Optimising Wastewater Plants (Improving what we have)

Denis McGuire
Process Optimisation Manager Irish Water

EPA National Water Event 2016
Galway
8th - 9th June

Objective

- Process Optimisation in context
- Role of Process Optimisation Team in IW
- How we go about our work
- Implementation Groups
- Case Studies to illustrate
- Process Optimisation Tips

UISCE ÉIREANN : IRISH WATER

Optimisation in IW

Process Optimisation

"Activities that will support the drive in improved compliance and plant resilience, enable completion of O&M activities at lower cost“

Tighter Ammonia ELV’s ,
Disinfection to meet bathing standards,
Phosphorus removal and
Nitrogen removal

UISCE ÉIREANN : IRISH WATER

Value for money

- Reduction at Source
  - FOG projects,
  - Volume & concentration reduction (trade licensing & infiltration)
- Process Optimisation
  - Make best use of existing infrastructure
  - Identify correctly minor works (ANB) if required to improve performance
  - Deferred expenditure on major capital upgrade
- Capital Solutions (Whole Life Cost)

UISCE ÉIREANN : IRISH WATER

Process Optimisation Team

Water and Wastewater Process Optimisation Manager – Denis McGuire

	East & Midlands	South	North West
POLs	Aphra Leavy	Robert Kennedy	Patrick Real
POAs	Agnieszka Wojdowska Darran Killian Ger McIntyre Barry Leonard Catherine McDonough	Brendan Kidney Kieran Fay Anthony Hickey Salvador McNamara Robert Kennedy Aoife Kyne	Flint Walter Kevin Love Francis Hughes Louise Brennan Diarmuid Campbell Paul Cogan

HQ – Reporting Solution Analyst

Siobhán Mulford

HQ – PO Planning Analyst

Catherine Kelly

HQ – Electricity Management Analyst

Gearóid Fitzgerald

Intern
Haozhang Li

UISCE ÉIREANN : IRISH WATER

Supporting the Operator to deliver on Optimisation

Collaboration - The onsite operator is fundamental to the optimisation efforts. The Process Optimisation Team are there to support the operator (local authority).

Hands-on operator support to implement process control techniques and standard operating procedures (SOP's) to improve process performance.

UISCE
EIREANN : IRISH
WATER

What We're Here To Do – Our Current Approach

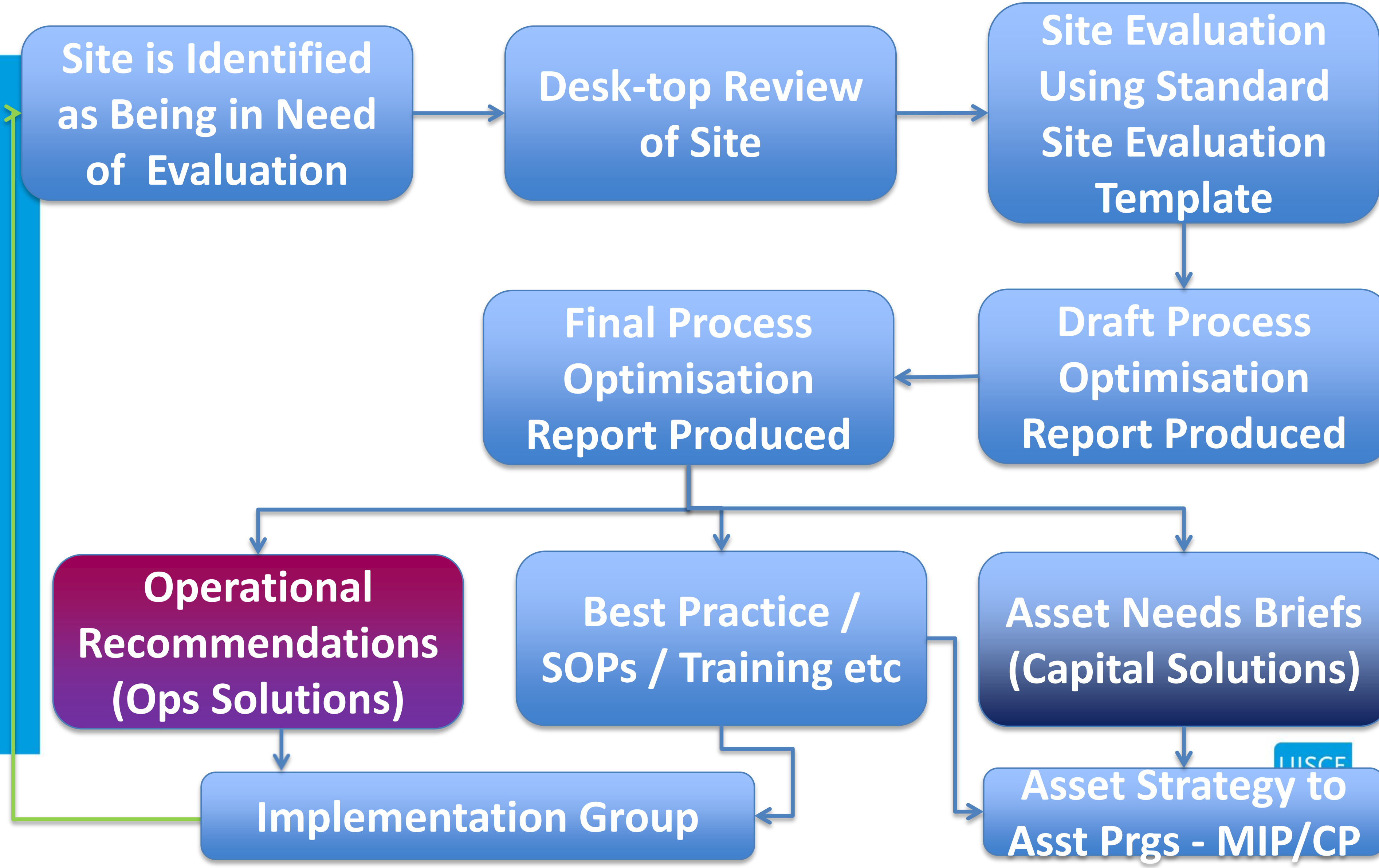
- Currently our main focus is on compliance related issues
- Efficiency related activities are taking place but they are always secondary to compliance needs
- Focus on implementation of recommendations through Implementation Group concept

UISCE ÉIREANN : IRISH WATER

Is the plant capable of meeting compliance?

- Operations
- Design
- Organisation
- Maintenance

Background – Process We Follow



What we have been doing

Wastewater - April 2014 to April 2016

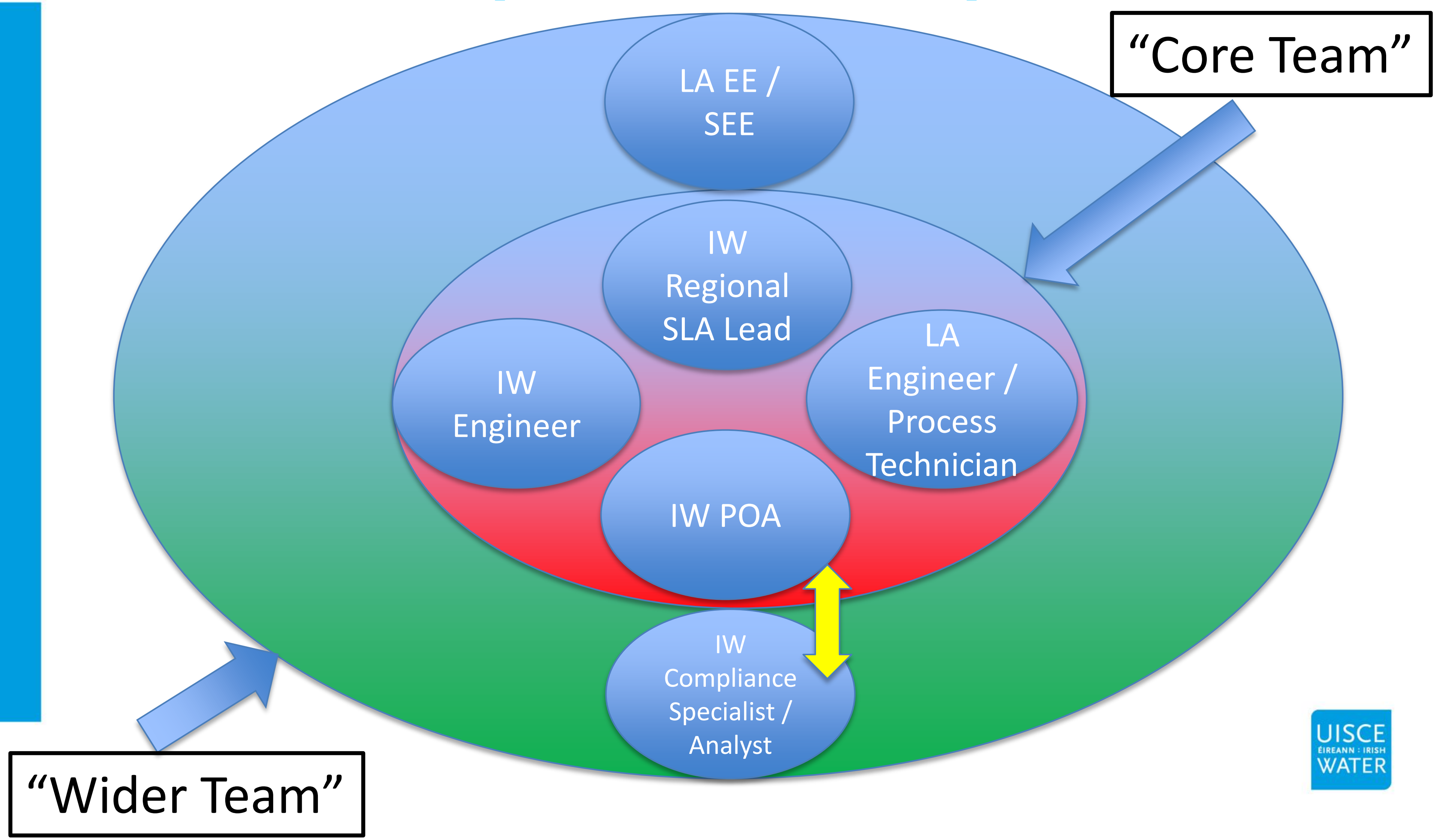
Site evaluations completed & reported to date	315
Focus on non compliant sites or WWAL	
Over 2000 Wastewater Recommendations Progressing through Implementation Groups	
Wastewater Asset Needs Briefs proposed to date	392
Energy Bill & Tariff analysis savings to date water	€670,392
Aeration upgrades at 16 WWTP being progressed should result in energy savings	€269,000

O&M Opportunities for improvement (Shortfall themes identified during evaluations)

- Process Control
- Operational Activity
- Maintenance Activity
- Flow and Load Control
- Instrumentation
- Chemical Dosing

Focus on Implementation Groups

(Delivery Mechanism)



Process Optimisation Case Studies

Castlerea WWTP – Aeration upgrade

Case study

Flint Walter, Ronan Daly

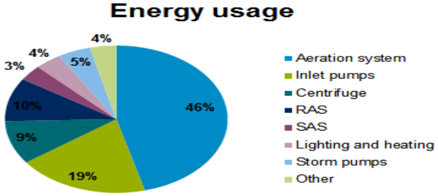
The site

- Castlerea WWTP , Co Roscommon
- PE : 8312 , DWF: 1300 m^3/d – Activated sludge plant
- ELV: cBOD 7, COD 125, SS 35, NH4-N 0.5, Ortho 0.2 mg/L

The issue

- Broken diffusers
- Dead zones (areas of very low aeration)
- High final effluent ammonia
- 30 Kw Air blower running continuously

at 99% resulting in high energy usage (€25-30,000/annum).



Diffusers replaced & aeration control optimised

- ✓ Improved effluent quality
- ✓ Increased nitrification
- ✓ DO probes repaired and calibrated
- ✓ Smaller Air Bubbles = greater oxygen transfer = less air flow required = 25-35% reduction in energy use .

→€8,000 - €10,000 in electricity savings + €1,500 in Low Power Factor savings

New and old diffusers

Diffuser air test

New diffusers – post upgrade

For more info: optimisation@water.ie

Birr WWTP – Optimisation & upgrade

Case Study

The site:

- **Birr WWTP , Co Offaly (Current P.E. ca.12,000)**

The issue:

- **IFI complaint** regarding the effluent quality during septicity event at plant in May 2015.
- **Effluent quality not in compliance** with the Urban Wastewater Directive.
- **Section 16 licenses contributing a significant load** above the Licence permits – aeration deficiency at WWTP as a result.

The Action:

IW assessed the operation of the plant and a number of recommendations were pursued. **Interim corrective measures** during the septicity event in May 2015:

- Additional **supplementary aeration** via Venturi's, was installed to address the aeration deficiency.
- **Enhanced wasting regime** was prepared for the Operator.
- More **suitable site specific MLSS** target was suggested.
- **Liaison with the Section 16 Licensee** to understand their discharge patterns and alleviate the potential for shock loading at the WWTP through lower volume, higher frequency discharges.

Longer term solution:

- Upgraded the existing surface aeration system to **FBDA** in May 2016 with enhanced DO control.

The Results:

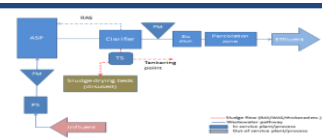
- ✓ **Robust Compliance - with Urban Wastewater Directive achieved in mid 2015.**
- ✓ **Enhanced aeration capacity - FBDA upgrade.**
- ✓ **Projected savings of 20% - per annum on aeration costs - FBDA**
- ✓ **Increased confidence in plant capability - for IW & LA.**

Moylough Sludge Reed Bed Retrofit

Case study

The site

- Moylough WWTP , Co Galway
- PE : 465 , DWF: 108 m^3/d



The issue

-High Operational costs relating to sludge tankering. €12-14,000 per annum
-No sludge storage on site resulting in major risks to compliance.
-Excessive Mixed Liquor Suspended Solids (MLSS) followed by insufficient MLSS
-Lack of process control leading to an inability to vary treatment potential.

The solution

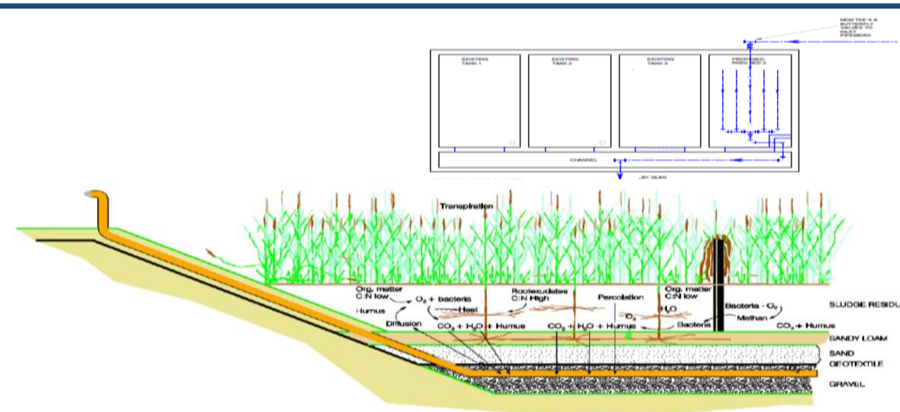
✓Retrofit redundant sludge drying bed (s) into a sludge drying reed bed.
✓ Use of the RAS pumps to deliver SAS to the sludge reed bed (SRB)
✓ MLSS now controlled on site

The benefits

- Payback only <u>1.5 years</u>

(Cost of retrofit: €16k, Opex of Capex: € 0.2K)

- Habitat creation
- Lower CO^2 emissions vs . sludge tankering



For more info: optimisation@water.ie

Ballinaclash WwTP Optimisation

Case study

The site:

- Ballinaclash WWTP, Co Wicklow (600 P.E.)

The issue:

- Emission Limit Value exceedances (ELV) for Ammonia, Orthophosphate and Total Nitrogen, 2011-2014.
- WwTP was not designed to treat Total Nitrogen (i.e. no dedicated anoxic zone, only small selector available).

The solution:

Phase 1: Achieving compliance with ELV for Ammonia and Orthophosphates:

1) Second Aeration Tank was brought into operation to enable full nitrification.
2) LA personnel advised on adequate sludge age/ MLSS concentration for the process.
3) An improved Sludge wasting regime has been implemented (i.e. regular small volumes v's irregular large volumes).
4) DO levels were increased in the aeration tanks to 2 mg/l.
5) Ferric Dosing regime was improved via routine calibration of pumps, weekly Orthophosphate testing, etc.

Phase 2: Achieving compliance for Total Nitrogen via simultaneous nitrification – denitrification.

1) Periodically shut down the aeration to achieve anoxic zone.
2) Pumping rates were adjusted to ensure raw influent is received during anoxic phase (BOD source food for denitrification).
3) The process was tightly monitored to get robust compliance results.

The results:

- ✓ Avoidance of Capital investment: No new anoxic tank required to achieve Total Nitrogen Standards (€100,000).
- ✓ Energy usage: no noticeable change despite 2^{nd} aeration tank now in operation.
- ✓ Compliance achieved 2015-2016:
  - ✓ 12 months for ammonia to date,
  - ✓ Orthophosphate since April 2015 to date, and
  - ✓ Total Nitrogen since November 2015 to date.

Ballincollig WWTP

Case study

The site:

- Ballincollig WWTP , Co Cork
- PE : 23,000

The issue:

- Over dosing of ferric sulphate for phosphate removal. Effluent phosphate concentrations were well below license ELV
- Ferric sulphate is very corrosive and is toxic to aquatic environment

The solution:

1) Operational tests on effluent phosphate concentrations were conducted
2) Baseline ferric dose established
3) Theoretical dosage based on influent load (kg) established
4) Hydraulic retention time established
5) Procedure formulated
6) Total Phosphate (TP) ELV was 2mg/l but effluent TP concentrations could be as low as 0.1 mg/l
7) Incremental reduction in ferric dose with effluent testing - iterative process
8) Also testing for worst case – importations of septic tank
9) Reduction from 20L/hour to 15L/hour (Saving 43,800L/annum)
10) More savings could be achieved by profiling phosphate against flows

The Result:

✓ Operational savings - €10,000/annum on ferric sulphate usage

The above case study is strong example of IW personnel and LA personnel working together to achieve compliance results.

Knockieran WWTP – Optimisation

Case Study

The site:

- **Knockieran WWTP , Co Wicklow (Certified)**

The issue:

- **Public complaint** regarding the quality of discharging effluent
- **Effluent quality** - not in compliance with the Urban Wastewater Directive.
- Discharge is adjacent a **public amenity area.**

The Action:

IW assessed the operation of the plant and identified a number of area's for improvement;

- **Repair distributor elements** supplying effluent to the filter media (Bioclere unit).
- **Adjust time on Irrigation pump** (serving Bioclere unit from the primary settlement tank) to optimise forward feed intervals.
- **Cessation of power washing of filter media** which was inhibiting beneficial biomass growth.
- **Recommission the fan on the Bioclere unit** which promotes oxygenation of biomass.
- **Optimised desludging practises and intervals** from the primary tank (allowing small amount of sludge to remain as seed) and Bioclere unit.

IW worked in close cooperation with the LA to ensure implementation of the recommendations which involved minor expenditure (less than €100) to remedy operational deficiencies.

The Results:

✓ **Avoidance of capital cost - ca. €80,000 in capital investment proposed to upgrade the plant was avoided.**

✓ **Public health risk - significantly reduced.**

✓ **Compliance - with Urban Wastewater Directive achieved in late 2015.**

Callan WwTP Optimisation

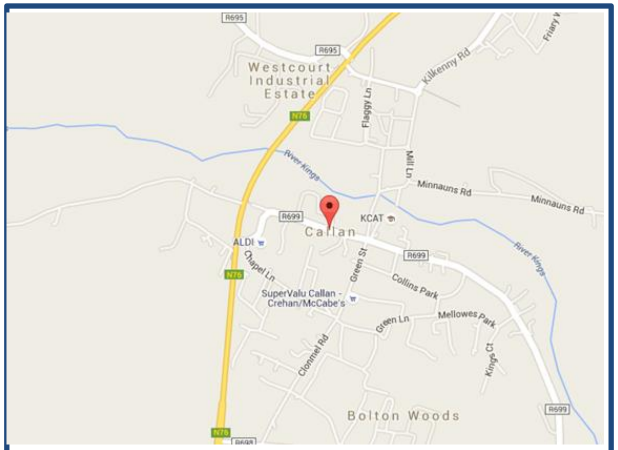
Case study

The site:

- Callan WWTP, Co Kilkenny
- PE: 4000

The issue:

- Historical performance was impacted by discharges containing very high organic loading and saline content from Section 16 Discharge.
- Saline content impacting on biological activity resulting in elevated BOD and Organic loads were twice design loadings on occasion.



The solution:

1) Section 16 Licence reviewed and chloride limits of 1000 mg/l applied.
2) Maximum organic load permitted reduced to 56 kg day.
3) Installation of balance tank.
4) Trial of aerobic digestion of sludge arranged and due to commence shortly to reduce sludge volumes and tankering off site.
5) Modifications to decanting arms to enable them be raised out of SBR tanks.
6) Modifications to SBR Sequence increasing anoxic fill and anoxic mix duration to improve SVI & reduce sludge bulking.

The results:

- ✓ Improvement in compliance and elimination of shock loading and inhibition
- ✓ Improvement in SVI and Sludge settleability
- ✓ Reduction in Energy use for Aeration
- ✓ Expect reduction in sludge tankering costs if trial successful

Inniskeen WWTP – Monaghan

Case study

The site:

- PE: 1750 – Fine Bubble Diffused Aeration /Activated Sludge Plant.
- ELV: cBOD 10 mg/l COD 125 mg/l, SS 10 mg/l NH_4-N 2 mg/l , Ortho 1.5 mg/l

The issue:

- **Inniskeen WWTP failed its ELV's in 2015 in relation to Suspended Solids 76mg/l, Ammonia 6.7mg/l.**
- **Inniskeen WWTP discharges into the River Fane. The River Fane is the main source for the Cavanhill-Dunbin WTP. (Cavanhill-Dunbin WTP is a 26 MLD which supplies treated water to the Dundalk-Louth Area).**

The solution:

- ✓ **Training of the Caretaker in relation to Process Monitoring /Optimisation of WWTP, in relation to**
- ✓ **(Mixed Liquor Suspended Solids (MLSS), Sludge Volume Index, Sludge Age & F/M ratio, Dissolved Oxygen, Microscopic Analysis of Activated Sludge).**
- ✓ **Upgrade of the Tertiary Sand Filter System**

The Benefits:

- ✓ **Inniskeen WWTP achieved compliance in relation to it's ELV's for Suspended Solids (SS) (SS went from a maximum 76mg/l in 2015 to average 5.9 mg/l in 2016.**
- ✓ **Inniskeen WWTP achieved compliance in relation to it's ELV's for Ammonia (Ammonia went from a maximum 6.7mg/l in 2015 to an average of 0.07 mg/l in 2016.**
- ✓ **Inniskeen WWTP achieved compliance in relation to it's ELV's for cBOD (cBOD went from a maximum 6.0mg/l in 2015 to an average of 1.9 mg/l in 2016.**

Process Optimisation of Inniskeen WWTP

For more info: optimisation@water.ie

Ballyjamesduff WWTP – Sludge Press

Dr. Louise Brennan

Case study

The site:

- Ballyjamesduff WWTP, Co. Cavan.
- PE: 2,568 , DWF: 451 m³/d – Activated Sludge Plant with Single Belt Press.
- ELV: cBOD 25 (4*), COD 125, SS 35, NH_4-N 0.2*, Ortho 0.1* mg/l

(* as of 31/12/2019).

The issue:

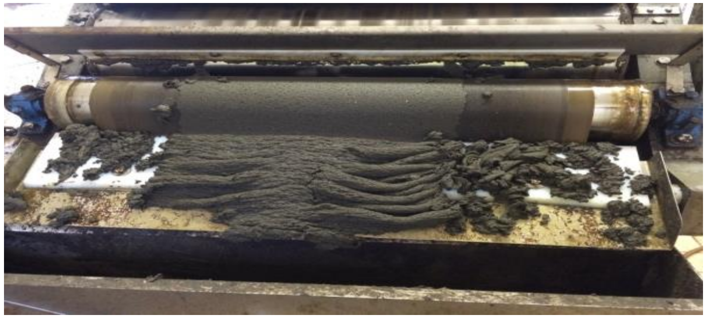
- Final cake produced from Single Belt Press at 7-8 % DM.
- Large SHT (sludge septicity during storage).
- 6.7 kW blower operating as a mixer during pressing resulting in high energy usage (€3,000/annum).

The solution:

✓ New Mixer to replace blower & new intake to Belt Press Configuration.
✓ Turned off 6.7 kW Blower on Sludge Holding Tank.

The Benefits:

✓ Improved process control due to reduced loading from belt press as a result of improved centrate.
✓ Improved % DM from 7-8 % to 13 %.
✓ Estimated Energy Savings from increased % DM = €6,000 / yr.
✓ Reduction in Energy usage moving from a 6.7 kW Blower on the SHT to a 0.37 kW Mixer adjacent to the belt press.
✓ Reduction in the cost of pressed sludge haulage & sludge disposal costs.
✓ Reduction in operator man hours.
✓ Environmental benefits from reduced transportation emissions.



Sludge Leaving Press – 13 % DM

Inadequate Feed to Press

New Mixer & Intake to Press

Process Optimisation Tips

Chemical Dosing – Ensuring Phosphorous Compliance

- Carry out Jar tests to establish optimum Ferric dose for phosphorous removal
- Monitor for phosphorous levels in both Influent and Final Effluent and develop a profile of ferric dosing requirements.
- Consider using dual injection points before and after aeration basin

UISCE ÉIREANN : IRISH WATER

Achieving Ammonia Compliance

- Ensure sufficient alkalinity for nitrification
- Ensure Dissolved Oxygen set points 2 ppm
- Ensure sufficient MLSS or SRT >12 days

UISCE ÉIREANN : IRISH WATER

BOD & Suspended Solids Compliance

- Ensuring good SVI
- Monitor blanket dept in clarifier
- Ensuring proper WAS and RAS flow rates
- Prepare for and manage Peak Flow events

Achieving Denitrification (Total Nitrogen ELV)

- Maximise anoxic zone\period either in aeration ditch or SBR Cycle
- Ensure RAS is returned to influent - anoxic zone
- Monitor ORP and ensure anoxic conditions for conversion Nitrate to Nitrogen

Tips for energy saving

- Cleaning of diffuser heads –
  Monitor pressure levels & cleaning with formic acid (about 35 ml formic acid/m2)
- Check for air leaks
- Ensuring appropriate dissolved oxygen set points
- Ensuring appropriate MLSS levels
- Ensure RAS is returned with influent
- Maximise use of anoxic zones
- Make use of Variable Speed Drives

Thank you for your attention!

Contact email: dmcguire@water.ie