REPORT

Report on draft guidelines

Report on draft guidelines for recycle, reuse and zero liquid discharge of treated industrial and domestic wastewater

Sajid Hussain Inayath

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adelphi

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List of Abbreviations

ASP	Activated Sludge Process
ATFD	Agitated Thin Film Dryer
BAT	Best Available Technology
BIOT	Biological Oxidation Tank
BOD	Bio-chemical Oxygen Demand
BREF	Best Available Technique Reference Document
Capex	Capital Expenditure
CCERP	Charter for corporate environmental responsibility program
CEPI	Comprehensive Environmental Pollution Index
CETP	Common Effluent Treatment Plant
CFO	Consent For Operation
CGWA	Centre Ground Water Authority
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPP	Captive Power Plant
DPR	Detailed Project Report
ETP / IETP	Effluent Treatment Plant / Individual Effluent Treatment Plant
GPI	Grossly Polluting Industry
gpl	Gram per Litre
GWI	Global Water Intelligence
HPI	Highly Polluting Industries
HRTS	High Rate Transpiration System
IIUS	Industrial Infrastructure Upgradation scheme
ILDP	Indian Leather Development Programme
IPDS	Integrated Processing Development Scheme
KW	Kilo Watt
LWG	Leather Working Group
MBR	Membrane Bio Reactor
MEE	Multiple Effect Evaporator
MLD	Million Littre per Day
MoWR	Ministry of Water Resource
MSME	Micro, Small, and Medium Enterprises
MVR-E	Mechanical Vapour Recompression Evaporator
MW	Mega Watt
NF	Nano Filtration
NGT	Nation Green Tribunal

NMCG	National Mission for Clean Ganga
NOC	No Objection Certificate
OCEMS	Online Continuous Emission Monitoring System
Opex	Operational Expenditure
OTCLA	One Time Controlled Land Application
PCC	Pollution Control Centers
PFD	Process Flow Diagram
RE	Resource Efficiency
RO	Reverse Osmosis
SBR	Sequencing Batch Reactor
SCP	Sustainable Consumption & Production
SEIAA	State Environment Impact Assessment Authority
SEIP	Sustainable and Environment-friendly Industrial Production
SIPCOT	State Industries Corporation of Tamilnadu Limited
SITP	Scheme for Integrated Textile Park
SPCB	State Pollution Control Board
SPI	Seriously Polluted Industry
STP	Sewage Treatment Plant
TDS	Total Dissolved Solid
TNPCB	Tamilnadu Pollution Control Board
TSDF	Treatment, Storage. Disposal, Facility
TSS	Total Suspended Solid
TWIC	Tamilnadu Water Investment Company Limited
UF	Ultrafiltration
WCF	Water Conservation Fee
ZDHC	Zero Discharge of Hazardous Chemicals
ZLD	Zero Liquid Discharge

1. Executive summary

The draft guideline report for recycle, reuse and zero liquid for industrial wastewater in India has been prepared based on the outcome of Gap Analysis, Need assessment, Case studies, Stakeholder meeting held on 14th May, 2020 and various policies and guidelines of Central and State Governments for reuse, recycle of wastewater.

Gap analysis reveals gaps in Policy, Technology and Capacity and there is a need for actions to bridge the gaps so that ZLD implementation is successful and the systems work efficiently and with efficacy and achieve the desired goals. The recommendations for actions to bridge the gaps has also been prepared.

Need basement study reveals requirement for Zero Liquid Discharge (ZLD) with respect to following aspects

1. Regulatory requirements
2. Ensure compliance with current EPA discharge standards (COD/TDS) consistently.
3. Pollution issues
4. Water Scarcity and compliance with CGWA rules for Over Exploited Zones
5. Water Conservation
6. Water Economics
7. Compliance with Buyers/ Customer/ brand requirements (LWG rating for leather, ZDHC for Textile Ind.)
8. Resource recovery (e.g. salts for dyeing/ nutrients for fertilizer).
9. Help Industrial growth by avoiding conflicts. Help retain Jobs and manufacturing which otherwise is showing a shift towards lower income group countries.

The Scoping of the framework to be developed for recycle / reuse / ZLD of treated wastewater with the following level has been identified:

1. Strategic Level: Objectives and strategic policies
2. Development Level: Developing legal framework to support Strategic Level and implementation levels
3. Implementation Level: Short and long term activities for implementation and achieving results

A Case study report has been prepared for following Seriously Polluting Industries based on references from the public domain. Despite handicaps in industry visits due to covid19 restrictions and lockdown, we have collected data on ZLD from as a many industries as possible.

1. Dyes & Dye Intermediaries
2. Cement
3. Copper smelting
4. Caustic Soda
5. Basic Drugs & Pharmaceuticals Manufacturing
6. Aluminium Smelting
7. Fermentation (Distillery)
8. Fertilizer
9. Iron & Steel
10. Leather Processing
11. Oil Refinery
12. Pesticides
13. Pulp & Paper (Manufacturing with and without Pulping)
14. Petrochemical
15. Sugar
16. Sulphuric Acid

17. Thermal Power
18. Zinc Smelting
19. Breweries
20. Textiles
21. Glass
22. Paints and Pigments
23. Ceramic
24. Electroplating/Phosphating/Pickling
25. Abrasives

Based on stakeholder's consultation workshop, the following broad framework requirements for ZLD has been planned:

1. Definition and standards for ZLD needs to be specified,
2. Standards and guidelines for disposal of waste mixed salts, recovery and reuse of salts from ZLD systems
3. Uniform guidelines for ZLD and applicability across the country
4. Techno-economic viability
5. ZLD for selected wastewater streams
6. Water conservation and waste minimisation, Water reuse requirements
7. Impact on policy for Tertiary treated sewage on ZLD
8. ZLD benefits and Incentives
9. Fiscal support- grants, subsidies, loans etc. from state/central government and other agencies
10. Financial Impact
11. ZLD Cost transfer across value chain in a sector
12. To address the issue of high carbon footprint and energy costs associated with ZLD systems
13. Manpower resources- Training – for Design &Engineering, O&M, Monitoring Staff, need for Industry-institute linkage
14. Technology/ BAT and Need for R&D

Instead of blanket directions for implementation of ZLD across all sectors, this report recommends the following four point criteria to determine applicability:

1. Identified specific sectors based on Water intensive & Pollution.
2. Environmental Situation
3. Technical Viability
4. Economic Viability

Specific Industrial sectors can be directed to implement ZLD if it fulfils all the above four criteria. A ZLD matrix has been developed to determine any industry fulfils the above criteria.

2. Introduction

2.1. Background

Discharge of industrial wastewater poses severe challenges particularly in landlocked areas. Serious negative environmental impacts are visible, for example, at the holy river Ganga, where around 501 million litres of industrial wastewater are discharged into the river every day. As the rejuvenation of rivers and remediation of polluted areas is complex, costly and time consuming, the Indian government has set the focus on the abatement of industrial wastewater pollution. To facilitate recycling and reusing of industrial wastewater and achieving Zero Liquid Discharge (ZLD) amongst industries and institutions, there has to be an adequate legal framework, consisting of guidelines, standards and legal provisions.

In light of this, adelphi is supporting GIZ in the second phase of the Sustainable and Environment-friendly Industrial Production (SEIP) program that aims to strengthen the strategic and operational governance structures of the Indian Government to effectively combat water pollution from industrial wastewater. The program aims for the following main outputs:

- Stronger legal framework
- Improved organizational procedures and processes
- Stronger incentive mechanisms
- Guidelines/e-portals/reference documents
- Resource efficiency (RE) and sustainable consumption & production (SCP)

The second phase is thus a continuation of the activities of the first phase, in which adelphi also participated.

In close cooperation with the Ministry of Environment, Forests and Climate Change of the Indian government, adelphi will assist the Central Pollution Control Board in developing a framework of guidelines, standards and recommendations on regulatory requirements. Since the ZLD approach in particular has been controversial in the past, it is particularly important to work closely with relevant local stakeholders. Thus, based on numerous bilateral meetings and workshops, the adelphi team performs a gap analysis and needs assessment, taking into account national and international best practices. The final project results and a series of training sessions will guide and assist selected government agencies in preparing and adopting documents to introduce recycling, reuse and ZLD approaches for selected sectors.

2.2. Purpose of the report

The present report proposes a suitable design for necessary guidelines that specify how and when recycling, reusing and ZLD of wastewater can be achieved for the national level.

Therefore, a wide range of issues are addressed, such as: i) clear and objective definitions of approaches for recycling, reusing and ZLD as well as their applicability to specific sectors and environmental and economic situations; ii) permissible options for recycling and reusing and corresponding hierarchies; iii) standards and discharge limits for approaches qualifying as recycling, reusing and ZLD techniques; iv) monitoring requirements; v) Best Available Techniques (BAT) for recycling, reusing and ZLD; and vi) specific examples and best practices as industry-specific benchmarks, drawing from both Indian and international experiences.

2.3. Proposed Approach and Methodology

Data mapping:

a. Collection of Data from SPCBs on industries practicing ZLD, Recycle and Reuse
b. Conducting field survey with questionnaires to Industries.
c. Preparation of list of Industrial sectors which have implemented ZLD, Recycle and Reuse.

Preparation of case studies challenges faced by the Industries for compliance to Regulatory requirements.

In view of Covid19 situation and the delay in obtaining official letter from CPCB to access SPCB and industries, the work has now been done based on collection of data from 8 Industrial Clusters and already existing data with the experts, information available in the public domain and feedback during the first stakeholder workshop.

3. Summary of Gap analysis, needs gathering and scoping for recycle/reuse of treated industrial wastewater

The Gap analysis, needs analysis, and performance analysis through case studies are forming part of needs assessment and generally these steps have been performed to achieve any desired results. Hence Gap analysis, needs gathering and scoping have been carryout as Main Task -1 under the assignment to develop framework for recycle/reuse of treated industrial wastewater in India

3.1. Gap analysis

The goals to be achieved by this Legal Framework on Zero Liquid Discharge are also to be in line with the Constitution of India and the Environment Protection and Pollution Control legislations of India but more focused specifically towards better implementation of Zero Liquid Discharge (ZLD) so that the desired results are attained.

For a better environment as envisioned in the Constitution of India, the goals for successful Zero Liquid Discharge would be:

a. To have an effective and implementable policy framework for ZLD which should have legal definition of ZLD, operating parameters for the ZLD system, standards and parameters for the treated water (permeate) generated from ZLD system etc.,
b. To suggest legislative amendments and reforms necessary for enforcement of the policy framework for ZLD
c. To have good examples of Zero Liquid Discharge Technology which are complying to the policy framework and is implementable by industry
d. To have reference document on Best Available Techniques (BAT) for ZLD to make it mandatory for industries to implement along with complying with the policy framed for ZLD

Thus, current framework for ZLD are basically:

1. The prevalent laws and statutes for preservation and conservation of water as a shared, scarce and precious natural resource derived from the Constitution of India.
2. The orders from the Apex Court and National Green Tribunal which were again in congruence with the principle to preserve and conserve the natural resources.

But, in-spite of current regulatory framework, India has treated effluent standards and there are no legal standards or norms for the ZLD. Even, there is no legal definition of ZLD although as per CPCB guidelines ZLD is defined as:

Zero Liquid Discharge refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and or thermal evaporation.

ZLD will be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents).

No groundwater injection or use of the effluents or permeate for irrigation or horticulture is allowed as per above. RO, micro/nano filtration and Multiple Effect Evaporators (MEE) can be options.

A ZLD treatment system utilizes advanced technological water treatment processes to limit liquid waste at the end of your industrial process to, as the name suggests, zero.

Thus, an efficient and well-designed ZLD treatment system should be able to:

- handle variations in waste contamination and flow
- allow for required chemical volumes adjustments
- recover around 95% of your liquid waste for reuse
- treat and retrieve valuable by-products from your waste (i.e. salts and brines)
- produce a dry, solid cake for disposal

Thus, there are gaps that exist in the current statues and rules which need to be bridged for a successful ZLD thus leading to conservation and preservation of precious natural resource and hence conform to the Constitution of India.

Based on the Goals to be accomplished and the current status about ZLD, gaps can be identified and enlisted as under:

A. Policy Gaps
B. Technology Gaps
C. Capacity Gaps

3.1.1. Policy Gaps

Rules in India related to conservation of water and pollution abatement need to be fine-tuned and made in line with the National Environmental Policy 2006 and in doing so many policy gaps can be bridged which can broadly be identified as under:

A. No policy or rules for reuse-recycle of treated waste water and hence making ZLD compulsory:

Currently there is a need of water policy which mandates such ZLD system and thereby forcing reuse-recycle of treated waste water thus saving precious natural resource. One such policy exists in Gujarat to reuse treated domestic sewage for industrial purpose but any such policy for industrial waste water does not exist.

Further, there are no policies or rules for legal enforcement of ZLD in general or for particular sector of industrial installations. Any Acts or Rules do not state that for a particular sector of industries such as pharmaceuticals or chemicals ZLD is mandatory. Thus, in absence of any such legal compulsions, the industrial installations opt for ZLD only when other options for discharge of treated effluent are absent and thus water instead of being treated as a valuable resource it is taken only for disposal of waste generate from manufacturing process.

B. No standards or parameters for enforcement of ZLD

Like there is no policy or rule for mandatory enforcement of ZLD in industrial installations, similarly there are no standards or parameters for enforcement of ZLD. Due to this, inspite of industries having implemented ZLD, it is not possible to check and verify whether they are actually operating and using the ZLD system installed in an effective and efficient manner. If a ZLD not operated in efficient and effective manner then it becomes a burden to the industry and then the industry tends not to operate the ZLD and opt for disposal of untreated or improperly treated waste water in haphazard manner.

C. Overall legal framework

The National Water Policy does not speak much about ZLD and hence it is required that ZLD is included in National Water Policy as one of the ways to promote water conservation and its efficient use.

Even if there is a mandate in the rules for enforcing ZLD, there should be an overarching legal framework which links the technology and the rules or policy so that they make ZLD enforceable and compulsory for industries. One such tool can be a legal framework which provides that an industry should implement ZLD as stated in a document such as Best Available Technique Reference Document (BREF) compulsorily.

There is lack of financial penalties in the legal framework which would otherwise deter people from discharging untreated or partially treated effluent into the environment and thus leading to ZLD of effluents from those production processes which are difficult or almost impossible to treat from technically as well as financially.

Till Water Cess Act was subsumed in Goods and Services Tax Act, the industrial units had to pay a Cess for using water which was considered as a common natural resource. Hence, there is a lack of making industries realise that they are using common natural resource which is precious and not free to use.

3.1.2. Technology Gaps

A. Non-availability of good examples of ZLD technologies

Even if an industrial installation wishes to implement ZLD technology, currently there are no demonstrated and published good examples of ZLD technologies which the industries can follow or take as guidance examples. Hence, absence of such case studies of such good examples within the different industrial is an existing gap.

B. Non-availability of Best Available Techniques (BAT) for ZLD

Best Available Techniques (BAT) mainly mean bench marking of technologies for a specific process or industry. If such bench marking is available and published officially then it becomes easy for the regulatory authorities to prescribe the technologies in the permits making it mandatory for industries to implement it. Further the industries may implement ZLD technologies better than those prescribed / suggested in BREF (BAT Reference) Document.

3.1.3. Capacity Gaps

A. Capacity of Regulatory Authorities

Inspite of the above policy and technology gaps existing currently, there are good number of ZLD systems in operation within the country. But there is lack of clear understanding of the operating parameters and monitoring of ZLD system within the Regulatory Authorities. Due to this gap, ZLD systems are not monitored properly and whether ZLD are efficiently operated or not and whether they achieve the desired goals or not is never monitored or verified. This results into loss of precious resource such as energy, water etc.

B. Capacity of Representatives of Industrial Installations

ZLD systems are energy intensive and need highly skilled personnel to operate the complex systems involved. There is a dearth of such highly skilled personnel due to which even after installation of ZLD system by industries desired results are not achieved.

3.1.4. Recommendations for actions to bridge the gaps

With the Gap Analysis as mentioned above, there is a need for actions to bridge the gaps so that ZLD implementation is successful and the systems work efficiently and with efficacy and achieve the desired goals.

The recommended actions for bridging the gaps analysed are:

Sr. No.	Gap Analysed	Recommended action to bridge the gap
A	Policy Gaps	
i.	No policy or rules for reuse-recycle of treated waste water and hence making ZLD compulsory directly or indirectly	Since water is a state subject, it would be difficult for the industries if the states made different and separate policies and rules for ZLD and reuse-recycle of treated waste water (permeate) hence it would be necessary that the Central Government comes out with a policy where in such reuse-recycle of treated waste water from industrial units is made mandatory. The policy may consider the differences sector wise and prescribe separate policies or rules for each sector. Similarly, differences within sectors should also be considered by the policy. The state can fix the rate which the industries have to pay for using water and this can be less than the ZLD rate and in this way ZLD can be encouraged. Similarly, cost for discharging waste water can be fixed by the state which can be higher than the ZLD cost making ZLD a feasible option for industries having effluent from processes that is difficult or almost impossible to treat technically. The policy instead of just enforcing ZLD should guide the industries that first step should be optimisation of water service, second step should be optimising Waste Water Treatment and then minimising of flow to ZLD thereby decreasing cost and load on ZLD system.
ii.	No standards or parameters for enforcement of ZLD	Even if the industrial units install and implement ZLD there are no standards and mechanisms to monitor the efficient and effective functioning of ZLD systems. So, it is required to come out with enforceable norms / standards so that the ZLD can be monitored for effective and efficient functioning which will be of help to industries as well as to the nation as a whole.

Sr. No.	Gap Analysed	Recommended action to bridge the gap
iii.	Overall legal framework	An overall legal framework needs to be developed which links the policies to the technologies and bench marks thus giving teeth to the regulators to enforce the ZLD installations and implementations. ZLD should be included in National Water Policy of India so that “Water may be treated as an economic good to promote its conservation and efficient use after basic needs such as those of drinking water and sanitation are met” be realised. As mentioned at point above, A Water Regulatory Authority should be established in all states. The authority would be responsible for fixing and regulating the water tariff system and the charges to be levied on the industries using water. Recycle and Reuse of water should be incentivized by a properly planned tariff system. This overall legal framework should take into account various characteristics like individual ZLD, Common ZLD, location, sector of industries, feasibility of other modes of disposal etc. Thus, instead of each ZLD policy formulated sector wise or location wise, it should be integrated into an overall legal framework to be implementable and enforceable. Further, the overall legal framework should be flexible and open enough to include future similar policies.
B	Technology Gaps	
i.	Non-availability of good examples of ZLD technologies	Case studies of successful and efficient / effective ZLD systems in each sector should be carried out and published so that the industries who are mandated to install / implement them can learn and be guided from those case studies. The case studies can also include the problems and challenges faced so that will act as facilitation for the emerging industries going for ZLD system.
ii.	Non-availability of Best Available Techniques (BAT) for ZLD	Either the BREF (Best available technique Reference Document) should be developed for each sector which should cover ZLD in that particular sector or specific BREF for ZLD should be developed which gives a bench marking for ZLD and thus makes implementation and enforcement easier.

Sr. No.	Gap Analysed	Recommended action to bridge the gap
C	Capacity Gaps	
i.	Capacity of Regulatory Authorities	Workshops and practical hands on training programs should be organised for capacity building of regulatory authorities so that when they monitor a ZLD system they can verify the efficiency and efficacy of the system and know whether the ZLD system installed by the industry is achieving desired results and complying to prevalent environmental norms.
ii.	Capacity Building of Representatives of Industrial Installations	Representatives of Industrial Installations should be given training programs for ZLD system so that their knowledge about operating ZLD systems increases and that they operate them at best efficiency and achieve best efficacy. Further, they should be made available the Best Examples so that they can learn and overcome the challenges within the ZLD systems they operate. This way they can achieve the desired results and also comply to prevalent environmental norms.

3.2. Needs Assessment

3.2.1. Current Practice of ZLD in the industry across the country

Zero Liquid Discharge is already in operation across several Industrial sectors in the country for almost two decades, it has gained serious traction for the most part in the last decade. However, all this without any legislation specifying ZLD standards or applicability for any industry. Therefore, there is a necessity to study the origins of such practices, the reasons and current status to develop a framework for ZLD including recycle and reuse. To understand the current practice on ZLD the following strategies were employed

a. Desktop Study
b. Collection of data from SPCB on industries practicing ZLD, Recycle and Reuse
c. Survey Questionnaire to Industries

3.2.2. Industrial sectors which have implemented ZLD, Recycle and Reuse

A. Majorly Polluting Industries which have implemented ZLD, Recycle and reuse

Following are the majorly polluting industries categorised by the CPCB, most of these industries today have implemented ZLD with recycle and reuse or just recycle and reuse only with some discharge of treated wastewater.

1. Pulp & Paper (ZLD in Waste paper only) ,
2. Distillery,

3. Sugar,
4. Leather Tanneries,
5. Thermal Power Plants,
6. Iron & Steel,
7. Cement,
8. Oil Refineries,
9. Fertilizer,
10. Chlor-Alkali Plants,
11. Dye & Dye Intermediate Units,
12. Pesticides,
13. Zinc smelting
14. Copper smelting
15. Aluminum smelting,
16. Petrochemicals
17. Pharma Sector
18. Sulphuric Acid

B. Other Industries which have implemented ZLD, Recycle and Reuse

Following are some of the industries identified, which have implemented ZLD

1. Breweries
2. Textile Dyeing
3. Glass
4. Paints and Pigments & Ceramic.

3.2.3. CETP Sector

There are 193 CETPs in the country, primarily to treat effluents from Leather Tanneries, Textile Dyeing, Electroplating, Pharmaceuticals and Chemical industry clusters. There are CETPs for mixed industrial clusters too. A brief summary of the status of CETPs in the country is given in annexure II.

Tamilnadu state has the largest number of CETPs in the country with 49 CETPs (25% share), followed by Gujarat (30), Maharashtra (27) and other states. However, in terms of effluent Processing capacity, the situation I completely altered with Gujarat state taking 40% of the total CETP capacity which stands at 1600 MLD

The CETPs have different treated effluent discharge requirements based their 'Consent For Operation (CFO) issued by the respective State Pollution Control Boards, which is generally based on the location of the cluster i.e. near a River, coastal or landlocked. The different treated effluent discharge requirements are

1. Marine Discharge
2. Inland Surface Water Discharge (River, Lake, canal, stream or nallah)
3. Discharge into a sewer
4. Zero Liquid Discharge

Our summary findings on the desktop study on CETPs is therefore as follows:

a. There are 193 CETPs in the country, with a total volume of 1600 MLD.
b. Tamilnadu has the highest number of CETPs (49 CETPs, 25% share) whereas Gujarat has the highest effluent capacity (645 MLD, 40% Share).
c. Totally 48 CETPs (25%) have implemented some kind of Reuse and recycle (All operating CETPs in Tamilnadu have implemented ZLD (40 CETPs) and 8 CETPs in the rest of the country have

implemented partial ZLD and HRTS). Remaining 145 CETPs (75%) discharge to the environment (Marine/ River/ Sewer).

d. There is no recycling/reuse/ ZLD for the 86% of the effluent capacity of the CETPs. In terms of volume, only 130 MLD (8%) have implemented ZLD and 58.5 MLD (4%) have implemented partial ZLD and HRTS.
e. 60 CETPs (31%) do not meet COD and/or TDS standards. 46 CETPs (46%) meet these standards. No data is available online on COD/TDS performance of 88 CETPs.
f. Also 88 CETPs (45%) are involved in some litigation on pollution issues.

3.2.4. Overall summary status of implementation of ZLD

a. There is no EPA standard on ZLD. Only treated effluent based discharge standards is in force.
b. ZLD implementation today is based on either court litigation and/or SPCB/ SEIAA directions.
c. There is no standard definition of ZLD –it is not clear if discharge of treated wastewater to industry's own land can be called as ZLD, some SPCBs seem to accept this as ZLD. The definition as per CPCB draft report in 2015 talks of recovery of water and salt residue but does not mention the point of disposal of the waste salt residue. It is understood that some SPCBs agree for disposal to TSDF while some SPCBs like TNPCB prohibit it. Therefore, Standards and guidelines for disposal of mixed waste salt- TSDF or not? Salt recovery & reuse is required
d. There is no mention of Recovery and Reuse of salts in the definition but is already in practice in the Textile Dyeing cluster of Tirupur.
e. Most Industrial clusters are accused of polluting rivers and ground water. 88 CETPs are involved in some kind of litigation on pollution issues. NGT has taken up river pollution issues in a big way.
f. ZLD implemented across most GPI sectors and is in operation for several years now.
g. ZLD Technology not standardised/ No BAT
h. Techno-economic viability issues needs to be studied. Comparison with marine discharge for treated wastewater or RO rejects versus ZLD needs to be studied to understand which becomes economical under what circumstances while meeting EPA standards.
i. Status of Implementation of ZLD – countrywide is not uniform, same industrial sectors have either ZLD or marine discharge or inland surface water discharge making a situation of non-uniform application of norms. This can be seen from the discharge requirements for CETPs across the country as explained in the previous sections.
j. There is no incentive today for any industry or CETP for implementation of ZLD other than getting environmental clearance or avoiding complaints on pollution issues from public and courts. This will be addressed in a separate section.
k. Non-competiveness due to additional cost of capex and opex due to implementation of ZLD is causing a national & regional imbalance in terms of productions costs and profitability. This is resulting in shift of polluting industries within the country and to other lower income group countries. This will be addressed in a separate section.
l. Funding – Grant and subsidies for implementation of ZLD is limited only to Textile Dyeing CETPs under the Integrated Processing Development Scheme (IPDS) of the Ministry of Textiles (MoT), government of India. It is understood that an earlier CETP funding scheme from the MoEF &CC is not in force now. Schemes like Industrial Infrastructure Upgradation scheme (IIUS) is available for Industrial clusters although not exclusively for ZLD. Therefore there limited funding opportunities. This will be addressed in a separate section.
m. There is a clear need for R&D due to technology challenges. This will be addressed in a separate section.

3.2.5. Need for ZLD

A. Necessity for Zero Liquid Discharge (ZLD)

After having recognition of problems, that many industrial sectors are not able to achieve standards and this ultimately necessitates to work towards Zero Liquid / effluent discharge standard. (CPCB- Guidelines on Techno-Economic Feasibility Of Implementation Of Zero Liquid Discharge (ZLD) For Water Polluting Industries, Draft Jan 2015)

The above statement from a CPCB policy document clearly summarises the situation. However, a deeper analysis is required for better understanding the need for ZLD.

I. Regulatory requirements

In some states- SPCB directions, EC conditions or court directions. Draft ZLD notification dropped by MoEF but the revised notification speaks of exhausting recycling and reuse options. The Gaps in policy is extensively dealt with in the Gap analysis report and is therefore not elaborated here

II. Ensure compliance with current EPA discharge standards (COD/TDS) consistently.

a. Most Industrial Effluents have high salinity/TDS- polluting industries such as Pharma, Pulp& Paper, Tanneries, Textile Dyeing, Chemicals, and Power Plants etc. The TDS content is well above the statutory limit of 2100 mg/l. Discharge of saline but treated wastewater pollutes ground and surface waters. The conventional ‘Physico-chemical-biological’ treatment does not remove salinity in the treated effluent. This requires membrane processes like Reverse Osmosis (RO) and Nano Filtration (NF). This also means that the membrane reject also need to be managed.
b. Achieving COD of 250 mg/l at the secondary treatment stage is also a challenge as most polluting industry wastewaters are not easily biodegradable. This requires additional tertiary treatment like Advanced chemical oxidation systems or electro-oxidation etc. However, the additional cost for treatment does not justify the expensive treated wastewater from being discharged, therefore it would make better sense to recycle and reuse if you need expensive treatment systems to achieve such discharge standards.

III. Pollution issues

a. With 193 CETPs in the country, non-compliance is a major issue.
b. Several landmark pollution cases and court battles -Vellore and Tirupur court cases.
c. Most rivers in the country are polluted.
d. ZLD is easy to monitor for compliance, any discharge from the factory 24 x7 means non-compliant. No need for lay man to complain, inspect, collect samples or test in lab and check with standards.
e. NGT actively perusing pollution cases and prohibiting discharge to rivers.
f. Poor experience with marine discharge and effluent channels polluting enroute and the sea, affecting coastal communities are also known.
g. Industry/ clusters can avoid public/farmer litigations & environmental compensations related to River Pollution &Ground water contamination. The NGT has taken such cases across the country for various River Pollution issues.
h. Expansion of Industries near Rivers/ Comprehensive Environmental Pollution Index (CEPI) listed clusters due to moratorium or ban can be relaxed due to implementation of ZLD
i. Better chances for Environmental Clearance for new projects.

IV. Water Scarcity and compliance with CGWA rules for Over Exploited Zones

a. Several states in India are water stressed 54% of India faces High to extremely high water stress and 54% of ground water wells are decreasing– WRI. The report also says that there would be no ground water for irrigation by 2025 in Delhi, Rajasthan and Haryana.
b. UNESCO Report says India holds the number 1 spot for the annual Ground water extraction at 251 cu.Km as against 112 cu.km in China and USA, a distant second.
c. Competing demands for water from agriculture and domestic use has limited industrial growth.

d. The Central Ground Water Authority (CGWA) has come with zoning based on water availability. Has notified over exploited zones and has directed for recycling and reuse of wastewater instead of using ground water which is prohibited in such zones.

V. Water Conservation

a. The CPCBs Charter for corporate environmental responsibility program (CCERP) specifies specific water consumption targets to be achieved by various industries.

VI. Water Economics

a. Indiscriminate withdrawal of ground water ‘free of cost’ is observed in most parts of the country. Water is priced low in many parts.
b. However, cost of fresh water for Industry is rising due to scarcity, for example Tirupur it is Rs.78/m3, Vellore –Rs.50/m3, Pali- Rs. 100/m3.
c. Location of industries in ‘Inland areas’ therefore marine discharge may not feasible. Cost of marine discharge increases with distance from shore and if the cost of fresh water is high (say Rs. 50/m3) then beyond 20 KM, ZLD becomes competitive.

VII. Compliance with Buyers/ Customer/ brand requirements (LWG rating for leather, ZDHC for Textile Ind.)

The Leather Working Group (LWG) audits leather tanneries on various aspects including Environment management, water, energy, waste etc. and rates them Gold, Silver or Bronze. Such audit certificates help buyers buy from the certified tanneries with confidence in compliance with their customer expectations. It is understood, that with higher ratings, the leather tanneries are able to achieve higher prices for the product. ZLD Tanneries outscore other tanneries on the following aspects of their audit

a. They have to meet local environmental regulation. As the regulation is ZLD, they pass the audit: The quality of RO permeate exceeds all EPA standards easily and since there is no discharge, the regulations are easily met.
b. Parameter Score- The score in LWG in effluent section is based on parameters they achieve. Minimum four criteria namely BOD or COD, SS, any nitrogen TKN or ammonia nitrogen and chromium VI. Due to implementation of ZLD they achieve very low parameters in the recovered water (RO permeate, Condensate). These low values in four parameters help them to reach highest score. Normally ZLD tanneries achieve 90 to 100% in effluent section.
c. Salt discharge score- As there is no salt discharge outside to environment, all ZLD tanneries achieve full score of 20 in question thus most ZLD tanneries achieve 90 to 100 marks in this section.
d. Fresh water usage- ZLD facilities recover 85-95% of the wastewater. The top-up requirement for fresh water is about 15-20% including for shop floor losses. Therefore, water consumption per tonne of rawhide or skin is very low. Also with ZLD being high in operational cost and more importantly, you need to demonstrate ZLD to regulatory agencies online through electromagnetic flow meters (raw effluent generated, recovered water produced), a host of water meters are installed in all section of shop floor and the ETP, resulting in every drop being counted and analysed. This results in drastic drop in water wastage and consumption and internal recycling. Best case have reported 9- 12 litres per Kg as against no ZLD units, which have as high as 50 to 100 litres per kg.

For Tanneries without ZLD, score much less on the above points

The Zero Discharge of Hazardous Chemicals (ZDHC): The ZDHC Roadmap to Zero Programme (ZDHC) is a collaboration of brands, value chain affiliates and associates committed to eliminating hazardous chemicals from the textile, apparel and footwear value chain. This alliance has come out with stringent guidelines in line with their customer expectations. The growing ZLD implementation has led to amendment of the ZDHC guidelines with recognition of ZLD recently, to achieve and exceed the ZDH Targets

VIII. Resource recovery (e.g. salts for dyeing/ nutrients for fertilizer).

IX. Help Industrial growth by avoiding conflicts. Help retain Jobs and manufacturing which otherwise is showing a shift towards lower income group countries.

3.2.6. Broad framework requirements for ZLD (based on stakeholder consultation workshop)

Following were the general questions posted during the stakeholder consultation workshop held on May, 14th, 2020.

1. What are the resource requirements to achieve our objectives of guidelines and standards for ZLD/ recycle & reuse?
2. What are the Gaps in the resources required?
3. Will ZLD, reuse and recycle reduce pollution of water bodies?
4. Should ZLD, recycle and reuse be made mandatory for all polluting Industries and water intensive industries or should it be selective?
5. What incentives would you seek from government to implement ZLD?

The discussion and feedback were received on the following aspects and are presented with some additional comments.

I. Definition and standards for ZLD needs to be specified

Zero Liquid discharge refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation (Ref. CPCB – Guidelines for Techno-economic feasibility of implementation of Zero Liquid Discharge (ZLD) for water polluting industries, Draft Jan 2015).

ZLD parameters to be monitored as per the definition are:

a. Water consumption versus waste water re-used or recycled (permeate)
b. Corresponding solids recovered (percent total dissolved / suspended solids in effluents).

However, the above definition does not include recovery and reuse of salts (or nutrients) like NaCl, Na_2SO_4 as already in practice.

II. Standards and guidelines for disposal of waste mixed salts, recovery and reuse of salts from ZLD systems

The issue of disposal of waste mixed salts also needs to be addressed, as some SPCBs do not permit disposal of mixed waste salt to TSDF facility. Storage and disposal of the salts is a challenge as salts are hygroscopic and corrosive. This therefore needs to be addressed.

ZLD is not defined in the EPA of India and so far, there is no notification from CPCB/ MoEF.

III. Uniform guidelines for ZLD and applicability across the country

While some industries feel that unequal application of law across the country for the same industrial sector, makes it unviable and shifts pollution. For example, ZLD in Tirupur may make the Textile Industry less competitive than other states in India or that of Bangladesh. Another example probably is the change in market share of the leather Tanning Industry from 70% share to less than 30% due to this stringent application of law, corresponding with growth in the same industry in several northern states in the country, which do not insist on ZLD.

The issue of shifting of Industry is also heard in China to other third world countries due increasing focus on water pollution including ZLD. The Hawasa Textile Park in Ethiopia has established ZLD facilities with investors from China and even Tirupur. This shift in polluting industries would also mean loss of manufacturing jobs within the country.

On the opposite end are industries, which do not want uniform application of ZLD across the country, citing reasons like no water shortage, possibility of marine discharge, scale of industry, domestic market and such. This needs to be studied in further detail.

IV. Techno-economic viability

Specific sectors or location specific exemptions need to be considered based on Techno-economic viability, or for marine discharge. A clear basis needs to be arrived.

V. ZLD for selected wastewater streams

ZLD for select wastewater stream (with high pollution load) instead of the entire wastewater can be considered (example high TDS stream in a Pharma or bleach plant effluent in Pulp & Paper). These need to be evaluated and sector specific guidelines can be made.

VI. Water conservation and waste minimisation

Water conservation and waste minimisation should precede ZLD, as this will reduce both the water to be treated and the pollution load. While this is true, it is observed that unless there is a significant push and legislation there is no significant change. The Charter for Corporate Environment responsibility Program (CCREP) of CPCB clearly specifies the specific water consumption to be targeted by various industries but it is not mandatory. The waste minimisation circles too are in place. However, with ZLD with significant costs and to stop discharge of effluent at all times, industry is seen to closely monitor water consumption and look at wastages much closely. For example the Textile Dyeing industry in Tirupur switched over from 1:16 Material Liquor ratio machines to 1:3.5 MLR, reducing water consumption significantly. The leather Tanneries in TN have exceed the CCREP the 28 .liters per Kg but the best case today is reported to be around 12 litres per Kg. The downside of water conservation is increase in pollution concentration, which is observed with increase in TDS, COD etc. TDS in Textile Dyeing CETPs with ZLD has increased from 6000 mg/l to 10000 mg/l. TDS in ZLD tanneryu CETPs have increased from 10000 mg/l to 20000 mg/l.

VII. Water reuse requirements

Water reuse requirements based on ground water availability based on Central Ground Water Authority (CGWA) guidelines need to be taken into consideration. For example in over-exploited zones as demarcated by CGWA.

VIII. Impact on policy for Tertiary treated sewage on ZLD

The proposed government policy for reuse of tertiary treated sewage needs to be incorporated with the proposed ZLD policy to understand its technical and financial impact. The top-up requirements of fresh water for ZLD is typically 15-20%, can this top-up water be also met with tertiary treated sewage? Will this be acceptable and viable needs to be studied?

IX. ZLD benefits

ZLD provides for long-term sustainability of the Industry due to consistent meeting of pollution discharge standards, stoppage of pollution completely, reduction in dependence on municipal of ground water or River water source due to high recovery of water. High quality of recovered water that improves production process, recovery of resources like salts is an additional benefit. These benefits need to be documented and possibly quantified.

X. Incentives

At present few incentives available to industry, that too only from the buyers/ brands. Government incentives can push ZLD implementation. The example of LWG and ZDHC is already explained in the previous section. Similar such cases needs to be documented. Possible government incentives also needs to be looked at.

XI. Fiscal support- grants, subsidies, loans etc. from state/central government and other agencies

At present Ministry of Textiles provides 50% grants towards ZLD CETP up to a ceiling limit of 75 crores under the Integrated Processing Development Scheme (IPDS). The earlier MoEF scheme for CETPs is not available any more. Ministry of Commerce under the Assistance to States for Infrastructure Development of Exports (ASIDE) scheme provides for CETPs including ZLD. However, there seems to be no funding support for individual ETPs/ industry. Therefore, there is a need for a clear need for fiscal support including grants from state and central governments.

XII. Financial Impact

The cost of ZLD along with cost of recovered water and any other resources on the finished product, needs to be studied to understand its viability. National and regional cost competitiveness with similar industries needs to be studied to understand the impact.

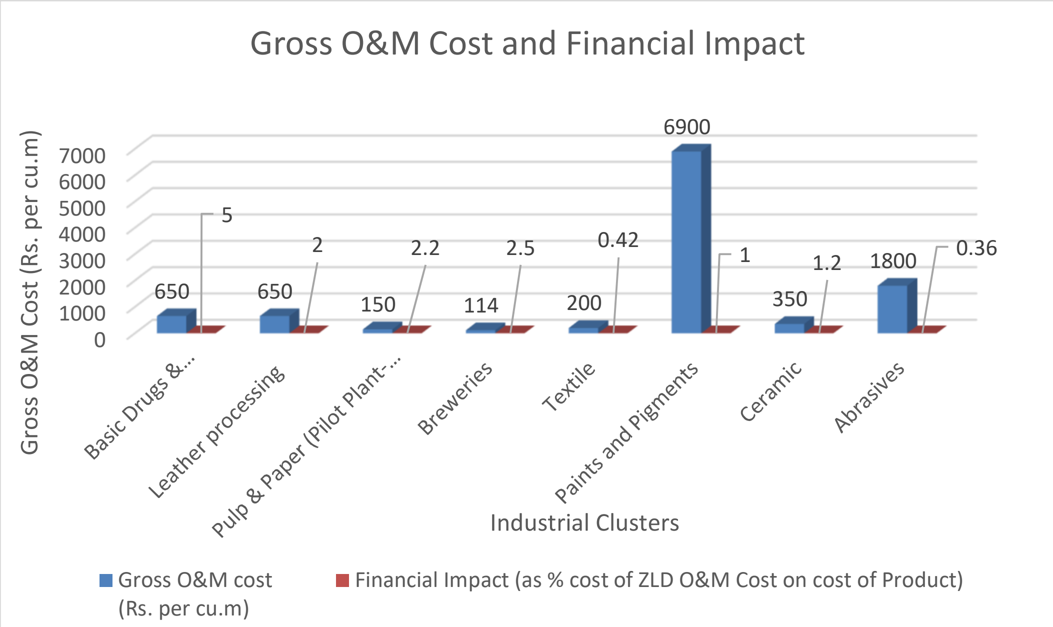
Gross O&M costs of ZLD Effluent Treatment Plants in few industrial sectors is furnished below:

Sl. No.	Cluster	Gross O&M cost (Rs. per cu.m)
1.	Basic Drugs & Pharmaceuticals	650
2.	Leather processing	650
3.	Pulp & Paper (Pilot Plant- Techno-commercial feasibility study)	150
4.	Breweries	114
5.	Textile	200
6.	Paints and Pigments	6900
7.	Ceramic	350
8.	Abrasives	1800

Financial Impact Product Cost / Finished Goods of HPI is furnished below

Sl. No.	Cluster	Financial Impact (as % cost of ZLD O&M Cost on cost of Product)
1.	Basic Drugs & Pharmaceuticals	5
2.	Leather processing	2
3.	Pulp & Paper (Pilot Plant- Techno-commercial feasibility study)	2.2
4.	Breweries	2.5
5.	Textile (for International Brand)	0.42
6.	Paints and Pigments	1
7.	Ceramic	1.2
8.	Abrasives	0.36

Figure 1: Gross O&M Cost and % Financial Impact of ZLD



XIII. ZLD Cost transfer across value chain in a sector

Policy on cost transfer of ZLD Costs from wet processing intermediate (polluter) to finished goods manufacture (the foreign exchange earner) and buyer. For example, the leather tanning is the polluting segment of the Leather goods manufacturing chain. However, most leather tanners are based on job-work where the raw material is given to them and they produced finished leather based on piece rates with low margins. The cost of ZLD on such tanneries can be as high as 24% on the cost of finished leather. The finished leather is then manufactured into shoes or garments by the leather goods manufacturer and the cost of ZLD on the finished product can be as low as 2%. The financial impact on processing / sale price of finished product has been worked for two Industrial clusters viz. Tannery and Textiles

Figure 2: Financial Impact on Leather Processing / Sale price of the finished Product

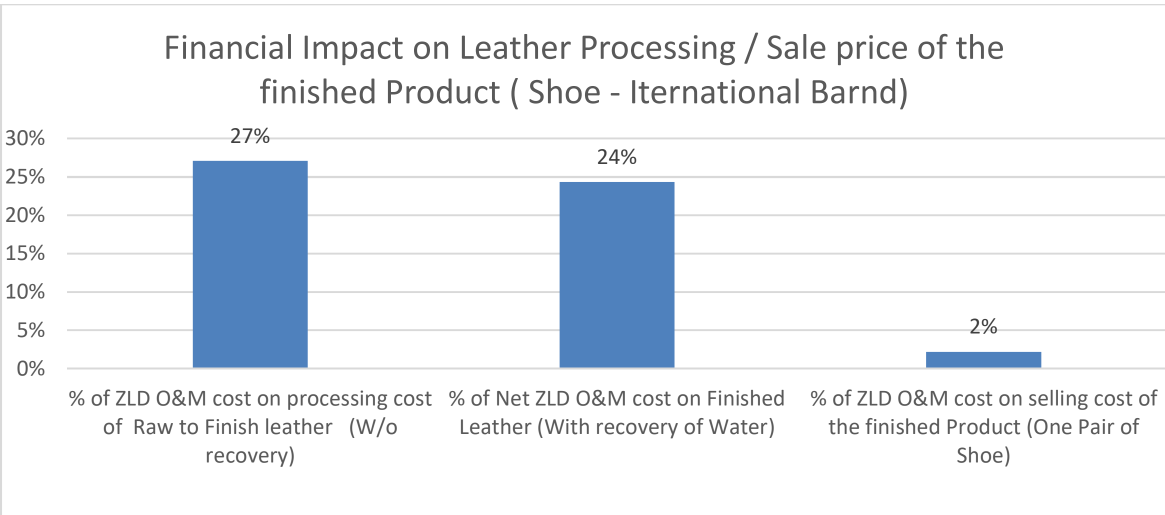
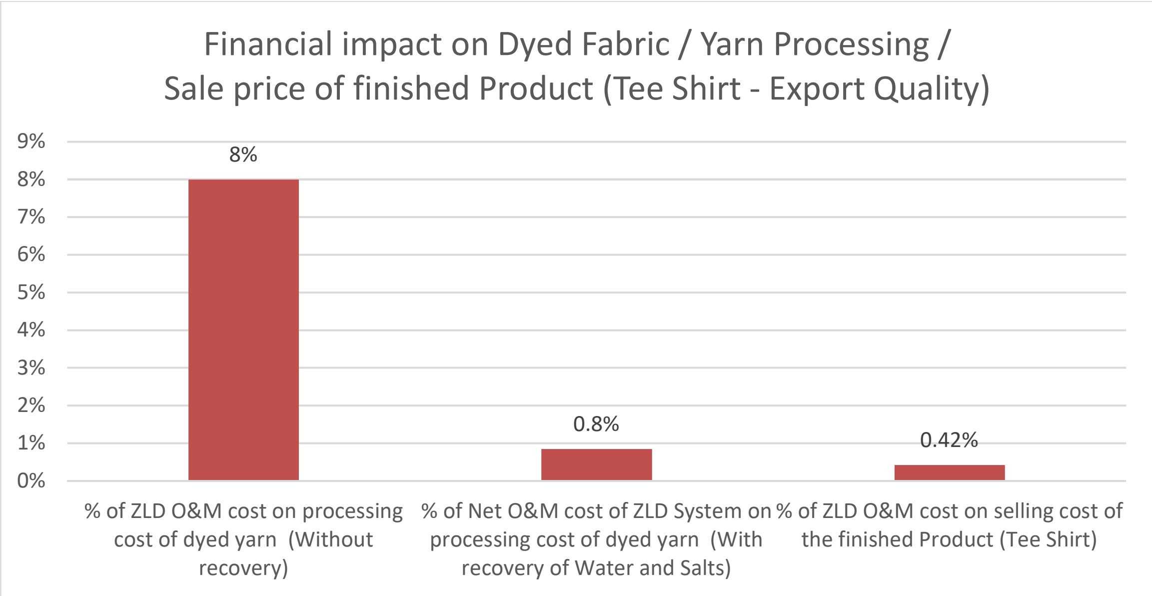


Figure 3: Financial Impact on dyed fabric / yarn processing / Sale price of finished Product



XIV. To address the issue of high carbon footprint and energy costs associated with ZLD systems

The carbon footprint is high in ZLD plants, mainly due to thermal evaporators and membrane processes. For example, typical power requirements for Textile Dyeing ZLD is in the range of ~ 0.5MW/ MLD as compared to say a sewage recycling plant which is at ~ 0.1 MW/ MLD or a desalination plant ~ 0.25/MLD This is the reason why future ZLD Plants should be installed with Captive Power Plants with cogen. To ensure reduced power and steam costs, resulting is reduction of operating costs of ZLD by almost 50%. The technology is also rapidly improving, like high pressure RO for reduction in volume of rejects for thermal evaporation (brine volume for a 120 bar High Pressure RO can produce 50% less brine than a 80 bar pressure RO) , Membrane distillation for management of rejects etc. have been piloted and will bring down the carbon foot print even more. ZLD can also be coupled with renewable energy including Solar Photovoltaic or solar thermal to reduce the carbon footprint. In any case, the recovery of water and salts will reduce the carbon footprint and make it more sustainable. The impact of this need to be studied in detail.

XV. Manpower resources- Training – for Design &Engineering, O&M, Monitoring Staff, need for Industry-institute linkage

There is a need for highly skilled ETPs / CETPs Designers and operators to support and maintain an increasing number of Industrial wastewater treatment facilities in India. ZLD systems are highly complex and need high expertise in designing, project management and O&M. Operator training and Grade certification for employees of industrial wastewater management and for providing employment to fresher's out of institutes and colleges. Industry- institute linkage can help bridge this vital need. Formalisation of certification and licensing would be required.

XVI. Technology/ BAT and Need for R&D

The Indian Industry has been facing ever-growing stringent environmental regulations such as Zero Liquid Discharge (ZLD) for highly polluting Industries in order to protect lakes and rivers. Environmental degradation has led to severe public pressure and demand for stringent regulations, which the authorities oblige by framing stringent standards. However, the stringent standards have not necessarily been backed or based on the concept of 'Best Available Technique or BAT'. The result is that most industries and Industrial clusters fail to achieve these standards leading to non-compliance of the regulations, resulting in litigation and closure.

The sequence of events then is as follows:

Environmental Pollution → Public Pressure → Regulation or Standards → Non-Compliance → Litigation/ Judgements/ Closure → Hurried Project Implementation → Technology Failure → Closure/Penalties → Technology up-gradation/ R&D on Industrial Scale → Compliance (after long delays and at much higher cost to Industry, Govt. & Public).

The more preferred route and that employed in most developed nations is as follows:

R&D → Best Available Technology (BAT) → Regulations/ Standards → compliance.

Although several Technical Universities and research Labs work in the field of water and wastewater, they basically do high quality fundamental research which takes considerable time to find an application in the real world. Moreover, these scientists find difficulties in up-scaling and technology demonstration. Therefore, there is a clear need for Institute- Industry linkage for R&D and development of BAT.

3.3. Scoping of the framework to be developed for recycle / reuse / ZLD of treated wastewater

The scoping is for generating an outline for the development of framework for recycle, reuse and zero liquid discharge of sewage and treated industrial wastewater in India, which involves Collecting Information, Making Decisions, and achieving Development. It is based on the results of the needs assessment.

Table 1: The Scoping of activities and contents for developing the framework

Sl. No.	Scoping Level	Activities / Contents
1.	**Strategic Level:** Objectives and strategic policies	Data mapping: i. Collection of Data from SPCBs on industries practicing ZLD, Recycle and Reuse ii. Conducting field survey with questionnaires to Industries. iii. Preparation of list of Industrial sectors which have implemented ZLD, Recycle and Reuse. iv. Preparation of case studies challenges faced by the Industries for compliance to Regulatory requirements
		Addressing Necessity for recycle, reuse and Zero Liquid Discharge (ZLD) with respect to: i. Regulatory requirements - CPCB / SPCBs directions/ Stakeholders / Local Bodies / River development etc., ii. Current EPA discharge standards and compliance issues iii. Legal conflicts / litigation related to pollution / NGT / Court Orders iv. Water Scarcity and compliance with CGWA rules for Over Exploited Zones. v. Compliance with Buyers/ Customer/ brand requirements

Sl. No.	Scoping Level	Activities / Contents
		vi. Preparation of broad framework and strategic policy for ZLD based on case study, Stakeholders consultation workshop, ZLD benefits, Impact on policy for Tertiary treated sewage on ZLD, Techno-economic viability and Financial Impact and addressing the issue of high carbon footprint and energy costs associated with ZLD systems and further requirements
2.	**<u>Development Level:</u>** Developing legal framework to support Strategic Level and implementation levels	**<u>Developing legal framework for the followings:</u>** i. Standards for recycle, reuse and ZLD needs ii. Standards and guidelines for disposal of waste mixed salts, recovery and reuse of salts from ZLD systems iii. Uniform guidelines for ZLD and applicability across the country iv. ZLD for selected wastewater stream v. Water conservation and waste minimisation vi. Water reuse requirements vii. Incentives, Fiscal support- grants, subsidies, loans etc., from state/central government and other agencies. viii. ZLD Cost transfer across value chain in a sector. ix. Need for R&D x. Manpower resource training
3.	**<u>Implementation Level:</u>** Short and long term activities for implementation and achieving results	**<u>Short term:</u>** i. Developing Technology / BAT and setting-up of for R&D facilities ii. Technology demonstration / piloting. iii. Manpower resources- Training – for Design & Engineering, O&M, Monitoring Staff, need for Industry- institute linkage **<u>Long Term:</u>** iv. Implementation ZLD based on new Policies, Procedures and guidelines with provision of Incentives, Fiscal support- grants, subsidies, loans. v. Monitoring Water conservation, waste minimization, Water Reuse and ZLD Cost transfer across value chain in a sector

3.4. Good case examples

The demonstration of ZLD technique at industrial scale has been explained through two case studies. The case studies proof the applicability of this advanced technique with respect to water recycling. However, the second case example does not cover the evaporation of the concentrate.

The three good case examples is to explain the processes where wastewater is generated, the composition of mixed wastewater and the sequence of techniques to treat the wastewater, its recycling at a percentage of more than 90 % and the issue of disposal of the final evaporation residue. The approach of the third example is to explain the end-of-pipe ZLD plant process.

3.4.1. Case Study 1:

I. General Information

The company at that site belongs to a bigger one, which is an integrated textile company doing spinning from cotton, which is mainly sourced from India, and knitting. Then, finishing is carried out at the company. Not far from the site, there is another site where printing is carried out. The operation of this site started in 2015. About 70 people work there. Finally, the integrated company is doing final garment making and is selling the pieces to C&A, CAbi and other companies.

The site manager told that most of the numerous textile-finishing plants in Tirupur closed and were shifted to other places around Tirupur.

The company is certified according to GOTS and Organic Cotton Standard (OCS) as well as to ISO 9001, 14001 and 18001.

It is interesting to note that the company has installed a considerable number of solar panels on the roof of the factory (see **Error! Reference source not found.**) but also on the ground next door. The capacity is 1 MW. In addition, at another place, the company has invested in a wind turbine with a capacity of 1.34 MW.

1) Information on production

The plant went into operation in 2007, i.e. 10 years ago. About 270 people are working there in three shifts. The plant operates 2 weeks in a series and then stops for two days for maintenance. Thus, there are about 300 working days.

About 10 tonnes of knitwear is finished. The substrate is knitwear exclusively consisting of 100 % cotton (about 50 %) and cotton/lycra blends (about 50 %). In case of blends, the lycra percentage of the knitwear is about 6-8 %.

The company claims that the first-right-time percentage is 96 % and tells that this is due to automated processes. The low water consumption is due to the low liquor ratio (1:6) and the minimized number of baths, which are usually 10 as follows:

1. Scouring and bleaching in one bath but in a sequence (bleaching only in case of full-white quality),
2. 80°C wash,
3. Neutralisation and addition of “H_2O_2 killer”(catalase),
4. Dyebath (reactive dyes, Na_2SO_4, Na_2CO_3, NaOH) at pH 10.2-10.5 at 60°C,
5. First rinse,
6. Cold wash,
7. Neutralisation,
8. Hard wash at 80°C,
9. Soaping at 90°C,
10. Cold wash.

II. Wastewater generation

The wastewater treatment plant is very impressive and it really seems to work. The company invests a lot of efforts in properly operating it. The most important driver is the non-availability of water. The company does not have own wells and says that there is no groundwater available. Thus, in order to keep the production running, the company has to recycle the water.

It is interesting to note that in 2011 the company established a facility to evaporate RO concentrates which consisted of a huge rack out of wood pieces over which the concentrate was falling down to further evaporate. The managing director has seen this technique in Germany where it is used to generate salty aerosols in a clinic to treat longue diseases. There was an article in "The Hindu" from R. Vimal Kumar in 2011.

According to the design, 670 m^3/d are needed for wet processing. In addition, the afore-mentioned losses have to be compensated (163 m^3/d) and 50 m^3/d are needed for the boiler house. Thus, in total, the total water demand is about 890 m^3/d (see following part of a scheme, the company provided. This scheme also shows the water flows of the different stages of the ZLD plant. In addition to the industrial water demand, about 40 m^3/d are required for domestic use.

III. ZLD plant

The concept of the ZLD plant is to collect all wastewater streams and to mix them in an equalisation tank. After neutralisation, most of the organic compounds are removed by biodegradation in an activated sludge system operated at low food-to-microorganism ratio. Then, residual colour is removed by using elemental chlorine, which should be avoided as organochlorine compounds are formed as by-products. Subsequently, after clarification, residual suspended solids are removed in a sand filter. After that, the recovery of water starts. First colloidal compounds and very small suspended solids are removed in a microfiltration and ultrafiltration unit followed by a three-stage RO plant. The RO permeates are recovered. The concentrate is evaporated in two stages with recovery of sodium sulphate between the two stages. Finally, the concentrate is concentrated to dry matter that is disposed under roof onsite.

Between the multiple effect evaporator and the final flash dryer, sodium salt is recovered by reducing the temperature of the concentrate down to about 15°C.

The dried concentrate is the final residue that is stored under roof onsite. The final disposal of the evaporation residue is still not solved. Different options such as facilities that keep the residues under roof, to oxidise the organic compounds of the salty residue and to reuse the salt, or to dispose in the sea.

The investment costs are not available yet. The operating costs are about 3 US$/$m^3$.

3.5. Case Study 2:

I. General Information

The company is placed in Karachi, South of Pakistan. The own bore wells for water supply fell dry and public water supply is unstable. Consequently, the company had to decide whether to leave the site or to invest in reliable water recycling with high availability. The company did not leave Karachi but invested in a wastewater treatment plant enabling high recycling rates of about 90 % and more.

The company finishes woven fabric mainly consisting of cotton and cotton/polyester blends by means of continuous pre-treatment (desizing, scouring, bleaching, mercerisation), continuous dyeing with mainly reactive and disperse dyestuffs, rotary printing mainly with reactive and disperse dyestuffs, i.e. the fabric is washed after printing, and final finishing on stenters. Due to advanced minimization of specific water consumption (around 60 L/kg), the wastewater has high concentrations of organic compounds (average COD of about 3200 mg/L

II. Wastewater generation and its treatment to more than 90 % recycling

The wastewater is collected on site. After central heat exchange to recover heat, the wastewater is neutralized by flue gases from the boiler house that is a common technique in Europe but not in Asia yet. Then, coarse fibres are removed by means of a sieve. Finally, the so pre-treated wastewater is pumped to a plant at about 2 km distance, as there was no land available directly at the production site. The recycled water (more than 90 %) is pumped back to the wet processing unit and can be used for any purpose without limitations.

The concentrate from reverse osmosis is still discharged to the sewer system without treatment. However, the step may be taken to go for zero discharge by evaporating the concentrate from final RO stage. This means that the plant has the typical design of a ZLD plant but the last stage (evaporation) still needs to be installed.

It is important to note that this plant is equipped with a membrane bioreactor (MBR). The activated sludge system is operated at low food-to-microorganism ratio (about 0.1 – 0.2 kg BOD_5/kg MLSS x d) and high MLSS concentration (average 7 g MLSS/l – see Table 1). **Error! Reference source not found.** shows the activated sludge and the external ultrafiltration unit for separating the biomass from water. Due to the ultrafiltration unit (UF), the permeate can be directly pumped to the 3-stage RO plant. However, fine particles filter are placed just before the reverse osmosis (RO)

3.6. Case Study 3:

I. General information

So-called ZLD plants have been devolved in the region of Tirupur (South of India in the federal state Tamilnadu) due to excessive pollution of the local Noyyal River, groundwater and soil with inorganic and organic chemical compounds because of the discharge of insufficiently treated wastewater from about 800 textile wet processing units mainly finishing cotton knitwear using high amounts of neutral salt for reactive exhaust dyeing. Several Supreme Court decisions forced the industry to develop the ZLD technique (Grönwall/Jonsson, 2017 a and b). The Supreme Court also directed the removal of neutral salts as they heavily polluted groundwater and agricultural land. In practice, this can only be achieved by ZLD and thus, this approach was developed. A number of obstacles and technical failures had to be overcome, so that the development required many years.

II. ZLD plant

The sequence of treatment operations is illustrated in Figure 18. The wastewater is neutralised and collected in an equalization tank. In the activated sludge system with a low ratio of food to microorganisms with fine bubble aeration from the bottom, most of the organic compounds are degraded and recalcitrant compounds with elevated octanol/water partition coefficient adsorb to activated sludge matrix to a considerable extent. After this most important sink of organic compounds, residual dyestuffs are oxidized, at least partly. Subsequently, remaining suspended solids are removed in a quartz filter, and colloid compounds in an UF unit. After a softener filter, the wastewater is treated in a four-stage RO unit. The concentrate from the last RO stage is first evaporated mechanical vapor recompression evaporator (MVR-E) and then in a multiple effect operator. Finally, the concentrate is cooled down to precipitate sodium sulphate (Glauber Salt) and again evaporated in a forced circulation evaporator (FCE) and an agitated thin film dryer (ATFD) to dry residue which is stored under roof as there is no final adequate disposal route available yet.

The concentrate from reverse osmosis is evaporated combined with recovery and treatment of neutral salt solution (brine) which is pumped back to the textile finishing industries (dye houses); the same is true for the permeate from reverse osmosis to be re-used for any textile wet process. The total energy consumption is 28 kWh/m^3, about 10 khW/m^3 for electricity and 18 kWh/m^3 for steam generation from fossil fuels (Hussain et al, 2018).

More technical details can be provided on the basis of publications of Sajid Hussain (e.g. Hussain, 2018).

The energy consumption is considerable and, mainly due to the evaporation processes, about factor 30 higher compared to a conventional activated sludge process. Consequently, the costs are much higher and are in the range of 2 - 3 US$/m^3.

4. Objectives of the guidelines their applicability to specific sectors and environmental and economic situations

It is proposed that the Guidelines on ZLD instead of a blanket application across all sectors, provides a basis for applicability of the proposed ZLD standards based on certain specific criteria. To arrive at the criteria, it is good to understand the rationale, of the regulatory agencies at the centre and states, in pursuing ZLD until now.

I. Approach of CPCB:

India's principal regulatory agency, the CPCB in its January 2015 report on Guidelines for Techno-economic feasibility of implementation of Zero Liquid Discharge (ZLD) for water polluting industries clearly mentions the necessity for ZLD as "After having recognition of problems that many industrial sectors are not able to achieve standards and this ultimately necessitates to work towards Zero Liquid / effluent discharge standard"

Water polluting industries (GPI), are mainly of industries discharging effluents having BOD load of 100kg/day and/ or having toxic / hazardous chemicals. The industries identified as water polluting industries are: - Sugar, Distilleries, Pulp and Paper, Tanneries, Chemicals, Dyeing and Textiles, Refineries, Food, Dairy and Beverages, Electroplating and others. The water polluting industries discharge their effluent having high organic contents measured in-terms of bio-chemical oxygen demand (BOD), and other toxic constituents like metals, organic and in-organic compounds.

The report also mentions that "Standards for compliance have been notified under the Environment Protection Act, 1986. The notified standards permit industries to discharge the effluents only after compliance. However, CPCB and SPCBs / PCCs now, are insisting industries to reduce water consumption and also take measures to not-to-discharge effluents. But, it has been observed that industries are not able to meet all time compliance standards and as a result, rivers like Ganga and its tributaries is carrying high pollution load and it is the dilution available in river water which helps in minimizing pollution load"

The 168th meeting of the Central Board in March, 2015 and 59th Conference of Chairmen & Member Secretaries held in April, 2015 endorsed the requirement of adoption of Zero Liquid Discharge in heavily water consuming and water polluting sectors including distilleries and also agreed to the proposed standards.

CPCB has issued directions in March, 2015 under Section 18(1)(b) of Water (Prevention and Control of Pollution) Act, 1974 to Pollution Control Boards of five Ganga Basin states to further direct industries to achieve Zero liquid Discharge (ZLD) standards. They identified five industrial sectors are Pulp and paper, Distillery, Sugar, Textile and Tannery.

From the above references, it is clearly that CPCB approach towards ZLD has been to focus on **water intensive** and **water polluting industries**, particularly **to stop pollution of Rivers** in the country. So far 5 of the 18 category of **Highly Polluting Industries (HPI)** have been directed to achieve ZLD in the Ganga Basin states.

It is also to be noted that the draft standards for ZLD for the Textile sector brought out in January 2015 was not notified.

There is no notified standards on ZLD as on date.

II. Approach of SPCBs:

In response to the NGT case on 51 polluted river stretches (OA No.673 of 2018, NGT order dated 29/11/2019), in 1st Quarterly report submitted by NMCG of MoWR &CG, has summarised the findings of the status of measures taken by various states based on inspections done by a committee of NMCG, NRCD and CPCB officials. This report has been referred to arrive at the latest position. In the absence of direct response from SPCBs to our request to provide details on implementation of industries practicing recycle, reuse and ZLD lockdown period and our inability to visit industries during this and permission required from CPCB and SPCB, the approach of the SPCBs can be understood from this latest report dated 19th June 2020.

States which have reported ZLD implementation in industries as per the report are:

1. **Tamilnadu**- As per the MPR, no industrial discharge of effluent. The effluent generating industries are provided with individual ETP/STP/connected to CETP/CSTP. The treated effluent is utilized for process in case of ZLD/ others gardening/irrigation inside the unit premises. All polluting industries are under ZLD only.
2. **Maharashtra**, has reported that industries are operating under ZLD condition and no industry is allowed to discharge to treated/untreated effluents to the River. In order to maintain a safe distance between industrial units and rivers to avoid discharge of effluent into water bodies, the State has its policy which also states that no industry will be allowed to establish along a river bank.
3. **Odisha**- 12/22 industries have already adopted ZLD. 3 industries have been directed to adopt ZLD and the remaining 7 are discharging to River or sea after achieving applicable standards.
4. **Uttarakhand-** 2 GPIs are reported to have adopted ZLD
5. **Kerala-** M/s Travancore Titanium Products ltd (TTPL) is reported as ZLD but discharging its treated effluent to sea.
6. **Punjab-** 3 CETPs of 5.55 MLD capacity are ZLD and 10 Electroplating industries are ZLD

Following states have policy for recycle and reuse of treated effluent

1. Haryana	2. Gujarat
3. Maharashtra	4. Tamilnadu
5. Uttar Pradesh	6. Rajasthan
7. Chhattisgarh	8. Karnataka
9. Madhya Pradesh	

It is clear that despite the absence of ZLD standards under the EPA some of the states have directed to the industry to adopt ZLD, with Tamilnadu taking the lead in enforcing it for all polluting industries. Focus is on protection of Rivers from the effluent discharge.

4.1. Definitions

ZLD:

Zero Liquid discharge refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation. ZLD will be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents). Source: Guidelines on Techno – Economic Feasibility of Implementation of Zero Liquid Discharge (ZLD) for water polluting Industries, CPCB, Jan 2015

GPI – Grossly Polluting Industries:

GPI are specified as Industries discharge effluent into a water course and (a) handling hazardous substance, or (b) effluent BOD load of 100 kg per day or more, or (c) a combination of (a) and (b).

HPI- Highly polluting industries, which are:

1. Pulp & Paper,
2. Distillery,
3. Sugar,
4. Leather Tanneries,
5. Thermal Power Plants,
6. Iron & Steel,
7. Cement,
8. Oil Refineries,
9. Fertilizer,
10. Chlor-Alkali Plants,
11. Dye & Dye Intermediate Units,
12. Pesticides,
13. Zinc smelting
14. Copper smelting
15. Aluminum smelting,
16. Petrochemicals
17. Pharma Sector
18. Sulphuric Acid

SPI – Seriously Polluting Industries as approved by Principal Committee constituted by NGT vide Original Application No. 196 of 204 & Ors. Dated 17.11.2014

1. Distillery including Fermentation Industry
2. Sugar
3. Tannery
4. Pulp & Paper (Paper manufacturing with or without pulping)
5. Slaughter houses and meat processing industries
6. Dyes and Dye Intermediates
7. Yarn and Textile processing involving bleaching, dyeing, printing and scouring etc.,
8. Thermal Power Plants
9. Milk processing and dairy products
10. Pesticides (Technical) (excluding Formulation)
11. Pharmaceuticals (excluding Formulation)
12. Petrochemicals (Manufacture of and not merely use of raw material)
13. Aluminum Smelter
14. Chlor Alkali
15. Organic Chemicals manufacturing
16. Synthetic fibre including rayon, tyre cord, polyester filament yarn
17. Industry or process involving metal treatment or process such as pickling / electroplating/phosphating/anodizing/galvanizing etc.,
18. Manufacturing of Pints, Varnishes, Pigments and intermediate (excluding blending / mixing)
19. Automobiles Manufacturing (Integrated facilities)
20. Coal Washers
21. Copper Smelter
22. Oil Refinery (Mineral oil or Petro refineries)

23. Heavy Engineering including ship building (with investment on Plant & Machineries more than 10 crores)
24. Hydrocyanic acid and its derivatives
25. Manufacturing of Lubricating oils, greases of petroleum based products
26. Coke making, liquefaction, coal tar distillation or fuel gas making
27. Zinc Smelter
28. Chlorine, Fluorine, bromine, iodine and their compounds
29. Chlorates, perchlorates and peroxides
30. Basic Chemicals and electro chemicals and its derivatives including manufacture of acids
31. Food & Beverages (Alcoholic and non – alcoholic)
32. Photographic films and chemicals
33. Industrial carbon including electrodes and graphite blocks, activate carbon, carbon black.

Source: CPCB letter to MoEF & CC, dated 29.02.2016

Water Intensive Industries

The following different industries category has been listed as Water Intensive Industries:

1. Packaged drinking water
2. Mineral water plant
3. Tannery
4. Distillery
5. Brewery
6. Soft drink
7. Paper & pulp
8. Fertilizer
9. Textile Dyeing
10. Textile Printing
11. Textile spinning
12. Sugar
13. Dairy Product
14. Water park & amusement Centre

Source: Central Ground Water Authority Guidelines / Criteria for evaluation of proposals /requests for ground water abstraction (with effect from 16.11.2015)

5. Applicability of these guidelines to sectors and situation

5.1. Ensuring the guidelines are consistent with Indian law

I. Compliance to EPA standards as per the Environment (Protection) Act, 1986 (EPA)

This Act is an umbrella legislation designed to provide a framework for the co-ordination of central and state authorities established under the Water (Prevention and Control) Act, 1974 and Air (Prevention and Control) Act, 1981. Under this Act, the central government is empowered to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time the central government issues notifications under the EPA for the protection of ecologically-sensitive areas or issues guidelines for matters under the EPA.

As stated in this report earlier; CPCB's report on the Guidelines for Techno-economic feasibility of implementation of Zero Liquid Discharge (ZLD) recognises the problems that many industrial sectors are not able to achieve standards and this ultimately necessitates to work towards Zero Liquid / effluent discharge standard. The penalty for non-compliance of the EPA standards for discharge of treated wastewater can ultimately result in revocation of the 'consent-to-operate' and ultimately closure of the industry.

II. The Environment (Protection) Rules, 1986

These rules lay down the procedures for setting standards of emission or discharge of environmental pollutants. The Rules prescribe the parameters for the Central Government, under which it can issue orders of prohibition and restrictions on the location and operation of industries in different areas. Directions for ZLD or restrictions with respect to discharge can be notified by the government under these existing rules.

However, so far there has been no notification on ZLD. However draft standards have been issued for Textile dyeing and .distilleries which was however not notified (refer Annexure I).These draft were based on amendment to the Environment Protection rules, 1986 and amendment of the discharge standards therein.

III. Directions to state pollution control boards

CPCB can issue directions under section 18 (1) (b) of the Water (Prevention & control of Pollution) Act 1974 and has done so in the past for example for ZLD for select industries in the Ganga basin states (CPCB directions dated Feb 24th, /2014) which was later relaxed

IV. SPCB can make stringent provisions

The SPCBs/ PCC can stipulate more stringent standards for discharge of environmental pollution from various categories of industries than those notified by the central government, under the Environment (Protection) Act 1986 and rules framed there under.

Examples:

i. Andhra Pradesh state issued Permanent Ban on Establishment/ Expansion of certain polluting industries in Medak, Ranga Reddy, Mahaboobnagar & Nalgonda District vide G.o.Ms.No.9S dated 21-Aug.-2007 for certain polluting industries. This was later amended stating that "Provided that the expansion of production of all types of existing Bulk Drug and Bulk Drug Intermediate manufacturing units are permitted, subject to the installation of Zero Liquid Discharge (ZLD) facilities by such units" vide G.O.Ms.No.64 dated 25-07-2013.
ii. Tamilnadu state pollution control Board (TNPCB) has issue directions for ZLD to polluting industries.

V. Central Ground Water Authority guidelines and its impact on recycling and reuse of treated wastewater by industries

As per Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction with effect from 16.11.2015 by Central Ground Water Authority, Ministry of Water Resources, RD & GR of GoI,, the following criteria for Industries/Infrastructure/Mining Projects has been set for obtaining NOC for Ground Water withdrawal in India:

Category	**Mandatory Recycle/Reuse (for various purposes except recharge to ground water)**	**Withdrawal permitted (% of proposed recharge)**
Safe	Major and Medium Industries to recycle and reuse at least 40% of the waste water	NOC is required for ground water withdrawal subject to adoption of artificial recharge to ground water.
Semi- critical	Major and Medium Industries to recycle and reuse at least 50% of the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge* measures. The withdrawal should not exceed 200% of the recharged quantity.
Critical	Major and Medium industries should fully recycle and reuse the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge* measures. The withdrawal should not exceed 100% of the recharged quantity.
Over- exploited	All Industries to fully recycle and reuse the waste water	Withdrawal may be permitted subject to undertaking of ground water recharge* measures. The withdrawal should not exceed 50% of the recharged quantity.

*The recharge should be implemented within the premises and/or same water shed/assessment unit. However, industries using ground water as raw material/water intensive industries shall not be granted NOC for ground water withdrawal in Over-Exploited areas. In Safe, Semi-Critical & Critical areas NOC for ground water withdrawal is mandatory for these industries subject to the following conditions:

Category	Ground Water Withdrawal Limit
Safe	Withdrawal limited to 200% of ground water recharge.
Semi- Critical	Withdrawal limited to 100% of ground water recharge.
Critical	Withdrawal limited to 50% of ground water recharge.
Over- Exploited	No permission for Industries under this category.

As per the guideline to regulate and control Ground Water Extraction in India with effect from 01.06.2019

The Industries which are likely to cause ground water pollution e.g. Tanning, Slaughter Houses, Dye, Chemical/ Petrochemical, Coal washers, other hazardous units etc., need to undertake following measures to ensure prevention of ground water pollution:

i) The industries/ projects under this category should not implement any recharge measures within the plant premises.
ii) Any tube well/ bore well located/ constructed in the vicinity of Sewage Treatment Plant or Effluent Treatment Plant should be abandoned and filled back.
iii) The piezometer to be constructed for monitoring purpose should follow the same procedure as that for tube well/bore well for such industries/ projects.

As per NGT order dated 13th July, 2017 in OA No. 200/2014, the ground water user should pay Water Conservation Fee (WCF), which is based on quantum of ground water extraction. The Rate of Water Conservation Fee shall vary depending upon category of area i.e (i) Safe, (ii) Semi Critical, (iii) Critical & (iv) Over exploited and volume of ground water extraction. The levy of WCF is varying from Rs. 3.00 to Rs. 100.00 cu.m per day.

VI. River discharge and restrictions in location of industry

Two example of restrictions on industry near the river are cited here:

a) Restrictions for setting up polluting industries near Rivers in the state of Tamilnadu

E&F Department, Govt. of Tamilnadu has issued direction through G.O. No. 213 dated 30.03.1989 and 127 dated 08.05.1998 to restrict new establishment of highly polluting / Red Category industries, like the Bleaching & dyeing industries, within a radius of 1 Km from any of the water bodies & 5 Kms from the embankments of rivers, streams, dams etc.,

b) MoWR notification for Ganga

The MoWR has issued a Notification dated 7th October, 2016 where it, has been stated that no person shall discharge any treated or untreated sewage into river Ganga, its tributaries or on its bank, directly or indirectly. However, the Notification issued by MoEF&CC dated 10th October, 2016, provides that the treated effluent as well as sewage could be discharged into the water bodies provided it satisfies prescribed standards.

VII. Water Reuse Policy adopted in India and few other States

Ministry of Power, Govt. of India has revised tariff policy on January 28, 2016 to mandate reuse of wastewater in the thermal power plants including the existing plants located within 50 km radius of sewage treatment plant of any municipality / local bodies / similar organization.

Rajasthan State has issued a Policy on “Reuse of Treated Effluent and Sludge Rajasthan in the Year 2016, in which, it was stated that reclaimed wastewater is ideal for many industrial purposes. Where effluent is to be used in the industrial processes, it should be the responsibility of the industry to treat it to the quality standards required

Industrial uses for reclaimed water include (i) Evaporative cooling water (ii) Boiler –Feed water. (iii) Industrial process water in industrial process depends upon particular use like Pulp and paper, Chemical industry, Textile industry, Petroleum and coal whenever possible, other end uses of treated effluents; such as recycling, cooling, power generation, etc. shall be also considered.

Urban administration & Development Department, Govt. of Chhattisgarh had issued Wastewater reuse and recycle policy to formulate effective policies and action plans for the planning and management of 'Onsite Water Reuse Policy' to reduce using of fresh water by the core and water intensive Industries viz. Steel Plants, Power Plants & Cements Industries etc., from perennials and good water sources and putting stress on the source of water for portable requirements.

Urban Development Department, Government of Uttar Pradesh has made mandatory for UPSIDC to use Treated wastewater of Local bodies, for every industry which is consuming 1 lacs or more fresh water for their non-potable use to reuse treated waste water situated within 20 km premises.

Government of Tamilnadu has also issued a draft policy on 29.11.2019 for development of extensive treated wastewater use grids which can serve to provide treated wastewater as a reliable, sustainable and an additional water resource to various stakeholders viz. Industrial, Commercial, Agricultural and domestic (by ground water recharge / surface water augmentation) end users.

Govt. of Maharashtra has made regulation called "Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019" for setting the Targets for efficient use of fresh water Entitlements and Recycle and Reuse of the treated water generated by the Water User Entities in all sectors including Industries.

Other states viz. Karnataka, Madhya Pradesh, Gujarat, Maharashtra are also adopted the Reuse of Treated Wastewater Policy.

VIII. NGT/ Court Judgements

Five recent judgement are worth referring to here:

a) TNPCB directions for ZLD for Textile dyeing and bleaching industry is based on the Hon'ble High Court directions.

As per the Court order W.P.M.P.No.811 of 2008 in W.P.No.29791 of 2003, is directed as under:

The CETPs are given time up to the 31st of July, 2007 to achieve the Zero Liquid Discharge (ZLD) of trade effluents subject to the following conditions:

i. The concerned CETPs are directed to pay a fine on pro rata basis at the rate of six paise per litre from 1st January, 2007 to 31st March, 2007; at the rate if eight paise per litre from 1st April, 2007 to 31st May, 2007; and at the rate of ten paise per litre from 1st June, 2007 to 31st July, 2007. The fine amount payable by the respective CETPs shall be arrived at by multiplying the fine amount i.e., six, eight or ten paise, as the case may be, by the total quantity of discharge of each Member units of CETP as per the consent certificate or as the quantity found in the application for consent and also by the total number of working days in a month. The fine amount thus calculated shall be paid by the respective CETPs on the last date of every month. In case the CETPs or any of them commit any default in payment of fine, the Pollution Control Board shall direct closure of such defaulting C.E.T.P and the Member Units and also disconnect the power supply to such defaulting CETP and the Member Units.
ii. The CETPs or any of them on achieving Zero Liquid Discharge shall satisfy the Pollution Control Board about their ZLD status and the Pollution Control Board upon verification shall issue appropriate certificate from which date, such CETP shall not be liable to pay the fine. In any event, if the CETPs or any of them fail to achieve the ZLD on or before 31st July, 2007, the Pollution Control Board shall forthwith direct closure of such CETPs and the Member units and also disconnect the power supply to such defaulting CETP and the Member Units.

iii. As per the Contempt Petition 1013 of 2010 & 1068 of 2010, the following directions were issued:
iv. All the CETPs/ IETPs Bleaching & Dyeing units in Tirupur area shall be closed down forthwith by the Pollution Control Board and the Electricity supply shall be disconnected.
v. Such CETPs/ IETPs/ Units shall not be permitted to operate unless and until they achieve Zero Liquid Discharge as per the directions issued paragraph No.30(a) (ii) of the order of the Division Bench dated 22.12.2006;
vi. All CETPs/ IETPs/ Units shall be individually inspected by a team of officers nominated by the Tamilnadu Pollution Control Board along with the members of the Monitoring Committee and a detailed report shall be prepared individually for each CETPs/ IEPTs/ Units;
vii. The report shall be the sole basis to assess as to whether the CETPs/ IETPs/ Units should be granted permission to commence operations;
viii. If the CETPs/ IETPs/ Units are deficient or have not achieved the required parameters, they shall not operate and be directed to rectify the deficiencies and report to the Pollution Control Board for fresh inspection by the team of officers of the Board and the Monitoring Committee;
ix. In respect of the CETPs/ IETPs/ Units, who have fulfilled all the conditions, it would be open to the Tamilnadu Pollution Control Board to issue orders of consent to operate such units shall be continuously and closely monitored in order to ensure strict compliance of the orders;
x. For the purpose of trial run for testing the efficiency of the equipments, the Pollution Control Board is entitled to issue temporary authorisation to the Electricity Board for temporary electric supply. While such testing operations are being carried out it shall be done in the presence of an official of the Tamilnadu Pollution Control Board;
xi. During the course of inspection of these CETPs/ Units, if any extra machinery has been found to be installed or any pipelines have been laid, they shall be forthwith removed and such units shall be directed to remove those additional machinery from precincts of the factory premises.
xii. Division Bench granted time to the units till 31.07.2007, failing which directed closure. This portion of the order was stayed by the Supreme Court and the stay remained in force till 06.10.2009. The Supreme Court did not interfere with a direction passed by the Division Bench and granted extension of time to comply with the condition by three months, this extended period came to an end in January, 2010. Such of those units, who have failed to comply with the directions of the Division Bench, inspite of the extension of time granted by the Supreme Court shall be liable to pay fine at the rates fixed in paragraph 30(a)(i) of the order passed by the Division Bench dated 22.12.2006
xiii. As against the CETPs/ IETPs/ Units which have flouted the order and direction issued by this Court and conditions stipulated by the Tamilnadu Pollution Control Board and continued to cause pollution and failed to rectify the defects despite the show cause notice issued by the Board, the Board shall initiate the criminal prosecution against such CETPs/ IETPs/ Units.
xiv. The Board shall also furnish the list of names of the /officers of the Pollution Control Board who were in charge of the affairs of the Board during the relevant time when those CETPs/ IETPs/ Units filed to comply with the orders of this Court and the directions issued by the Pollution Control Board so that appropriate actions may also be taken against them.

b) Honourable Supreme Court of India Order and Writ Petition (C) no.375 of 2012 dated 22.2.2017 stating that that while acquiring land for the 'common effluent treatment plants', the concerned State Governments (including, the concerned Union Territories) will acquire such additional land, as may be required for setting up “zero liquid discharge plants”, if and when required in the future”

c) The NGT judgement on River Ganga pollution

Hon’ble NGT has given a verdict on 13th July, 2017 **in the matter of O.A. No. 200 of 2017 (C. Writ Petition No. 3727/1985, M.C. Mehta v/s Union of India and others)** regarding River Ganga pollution, where in, it was stated that ZLD cannot be adopted across the board. It must have rationality as its sole criteria, should be unit centric and industries specific. The Board in its advisory capacity may be able to suggest or guide as to the appropriate technology, which may be feasible for the industries for attaining the prescribed norms. To impose ZLD on such industries would neither be fair nor just. In fact, it will not be in consonance with the requirement of law under relevant Acts. The Board must take into consideration of the aspects including technology, financial viability, limitations of the unit, process adopted by the industries but in all events ensuring that the discharge of effluents from the unit has to be strictly in compliance with the prescribed standards. Effluent discharge must be strictly within the prescribed norms and the Board in appropriate cases could issue directions with regard to recycle, reuse of the treated effluent appropriately. The ZLD as inferred from the notification (MoWR's notification) dated 7th October, 2016 is incapable of being enforced across the Board without reference to the member industries and other relevant aspects aforestated.

The relevant portion of the judgement is reproduced below:

ZERO LIQUID DISCHARGE (ZLD), CONTINUOUS EMISSION MONITORING SYSTEM (CEMS) AND ONLINE MONITORING SYSTEM:

In this judgement, the Tribunal is concerned with the identification and resolution of all sources causing contamination of river Ganga and its tributaries. The paramount source of pollution of the river is the effluent discharge from the industrial sectors. Regulation of (P.339) industrial effluents introduced directly or indirectly into the river Ganga or its tributaries is a fundamental requirement for abatement of pollution. In segment-B, highly polluting industries like sugar, distillery, textile, tannery, paper mills and slaughterhouses, amongst others are located. These industries discharge treated or in majority of cases even untreated effluents into the water bodies. All industries are required to discharge their effluents strictly in accordance with the prescribed parameters. Violation thereof, leads to consequences including closure of the units in accordance with the law. Despite such serious consequences, the industrial pollution of the river has been on escalation, since past many years. There are apparent deficiencies in the effectiveness of the regulatory and supervisory regime, provided under various environmental laws in force in the country. One of the ways to improve the regulatory regime and to ensure that the industries should adhere to the relevant environmental laws was to enforce ZLD and online monitoring system. In fact, the CPCB had issued directions to the UPPCB under section 18(1)(b) of the Water Act, 1974 for seeking action plan from industries on implementation of ZLD in identifying industrial sectors in March–April, 2015. It had even issued guidelines for techno-economic feasibility of implementation of ZLD for water polluting industries in June 2015. It required that there shall be (P.340) compliance with the environmental standards notified under Environment Protection Act of 1986 and to permit the industries to discharge effluents only after compliance. It was acknowledged that ZLD was a necessity and technically exigent. It was also stated that ZLD can be achieved by adopting conventional primary, secondary and tertiary effluent treatment and polishing by filtration and using clean water back into process or domestic use. It also provided an option to select the technical system facilitating achievement of ZLD. In other words, ZLD could be attained by recycling or by achieving no discharge at all by use of appropriate technology. Similarly, the CPCB on 5th February, 2014 had directed the State Boards to further direct the 17 categories of the industries which were highly/grossly polluting industries in Ganga River Basin States to install CETPs, common bio-medical waste treatment facility, common treatment storage, disposal facility of hazardous waste and to install online monitoring system covering 13 effluent parameters in relation to pH, BOD, COD, TSS, Flow, Chromium, Ammoniacal Nitrogen, Fluoride, Phenol, Cyanide, Temperature, AOx and 8 technical parameters, PM, CO, Fluoride, NOx, SO2, Cl2, HCI and NH3. In the directions, values thereof were even provided.

During the course of hearing, all these aspects raised serious controversies. Some of the stakeholders including (P.341) the Industries Association, particularly, All India Distillery Association vehemently objected to the enforcement of these directions. Vide its order dated 17th February, 2016, the Tribunal noticed the presence of the various Associations like sugar, textile, tannery industries, etc., which were provided time to submit their written submissions in relation to attainment of ZLD and installation of online monitoring system if ordered across the board. In response to this, written submissions were filed on behalf of the various stakeholders as well as the Industries Associations. We may briefly examine the same. The challenges to ZLD on behalf of the All India Distillery Association is that the UPPCB had issued ZLD directions to member industries of the association on 4th March, 2015 stipulating Concentration and Incineration as the only option available to industries. It is stated that the CPCB and UPPCB had not considered the negative environment impacts, burden on natural resources, economic unviability, high capital cost and long term sustainability of the directions. It is stated that the directions would result in increase in the emission levels and substantially cause air pollution from pollutants such as PM 2.5, PM 10, RSPM, NOx, SOx and Hydro Carbons. The energy required for concentration system would be un-economical and at the same time would consume huge quantity of water, (P.342) additional effluents generation as MEE. The concentrated distillery effluents incinerators are very inefficient in stalk emission norms as Electro Static Separators are not installed due to technical feasibility and specifically high moisture in flue gases. The directions would result in substantial increase in greenhouse gases. Distillery effluent is a rich source of BOD and COD, which can be anaerobically treated to generate methane gas. Control line application is one of the most plausible feasibility options that should be provided. It has been practiced in various countries including Brazil, South Africa, Indonesia, etc. One Time Controlled Land Application (OTCLA) should be applied instead of 'Ferti-Irrigation' as earlier directed by the Board. OTCLA would be applied in a controlled manner through tankers and shall be once in 3 to 5 years depending on the soil nutritional deficiency, rainfall patterns, groundwater levels and soil characteristics. According to the affidavit filed on behalf of the Industries Association, it is also stated that it acknowledges the cooperation of the CPCB in allowing Bio-composting as an alternative method of achieving ZLD. The bio-composting and use of spent wash for agriculture is most environmental friendly and ecologically sustainable technology as it records the waste as a source and prescribes a policy shift. The CPCB estimates that an addition of ? 6–8 per liter of product cost shall be escalated (P.343) by installing the systems of MEE, RO+MEE with incineration. There would be different criteria for different areas in the country.

The MoEF&CC had filed an affidavit dated 4th November, 2016. It has been in compliance to the directions issued by the Tribunal. It is stated that ZLD is not insisted for those tanneries which are connected with CETPs. Any tannery unit attached with CETPs shall achieve the inlet and treated effluent quality standards as per notification dated 1st January, 2016. The stipulation of ZLD has been proposed for large scale units in environmentally sensitive/critical areas based on the approval of CPCB. Similarly, directions have been issued for large scale units of Textile Industries in relation to ZLD. It was intended to introduce self-regulation. It is also stated with regard to the concept of ZLD that there is no discharge of processed wastewater from the premises of the industries. It is to permit water resource by reuse, recycle and recovery to the extent possible. Similar stand has been taken by the MoWR. The UPPCB also filed a detailed affidavit answering the issue whether ZLD can be applied across the board in respect of all industries. It was stated that ZLD cannot be applied to all industries in segment-B. In relation to distillery units, after applying ZLD technology, the industries have become ZLD units. This seems to be factually incorrect. In relation to Sugar Industries, it is (P.344) stated that notification has been issued providing the standards for discharge of treated effluent on the land. In respect of Textile Industries, the Notification dated 10th October, 2016 has been laid down and ZLD has not been insisted upon. In respect of Paper and Pulp Industries, no final notification has been issued and as per the Charter, the Paper and Pulp units which are using agro base as raw material has to treat black liquor and they could become ZLD with Chemical Recovery Plant, where black liquor is concentrated and evaporated. For tanneries, draft Notification dated 10th October, 2016 has been issued for comments and no final notification has yet been issued. The MoWR has issued a Notification dated 7th October, 2016 issued under section 24 of the Act of 1986 where it has been stated that every endeavour will be made to ensure that uninterrupted flow of water is maintained at all the times in the river and no person shall discharge any treated or untreated sewage into river Ganga, its tributaries or on its bank, directly or indirectly. Similarly, restriction has been placed on industrial waste, biomedical waste or any hazardous substance.

It needs to be noticed that there is contradiction in terms, not only between the two Notifications issued by the MOWR and MOEF&CC dated 7th October, 2016 and 10th October, 2016, respectively but also the principal statute, i.e., Water Act. The MoWR has issued a Notification dated (P.345) 7th October, 2016 which requires that no person shall discharge directly or indirectly any treated or untreated sewage or sewage sludge into river Ganga, its tributaries or its bank. Similarly, it also prohibits discharge of treated or untreated trade effluent and industrial waste, bio-medical waste or other hazardous substance both directly or indirectly into river Ganga or its tributaries or their banks. On the other hand, the Notification issued by MoEF&CC dated 10th October, 2016, provides that the treated effluent as well as sewage could be discharged into the water bodies provided it satisfies prescribed standards. The Notification, particularly, in relation to the Textile Industries prescribes the standards and states that in case of direct disposal into river or in the lake, stringent standards could be provided to the satisfied standards, as already noticed on similar lines the draft Notification in relation to Tannery Industry. The provisions of the Water Act specifically permits discharge of trade effluents on land, drains, water bodies and other places if it specifies the prescribed norms. The Notification issued by MoWR, thus places a complete prohibition on discharge of sewage or trade effluent, which in terms is contrary to the statutory provisions of the Water Act and the Notification issued by the MoEF&CC in terms of Environmental Protection Act, 1986. The Notification issued by MoWR can thus hardly be given effect to and the ZLD concept (P.346) proposed can hardly be complied across the Board. What probably was intended under the Notification of 7th October, 2016 was ZLD of the industrial units by ensuring recycle and reuse of effluents for irrigation, horticulture, industrial and cooling purposes. The other Notification provides a relaxation completely to various kinds of industries in relation to the effluent that such group of industries discharge. The Notification issued by MoWR cannot override the provisions of the Water Act, Environmental Protection Act, 1986 and other statutory Notifications. However, this Notification would have to be given its plausible meaning by holding that it suggests ZLD in the above terms but does not absolutely prohibit the discharge of the industrial trade effluent, i.e., inconsonance with the prescribed standards. If the Notification is given in literal interpretation it may result in shutting down of large number of industries in the country, that certainly does not seem to be the intent of the Notification, particularly, in face of the enacted law by the Parliament. The purpose is to achieve the prescribed trade effluent and preferably means for recycle, reuse thereof, unless the conditions of the Consent to Operate order specifically provide for installation of devices like incineration or evaporation.

At this stage, we may also refer to the compliance statement filed on behalf of the MoEF&CC and CPCB, (P.347) jointly, in furtherance to the Chamber meeting of 8th July, 2016. The issue afore-referred was fully clarified in its minutes of meeting, filed on 3rd August, 2016. It is stated that ZLD refers to installation of facilities and systems to enable the industrial effluents for recycling and converting solute into residue into solid by adopting method of concentration and thermal evaporation. Draft standards have also been spelled out by the Ministry, which were to be put up on the website inviting comments of the people. It was stated that in the case of ZLD there will be no discharge and upto 97% water can be recovered by reuse in the process. There would be salt generation of 4 tonnes per MLD, which can be recovered for reuse and would meet the prescribed standards. While the conventional treatment system would leave discharge into surface water bodies or use for irrigation releasing high TDS. It is also convenient to operate and maintain the treated effluents which can be used for irrigation purposes after compliance. Comments were also submitted with regard to online monitoring system with the purpose to create self regulation standards and comply with the stipulation. In furtherance to the order of the Tribunal dated 17th February, 2016, the association of industries were also directed to make representation to the CPCB and they were to be commented upon by the Central Pollution Control Board and record was to be placed before the Tribunal. The (P.348) representation from sugar sector, tannery sector and distillery sector were also received by the Board. Common argument was that and the raw distillery effluent if directly concentrated and incinerated, would not give beneficial results. It would lead to wastage of energy produced from non-renewal sources besides loss of nutrients present in the spent wash. Bio-composting, concentration or incineration had not been tested and proven to be correct and environment friendly. The cost of the technology is very high, therefore, economically not viable. It would be impossible for the industries to adhere to this technology. Probably treated effluents could easily be used for irrigation purpose. The Small Scale Industries are not capable of meeting the ZLD and therefore, CETP would be the proper remedy. Primarily, the comments of the Boards were primarily that the incinerator or bio-composting or insulation for spent wash and disposal is optional for the industries. Some industries have adopted this technology. A minimum quality specification of the finished compost is essential to ensure that the industries practice Biocomposting properly following the protocol and utilisation of finished compost in agriculture. The industries in any case should achieve the standards as per the Notification of 1st January, 2016 and textile units should be attached to CETPs. The remnant of treated effluent should be allowed to be discharged into river only after exhausting it 349 upon reuse for irrigation.

From the above discussion, on advantages and disadvantages of the ZLD, it is evident that ZLD cannot be adopted across the board. It must have rationality as its sole criteria, should be unit centric and industry specific oriented. The Sugar or Distillery Industries may be of a huge capacity say discharging 100 MLD per day. They could be a Sugar Industry or Distillery Unit with 10 MLD discharge and thus a very small-scale unit. To apply same yardstick to all would not be feasible and result oriented. They should be assessed on their own performance and function, however, ensuring in all the situations that the effluents permitted to be discharged on land/drain, etc. should be strictly adhering to the prescribed norms. The Board in its advisory capacity may be able to suggest or guide as to the integral technology, which may be feasible for the industries for attaining the prescribed norms. To impose ZLD on such industries would neither be fair nor just. In fact, it will not be in consonance with the requirement of law under relevant Acts. An industry should be permitted to operate, subject to grant of Consent to Operate, by the concerned Board. The CPCB has the competency under law to issue directions under Section 18 of the Water Act. The purpose of empowering Boards with certain powers is to restrict and control pollution. It is not expected from the Boards to stop the natural growth or (P.350) restrict industries from operating but compliance to the environmental laws is fundamental to exercise of their powers. The Board must take into consideration of the aspects including technology, financial viability, limitations of the unit, process adopted by the industries but in all events ensuring that the discharge of effluents from the unit has to be strictly in compliance with the prescribed standards. No industries, big or small can be permitted to pollute the groundwater, drains, water bodies and environment.

To put it simply, the ZLD directives cannot be applied across the board. On the one hand, it would be violative of the rights of the parties while on the other would not be in consonance with the provisions of the relevant environmental acts. ZLD should be applied on case to case basis. The concerned boards should exercise its technical know-how to issue appropriate directions in that behalf. The ultimate purpose is prevention and control of pollution and not an internal management of the plant. Effluent discharge must be strictly within the prescribed norms and the Board in appropriate cases could issue directions with regard to recycle, reuse of the treated effluent appropriately. The ZLD as inferred from the notification dated 7th October, 2016 is incapable of being enforced across the Board without reference to the member industries and other relevant aspects afore-stated. (P.351)

Similarly, the Online Monitoring System or Continuous Emission Monitoring System should also be applied on case-to-case basis with reference to the facts and circumstances of the given unit. They must be practicable, for instance, if there is a tannery unit which has consent for processing of hides at a day to be expected to become ZLD or to install Online Monitoring System or Continuous Emission Monitoring System would be opposed to any accepted principles of technology and safeguards of economic advancement. They would be compelled to operate and discharge their effluents only and strictly as per the prescribed norms in default. They would be liable to be shutdown. Another consequential issue that arises in this context, there has to be a specialised, technically sound and dedicated mechanism with every board including CPCB which monitors entire input of Online Monitoring System or Continuous Emission Monitoring System. This monitoring should include not only collection of data but to ensure that actions taken in default and operational deficiencies in the units are rectified within the prescribed time, failing which the unit should be ordered to be closed. The concept of self-regulation would achieve its object, only when there is an effective supervisory control. There have been serious and noticeable drawbacks, deficiencies, and omissions in regulatory regimes else, the current state of industrial (P.352) clusters, drains, tributaries of the river would not have been prejudicial to such an extent. Continuous calibration by CPCB to ensure that the online monitoring system shows the correct values and it must be compared with the actual effluent analysis collected by the Board on regular intervals.

d) NGT Judgement on polluted river stretches

Based on a news article that appeared in The Hindu newspaper which was based on a CPCB report on 351 polluted river stretches (1https://www.thehindu.com/news/national/more-river-stretches-critically-pollutedcpcb/article24962440.ece,http://cpcb.nic.in/cpcbold/RESTORATION-OF-POLLUTED-RIVER-STRETCHES.pdf) , the NGT has come hard on all states on the state of Rivers and discharge of effluent and sewage into the Rivers and their present states and has asked for a comprehensive action to stop the pollution of the Rivers. With this order the focus has clearly shifted from source to the receiving water body as a yard stick to measure effectiveness of pollution control in the country. The focus will not just be on checking compliance with EPA standards at source but achieving pollution free rivers. Therefore status quo on river discharge of treated effluents and sewage will no longer be possible.

e) NGT judgement on Environmental compensation regime for non-compliant ETP/CETP/ STP /MSW/ Illegal ground water extraction (arising from W.P. (Civil) No. 375/2012 on the file of the Hon'ble Supreme Court)

A brief extract of the discussions and the directions is reproduced below

Report dated 14.08.2019 with regard to monitoring of CETPs

18. The Committee inspected 127 CETPs in 14 States. Figure of CETP assumed to be 97 was not correct. 66 CETPs were found to be noncompliant. CPCB directed SPCBs to take following steps:

> "1. SPCBs shall direct non-complying CETPs to take immediate corrective actions to comply with the environmental standards.
>
> 2. CETP should be directed to take action as per the recommendations provided at Annexure A-N within a time frame.
>
> 3. In case of non-complying CETPs, action as deemed fit including levying of environmental compensation may be taken.
>
> 4. In case, OCEMS are not connected with CPCB & SPCB servers, ensure a robust system of physical inspections to verify compliance by drawing samples."

Discussion on the report dated 14.08.2019

19. We accept the recommendation of the CPCB and direct the Chief Secretaries, State Governments, Union Territories and the SPCBs/PCCs to take further action accordingly and furnish an action taken report accordingly. The CPCB to meanwhile compile and collate information with regard to ETPs, CETPs, STPs, MSW Facilities, Legacy Waste dump sites and complete the pending task on the subject before the next date and furnish a report.

20. The environmental compensation regime for CETP not meeting the prescribed norms need to be evolved by the CPCB.

Directions

21. We may now sum up our directions:

(i) The Environmental compensation regime fixed for industrial units, GRAP, solid waste, sewage and ground water in the report dated 30.05.2019 is accepted and the same may be acted upon as an interim measure.

(ii) SPCBs/PCCs may ensure remedial action against noncompliant CETPs or individual industries in terms of not having ETPs/fully compliant ETPs or operating without consent or in violation of consent conditions. This may be overseen by the CPCB. CPCB may continue to compile information on this subject and furnish quarterly reports to this Tribunal which may also be uploaded on its website.

(iii) All the Local Bodies and or the concerned departments of the State Government have to ensure 100% treatment of the generated sewage and in default to pay compensation which is to be recovered by the States/UTs, with effect from 01.04.2020. In default of such collection, the States/UTs are liable to pay such compensation. The CPCB is to collect the same and utilize for restoration of the environment.

(iv) The CPCB needs to collate the available data base with regard to ETPs, CETPs, STPs, MSW facilities, Legacy Waste sites and prepare a river basinwise macro picture in terms of gaps and needed interventions.

(v) The Chief Secretaries of all the States/UTs may furnish their respective compliance reports on this subject also in O.A. No. 606/2018.

We can briefly summarise the above judgements as below:

I. There is a past precedent for directions to implement ZLD to stop pollution of a River by the Hon'ble High Court in the case of Tirupur Textile Dyeing cluster.
II. ZLD cannot be applied across the board as stated by the NGT judgement on Ganga.
III. Large number of rivers/ river stretches are polluted and need to be restored by concerted action from all states/UT and the national union government. The focus will not just be on checking compliance with EPA standards at source but achieving pollution free rivers. Therefore status quo on river discharge of treated effluents and sewage will no longer be possible.
IV. Compliance of ETP/ CETPs/ STP is a major issue and violators are liable for environmental compensation.
V. Guidelines for irrigation with treated effluent

The Hon'ble National Green Tribunal (NGT), Principal Bench, New Delhi, vide order dated 24.05.2019 in the matter of O.A.No. 348/2017, Shailesh Singh Vs AL-Dua Food Processing Pvt. Ltd., issued the following directions to CPCB:

"We may add that no industry can be permitted to dispose treated effluents on land for irrigation, plantation or horticulture/ gardening by prescribing standards applicable without assessment of adequate availability of land and impacts of such disposal on agricultural/ crops/ plants and the recipient ground water. Impact of precipitation levels also needs consideration while granting such approvals. ZLD needs to be considered with respect to use of effluents in the industrial processes not in terms of its disposal on land or farm. Therefore, the CPCB needs to look into this aspect with the help of experts and issue appropriate guidelines in this regard. This aspect may also be covered in the report to be submitted in the present case."

In response to this direction CPCB has come out with guidelines for utilisation of treated effluent for irrigation dated September 2019. This specifically excludes ZLD.

5.2. Determining applicability of ZLD

Based on discussions in the preceding section, the following criteria instead of a blanket application of ZLD across all sectors, the following four point criteria is suggested:

1. Identified specific sectors.
2. Environmental Situation
3. Technical Viability
4. Economic Viability

An industry can be directed to implement ZLD if it fulfils all the above four criteria. To determine if any industry fulfils the above criteria, it may be checked on the following parameters.

S.No.	Parameters
1. Identified specific sectors	Water Intensive
	Grossly Polluting Industry (GPI)
	Discharge of treated effluent to Inland surface water body (River/Lake/streams), or marine discharge at a distance of >50 KM from Industry site (Sewer discharge with sufficient dilution and irrigation on land as per standards exempted).
	Existing in Critically Polluted Cluster as per WPI of CPI
	Court/ NGT directions
	Existing previously but in eco sensitive zone (Forest, wetland area, Marine Bio-reserve etc.) or Industry location within a Distance of less than 1 KM, from notified Rivers
	Difficulty in compliance of EPA standards
2. Environmental Situation	Court/ NGT directions
	Existing previously but in eco sensitive zone (Forest, wetland area, Marine Bio-reserve etc.) or Industry location within a Distance of less than 1 KM, from notified Rivers
	Difficulty in compliance of EPA standards
	Location of Industry in Over exploited Zone as per CGWA
3. Technical viability	Court/ NGT directions
	Prior ZLD operational experience in similar industrial sector elsewhere in other states within the country, for minimum 5 years
	ZLD Technology demonstration through R&D followed by piloting
	BAT/ BREF Availability for ZLD in the specific sector in India duly approved by CPCB
4. Economic Viability	Court/ NGT directions
	BAT/ BREF Availability for ZLD in the specific sector in India duly approved by CPCB
	Prior ZLD operational experience in similar industrial sector elsewhere in other states within the country, for minimum 5 years, particularly in Tiny and small scale industries.

The above four criteria and related parameters are clubbed together to arrive at an overall matric for applicability of ZLD. If anyone parameter is found applicable under each of the four criteria then the industry can be directed to implement ZLD.

Technical Viability

ZLD has been implemented across most GPI sectors and is in operation for over a decade now. However, Technology needs to be upgraded to reduce O&M cost & Carbon-foot print in the ZLD Systems. The Technology is also not standardised. There is no Best Available Technique (BAT) for ZLD as yet. Technology too is rapidly changing and improving in this short period for e.g. High Pressure RO membranes both in DTRO and SWRO, improved Nano Filtration membranes, Membrane distillation etc. are some of the technologies that have come up recently. It is also clear that 'one size doesn't fit all' and Techno-commercial viability needs to be studies for case to case and experiences across each sector needs to be shared. Any new Technology needs to be piloted for technology evaluation and demonstration.

Technical Challenge

1. High Capital expenditure
2. High O&M expenses
3. Accumulation of mixed waste salt a serious disposal issue, for which requires considerable R&D and piloting.
4. High energy and Carbon foot print
5. High Cost for disposal of sludge

The above challenges when addressed will significantly reduce the operating costs to near Zero and would also possibly contribute as a source of revenue to the CETPs/ ETP, thereby ensuring long term sustainability of the industry.

Financial Viability

Implementation of ZLD across the Country is not uniform, same industrial sectors have either ZLD or marine discharge or inland surface water discharge making a situation of non-uniform application of norms and non-competiveness due to additional cost of capex and opex due to implementation of ZLD is causing a national & regional imbalance in terms of productions costs and profitability. This is resulting in shift of polluting industries within the country and to other lower income group countries.

There is no incentive today for any industry or CETP for implementation of ZLD other than getting environmental clearance or avoiding complaints on pollution issues from public and courts.

Funding – Grant and subsidies for implementation of ZLD is limited only to Textile Dyeing CETPs under the Integrated Processing Development Scheme (IPDS) of the Ministry of Textiles (MoT), government of India. It is understood that an earlier CETP funding scheme from the MoEF &CC is not in force now. Schemes like Industrial Infrastructure Upgradation scheme (IIUS) is available for Industrial clusters although not exclusively for ZLD. Therefore there limited funding opportunities.

There is a need to address cost transfer of ZLD Costs from wet processing intermediate (polluter) to finished goods manufacture (the foreign exchange earner) and buyer. For example, the leather tanning is the polluting segment of the Leather goods manufacturing chain. However, most leather tanners are based on job-work where the raw material is given to them and they produced finished leather based on piece rates with low margins. The cost of ZLD on such tanneries can be as high as 12-15%. The finished leather is then manufactured into shoes or garments by the leather goods manufacturer and the cost of ZLD on the finished product can be as low as 2%.Therefore, there is a need to address these issue through suitable government policy. A detailed discussion on the Financial Impact of ZLD is given n section 8 of this report. To understand From the several case studies across several industrial sectors, it is evident that the operation of ZLD system in the Small and medium Industries is viable, hence there may be no difficulties for large scale Industries..

A detailed study is required on the cost impact of ZLD on the cost of manufacturing in various industrial sectors. For this purpose a detailed questionnaire has been prepared for obtaining data and preparing case studies. This data is awaited and hopefully we will have good data soon. At present we have data only on few sectors as indicated in the case studies section later in this report.

However, an indirect way of determining financial viability is to see if similar industrial sectors have implemented ZLD for a reasonable length of time. The assumption here is that if ZLD has already been at least for a 5 year period, by any industry in a particular sector in any part of the country, particularly if the industry is in the small scale sector, then it can be presumed that ZLD is financial viable for industries in same sector in SME or Large scale industries. For example, Textile Dyeing Industries in Tirupur which are basically based on cotton knitted fabric dyeing, many of them SME's connected to CETP or large industries connected to their own IETPs have implemented ZLD for the last 10 years. Therefore, it can safely be said that ZLD is technically and financially viable for industries in similar sector of cotton fabric dyeing elsewhere in the country. The direction for implementation of ZLD can then be given for industries across the country subject to fulfilling of the remaining two criteria given in Table 2.

Table 2: Overall ZLD Matrix

S.NO	Parameters	Identified specific sectors (1)	Environmental Situation (2)	Technical viability (3)	Economic Viability (4)
1.	Water Intensive	(1,1)			
2.	Grossly Polluting Industry (GPI) / Highly Polluting Industries (HPI)	(1,2)			
3.	Discharge of treated effluent to Inland surface water body (River/Lake/streams), or marine discharge at a distance of >50 KM from Industry site (Sewer discharge with sufficient dilution and irrigation on land as per standards exempted).	(1,3)			
4.	Existing in Critically Polluted Cluster as per WPI of CPI	(1,4)			
5.	Court/ NGT directions		(2,5)		
6.	Existing previously but in eco sensitive zone (Forest, wetland area, Marine Bio-reserve etc.) or Industry location within a Distance of less than 1 KM, from notified Rivers		(2,6)		
7.	Difficulty in compliance of EPA standards		(2,7)		
8.	Location of Industry in Over exploited Zone as per CGWA		(2,8)		
9.	Prior ZLD operational experience in similar industrial sector elsewhere in other states within the country, for minimum 5 years			(3,9)	(4,9)
10.	ZLD Technology demonstration through R&D followed by piloting			(3,10)	
11.	BAT/ BREF Availability for ZLD in the specific sector in India duly approved by CPCB			(3,11)	

S.NO	Parameters	Identified specific sectors (1)	Environmental Situation (2)	Technical viability (3)	Economic Viability (4)
12.	Prior ZLD operational experience in similar industrial sector elsewhere in other states within the country, for minimum 5 years, particularly in Tiny and small scale industries.				(4,12)

For example, if an industry falls under the following matrices, it can be a candidate for directions from CPCB/SPCB for ZLD:

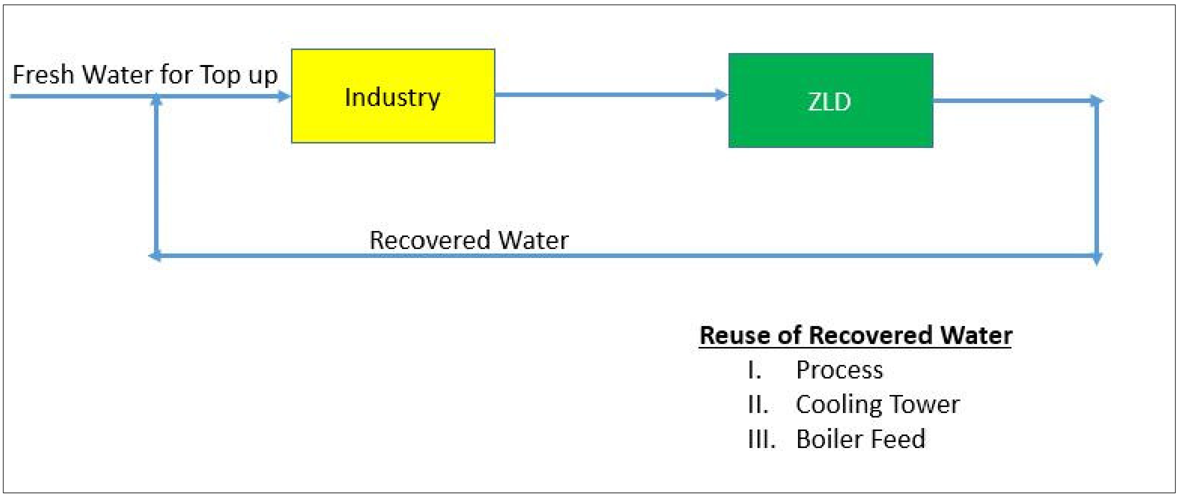
Example 1: (1,1); (2,5); (3,9): (4,12) = ZLD.
Example 2: (1,2); (2,6); (3,10): (4,12) = ZLD,

Based on the above a draft on Guidelines on ZLD and its applicability for specific Industries and Industrial sectors is given in the Annexure to this report. This is a template for discussion.

6. Permissible recycle, reuse and ZLD options/hierarchies

I. Total ZLD System

Under this system, no effluent is to be discharged from the industry to the environment and the entire water is recovered and reused. This is more an economical option where there is severe water scarcity, water costs are high, and the environment has been seriously impacted. Example; ZLD System installed in Tannery / Textiles Clusters in Tamilnadu.

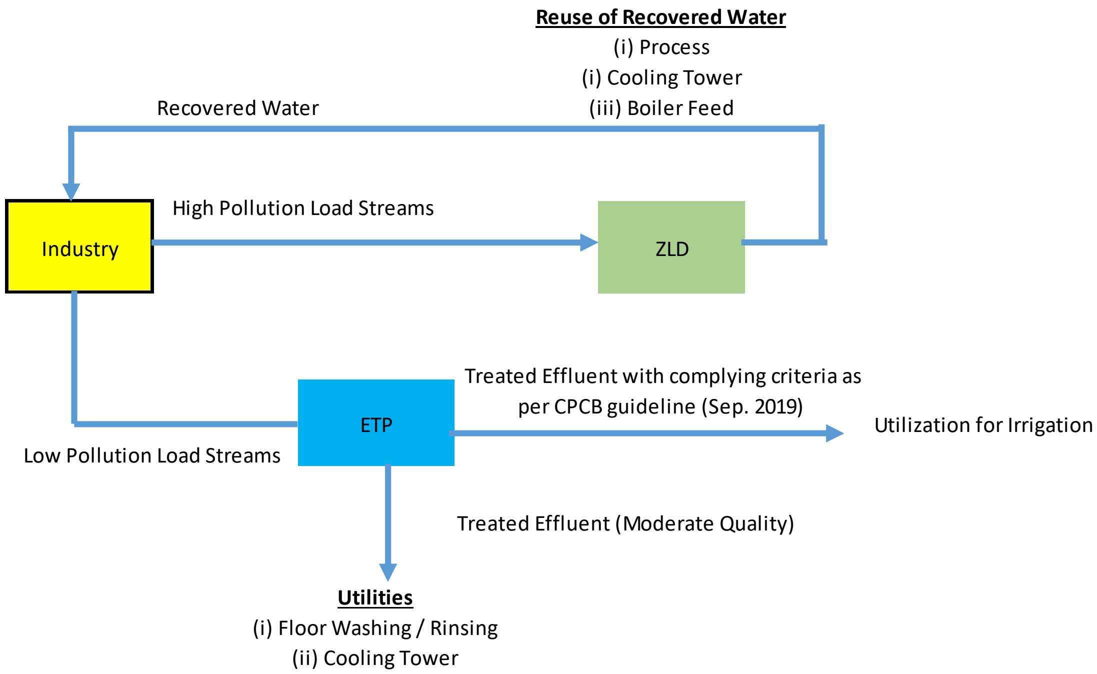


II. Partial ZLD / Selected High Polluted Effluent Streams and reuse of recovered water for process

The Partial ZLD is for High-Pollution load effluent streams, which would be segregated and treated separately in a ZLD facility, separate from other effluent streams. This reduces the need for implementing ZLD in the entire volume of effluent generated and thereby reduces capital and operating costs.. Typically, this can be applied for high effluent volume generating industries, like say an integrated pulp mill. However, this is too be employed only where, segregating of high pollution load effluent streams results in drastic reduction in pollution characteristics of the remaining wastewater. Typically the remaining wastewater (low pollution load stream) would be wash water. This treated wastewater can be used for irrigation or ancillary processes like floor washing, rinsing, etc. Example; bleaching effluent from the pulp mill which is having high salinity, and high COD content can be separated from the remaining wastewater streams.

The low pollution load streams can be treated in a conventional effluent treatment plant and treated effluent can be utilized either for irrigation by fulfilling following criteria as specified in the guideline dated September 2019 for Utilisation of Treated Effluent in Irrigation of Central Pollution Control Board

a. The treated effluent should meet the norms prescribed for irrigation under Environment (Protection) Rules, 1986/Consent. The effluent should also conform to Total Dissolved Solid (TDS): 2100 mg/l and Sodium Adsorption Ratio (SAR)- less than 18 but not more than 26, depending on soil/crop type, besides meeting any other parameters suggested by agricultural scientist or agricultural university.
b. Meeting the prescribed norms shall not be the only criteria for use of treated waste water in irrigation, the requirement of water for irrigation will also be a limiting condition and this depends upon various factors of Crop, Climate, Irrigation type, Soil Condition, Soil permeability, Total Salt Concentration.

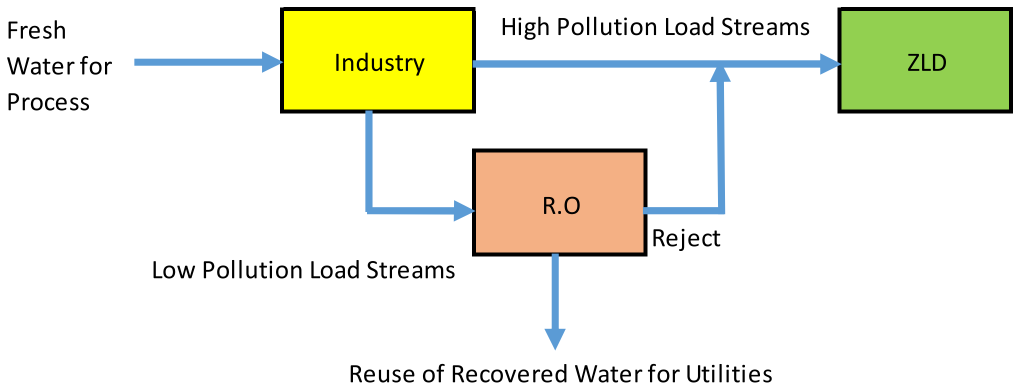


The treated effluent with moderate quality is suggested for floor Washing / Rinsing / Cooling Towers etc.,

III. Partial ZLD for High TDS Effluent Streams and no reuse of recovered water in production (e.g. Pharmaceuticals)

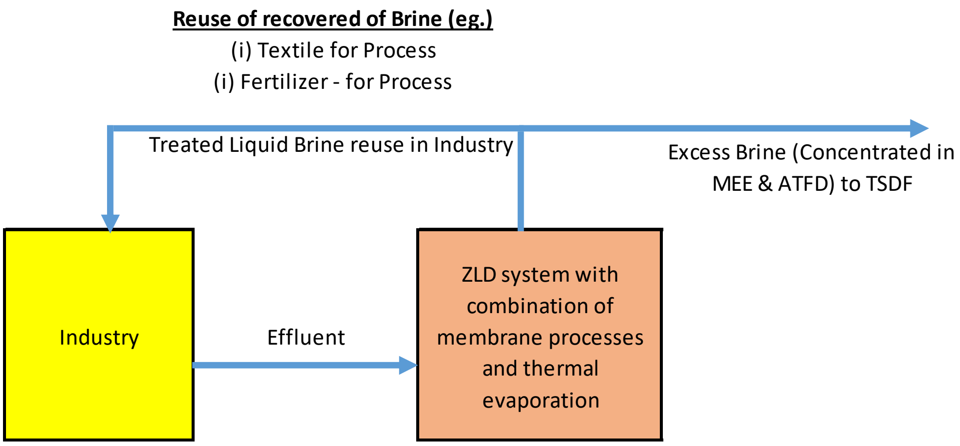
This Partial ZLD is also for High-TDS load effluent streams, <u>however no reuse of recovered water in the Production Process is allowed</u>. Example; Bulk drug manufacturing Pharmaceuticals Industries. The recovered water instead of being utilized in the production process can be used for ancillary purposes.

For low TDS load streams, Reverse Osmosis will be installed and recovered water from low pollution load streams can be reuse for Process and utilities. The brine concentrate from the RO plant of this low TDS ETP is discharge into the ZLD facility of the high TDS waste stream.



IV. Brine reuse

These type of ZLD plants are having systems for management of RO rejects for the recovery of salt through 'treated brine reuse technology'. Removal of salinity requires application of membrane processes. While membrane processes recover high quality water, they also generate highly concentrated rejects or brine. The brine is further treated for reuse in the process. This option includes a combination of membrane processes and thermal evaporation of saline membrane rejects. Reuse of salt as liquid brine reduces the need for thermal evaporation and concentration, thereby reducing operating and capital costs. These technologies have been successfully demonstrated and employed in the Tirupur Textile dyeing Cluster for over a decade. Reuse of RO Brine containing nutrients (N,P,K) in fertilizer industry in the manufacturing is also in practice.



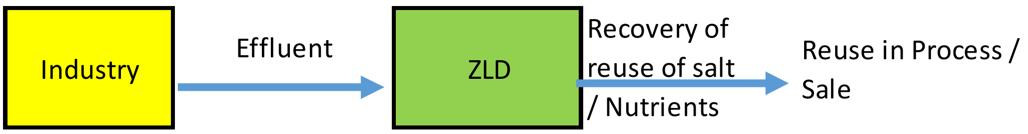
V. ZLD with Mixed Salt crystallization and disposal to TDSF

After recovery of water from R.O, the reject is concentrated in the membrane / thermal Evaporators sand crystallizers for crystallizing of salts. Typically, mixed salts with contaminants are produced during such crystallization. Typical salts in this crystallized salt is Sodium & Calcium salts of Chlorides, sulphates, nitrates and phosphates. It is also to be noted that most salts are hygroscopic and corrosive, therefore long term storage in plastic bags in containment sheds is not feasible. Such mixed salt waste should be disposed of promptly to a TSDF, provided such facilities have treatment systems for handling mixed waste salts. Example: Tannery ZLD CETPs in Tamilnadu dispose off the mixed waste salt to a TSDF facility.

VI. ZLD with Individual Salt Recovery and reuse in the industry's own process or for sale

ZLD processes with salt separation technologies and selective crystallization techniques are able to produce high purity individual salts which can be reused either in the industry's own process or sold in the market for similar industrial use.

Example; Recovered High purity sodium sulphate salt (reuse in the dyeing process) and sodium chloride (sale) as has been done in some of the CETPs in the Tirupur Textile dyeing Cluster in Tamilnadu. Part of the salt is also reused as liquid brine without crystallization, thereby reducing thermal evaporation costs.



Exclusions

Discharge of treated effluent within industry's own premises or contract land for farming cannot be considered as ZLD. Since, such practice does not rule out contamination of underground aquifer, effects on soil fertility due to long-term use and run-off due to reduction in permeability of soil due to change in soil matric due to raising sodicity of soli or run-off to the near waterbody due to saturation or during rains. This permitted discharge falls under existing standards for irrigation.

7. Standards and discharge limits

Basically there are three products possible from a ZLD facility. These are Recovered water, recovered salt and brine. This is other than chemical sludge and mixed waste salt, which are already covered under the Hazardous waste management Act.

I. Standards for recovered water from ZLD facility

The standards and discharge limits are based out of existing standards for use of fresh water for various purposes including industrial production, boiler, cooling, washing etc. Therefore the recovered water from ZLD facility should meet these existing standards. The relevant BIS codes for quality of water for industrial purposes shall be applicable.

II. Standards for reuse of salt within the industry

The purity of the recovered salt or brine can be as per industry's own need and as long as it is not disposed off outside there is no specific standard required. The concentration, purity, quantity and volume requirements can be as per Industry's own requirement for its internal use. Example: Reuse of treated liquid brine and salt in the Tirupur Textile Dyeing cluster.

III. Standards for recovered salt for sale in the open market

The recommended standards for recovered salt should also meet existing BIS standards for industrial grade salt. A sample standard is given below:

Table 3: Comparison of Recovered Sodium Sulphate Salt quality with BI standard

S.No	Characteristics	As per BI standard (IS :255) for Grade-B**	Test result of recovered salt
1.	Sodium Sulphate (as Na_2SO_4) % by mass	98.0 %	98.15 %
2.	Matter Insoluble % by mass	0.5 %	< 0.05 %
3.	Sodium Chloride (as NaCl) % by mass	2.0 %	1.2 %
4.	Iron, Aluminium and Chromium (as R_2O_3) % by mass	0.02 %	0.008 %
5.	Iron (as Fe) % by mass	0.002 %	0.0016 %
6.	Loss on drying, % by mass	2.0 %	0.36%
7.	pH (of 10% solution)	7.5 to 8.0	10.07

**Suitable for Paper, Glass, Textile and Chemical Industries
Source: Chinnakarai CETP, Tirupur.

Table 4 : Comparison of Recovered Sodium Chloride Salt quality with BI standard

S.No	Characteristics	As per BI standard (IS: 797) for Grade-2*	Test result of recovered salt
1.	Sodium Chloride as NaCl % by mass	98.5 %	98.53 %
2.	Matter Insoluble % by mass	0.2 %	0.05 %
3.	Calcium Salt % by mass	0.2 %	0.014 %
4.	Magnesium Salt % by mass	0.1 %	0.014 %
5.	Sulphate (as SO_4) % by mass	0.6 %	1.95 %
6.	Iron Compound (as Fe) by ppm	20 ppm	15.9 ppm

*Suitable for Chemical Industries, slaughter house
Source: Chinnakarai CETP

8. Financial incentives

i. Many of the GPI fall under the SME category and some are even in the tiny sector. Therefore the capex towards ZLD can be a burden. In such cases the industry/ cluster must be encouraged to become part of a CETP to share the cost and reduce the burden. However there is a need for a higher grant towards capex as most such polluting industries fall under the Tiny and SME category.
ii. Issues with Regional/ National competitiveness due higher operating expenses due to ZLD needs to be addressed. ZLD is not yet a policy almost anywhere in the country and is implemented in few states only. Also Asian & African countries, where most of the manufacturing polluting industries exist today, do not have a ZLD policy, although there are examples in China, Ethiopia etc. To offset this regional/ national trade imbalance due to additional costs, the viability gap needs to be funded.
iii. For example, the fabric dyer or the raw hide tanner, are essentially the polluters in the manufacturing value chain of textile & leather garments and goods manufacturing. The dyer or tanner, has to implement ZLD and bear the additional costs, which can be as high as 5 to 15%. This increases the cost of the dyed fabric or finished leather. Moreover, most of these units only do 'job work' wherein the raw material (cloth/ raw hide) comes from the buyer and the unit processes it and gives the finished product (dyed fabric/ finished leather) back with their processing charges. However the buyer, who is the Garment or goods manufacturer may prefer to buy the dyed fabric or finished leather from a state or country where it is cheaper due to no ZLD Policy. This would then result in closure of such manufacturing industries and loss of manufacturing jobs and shifting of such polluting industries to other lower economies. This loss of manufacturing jobs due to higher pollution and labour costs has already been witnessed in the Europe & USA in 70s/80s. A similar shift may happen from Asia to Africa if we do not address the pollution issue and the costs associated with it. This therefore requires a policy intervention where in the higher costs of ZLD is transferred from the polluting intermediate industry in the value chain to the final goods manufacturer and also incentivizing the goods manufactures with incentives or higher market price through ecolabels and certifications (e.g. ZDHC/ LWG Gold trading for ZLD described in the needs assessment report).
iv. It is too be noted that the actual increase in cost of product due to ZLD may still be affordable to the ultimate buyer, the customer. The ultimate customer may be able to bear the additional cost due to ZLD. E.g. Rs. 20 on a pair of shoes or Rs. 5 on a shirt. It is the transfer of ZLD costs from the polluting intermediate across the manufacturing value chain and incentivizing the goods manufacturer that is the issue.

8.1. Details of various funding schemes available for ZLD based CETP proposal

i. Integrated Processing Development Scheme (IPDS) for Textile Cluster with grant of 75% of the project cost, with a ceiling of Rs. 75 crores for Projects with Zero Liquid Discharge Systems (50% from Ministry of Textiles, Govt. of India & 25% from State Government).
ii. Scheme for Integrated Textile Parks (SITP) with grant of 49% of the project cost subject to a ceiling of Rs. 40 crores (40% from Ministry of Textiles, Govt. of India & 9% from State Government)
iii. Indian Leather Development Programme (ILDP), with grant of 85% of the project cost subject to a ceiling of Rs. 200 crores (70% from Department of Industrial Policy and Promotion, Government of India and 15% from State Government)
iv. A Centrally Sponsored Scheme to set-up Common Effluent Treatment Plants (CETP) with a grant of 50% of the project cost subject to a ceiling of Rs. 10 crores (25% each from MSME, Govt. of India and State Government)
v. Assistance to Bulk Drug Industry for setting up Effluent treatment Plants under common facility centre with grant of 70% of Project cost of Rs. 100 Crs. which is less from Dept. of Pharmaceuticals, Govt. of India

vi. Assistance to Pharmaceuticals Industry for setting up Effluent treatment Plants under common facility centre with grant of 70% of Project cost of Rs. 20 Crs. which is less from Dept. of Pharmaceuticals, Govt. of India

9. Monitoring requirements for pollution and any negative impacts

Typical monitoring of industries involves frequent/ periodic/ surprise inspection of the treatment facilities and collection of effluent samples for laboratory analysis and comparison with EPA standards and issue of notices and further penal action if required. During inspection effluent discharge volume details are also noted from the flow meters. Presently, most polluting industries have been directed to install Online Continuous Effluent Monitoring System (OCEMS) which is hooked with SPCB/ CPCB servers.

However, for units with Recycle, Reuse and ZLD collection of effluent samples is not possible as there is no discharge and additional date is required for estimating the extent of recycling and reuse done and to determine if ZLD is really being achieved. Some of the monitoring mechanisms that are being followed at present in ZLD industry cluster of Tirupur and additional monitoring mechanisms are suggested below:

1. Monitoring of the following flow meters and tallying it to ensure ZLD-
    a. Fresh Water source for top-up (municipal/ tankers/ ground water) – this is to be limited to less than 10-20% in ZLD as fresh water is used only for 'Top-up' purposes. For R&R projects the quantum can be fixed individually.
    b. Raw Effluent to ETP
    c. Recovered Water
    d. Treated liquid brine (if any)
2. When the total water consumed {fresh water plus Recovered water plus liquid brine (if applicable)} is matched with Raw effluent generated the difference should be less than ±5% to account for evaporation losses, moisture loss in sludge/salt generated and allowable flow meter errors). The fresh water top-up should not be more than 20% to account for losses during activities like floor washing/rinsing cooling towers/ boiler etc). A software app can be developed for this purpose as voluminous data is received and manual verification is not possible. This app can analyse real-time and give alerts by SMS/Email to regulatory agencies.
3. All flow meter data as above is to be hooked to SPCB/CPCB server on real-time basis for instantaneous and cumulative values. This can be made available in the public domain.
4. The quantity of waste salt generated or salt recovered from the effluent has to be mass-balanced with the inflow and TDS of the effluent and the final recovered water reused. Quantity of increase in TDSi due to chemical addition in the effluent treatment process is also to be accounted for. Mass balance reports for the same will have to submitted by the industry on monthly basis to the SPCB. For industries which are required to reuse the salt within their manufacturing process (eg Textile Dyeing), the usage of any fresh salt will also have to be monitored to ensure complete reuse of the recovered salt. Sale of any excess salt too has to be monitored and records maintained by the industry/ CETP for verification.
5. The EB units consumed by the CETP / ETP with regard to their inflow (kWhr/M3) can be noted for all CETPs/ ETPs and those consuming less than the average can be closely inspected. For example, typical power consumption range from 10-12 kWhr/m3 for Textile dyeing ETPs. With ZLD.
6. Monitoring of River upstream and downstream of each industry with online TDS/ Conductivity meters to ensure against any discharge to the River from ZLD units. This is being done for Noyyal River in Tirupur.

7. Over and above all this, while inspection of industry remains a highly skilled expertise; the verification of ZLD is not. Today one needn't wait for lab reports and compliance reports from regulatory agencies and even longer penal cation procedures in case of violations or non-compliance. Instead, a layman can say if a units is achieving ZLD or not by observing if any unit is discharge, any liquid, from the Industrial unit's premises which is considered a violation of ZLD. This has resulted in several complaints with layman making videos in their mobile phones with date, GPS & time stamps. It is noticed that immediate action is possible by both the industry and regulator and the unit can resume operations after the discharge is stopped immediately by stopping production activities and rectifying any defect in the ETP. Only serious deliberate violations with serious impacts to environment would require penal action in such cases. This situation again is seen in the ZLD clusters in Tamilnadu where today there are more complaints due to active public participation in the regulatory inspection process but possible lower penal procedures or actions. The industry too knows what it needs to do in case of any defects in ETP and acts to rectify it immediately instead of waiting for regulators to catch them.

10. Best Available Technologies (BAT) for recycle/reuse/ZLD

There are no BAT available for ZLD as on today and this needs to be developed and should cater to various sectors. Tamilnadu Water Investment Co. Ltd (TWIC) prepared a BAT for the Textile Dyeing effluent management for the Ministry of Textiles, government of India in January 2016. This can be used as a reference for a comprehensive study for requirements of ZLD for various sectors.

Sample BAT for Textile Dyeing effluent management

A brief extract of the BAT report for textile dyeing effluent prepared by TWIC in January 2016 for Ministry of Textiles, Government of India is presented below.

BAT Hierarchy

In the identification of BAT, emphasis is placed on pollution prevention techniques rather than end-of-pipe treatment. The IPPC Directive 96/61/EC and the Environmental Protection Agency Acts 1992 to 2007 (Section 5(3)), require the determination of BAT to consider in particular the following, giving regard to the likely costs and advantages of measures and to the principles of precaution and prevention (Source: EPA, Ireland)

i. The use of low-waste technology,
ii. The use of less hazardous substances,
iii. The furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate,
iv. Comparable processes, facilities or methods of operation, which have been tried with success on an industrial scale,
v. Technological advances and changes in scientific knowledge and understanding,
vi. The nature, effects and volume of the emissions concerned,
vii. The commissioning dates for new or existing activities,
viii. The length of time needed to introduce the best available techniques,
ix. The consumption and nature of raw materials (including water) used in the process and their energy efficiency,
x. The need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it,
xi. The need to prevent accidents and to minimise the consequences for the environment, and
xii. the information published by the Commission of the European Communities pursuant to any exchange of information between Member States and the industries concerned on best available techniques, associated monitoring, and developments in them, or by international organisations, and such other matters as may be prescribed.

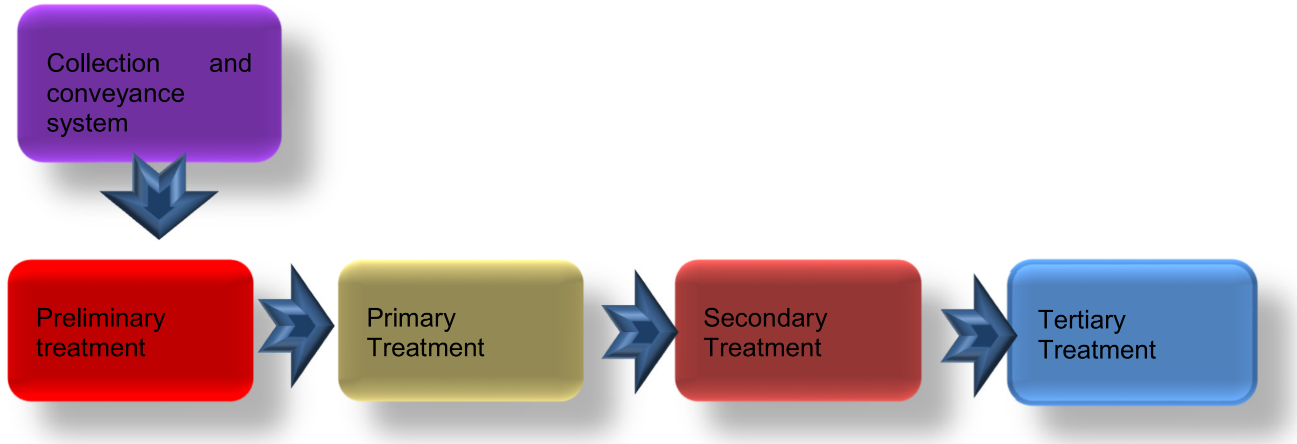
Need for this study:

In view of difficulties in selection of suitable effluent treatment technologies to meet the desired effluent quality, this study has been conducted to find the best practices followed by the CETPs/IETPs to treat the textile effluent to meet discharge standards / reuse stipulated by the statutory authorities.

An Overview of Treatment Technologies:

This section briefly explains the various treatment methodologies are adopted by the textile industries in the process of effluent treatment.

Figure 4: Typical Effluent Treatment Process in CETPs/IETPs



Conveyance system:

Collection and conveyance system would comprises DI/HDPE/Cement pipe line to transport the raw effluent from member units, manholes for cleaning, collection sump to receive effluent and effluent transfer pumps to pump the untreated effluent to the CETP. The choice of pipeline material depends on the nature (acidic/alkaline/ corrosive) of the effluent and costs. In some clusters, tankers are used for transportation of effluents. Transportation with tankers, may be viable where it is difficult to lay pipelines and the volume of effluents to be transported is low, along with close monitoring (with GPS tracking) & licencing, to avoid illegal discharges.

Preliminary Treatment in member dyeing units:

Preliminary treatment is essential process to remove the coarse solids and other large materials from untreated raw effluent discharged from the dye house/member units. Removal of these materials is necessary to enhance the proper operation and maintenance of downstream treatment units. SPCB/ CPCB also prescribes standards for discharge of effluent into the CETP. Preliminary treatment system comprises:

a. Manual Bar screen and Fine screens
b. Oil & Grease Traps
c. Pre aeration for Odour control
d. Equalisation / Homogenisation
e. Neutralisation, if required.
f. Tamper proof Flow measurement with data acquisition system

However, typical preliminary treatment in homogenous textile clusters involves, screening for removal of trash & floating solids and storage talks to reduce the temperature of dye bath effluents to ambient temperature.

Member units which are associated with the CETP have civil tanks to hold one day effluent, generating from its dye house. The main objective was to reduce the temperature, homogenisation of various effluent streams.

Primary treatment

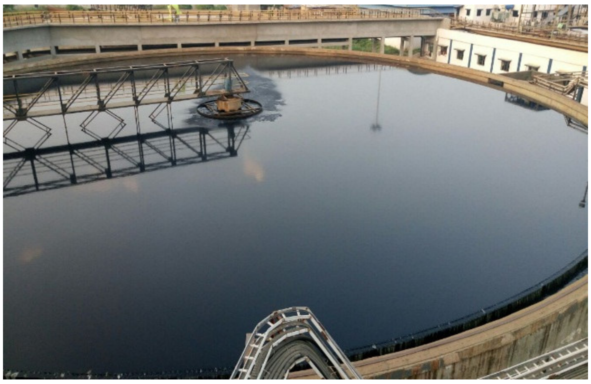
Primary wastewater treatment, system plays a significant role in the physical separation of suspended solids from the textile dyeing effluent using primary clarifiers. This process enhances in reduction of total suspended solids (TSS) and associated biochemical oxygen demand (BOD) levels and prepares the waste for the next downstream treatment process. The objective of primary treatment is to remove settle able solids by plain sedimentation / by addition of coagulants and removal of materials that float (scum) by skimming. Approximately 25 to 50% of the insoluble biochemical oxygen demand (BOD5), 50 to 70% of the total suspended solids (TSS), and 65% of the oil and grease are removed during primary treatment. In addition to this, organic nitrogen, phosphorous and heavy metals are also removed and settled as sludge. If chemicals like lime and Ferrous sulphate is used in the chemical treatment this will generate enormous quantity of sludge, which poses a disposal issue. Components of primary treatment system is shown in below figure.

Figure 5: Typical Primary Treatment system

Screening system

Cascade Aerator

Neutralisation System /pH Correction



Primary Sedimentation Tank

Biological Treatment / Secondary Treatment:

Aerobic Process:

Secondary treatment system is primarily a biological treatment process, which involves decomposition of suspended and dissolved organic matter in waste water using microbes. The mainly used biological treatment processes are suspended culture type activated sludge process or attached culture methods. Microbes /MLSS use the organic compounds as both a source of carbon and as a source of energy. Biological treatment can be either aerobic where microbes require oxygen to grow or anaerobic phase where microbes grow in absence of oxygen or facultative where microbes can grow with or without oxygen. Typical biological treatment aeration tank is shown in below figure.

Figure 6: Secondary Treatment / Aerobic type Biological treatment system

Anaerobic Process

This process is slower than aerobic degradation and when sulphide is present, obnoxious hydrogen sulphide gas is generated and affects the system performance. Therefore, this may be s feasible for chloride salt based dyeing instead of sulphate based dyeing effluents. Though the capital cost is high, part of it can be compensated by recovery of bio gas but in the textile effluent, gas generation is too lower due to lower organic strength (Low COD 1000-2000 mg/l)and poor biodegradability index i.e. < 0.3. They are not so commonly used in wastewater treatment systems for CETPs except as a means for sludge stabilization.

Tertiary Treatment Process:

Filtration units:

Tertiary treatment system plays a significant role in the final polishing of the secondarily treated effluent. This system is comprises, quartz/pressure sand filters, Ion Exchange resins and hardness removal resins.

Figure 7: Typical Filtration unit

Ion Exchange Process:

Ion exchange is a process of exchange of ions between solid and liquid interface. Ion Exchange is widely used to remove colour and calcium and magnesium ions present in the textile effluent there are basically two types of ion exchange systems, the anion exchange resins and the cation exchange resins. The major advantages of using these resin is to produce high quality of treated water and safeguarding the RO membranes. Colour and hardness removal system is shown below figure.

Figure 8: Colour removal and Softener filter for colour and hardness removal

Colour removal Resin Filter

Softener Filter

Colour Removal from the Textile Dyeing effluent:

Classification of dyes based on the Colour removal Treatment technologies

Normally dyes are classified based on their solubility. An alternative classification (Treffry- Goatley and Buckley, 1991) that refers to colour removal methods places the various class of dyes in to three groups depending on their state in solution and type of charge possessed by the dyes. These groups are associated with potential colour removal methods. Typical colour removal methods are widely used are summarised below based on the dyes classification.

Table 5: Colour removal methods for various dyes (Treffry-Goatley and Buckley, 1991)

Classification	Dye class	Charge/Solution state	Technology
Group-I	Disperse Azoic Sulphur VAT	Negatively charged colloidal	Coagulation Membrane Oxidation
Group-A	Acid Reactive Direct Mordant Metal Complex	Anionic Soluble	Adsorption Ion Exchange Membrane Oxidation
Group-C	Basic	Cationic Soluble	Adsorption Ion Exchange Membrane Oxidation

Due to usage of huge amount of dyes stuffs in the dyeing process of cotton/synthetic fibres, coloured effluent is being generated and same will be discharged to the treatment plants. Currently various methods are being employed by the IETPs/CETPs to remove the colour which is present in the textile dyeing effluent. Some of plants are removing the colour in the raw effluent before subjecting it in to biological treatment, while some of the plants are removing the colour after biological treatment. Commonly used methods/chemicals for colour removal are discussed below.

1. Sodium hypochlorite (Nicole) : is a liquid solution and having the strength of available chlorine in the range of 3% to 11%
2. Gaseous chlorine: Normally chlorine gas is used for disinfecting the treated raw water in the WTP before pumping it to the domestic purposes. But recently, this chlorine gas is widely used for removing the colour present in the textile effluent. However, full automated system with chlorine leak absorption system is required for a safe operation of the system.
3. Cationic polymer: is a type of high molecular weight polymers are being used to remove the colour present in the treated / untreated effluent.
4. Electrochemical Treatment: This treatment system further classified as Electrocoagulation, Electro floatation and Electro-oxidation:
5. Weak Base Anionic Resins (WBA Resins):

Microporous, special type of WBA resin are also used in the removal of colour present in the biologically treated effluent. However, further treatment is required for their regeneration liquid waste which will be generated during activation of resins. For which chemicals such as Sodium hydroxide, Sodium Chloride and Sulphuric Acid are required for regeneration of resin.

6. Metal based coagulant (Ferric Chloride ($FeCl_3$ / Ferrous sulphate ($FeSO_4$) with hydrated lime: Metal salts such as Ferric Chloride / Ferrous sulphate are usually used along with the lime to precipitate the colouring matters in the textile effluent.

Table 6: Merits and demerits of the various colour removal methods employed in IETPs/CETPs for textile effluent treatment

S.No	Colour removal Method	Advantages	Disadvantages
1.	Sodium Hypochlorite Solution (NaOCl)	Low Capex & Opex	In addition to the TDS present in the textile dyeing effluent, it again contributing high amount of salt load.
2.	Gaseous Chlorine	1. High capex & Low Opex 2. No additional salt load as in usage of Sodium hypochlorite solution.	1. There no contribution of additional salt load to the system. But poor solubility in high TDS effluent which resulting in poor colour reduction. 2. This system requires complete automation including chlorine leak absorption system, because chlorine gas is highly toxic. 3. Necessary storage and handling license to be obtained as per the regulatory requirement.
3.	Organic / Cationic Polyelectrolytes	Low Capex and Opex	1. Doing requirement will be varied from case to case and hence it needs proper dosing optimisation. 2. Presence of residual polymer flocs may severely affect the Ion Exchange Resins and UF & RO Membranes used in the ZLD system
4.	Electrochemical Treatment	1. High capex and Opex 2. Electro-oxidation generates no sludge and it removes colour up to 80% and COD up to 20-30%	1. Electrocoagulation & Floatation process will generate enormous amount of ferric hydroxide sludge which again pose sludge disposal issues. 2. Every 10 years once Anodes must be replaced in Electro-oxidation.
5.	Ion Exchange Resins (WBA)	1. High Capex and Opex 2. This IX process is required where high grade quality of effluent is required	1. Regenerate liquid waste requires further treatment and also to be evaporated to reduce the volume and recovery waste salt.

S.No	Colour removal Method	Advantages	Disadvantages
		especially reuse of brine and salt.	2. Replacement and Top of resin needs to be done every year to make up the resin losses.
6.	Metal based coagulant with Hydrated Lime	1. Low capex and Opex	1. Optimization of dosing is essential since the nature and intensity of colour will be varied in the effluent from dyeing process. 2. Metals dyes such as Copper present in the turquoise dyes are highly resistant to precipitation by metal coagulants. Moreover colour will reappear after some time. 3. Usually it generates high amount chemical sludge and it will lead to sludge disposal issues, industries need to invest more towards sludge disposal cost to meet out the regulatory requirements.

Advanced Treatment processes:

In this process, membranes such as Ultra Filtration (UF), Reverse Osmosis RO and Nano Filtration (NF) are being used to recover low TDS water and brine solution. Typical RO plant installed in the textile CETP is shown in below figure-10. Basically UF is used as a pre-filter system to achieve SDI, a parameter which is used to assess fouling potential of a feed to RO. UF is basically classified as In to Out and Out to In. Likewise, RO membranes are of two types which are commonly used in the CETPs, they are 1. Brackish water Membranes (BW) and Sea water Membranes (SW).

Figure 9: Reverse Osmosis plant for water recovery

Reject Management system with salt recovery:

During the Reverse osmosis process, there two stream of water is generated one is low TDS permeate water which can be reused in the dyeing process and the other one is high TDS reject /saline water. This reject stream contains high concentration of salt, colour and organics. This stream is concentrated in the

MVR and MEE type Evaporators for recovering of sodium sulphate through adiabatic chiller. Reject management system with sodium sulphate recovery is shown in below figure.

Figure 10: Reject Management system with salt recovery

MVR-Evaporator

MEE-Evaporator

Salt separation through Pusher Centrifuge

Currently used best available technologies for textile effluent treatment, recycling and reuse are summarised below.

Table 7: Currently available technologies for textile effluent management currently

S.No	Technology /Components	Typical Pollution abated	Applicability
A	Raw effluent collection and conveyance system		Generally applicable for CETPs. For acidic and alkaline effluents HDPE / Reinforced FRP is preferred over DI/ CI pipes. In some case cement mortar lining over DI can be used. However, for pipes handling concentrated acids like Sulphuric acid (dosing lines) HDPE or PVDF (wherever heating is expected due to mixing of water and acid) pipe materials can be use.
1.	DI/HDPE pipelines/Cement	NA	
2.	Manholes		
3.	Receiving sump & Lifting pump station		

S.No	Technology /Components	Typical Pollution abated	Applicability
B	Preliminary Treatment in member dyeing units of the CETP		
4.	Manual Bar Screens & O&G separators (Coarse and Fine screen)	Suspended solids, floating materials, Oil and Grease	Mandatory for IETPs/CETPs in the upstream of preliminary treatment.
5.	Cascade Aeration	Reducing Temperature of waste water	Palsana CETP in Gujarat have implemented this.
6.	Homogenisation Tanks	Homogenisation of various streams (low TDS and High TDS) of Textile dyeing process.	Generally applicable
7.	Neutralisation	To adjust the pH close 7.5 to 8.0	The pH is adjusted to 7.5 to 8.0 o make it suitable for biological treatment. Acid or alkali is added as required depending on whether the effluent is acidic or alkaline.
8.	Flow Measurement with centralized data acquisition system	Instantaneous and totalized flow record	Electromagnetic flow meters with GPRS based centralized data acquisition system. Implemented in Tirupur for measurement of untreated effluent, recovered water and treated brine.
	Primary Treatment System		
9.	Mechanized Screening	For removal of trash and fine floating matter	Brush, type, rake type, step type fine screens used with less than 5 mm openings.
10.	Equalisation	Flow equalisation and Homogenisation	To ensure uniform quality and flow of effluent into the subsequent treatment components. Ensures effective performance and proper sizing of downstream components. Typically 24 hrs HRT is provided.

S.No	Technology /Components	Typical Pollution abated	Applicability
11.	Primary Sedimentation with Coagulation and Flocculation by Lime and Metal salts	Precipitation of Suspended solids and colour	Generally applicable, But generates huge volume of solids waste in the treatment plant. Has the advantage of good colour removal along with use of cationic polyelectrolytes. However, CETPs are switching over to a total biological treatment system as successfully demonstrated in Tirupur.
12.	Colour removal - Cationic Polymer	Colour removal	Few IETPs used this polymer to remove colour from the dyeing effluent
13.	Electro-coagulation	For removal of colour, organics and precipitation of solids.	Used in IETP, (M/s. shiny processing mills Pvt Ltd, Erode, Tamilnadu) Higher power consumption, replacement of electrodes and generation of ferric sludge for disposal as hazardous waste is an issue.
14.	Electro- oxidation	Removal of colour and organics	Limited experience. No generation of sludge, used for removal of difficult to biologically degrade or recalcitrant dyes and chemicals and colour.
	Biological Oxidation / Secondary Treatment		
15.	Conventional Activated sludge Process (ASP)/ Extended Aeration (EA)	Biodegradable organic compounds	Generally applicable. E.g Tirupur cluster
16.	Sequencing Batch Reactors (SBR)		Variation of the aerobic ASP (e.g. Palsana), avoids a separate secondary clarifier.
17.	Membrane Bio Reactors (MBR)		Variation of the aerobic ASP, suitable where space is a major constraint and high quality effluent is desired at the secondary stage. E.g. SPP CETP, Tirupur. Has not been very successful, so far.

S.No	Technology /Components	Typical Pollution abated	Applicability
18.	Anaerobic Digesters	Biodegradable compounds with additional generation of biogas	High strength effluents or for bio solids, not commonly employed in Textile. Optionally can be used in textile effluents, to reduce energy costs associated with aerobic processes, without significant generation of biogas (erg an IETP in Tirupur). Not generally recommended for sulphate based dyeing due to problems associated with generation of H_2S, including lower performance, toxicity, bad odour and corrosion. This component must be followed by aerobic treatment to ensure meeting of secondary discharge standards.
19.	Thickener		To thicken solids up to 5 to 6% by gravity thickening. Coagulant and flocculants are added if required. Used for bio sludge generated from ASP.
20.	Mechanized Sludge Dewatering		The thickened sludge is dewater to up to 25 to 35% solids to make it convenient for transportation and disposal. Used for thickened bio sludge or chemical sludge's. Plate and Frame type filter presses, belt press type and decanter type centrifuge are also used. Solar based sludge drying beds are best avoided for CETPs and large IETPs due to large area, bad odour, and manual labour and poor sludge dewatering issues.
	Tertiary Treatment		
21.	Reactor Clarifier with Lime and Soda ash dosing. Dolomite, Polyelectrolyte followed by neutralization with acid.	For softening, silica removal. Also for colour and COD reduction.	Lime and soda ash dosing is employed in reactor clarifiers as a tertiary chemical treatment system if hardness in the wastewater is high. Total Hardness is generally reduced to less than 100 mg/l. Dolomite is also added if Silica content is high. This followed by flocculation with polyelectrolyte for reducing turbidity and acid dosage to reduce the pH

S.No	Technology /Components	Typical Pollution abated	Applicability
			back to 7 to 8. An additional benefit is further reduction in colour and COD.
22.	Quartz / Pressure sand Filter	Suspended solids and Turbidity removal	Generally applicable for removal of TSS & turbidity
23.	Weak Base Anionic Resin Filter (WBA)	Colour removal	Generally applicable where high quality of effluent is required.
24.	Strong Base Anionic Resin(SBA)	Calcium and Magnesium removal	Generally applicable where high quality effluent is needed
	Membrane Technologies		
25.	Ultrafiltration (UF)	Turbidity and TSS removal and to achieve SDI	Generally applicable as pre-treatment to RO system for removal of turbidity and achieving of SDI < 3 as required for RO membrane operations.
26.	Nano Filtration	For segregation of monovalent and divalent salts, removal of hardness and colour	Segregation of chlorides and sulphates, reduction of hardness and also colour, more as a corollary benefit. Can be used before or after R.O depending on the actual case. The permeate from NF installed after R.O can also be used as brine for dyeing although would have a lower salt concentration than used for dyeing.
27.	Reverse Osmosis	TDS removal	Mandatory for water recovery and high grade quality for reuse.
28.	High Pressure Disc Type RO (HP-DTRO)	Brine concentrations	Alternative Technology option to replace MVR-Evaporators or reduce volume of effluents for thermal evaporations, which are an high cost (Capex & Opex) area. While HP-DTRO have been installed in Tirupur, VSEP is yet to be tried on a commercial scale in textile effluents in India.
29.	VSEP	Brine concentrations	

S.No	Technology /Components	Typical Pollution abated	Applicability
	Reject Management Systems (Brine reuse Technology and Thermal Evaporation System		
30.	Brine Reuse Technology	Reuse of concentrated rejects from RO or Evaporators	Typically RO rejects have to be concentrated up to 400 gpl for crystallization. To reduce the need for high energy for evaporation and thereby reduce operating costs, a treated brine reuse technology developed by TWIC has been implemented in Tirupur CETPs. Under this concentrated liquid brine up to 100-150 gpl is treated and reused in the dye bath, thereby recovering and reusing up to 70% of the influent salt load. Typically 2 to 3% v/v of inflow is recovered as brine and reused in the dyeing industry, thereby saving substantial energy costs.
31.	Mechanical Vapour Recompression Type Evaporators (MVR-E)	Brine concentration	For brine concentration at lower temperature thereby saving energy. MVR-E with polymeric heat exchangers have been implemented in Tirupur but have faced mechanical and performance issues. Several leading international OEMs with variations in the technology are available worldwide.
32.	Multiple Effect Evaporator (MEE) with Falling Film Evaporators (FFE) and Forced Circulation Evaporators (FCE) and crystallizers	Brine concentrations	1. For concentration of brine up to 350-400 gpl. 2. Crystallizing of salts.
33.	Adiabatic Chiller	Crystallization of sodium sulphate salt	Recovery of sodium sulphate salt at low temperature.
34.	Pusher type Centrifuge	Dewatering of salts	Recovery of chloride and sulphate salts
35.	Agitated Thin Film Dryer (ATFD)	Waste salt recovery	To evaporate highly concentrated mother liquor (from chillers & centrifuges) and production of dry waste salt

11. Case examples and best practices – Indian and international

Case study of Seriously Polluting Industries

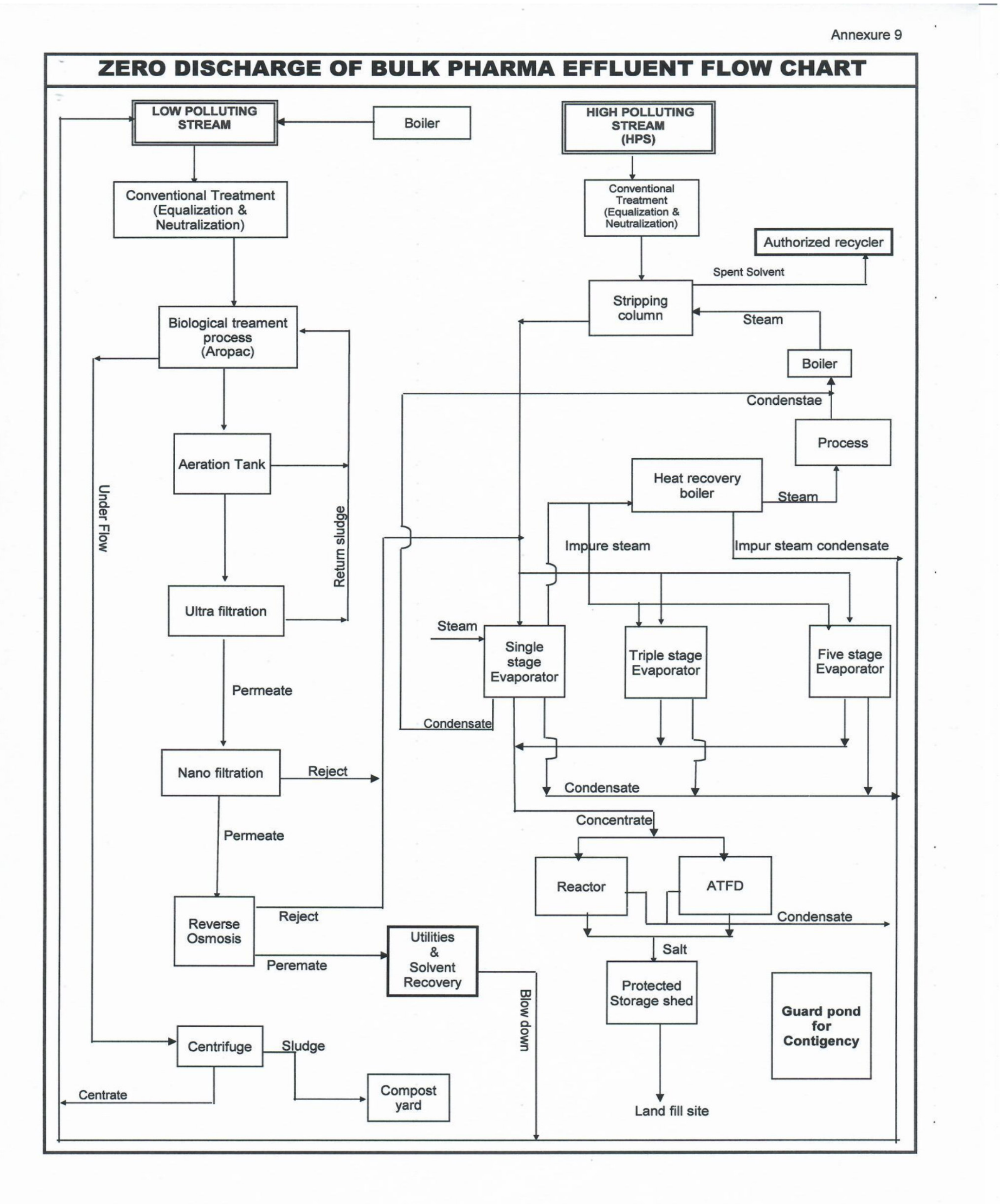
Si.No.	Description	Details
	Case Study	1
	Sector	Aluminium Smelting
	Name of the Industry	M/s. Malco Energy Limited, (Formerly Vedanta Aluminium Limited),
	Address of the Industry and Contact Nos.	Post Box No . 4, Mettur Dam, Salem 636 402. Ph.No. 04298 -222061,304309, 224 613
	Size of the Company	Large
	Size of the ETP	Not Available
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Zero Liquid Discharge consists of Primary Treatment → RO→ Evaporator
	Process Details	
	End Product	Unit not in operation as per TNPCB Report
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://malcoenergylimited.com/sustainability/health-safety-environment/ https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf

<table>
<tr><th>Si.No.</th><th>Description</th><th colspan="4">Details</th></tr>
<tr><td></td><td>Case Study</td><td colspan="4">2</td></tr>
<tr><td></td><td>Sector</td><td colspan="4">Basic Drugs & Pharmaceuticals Manufacturing</td></tr>
<tr><td></td><td>Name of the Industry</td><td colspan="4">M/s. Orchid Chemicals Limited, (Cephalosporin range of products)</td></tr>
<tr><td></td><td>Address of the Industry and Contact Nos.</td><td colspan="4">Alathur Village, Tiruporur Taluk, Kancheepuram Dt.
Ph. No. 044- 27444471 to 78
Email: api@orchidpharma.com</td></tr>
<tr><td></td><td>Size of the Company</td><td colspan="4">Large</td></tr>
<tr><td></td><td>Size of the ETP</td><td colspan="4">400 KLD</td></tr>
<tr><td rowspan="16"></td><td rowspan="16">Effluent Characteristics</td><td>Parameters</td><td>Unit</td><td>Low Polluting stream</td><td>High Polluting Stream</td></tr>
<tr><td>pH</td><td></td><td>6.83</td><td>7.12</td></tr>
<tr><td>Conductivity</td><td></td><td>6110</td><td>28970</td></tr>
<tr><td>TDS</td><td>ppm</td><td>4277</td><td>20279</td></tr>
<tr><td>Total Hardness</td><td>ppm</td><td>240</td><td>480</td></tr>
<tr><td>Calcium Hardness</td><td>ppm</td><td>160</td><td>290</td></tr>
<tr><td>Magnesium Hardness</td><td>ppm</td><td>80</td><td>190</td></tr>
<tr><td>Chlorides</td><td>ppm</td><td>850</td><td>6097</td></tr>
<tr><td>Alkalinity</td><td>ppm</td><td>1250</td><td>3100</td></tr>
<tr><td>Sodium</td><td>ppm</td><td>130</td><td>460</td></tr>
<tr><td>sulphates</td><td>ppm</td><td>19</td><td>127</td></tr>
<tr><td>Silica</td><td>ppm</td><td>24</td><td>90</td></tr>
<tr><td>Iron</td><td>ppm</td><td>0,25</td><td>15</td></tr>
<tr><td>Ammonia</td><td>ppm</td><td>392</td><td>1217</td></tr>
<tr><td>COD</td><td>ppm</td><td>5668</td><td>25910</td></tr>
<tr><td>Suspended solids</td><td>ppm</td><td>1472</td><td>429</td></tr>
<tr><td></td><td>Treatment Scheme</td><td colspan="4">High TDS Stream: Zero Liquid Discharge (Pre-treatment →RO→ MEE→ ATFD)
Low TDS Stream: Pre-treatment → UF→RO → Reuse</td></tr>
<tr><td></td><td>Process Details</td><td colspan="4">High TDS Effluent: The zero discharge of liquid trade effluent treatment plant comprises Membrane Bio Reactor, Nano Filtration, Reverse Osmosis, Solvent Stripping Column, Thermal Evaporation & Crystallization plant to treat the entire trade effluent and recycle back into the utility process.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Low TDS effluent is collected, equalized and neutralized into neutral pH and treated aerobically by Membrane Bio Reactor process and forwarded to Ultrafiltration System for reuse</td></tr>
<tr><td></td><td>End Product</td><td>RO Permeate water Recycled back into the utility process and Solvent Recovery.
Stored in protected storage shed and disposing it into the approved landfill sites / authorized recyclers</td></tr>
<tr><td></td><td>Capex</td><td></td></tr>
<tr><td></td><td>Operational cost</td><td>Rs.650/-Cu. M</td></tr>
<tr><td></td><td>Financial Impact</td><td>5%</td></tr>
<tr><td></td><td>Water requirement</td><td>198 liters/Kg</td></tr>
<tr><td></td><td>Reference</td><td>http://www.orchidpharma.com/abt_environment.aspx;
http://www.orchidpharma.com/stockexchangers/Intimation%20to%20NSE-BSE-%20Regulation%2034%20of%20the%20SEBI%20(LODR)%20Regulations,20....pdf

https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf;

TNPCB- Maraimalai Nagar - Email dated 8th Oct 2020</td></tr>
<tr><td></td><td>Case Study</td><td>2-A</td></tr>
<tr><td></td><td>Name of the Industry</td><td>M/s. Solara Active Pharma Sciences Limited, Cuddalore -5</td></tr>
<tr><td></td><td>Capacity of the plant</td><td>ETP & RO - 240 KLD
MEE – 10,000Kg/hr
ATFD -1 &2-1250kg/hr each
ATFD -3 - 1650 kg/hr.</td></tr>
<tr><td></td><td>Inlet parameter of ETP</td><td><table><tr><td>S. No.</td><td>Parameters</td><td>High TDS inlet - ppm</td></tr><tr><td>1</td><td>pH</td><td>7-9</td></tr><tr><td>2</td><td>Total suspended Solid</td><td>260</td></tr><tr><td>3</td><td>Total Dissolved Solids</td><td>39760</td></tr><tr><td>4</td><td>Oil & Grease</td><td>64</td></tr><tr><td>5</td><td>BOD</td><td>12158</td></tr><tr><td>6</td><td>COD</td><td>48000</td></tr></table></td></tr>
<tr><td></td><td>End use of RO+ ZLD treated water</td><td>Cooling Tower makeup</td></tr>
<tr><td></td><td>Investment cost</td><td>9.54 Crores.</td></tr>
<tr><td></td><td>Operating Cost per Cu.M</td><td>Rs.900/-</td></tr>
<tr><td></td><td>Reference</td><td>Email dated 12.10.2020</td></tr>
</table>

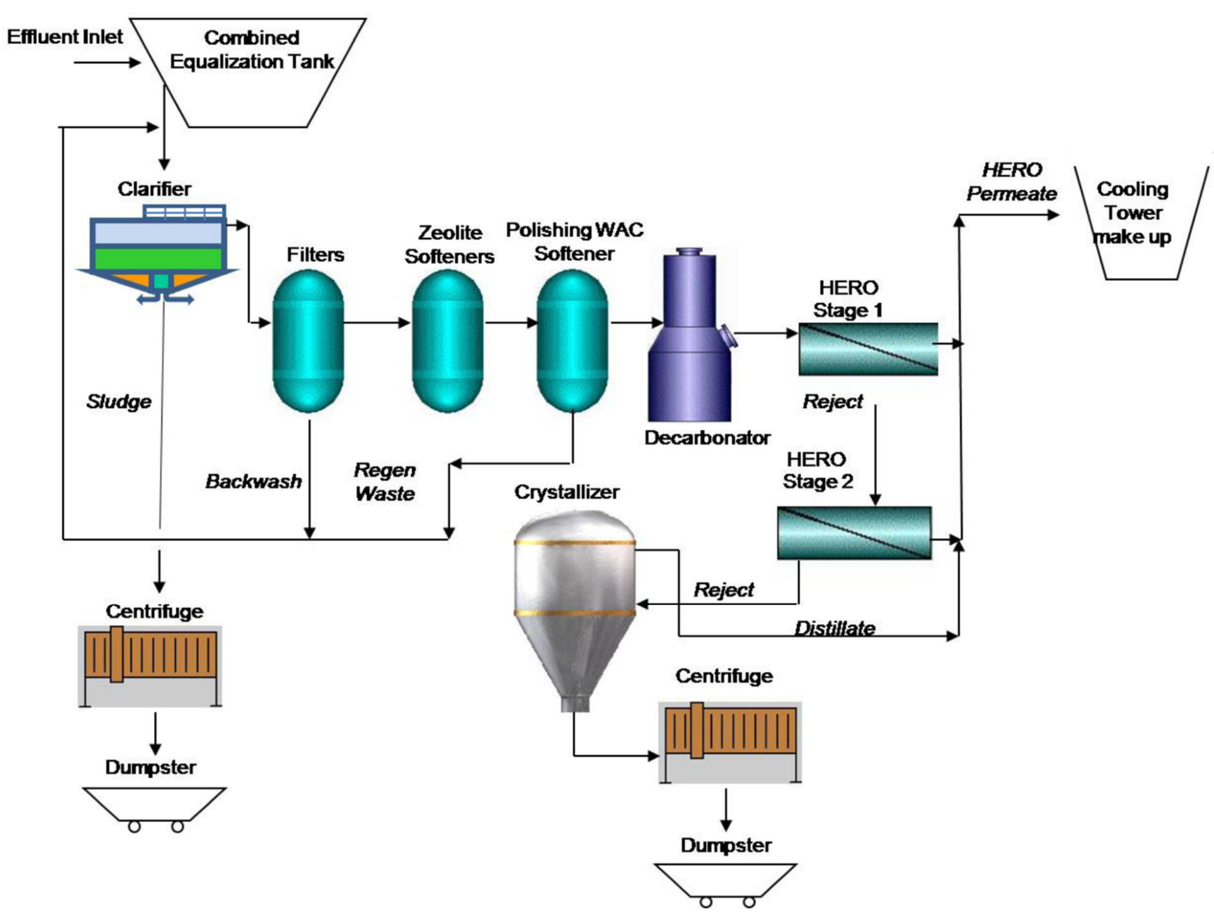


Source : DEE - TNPCB- Maraimalai Nagar - Email dated 8th Oct 2020

Si.No.	Description	Details	
	Case Study	3	
	Sector	Caustic Soda	
	Name of the Industry	Chemplast Sanmar Limited, (Sanmar Holding Limited)	
	Address of the Industry and Contact Nos.	Sipcot Phase-II, Cuddalore. Head Office: Tel : 04142 -239280 Fax.: 04142 -239 281	
	Size of the Company	Large	
	Size of the ETP	1.9 MLD	
	Effluent Characteristics	**Inlet Parameters**	**ZLD outlet Parameters**
		BOD: 25 ppm	TDS: 340 ppm
		COD: 560 ppm	pH: 6.5-8
		TDS: 9500 ppm	Turbidity: 1 NTU
		Calcium as Ca: 150 ppm	
		Magnesium: 65 ppm	
		Sodium: 1164 ppm	
		Sulphates: 124 ppm	
		Bicarbonates: 132 ppm	
	Treatment Scheme	Zero Liquid Discharge (Primary→ Zeolite Softener → Polishing WAC softener →De carbonator → RO → Crystallizer→ RO Permeate Reuse and solid waste send it to TSDF)	
	Process Details	The combined effluent from various streams (treated Polymer, combined Monomer, Caustic plant, CMP plant, RO reject & others) shall be treated in the ZLD system. Raw effluent streams internally produced by the plant are collected separately in a tank and pumped back into the system at an equated rate. Suitable arrangement is provided in the equalization tank to ensure proper mixing of the incoming streams. The RO system is used to concentrate the dissolved solids in its reject stream and recover the quality water from the permeate side of the system followed by Mechanical Vapor Compression based ZLD system. The overall recovery of the complete ZLD system is 97%. (	

	End Product	•Sludge is used as landfill •Salt is used as raw material to their main process
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://www.tnpcb.gov.in/success-stories.php; http://environmentclearance.nic.in/writereaddata/Online/TOR/05_May_2016_163207020X0QOQMUSPrefeasibilityReport_V5020516.pdf; https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf & Aquatech Project Profile Report #61

Typical flow diagram of Caustic Soda Plant



Source : M/s. Aquatech - Project Profile #61

Si.No.	Description	Details
	Case Study	4
	Sector	Cement
	Name of the Industry	J.K. Lakshmi Cement Limited
	Address of the Industry and Contact Nos.	Semaria Village, Ghikuria and Nandani Kundani, Tehsil Dhamda, Dist. Durg, Chattisgarh Fax No. : 011-23722251/23722021
	Size of the Company	Large
	Size of the ETP	4.5MLD
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Raw effluent collection cum neutralization tank →Primary clarifier→ Over flow goes to treated water collection tank for further use.
	Process Details	In cement industries water is used only for cooling operation of manufacturing process. Process wastewater with high pH and suspended solids may be generated in some operations. Generally, water used for cooling purpose is recycled and reused in the process. Screening and for suspended solid reduction are done by using settling basin and clarifier. Water treated from waste water treatment plant should use for green belt development and utilities. This green belt also helps in minimizing noise pollution
	End Use	used for cooling tower make-up and dust suppression
	Capex	
	Operational cost	
	Financial Impact	
	Remarks	http://environmentclearance.nic.in/writereaddata/modification/previousTOR/271120176A9RURWDAnnexurePreviousECLetter.pdf https://pdfs.semanticscholar.org/d603/bc728d3de038edad48bf40aa5d8a24c6ab9f.pdf

Si.No.	Description	Details
	Case Study	5
	Sector	Copper smelting
	Name of the Industry	M/s. Sterlite Industries
	Address of the Industry and Contact Nos.	SIPCOT Industrial Complex, Madurai Bye Pass Road, TV Puram P.O, Tuticorin
	Size of the Company	Large
	Size of the ETP	4.5MLD
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Pretreatment→ UF→RO→ MEE
	Process Details	Not Available
	Ende use	Treated effluent is completely recycled for copper slag quenching and Milk of lime
	Process details	
	Capex	
	Operational cost	
	Financial Impact	
	Remarks	https://www.vedantaresources.com/FactSheet/Tuticorin.pdf; https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf

Si.No.	Description	Details
	Case Study	6
	Sector	Dyes & Dye Intermediaries
	Name of the Industry	M/S. Clariant Chemicals (India) Limited,
	Address of the Industry and Contact Nos.	Kudikadu Village, SIPCOT Industrial Complex, Cuddalore -607 005
	Size of the Company	Large
	Size of the ETP	Designed capacity: 2.6 MLD
	Effluent Characteristics	RO inlet TDS: 14500 ppm RO outlet TDS : 700 ppm COD: 500 ppm COD : 50 ppm
	Treatment scheme	Raw Effluent collection and neutralization tank→ Flash mixer →Primary clarifier → Aeration system → Secondary settling → RO→ MEE→ All permeate water will be recycled in the process.
	Process Details	Primary treatment involves the neutralization of effluent, flash mixer, Primary clarifier, biological treatment forwarded by secondary clarifier to meet the downstream treatment process The quantity of treated water from ETP will around 2403 Cu.M/day out of which 400 Cu.M/day is reused for production process and 1100Cu.M/day is sent to RO plant and the remaining 903Cu.M/day is discharged into marine waters. The RO Reject of 137 Cu. M/day will be treated in MEE. The marine discharge facility already consents from TNPCB for disposing treated water to tune of 903 Cu.m/day to bay of Bengal
	End use	RO Permeate: 963 Cu. M./day for process reuse Marine discharge after secondary clarifier: 903 Cu. M /day Solid waste from MEE and ETP: TSDF disposal
	Capex	

	Operational cost	
	Financial Impact	
	Remarks	http://environmentclearance.nic.in/writereaddata/FormB/EC/EIA_EMP/081120174WBTGZSPClariant_EIA.pdf; https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; http://environmentclearance.nic.in/writereaddata/formB/MODIEC/31072018VM9KQCMNECamendmentrequestletter.pdf;

CLARIANT	EIA report of Proposed Expansion for the Manufacturing of Pigment and Intermediate Products at SIPCOT Industrial Complex, Kudikadu Village, Cuddalore Taluk, Cuddalore District, Tamil Nadu	Project No: PJ-ENVIR-20161013-988 June2017
		Chapter 3 – Proposed Project

Table 3-11 Technical details of the Upgraded ETP

S.No.	Description	Capacity
1	Equalization tank	510 KL
2	Flash mixer	2 x 2 x 3 mtr – 3 nos
3	Clarifier	9 mtr dia
4	Thickener	10 KL
5	Holding tank	200 KL
6	New filter press	1 No
7	Aeration tank with 400 m^3/hr blower – 2 Nos	675 m^3
8	Secondary clarifier-II	250 m^3
9	Holding Tank- 1 No	500 KLD
10	RO Plant	1100 KLD
11	MEE	100

Technical Details of the Two Stage Reverse Osmosis Plant

Table 3-12 Technical Details of the Two Stage RO Plant

Description		Value
RO Input Effluent Capacity	Total	1100 KLD
	First Stage	695 KLD
	Second Stage	405 KLD
RO Input Effluent Quality	pH	6- 6.5
	TDS	14500 ppm
	COD	500 ppm
RO Permeate Quality	TDS	750 ppm
	COD	50 ppm
Recovery of RO Permeate		70 %

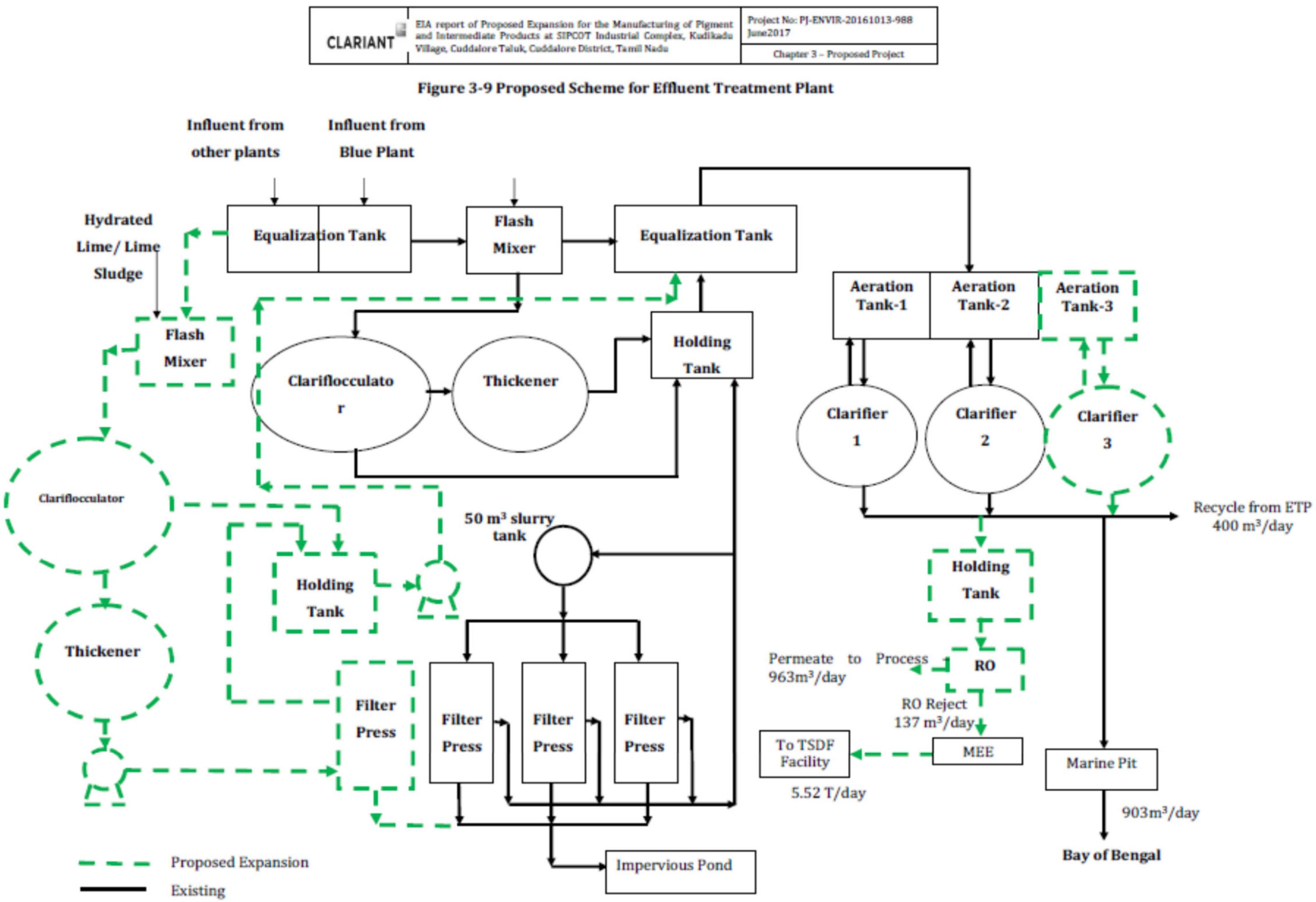
Technical Details of the MEE

Table 3-13 Technical Details of the MEE

S. No	Description	Unit	Value
1	Feed Quantity	KLD	100
2	Operating Hours	hrs	20
3	Sp. gravity	-	1.23
4	pH	-	6-8
5	Feed Temperature	^{0}C	Ambient
6	Initial TDS	%	20
7	Steam Pressure	Kg/cm^2 (g)	3.5
8	Steam temperature	^{0}C	Saturated
9	Cooling water temperature	^{0}C	32
10	Feed Rate	Kg/hr	6150
11	Water Evaporation Capacity	Kg/hr	4785

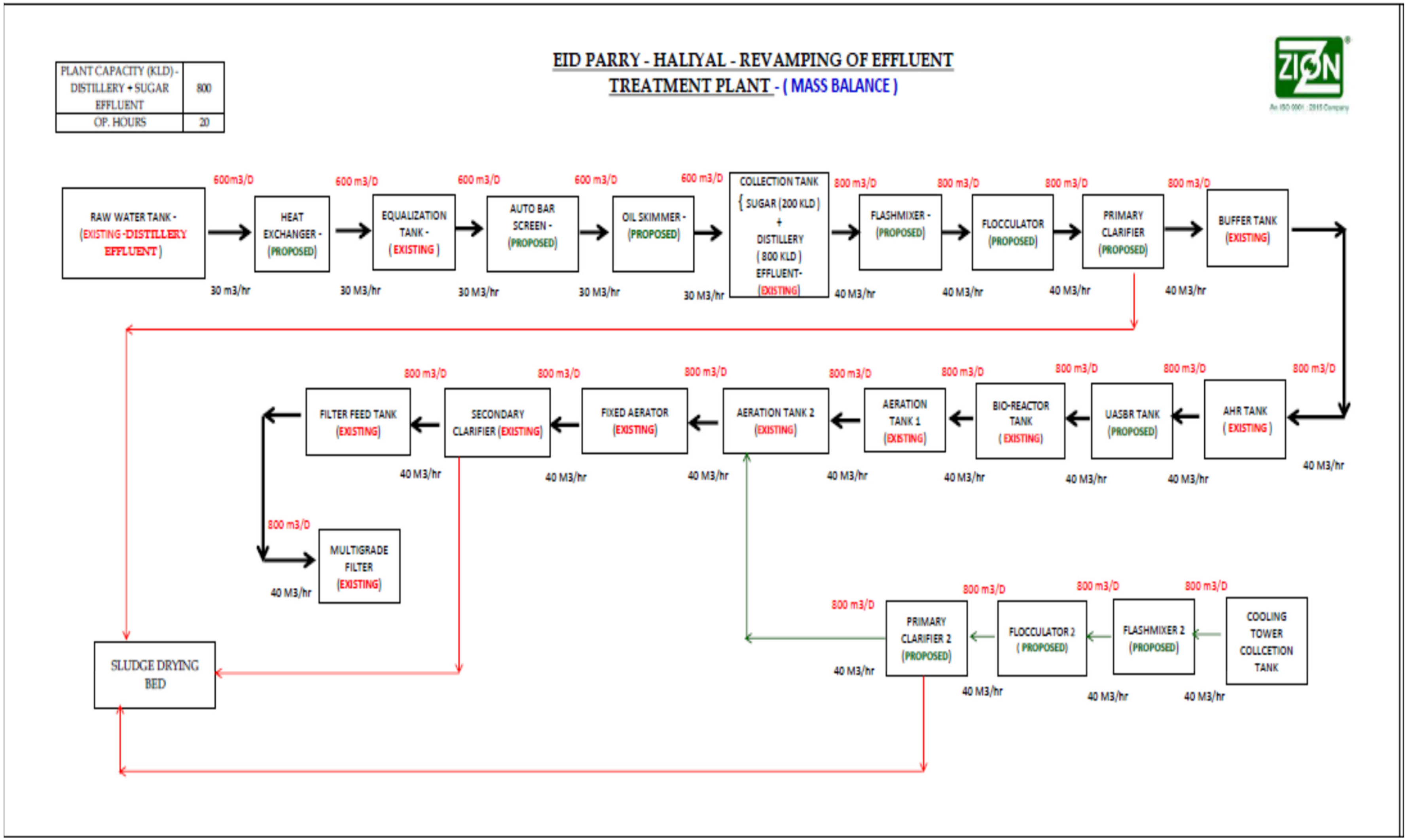
Source : Clarient EIA Report – June 2017

Typical ZLD based ETP Process in Dyes and Dye Intermediaries



Source : Clarient EIA Report – June 2017

Si.No.	Description	Details
	Case Study	7
	Sector	Fermentation (Distillery)
	Name of the Industry	M/S. EID Parry India Limited,
	Address of the Industry and Contact Nos.	Nellikuppam Plant, Panruti TK, Cuddalore - 607105. Nallyal Plant, Uttara Karnataka.
	Size of the Company	Large
	Size of the ETP	1 MLD
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Equalization - Primary→ Aeration → Secondary settling → Inland discharge
	Process Details	
	End Use	For irrigation
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; & M/s. Zion Technical Offer



Source: M/s. Zion Technical Offer

Si.No.	Description	Details
	Case Study	8
	Sector	Fertilizer
	Name of the Industry	M/S. Madras Fertilizers Limited
	Address of the Industry and Contact Nos.	Manali Village. Madhavaram Taluk, Tiruvallur
	Size of the Company	Large
	Size of the ETP	8.4 MLD
	Raw Effluent Characteristics	Not Available
	Treatment scheme	Equalization →Clarifier → DMF → RO→ Reject
	Process Details	Not Available
	End Use	RO permeate reused for makeup water for utilities
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; http://madrasfert.co.in/the-plant/utilities/; and https://tnpcb.gov.in/pdf/Action_plan_Manali12092016.pdf

SL. No.	Description	Details
	Case Study	9
	Sector	Iron & Steel
	Name of the Industry	M/S. JSW Steel Limited,
	Address of the Industry and Contact Nos.	Potteneri Post Mecheri, Mettur Taluk Salem District -636 453
	Size of the Company	Large
	Size of the ETP	20 MLD
	Effluent Characteristics	Inlet TSS: 2500PPM and Outlet TSS: 50PPM
	Treatment scheme	Raw Effluent is collected in the Equalization tank and followed by settling tank for removal the suspended solids for further reuse in the steel plant.
	Process Details	No waste water envisaged.
	End use	
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; & https://www.jsw.in/sites/default/files/assets/industry/steel/IR/Environmental%20Clearances/JSW%20Steel%20Salem%20works%20EC%201.0%20to%201.30%20MTPA%20dated%2007.07.2017.pdf

<table>
<tr><td>Sl.No.</td><td>Description</td><td>Details</td></tr>
<tr><td></td><td>Case Study</td><td>10</td></tr>
<tr><td></td><td>Sector</td><td>Leather Processing</td></tr>
<tr><td></td><td>Name of the Industry</td><td>Ranipet Tannery Effluent Treatment Plant, (RANITEC CETP)</td></tr>
<tr><td></td><td>Address of the Industry</td><td>V.C. Mottur, Walajapet District.</td></tr>
<tr><td></td><td>Size of the Company</td><td>Large</td></tr>
<tr><td></td><td>Capacity of the plant</td><td>4 MLD</td></tr>
<tr><td></td><td>Raw Effluent Characteristics</td><td>
<table>
<tr><th>Sl.No</th><th>Parameters</th><th>Values</th></tr>
<tr><td>1</td><td>pH</td><td>7.5 - 8.5</td></tr>
<tr><td>2</td><td>Total Suspended Solids</td><td>1500 - 2000</td></tr>
<tr><td>3</td><td>Total Dissolved Solids</td><td>20000 - 23000</td></tr>
<tr><td>4</td><td>Chemical Oxygen Demand</td><td>4000 - 8000</td></tr>
<tr><td>5</td><td>Biochemical Oxygen Demand</td><td>1400 - 1800</td></tr>
<tr><td>6</td><td>Chloride (as Cl^-)</td><td>10000 - 13000</td></tr>
<tr><td>7</td><td>Sulphide (as S^-)</td><td>200 - 300</td></tr>
<tr><td>8</td><td>Sulphate (as SO_4^{2-})</td><td>3400 - 4000</td></tr>
<tr><td>9</td><td>Chromium (Cr^{3+})</td><td>1.5 - 2.5</td></tr>
<tr><td>10</td><td>Oil & Grease</td><td>15 - 25</td></tr>
<tr><td>11</td><td>Ammoniacal nitrogen (as N)</td><td>350 - 450</td></tr>
<tr><td>12</td><td>Total phosphate (as $PO_4^{2-)}$</td><td>15 - 25</td></tr>
<tr><td>13</td><td>Total alkalinity</td><td>2000-3000</td></tr>
<tr><td>14</td><td>Ammonical nitrogen (as N)</td><td>50-100</td></tr>
<tr><td>15</td><td>Silica as SiO_2</td><td>15-20</td></tr>
<tr><td>16</td><td>Total Hardness</td><td>900-1200</td></tr>
<tr><td>17</td><td>Ca Hardness</td><td>200-300</td></tr>
<tr><td>18</td><td>Mg Hardness</td><td>700-900</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td>Treatment Scheme</td><td>Primary→ Biological Treatment → Secondary treatment →Tertiary Treatment → UF →RO→MEE</td></tr>
<tr><td></td><td>Process Details</td><td>ZLD based CETP Plant: Refer Annexure -I

Chrome Recovery Plant:

Tanneries doing chrome Tanning Process have installed chrome Recovery Units in their own. These tanneries segregate the chrome liquor and collect in a tank for precipitation of the chrome by adding magnesium oxide solution. The precipitated chrome slurry is added with sulphuric acid to regenerate chrome and filled in carboys. The same can be reused in the tanning process.</td></tr>
<tr><td></td><td>End Use</td><td>RO Permeate: back to industries for reuse

MEE Recovered mixed Salt: stored in SSY (Safe Storage Yard) Waste salt Generation = 8-12 Tons/MLD of permeate flow</td></tr>
<tr><td></td><td>Capex</td><td>RANITEC -Invested Amount – 165 Crores (Brown field)

CETP + ZLD = Rs. 12 to 15 Crores /MLD (Green field Project)</td></tr>
<tr><td></td><td>Operational cost</td><td>Rs. 650/- per Cu. M</td></tr>
<tr><td></td><td>Financial Impact</td><td><table>
<tr><th>Description</th><th>International Brand</th></tr>
<tr><td>% of ZLD O&M cost on processing cost of Raw to Finish leather (W/o recovery)</td><td>27%</td></tr>
<tr><td>% of ZLD O&M cost on Finished Leather (With recovery)</td><td>24%</td></tr>
<tr><td>% of ZLD O&M cost on selling cost of the finished Product (One Pair of Shoe)</td><td>2%</td></tr>
</table></td></tr>
<tr><td></td><td>Reference</td><td>http://www.ranitec.com/inaugationzld.php;
https://www.tnpcb.gov.in/success-stories.php;
CPCB Guidelines of ZLD for all sectors
TWIC - Jajmau ZLD based CETP DPR -2017

RANITEC – Email dated 14th Oct 2020</td></tr>
</table>

Annexure -I - Process Details

Annexure -I

Technology Summary of Process employed in Tannery CETPs

The effluent generated from the Leather manufacturing process needs some Pre-treatment before sending the same to CETP for further treatment. Depending on the quality and quantity, there are various forms of treatments to treat the waste water discharged from the Tannery units. A Summary of various types of treatment that are usually employed to treat the Tannery waste water is given below. The treatment is broadly divided into Pre-treatment, Primary Treatment, Secondary Treatment, Tertiary Treatment and Reject Management System.

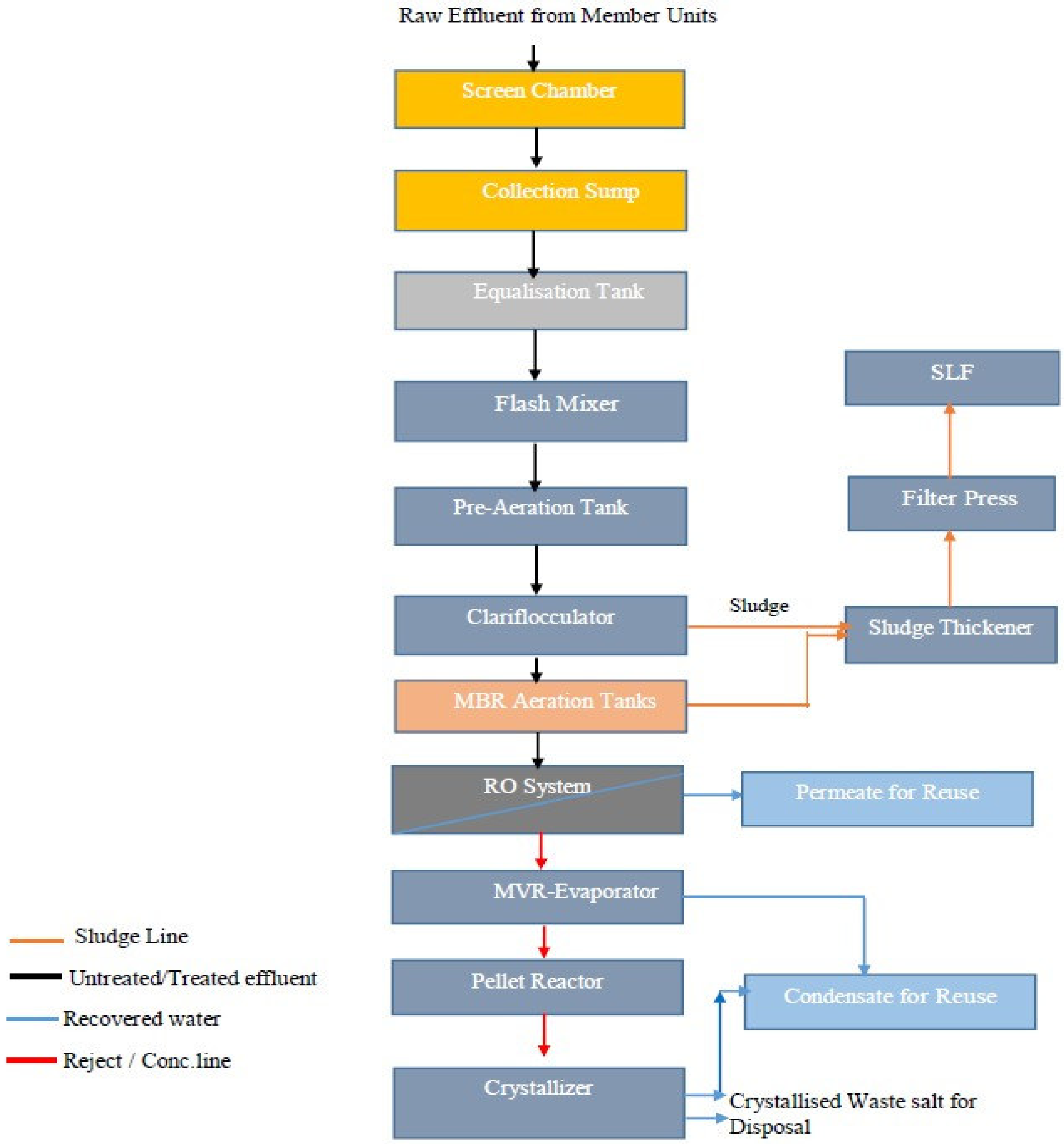
Technology Summary of Treatment Process employed in Tannery CETPs'

S. No	Type of Treatment System	Objective
	Pre-treatment system	• Pre-treatment system in Tanneries involves variety of unit process to remove undesirable characteristics of effluent. • Unit process includes Screening, grit chambers, Oil & Grease trap, sedimentation and segregation of effluent streams etc. • Pre-treatment system is an essential one and it is required in member units to treat the waste water properly before sending it to Collection and Conveyance system of the CETP. • In case of Tanneries, Pre-treatment system is essential to avoid choking of the sewer pipeline network. In case of Chrome tanning Tanneries segregation of chrome liquor for recovery of chrome is essential.

2.	Primary Treatment System	• This treatment involves equalization and neutralization of the effluent and prepare the effluent suitable to other downstream treatment process. • Primary settling tank / Primary chemical treatment is used in some CETPs to remove the TSS, Colour and Insoluble BOD & COD by addition of Lime, Coagulants and flocculants. • All Tannery CETPs employ Equalization. • Tannery CETPs do not require or employ any neutralization step as pH is around 7.5 to 9.0. • The sludge from the Primary clarifier is thickened and dewatered in Filter press / Centrifuge.
3.	Secondary Treatment System	• This is primarily used to remove the organic pollutant load from the wastewater. Usually Aerobic and Anaerobic system is used to treat the wastewater. • **Types of Aerobic System** 1. Activated Sludge Process (ASP) 2. Aerated Lagoons (AL) 3. Membrane Bio Reactors (MBR) • Types of Anaerobic System 1. Up flow Anaerobic Sludge Blanket Reactors (UASBR). 2. Anaerobic Lagoons • However anaerobic systems have not been very successful due to presence of sulphates (Sulphidogeneis) and chrome resulting in poor performance and foul odour issues. • Tannery CETPs have extensively activated sludge process (ASP) based on extended aeration. • Aerated lagoons have been employed by Tannery CETPs for pre-aeration and oxidation of sulphides. • Some CETPs in both the sectors have employed MBR in lieu of extended aeration type ASP.

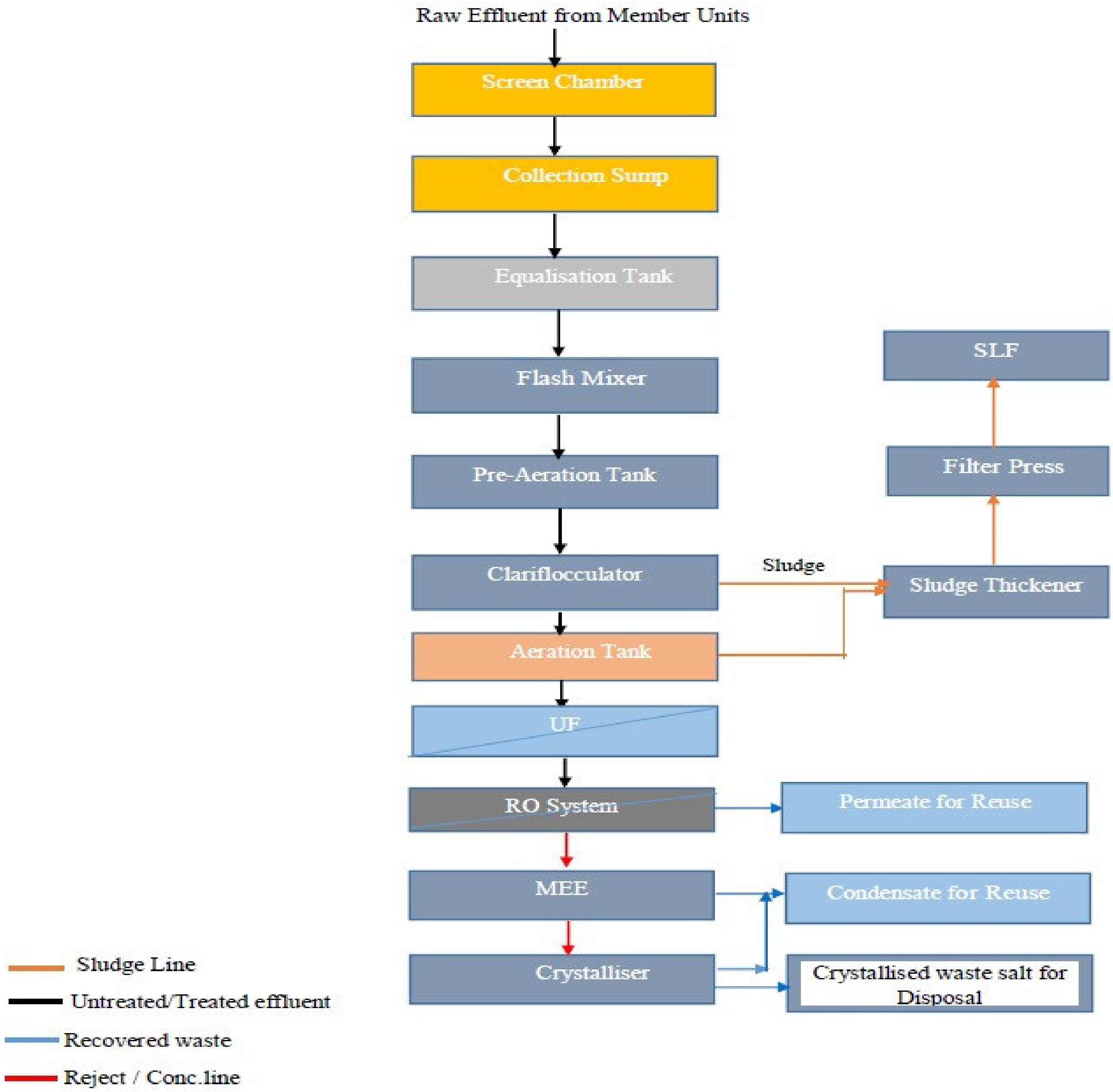
4.	Tertiary Treatment System	• Lime Soda ash Softening System to reduce hardness elements (Calcium & Magnesium). • This treatment system also includes Pressure Sand Filter, Microfiltration (MF), Ultrafiltration (UF), Nano Filtration, and Reverse Osmosis. Ion Exchange Resins for Colour and Hardness removal • The Various combinations of membrane filtration is adopted in tertiary treatment system especially in water reuse applications as in ZLD system they are: Case-I : MBR with RO Case-II : UF with RO
5.	Reject Management System (RMS)	RMS is the final level of Treatment system to handle the NF / RO rejects. • Various Unit Process involved in this system are as follows. 1. Mechanical Vapor Recompression Evaporator (MVR-E): as a brine concentrator to increase salt concentration up to 90-100 gpl. 2. Multiple Effect Evaporation system (MEE): To increase the Solids / Salt concentration up to 300 – 400 gpl before fed in to a salt recovery system.

Case :I : Schematic of a typical ZLD based tannery CETP with MBR System



Source: TWIC – Jajmau ZLD based DPR -2017

Case II: Schematic of a typical ZLD based tannery CETP with conventional activated Sludge Process with Ultrafiltration



Source: TWIC – Jajmau ZLD based DPR – 2017

Financial Impact for Leather Processing / sale price of the finished Product			
S.No	**Item Description**	**UOM**	**Value**
1	Capacity of the CETP	cu.m/day	4500
2	Water consumption for Tanning	Litres/Kg	30
3	Total Processing capacity of Raw Hide	Tons /Day	150
4	Total Processing capacity of Finished leather @40% of Raw Hide	Tons /Day	60
6	Processing cost of Raw to Finish leather (Rs/sq.ft)	Rs./sq.ft	60
7	Processing cost of Raw to Finish leather (Rs/kg)*	Rs./kg	180
8	Processing Cost	Rs. Million/day	11
9	Estimated O&M Cost of ZLD CETP	Rs./m^3 of CETP inflow	650
10	O&M Cost of ZLD system without recoveries	Rs. Million/day	2.9
11	**% of ZLD O&M cost on processing cost of Raw to Finish leather (W/o recovery)**	**%**	**27%**
12	Water Recovery @ 95% v/V	m^3/day	4275
13	Water Cost (Cost considered for supply of process from ULB source)	Rs/m^3	70
14	Total Recovered cost	Rs/m^3 of CETP inflow	67
15	Net O&M Cost of ZLD System after considering water recovery	Rs./m^3 of CETP inflow	584
16	Cost of ZLD system @ Rs. 650/ cu.m	Rs. Million / day	3
17	**% of ZLD O&M cost on Finished Leather (With recovery)**	**%**	**24%**
18	Cost of ZLD for finished leather	Rs. /Kg	44
19	**Impact on Shoe selling cost**		
19.1	Area of Finished leather	sq ft./kg	3
19.2	Amount per sq.ft of Finished leather	Rs / sq.ft	15
19.3	Approximate leather required for one pair of shoes	sq. ft	3
19.4	O&M Cost of ZLD System per pair of shoes	Rs / Shoe	44
19.5	Manufacturing cost/sale price of the finished Product of the company (Export Quality)**	Rs./Shoe	2000
19.6	**% of ZLD O&M cost on selling cost of the finished Product (One Pair of Shoe)**	**%**	**2%**

Note:

* Does not include cost of raw hide or skin

** Inclusive of all cost

Si.No.	Description	Details
	Case Study	11
	Sector	Oil Refinery
	Name of the Industry	M/s. Chennai Petroleum Corporation Limited.,
	Address of the Industry & Contact No.	Manali Village. Madhavaram Taluk, Tiruvallur. Tel : 044- 25944000 to 009 Fax. : 044-25941047
	Size of the Company	Large
	Capacity of the plant	6 MLD
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Raw effluent collection tank →oil removal system → sulphide removal system → UF →RO → Reuse
	Process Details	CPCL have primary treatment, secondary treatment and tertiary treatment. Primary treatment consists of primary oil separation, secondary oil separation and sulphide removal and biological treatment The tertiary treatment is mainly Reverse Osmosis and permeate is utilized and rejects are discharged into cooling tower. In some of the coastal refineries the sea water is used as cooling water and this itself is having higher TDS and RO rejects are having lesser TDS.

		In some of the Refineries High Efficiency Reverse Osmosis are provided as these operate at elevated pH resulting in significant advantages over conventional Reverse Osmosis which operates at neutral pH and efficiency is 86% thereby reducing the cost of desalination.
	End Use	RO Permeate is mostly utilized as make up water, for firefighting purposes, green belt development and other maintenance works.
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; https://www.cpcl.co.in/EC%20Letter.pdf & CPCL EIA Report dated December 2016

Si.No.	Description	Details
	Case Study	12
	Sector	Pesticides
	Name of the Industry	M/s. Tagros Chemicals India Limited.,
	Address of the Industry & Contact No.	SIPCOT Industrial Complex, Cuddalore -607 005 Tel: 04142-239373-74 Fax: 04142 - 239375
	Size of the Company	Medium
	Capacity of the plant	Total Capacity: 190KLD High TDS effluent: 71Cu.M/ day Low TDS effluent: 101Cu.M/day Sewage: 18 Cu.M/day
	Raw Effluent Characteristics	BOD: 26000 ppm; COD: 8610 ppm TDS: 14000 ppm
	Treatment Scheme	Pretreatment → UF→RO→MEE

	Process Details	High TDS effluent is being treated through a seven effect Multiple Effect Evaporator (MEE) system where condensate water is recovered for reuse, while the concentrate is further concentrated and crystallised as a waste salt through VTFD system. As the recovered condensate from the HTDS stream contains 760-1800 mg/l TDS also high COD (1400 mg/l) & Colour (117 Pt. Co), it is separately treated and water is recovered using a DTRO system.
	End Use	Use with cooling tower makes up and boiler water make up. The generated solid waste from the LTDS and HTDS streams is processed at TSDF /land fill site located at Madurai / Gummidipoondi.
	Capex	Rs. 15Crores
	Operational cost	Rs.944/Cu. M.
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; & TWIC Audit Report -2019

TYPICAL ZLD-ETP FLOW CHART PESTICIDES INDUSTRY

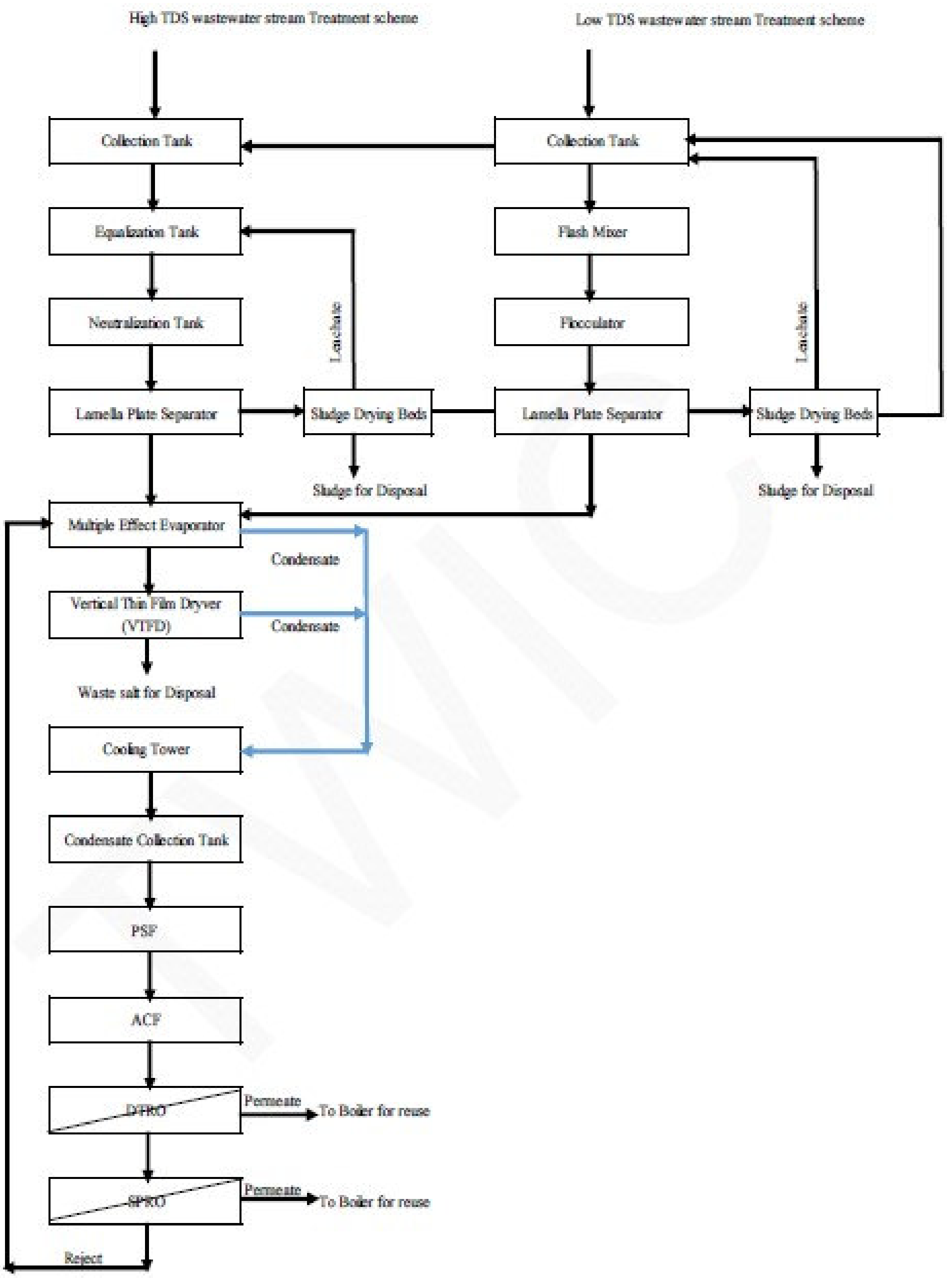


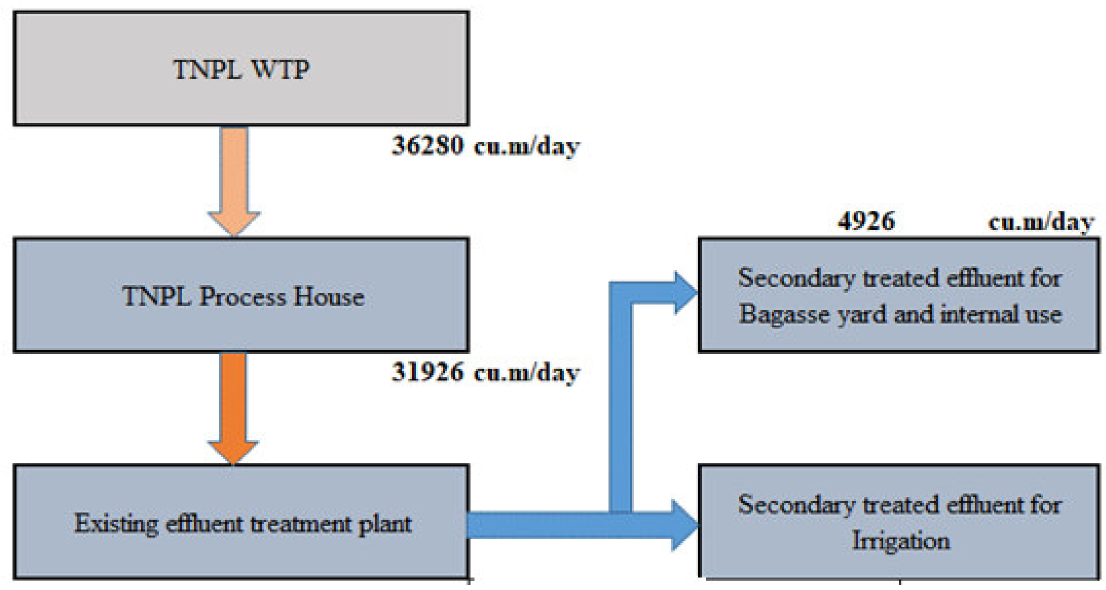
Figure 5: Process Flow Diagram (PFD) showing the existing treatment scheme of low

Source: TWIC Audit Report -2019

Si.No.	Description	Details
	Case Study	13
	Sector	Pulp & Paper (Manufacturing with and without Pulping)
	Name of the Industry	Tamilnadu News Print Limited,
	Address of the Industry	Kagithapuram, Karur District. Tel. : 04324-277044
	Size of the Company	Large
	Capacity of the plant	Submitted the detailed project report for 10 MLD water recovery system from High Pollutant Waste Water Streams out of 50 MLD Effluent generated from TNPL factory
	Raw Effluent Characteristics	BOD: 1200 to 1800 ppm ; COD: 3800 to 5800 ppm TDS: 4500 to 6100 ppm
	Treatment scheme	Existing Treatment: Preliminary Treatment → Primary Treatment → Anaerobic Treatment → Aerobic Treatment Tertiary Lime Soda Softening Treatment → Chlorination → QF/DMF Proposed treatment based on the pilot study after above treatment followed by NF, RO for water recovery and Reject management consists of MEE and Membrane distillation.
	Process Details	Pre-Treatment section includes primary (settling, storage & homogenization), secondary (anaerobic, biological oxidation and sludge management) and tertiary (including LSS, filtration and softener) stages before entry into the Reverse Osmosis (RO)

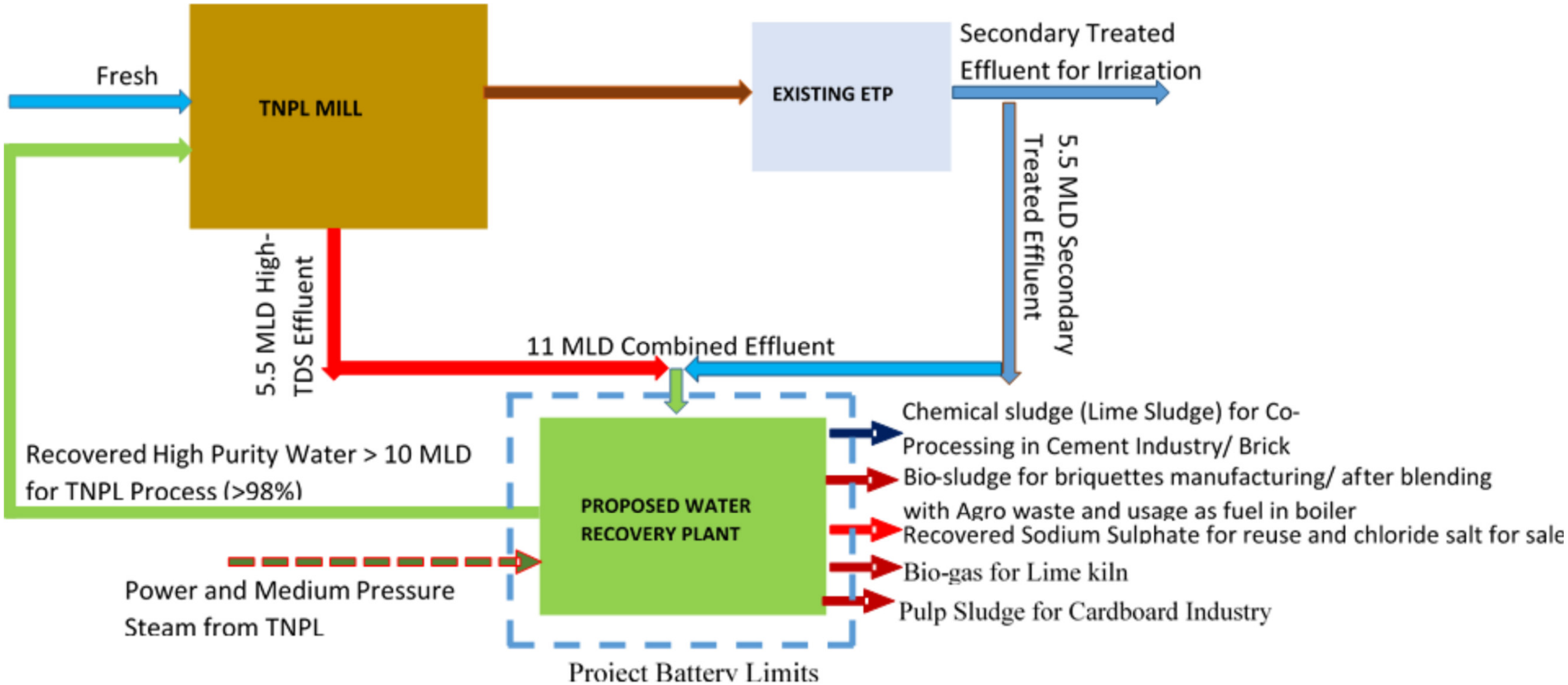
		section (NF, RO & HPPTRO). The RO section includes NF, RO system and separate HPPTRO system for chloride stream. The reject management section comprises separate MEE for chloride and MD for sulphate stream.
	End Use	Pulp sludge: Sale to cardboard industries Chemical Sludge: Used to TNPL's own cement plant for transportation and co-processing of the generated chemical sludge.
	Capex	Rs. 217.00 Crores (Proposed project as per TWIC DPR)
	Operational cost	Rs. 132 to 152/- per Cu. M
	Financial Impact on manufacturing cost	2.2%
	Reference	TWIC Pilot study Report and 10 MLD Detailed Project Report

Typical Schematic of the Existing ETP of Paper Processing Industry



Source : TWIC – TNPL- DPR for establishment of water recovery system - 2018

Typical Schematic of the Proposed ZLD based ETP of Paper Processing industry



Source : TWIC – TNPL DPR for establishment of water recovery system - 2018

ANNEXURE - I

Table 38: Financial impact of the project for the selected option

S.No	Financial Impact of the proposed Project	Unit	Maximum influent parameter
1.	Paper Production	TPA	403261*
2.	Sale price (Assumed)	Rs/tonnes	60000
3.	Annual Revenue	Rs in Crore	2420
4.	Total Operating Cost	Rs/Cu.m	152
5.	Total Operating Cost per year @ 350 days/year	Rs in Crore	58.5
6.	Capital Cost	Rs in Crore	217.3
7.	Amortization of Capital Cost @ 15% p.a (100% loan)	Rs in Crore	37.2
8.	Total Operating Cost per year including Amortization	Rs in Crore	95.6
9.	**Operating Cost /Ton of paper**	**Rs/ton of paper**	**1450**
10.	**Total Operating Cost as % of Revenue**	**%**	**2.4%**
11.	**Total Operating Cost /Ton of Paper (including Amortization @ 15 % p.a)**	**Rs/ton of paper**	**2372**
12.	**Total Operating Cost including Amortization as % of Revenue**	**%**	**4.0%**
13.	**Recoveries:**		
14.	Savings in Cost of Water @Rs. 3.83 /Cu.m	Rs/Cu.m	3.77
15.	Recoveries through Sale of Pulp Sludge @Rs.0.785/kg	Rs/Cu.m	0.29
16.	Savings in Cost of Sodium Sulphate salt @Rs.5.74/kg	Rs/Cu.m	8.10
17.	Savings in Cost of Bio-Gas @Rs.2.96/ Cu.m	Rs/Cu.m	1.27
18.	**Total Recovery**	Rs/Cu.m of inflow	**13.43**
19.	Net Operating Cost (NOC) (Incl. Recoveries) of Water Recovery System	Rs/Cu.m of inflow	138
20.	Net Operating Cost per year @ 350 days/year	Rs in Crore	53.3
21.	Net Operating Cost of the Project per year including Amortization	Rs in Crore	90.5
22.	**Net Operating Cost with Recovery /Ton of paper**	**Rs/ton of paper**	**1322**
23.	**Net Operating Cost (NOC) with Recovery as % of Revenue**	**%**	**2.2%**
24.	**Net Operating Cost (NOC) with Recovery /Ton of Paper (including Amortization @ 15 % p.a)**	**Rs/ton of paper**	**2244**
25.	**Net Operating Cost (NOC) with Recovery as % of Revenue (including Amortization)**	**%**	**3.7%**

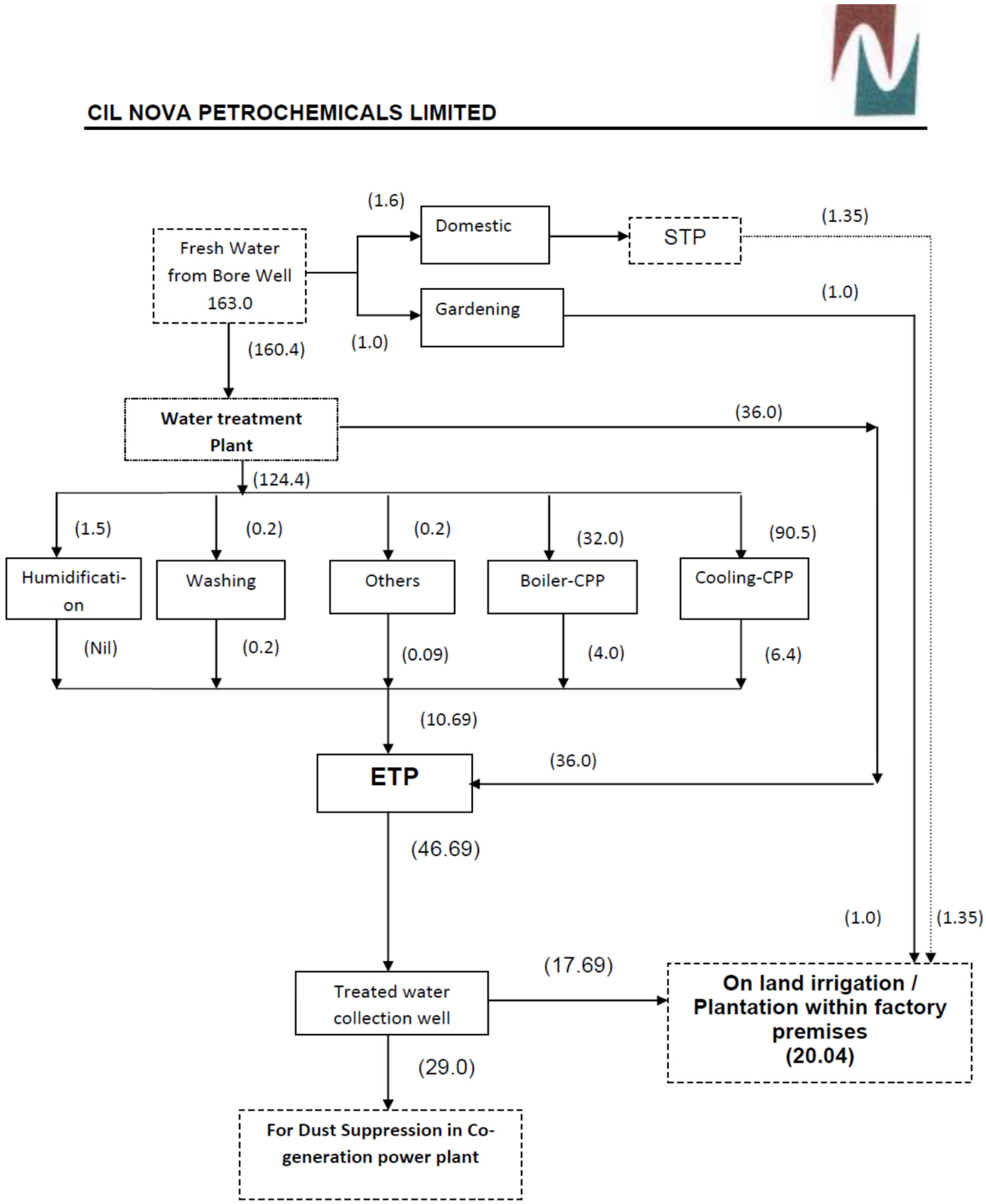
Note for the above Table:

1. Production figure is based on FY 2016-17 Annual Report and sale price of paper considered as Rs. 60000/Ton.
2. The amortization considered is based on interest working for 100% project cost (for BOOT Model). In case of implementation through EPC model, where 100% funding would be by TNPL, the net operating cost (NOC) after recovery as a % of revenue drops down to 2.2% from 3.7%, while NOC per ton of paper drops down to Rs. 1322 from Rs. 2244.
3. Cost of power considered as per TNPL @ Rs. 3.00 / kWh. No demand charge considered in the power cost.
4. Cost of steam considered as per TNPL @ Rs. 800 / Ton, Cost of Recovered Water considered as per TNPL @ Rs. 3.83 / cu.m and Cost of Recovered Sodium Sulphate Cost considered as per TNPL @ Rs. 5.74 / kg
5. Pulp Sludge to Cardboard Industry considered as per TNPL @ Rs. 0.785 / kg
6. Water consumption for paper making is considered as 30 litres/kg of paper

Source : TWIC TNPL DPR – May 2018

Si.No.	Description	Details
	Case Study	14
	Sector	Petrochemical
	Name of the Industry	M/s.CIL Nova Petrochemicals Ltd.,
	Address of the Industry & Contact No.	Survey No. 396 (P)-395/4 (P), Moraiya Village, Sarkhej Bavla Highway, Ahmedabad -382 210 Gujarat. 02717- 250556
	Size of the Company	Medium
	Capacity of the plant	46 Cu. M/Day
	Effluent Characteristics (Treated Water)	BOD: 8 ppm; COD: 31ppm TDS: 1400 ppm
	Treatment Scheme	Primary and Secondary Treatment and DMF
	Process Details	Not available
	End Use	Dust Suppression and on land irrigation/gardening
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; & Compliance Report of Environmental Clearance for Period (Oct2015 to March 2016) submitted on Nov 2016

<u>**TYPICAL PETROCHEMICAL EFFLUENT TREATMENT PLANT FLOW CHART**</u>

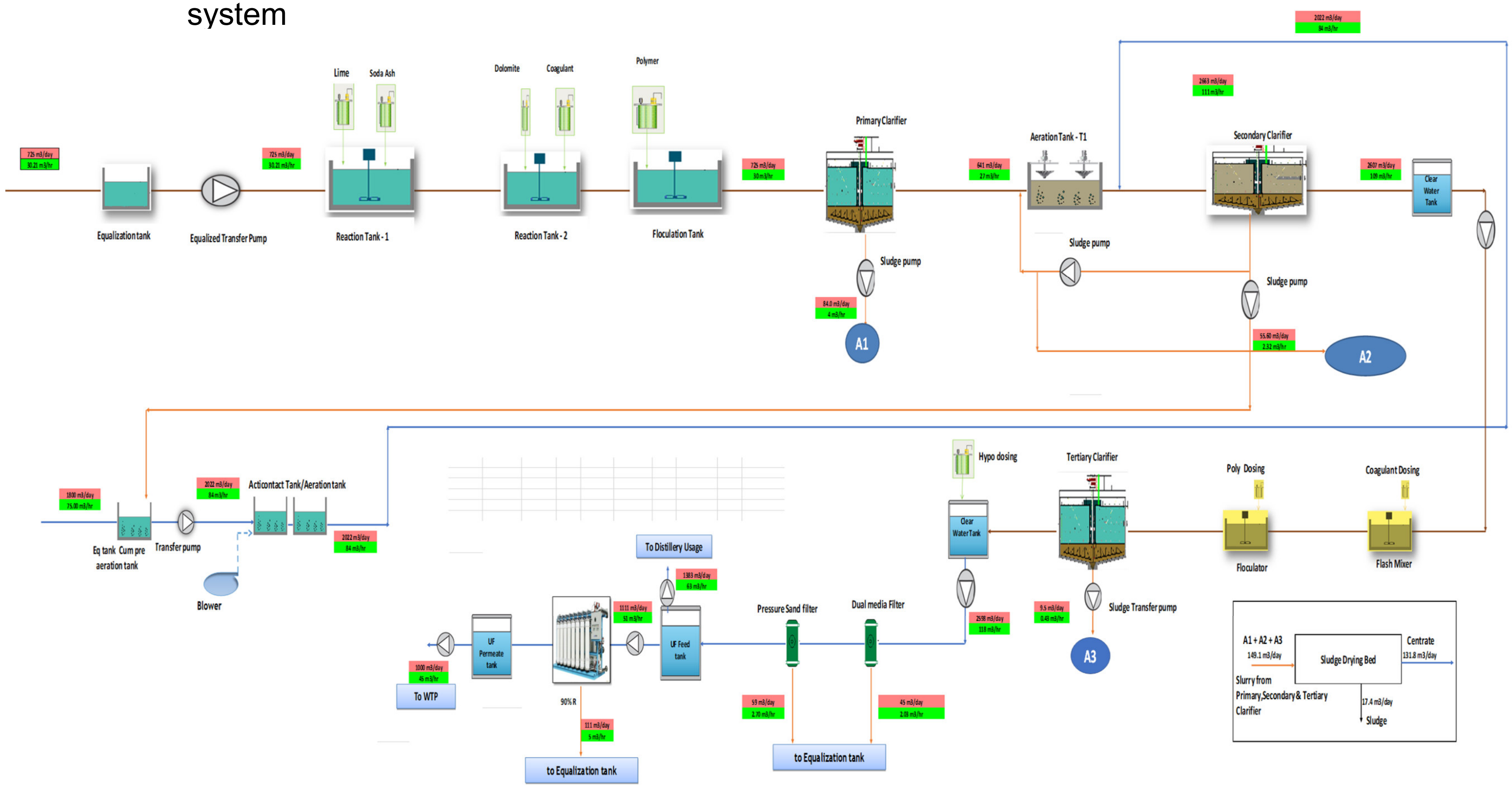


Source : Compliance Report of Environmental Clearance on Nov 2016

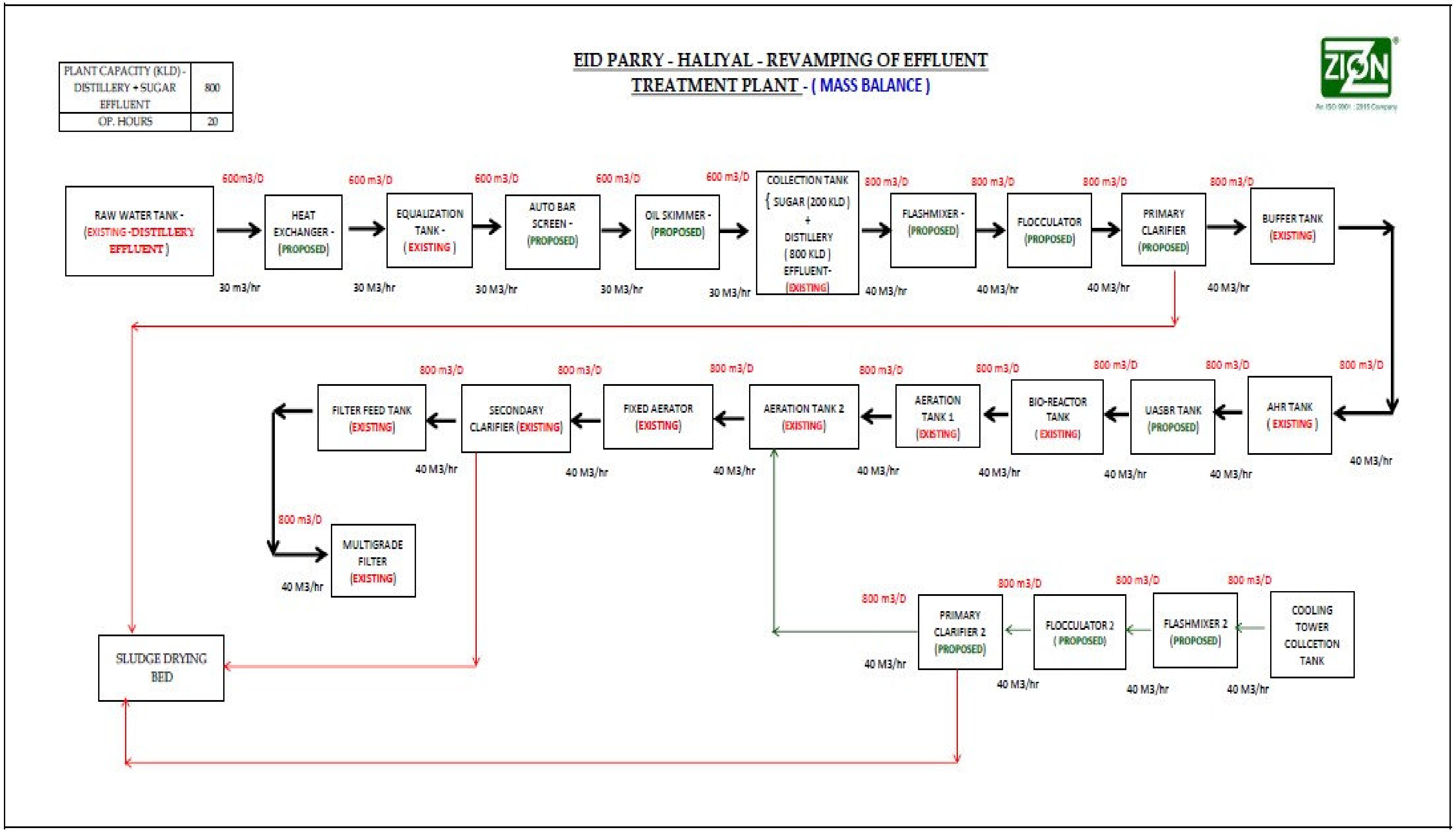
Si.No.	Description	Details
	Case Study	15
	Sector	Sugar
	Name of the Industry	M/s. EID Parry India Limited,
	Address of the Industry & Contact No.	Nellikuppam, Panruti Tk., Cuddalore District- 607105. Halyal. karnataka
	Size of the Company	Large
	Capacity of the plant	Nellikuppam Plant: 2 MLD & Halyal Plant: 800 KLD
	Raw Effluent Characteristics	BOD: 3000 to 4000 PPM COD: 6000 to 7000 PPM TDS: 1500-2000 PPM
	Scheme of treatment	Raw effluent collection tank → Heat Exchanger → Neutralization →Oil Separation →Bar screen → Chemical Treatment→ Anaerobic digester → Aeration tank→ Secondary Clarifier and followed by Filtration system → Inland discharge

	Process Details	After Neutralization and removal of Oil and suspended solids in the primary treatment, treated effluent will fed into Anerobic reactor and aeration system to reduce the BOD and COD parameters and forwarded to tertiary treatment for meet the irrigation standard.
	End Use	Cooling Tower make-up & Irrigation. Seasonal, ZLD not recommended by CPCB
	Capex	
	Operational cost	
	Financial Impact	
	Reference	https://tnpcb.gov.in/pdf/17Category_Unit181013.pdf; http://www.indiaenvironmentportal.org.in/files/file/Final-ZLD%20water%20polluting%20industries.pdf & EID parry India Ltd – Email dated 6th Oct 2020

PROCESS FLOW DIAGRAM - Condensate & Injection channel water treatment system



Source : EID parry India Ltd – Email dated 6th Oct 2020



Source: Ms. Zion Technical Offer for upgradation of ZLD based ETP

Si. No.	Description	Details
	Case Study	16
	Sector	Sulphuric Acid
	Name of the Industry	M/s. Tamil Nadu Chemical Products,
	Address of the Industry & Contact No.	Kundrakudi Road, Karaikudi H.O, Karaikudi 630001. Koviloor. Tel: 04565-232100 and 106
	Size of the Company	Medium
	Capacity of the plant	Not Available
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Primary →UF →RO →MEE
	Process Details	Not Available
	End Use	Not Available
	Capex	
	Operational cost	
	Financial Impact	
	Reference	http://www.indiaenvironmentportal.org.in/files/drinking%20water%20pollution%20Karaikudi%20Sivagangai%20NGT%20order.pdf

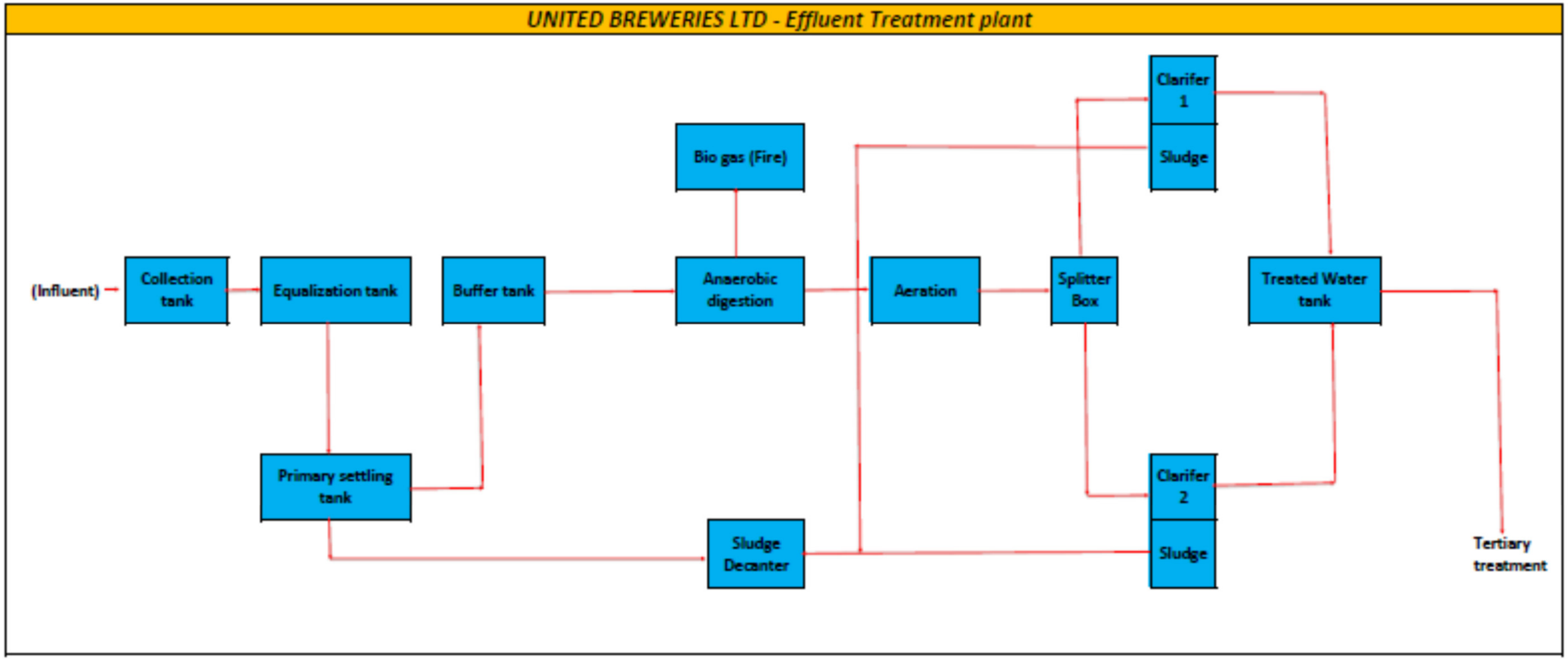
Si.No.	Description	Details
	Case Study	17
	Sector	Thermal Power
	Name of the Industry	Kota Super Thermal Power Station
	Address of the Industry & Contact No.	Kota, Rajasthan
	Size of the Company	Large
	Capacity of the plant	14MLD
	Raw Effluent Characteristics	Not Available
	Treatment scheme	Raw effluent collection and neutralization system → Primary settling tank → treated water tank
	Process Details	Raw effluent collected in the collection well for neutralization of pH and Suspended solids and followed by Settling tank for removal of solids.
	End Use	Reuse to cooling Tower, Ash slurry Dykes, Gardening and cooling tower make-up
	Capex	
	Operational cost	
	Financial Impact	
	Reference	Tender - 2018

Si. No.	Description	Details
	Case Study	18
	Sector	Zinc Smelting
	Name of the Industry	M/s. Hindustan Zinc Limited (Vedanta Group)
	Address of the Industry & Contact No.	Chandreiya Lead Zinc Smelter, Chittorgarh, Rajasthan. Tel.: +91 294-6604000-02 Email: rejendra.pandwal@vedanta.co.in
	Size of the Company	Large
	Capacity of the plant	5.2 MLD
	Raw Effluent Characteristics	Not Available
	Treatment scheme	ETP →RO → Solar Pond → Reuse
	Process Details	Raw effluent passes through Neutralization, Chemical treatment and then will pass through tertiary treatment consist of Filtration and Reverse Osmosis Plant for water recovery. RO Reject will send it to Solar pond for crystallization of residual solids.
	End Use	1.2MLD treated water used for slag granulation and lime slurry preparation. 3 MLD - RO Permeate reused in Hydro Plant -I and Hydro Plant -II
	Capex	
	Operational cost	
	Financial Impact	
	Reference	http://www.environmentclearance.nic.in/writereaddata/modification/PreviousTOR/08042019UTU0QHGTFormIPFR.pdf

Si. No.	Description	Details
	Case Study	19
	Sector	Breweries
	Name of the Industry	M/s. UB Breweries
	Address of the Industry & Contact No.	Aranvoyal Plant & Kutthambakkam Plant, Trivellore Tel: 044-27621188/78 Email: ashankar@ubmail.com
	Size of the Company	Large
	Capacity of the plant	1200 KLD & 450 KLD respectively
	Raw Effluent Characteristics	TSS : 800 ppm BOD: 800 ppm COD: 4300 ppm TDS: 2000 ppm
	Treatment Scheme	ETP →UF → RO → MEE →ATFD
	Process Details	Raw effluent passes through, Neutralization for homogeneous mixing, Chemical treatment, Primary clarifier followed by UASB and Aeration system, settling system.

		After primary treatment, treated water will pass through UF, RO for water recovery and RO Reject will fed in to MEE for further recovery and ATFD for residual removal.
	End Use	Permeate reused in the process, Boiler feed, washing
	Process water cost	Rs.300/KL
	Capex	Rs.17.50 Crores
	Operational cost	Rs.114/- per Cu. M
	Manufacturing cost	Rs.194/case (12 bottles@ 650ml) – Rs.24.8/liter of Beer
	Financial Impact	2.5%
	Reference	Sutharson C, United Breweries Ltd, Mail reference 19th Sep 2020

TYPICAL PROCESS FLOW DIAGRAM OF BREWERIES

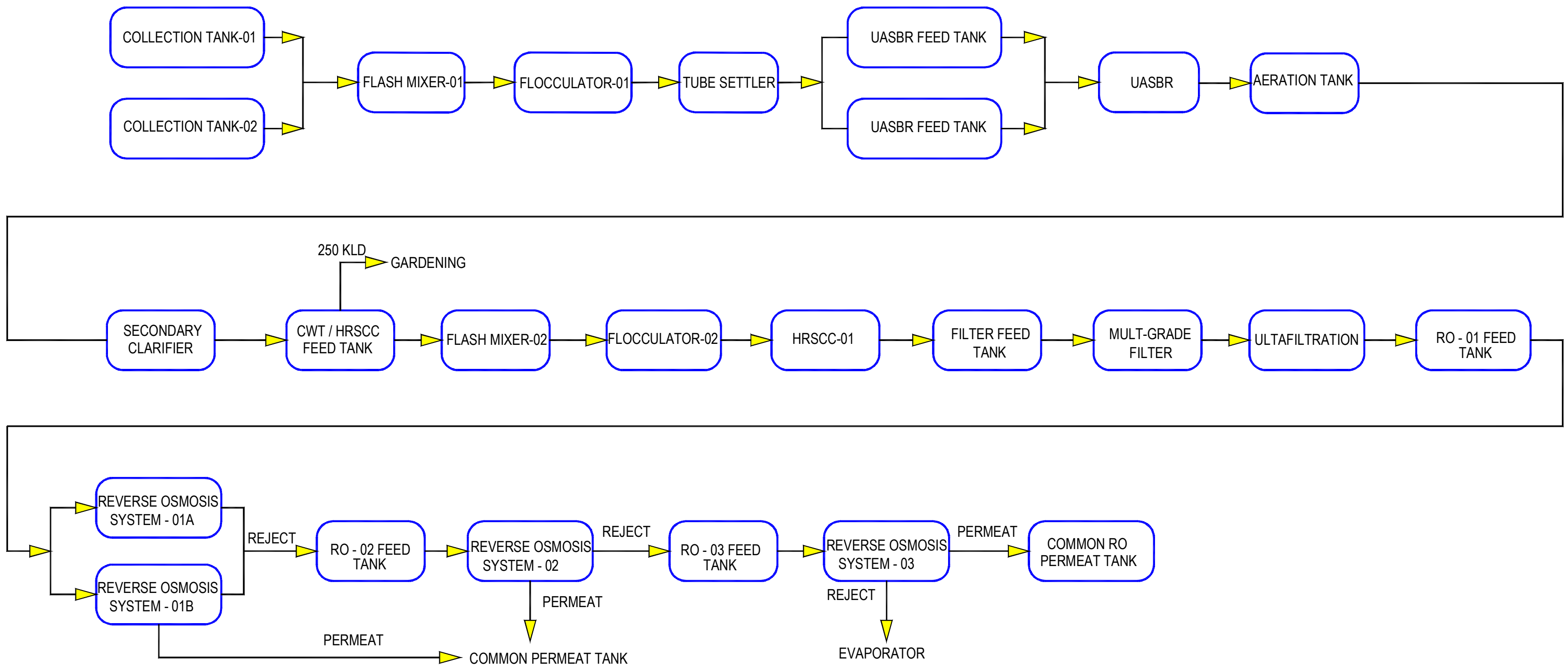


Source : United Breweries Ltd, Mail reference 19th Sep 2020

PROCESS FLOW DIAGRAM

UBL - KUTHAMBAKKAM

WASTE WATER TREATMENT PLANT CAPACITY - 450 KLD



Source : M/s. Zion Enviro system – O &M offer

Si. No.	Description	Details
	Case Study	20
	Sector	Textiles
	Name of the Industry	M/s. Murugampalayam Common Effluent Treatment Plant. M/s. Arulpuram Common Effluent Treatment Plant.
	Address of the Industry & Contact No.	Tirupur, Tamilnadu. Email: arulpuramcetp@gamil.com murugampalayamcetp@gmail.com
	Size of the Company	SPV
	Capacity of the plant	11 MLD, (Currently inflow: 3.8 MLD)
	Raw Effluent Characteristics	Refer Annexure
	Treatment Scheme	ETP →UF → RO → MEE → ATFD
	Process Details	The treatment methodologies in the CETP comprises of Collection and Conveyance system, Pre-treatment unit consists of primary treatment, aeration system and ultra-filtration to reduce the suspended solids, BOD and COD etc. to meet the inlet standard of RO System. (PT), Reverse Osmosis system (RO) and Reject Management system. The recovered products like recovered water

<table>
<tr><td></td><td></td><td>with very low salinity permeate from RO, condensate from evaporator system, treated brine concentrate from the evaporators and Glauber’s salt ($Na_2SO_4.10H_2O$) from the adiabatic chiller is returned back to its associated member units for reuse in their dyeing process.</td></tr>
<tr><td></td><td>End Use</td><td>Permeate reused in process Recovered salt used in About 95% of permeate water is recovered from the RO plant in ZLD system for textile processing industries. Also salts and condensate is recovered from MVRE / MEE</td></tr>
<tr><td></td><td>Capex</td><td>Rs. 15-20 Crores/MLD</td></tr>
<tr><td></td><td>Operational cost</td><td>Rs. 200-350/- cu.m</td></tr>
<tr><td></td><td>Financial Impact</td><td>
<table>
<tr><th>Description</th><th>Local Brand</th><th>International Brand</th></tr>
<tr><td>% of ZLD O&M cost on processing cost of dyed yarn (W/o recovery)</td><td>10%</td><td>8%</td></tr>
<tr><td>% of ZLD O&M cost on processing cost of dyed yarn (With recovery)</td><td>1.1%</td><td>0.8%</td></tr>
<tr><td>% of ZLD O&M cost on selling cost of the finished Product (Tee Shirt)</td><td>1%</td><td>0.4%</td></tr>
</table>
</td></tr>
<tr><td></td><td>Reference</td><td>https://www.tnpcb.gov.in/success-stories.php;

TWIC Textile DPR TWIC O&M Report.</td></tr>
</table>

Quality of inlet effluent into CETP and stage wise treated effluent quality

Unit Processes	Parameters	Units	Stage-Wise Effluent Quality
SHT	pH		8.5 – 10
	COD	mg/l	600 – 1300
	BOD	mg/l	300 – 500
	Colour	Pt. Co units	900 – 1200
	TSS	mg/lt	150 - 200
	TDS	mg/lt	8000 – 9000
	Total Hardness	mg/lt	100-150
BIOT and Secondary Clarifier Outlet	COD	mg/l	200-300
	BOD	mg/l	0 – 5
	Colour	Pt. Co units	800-900
	TSS	mg/l	15 - 30
Chlorine (Gaseous Chlorine) Contact Tank	COD	mg/l	190-290
	BOD	mg/l	0 - 5
	Colour	Pt. Co units	200- 250
	TSS	mg/l	10 – 25
QF Outlet	COD	mg/l	180-280
	BOD	mg/l	0 – 5
	Colour	Pt. Co units	200- 250
	TSS	mg/l	5 – 15
	Turbidity	NTU	2 – 5
Ultra-filtration	COD	mg/l	170-250
	BOD	mg/l	0 – 2
	Colour	Pt. Co units	180 – 225
	TSS	mg/l	0 - 1
	Turbidity	NTU	BDL

Unit Processes	Parameters	Units	Stage-Wise Effluent Quality
	SDI		< 3.0
Decolourant Resin Filter	COD	mg/l	140-200
	BOD	mg/l	0 – 1
	Colour	Pt. Co units	100 – 150
	TSS	mg/lt	0 – 1
	Turbidity	NTU	BDL
	Total hardness	mg/lt	100 - 150
Softener Filter	Total hardness	mg/lt	0 – 10
R.O feed	COD	mg/l	140-200
	BOD	mg/l	0 – 1
	Colour	Pt. Co units	100-150
	TSS	mg/lt	BDL
	TDS	mg/lt	8000- 9000
	Turbidity	NTU	BDL
	Total hardness	mg/lt	0-10
	SDI		<3
R.O Rejects (4^{th} stage)	COD	mg/l	700-1000
	BOD	mg/l	2 – 5
	Colour	Pt. Co units	500-750
	TSS	mg/lt	2 – 10
	TDS	mg/lt	30000-37000
	Total Hardness	mg/lt	50-60
R.O Permeate (4^{th} stage)	COD	mg/lt	BDL
	BOD	mg/lt	BDL
	Chloride	mg/lt	30 -40
	Sulphate	mg/l	70 – 90

Unit Processes	Parameters	Units	Stage-Wise Effluent Quality
	TDS	mg/l	200-250
Additional Stage R.O. Feed	TDS	mg/l	30000-37000
	Colour	Pt. Co units	500 – 750
	Total Hardness	mg/l	50-60
Additional Stage R.O Reject	TDS	mg/l	55000-60000
	Colour	Pt. Co units	900-1200
	Total Hardness	mg/l	90 - 100
Additional Stage R.O permeate	TDS	mg/l	350 – 450
	Colour	Pt. Co units	BDL
	Total Hardness	mg/l	BDL
Crystallizer (MEE)	Sodium sulphate salt	Tons/day	
Centrifuge. Chiller			10.2
FCE	Mixed salt	Tons/day	11
Solar Pan	Residue	Tons/day	0
ATFD	Residue	Tons/day	26.7
Brine Treatment System	pH		5.0-5.5
	Colour	Pt. Co units	1500-2000
	TDS	gpl	150-170
	Total Hardness	mg/l	150-200
	Total Alkalinity	mg/l	150 - 200

Typical Process Flow Diagram of ZLD based CETP Plant

Typical ZLD process flow diagram adopted in CETP for textile processing units and water balance diagram is furnished below.

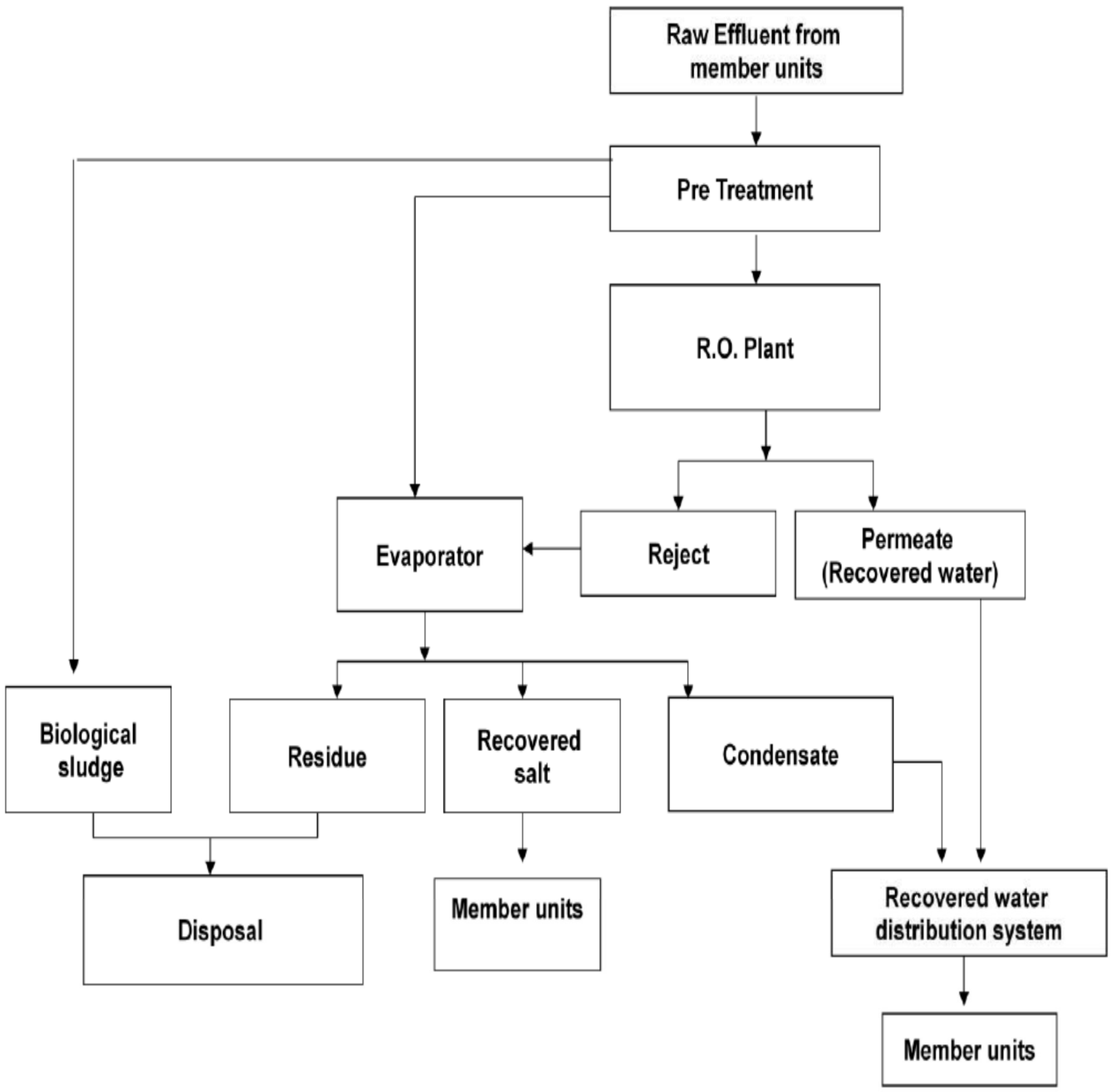
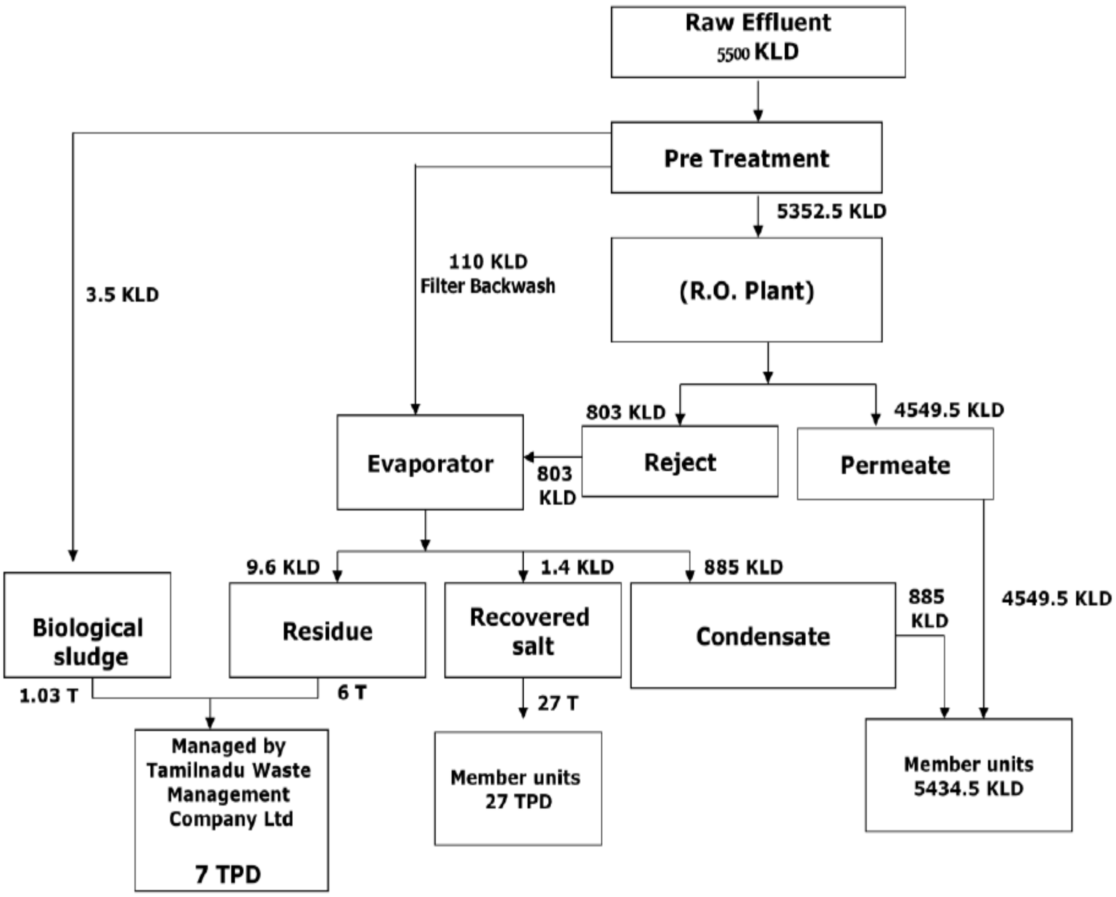


Fig.2 ZLD Process Flow Diagram (in a CETP)

Source: TNPCB Portal – Success story of Textile Industries

Typical Textile Effluent Treatment Water Balance

Water Balance Diagram (for 5500 KLD)

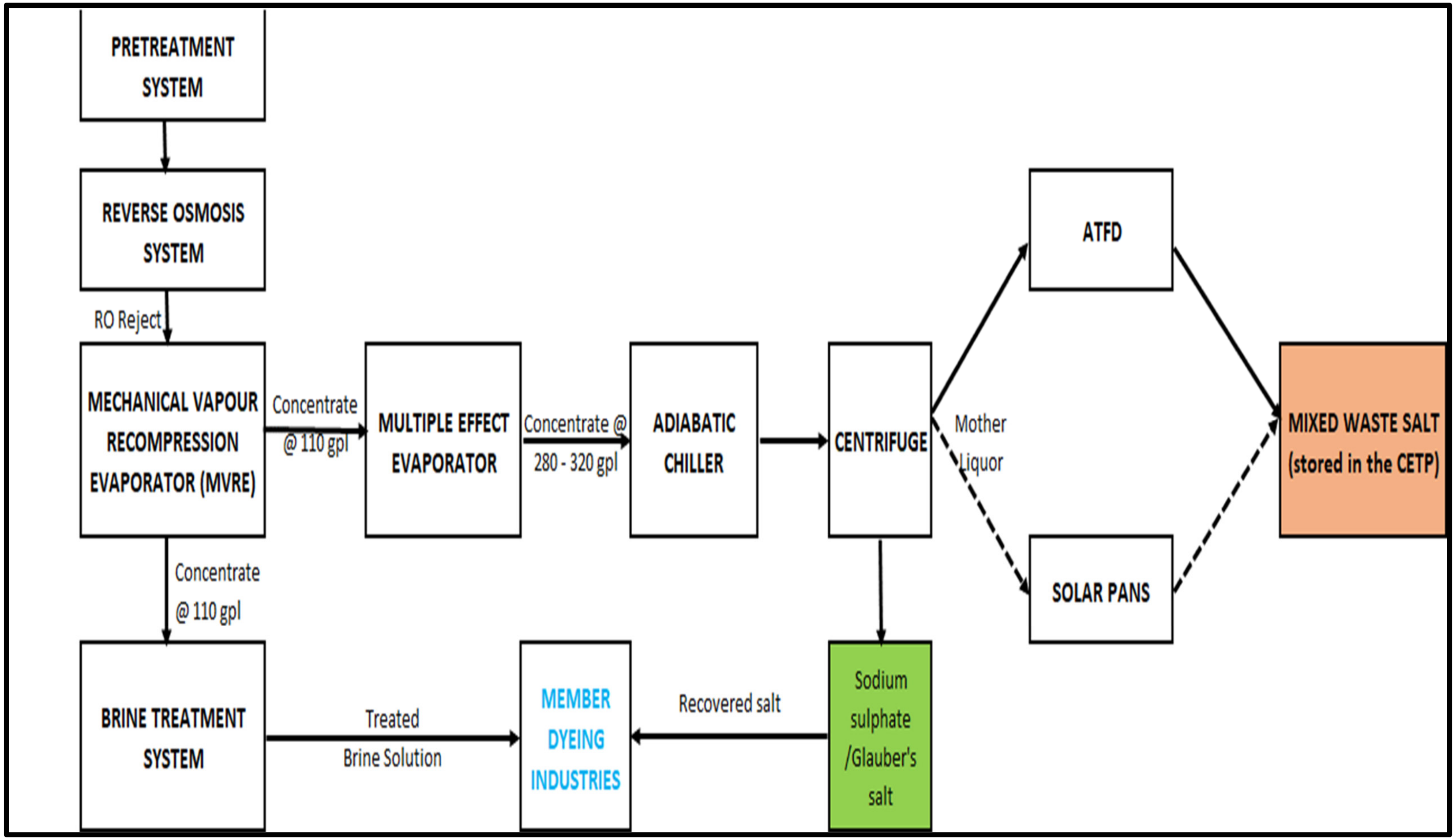


(>95% water will be recovered)

Fig. 3 Water Balance Diagram for 5500 KLD

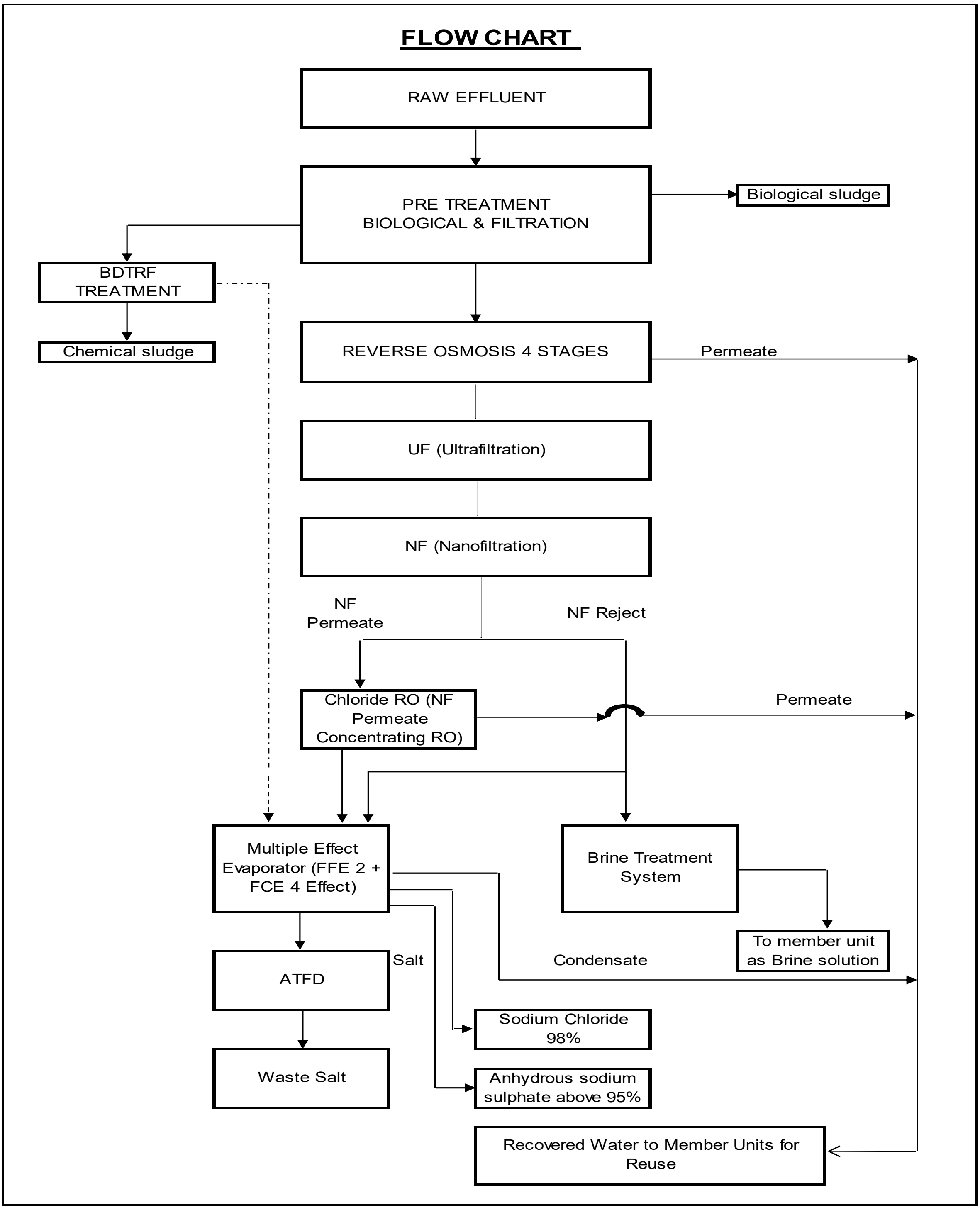
Source: TNPCB Portal – Success story of Textile industries

Schematic Diagram of Salt Recovery System in the textile industry with MEE system



Source: TWIC – PPT presentation to MD, TNPCB on 16.11.2019

Schematic Diagram of Salt Recovery System in the textile industry with NF & MEE system



Source: TWIC O &M Report

Financial Impact for Dyed Fabric / Yarn Processing / sale price of the finished Product

S.No	Items Description	UoM	Local Brand	International Brand
1	Capacity of the CETP	cu.m/day	3800	3800
2	Water consumption for dyeing	Litres/Kg	40	40
3	Total Processing capacity	Tons /Day	95	95
4	Processing cost of Dyed fabric / yarn	Rs/Kg	80	100
5	Processing Cost	Rs. Million/day	8	10
6	O&M Cost of ZLD based CETP system	Rs. / cu.m	200	200
7	O&M Cost of ZLD without recoveries	Rs. Million/day	0.8	0.8
8	O&M Cost of ZLD (W/o recovery)	Rs / kg	8.0	8.0
9	**% of ZLD O&M cost on processing cost of dyed yarn (W/o recovery)**	**%**	**10%**	**8%**
10	**Recoveries:**	-		
10.1	Cost of process Water	Rs. / KL	82	82
10.2	Cost of Sodium Sulphate salt	Rs./ Kg	14	14
10.3	Cost of recovered water (Design recovery 90%)	Rs/m^3 of CETP inflow	74	74
10.4	Recovered Salt (Sodium Sulphate)	Rs./cu.m	105	105
10.5	Total Recovery		179	179
10.6	Net O&M Cost of ZLD System	Rs./cu.m	21	21
10.7	Net O&M Cost of ZLD System	Rs. Million/day	0.1	0.1
10.8	**% of ZLD O&M cost on processing cost of dyed yarn (With recovery)**	**%**	**1.1%**	**0.8%**
11	O&M Cost of ZLD System for dyed yarn (with recovery)	Rs. /Kg	0.85	0.85
12	No. of Tee shirts per kg	Nos./ kg	*3*	*3*
13	Selling cost of Tee Shirt (export quality)*	Rs. per Tee Shirt	*200*	*600*
14	**% of ZLD O&M cost on selling cost of the finished Product (Tee Shirt)**	**%**	***1%***	***0.42%***

Note for above Table:

1. The above Production cost is based on 1:6 liquor ratio for yarn and fabric respectively

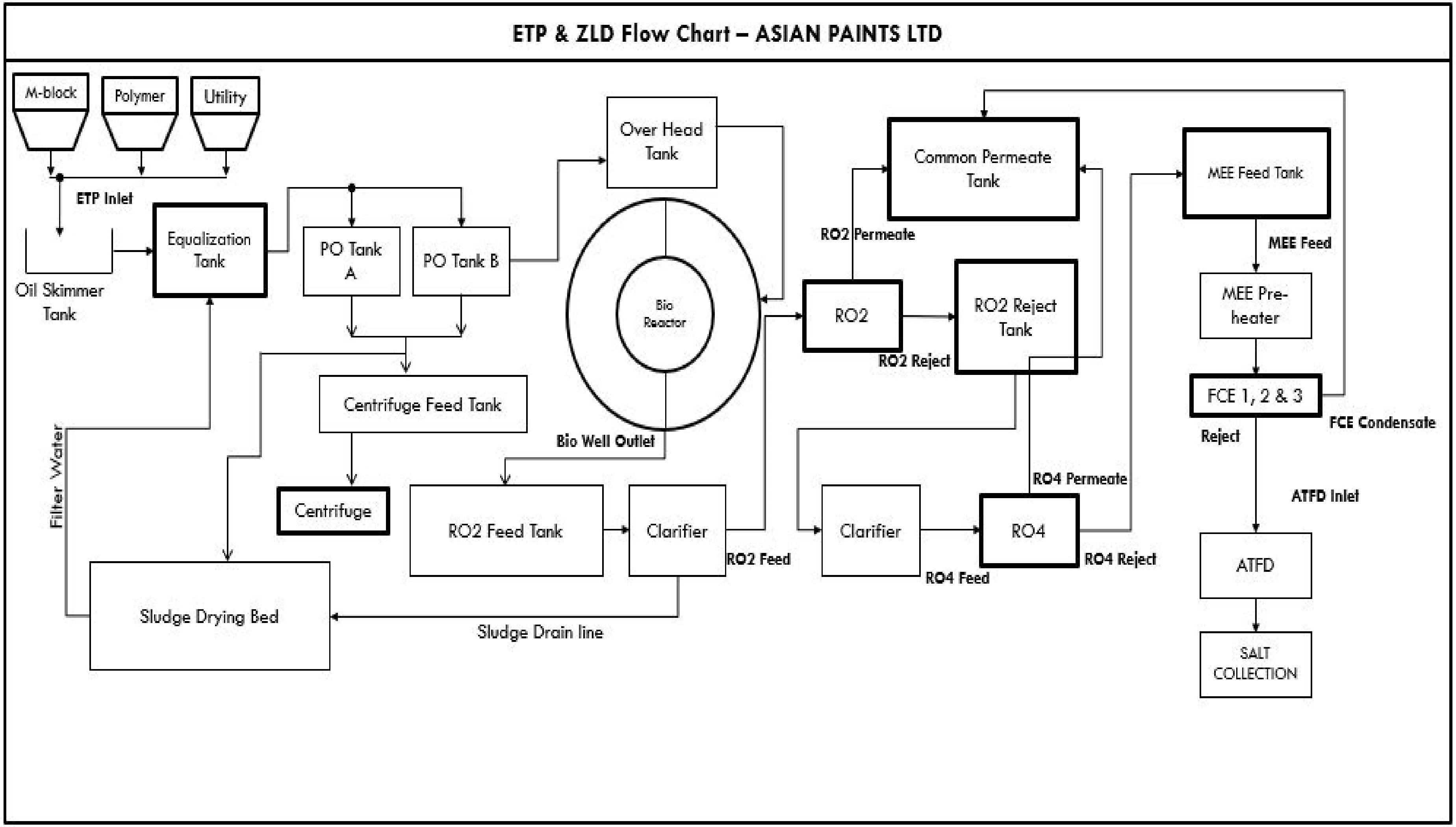
2 Dyeing cost for yarn by machine is in the range of Rs. 80 / kg including yarn cost

ANNEXURE – II

Si. No.	Description	Details
	Case Study	21
	Sector	Glass
	Name of the Industry	M/s. Saint Gobain (India) Limited.
	Address of the Industry & Contact No.	Sriperumbudur, Tamilnadu. Ph. No. 044-2716 2832
	Size of the Company	Large
	Capacity of the plant	Not Available
	Raw Effluent Characteristics	Not Available
	Treatment Scheme	Recycle (Primary Settling → Polishing → Secondary settling)
	Process Details	Primary Settling → Polishing → Secondary settling
	End Use	Process reuse
	Capex	
	Operational cost	
	Financial Impact	
	Reference	Details not available in the web site. We collected the data through Ex-employee

Si. No.	Description	Details
	Case Study	22
	Sector	Paints and Pigments (Water based paint)
	Name of the Industry	M/s. Asian Paints,
	Address of the Industry & Contact No.	E6, E7, F11, F12, F13, F6 and F7, SIPCOT Industrial Park, Pondur Village, Sriperumbudur, Tamilnadu. Ph. No. 09790156405
	Size of the Company	Large
	Capacity of the plant	104 KLD
	Raw Effluent Characteristics	Ph - 5.0 – 9.0 TDS - 3000 - 6000 mg/L TSS - 400 -1000 mg/L COD - 2200- 10000 mg/L BOD - 300 -1000 mg/L
	Treatment Scheme	Zero Liquid Discharge (Pretreatment→ Biological Treatment→ Filtration system → RO →MEE→ATFD
	Process Details	After chemical and biological treatment in the primary section. same treated water will pass through Reverse Osmosis Plants for quality water recovery followed by MEE-Multiple Effect Evaporator further recovery of

		quality water as a condensate and ATFD (Agitated Thin Film Dryer) for removal of solid residual from the MEE.
	End Use	RO + ZLD treated water reused in the process (Cooling tower) and RO rejects disposed through mechanical evaporator and the unit achieves zero discharge of trade effluent.
	Capex	Rs.1.93 Crores
	Operational cost	Rs. 6900/-
	Product Manufacturing Cost/Ton	Rs. 4485/-
	Financial Impact	1.00%
	Water required	466 Liters/KL
	Source & Cost of raw water	Sources: Borewell, SIPCOT(TTRO), Tanker 1. Borewell - Rs.200/KL 2. SIPCOT (TTRO) - Rs.80/KL 3. Tanker - Rs.85/KL
	Reference	http://www.environmentclearance.nic.in/state/FORM_B_PDF.aspx?cat_id=SIA/TN/IND2/16992/2016&pid=New; and Asian Paints Email Dated 5th Oct 2020



Source : Asian Paints - Email Dated 5th Oct 2020

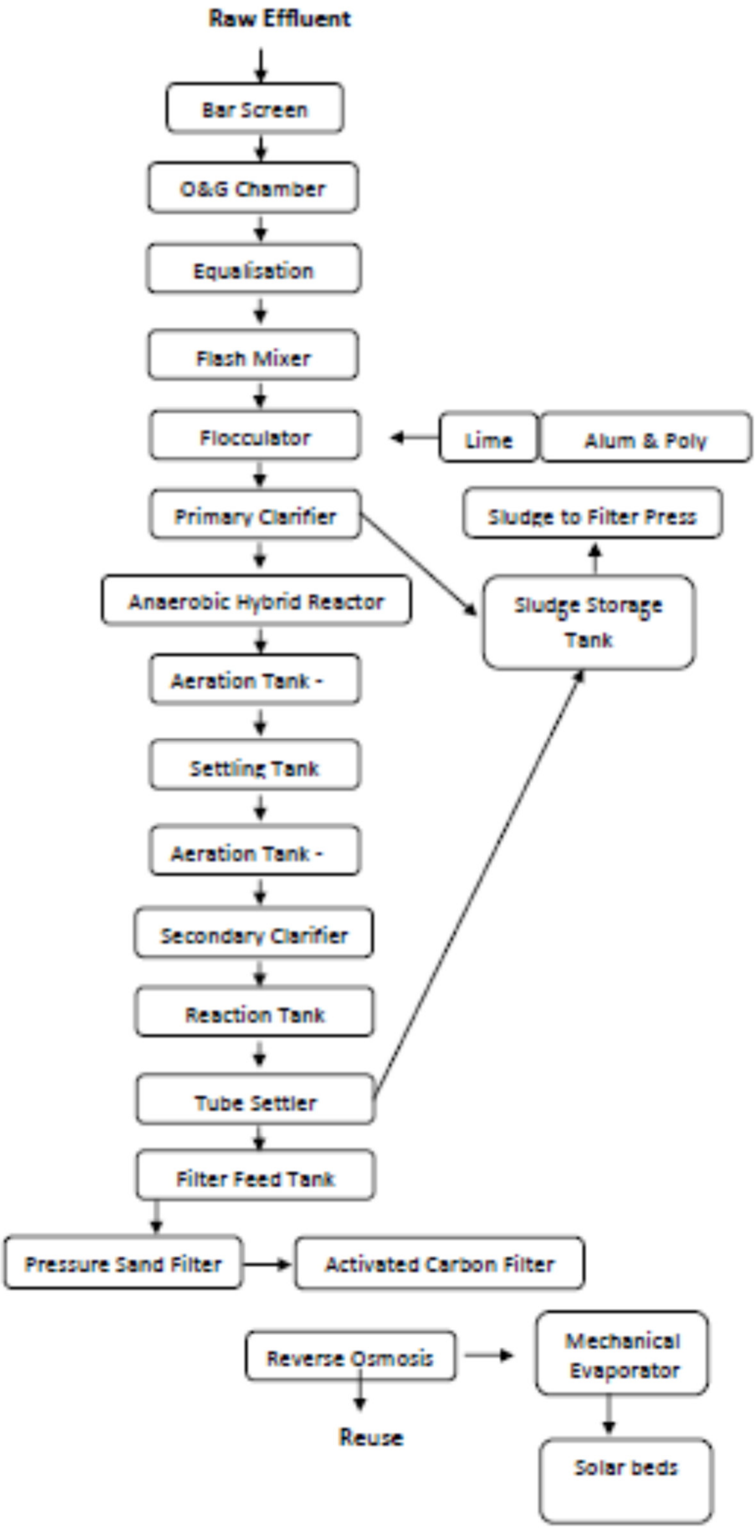
Si. No.	Description	Details
	Case Study	23
	Sector	Ceramic
	Name of the Industry	M/s. Murugappa Morgan Thermal Ceramics Ltd.,
	Address of the Industry & Contact No.	SIPCOT Industrial Area, Ranipet
	Size of the Company	Large
	Capacity of the plant	100 KLD
	Raw Effluent Characteristics	Products: Refractory Ceramic fiber, Super wool fiber Not Provided
	Treatment Scheme	Zero Liquid Discharge (Effluent treated in ETP and further treated with Reverse Osmosis Plants.)
	Process Details	After chemical treatment in the primary section, treated water will passes through Reverse Osmosis Plants for recovery quality water followed by Forced Evaporation/ Filter Press for removal of solid residual in the RO Reject effluent.
	End Use	RO Permeate: Process recycle Solid waste recycled in the process.
	Capex	Rs. 1.25Crores
	Operational cost	Rs. 350/- per Cu.M
	Financial Impact	1.2% on the sale products (Product Range from Rs.100/- to 500/- per kg)
	Reference	Through telecon discussion on 16th Sep 2020

Si. No.	Description	Details
	Case Study	24
	Sector	Electroplating/Phosphating/Pickling
	Name of the Industry	M/s. Jalandhar Effluent Treatment Society
	Address of the Industry & Contact No.	E-41 to E-46 on backside of Plot no. E47 to E54 abutting Kala Sanghian Drain, Industrial Focal Point (Extn.), Jalandhar (Punjab)
	Size of the Company	SPV
	Capacity of the plant	150 KLD
	Raw Effluent Characteristics	TSS: 350 to 450 ppm pH: 1 to 2.5 Total chrome: 110 to 120 ppm Zinc: 30-40 ppm Nickel: 50 to 60 ppm TDS: 12000 to 15000 ppm
	Treatement Scheme	Primary Treatment →Filtration system →RO
	Process Details	Pre-treatment, primary treatment (neutralization, precipitation/coagulation, flocculation, and resulting sludge separation and dewatering – a hazardous waste), followed by pressure depth multi-grade filters and activated carbon adsorption. In order to achieve zero discharge, the effluent will be conditioned and subjected to multi-stage membrane treatment (three-stage reverse osmosis). The permeate from each stage will be collected for reuse. Reject water from MEE will fed into MEE forwarded by Spray Drier.

	End Use	The water lost in evaporation will be collected as purified water in form of condensate from each evaporation stage. Excess water will be sold to the participating industries. Residual water content in the concentrated slurry (obtained from the MEE) is further removed in spray drier and the dried solids so obtained are disposed as hazardous waste.
	Capex	
	Operational cost	
	Financial Impact	
	Reference	http://www.environmentclearance.nic.in/writereaddata/FormB/EC/EIA_EMP/271220166TV0QVBG1FinalEIAreportCETPJalandharR1.pdf; http://environmentclearance.nic.in/writereaddata/FormB/EC/EC_Letter/052020179L2M1ZH7FD17044.pdf

Si. No.	Description	Details
	Case Study	25
	Sector	Abrasives
	Name of the Industry	M/s. Carborundum Universal Ltd.,
	Address of the Industry & Contact No.	SIPCOT Industrial Area, Sriperumbudur. B. Elamaruthu, DGM - 9940099247
	Size of the Company	Large
	Capacity of the plant	24 KLD
	Effluent Characteristics	COD (7000-8000ppm), BOD (4500ppm) TDS-3000ppm, TSS-500ppm, pH-(6.5-10)
	Treatment Scheme	Pretreatment → UF → RO→ Solar Pond
	Process Details	After Primary settling will goes to Biological treatment, secondary settling, Filtration. Then treated effluent will go to Reverse Osmosis system for water recovery system followed by Solar Pond for reject management.
	End Use	Boiler feed water. Solid waste stored in the TSDF
	Capex	Rs. 150 Lacs
	Operational cost	Rs. 1800/- Cu. M
	Product manufacturing cost	Average: Rs.250/Sq. M
	Financial Impact	0.36% (0.9/250 *100)
	Other details	SIPCOT supply, Rs.80/KL Water requirement: 0.5 Liters/Sq. M
	Reference	Through mail 25th Sep 2020

TYPICAL FLOW CHART OF ABRASIVES INDUSTRY



Source: M/s. Carborundum Universal Limited, Sriperumbudur- Email dated 25th Sep 2020

12. Need for research and development

The Indian Industry has been facing ever growing stringent environmental regulations such as Zero Liquid Discharge (ZLD) for highly polluting Industries in order to protect lakes and rivers. Environmental degradation has led to severe public pressure and demand for stringent regulations which the authorities oblige by framing stringent standards. However, the stringent standards have not necessarily been backed or based on the concept of '**Best Available Technique or BAT'**. The result is that most industries and Industrial clusters fail to achieve these standards leading to non-compliance of the regulations, resulting in litigation and closure.

The sequence of events then is as follows:

Environmental Pollution → Public Pressure → Regulation or Standards → Non-Compliance → Litigation/ Judgements/ Closure → Hurried Project Implementation → Technology Failure → Closure/Penalties → Technology up-gradation/ R&D on Industrial Scale → Compliance (after long delays and at much higher cost to Industry, Govt. & Public).

The more preferred route and that employed in most developed nations is as follows:

R&D → Best Available Technology (BAT) → Regulations/ Standards → compliance.

Although several Technical Universities and research Labs work in the field of water and wastewater, they basically do high quality *fundamental research* which takes considerable time to find an application in the real world. Moreover, these scientists find difficulties in up-scaling and technology demonstration.

Technology Challenges, unresolved issues and need for R&D and innovation

ZLD implementation in Industries has been just over a decade in the country. While ZLD has helped industry become compliant while recovering water for reuse, there are still several unresolved issues, which needs addressing. These issues are summarised below;

1. High Capital expenditure @ Rs. 15- 20 Cr per MLD as against Rs. 2 to 4 Cr per MLD for conventional treat and discharge systems.
2. High O&M expenses @ Rs. 200 (example Textile Dyeing) to Rs 600 per m3 (example Leather Tannery) of effluent depending on the type of wastewater. This add significantly to the cost of the finished product eg . ZLD adds gross 12% (nett 6% after recovery of water and salt) to the cost of dyed fabric.
3. The present ZLD systems recover 95- 98% of the wastewater for reuse it generated mixed waste salt which is a serious disposal issue Today around 30000 tons of salts are accumulated and stored in the Tirupur cluster without a solution for disposal. A Zero Waste Salt system has been implemented with recovery of high quality Sodium Chloride along with sodium sulphate for reuse and sale in one of the CETPs. Alternative technologies based on salt separation based on Nano-filtration and selective crystallization have been implemented in the dyeing industry. This needs to more widely adopted in the dyeing industry but also adapted to other sectors, which requires considerable R&D and piloting.
4. High energy and Carbon foot print- the ZLD units consume around 0.5 MW per MLD of effluent treated and also require around 0.35 tons of steam / hr/m3 for evaporation. This accounts for 50% of the O&M cost and requires urgent attention. Alternatives to thermal evaporators for reject management and use of renewable energy are challenges proposed to be addressed.
5. Today, disposal of sludge to cement industries for co-processing is done around Rs. 3500 per ton. Manufacture of bricks as a by-product would reduce this cost.
6. The above challenges when addressed will significantly reduce the operating costs to near Zero and would also possibly contribute as a source of revenue to the CETPs/ ETP, thereby ensuring long term sustainability of the industry. It is expected that with this a 'threat' would be converted into an 'opportunity'.
7. To implement the Best Available Technique (BAT) concept for evaluation and certifying of various technologies available in the Market.

8. There is a need for extensive piloting before implementation to demonstrate Techno-commercial feasibility for each project.
9. One Size does not fit all: Need to remember “not all Textile dyeing effluent are same” or “not all Tannery effluent are same” or “not all paper industries are same” or “not all ZLD are same”.
10. ZLD has been there particularly in the country for just over a decade and with increasing adaptation there are more challenges observed. This requires constant improvements. Need for newer technology is being felt and more are coming into the market based on growing demand which require evaluation and certification by an independent body.
11. ZLD is a technological challenge which must focus on Zero Waste Discharge (ZWD) to achieve ZLD, therefore R&D is recovered in resource recovery fro the wastewater, like energy, slats, nutrients etc This requires serious R&D efforts which practically do not exist today.

13. Manpower resource training and Certification needs assessment

ZLD are complex systems and require highly skilled Operators and Technicians for O&M of these facilities. Therefore a capacity building program with certifying & licensing system is a requirement, which today none exists. If implemented this would also create new job opportunities.

There is a need for highly skilled ETPs / CETPs operators to support and maintain an increasing number of Industrial wastewater treatment facilities in India. Operator training and Grade certification for employees of industrial wastewater management and also for providing employment to fresher's out of institutes and colleges

Main objectives of such a program would be:

(1) For developing courses to bring the skill sets to staff working in Industrial Wastewater sector.
(2) To bring water sector certification standards for Operators in this sector related to minimum education requirements, mandatory training, and knowledge verification through standardized examinations, experience requirements, and annual continuing education. This certification in each state can be delivered in collaboration with the regulator of the sector, State Pollution Control Boards (SPCB) and a Technical university.
(3) Certification offers a mechanism for employees to receive recognition and credibility in their chosen career. Becoming certified/ accredited can increase personal marketability and demonstrates proficiency in the water sector. Employers use certifications to screen potential new hires and select contractors, motivate employees to expand their knowledge and skills, ensure employee competence, and help employee's complete relevant continuing education. Such certification is not one-time certification for life but it is a continuous process of learning and evaluation of industry staff. As the complexities of the plant increase newer trainings are mandated from time to time.
(4) The certification can become a licensing/permit system for Operators/ Technicians to be employed in CETP/ETPs similar driving licenses/ Boiler licenses/ Electrical inspectorate licenses already in the country. This will ensure uniform standards of O&M.

A benchmark can be developed for employers to measure workforce performance. It is important to have qualifications that allow people to be assessed and certified as competent, regardless of the route they took to obtain their skills and knowledge. This will be the reference point for development of training qualifications and curricula for developing training programs to up-skill existing workers. A licensing system can be introduced to ensure that the staff is continually progressing and moving up in the job as well as is appraised of latest developments in the sector.

The below table give a sample program and the target audience.

Table 8: List of Training Course proposed for ETP / CETP personnel

S. No.	Name of the Training Program	Category of Course	Program Contents	Designated Role
1.	Waste Management (WM)	Senior Staff	Legal Requirements, Cleaner Technologies and reduction of pollution at source, Testing requirements and analytical procedure, General principles of effluent treatment - Design, O&M, end of pipe Treatment for liquid Waste, Membrane Technologies, Sludge Generation Treatment and Disposal, Energy Conservation, Instrument Automation, Management, maintenance and Health Safety in ETP, Case Studies, Site Visits and Demonstration	CETP / IETP Managers
2.	Occupational Health and Safety with focus on WWTP (OSH)	Technical Staff	OSH Audit, Emergency First Aid, Personal Protective Equipment's, OSH in CETPs, Demonstration of Sewer Cleaning, Air Supply units, PPE etc.,	Managers, Technicians, Chemists and member units, CETP / IETP Workers
3.	Cleaner Technology (CT)	Technical Staff	Introduction to Cleaner Technology Options, Recovery and Reuse, Solid Waste Prevention, Reduction & Utilization, Options for TDS reduction, Site visit.	Member Unit Managers, Technicians, Chemists
4.	Machinery Maintenance (MM)	Technical Staff	Preventive Predictive and Breakdown maintenance of CETP machinery, Mixers/Flow makers and Clarifier, Diffused aeration System, agitators and Gear Boxes, pumps - Centrifugal, Positive displacement / submersible pumps and mixers, Site Visit, Demo.	Managers, Engineers, Technicians, Chemists

S. No.	Name of the Training Program	Category of Course	Program Contents	Designated Role
5.	Microbiology of Waste Water Treatment Plant (WWTP) (MICRO)	Technical Staff	Introduction to Microbiology, saprobian Index - Monitoring the Health of Activated Sludge Process - Trouble Shooting, Microscopic Examination of Samples from various CETPs / IETPs.	Managers, Lab Technicians, Chemists, Micro-biologists.
6.	Sewer Maintenance (SM)	Technical Staff	Sewer Maintenance - Hazards involved and Safety precaution, Sewer Maintenance Machinery, Air Supply Units, Hydrogen Sulphide Gas Detection.	CETP / IETP / member unit Workers.
7.	Energy Conservation in WWTP (EC)	Senior Staff and Technical Staff	Energy consumption in CETPs / IETPs - benchmarks and Comparative Evaluation, Energy Monitoring - Instrument and devices, Energy Auditing in CETPs / IETPs, Case Studies.	CETP Managers Technicians, Chemists.
8.	Pre-Treatment of Effluent (PTU)	Technical Staff	Pre- Treatment unit design and operation, Safety Requirements in Sludge removal and Tank cleaning, Sludge pumping.	CETPs / IETPs / member unit Workers
9.	Process Automation and Instrumentation in WWTP (PAI)	Senior Staff and Technical Staff	Introduction to instrumentation in ETPs, Wastewater Instrumentation and Online Monitoring Equipment's, Process Automation, Demonstration.	IETP, CETP Managers, Engineers, Technicians, Chemists
10.	Lab Analysis and Monitoring (LAM)	Senior Staff and Technical Staff	Sampling Procedures for Collection of Waste Water for Analysis, Analysis of Tannery Waste Water Samples, Laboratory - Design, Equipment's and Chemists, Effluent Treatability Studies, Demonstration on the Job Training for Participants.	IETP, CETP Managers and Chemists

S. No.	Name of the Training Program	Category of Course	Program Contents	Designated Role
11.	Salt Management (SM)	Senior Staff and Technical Staff	Waste salt minimization, SLF design & Operation, Salt recovery methodologies & SOP for Chiller operation, Recovered salt quality testing procedures.	IETP, CETP Managers, Engineers, Chemists
12.	Specialization Courses in Membrane Processes (MF/ UF/ RO)	Senior Staff and Technical Staff	Operating principle, limitations, membrane chemistry, selection of membrane, SOP as per manufacturers recommendation & Trouble shooting, Site Visit	IETP, CETP Managers, Engineers, Technicians, Chemists
13.	Specialization Courses in Thermal Evaporation (MEE/ MVR/ TVR/ CHILLER)	Senior Staff and Technical Staff	Basic principle of Evaporation, Design norms, Selection of MoC for Evaporator components, SOP for Evaporator & Trouble shooting. Basic Principles of Boiler operation and Feed water quality testing, Feed water chemical addition to control scaling, Site Visit	IETP, CETP Managers, Engineers, Technicians, Chemists
14.	Design and Engineering of ETP/ CETPs	Senior Staff	Fundamentals for the selection and design of the most appropriate, cost-effective and sustainable wastewater or sanitation treatment system. It also provides the basics on technology selection and costing and engineering economics for the analysis, evaluation and comparison of different treatment alternatives.	IETP, CETP Managers, Engineers
15.	Management of Water Reuse Business	Senior Staff and Technical Staff	Understand principals of reuse of water and kinds of water that can be reused. Understand water chemistry and underlying principals and apply them to varied technologies for Water reuse.	IETP, CETP Managers, Engineers, Technicians, Chemists

Note: This is not an exhaustive list and can be added more to the list as per expectations

Bibliography

i. Guidelines On Techno-Economic Feasibility Of Implementation Of Zero Liquid Discharge (ZLD) For Water Polluting Industries Vide Letter No B-400/Pc-Iii/2014-15/ Dated 19/01/2015 (http://www.indiaenvironmentportal.org.in/files/file/Final-ZLD%20water%20polluting%20industries.pdf)

ii. The 168th meeting of Central Board in March, 2015 and 59th Conference of Chairmen & Member Secretaries held in April, 2015 endorsed the requirement of adoption of Zero Liquid Discharge in heavily water consuming and water polluting sectors including distilleries and also agreed to the proposed standards.(https://www.aidaindia.org/pdf/Bengaluru2017/Dr.%20M.MADHUSDANAN.pdf)

iii. Power Point Presentation of Zero Liquid Discharge Concept, Water Reuse: Regulatory requirements by Dr. M. Madhusudanan, Central Pollution Control Board (https://www.aidaindia.org/pdf/Bengaluru2017/Dr.%20M.MADHUSDANAN.pdf).

iv. A news letter from ENVIS Ventre – Central Pollution Control Board listing 18 categories of major polluting industries for priority action (http://cpcbenvis.nic.in/cpcb_newsletter/Polluting%20Industries.pdf)

v. Guideline on Techno – Economic feasibility of Implementation of Zero Liquid Discharge (ZLD) for water pollution Industries by Central Pollution Control Board, January 2015 http://www.indiaenvironmentportal.org.in/files/file/Final-ZLD%20water%20polluting%20industries.pdf

vi. Criteria for determination of Grossly Polluting Industries (SPI) released by CPCB vide letter dated 29.02.2016 (https://erc.mp.gov.in/adminfiles/RTM/XGPI_SPI.pdf)

vii. Honourable Supreme Court of India Order and Writ Petition (C) no.375 of 2012 dated 22.2.2017 stating that that while acquiring land for the 'common effluent treatment plants', the concerned State Governments (including, the concerned Union Territories) will acquire such additional land, as may be required for setting up “zero liquid discharge plants”, if and when required in the future” (https://indiankanoon.org/doc/190799178/

viii. Revised modified Direction under Section 18(1) (b) of Water (Prevention & Control of Pollution) Act, 1974 to Textiles units & Clusters by Central Pollution Control Board (http://www.indiaenvironmentportal.org.in/files/file/Latest%20Direction_textile.pdf).

ix. Ministry of Power, Govt. of India has revised tariff policy on January 28, 2016 to mandate for reuse of wastewater in thermal power plant; http://www.cercind.gov.in/2018/whatsnew/Tariff_Policy-Resolution_Dated_28012016.pdf

x. Rajasthan State Sewerage & waste Water Policy- 2016 on Reuse of Treated Effluent and Sludge; https://urban.rajasthan.gov.in/content/dam/raj/udh/organizations/rudifco/pdf/CM%20Message%20ProofRead__FD_State_Sewerage_and_Waste_Water_Policy_07.09.2016.pdf

xi. Wastewater reuse and recycle policy released by Urban administration & Development Department, Govt. of Chhattisgarh http://www.korbamunicipal.in/mck/images/Scheme/policy_for_wate_water_recycle_an_reuse_policy.pdf

xii. Maharashtra Water Resources Regulatory Authority Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations, 2019; https://mwrra.org/wp-content/uploads/2019/08/WRC-Regulation-draft.pdf,

xiii. Urban Development Department, Government of Uttar Pradesh has made mandatory for UPSIDC to use Treated wastewater of Local bodies, for every industry which is consuming 1 lacs or more fresh water for their non-potable use to reuse treated waste water situated within 20 km premises http://kmc.up.nic.in/Documentary%20Evidence_ANNEXURE/ANNEXURE%2010.4%20Waste%20Water%20%20Recycle%20and%20Reuse%20Policy(final).pdf

xiv. Scheme for assistance to Bulk Drug Industry for CETP project under Common Facility Centre by Department of Pharmaceuticals, Govt of India https://pharmaceuticals.gov.in/sites/default/files/Asistance%20to%20Bulk%20Drug%20Industry%20for%20Common%20Facility%20Centre.pdf

xv. Scheme for assistance to Pharmaceutical Industry for CETP project under Common Facility Centre by Department of Pharmaceuticals, Govt of India https://pharmaceuticals.gov.in/sites/default/files/Cluster%20Development%20Scheme.pdf

xvi. Guideline for utilization of Treated Effluent in Irrigation by Central Pollution Control Board, Sep, 2019 (https://kspcb.gov.in/Circular_4588-26-11-2019.pdf).

xvii. Central Ground Water Authority Guidelines / Criteria for evaluation of proposals /requests for ground water abstraction (with effect from 16.11.2015) http://cgwb.gov.in/CGWA/Documents/Revised%20guidelines_12112015.pdf

ANEXURE

Draft Guidelines on ZLD and its applicability for specific Industries and Industrial sectors

1. **Background**

CPCB's 2015 report on the *Guidelines for Techno-economic feasibility of implementation of Zero Liquid Discharge (ZLD)* recognises the problems that many industrial sectors are not able to achieve standards and this ultimately necessitates to work towards Zero Liquid / effluent discharge standard.

The penalty for non-compliance of the EPA standards for discharge of treated wastewater can ultimately result in revocation of the 'consent-to-operate' and ultimately closure of the industry.

Zero Liquid Discharge is already in operation across several Industrial sectors in the country for almost two decades, it has gained serious traction for the most part in the last decade. However, all this without any legislation specifying ZLD standards or applicability for any industry.

The reasons for the industries to implement ZLD can be briefly summarised as follows:

vii. Regulatory requirements - CPCB / SPCBs directions/ Environmental Clearance conditions / Local Bodies / River development etc.,

viii. Current EPA discharge standards and compliance issues

ix. Legal conflicts / litigation related to pollution / NGT / Court Orders

x. Water Scarcity and compliance with CGWA rules for Over Exploited Zones.

xi. Compliance with Buyers/ Customer/ brand requirements.

However, the EPA and rules thereof does not define ZLD and there are no guidelines on applicability of ZLD to any industries or any standards for ZLD. This issue is proposed to be addressed through this guideline.

2. **Definitions**

ZLD:

Zero Liquid discharge refers to installation of facilities and system which will enable industrial effluent for absolute recycling of permeate and converting solute (dissolved organic and in-organic compounds/salts) into residue in the solid form by adopting method of concentration and thermal evaporation. ZLD will be recognized and certified based on two broad parameters that is, water consumption versus waste water re-used or recycled (permeate) and corresponding solids recovered (percent total dissolved / suspended solids in effluents). (Source: Guidelines on Techno – Economic Feasibility of Implementation of Zero Liquid Discharge (ZLD) for water polluting Industries, CPCB, Jan 2015).

Zero Liquid Discharge (ZLD) implies that the industries are not discharging any effluent, either on the land or in the water body or at any other place i.e. recycling the same in the process entirely without releasing any effluent (Source: CPCB report on Guidelines for Utilisation of Treated Effluent in Irrigation, September 2019).

The salt residue from thermal evaporation of brine concentrates from Membrane processes has to be suitably disposed off to Treatment Storage & Disposal Facilities (TSDF) as per the Hazardous Waste management Act and Rules.

Industries would be encouraged to recover individual salts from the residue from the ZLD system, wherever feasible, for reuse within their own production process or for sale to other industries. Industries which cannot reuse in full or in part and want to sell the entire or excess quantity of salt to other industries subject to the quality meeting Industrial grade for sale.

GPI – Grossly Polluting Industries:

GPI are specified as Industries discharge effluent into a water course and (a) handling hazardous substance, or (b) effluent BOD load of 100 kg per day or more, or (c) a combination of (a) and (b).

HPI- Highly polluting industries, which are:

1. Pulp & Paper,
2. Distillery,
3. Sugar,
4. Leather Tanneries,
5. Thermal Power Plants,
6. Iron & Steel,
7. Cement,
8. Oil Refineries,
9. Fertilizer,
10. Chlor-Alkali Plants,
11. Dye & Dye Intermediate Units,
12. Pesticides,
13. Zinc smelting
14. Copper smelting
15. Aluminum smelting,
16. Petrochemicals
17. Pharma Sector
18. Sulphuric Acid

SPI – Seriously Polluting Industries as approved by Principal Committee constituted by NGT vide Original Application No. 196 of 204 & Ors. Dated 17.11.2014

1. Distillery including Fermentation Industry
2. Sugar
3. Tannery
4. Pulp & Paper (Paper manufacturing with or without pulping)
5. Slaughter houses and meat processing industries
6. Dyes and Dye Intermediates
7. Yarn and Textile processing involving bleaching, dyeing, printing and scouring etc.,
8. Thermal Power Plants
9. Milk processing and dairy products
10. Pesticides (Technical) (excluding Formulation)
11. Pharmaceuticals (excluding Formulation)
12. Petrochemicals (Manufacture of and not merely use of raw material)
13. Aluminum Smelter
14. Chlor Alkali
15. Organic Chemicals manufacturing
16. Synthetic fibre including rayon, tyre cord, polyester filament yarn
17. Industry or process involving metal treatment or process such as pickling / electroplating/phosphating/anodizing/galvanizing etc.,
18. Manufacturing of Pints, Varnishes, Pigments and intermediate (excluding blending / mixing)
19. Automobiles Manufacturing (Integrated facilities)
20. Coal Washers
21. Copper Smelter
22. Oil Refinery (Mineral oil or Petro refineries)
23. Heavy Engineering including ship building (with investment on Plant & Machineries more than 10 crores)
24. Hydrocyanic acid and its derivatives
25. Manufacturing of Lubricating oils, greases of petroleum based products
26. Coke making, liquefaction, coal tar distillation or fuel gas making
27. Zinc Smelter
28. Chlorine, Fluorine, bromine, iodine and their compounds
29. Chlorates, perchlorates and peroxides
30. Basic Chemicals and electro chemicals and its derivatives including manufacture of acids

31. Food & Beverages (Alcoholic and non – alcoholic)
32. Photographic films and chemicals
33. Industrial carbon including electrodes and graphite blocks, activate carbon, carbon black.

Source: CPCB letter to MoEF & CC, dated 29.02.2016

Water Intensive Industries

The following different industries category has been listed as Water Intensive Industries:

1. Packaged drinking water
2. Mineral water plant
3. Tannery
4. Distillery
5. Brewery
6. Soft drink
7. Paper & pulp
8. Fertilizer
9. Textile Dyeing
10. Textile Printing
11. Textile spinning
12. Sugar
13. Dairy Product
14. Water park & amusement Centre

Source: Central Ground Water Authority Guidelines / Criteria for evaluation of proposals /requests for ground water abstraction (with effect from 16.11.2015)

3. Determining applicability of ZLD

Based on discussions in the preceding section, the following criteria instead of a blanket application of ZLD across all sectors, the following four point criteria is suggested:

a) Identified specific sectors.
b) Environmental Situation
c) Technical Viability
d) Economic Viability

An industry can be directed to implement ZLD if it fulfils all the above four criteria. To determine if any industry fulfils the above criteria, it may be checked on the following parameters.

a) Identified specific sectors

i) Water Intensive and Polluting Industries- Industries which fall under water intensive category or grossly polluting industry category (GPI) or Highly Polluting industry (HPI) or Seriously Polluting Industry (SPI) category will be considered as candidates for directions for Zero Liquid Discharge.

ii) Point of discharge- This would be applicable to above industries which are discharging their treated wastewater to inland surface water body (River/lakes/ streams) or marine discharge at a distance of more than 50 KM from the coast (HTL).

iii) Exemptions- Industries which are permitted to discharge their treated wastewater for irrigation (as CPCB guidelines September 2019) or to a sewer network (meeting sewer discharge standards) or industries permitted to discharge their treated effluent by mixing with treated sewage for dilution will be exempted.

b) Environmental Situation of concern

i) Non-compliance of EPA standards- industries in the above identified specific sectors which are not meeting the existing EPA standards.

ii) Industry from the specific sector which has been directed to implement ZLD or has been made liable for pollution by the NGT/Court.

iii) Industries from the above specific sector which are located in critically polluted clusters as per Water Pollution Index of the Comprehensive Environmental Pollution Index (CEPI).

iv) Industries already located in the "Over –Exploited Zone" and which have been mandated for full recycling as per the CGWA guidelines.

v) Industry is existing previously in an eco-sensitive zone (Forest, wetland area, Marine bio-reserve etc.) or if industry location is within 1 KM from notified rivers.

vi) Any industry from the identified specific sector, having any one or more of the above situations listed (i) to (v) above, will be identified as having an environmental situation of concern.

c) <u>Technical Viability</u>

i) Availability of a BAT/BREF document for the specific industry sector, will be considered for assuming technical viability of ZLD. The ZLD guidelines for selected industries prepared by CPCB in 2015 can be considered as one such document. Similar BAT/ BREF documents can be prepared.

ii) ZLD will be deemed to be technically viable for industries in the above identified specific sectors based on prior ZLD operational experience in similar industrial sector elsewhere within the country for a minimum period of 5 years.

iii) Identified specific sectors with no prior ZLD operational experience but with environmental situation as described in section 'b' above, will be directed to carry out techno-commercial viability of ZLD through R&D and pilot plant, through a reputed Technical university or agency within a span of 1 year before proceeding for implementation of ZLD.

d) **<u>Economic viability</u>**

i) ZLD will be deemed to be economically viable for industries in the above identified specific sectors based on prior ZLD operational experience in similar industrial sector elsewhere within the country for a minimum period of 5 years, particularly in tiny or small scale industries or clusters.

ii) Availability of a BAT/BREF document for the specific industry sector, will be considered for assuming technical viability of ZLD. The ZLD guidelines for selected industries prepared by CPCB in 2015 can be considered as one such document. Similar BAT/ BREF documents can be prepared.

4. **<u>General</u>**
   i) Industries from the identified specific sectors in (section a above) with any of the above mentioned 'Environmental Situation' as given in section b can be directed to implement ZLD.
   ii) If these industries claim that they are unable to demonstrate Technical and/or economic viability for ZLD, such industries may be proceeded against as per existing Environmental Protect Act and rules thereof.

5. **<u>Standards for ZLD</u>**

Basically there are three products possible from a ZLD facility. These are Recovered water, recovered salt and brine. This is other than chemical sludge and mixed waste salt, which are already covered under the Hazardous waste management Act.

i) Standards for recovered water quality from ZLD facility

There are existing standards for use of fresh water for various purposes including industrial production, boiler, cooling, washing etc. Therefore the recovered water from ZLD facility should meet these existing standards. The relevant BIS codes for quality of water for industrial purposes shall be applicable. . However, if the industry is able to demonstrate reuse of the recovered water for its own use including process or utilities, then the quality of recovered water shall be deemed to be acceptable.

ii) Standards for quality of recovered salt for reuse within the industry

The purity of the recovered salt or brine can be as per industry's own need and as long as it is not disposed off outside there is no specific standard required. The concentration, purity, quantity and volume requirements can be as per Industry's own requirement for its internal use. Example: Reuse of treated liquid brine and salt in the Tirupur Textile Dyeing cluster.

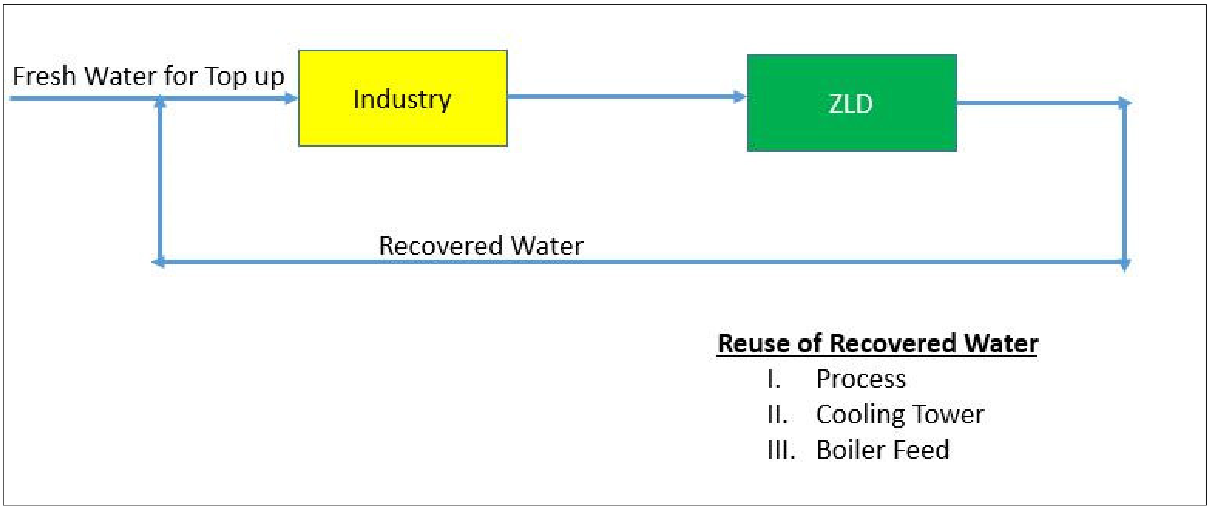
iii) Standards for recovered salt for sale in the open market

The recommended standards for recovered salt should also meet existing BIS standards for industrial grade salt.

6. **<u>Permitted ZLD System hierarchies</u>**

i) Total ZLD System

Under this system, no effluent is to be discharged from the industry to the environment and the entire water is recovered and reused. This is more an economical option where there is severe water scarcity, water costs are high, and the environment has been seriously impacted. Example; ZLD System installed in Tannery / Textiles Clusters in Tamilnadu.



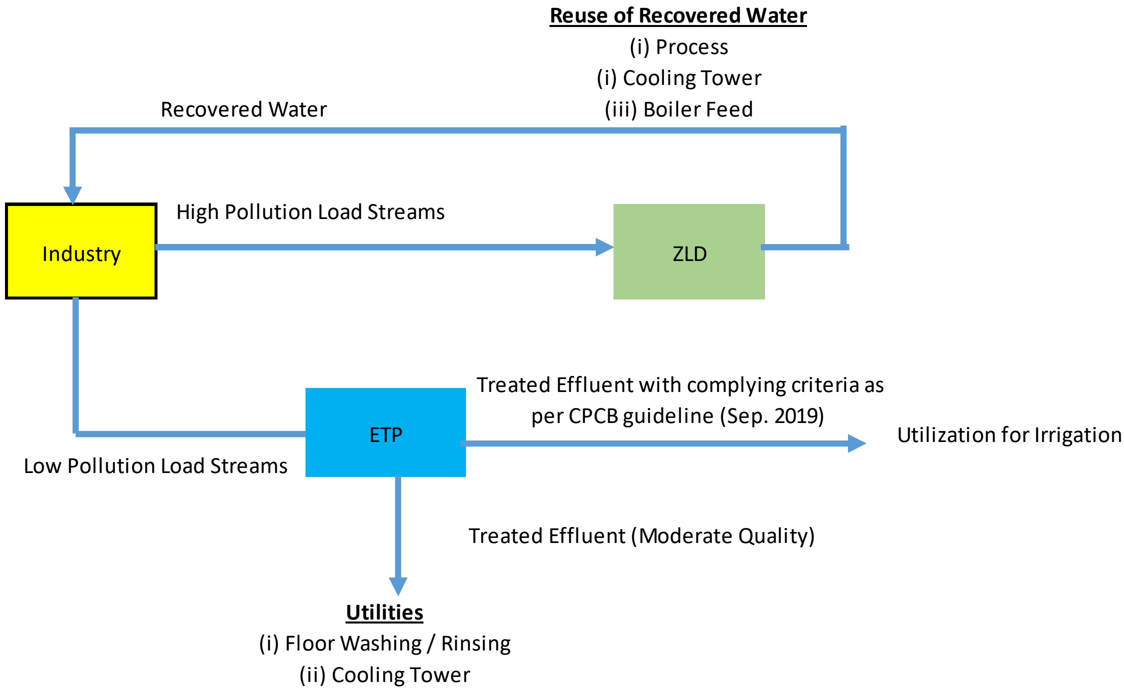
ii) Partial ZLD / Selected High Polluted Effluent Streams and reuse of recovered water for process

The Partial ZLD is for High-Pollution load effluent streams, which would be segregated and treated separately in a ZLD facility, separate from other effluent streams. This reduces the need for implementing ZLD in the entire volume of effluent generated and thereby reduces capital and operating costs.. Typically, this can be applied for high effluent volume generating industries, like say an integrated pulp mill. However, this is too be employed only where, segregating of high pollution load effluent streams results in drastic reduction in pollution characteristics of the remaining wastewater. Typically the remaining wastewater (low pollution load stream) would be wash water. This treated wastewater can be used for irrigation or ancillary processes like floor washing, rinsing, etc. Example; bleaching effluent from the pulp mill which is having high salinity, and high COD content can be separated from the remaining wastewater streams.

The low pollution load streams can be treated in a conventional effluent treatment plant and treated effluent can be utilized either for irrigation by fulfilling following criteria as specified in the guideline dated September 2019 for Utilisation of Treated Effluent in Irrigation of Central Pollution Control Board

The treated effluent should meet the norms prescribed for irrigation under Environment (Protection) Rules, 1986/Consent. The effluent should also conform to Total Dissolved Solid (TDS): 2100 mg/l and Sodium Adsorption Ratio (SAR)- less than 18 but not more than 26, depending on soil/crop type, besides meeting any other parameters suggested by agricultural scientist or agricultural university.

Meeting the prescribed norms shall not be the only criteria for use of treated waste water in irrigation, the requirement of water for irrigation will also be a limiting condition and this depends upon various factors of Crop, Climate, Irrigation type, Soil Condition, Soil permeability, Total Salt Concentration.

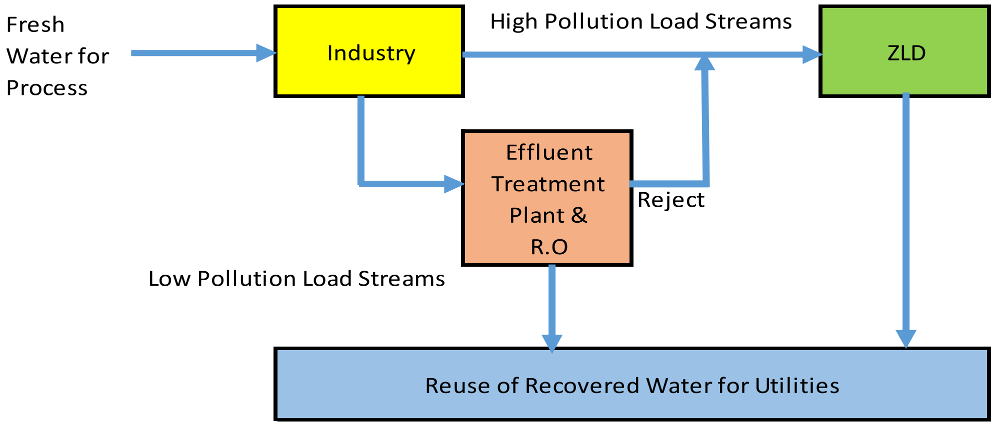


The treated effluent with moderate quality is suggested for floor Washing / Rinsing / Cooling Towers etc.,

iii) Partial ZLD for High TDS Effluent Streams and no reuse of recovered water in production (e.g. Pharmaceuticals)

This Partial ZLD is also for High-TDS load effluent streams, <u>however no reuse of recovered water in the Production Process is allowed</u>. Example; Bulk drug manufacturing Pharmaceuticals Industries. The recovered water instead of being utilized in the production process can be used for ancillary purposes.

For low TDS load streams, Reverse Osmosis will be installed and recovered water from low pollution load streams can be reuse for Process and utilities. The brine concentrate from the RO plant of this low TDS ETP is discharge into the ZLD facility of the high TDS waste stream.



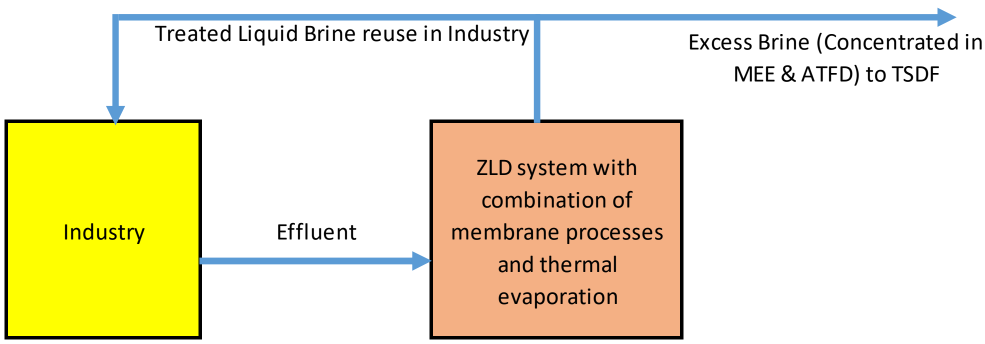
iv) Brine reuse

These type of ZLD plants are having systems for management of RO rejects for the recovery of salt through 'treated brine reuse technology'. Removal of salinity requires application of membrane processes. While membrane processes recover high quality water, they also generate highly concentrated rejects or brine. The brine is further treated for reuse in the process. This option includes a combination of membrane processes and thermal evaporation of saline membrane rejects. Reuse of salt as liquid brine reduces the need for thermal evaporation and concentration, thereby reducing operating and capital costs. These technologies have been successfully demonstrated and employed in the Tirupur Textile dyeing Cluster for over a decade. Reuse of RO Brine containing nutrients (N,P,K) in fertilizer industry in the manufacturing is also in practice.

Reuse of recovered of Brine (eg.)

(i) Textile for Process

(i) Fertilizer - for Process



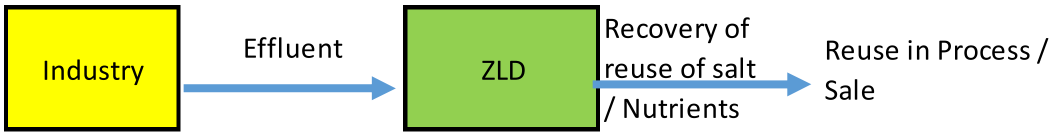
v) ZLD with Mixed Salt crystallization and disposal to TDSF

After recovery of water from R.O, the reject is concentrated in the membrane / thermal Evaporators sand crystallizers for crystallizing of salts. Typically, mixed salts with contaminants are produced during such crystallization. Typical salts in this crystallized salt is Sodium & Calcium salts of Chlorides, sulphates, nitrates and phosphates. It is also to be noted that most salts are hygroscopic and corrosive, therefore long term storage in plastic bags in containment sheds is not feasible. Such mixed salt waste should be disposed of promptly to a TSDF, provided such facilities have treatment systems for handling mixed waste salts. Example: Tannery ZLD CETPs in Tamilnadu dispose off the mixed waste salt to a TSDF facility.

vi) **ZLD with Individual Salt Recovery and reuse in the industry's own process or for sale**

ZLD processes with salt separation technologies and selective crystallization techniques are able to produce high purity individual salts which can be reused either in the industry's own process or sold in the market for similar industrial use.

Example; Recovered High purity sodium sulphate salt (reuse in the dyeing process) and sodium chloride (sale) as has been done in some of the CETPs in the Tirupur Textile dyeing Cluster in Tamilnadu. Part of the salt is also reused as liquid brine without crystallization, thereby reducing thermal evaporation costs.



Exclusions

Discharge of treated effluent within industry's own premises or contract land for farming cannot be considered as ZLD. Since, such practice does not rule out contamination of underground aquifer, effects on soil fertility due to long-term use and run-off due to reduction in permeability of soil due to change in soil matric due to raising sodicity of soli or run-off to the near waterbody due to saturation or during rains. This permitted discharge falls under existing standards for irrigation.