# The Effect of Screen Design on Capture Rate and Plant Maintenance

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Enviro-Care
Regional Sales Manager - Midwest

WAMGROUP®

Ohio Water Environment Association
Preserving & Enhancing Ohio's Water Environment

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# Agenda

- Problems Related to Low Capture Ratio
- Screen Technologies
- UKWIR Test Facility.
- Screen Details and Design Considerations

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# Poor Screening Systems

Material pulled from clarifiers after bypassing the screens

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# Poor Screening Systems

Material pulled from clarifiers after bypassing the screens

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# Poor Screening Systems

Clogged Pumps

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# Poor Screening Systems


Material from a clogged MBR system

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# Screen Technologies

An Overview

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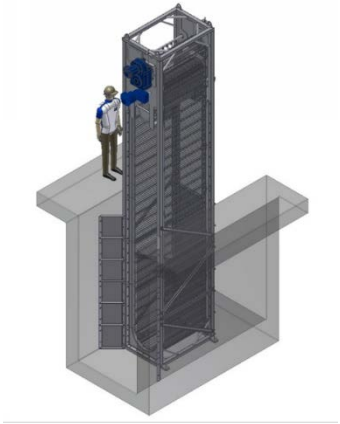
# Types of Screens

Spiral Screw



Center Flow

Trash Rake/Grab


Perforated

Step Screens

Drum Screens

Multi-Rake

…and more!

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# Filter Media – Bar Screens

- Examples
  - Multi-Rake
  - Catenary (single and double acting)
  - Climber / Grab
  - Step
  - Drum
- Variations:
  - Tapered Bar Field
  - Narrow Lamella Plates
  - Wedgewire

All are characterized by screening in 1 direction – Slotted Opening

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# Filter Media – Mesh Screens

- Examples
  - Spiral Screw
  - Perforated (belt)
  - Center Flow (band)
  - Drum
- Variations:
  - Perforated Plate
  - Plastic Filter Element
  - Steel Mesh

All are characterized by screening in 2 direction – Round or Rectangular Opening

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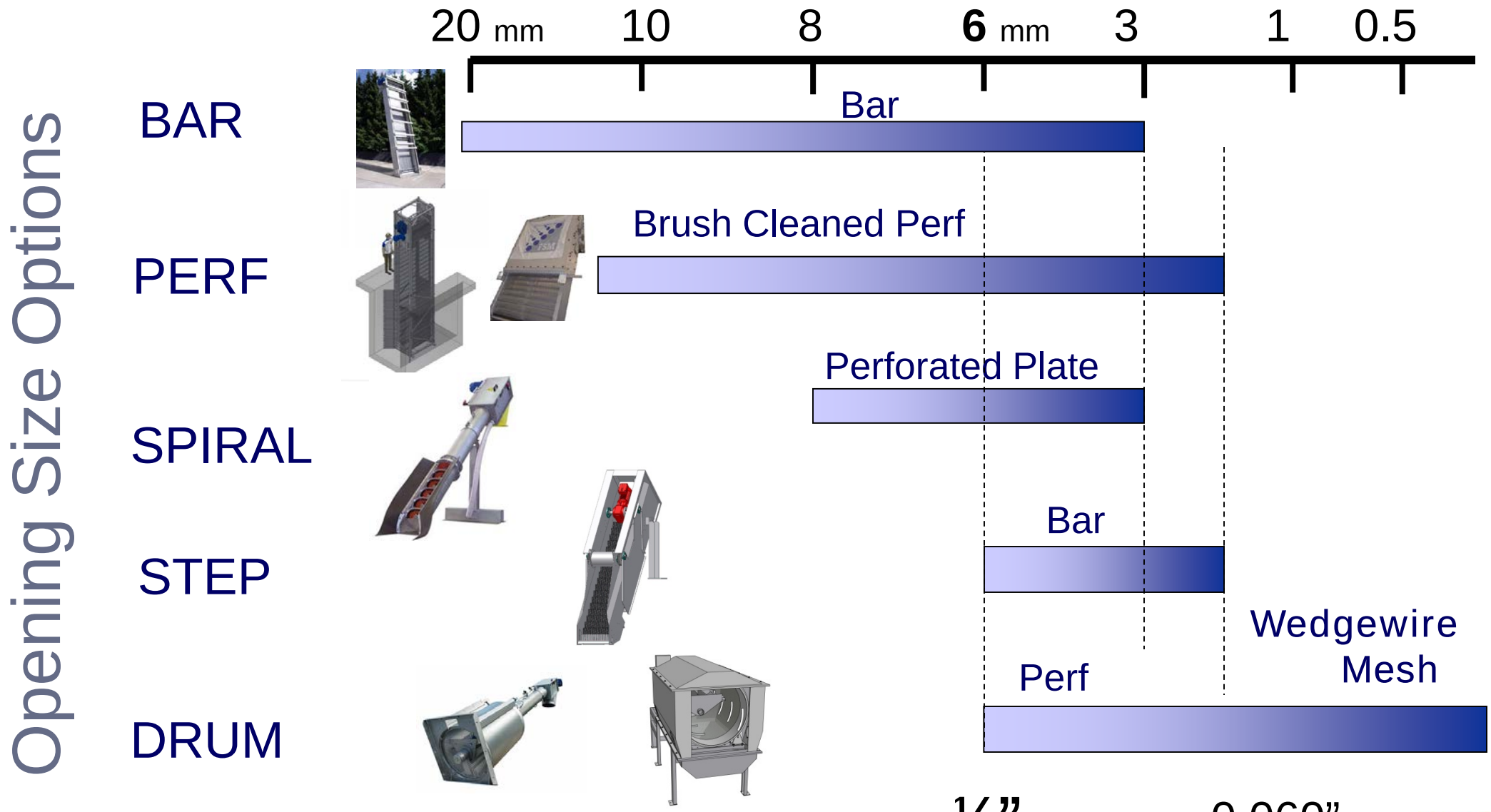
# Opening Size Options

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# Independent Testing

UK Water Industry Research (UKWIR)

Equipment Comparison

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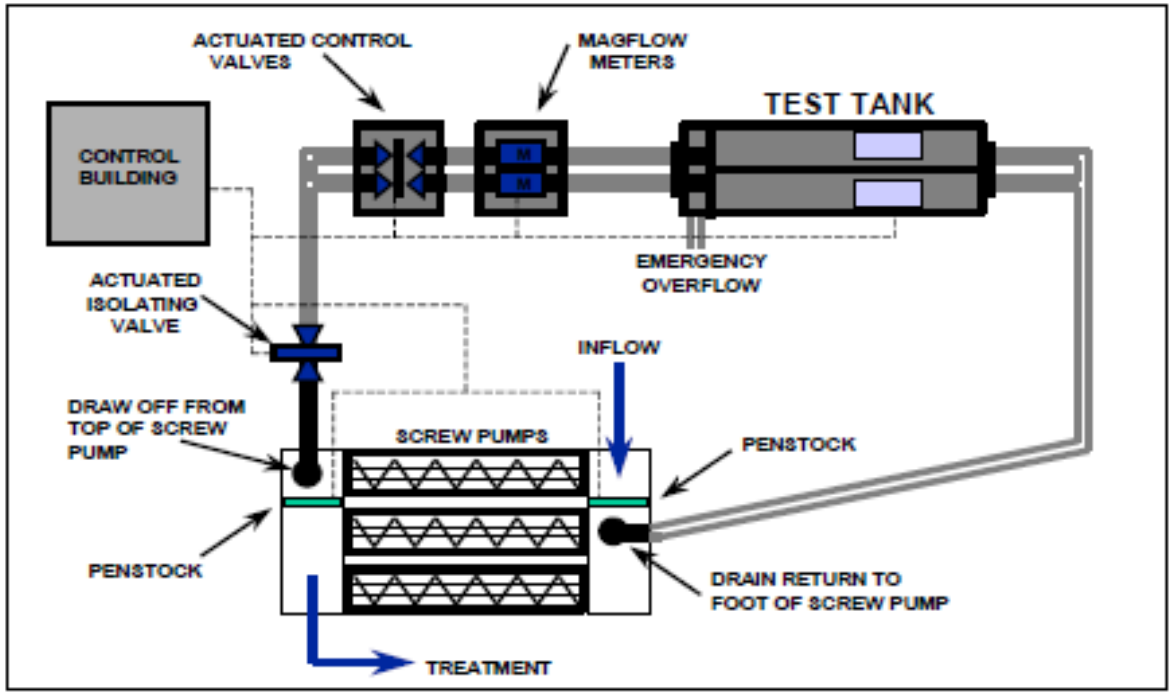
# UK Water Industry Research

National Screen Evaluation Facility (NSEF)

Opened in 1998 to provide process and mechanical type testing to establish minimum standards for screen

As of December 2015, over 70 different screens have been subjected to evaluation.

Schematic Diagram of National Screen Evaluation Facility (NSEF)




UKWIR COLLABORATIVE, IMPARTIAL RESEARCH

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# UK Water Industry Research

Each screen tested for two weeks under controlled conditions and operated to simulate differential operation

For Example: FSM Flow Through Filter Screen – 6 mm

Screenings collected and weighed

Debris that passes screen is collected in Copa Sacs

UKWIR COLLABORATIVE, IMPARTIAL RESEARCH

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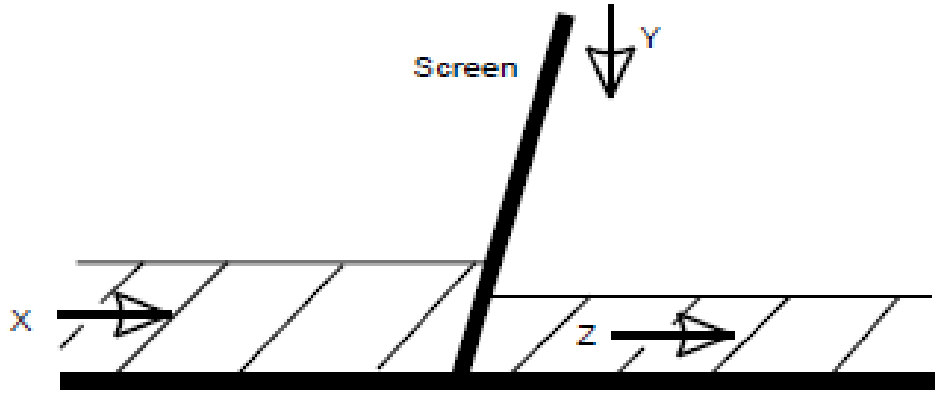
# UK Water Industry Research




Where: X is the screenings load in the raw sewage;
Y is the screenings removed from the flow by the screen; and
Z is the screenings load in the screened sewage.

$$SCR = \left(\frac{Y}{Y+Z}\right)100\%$$

# Screen Details and Design Considerations

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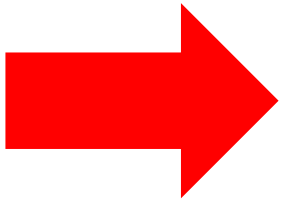
# Screen Classification



- Bar/Slot Screens
- Step Screens (bar screen)
- Combination Screens
- Fine Screens – Flow Through
- Fine Screens – Band Screens

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# Coarse Bar Screen

- Heavy Duty coarse bar screens with 1 to 3 inch bar spacing.
- Simple single cleaning rake mechanism.
- One dimensional cleaning.
- Removes large solids, bottles, wood, stones, and other debris.
- Cannot remove fibrous material.


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# Coarse Bar Screen

- Traditional Bar Screens.
- Heavy Duty Carbon Steel Painted Frames.
- Very tall – requiring tall building with headspace.
- Very inefficient screenings capture rate (~30-35%).

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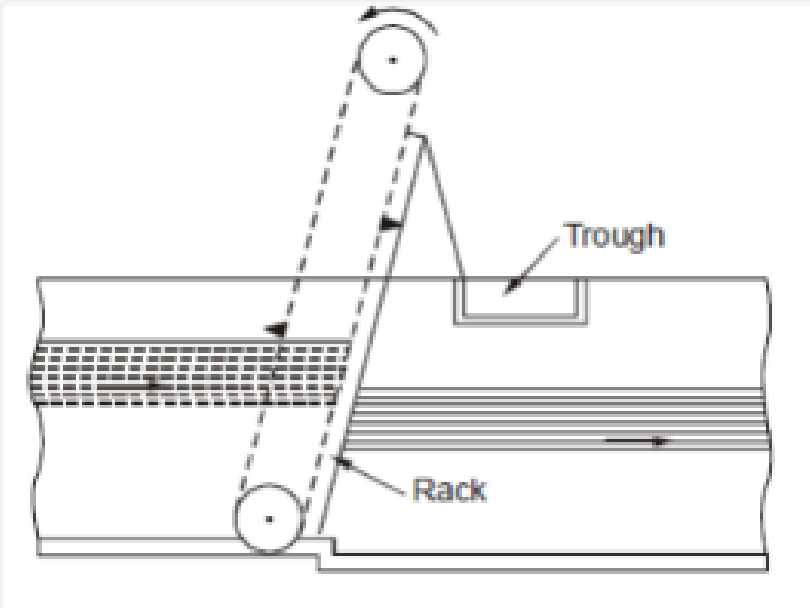
# Bar/Slot Screen

**BAR OPENINGS: ¼” to 2”**




Front Rake – Front Return

Catenary Style MultiRake

Climber Style

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# Multi-Rake Bar Screen

- Sturdy Structure
- High Flow Rate
- Perfect for the protection of fine screens
- Low Maintenance

…. BUT A LOW CAPTURE RATIO!

**SCR with 6mm (1/4”) bar is ~35%**

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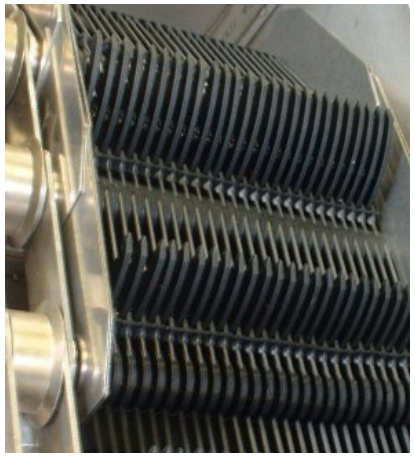
# Continuous Belt Screens with Plastic Elements



- Slotted Opening
  - Increasing bar opening capture rates
  - Poplar Style Screen in the 70 and 80's – revolutionized fine screen filtration.
- Plastic Elements weak – tend to break under heavy load.
- Replacement of the plastic elements – expensive and time consuming
- Problem with cleaning filter elements, which leads to high carry over of solids to the downstream process.
- Middle-Ground Capture Ratio:  up to 71%

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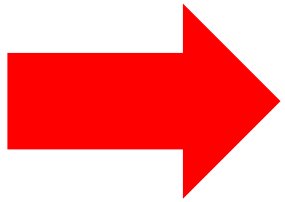
# Screen Classification



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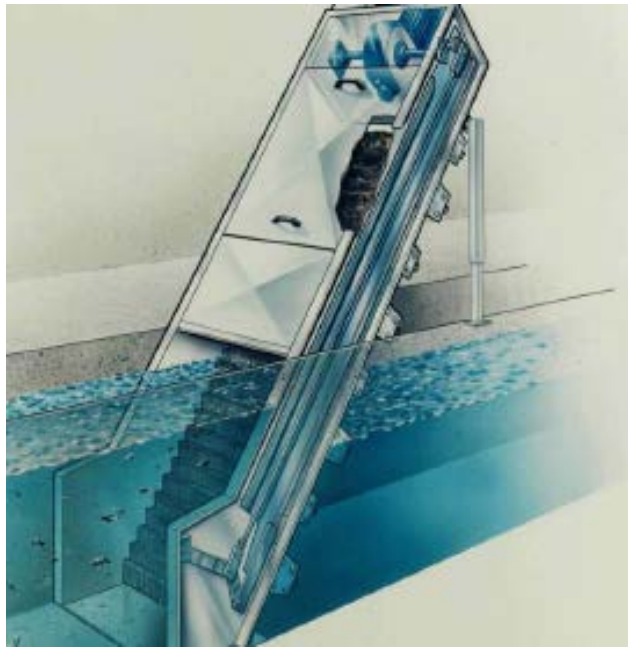
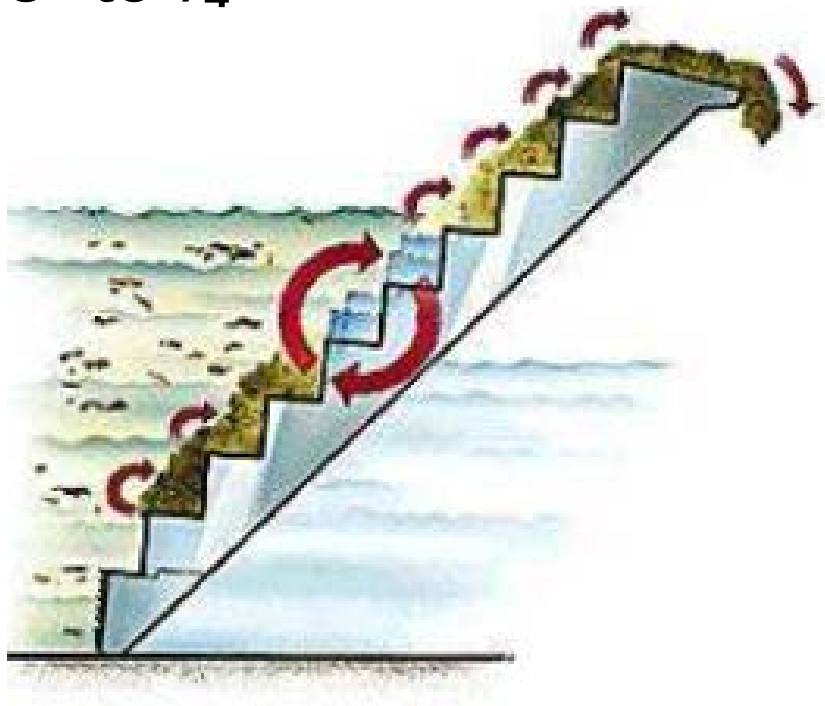
# Step Screens – 3mm and 6mm

**BAR OPENINGS: 1/8” to ¼”**





Solids are elevated a step at time to the discharge point

**SCR with 6 mm (¼”) bar is ~35% with 3 mm (3/8”) is between 50% and 56%**

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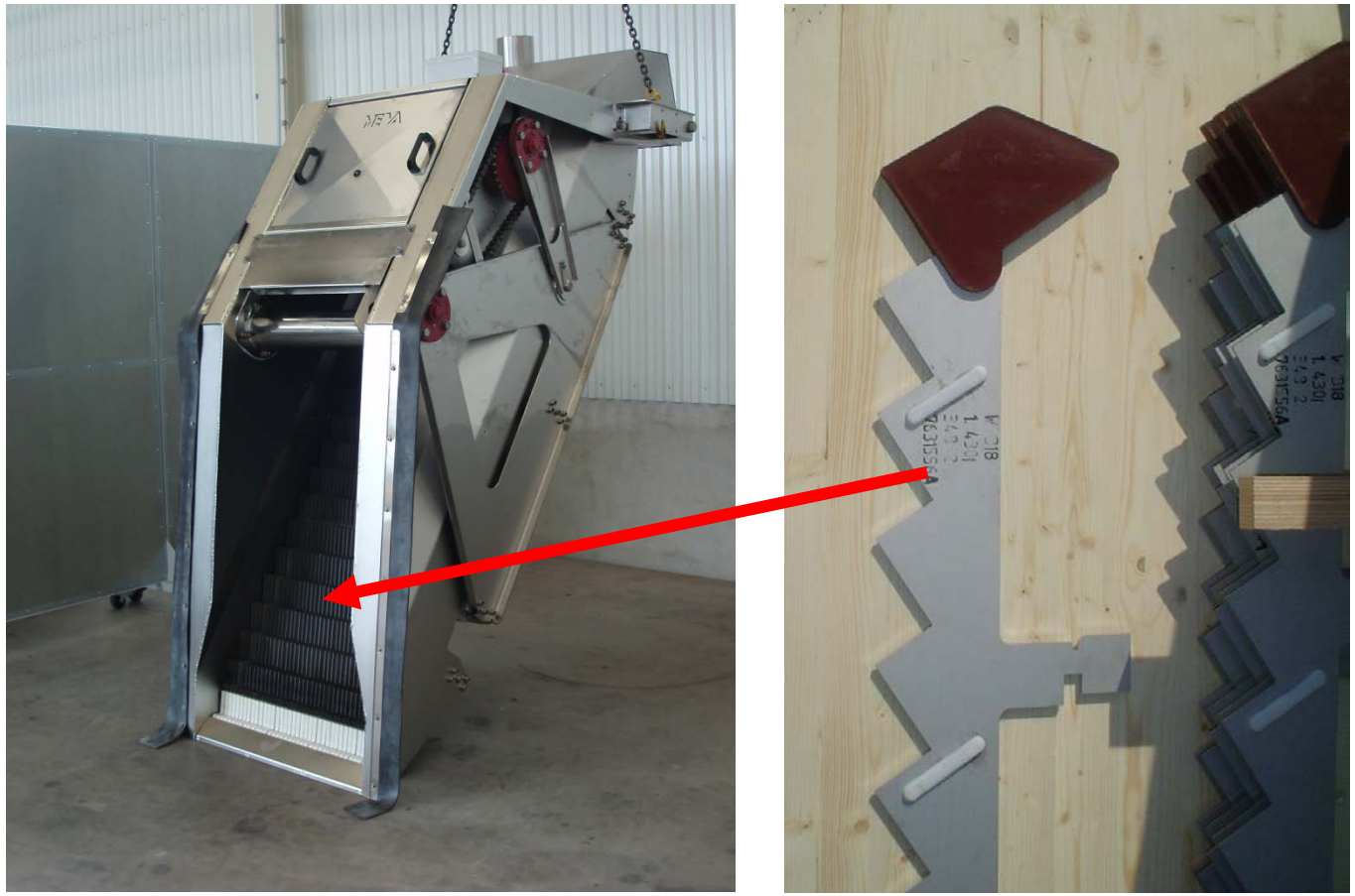
# Step Screens





"Step" shaped bar forms screening surface

- Good low cost screen alternative.
- Small Footprint.
- Screenings Capture Ratio varies (35% at 6mm to ~53% at 3mm).
- Some problems with lifting heavy solids – roll back.
- Needs shallow channel.
- Does not react well to grit or stones.

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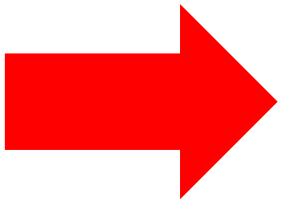
# Screen Classification



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**Stationary Screens**

Rotating Screens

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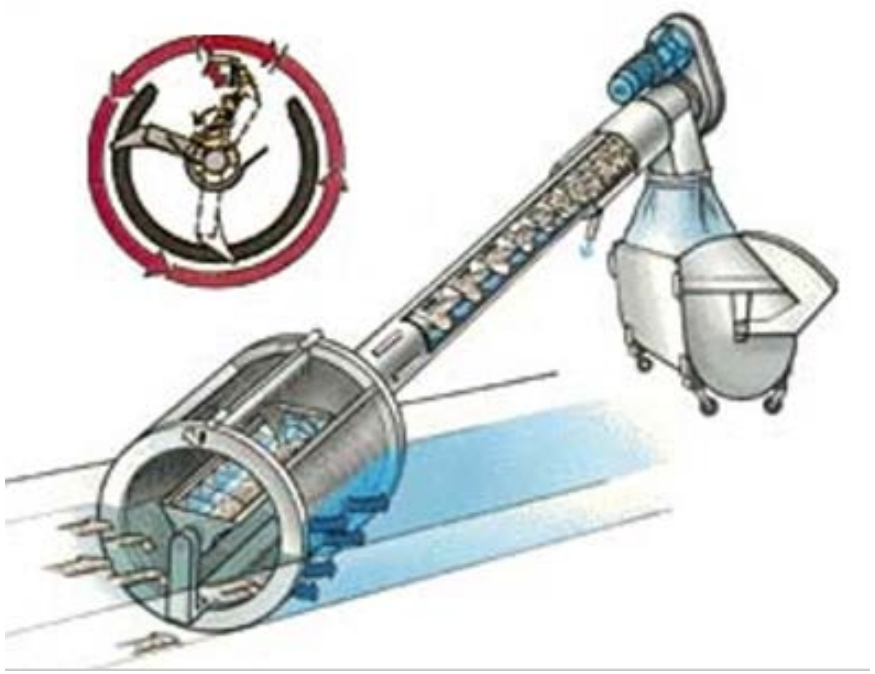
# Combination Screens – 6mm

## Type 1. Stationary Screen Field

Rotating Screw - with brushes and **Perforated Plate Screen**



Rotating Cleaning Rake - with **Bar Screen**

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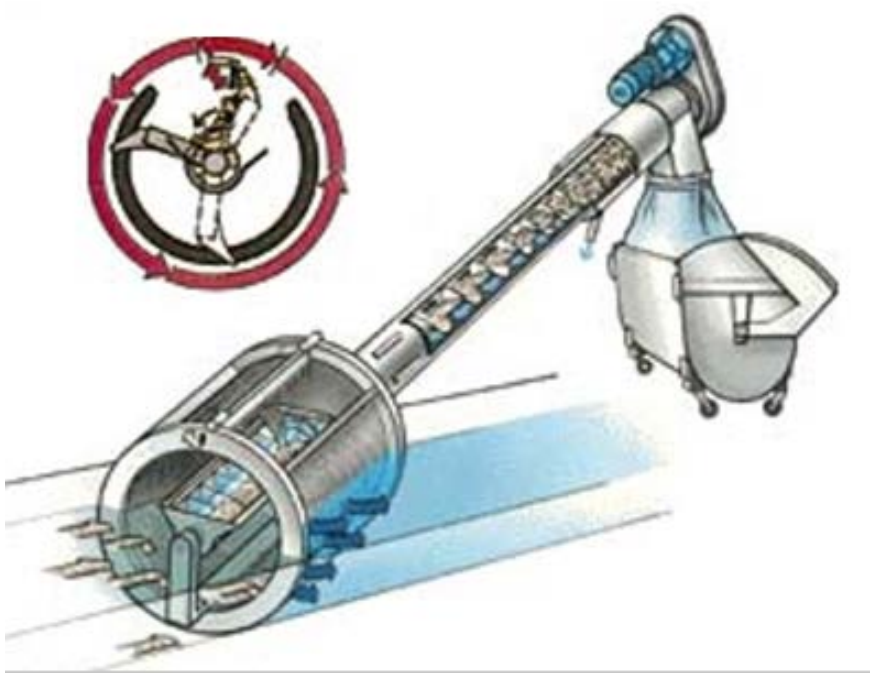
# Combination Screens – 6mm

## Type 1. Stationary Screen Field

**SCR with 6 mm (¼”) bar is ~32%**



Rotating Cleaning Rake - with **Bar Screen**

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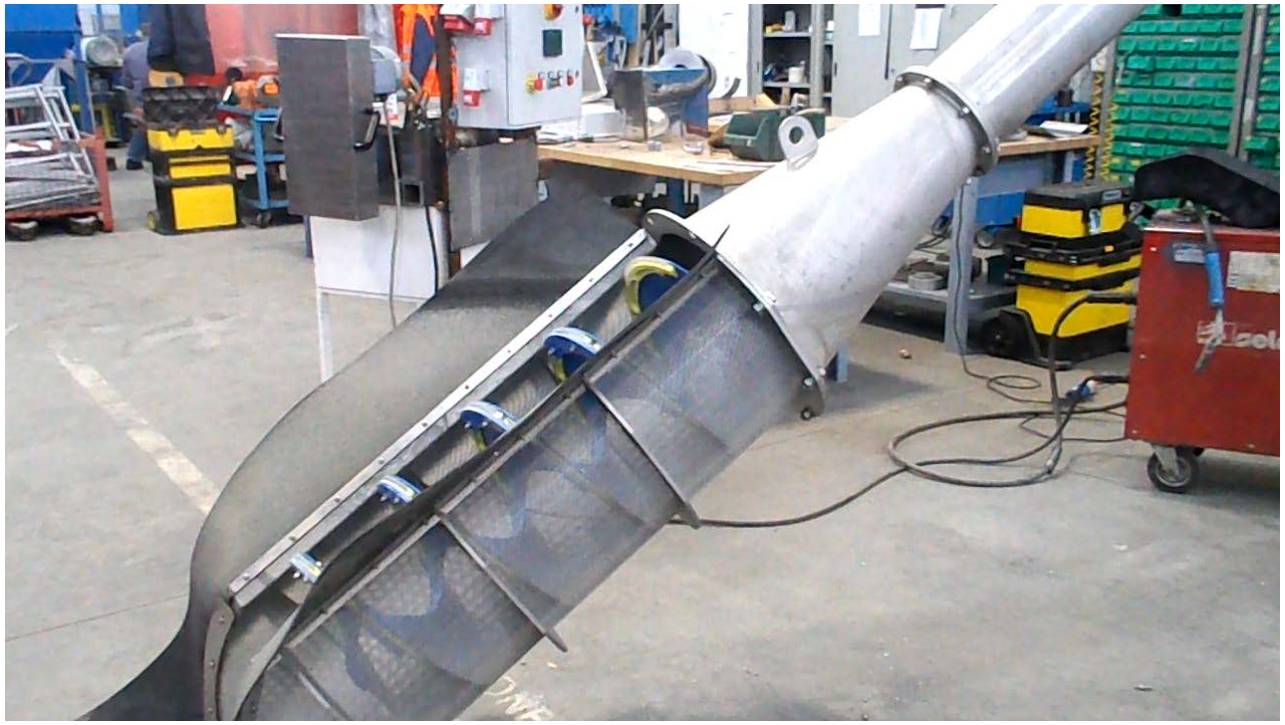
# Combination Screens – 6mm

## Type 1. Stationary Screen Field

Rotating Screw - with brushes and **Perforated Plate Screen**



**SCR with 6 mm (¼”) round holes is > 52%**

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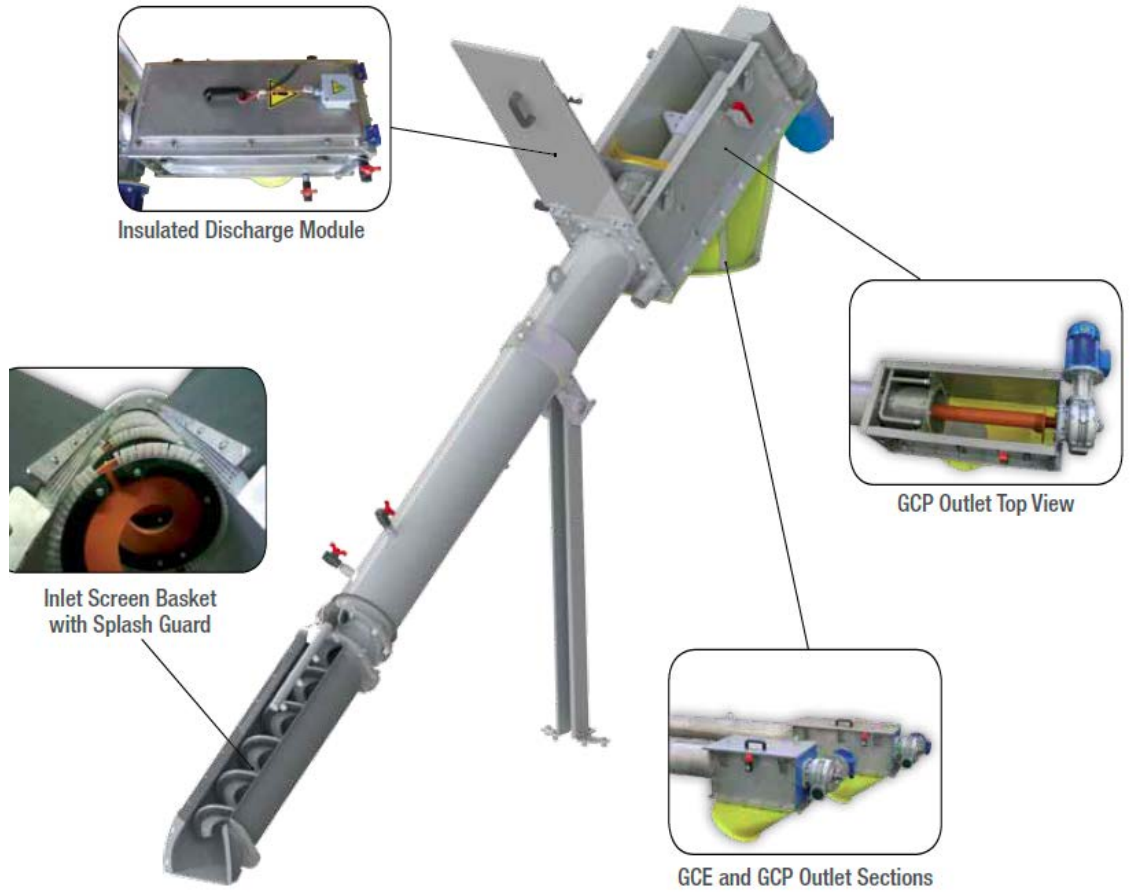
# Screw Screens

Flow Rates up to 9 mgd

- Excellent choice for small plants
- Best solution when an economical screen is required
- Stainless steel construction
- Screenings Capture Ratio – 52%

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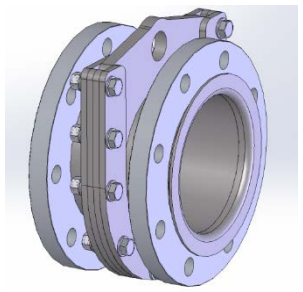
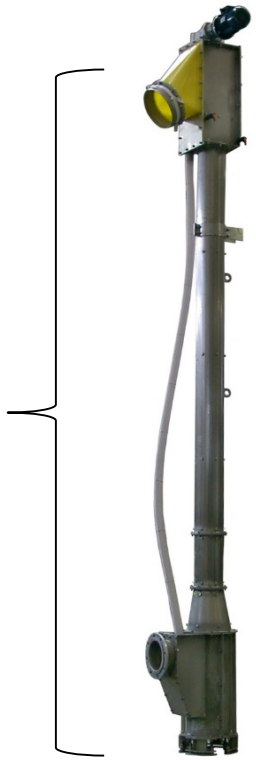
# Vertical Screw Screens

Flow rate up to 2.5 MGD

Up to 30 ft



Quick disconnect available



In channel application available

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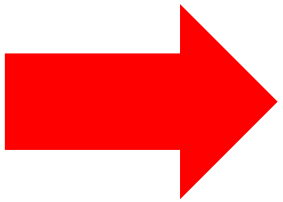
# Screen Classification



- Bar/Slot Screens
- Step Screens (bar screen)
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- Fine Screens – Flow Through
- Fine Screens – Band Screens

Stationary Screens

**Rotating Screens**

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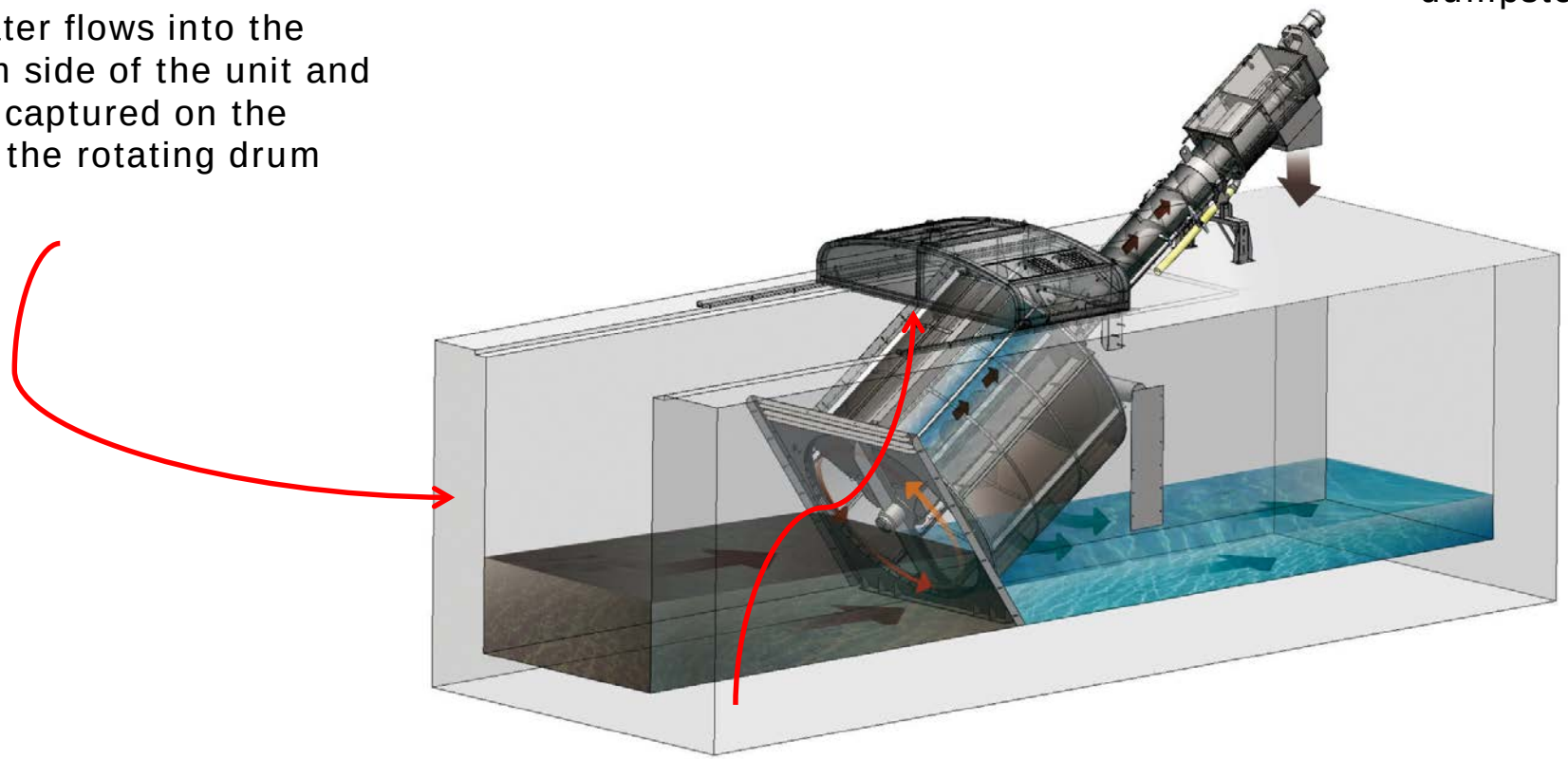
# Combination Screens – 6mm

The screened material is washed, dewatered and discharged into a dumpster, conveyor or optional bagger

Wastewater flows into the upstream side of the unit and debris is captured on the inside of the rotating drum



As the drum rotates, a spray bar cleans the debris from the inside of the drum, depositing it into the auger trough. A nylon brush removes any additional material from the outside of the drum

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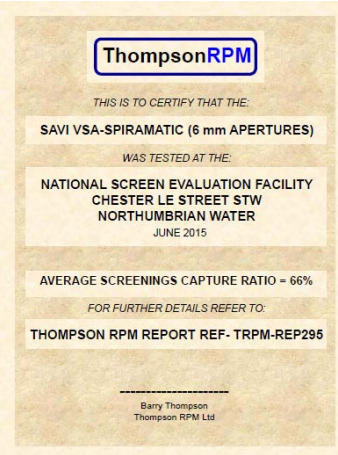
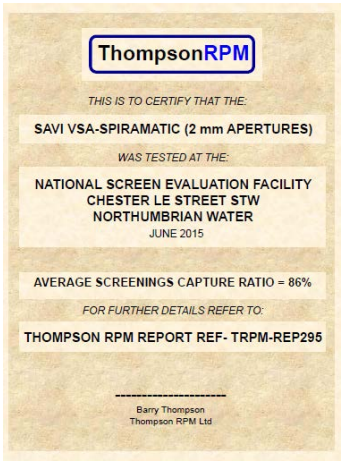
# Combination Screens – 6mm

## Type 2. Rotating Screen Field

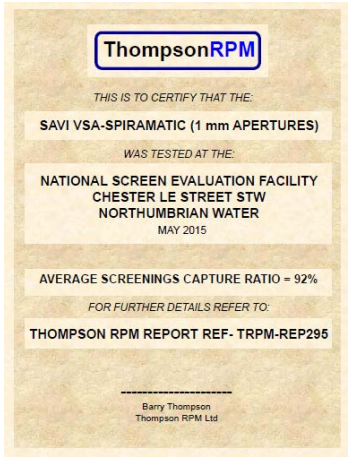
**Flow Drum**




**66% - 6 mm**




**86% - 2 mm**




**92% - 1mm**

**Twice the capture of a stationary bar screen!**

**SCR with 6 mm (¼”) round holes is 66%**

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# Drum Screen

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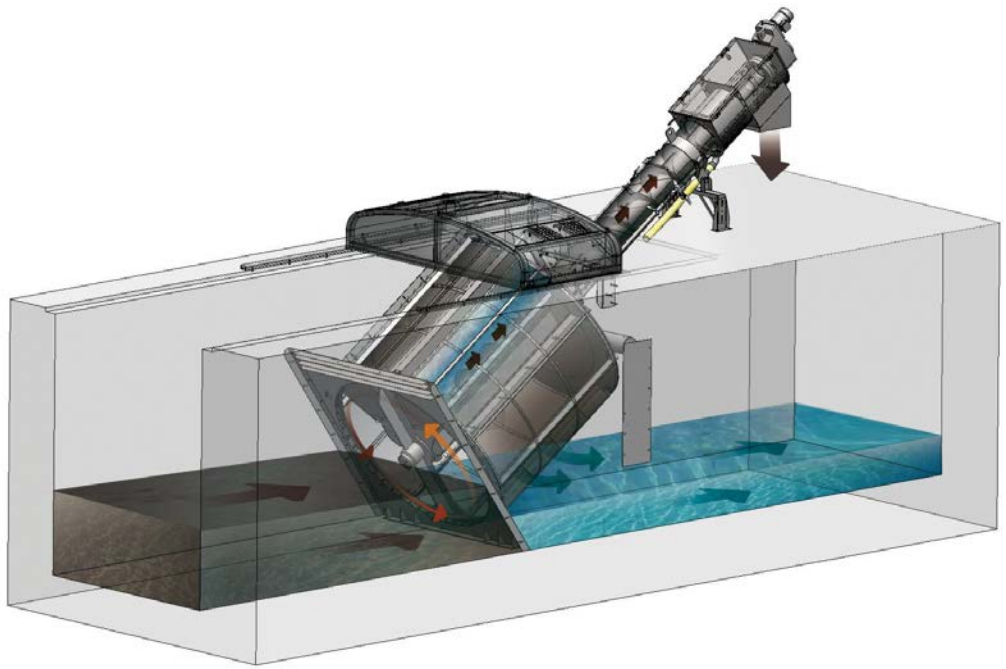
# Drum Screen



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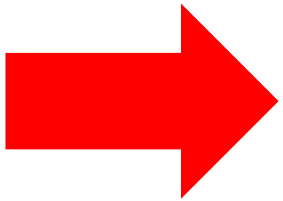
# Screen Classification



- Bar/Slot Screens
- Step Screens (bar screen)
- Combination Screens
- Fine Screens – Flow Through
- Fine Screens – Band Screens

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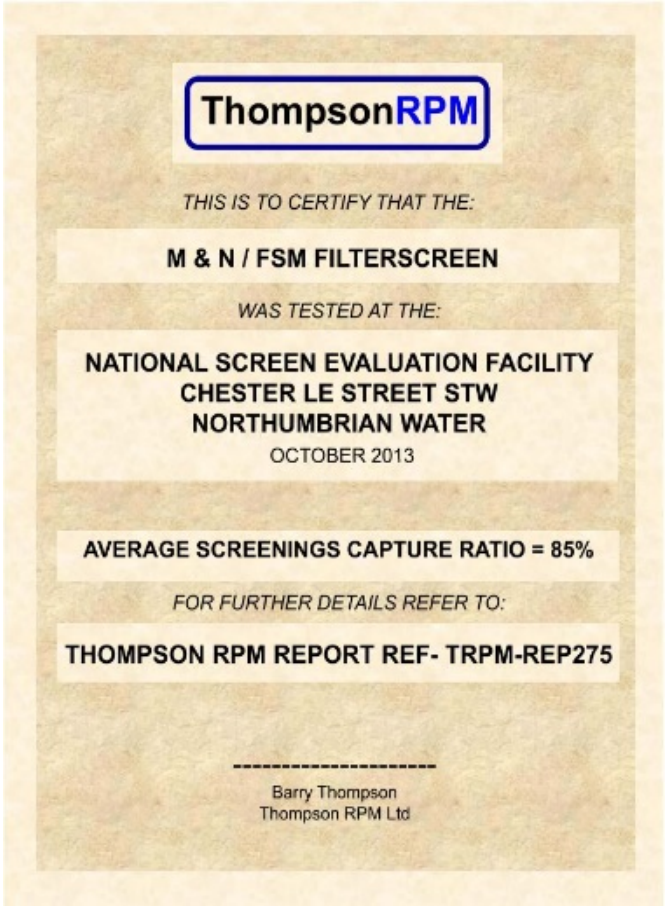
# Filter Screens – Flow Through

High separation performance with a simple uncomplicated screen using perforated filter elements – up to 100% more retention than bar screen systems



ThompsonRPM

*THIS IS TO CERTIFY THAT THE:*

**M & N / FSM FILTERSCREEN**

*WAS TESTED AT THE:*

**NATIONAL SCREEN EVALUATION FACILITY**
**CHESTER LE STREET STW**
**NORTHUMBRIAN WATER**
OCTOBER 2013

**AVERAGE SCREENINGS CAPTURE RATIO = 85%**

*FOR FURTHER DETAILS REFER TO:*

**THOMPSON RPM REPORT REF- TRPM-REP275**

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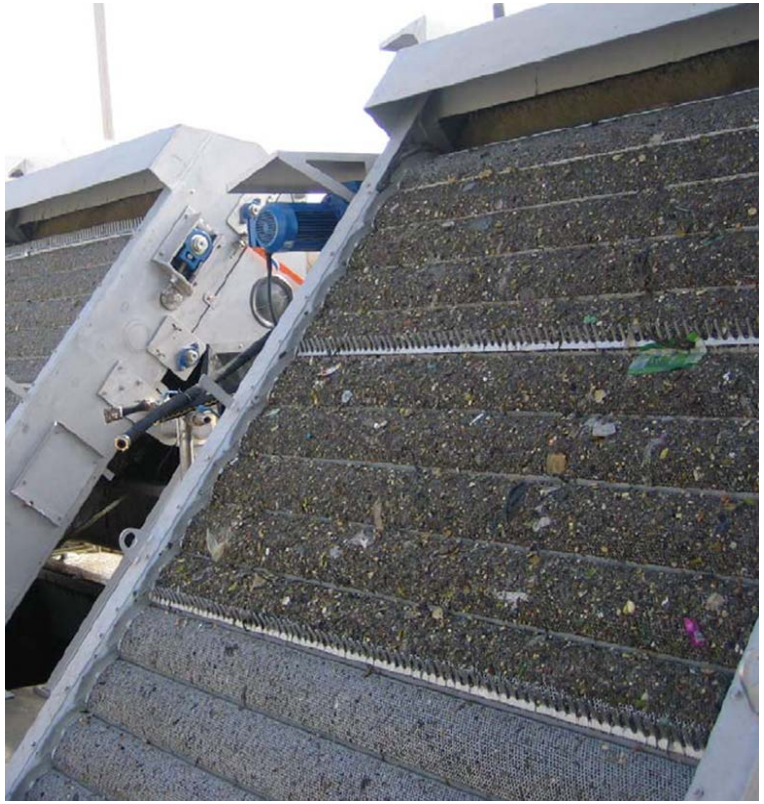
Barry Thompson
Thompson RPM Ltd

85% Avg. Screenings Capture Ratio – Highest capture rate tested at UKWIR – National Screenings Testing Facility



**SCR with 6 mm (¼”) round holes is 70% to 85%**

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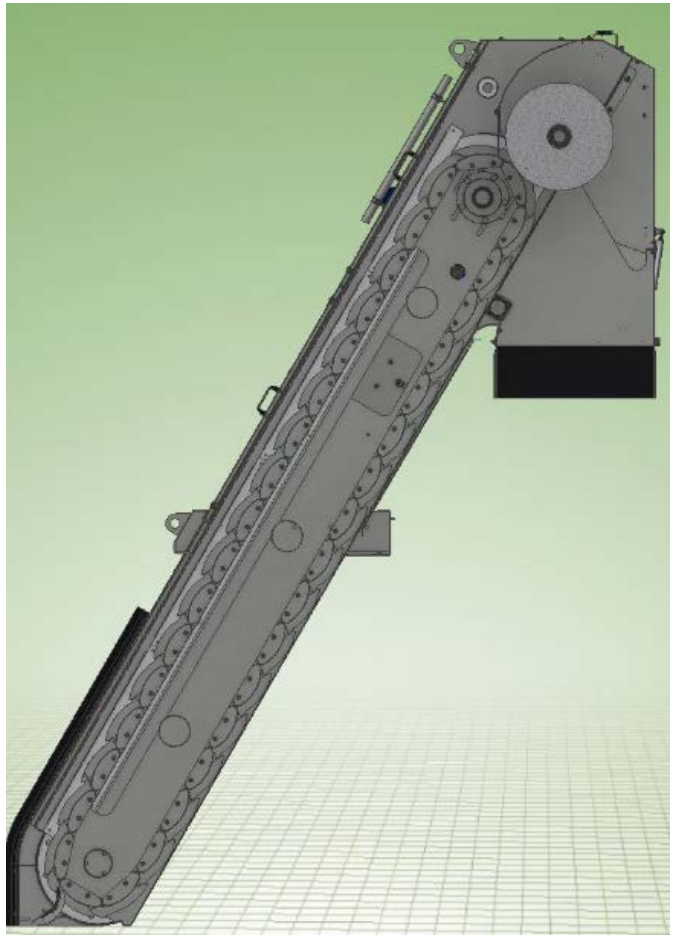
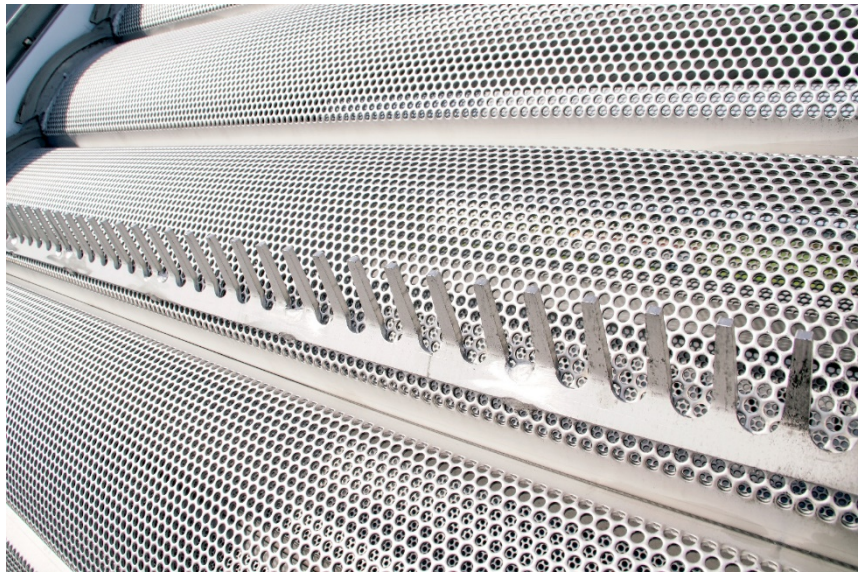
# Fine Screens – Flow Through



## A screen that consists of:

- A series of perforated stainless steel screening panels which are joined together on heavy duty box conveyor chain
- The filter panels are of a stepped or curved design with some panels fitted with lifting tines for lifting material from the bottom of the channel



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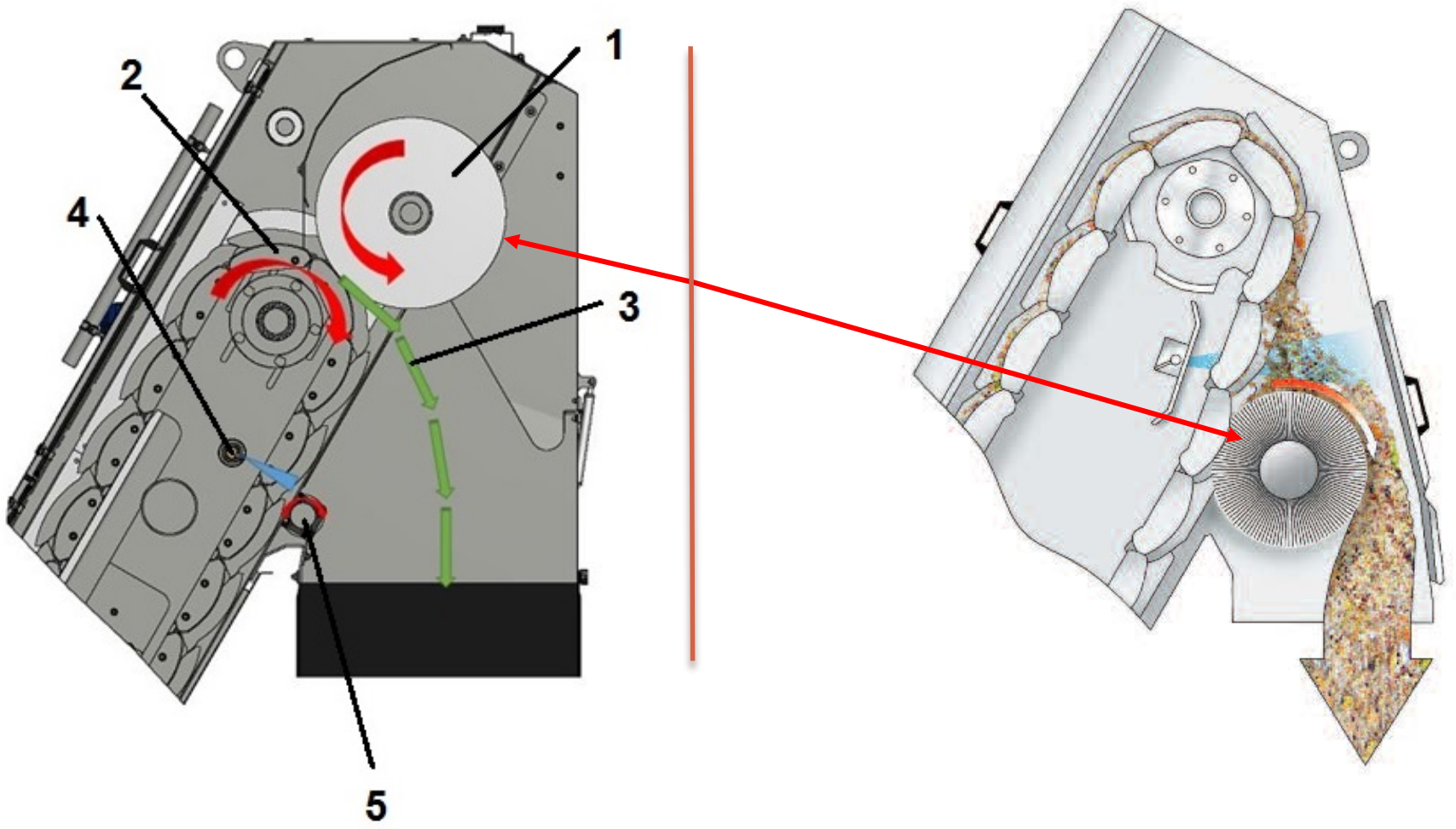
# Filter Screens – Perforated Belt




**POSITION OF THE BRUSH IMPACTS CLEANING EFFECTIVENESS**

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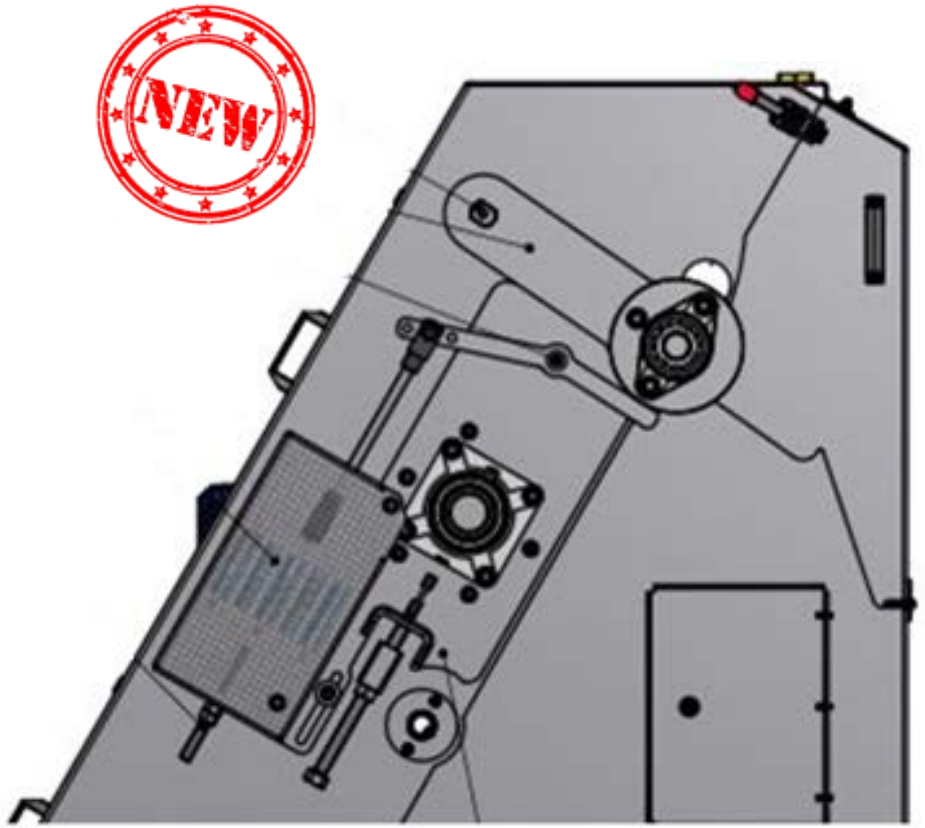
# Filter Screens – Perforated Belt

**New – Self Adjusting Cleaner Brush**




- Optimal cleaning efficiency results in high capture efficiency
- Brush shaft can pivot
- Reduction in maintenance – no regular brush adjustments required
- No gradual degradation of cleaning performance
- Chain can be adjusted without necessitating readjustment of the brush

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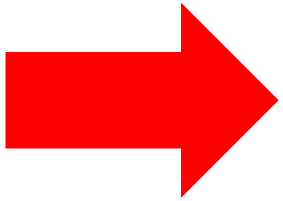
# Screen Classification

- Bar/Slot Screens
- Step Screens (bar screen)
- Combination Screens
- Fine Screens – Flow Through
- Fine Screens – Band Screens



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# Fine Screens – Band Screens

## Center and Dual Flow - Perforated Belt 6 mm

ThompsonRPM

*THIS IS TO CERTIFY THAT THE:*

**M & N / FSM CENTRE FLOW BANDSCREEN**

*WAS TESTED AT THE:*

**NATIONAL SCREEN EVALUATION FACILITY**
**CHESTER LE STREET STW**
**NORTHUMBRIAN WATER**
OCTOBER 2015

**AVERAGE SCREENINGS CAPTURE RATIO = 84%**

*FOR FURTHER DETAILS REFER TO:*

**THOMPSON RPM REPORT REF- TRPM-REP301**

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Barry Thompson
Thompson RPM Ltd

**SCR with 6 mm (¼”) round holes is 84%**

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# Center and Dual Flow

**Applications in municipal and industrial WWTP**

- Waste water pre-treatment / fine screening
- Membrane treatment plant – NO carryover.

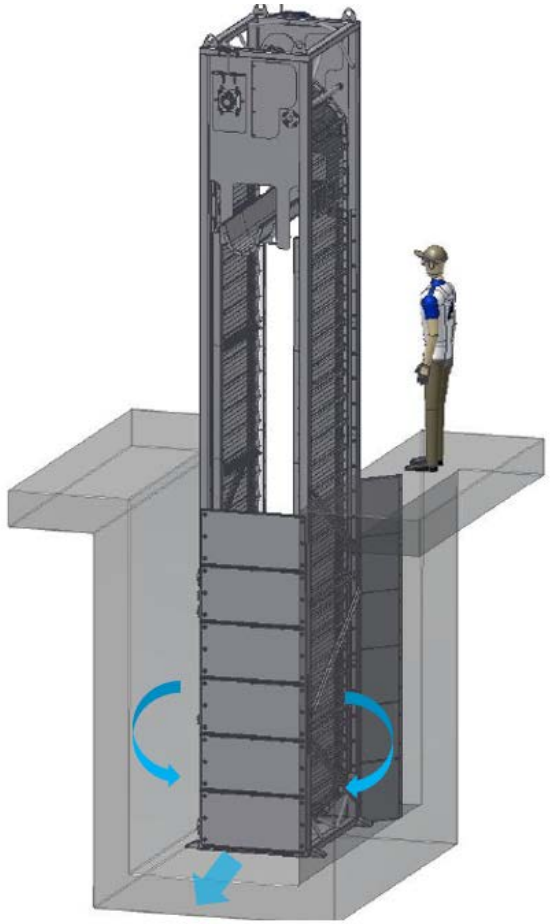
**Applications in power stations**

- River or sea water screening

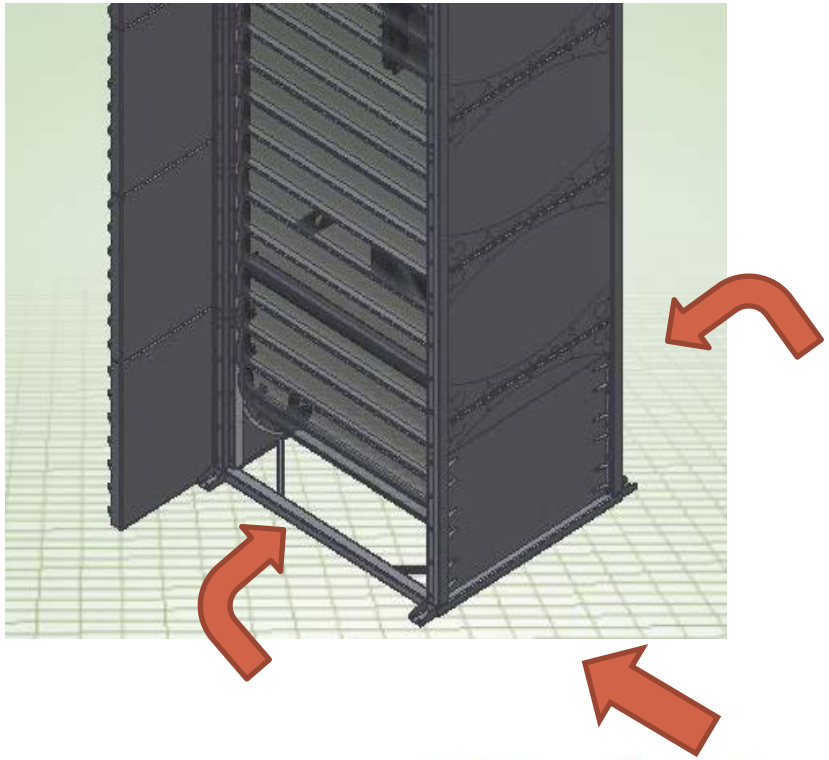
**Applications in potable water treatment plants**

- River or sea water screening

## CENTER FLOW



## DUAL FLOW



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# Screen Capture Rates (SCR) by Product Type

| Screen Type | Cleaning Method | 1mm Capture | 2mm Capture | 3mm Capture | 6mm Capture |
|---|---|---|---|---|---|
| Step Screen - Slotted | Self Cleaning | | | 53% | 35% |
| Spiral Screw Screen - Perforated | Brush & Water | | | | 52% |
| Filter/Element - Slotted | Self Cleaning, Brush & Water | | | 84% | 71% |
| Perforated Filter Screen | Brush & Water | | | | 71 - 85% |
| In Channel Cylindrical Bar Screen | Self Cleaning & Water | | | | 32% |
| Perforated in channel Flo-Drum | Brush and Water | 92% | 86% | | 62 - 66% |
| Center Flow Screen - Perforated | Brush (FSM) and Water | | | 93% | 84% |

See attached UKWIR Test Certificates

Source: UK Water Industry Research Report (1999-2015) by Barry Thompson

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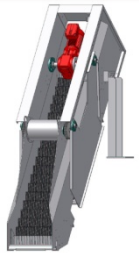
# Choosing the Right Screen

Highest Capture



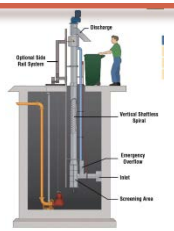
- Center Flow
- Perf
- Drum

Most Economical

- Screw Screen
- Step

Smallest Footprint



- Vertical Screw Screen

Deep Channels [30'+]



- Grab Screen
- Perf
- Center Flow

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# Design Consideration

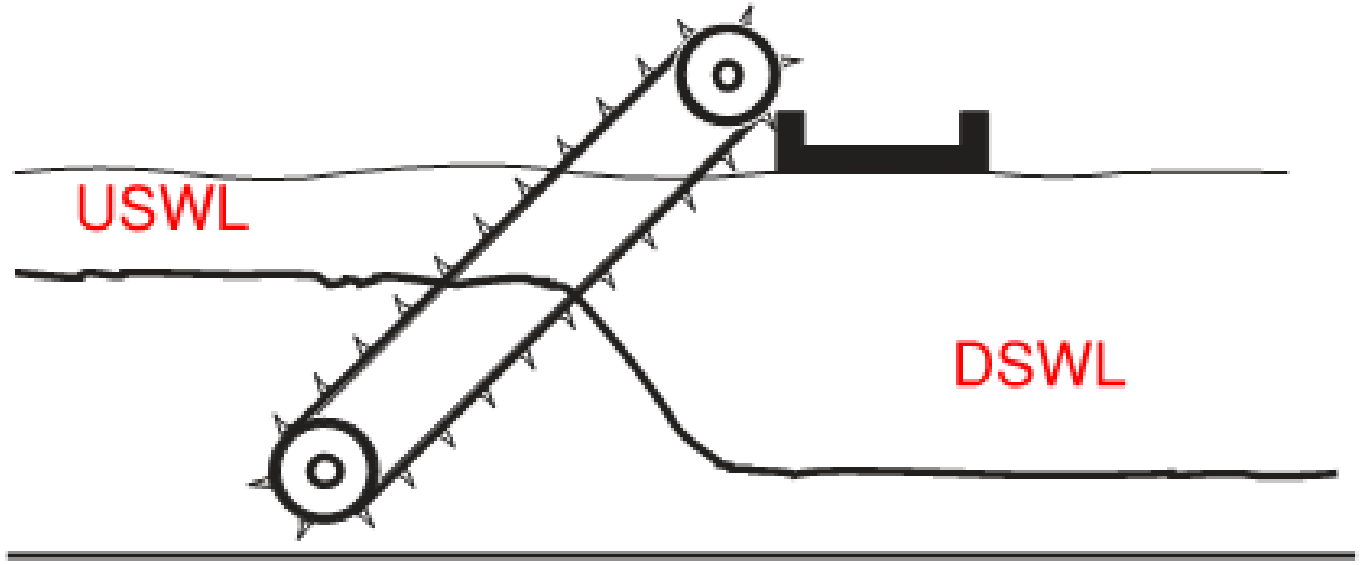
**Fine screening in general requires more screen area than old coarse screens**

**Flow velocity through the screen is important to reduce the chance of forcing solids through the screen openings**

- Channel Dimensions
- Screen Angle
- Downstream Water Level – Control with Parshall Flume, grit system, weir or water level in wet well.  Maximizes wetted area.
- Maximum upstream water level
- Peak Flow Rate
- Percent of TSS in flow
- Screen Channels Velocity – Optimum between 2 and 3 feet per second
  - Low to peak flow range – 1 to 4.5 feet per second

# Design Consideration

A conventional screen installed in a channel calculates the “Screen Headloss” as the difference between USWL and DSWL (see below).

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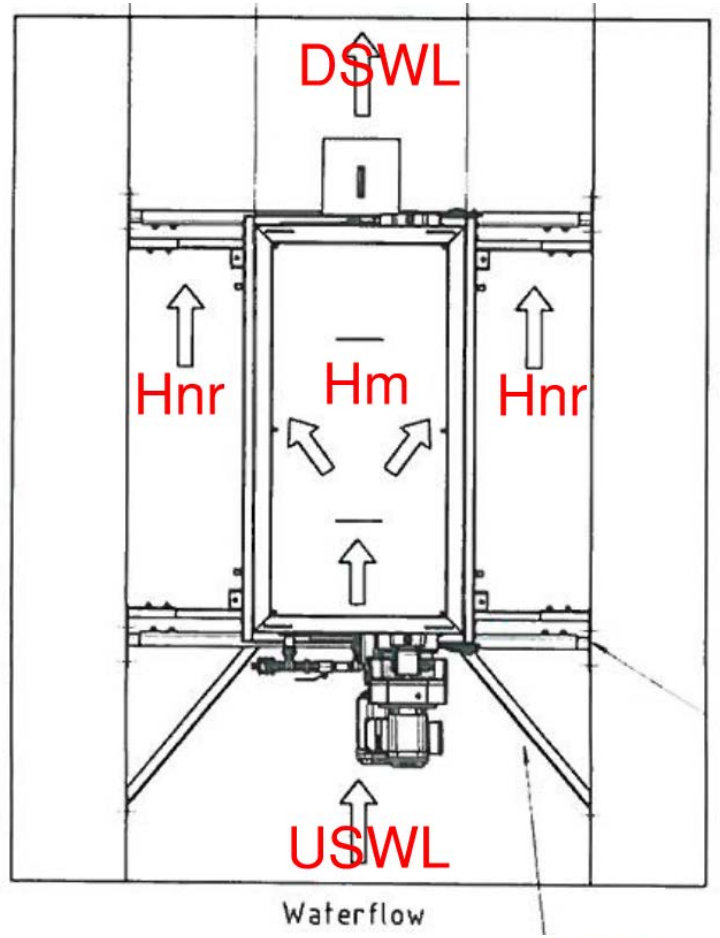
# Design Consideration

**EXAMPLE: CENTER FLOW SCREEN - Not your standard screen calculation**

- A Center Flow screen has many headloss points – headloss across the screen and the total hydraulic gradient across the screen system (see below).

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# Good to Know!

Overall fine screens are inexpensive and quickly pay for themselves. They represent about **4%** of the equipment cost used in a WWTP.

However, they provide between **25 to 50%** of the overall treatment.

Fine screening will improve any downstream process, prevent damage and clogging of equipment, reduce sludge dewatering costs and reduce overall maintenance of the plant.

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# Questions?

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