Preliminary Guidelines: *Control of Microfibres in Wastewater*

May 2022

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TMC's position on the control of microfibres in wastewater

The textile manufacturing supply chain consists of thousands of manufacturing facilities in dozens of countries. Although the products and processes may vary greatly from one facility to the next, they all have one thing in common: the ability to shed fibres from textiles into the wastewater discharged from each facility.

Almost all facilities are required to meet regulatory discharge standards for total suspended solids (TSS) and failure to meet these will almost certainly result in discharges of large quantities of textile fibres. There is a likelihood that more stringent standards for discharge of microfibres will be developed in the near future and facilities will need to ensure existing processes for removal of solids are optimised and possibly invest in more advanced, zero-discharge filtration technologies.

As the industry looks for best practice to support its drive to mitigate fibre fragmentation, an in-depth, aligned and globally relevant textile manufacturing perspective is paramount. This approach is crucial in ensuring cross industry uptake, effective and measurable impact, whilst upholding a 'no regrets' attitude within the larger sustainability agenda.

The TMC Manufacturing Task Team with consultancy to the larger industry sector, over the course of two years, have developed the Preliminary Guidelines: '*Control of Microfibres in Wastewater'.* This document identifies an approach that can be taken across the supply chain to best support change within manufacturing. The scope of work includes industrial wastewater discharge produced within operations of textile, apparel and footwear suppliers with wet processing facilities.

TMC recognizes that the textile and clothing industry is responsible for fibre fragmentation from textiles at both the consumer level and within the manufacturing process. TMC considers a step-wise, scalable approach where the capture of fibre loss through the use of wastewater management at a facility level is a complimentary action to the root cause mitigation that can be done at the textile design and development level to prevent loss from occurring.

In support of the capture of unintentional fibre loss during manufacture, TMC is proposing a wide, cross industry adoption of the Preliminary Guidelines, '*Control of Microfibres in Wastewater'* within the global supply base, so that an aligned and industry wide adoption of these best practices can achieve the greatest impact in a timely manner. TMC's current position is outlined below:

1. All businesses along the footwear and apparel value chain (i.e., brands, retailers and their supply chain partners) are **encouraged to adopt and adhere to aligned cross industry guidelines** to minimize impact from fibre fragmentation.

2. Both synthetic and natural fibres shed during textile manufacturing and both pose a risk to the environment (see TMC Positioning Statement: *Biodegradability in the context of Fibre Fragmentation*). Therefore, **all fibre types are equally important**.

3. TMC recognise that there are some low / no-cost steps that can be taken to reduce discharges of microfibres. Facilities should **optimise existing on-site processes to remove microfibres and larger fibres that can subsequently fragment to form smaller fibres**. If removal is still not satisfactory there will be a need to augment existing equipment with more advanced filtration technology.

4. Although out of scope of the current TMC agenda, it is **recommended that centralised effluent treatment plants (CETP) and municipal effluent treatment plants (METP) consider the methods and approaches outlined within the Preliminary Guidelines** to mitigate release of fibres generated primarily from domestic sources.

5. It is understood that each manufacturing facility is unique so **differing mitigation technologies may be applied** depending on specific circumstances. A number of different options are provided within this document.

6. The different mitigation technologies outlined in this guideline may have **benefits beyond the reduction of microfibre releases** and this should be taken into consideration, especially where investments are being made and ROI calculated. For example, the use of more advanced filtration technologies may significantly reduce the risk of regulatory non-conformance for many conventional parameters and may even permit water recycling.

7. In the absence of test methodologies and standards it is **not yet possible to operate a conformance / non-conformance approach to microfibre releases** and these guidelines are aimed to reduce discharges from facilities. However, we are developing a test methodology and baseline that will be the focus of Phase 3 of this work.

This positioning statement forms a time relevant response to ongoing work in this area. The *Manufacturing Task Team*, as part of the *Microfibre* *2030 Commitment and Roadmap* continues to support moving the agenda forwards. Further information and can be found here.

Contents

List of Figures/Tables

Abbreviations

BOD: biological oxygen demand

CETP: central effluent treatment plants

CO_2: carbon dioxide

COD: chemical oxygen demand

DAF: dissolved air flotation

EOP: end of pipe

METP: municipal effluent treatment plant

MBR: membrane bioreactors

PFA: perfluoroalkoxy alkane

TSS: total suspended solids

UF: ultrafiltration

ZLD: zero liquid discharge

Definitions

In the textile industry 'microfibre' is a technical term for a synthetic fibre < 10 µm in diameter.

However, outside of the industry, the term 'Microfibre' is is commonly used to describe fibers that are shed from clothing during production, consumer use, or end of life, and end up as pollution in the environment.

As such, the term 'microfibre' in this document refers to any textile fibre, or fragment from a textile fibre, natural or synthetic.

For the purposes of this document, the following terms and definitions apply*:

- **End of pipe (EOP) -** the point where no further treatment is conducted outside of transference of the wastewater to its discharge point from the site.
- **Fibre fragment** - a short piece of textile fibre, broken from the main textile construction.
- **Fibre, *n*.** - in textiles, a generic term for any one of the various types of matter that form the basic elements of a textile, and which are generally characterised by flexibility, fineness, and high ratio of length to thickness.
- **Point of generation** - the location at which a microfibre is generated. Generally, this occurs during the scouring, dyeing, finishing, and/or cleaning of a fabric.
- **Manufacturing facility** – facility or factory that produces fibres or yarns e.g., textile mill.
- **Microfibre** - a textile fibre (or fragment of) of natural or synthetic origin.
- **Microfibre fragment** - see 'Fibre fragment'.
- **Microplastic, *n*.** - a plastic particle originating from a number of different industries and measuring < 5 mm in size.
- **Natural fibre** - fibre obtained from, or produced by, animals, plants or minerals.
- **Solids separation** - the act of partitioning liquids and solids from a blended solution.
- **Synthetic fibre** - used to denote a manmade fibre or a fibre formed by chemical process.

* Due to ongoing topic and global topic alignment, the accepted definitions of these terms are under continuous revision and as such may evolve.

Introduction

In recent years, the presence of microfibres in the environment – specifically the oceans and other waterbodies – have garnered much attention by academia[1,2,3], civil society organizations [4,5,6] and the media[7,8,9] due to the potential negative impact on the food chain.

TMC's Microfibre 2030 Commitment and Roadmap delivery identifies the importance of understanding the root cause of fibre fragmentation to mitigate it at source through science led, informed decision making in the design of fabrics. However, a holistic and complimentary approach is required if we are to reduce the environmental impact of microfibres. Fibre loss from textiles occurs throughout the supply chain, from the production of fibres and fabrics, processing into textiles to through consumer use (Figure 1).

Wastewater discharge from apparel and footwear manufacturing contributes to the microparticle load in the environment as microfibres and particles shed and/or fragment from natural and synthetic fabric during the manufacturing and processing of textiles. Particles and fibres can be released from greige fabric during the scouring and cleaning process prior to dyeing and finishing; and from the agitation of the fabric during the dyeing process. Microfibres are released from the fibres and yarns within a fabric while particles from the ambient manufacturing environment are entrained within a fabric.

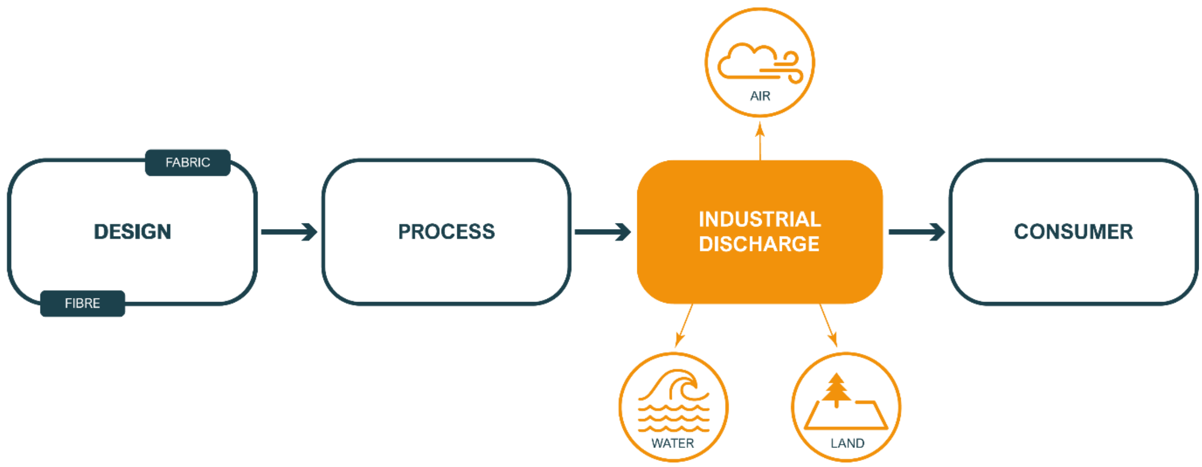

Figure 1. Industrial discharge of microfibres within the textile manufacturing supply chain

Wastewater effluents have thus been identified as a source of microfibre pollution, and studies have shown that the concentration of microplastics is greater downstream of a wastewater treatment plant than upstream.[10,11,12,13] Wastewater treatment systems have the ability to remove and retain microfibres, but they are not 100 percent efficient in their removal.[14]

Thus, it is critical that a no regret approach is taken across the supply chain to mitigate fibre fragmentation at all stages.

Over the past two years, the TMC Manufacturing Task Team has worked to define and scope the problem of microfibre pollution in textile manufacturing. This document is the outcome of that work and is intended to be used as guidance to:

- Define a method of controlling / managing microfibre pollution in manufacturing wastewater.
- Provide information of the technologies which exist to control microfibre pollution from manufacturing.
- Identify and confirm the location within a manufacturing facility at which microfibre pollution can be controlled / measured.
- Provide a vehicle to engage manufacturing partners and identify / landscape where suitable technologies already exist.
- Identify knowledge gaps and next steps.

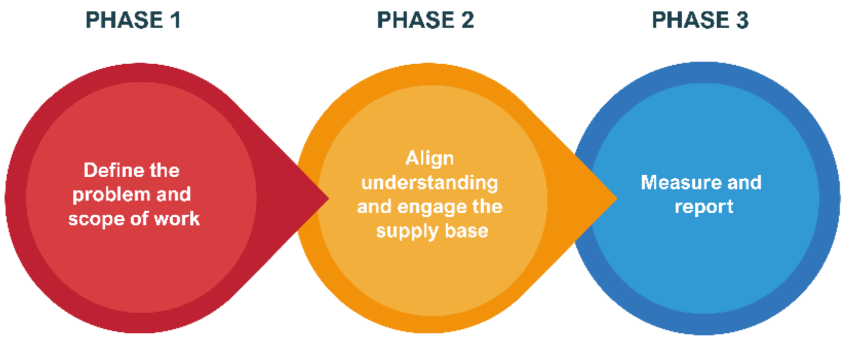

Figure 2: TMC Manufacturing Task Team Process

Objectives

Phase 1 – Define the overall problem of microfibre discharge from manufacturing wastewater and scope the work required to address it [COMPLETE].

Phase 2 – Align understanding and engage the supply base.

1) Provide guidance on methods to control / manage microfibres in textile wastewater to prevent their release to the environment.

2) Establish a consistent industry-wide approach on how to minimise microfibres in textile wastewater effluent.

Phase 3 – Determine a globally aligned test methodology to facilitate the measurement and reporting of microfibre discharge from manufacturing facilities.

The removal of microfibres from manufacturing wastewater

The intent of these Preliminary Guidelines is to identify strategies and technologies to remove microfibres and larger fibres that can subsequently fragment from textile wastewater and capture them, for example, in the sludge of the wastewater treatment system.

However, wastewater treatment systems and older piping systems at textile mills are known to release other solids and particles into the wastewater. Therefore, in addition to the removal of microfibres, methods included in these Preliminary Guidelines will also result in the removal of various microparticles in wastewater such a microbes, insoluble chemicals and assorted trash. Consequently, the removal of all microparticles will be considered, where microfibres are a subset of the total. In due course, as cost effective methods and standards for effluent assessment are developed, it is likely that it will be necessary to consider the count of all microparticles where microfibres are a subset of the total.

It is possible to consider point-of-generation measurement and control of microfibres (e.g. in a dyeing machine) but these Preliminary Guidelines focus on a centralised approach for measurement and control of microfibres in textile wastewater as the wastewater from the textile mill has been blended together.

A centralized approach offers a singular location for measurement and control reducing the overall complexity of the facility operations, providing:

a. Less labour for operations and maintenance when compared to filters at the point of generation of the microfibres.
b. Less waste (in the form of used filters) to landfill.
c. Relatively lower costs to retrofit existing facilities to install filtration equipment.
d. More control over the final disposition of microfibres.
e. If the facility has on-site wastewater treatment, the treatment system will be able to remove a significant amount of microfibres.

However, as demonstrated in the following section, it is advisable and commonplace to use coarse filtration in processing machines to remove loose fibres from the process. This is primarily done to prevent redeposition onto substrates, but it removes large amounts of fibrous waste from effluent streams – especially where natural fibres are concerned.

Technologies for microfibre removal from wastewater

Various systems and technologies exist to target the separation of solids from textile wastewater. Generally, the closer a mitigation step is to the point of generation, the larger the size of microfibres that will be present in the wastewater.

Settlement methods rely on gravity to pull solids to the bottom of a vessel.

Filtration methods recommended for the mitigation of microfibres will capture particles other than microfibres in the wastewater if those particles are larger than the pore size of the filtration methods.

A typical on-site 'direct discharge' effluent treatment process is depicted in Figure 3, with recognition that some facilities may differ from this system. It highlights where microfibres and other solids are typically removed and opportunities to augment the set up with additional mitigation technology. Details of the systems and technologies are provided below.

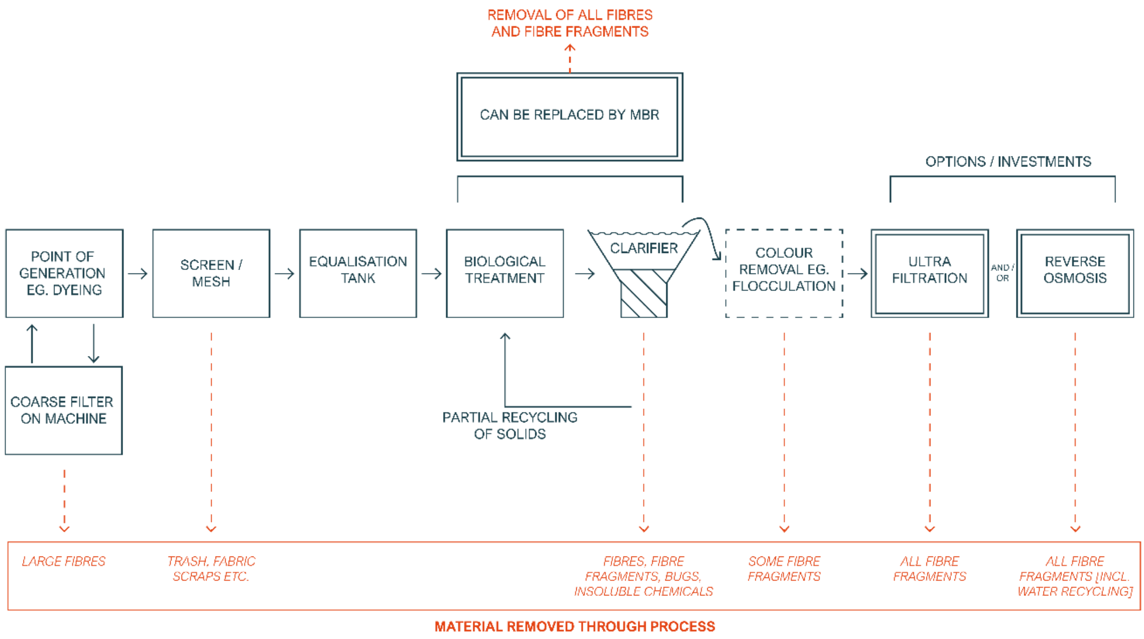

Figure 3. A typical step-wise procedure of systems and technologies within a manufacturing facility for the separation of solids from textile wastewater

1) Point of generation filtration
    a) A large number of fibres and microfibres can be shed by a textile substrate in a wet processing machine such as a dyeing machine and, to stop redeposition, they are often removed via coarse filtration built into the machine. The filters can be improved by adding a fine knitted sock but care has to be taken so that the flow rate isn't affected so much that the machine pumps cease to function.
    b) Coarse filtration removes large amounts of fibres from regenerated fibres such as viscose and lyocell and this is generally disposed as solid waste.
    c) Removal of larger fibres ensures they cannot subsequently degrade to become microfibres.

2) Screens and Strainers
    a) Screens and strainers are generally used to remove the largest particles and fragments, and can have mesh/pore sizes upwards of 50 mm.
    b) Screens and strainers will not remove the smallest of microfibres. The intent of these screens and strainers is to remove any trash from the wastewater that could damage or clog downstream equipment.

3) Traditional Clarification
    a) Traditional clarification is the most common form of solids-liquid separation in a textile wastewater treatment plant since the density of a particle is generally greater than the density of the wastewater.
    b) Clarifiers rely on gravity to settle particles to the bottom of the clarifier while the treated wastewater flows upward and out of the clarifier. There is no physical barrier preventing particles from flowing downstream.
    c) The smaller the particle, the less likely it will be captured in the clarifier unless the velocity of the upward flowing wastewater get closer to zero. This can occur by increasing the overall size of the clarifier.
    d) In order to achieve the best results in terms of removal of solids the flow rate should be low, the exit at the top horizontal with no gaps or channels, and there should be very low turbulence.
    e) Solids are partially recycled back into the biological treatment vessel and partially removed as sludge which is disposed as solid waste.

4) Membrane Bioreactors (MBR)
    a) Membrane bioreactors are a contemporary approach to wastewater treatment and provide a higher quality treated effluent than the classical approach using separate biological treatment and clarifiers. Additionally, the product water is much more amenable to a water recycling plant using technologies such as reverse osmosis.
    b) Membrane bioreactors are proven, commercially available, technology that is a combination of a membrane process such as microfiltration or ultrafiltration with a biological wastewater treatment process.
    c) In light of growing concerns over the release of microfibres, Membrane Bioreactors should be seriously considered as an option in new build wet processing facilities or where existing effluent treatment plants are being upgraded.
    d) The nominal pore size of an MBR is generally less than 1 µm, which can filter out most of the microfibres of concern, trapping them into the sludge of the aeration basin.
    e) The membranes can be designed for and operated in small spaces and with high removal efficiency of contaminants such as nitrogen, phosphorus, bacteria, biological oxygen demand, and total suspended solids.
    f) The membrane, submerged in the aeration basin of an activated sludge process, allows for a higher biomass concentration, reducing the overall size of the

bioreactors. Because the membrane prevents the biosolids from moving downstream, the membrane replaces the traditional clarifier that has historically been used to separate the sludge from the treated wastewater, significantly reducing the overall space needed for a wastewater treatment system.

g) As an MBR ages, it may experience broken fibres, which would then allow particles to pass through. The MBR should be inspected for broken fibres as part of normal preventative maintenance.

5) Colour Removal Technologies

There are normally regulatory requirements for the removal of colour from effluent before it is discharged and there are several techniques available. The type and positioning of the colour removal step can vary from facility to facility and is a matter of choice for the ETP designer and manager.

Simple addition of bleach, such as ozone, will have no bearing whatsoever on the levels of microfibres present.

However, methods that use some form of coagulation or flocculation are *likely* to remove *some* microfibres that may be present. At this stage it is not known how effective these methods are and further study is required.

a) Coagulation and Settlement
   i. Colour is often in the form of soluble dyes and if it is not bleached it has to be made insoluble in order to be physically removed.
   ii. The addition of either inorganic coagulants (such as ferrous lime) or specialised organic flocculants are used to insolubilise dyes.
   iii. Once insolubilised the solid mass can be settled by gravity to yield colourless wastewater. The solids are treated as solid waste.
   iv. In addition to removing colour, coagulation / flocculation will remove other chemicals and it is probable that some fibres will become entangled in the newly formed solids and removed.

b) Coagulation and Dissolved Air Flotation (DAF)
   i. Dissolved air flotation relies on microbubbles of air that adhere to solid particles in the water to carry those particles to the surface of the water.
   ii. Once on the surface of the water, the particles are skimmed off from the surface of the water into a collection bin, where they are disposed in a landfill.
   iii. Dissolved air flotation is occasionally used to treat textile wastewater by removing insoluble organics that contribute to biological oxygen demand (BOD) and chemical oxygen demand (COD), microfibres and other particles less than 5 mm diameter.

6) Ultrafiltration and Reverse Osmosis

Optimised typical effluent treatment processes will remove significantly more microfibres than non-optimised processes and this should be an immediate priority.

However, ultimately, TMC believes that, in order to reduce releases to almost zero, ultrafiltration and/or reverse osmosis should be employed.

a) Ultrafiltration
   i. Ultrafiltration is a technique that uses a fine membrane to remove entities smaller than the membrane pore size (typically 0.1 – 0.01 µm).
   ii. It is possible to filter out microfibres and divert them into the effluent treatment sludge using one of two variants - crossflow or dead-end ultrafiltration modules.
   iii. Crossflow ultrafiltration modules allow for microfibre-free water to flow downstream, while a concentrated reject (the wastewater that did not pass through the membrane) returns to the aeration basin, trapping the microfibres in the sludge.
   iv. Crossflow ultrafiltration modules downstream of a biological wastewater treatment plant are typically associated with a wastewater recycling strategy. Therefore, not only does an investment in crossflow modules mitigate microfibres, but it also prepares the facility to recycle their treated wastewater.
   v. Unlike a crossflow ultrafilter which flows a reject stream out of the filter, the upstream surface of a dead-end ultrafilter is cleared of microfibres and particles with a pulsed backwash where the pulsed backwash returns to the aeration basin, trapping the microfibres in the sludge.
   vi. Dead-end ultrafiltration, typically configured as Hollow Fibre membranes in an outside-In flow process, has been shown to utilize less energy than typical crossflow filtration.
   vii. Because of the nature of untreated textile wastewater, it may be necessary to install other forms of filtration upstream of the dead-end ultrafilter to avoid clogging and excessive fouling of the ultrafilter membrane, especially if installed at a facility that does not perform wastewater treatment prior to discharge to a centralized effluent treatment plant.
   viii. Dead-end filtration typically produces less wastewater needing to be treated as compared to crossflow filtration.

b) Reverse Osmosis
   i. Reverse osmosis is similar to ultrafiltration but uses much finer membranes (typically 0.001 µm) that only allow pure water to pass and which capture all solids and chemicals.
   ii. Not only does reverse osmosis capture microfibres but it removes all contaminants yielding fresh water that can be re-used in the facility.
   iii. Reverse osmosis requires relatively high pressures and the membranes are susceptible to fouling so facilities may choose to put ultrafiltration and reverse osmosis units in series to reduce operating costs and to prolong the life of the reverse osmosis membrane.
   iv. The filtrate, including microfibres, are recirculated back into the ETP and removed as sludge.

v. Reverse osmosis removes colour, so a separate colour removal stage can be avoided.

Sludge Management

Once captured in the sludge, the sludge must be handled and disposed of in a manner that does not release those microfibres back into the environment.

TMC recommends that ZDHC guidance[15] is followed with respect to disposal of sludge and, additionally, recommends that alternatives to land spreading of sludge are adopted to avoid the re-release of captured microfibres into the environment.

Common and Municipal Effluent Treatment Plants (CETP and METP)

Not all facilities have on-site effluent treatment, and it is common for effluent to be discharged to CETP or METP for treatment alongside the discharges of multiple facilities.

TMC hope that, in time, these centralised facilities will adopt mitigation technologies set out in this guidance to stop the discharge of microfibres and facilities should check with downstream treatment facilities what steps are in place.

For facilities that discharge into CETPs or METPs it is possible to divert microfibres from the discharge by using a dead-end ultrafiltration unit.

Unlike a crossflow ultrafilter which flows a reject stream out of the filter, the upstream surface of a dead-end ultrafilter is cleared of microfibres and particles with a pulsed backwash where the pulsed backwash must be collected and treated.

Sampling and Testing

Although there are currently no universally agreed test methods and standards specifically for microfibres, it is strongly recommended that all stakeholders keep abreast of developments and use available techniques to monitor their performance.

Technologies to detect microfibres in a matrix of other solids are still developing (e.g., activated sludge from a wastewater treatment system) and current methods of analysis are expensive and time-consuming when compared to measuring total mass of solids.

Although it is understood that very tiny fragments may not be captured during testing, it is vitally important that all facilities test for total suspended solids (TSS) as per regulatory requirements on a frequent basis and that is this considered as a critical failure. Additionally, the facility should monitor total water use and calculate total mass of solids released.

Ultimately, there may be an additional need to analyse a wastewater sample to determine the types of microfibres present. Generally, the types and sources of microfibres are generally known in textile mills as the mill will be focused on one particular fibre type e.g., a cotton mill.

Bespoke testing and particle size analysis can be conducted by specialist labs such as Hohenstein (e.g., Dynamic Analysis Testing) and, although this will form part of the Phase 3, as we work towards aligned methods and standards, suppliers are encouraged to profile their discharges where possible.

Sampling

Facilities with on-site wastewater treatment

1) To ensure that microfibres generated from the textile mill have been removed from wastewater, sampling is expected to occur immediately after the last filtration or solids separation step in the wastewater treatment system. This may be clarifiers, membrane bioreactors, ultrafiltration, or other filters.
   a) The goal of testing downstream of the last filtration is to ensure that other particles that may be generated in the wastewater treatment system or downstream processes do not bias the particle measurements.
   b) If no microfibres are measured immediately downstream of the last filtration step, then the filtration step has effectively removed from the wastewater the microfibres generated in the textile mill.
2) If a supplier has multiple points/locations for the discharge of industrial wastewater, samples must be taken from each discharge point.
3) Samples from multiple discharge points are to be tested separately and not blended together.

Sampling wastewater for the measurement of microfibres may occur two different ways:

1) Grab sample for laboratory analysis shall be in accordance with ASTM D8332-20.
   a) To minimize contamination from the sampling apparatus, rinse the sampling apparatus thoroughly with deionized water filtered to less than 1 µm.
   b) Be mindful of ISO-standard hold-times for bacteria sampling since proliferation of bacteria could impact the particle reading.
   c) All attempts should be made to run the wastewater samples through the sampling apparatus for approximately six hours.[16]
2) Continuous sampling connected to an on-line, flow-through particle counter:
   a) For monitoring purposes, it is recommended that online particle analysers are considered.
   b) Install a freshly calibrated analyser in accordance with the manufacturer recommendations; ensure that it is maintained and calibrated on a regular basis per the manufacturer's instructions.
   c) Plumb the particle counter with clean tubing such as PFA or propylene tubing.
   d) Because of the flow-through nature of a particle counter, it will be necessary to properly dispose of the wastewater leaving the particle counter.
   e) In terms of understanding how and when microfibres are discharged from a wastewater treatment system, use of an on-line particle counter is recommended so the continuous stream of data can be correlated with other process parameters such as time of day, average flowrates, etc.

Facilities with no on-site wastewater treatment

1) Sampling shall occur at a point closest to the location where the industrial wastewater leaves the property boundary of the facility.
2) This location will most likely be the same location used to sample the wastewater for legal compliance.
3) For facilities without any on-site wastewater treatment who discharge into a CETP or METP, it is recommended the facilities collaborate with the CETP to install microfibre control at the CETP to simultaneously address the microfibre discharges from many point sources.

Facilities that operate as Zero Liquid Discharge (ZLD)

1) For suppliers with an on-site Zero Liquid Discharge (ZLD) treatment system for industrial wastewater, there is no need to test for microfibres as there should not be any liquid discharge.
2) If for any reason there is a liquid discharge from a ZLD facility, the supplier is expected to sample and test the wastewater for microfibres.
3) The sludge produced from ZLD operations is expected to be disposed of in a manner that prevents the release of the microfibre fragmentation into the environment.[16]

Sampling Point Examples

The following schematic diagrams are provided to indicate where effluent samples should be taken from (or on-line monitoring installed) to check for presence of microfibres (specific wastewater treatment facilities may vary from that shown in the schematic). Diagrams are provided for both on-site effluent treatment with direct discharge and for indirect discharge to either CETP or METP. Recommended microfibre measuring points (coloured green) are indicted in the schematics along with process changes that would require capital investment (coloured yellow). However, it is recommended that each facility should work with a wastewater engineering consultant to identify the most optimal design for their facility.

Direct discharge arrangement with a clarifier (Figure 4) has no specific additional technologies for capture of microfibres and sampling and testing gives a benchmark for the effectiveness of the gravitational settling.

An MBR should remove microfibres and the sampling and testing should be used to confirm that and serve to monitor the integrity of the MBR membrane.

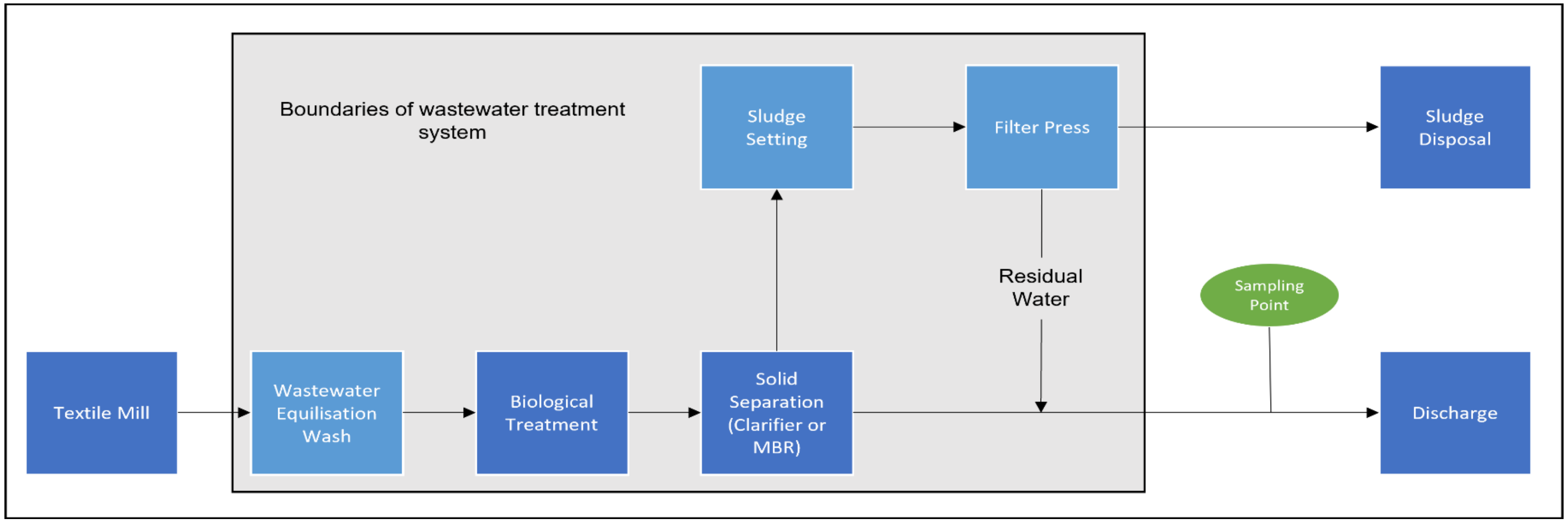

Figure 4: Basic Layout – Direct Discharge

Ultrafiltration should remove microfibres and the sampling and testing should be used to confirm that and serve to monitor the integrity of the UF membrane (Figure 5).

Note: It would be highly unlikely to augment an MBR facility with UF as it would be largely unnecessary.

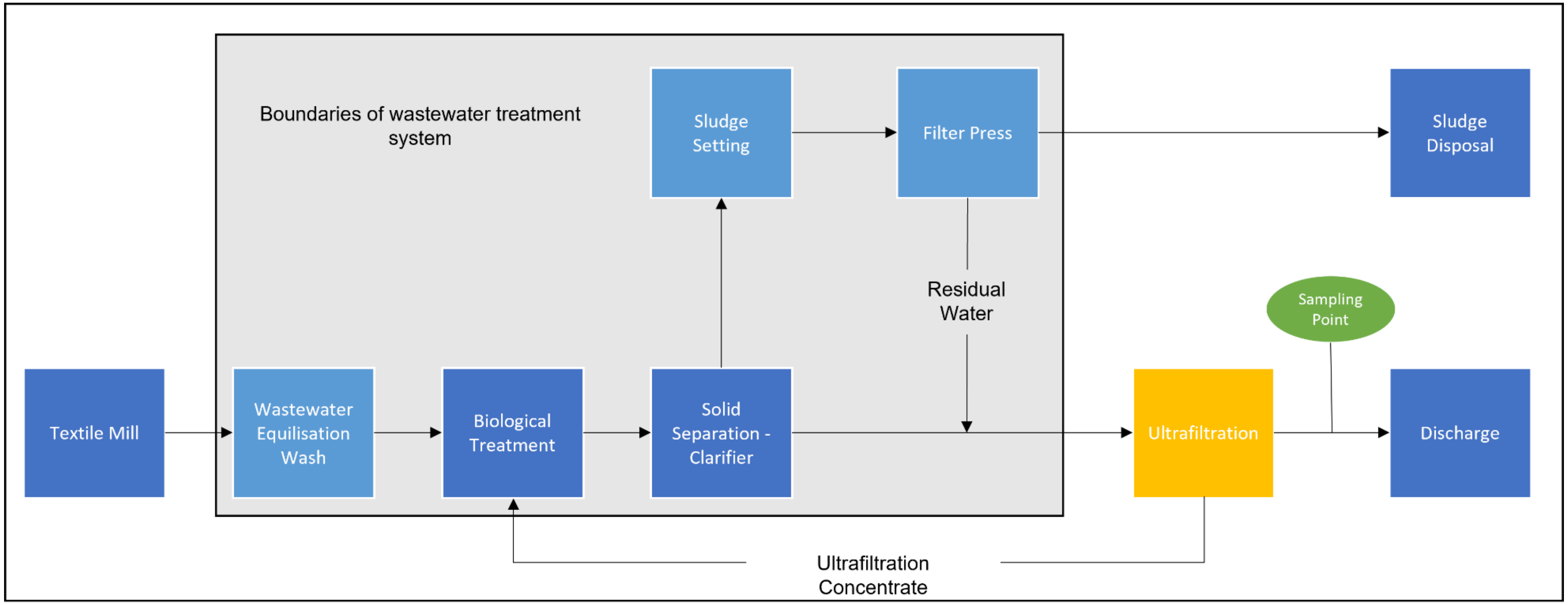

Figure 5: Direct Discharge augmented with Ultrafiltration

Ultrafiltration should remove microfibres and the sampling and testing should be used to confirm that and serve to monitor the integrity of the UF membrane. In this instance, reverse osmosis is used to recycle water, but RO can be used without UF to remove microfibres (Figure 6).

Where water recycling is in operation, the contaminants (RO concentrate) become concentrated, and care must be taken to ensure they meet regulatory requirements before discharge. If RO is used without UF the RO concentrate must be recycled back into the ETP to avoid discharge of microfibres.

Note: It would be highly unlikely to augment an MBR facility with UF as it would be largely unnecessary, but RO can be used where water recycling is desired.

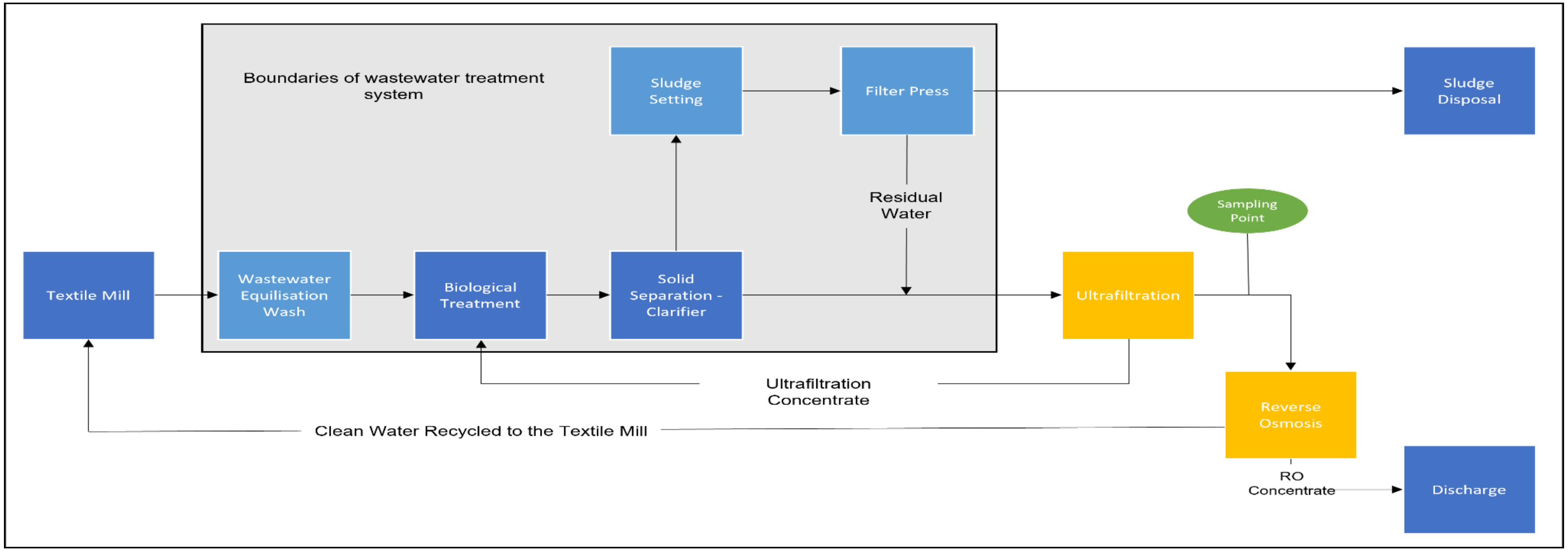

Figure 6: Direct Discharge augmented with Ultrafiltration and Reverse Osmosis

There are no processes to remove microfibres from the effluent stream, so the measurement and monitoring is for benchmarking only.

Facilities with this situation should consider investment in their own microfibre removal technologies or, preferably, encourage the CETP or METP to adopt microfibre removal technologies (Figure 7).

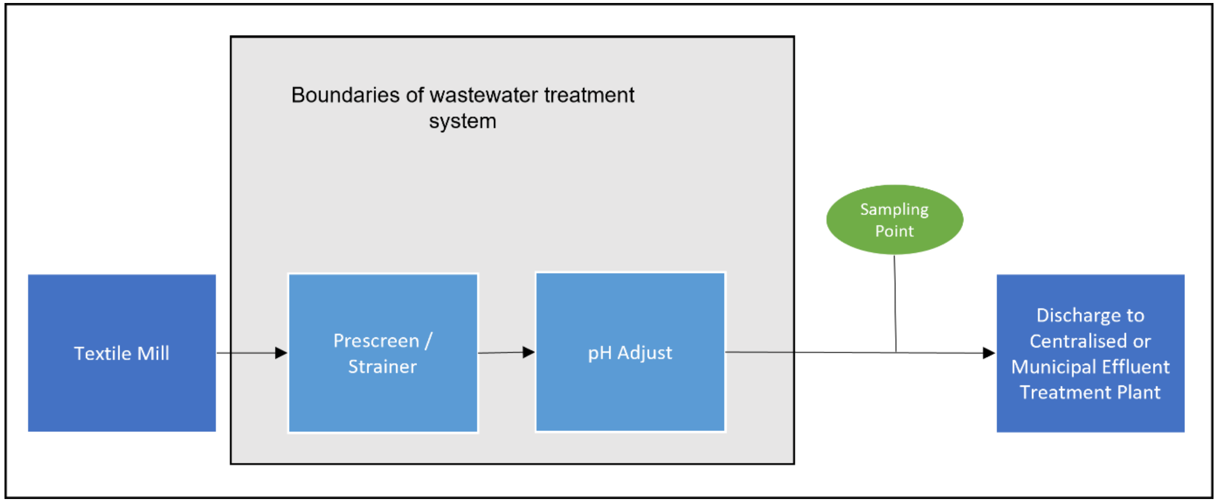

Figure 7: Indirect Discharge – basic layout

Figure 8 is example of an ultrafiltration system requires significant capital investment and is more complex than a UF module added to a typical direct discharge ETP. This is because it is not possible to pump raw wastewater through a UF membrane without risking fouling or damage.

With this in mind, if a mill is located in a hub where the wastewater is collected and treated by a CETP or METP then the CETP/METP should consider investing in microfibre mitigation outlined in Figure 4. In terms of overall cost, a CETP/METP adopting this will be significantly cheaper than each mill connected to the CETP/METP individually treating their own wastewater for microfibres.

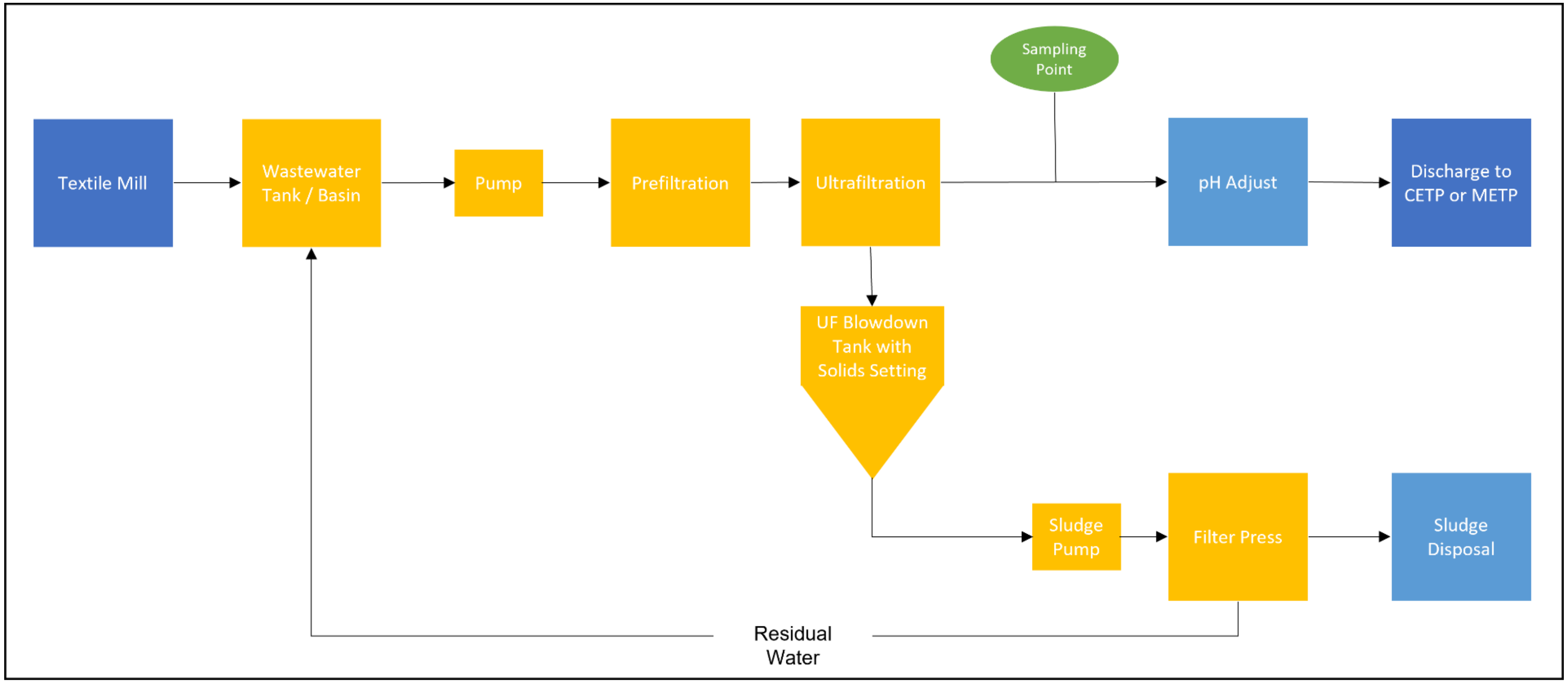

Figure 8: Indirect Discharge – augmented with microfibre removal technology

Knowledge gaps: Identified next steps

The next phase of the work will be developed collaboratively with ZDHC, again using a Task Team approach in building knowledge, progressing work and ensuring industry suitability and adoption. The work will be split into 3 key interconnected work packages that draw from the strengths of the two organisations, whilst leveraging from the unique knowledge building that is achievable as a result.

Test methodology

Identification and alignment of a globally available test method to measure fibre loss within wastewater at a manufacturing level.

Determine baseline

Establish a baseline for microfibre loss from manufacturing facilities.

Determine a reporting data structure

Working in collaboration with ZDHC to identify a reporting structure and harmonised data infrastructure to capture the measurement and control of microfibres from manufacturing facilities.

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Appendix

A.1 In / Out of Scope

In Scope:

A. These Preliminary Guidelines apply to industrial wastewater discharges and sludge produced from wastewater treatment operations of textile, apparel and footwear suppliers with wet processing facilities including, but not limited to:
   1) Dyeing and finishing of fibres, yarns, threads, fabrics, garments, trims and laces.
   2) Fabric mills.
   3) Laundry, washing and finishing facilities.
   4) Printing facilities.
   5) Vertical finished goods manufacturing facilities where any of the above wet processes occur.
   6) Synthetic materials (synthetic fibres or textile-polymer composite microfibres), coated with PU, PVC or similar that hold the appearance of leather but is not made from animal skin or hide (mock leather).

B. These Preliminary Guidelines apply to suppliers with direct discharge, indirect discharge and on-site Zero Liquid Discharge (ZLD) treatment plants. Where a supplier combines their industrial wastewater with domestic wastewater, the combined wastewater is classified as industrial wastewater, to which these Preliminary Guidelines would apply.

Out of Scope:

A. Discharges of domestic wastewater (for instance from a sewing/garmenting facility that employs workers but has no in-house wet processing), that is not blended with industrial wastewater, are out of the scope of these Preliminary Guidelines. These Preliminary Guidelines do not apply to domestic septic sewage treatment system or sludge when used only for domestic sewage.

B. These Preliminary Guidelines do not apply to wastewater management and treatment systems beyond the property boundaries of the suppliers. This includes any third-party, off-site, central, or common effluent treatment plants (CETP) that are not under direct control and/or ownership of the suppliers. However, it is recommended that CETP owners and operators consider some of the mitigation approaches outlined in these Preliminary Guidelines to address microfibre fragmentation from domestic and industrial point sources.

C. Microfibre and microparticle control in air.

D. Toxicological impact of fibre fragmentation.

A.2 Initial engagement with textile manufacturing partners

Whether you are reading these Preliminary Guidelines directly as a manufacture from across the textile chain, or a brand and retailer who will be communicating within your supply base, the following questions have been put together in support of your initial enquiry.

To support subsequent phases of work, we encourage you to upload your answers through this link so that we can best identify the most appropriate subsequent work and landscape the current position across the textile industry.