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## Session E9: Incorporating Fish Friendly Solutions in Existing Pumping Stations; An Economical Solution Enabling Fish Migration

Lars Krakers  
*Flowserve Hengelo*

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# **Incorporating fish friendly solutions in existing pumping stations;**

*An economical solution enabling fish migration*

***Fish Passage 2015***

***By: Lars Krakters***

***Date: June 20-24, 2015***

***Location: Groningen***

***Experience In Motion***

1. Introduction
2. Philosophy
3. Fish Friendly Project
  - Project overview
  - Design
  - Validation
4. Examples
  - Pumping station: Berkel
  - Pumping stations: Ropta & Miedema
5. Conclusions

# 1. Introduction

## 1. Introduction

## 2. Philosophy

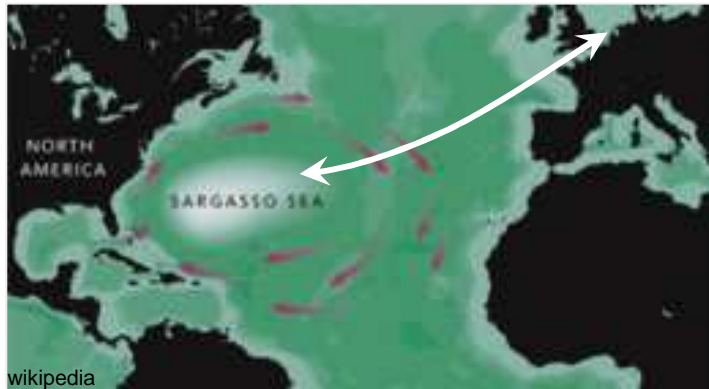
## 3. Fish friendly project

## 4. Examples

## 5. Conclusions

For survival of many fish species migration between different wetlands is a necessity

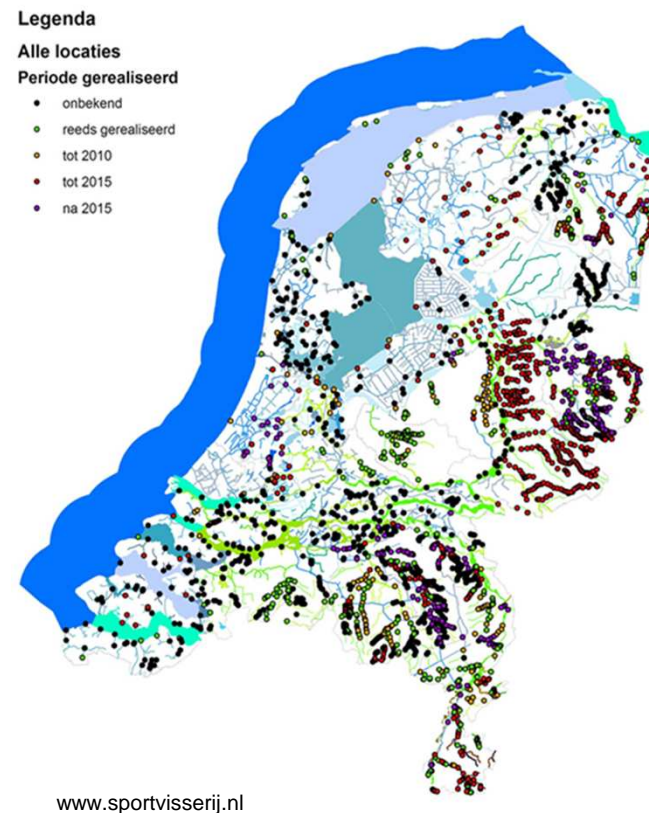
Example Eel: Wetlands ↔ Sargasso Zee



Increased focus on environment:

- European/local laws on enabling fish migration through barriers.
- Fish friendly market

Many pumping stations prove impassable barriers.



## 2. Philosophy

1. Introduction

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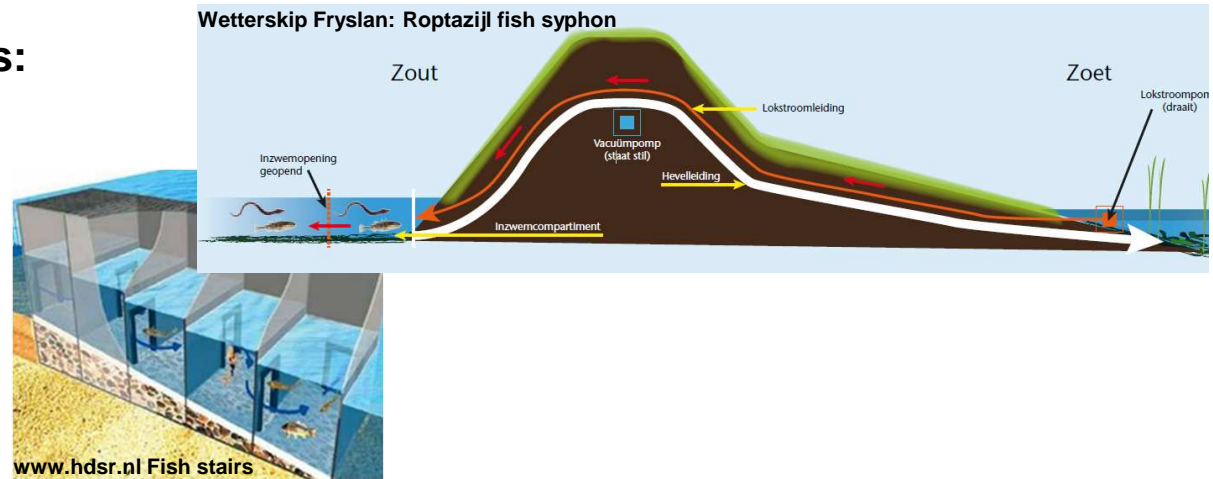
### Solving fish migration barriers:

#### 1. Add fish passages:

fish stairs, fish siphons

Expensive (extra civil works)

Introduces leakage



#### 2. Solutions to prevent fish entering pumps:

stroboscopic lights, acoustic barriers, fixed screens,

bubble curtains

No migration → Combination with fish passage systems

#### 3. Fish passable pumps

Relatively cheap (no extra civil works required)

Survival rates



Fishflow Innovations:  
Stroboscopic light screen



Fish guidance systems Ltd:  
Acoustic sound projectors at  
Amer centrale

## 2. Philosophy

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**Philosophy: “Bigger is better”**



**Pumping stations exist in a large variety in capacity but always have relatively low heads**

Selection on purchase price → Pumps with small diameters and high speed; (axial impellers)

**Fish friendly solution 1: Select pumps that are larger than required with relatively low speed**

- Advantage: Fish Friendly, longer lifetime
- Disadvantage: Higher purchase cost

**Fish friendly solution 2: Improve survival rates due to fish friendly design**

## 3. Fish friendly project

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### Project overview:

#### Content:

Three parts:

- Fish friendliness criterium  
→ AJK 2015 Seoul, South Korea
- Standard fish survival rate test method  
→ call for participation in NTA by **NEN** institute
- Validation with new fish friendly pump design

**Project duration:** 31 aug 2012 – 1 feb 2015

**Subsidy RVO:** Biodiversity & Business framework

#### Partners:



UNIVERSITEIT  
TWENTE.



#### Visvriendelijke pompen: NEN peilt behoefte aan afspraken

NEN wil een werkgroep oprichten die een Nederlandse Technische Afspraak (NTA) gaat ontwikkelen voor de bepaling van de 'visveiligheid/visvriendelijkheid' van pompen. Naast een standaard testmethode, wil NEN een criterium vastleggen om de overlevingskans van vissen te voorspellen. Op basis hiervan kan een classificatiesysteem worden opgezet. De te ontwikkelen NTA geeft pompfabrikanten duidelijkheid over de testcondities en afnemers duidelijkheid over de prestaties op het gebied van vispasseerbaarheid.

Waar vroeger vooral de hoeveelheid water die werd verpompt belangrijk was, wordt nu steeds meer aandacht besteed aan de overlevingskans van de vissen. De Europese Kaderrichtlijn Water vraagt om een goede ecologische toestand van ons oppervlaktewater. Hieronder valt ook de visstand. Vissen ondervinden bij hun migratie vaak belemmeringen door gemalen. Met een visveilige pomp kan dit worden voorkomen.

Diverse pompfabrikanten claimen dat zij een visveilige pomp hebben. Omdat hier momenteel nog geen normen voor zijn, is het lastig om dit na te gaan. Afnemers van deze pompen geven echter aan dat zij op basis van geadviseerde resultaten een besluit willen nemen over de aanschaf van de juiste pomp voor hun situatie. Naar aanleiding van een workshop van Flowserve en Grontmij onderzoekt NEN de behoeften voor afspraken over de visveiligheid van pompen.

**Deelnemers**  
De ontwikkeling van deze NTA wordt gefinancierd door de deelnemende partijen en gaat van start bij volgende financierende partijen. Verschillende partijen hebben al laten weten te willen deelnemen. Deelnemers zijn als eerste op de hoogte van de eisen en procedure die worden opgenomen, en kunnen invloed uitoefenen op de aspecten in de NTA. Daarnaast biedt deelnemers een uitstekende kans om te netwerken en kennis over dit onderwerp te verdelen. NEN gaat de werkgroep procesmatig ondersteunen en verwacht dat de NTA in 2016 wordt gepubliceerd.

**Aanmelding en meer informatie**  
Aanmelden kan door een e-mail te sturen naar [mem@nen.nl](mailto:mem@nen.nl). Voor meer informatie over het normalisatieproces kunt u contact opnemen met Trias Fries of Marlijn van Rijn, consultants Milieu & Maatschappij, telefoon (015) 2 600 303 of e-mail [mem@nen.nl](mailto:mem@nen.nl).

Normalisatie: de wereld op één lijn.



## 3. Fish friendly project

1. Introduction

2. Philosophy

3. Fish friendly project

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### *Design:*

Axial hydraulic → BVOP/VOP/OVOP/SHG → BVOP

**Head range**

1m - 9m

**Capacity range**

0.5m<sup>3</sup>/s - 8m<sup>3</sup>/s

**Best efficiency rates:**

80%

**Diameter range**

0.35m - 1.25m

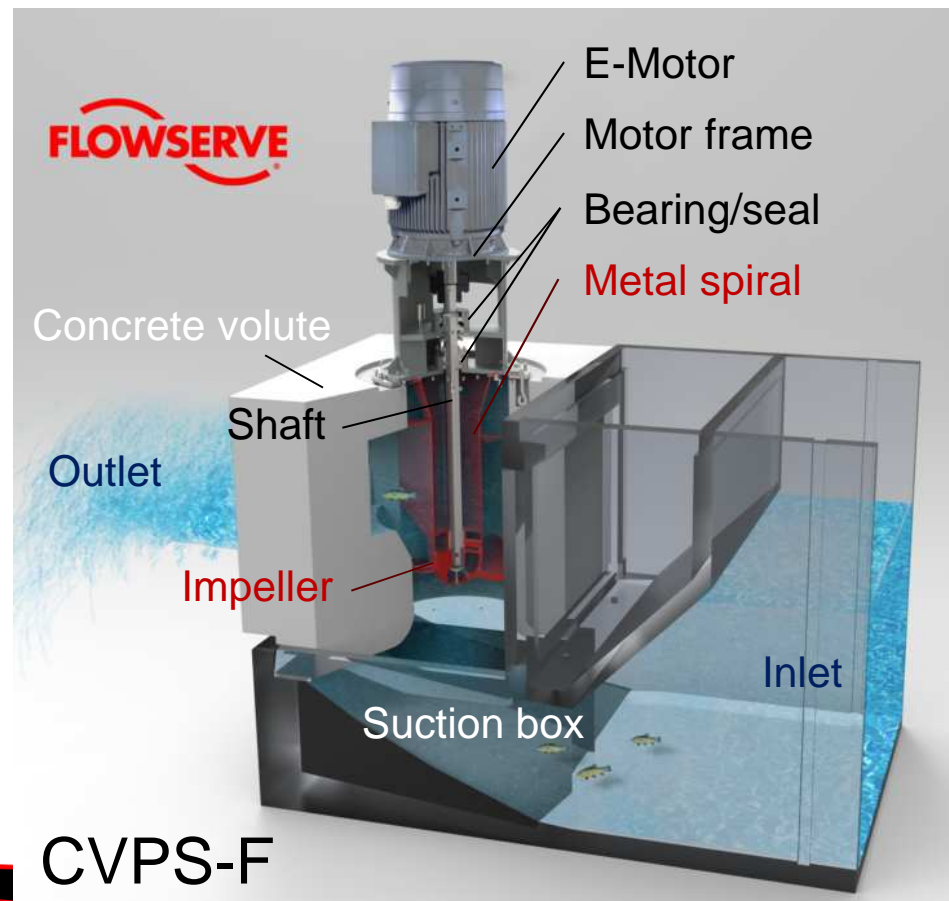
**Speed range**

750rpm – 150rpm

**Typical survival rates:**

Eel (50cm) 40%

Scale fish (20cm) 40%



CVPS-F



## 3. Fish friendly project

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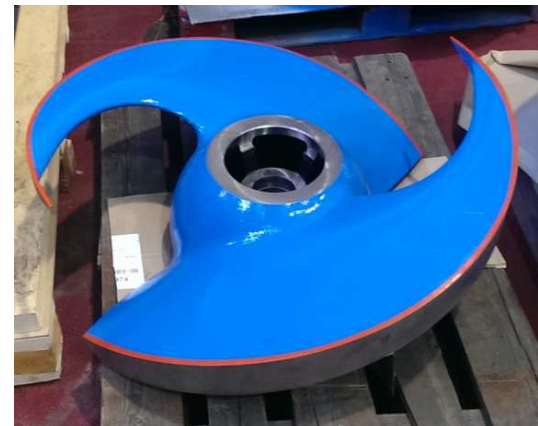
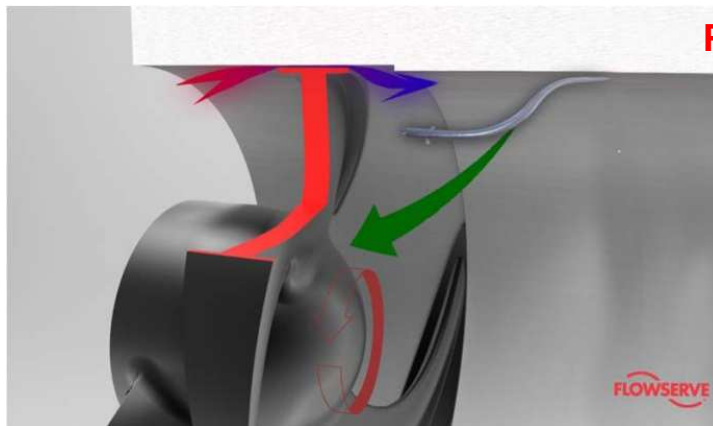
### *Design:*

#### Impeller redesign targets:

- Less vanes
- Straight → forward swept leading edge
- Minimum pressure drop (cavitation)
- Low speed
- High efficiency
- No gaps (Open/Closed impeller)

#### Constraints:

- Fit existing pumps/Motor power



## 3. Fish friendly project

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3. Fish friendly project

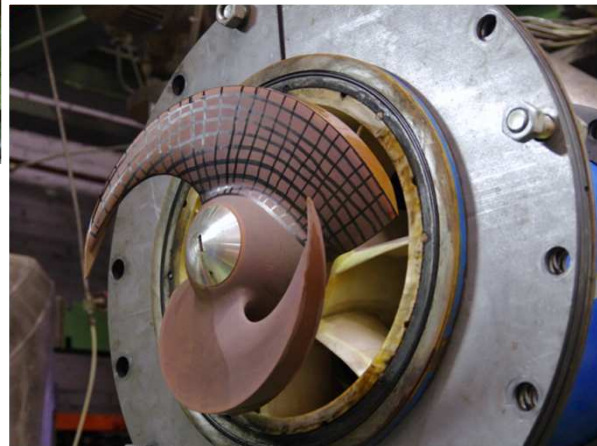
4. Examples

5. Conclusions

**Validation:** Hydraulic performance model test



Only 3.5% efficiency reduction at BEP



Pressure side cavitation



Suction side cavitation

## 3. Fish friendly project

1. Introduction

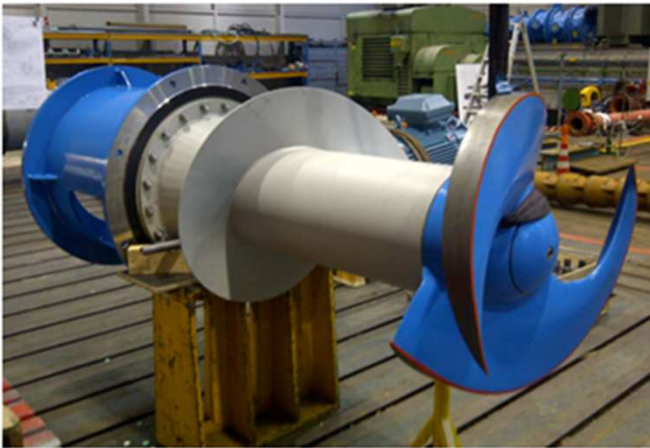
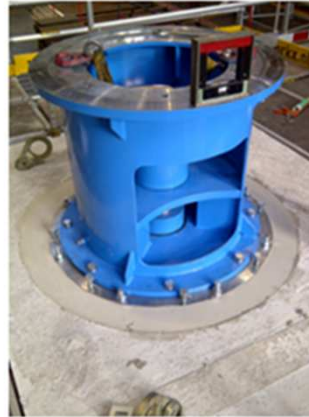
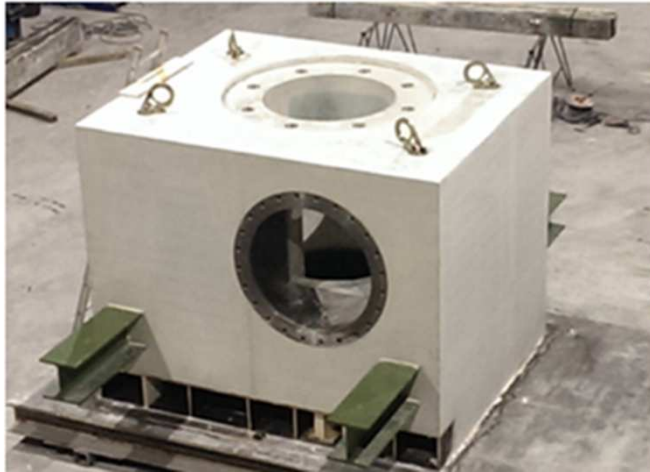
2. Philosophy

3. Fish friendly project

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**Validation:** Prototype CVPS-F 85





## 3. Fish friendly project

1. Introduction

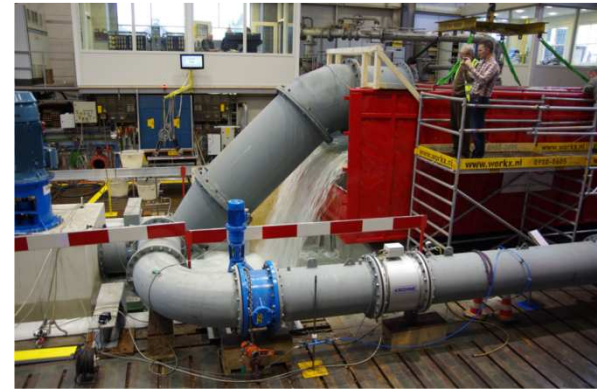
2. Philosophy

3. Fish friendly project

4. Examples

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**Validation:** Fish friendliness tests: 3 different heads



# 3. Fish friendly project

1. Introduction

2. Philosophy

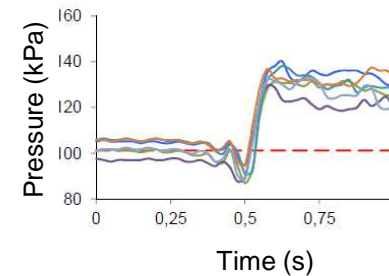
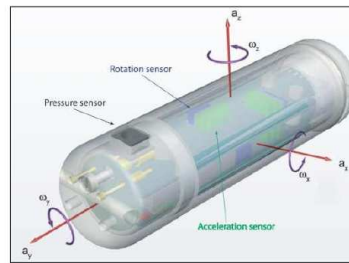
3. Fish friendly project

4. Examples

5. Conclusions

## Validation:

- Sensor fish test



- Live fish test results: survival rates (after 72hrs)

	Eel			Roach			Perch
Rpm	1m	3m	4m	1m	3m	4m	3m
200	100%			98.8%			
250	100%			97.3%			
300	100%	>99.5%		88.1%	90.6%		90.8%
340		100%	100%		85.0%	90.8%	
380			100%				

# 4. Examples

1. Introduction

2. Philosophy

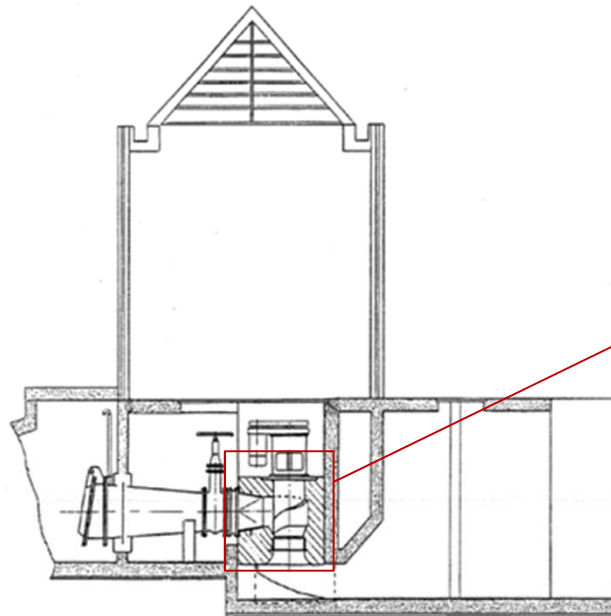
3. Fish friendly project

4. Examples

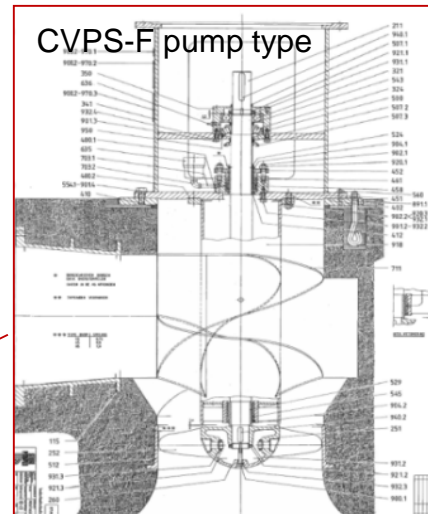
5. Conclusions

## ***Pumping station Berkel: BVOP 85 → CVPS-F 85***

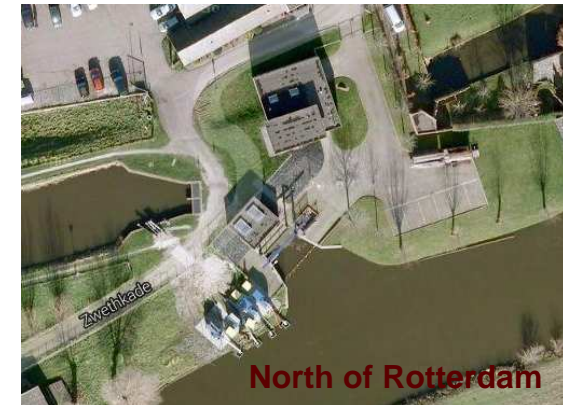
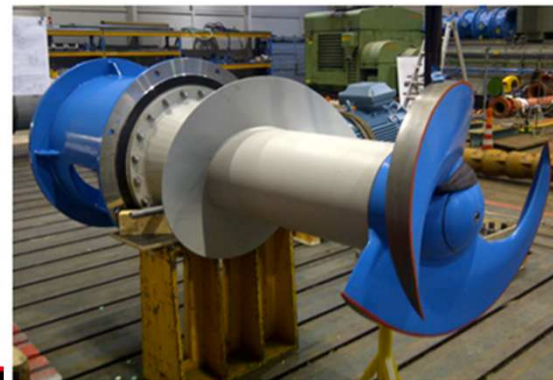
(Duty: 6300m<sup>3</sup>/hr, Head: 2.27m)



Typical BVOP pumping station



New pull-out unit: impeller/diffuser



Suction side



Discharge side



# 4. Examples: Ropta

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2. Philosophy

3. Fish friendly project

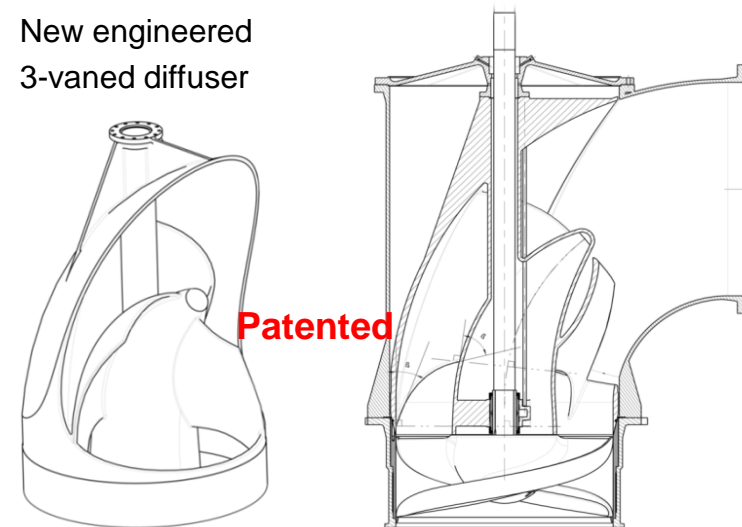
4. Examples

5. Conclusions

**Pumping station Ropta: SVO 105-110 → VOP-F 105-110 (Duty: 10800m<sup>3</sup>/hr, Head:1.6m)**



New engineered  
3-vaned diffuser



## 4. Examples: Miedema

1. Introduction

2. Philosophy

3. Fish friendly project

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5. Conclusions

**Pumping station Miedema: SVO 140-140 → VOP-F 140-140 (Duty: 18900 m<sup>3</sup>/hr, Head 1.9m)**



Existing pull-out with 4 vane impeller and 9 vane diffuser



New diffuser test mounted



New pull-out with 2 vane impeller and 3 vane diffuser



(Tour 2: "Fishways & Tidal Barriers" will visit pumping station Miedema on Thursday June 25th)



## 5. Conclusions

1. Introduction

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5. Conclusions

- Pumping stations with large pumps are already fish friendly
- Fish passable pumps are a cost effective solution to solve fish migration barriers caused by pumping stations
- Successfully developed and tested a high specific speed hydraulic suitable for many critical pumping stations
- Retrofitting for fish friendliness is a cost effective alternative
- Initiative for fish friendly NTA by NEN
- First retrofit projects in practice

## Questions?