Table 3.20. Test conditions and test acceptable criteria for whole effluent toxicity of treated effluent with pink zebra fish are presented in Table 3.21. Acute toxicity of treated effluent collected from the guard pond of M/s Hetero Infrastructure SEZ Limited with whole effluent toxicity test expressed in terms of median lethal concentrations (LC_{50}) was evaluated by subjecting the acclimatized pink zebrafish (*D. rerio*) exposed to different exposure periods (24 hrs; 48 hrs; 72 hrs. and 96 hrs.) with eight different concentrations (%, v/v) of treated effluent test solutions.

Table 3.20: **Physico-chemical characteristics of the treated effluent and dilution water used for preparing test solutions**

Parameter	Treated effluent	Dilution water
pH	7.4±0.1	7.06±0.4
Salinity (ppt)	0.8±0.2	0.6±0.1
Nitrite-Nitrogen (mg/L)		<0.03
Ammonium (mg/L)	32.1±0.7	<0.01
Nitrate-nitrogen (mg/L)	2.7±0.4	2.5±0.4
DO (mg/L)	6.48±0.2	7.01±0.1
BOD_5 (mg/L)	1.23 mg/L	0.2±0.1
TSM (mg/L)	20.7±1.2	1.5±0.1

Table 3.21: Summary of conditions and acceptance criteria for WET acute Toxicity Test with pink zebra fish as test species

Type	Comment
Test condition	Static non-renewal
Test duration	96 hrs.
Temperature	>28 °C
Photoperiod	12 hrs. light: 12 hrs. dark
Test chamber size	12 Litres
Length of test organisms	30±5 mm
No. fishes per test chamber	20 fishes
No. replicate chambers per Conc.	Three
Feeding	None
Test solution aeration	Yes, >6 mg l^{-1}
Dilution water	0 ± 1 ‰ salinity
Test concentrations	effluent conc. and a control
Dilution series	10%, 20%, 30%, 50%, 60%, 90% and 100% treated effluent
Endpoint	Mortality of fishes
Test acceptability criterion	90% survival in 100% effluent after 96 hours

Experiments were conducted under static conditions and all experimental tanks had a triplicate and each experimental set included a Control (0%). The test containers were inspected at regular intervals for recording mortality at different exposure periods of 12 hrs, 24 hrs, 36 hrs, 48 hrs, 60 hrs, 72 hrs and 96 hrs for calculating the LC_{50} values. The dead organisms were removed immediately from tanks in order to avoid any type of bacterial contamination. At the end of each test, the organisms were transferred to a clean tank for observing their recovery. The average percent mortality recorded at different test solutions in triplicate test containers during the four exposure periods was determined. The median lethal concentration (LC_{50}) values in the percentage of toxicant for zebra fish exposed to different concentrations of effluent were calculated based on the mortality rates. The average percent mortality recoded at different test solutions in triplicate test containers during the four exposure periods was determined.

The mortality of test organisms (pink zebra fishes) for effluent samples over different exposure periods are presented in Table 3.22. The mortality values of effluent water samples for different exposure periods (24 hrs, 48 hrs, 72 hrs and 96 hrs) were calculated following the method of log-probit transformation for time and dose-mortality curves suggested by Finney's method (1971) using LDP line software (http://embakr.tripod.com/ldpline).

Data on the average mortality of test animals (in %) recorded in different test concentrations of treated effluent from Hetero Infrastructure SEZ Limited over four exposure periods is presented in Table 3.23. The median lethal concentrations (LC_{50}) of treated effluent from Hetero Infrastructure SEZ Limited at different exposure periods are shown in Table 3.24.

Table 3.22: The survival rate of zebra fish exposed to different concentrations of treated effluent to different exposure periods

Exposure Time	Control	Effluent Concentration						
	0%	10%	20%	30%	50%	60%	90%	100%
1 hr.	100	100	100	100	100	100	100	100
6 hrs.	100	100	100	100	100	100	100	100
12 hrs.	100	100	100	100	100	100	100	95
24 hrs.	100	100	100	100	100	100	95	95
36 hrs.	100	100	100	100	100	100	95	95
48 hrs.	100	100	100	100	100	100	95	90
60 hrs.	100	100	100	100	100	95	95	90
72 hrs.	100	100	100	100	100	95	95	85
84 hrs.	100	100	100	100	95	95	90	75
96 hrs.	100	100	100	100	95	95	90	75

Table 3.23: Cumulative mortality of test (pink zebra) fish at different exposure periods in the 96-hour long experiment with treated effluent

Effluent conc. (% v/v)	Cumulative Mortality (%) of zebra fish during exposure periods			
	24 hrs	48 hrs	72 hrs	96 hrs
0%	0	0	0	0
10%	0	0	0	0
20%	0	0	0	0
30%	0	0	0	0
50%	0	0	0	5
60%	0	0	5	5
90%	5	5	5	10
100%	5	10	15	25

Table 3.24: Median Lethal concentrations (LC_{50}) of treated effluent from Hetero Infrastructure SEZ limited at different exposure periods

Exposure period (hrs.)	Median Lethal concentration (LC_{50}), %
24	-
48	-
72	326.7
96	187.6

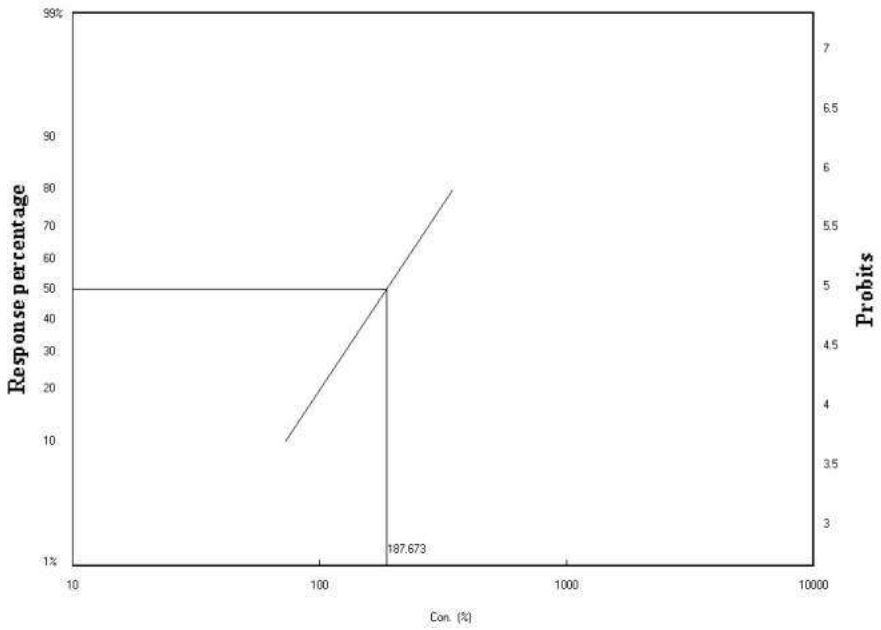
Experimental setup used for 96 hrs. LC_{50} of Hetero Infrastructure Limited effluent with pink zebra fish was shown Fig. 3.16. Dose-Mortality curves generated from the LDP Line software for median Lethal Concentrations (LC_{50}) during different exposure periods were shown in Fig. 3.17

During the 96 hrs. exposure period, no mortality was observed in control treatment. No mortality was found during the test time (96 hrs.) in the effluent concentrations of 10%, 20% and 30%. Effluent of 50% concentrations recorded 5% mortality during the last 24 hours. Whereas, 60% effluent recorded 5% mortality during the last 48 hours. The 90% effluent recorded 10% mortality while the 100% effluent recorded 25% mortality during the test time of 96 hours. These results indicate that the treated effluent collected from the guard pond of M/s Hetero Infrastructure SEZ Limited does not fulfill the test acceptability criterion. The results of this 4-day long bio-assay experiment revealed that the treated effluent of M/s Hetero Infrastructure SEZ Limited did not fulfil the CPCB norms for the bio-assay test, i.e. 90% of survival of zebra fish in 100% of treated effluent during the test time of 96 hours.

Fig. 3.16: Experimental set up for the bio-assay test

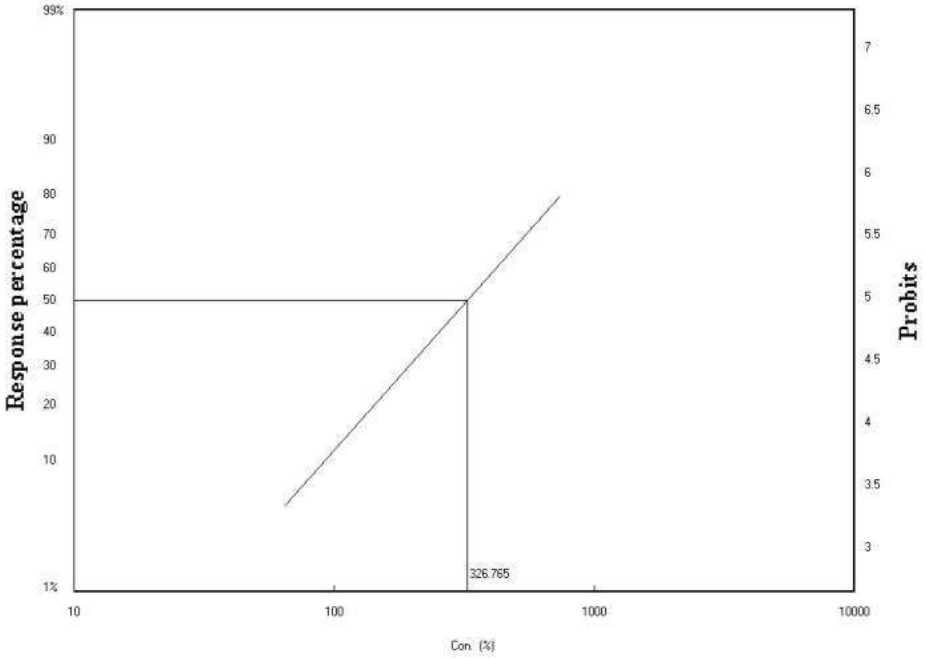
Fig. 3.17: Dose-Mortality curves generated from LDP Line software for median lethal concentration (LC_{50}) of zebra fish to the treated effluent during the exposure periods of (a) 72 hrs. and (b) 96 hrs.

(a)



72 Hrs.

(b)



96 Hrs.

Furthermore, an assessment of acute eco-toxicity of the treated effluent collected from M/s Hetero Infrastructure SEZ Limited was made in terms of Acute Toxicity Units (TUa). Recently, various industrial effluents that require discharge permits are assessed through the 'TUa' ($TUa=100/LC_{50}$ %v/v). It is a specified criterion used for discharge monitoring permits routinely used by the US-EPA. For each test performed the toxicity unit was calculated as 100% (full-strength effluent expressed as percentage) divided by the LC_{50} values. Acute toxicity units (TUa) obtained for treated effluents from M/s Hetero Infrastructure SEZ Limited is 0.56 (range: 0.35 to 0.71) for zebra fish.

The following criteria (Table 3.25) used by Pool et al (2009) were used to assess the level of eco-toxicity of treated effluents for zebra fish.

Table 3.25: Acute Toxicity Grading of treated effluents based on Toxicity Units (TUa)

Toxicity Unit (TUa)	Category
< 1.0	**Limited/or not acutely toxic**
1 - 2	**Negligibly acute toxic**
2- 10	**Mildly acute toxic**
10 – 100	**Acutely toxic**
>100	**Highly acutely toxic**

Based on the above criterion, the treated effluent from M/s Hetero Infrastructure SEZ Limited is graded as **Limited Toxic**.

3.4.2. Trace metals in the treated effluent

Trace element concentrations in the treated effluent were determined by the ICP-MS analysis. Concentrations of all the elements measured in the treated effluent fulfil the norms of the Central Pollution Control Board (CPCB) (Table 3.26) set for treated effluent for sea discharge.

Table 3.26: Trace metal concentrations in the treated effluent collected from the guard pond

Element	Concentration (µg/L)	Standard Limit Max. (µg/L)
Al	162.8	-
V	8.6	200
Cr	13.9	2000
Mn	160.2	2000
Fe	274.3	3000
Co	3.5	-
Ni	11.5	2000
Cu	87.5	3000
Zn	494.7	5000
As	1.4	200
Se	9.7	50
Cd	2.7	50
Pb	29.5	100

Chapter 4
SUMMARY AND CONCLUSION

1. The quality of waters around the marine outfall point during the observational period is similar to that of a typical coastal environment. The results of the present study are comparable to those obtained in earlier monitoring studies conducted in 2012 and 2014 in the same region. Relatively high nutrients and less dissolved oxygen in the bottom waters than that of the surface are due to the consumption of nutrients by phytoplankton in the surface and the release of nutrients and consumption of oxygen during the heterotrophic decomposition of organic matter in the bottom waters.
2. The concentration ranges of all chemical constituents in the vicinity of marine outfall are well within the ambient levels of a healthy coastal environment and would not pose a threat to marine biota.
3. The normal range of microbial flora such as total viable bacterial counts (TVC), total coliform and *E. coli* like organisms (ECLO) in the surface waters (5.6 -13.6x10^3, 0.3-0.8x10^3 and 1.5-3.7x10^3 CFU/ mL respectively) and bottom waters (3.2-33.0x10^3, 0.2-1.2x10^3 and 0.7-7.4x10^3 CFU/ mL respectively) suggest that the marine environment the vicinity of the outfall location is healthy and no significant microbial contamination is evident in the region.
4. A total number of phytoplankton genera recorded in the surface water varied from 12-19 in the surface and 15-22 in the bottom waters. The majority of the phytoplankton taxa are diatoms. The important genera of phytoplankton in the region are *Cheatocerus, Nitzschia* sp*., Pseudo-nitzschia*, *Rhizosolenia* sp., *Skeletonema, Navicula Thalassionema Thalassiosira Thalassiothrix Coscinodisus and Guinarida*.

5. A total of 15 different taxa including larvae were recorded for zooplankton. The numerical counts of different taxa recorded in the study area varied between 500 and 3239 Nos/m^3 while the biomass was in the range of 0.03 - 0.41 mL /m^3. The most dominant taxa recorded was the copepod, with a contribution of 75.8 to 94.3% to the total abundance. The overall picture of the zooplankton in the study area suggests that the composition and biomass were moderately high and attributed to inter annual variations.
6. The population density of macrofauna ranged from 900 to 4650 Nos/m^2. The total wet weight of biomass was in the range of 1.22–8.99 g/m^2. Polychaetes are the major contributor to the wet weight of biomass.
7. The total count of meiofauna was in the range of 416-1006 No/10cm^2 with a mean value of 661$\pm$186/10cm^2. Nematodes were the most dominant group with numerical density of 311-710/10cm^2 and percent composition of >80% at all stations
8. A comparison of biological data of the present study with the results of previous monitoring studies conducted in 2012, 2014 and 2017 revealed that the abundance of both phytoplankton and zooplankton were relatively low in this study compared to those found in 2017 but comparable with those found in 2012 and 2014. Therefore, relatively low abundance of phyto- and zooplankton may be due to inter annual variability associated with inter annual variability in physical and biogeochemical processes
9. Bioassay tests conducted on treated effluent collected from the guard of M/s Hetero Infrastructure SEZ Limited using zebrafish revealed that the treated effluent did not fulfill the CPCB norms for bioassay test of treated effluent for sea discharge,,i.e., 90% survival in 100% effluent during the test time of 96 hours. Only 75% survival of zebra fish was found in the 100% effluent after 96 hours, suggesting that it is required to

improve the quality of effluent before releasing it into the sea. Extensive algal growth in the guard ponds, due to the availability of nutrients such as nitrate, phosphate and silicate, may be suppressed in eco-friendly manner.

Chapter 5
RECOMMENDATIONS

Based on in-situ observations and results on laboratory analysis of samples collected during the field work the following recommendation are given to improve the quality of treated effluent and to maintain the health of the ecosystem in the coastal waters of Nallamattipalem.

1. Due to the decrease in the abundance of phytoplankton and zooplankton in this study compared to the previous study conducted in 2017, it is recommended to monitor the marine environment continuously for the next three years during the pre-SW monsoon season of each year.
2. Sludge should be removed from the guard ponds on regular time intervals, at least quarterly time scales
3. Extensive algal growth found in the guard ponds caused by the availability of plenty of nutrients such as nitrate, phosphate and silicate, should be suppressed. Algal growth suppression should be achieved in eco-friendly manner, such as continuous mixing of effluent in the guard pond using air blowers.

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HETERO INFRASTRUCTURE SEZ LTD

DISPLAY BOARDS INSTALLED AT

THE CROSSING OF ROAD AND CREEK

ANNEXURE-V

HETERO

CSR ACTIVITIES CONDUCTED BY THE INDUSTRY

1. Medical Camps conducted by the Industry in nearby villages are as below:

 Medical Camps in Upmaka Village, Nakkapalli, Janakayyapet, Butchiraju Peta, Rajayyapeta, N.Narasapuram and Vempadu villages covering almost all the villages around industry. This includes free medical Check ups, Medicines, Spectacles etc.

 Mobile medical van for Free medical camps in nerby 27 Villages.

2. Vision Centre at Nakkapalli for free testing, Operations, Goggles etc to all villagers

3. Installation of Drinking water RO plants in the Villages for providing Safe drinking water to the villagers. Till date the industry has installed 12 Nos RO plants.

4. Piped water supply to the villages including laying of pipeline, water tank construction, taps fixing etc.

5. Plantation of saplings in nearby Schools, Govt. Offices. Plants have been donated by the industry for the same purpose.

6. Construction of Concrete Roads in the nearby villages

7. Construction of temples and compound walls in the villages.

8. Community centers in the villages

9: construction of bus shelters:

10. Financial support for education:

- Vidya volunteers,
- Distribution of study material
- Furniture in all the schools
- Construction of toilets
- Construction of compound walls to the schools

 financial support to the poor etc.

11. Renovation of Government Offices in Nakkapalli Mandal for the convenience of the public.

12. Providing/installing LED streetlights to the villages.

13. Sponsoring the local festivals functions as per the request of villagers.

14. Distribution of Groceries and basic needs to the villagers during natural calamities

15.Nutrion food packets distribution to TB patients.

16.Warining boards fixing at beach area.

1.Medical van services:-


Equipment for Nakkapalli Government hospital & Biomedical rooms



2: Vision Centre at Nakkapalli for free testing, Operations, Goggles etc to all villagers:



3:Drinking water:

4:Piped water supply

5:Laying of CC roads at villages

6:Construction of temples and compound walls in the villages.



7: **Construction of Community centers in the villages**


8;Construction of bus shelters:

9: Distribution of Groceries

:

10: Education





11.Nutrion food packets distribution to TB patients:

Total :470 patients 6months

12.Warining boards fixing at beach area.

13:Cleaning programme at government hospital and school

1.Nakkapalli Hospital




2.KGBV School at Nakkapalli



Street lights: