

# CLEAN WATER

News From **GURNEY ENVIRONMENTAL** — Water & Wastewater Treatment Solutions  
FROM WATER SUPPLY TO WATER RE-USE

## Advanced Design Lagoons — Building on 4 Decades of Research and Success in Municipal & Industrial Wastewater Treatment.

*Gurney Environmental provides technology that offers superior performance & problem resolution.*



*The unique Aero-Fac® wwtp system provides high rates of removal, no odours, complete sludge digestion and superior water for re-use — all in a compact footprint with extremely low operating expenses (OPEX).*

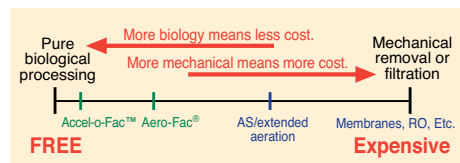
**1976** began an intensive and ongoing research program designed to resolve the common problems and limitations associated with traditional wastewater lagoons/ponds including odour, short-circuiting, uneven loading, sludge accumulation and poor processing rates. 40 years later, Gurney Environmental offers technology and designs based on this 4



*Four decades of intensive research into lagoon design and sludge digestion provides the basis for Gurney Environmental's unique designs and technologies.*

### Mechanical vs. Biological Removal

The more biological/biochemical removal of contaminants used in a treatment scheme, the lower the initial cost (CAPEX) and ongoing costs (OPEX) for a wwtp. 40 years of research have defined the extraordinary capabilities of advanced biological/biochemical wastewater treatment.



### What Are Lagoons Capable Of?

Gurney Environmental's advanced systems are easily capable of very consistent performance with high processing rates, advanced treatment levels, no perceptible odours, no sludge accumulations and excellent accommodation of peak and shock flows. They can, in some cases, even be practical for very large population applications as well.

What has been the cause of misconceptions and myths about lagoon-based systems? Essentially, incorrect assumptions and design. Some lagoon systems are actually designed assuming that erratic, poor performance is "normal" operation.

### The "Cardinal Sins" of Lagoon Design

In correct lagoon design, there are several key design factors that will affect performance. Using advanced design criteria based on years of correcting existing wwtp's ensures superior performance.

### Cell Geometry, Flow & Overall Design

An extraordinarily key factor in the performance of lagoons is correct physical design. Based on experience with hundreds of lagoon-based municipal and industrial wwtp's, experience proved that better physical design results in superior, more reliable and predictable performance of Gurney Environmental designed wwtp's.

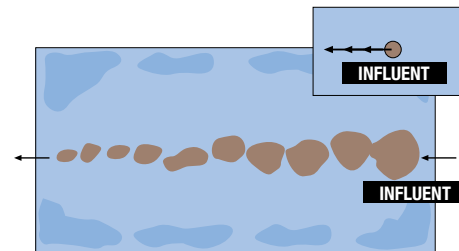
### Detention Time

The amount of time wastewater spends in each

stage of treatment is highly critical and is temperature dependent. Modern lagoon-based systems are typically comprised of two or three stages of treatment: primary, secondary and possibly a tertiary or polishing stage. Each stage is designed for an approximately 80–85% reduction at summer water temperatures (20° C) taking a predictable amount of time at any given water temperature for the biology to establish and perform its reductions. Colder water temperatures are offset by longer detention times. However, note that systems successfully operate in 1- 2° C water temperatures. The warmer the *average* yearly water temperature, the faster the biological/biochemical removal rate.

### Surface Organic Loading Rate

Nature can only provide a certain amount of natural aeration through photosynthesis and atmospheric absorption for a given climate. In colder climates, correct non-aerated/"accelerated" primary cell loadings typically run 20–25 kg/ha/day, while warmer climates can be loaded at up



*Short-circuiting decreases detention times whilst influent overloading dramatically reduces processing power, odour control and sludge digestion. Overloaded and under-loaded areas of the lagoon reduce performance to much less than standard calculations suggest.*

to 50–75 kg/ha/day. Loadings in excess of these rates in non-accelerated systems will cause the biology to become dormant (anoxic) and sluggish resulting in odours, sludge accumulations and low processing rates. Therefore, very specialised supplemental aeration and process "optimisation" equipment must be added to systems with higher loadings. Correct loading rates and detention times have been proven to provide strong, reliable and consistent performance in full-sized, commercially successful facilities — not just in "test" or experimental systems. Ignoring these basic design

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rules simply means that lagoon-based systems will not perform as well as correctly designed, *optimised* lagoons can and do.

## Aeration & Optimisation – Maintaining an Aerobic "Powerhouse"

Overall, aerobic processing is faster and offers other advantages — odour control, disinfection, better sludge digestion and ammonia-nitrogen removal. Unfortunately, this is where so many lagoon systems go wrong. Correctly aerating and "optimising" a lagoon requires a true understanding of the underlying process and inter-dependencies in order to enjoy the many benefits offered.

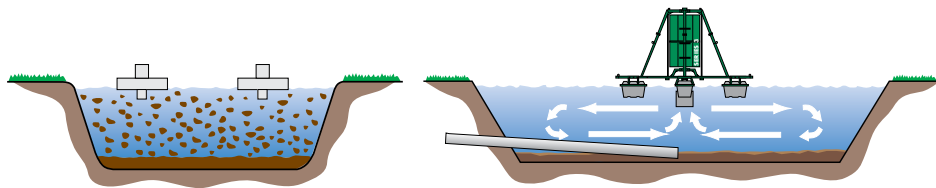
## Facultative Processing

For primary treatment, it is critical that the cell maintain 3 distinct zones. The top aerobic zone is the largest and most powerful. The larger and deeper the zone (*VERY* important!), the more raw processing power available. At the bottom,

suspension. Breaking down the solids, processing the BOD and providing odour control simply requires far too much horsepower and also results in solids carry-through to the secondary cells. In effect, the so-called "solution" causes new, just as serious problems. The system is no longer truly a facultative lagoon with its associated benefits.

## Correct Aeration & Optimisation

Using 40 years of extensive field work, trial and error, fixing/correcting numerous failing municipal and industrial wwtp's, and through ongoing research, specialised aeration and overall process optimisation equipment was developed that allows for a fully aerobic water column edge-to-edge throughout the cells — but without the aggressiveness that destroys the layering. Surplus DO is maintained throughout the water column, but the sludge blanket remains capped and undisturbed. The facultative bacteria remain at the critical sludge/water interface and the oxygen-rich water



*Oxygen demand that exceeds the capabilities of photosynthesis and atmospheric absorption requires supplemental methods to increase dissolved oxygen. However, traditional aggressive aeration can cause problems that are as bad as the original problem. The foundation of the process is a critical layering of the 3 treatment zones — aerobic upper layer, a capped and undisturbed anaerobic sludge layer, and a small but highly critical facultative bacteria layer separating the aerobic and anaerobic layers. Specialised "optimisation" equipment is required to increase the DO without disturbing the critical layering. Any solids in suspension increase the overall oxygen demand and must be broken down aerobically and allow solids to pass to the secondary cell — a much more expensive method of solids digestion as compared to "free" anaerobic sludge digestion in a correctly designed lagoon.*

a capped, *undisturbed* anaerobic sludge layer must be maintained for steady-state digestion to function. At the sludge water interface, a small protective zone of facultative bacteria operate both aerobically and anaerobically providing crucial sludge digestion help and other functions.

## Critical Layering

If these layers are disturbed or overly mixed, the system fails. If the entire depth of the upper zone is not fully aerobic with positive DO, processing power and odour control (through biochemical stripping) is lost. If solids from the sludge blanket are put into suspension, they will exert an oxygen demand that can shut down the aerobic processing, and the sludge will not fully digest. The sludge blanket must remain capped/undisturbed to achieve steady state anaerobic digestion.

## Common Aeration Techniques

Traditional aeration is often far too aggressive resulting in what can be termed a partial or total mixed primary cell, thus putting solids into

column provides the time needed to biochemically strip the noxious gases. Research also found ways to dramatically reduce energy costs for this specialised equipment in order to accomplish all

this as compared to total or even partial mix cells.

## "True" Cell Loading

Correct cell loading is critical in order to maintain truly aerobic cells. Unfortunately, many lagoons are designed so that a bulk of the organic loading is concentrated within the influent zone and the waste then short circuits directly to the effluent structure reducing actual true detention time. Massive overloading occurs in that influent-to-effluent stream whilst huge areas of the cells are dramatically under-loaded and poorly utilised.

The simple addition of the Gurney Environmental SERIES 3 windpowered aeration/optimisation units within the influent zone and throughout the cell does several critical things:

- 1) disperses the loading out from the influent zone, thereby uniformly loading the entire cell area;
- 2) increases true detention time by eliminating short circuiting, thus increasing removal rates;
- 3) improves the DO of the entire water column without disturbing the critical layering of the cell.

## Proper "Advanced" Lagoon Design

4 decades of research based on solving problems with hundreds of wwtp's worldwide has resulted in a design philosophy that provides high rate processing, no odours and complete sludge digestion.

New-build lagoon systems are designed with the correct length-to-width ratio, parallel trains of cells to avoid large, poorly performing cells, and correct/optimal depth of cells to maintain perfect aerobic conditions while allowing for a smaller footprint. Experience *does* make a difference.

## 100% Complete On-site Treatment

Both Accel-o-Fac® and Aero-Fac® wwtp's provide complete on-site treatment including the removal and digestion of all biosolids. Energy and manpower requirements are a fraction of activated sludge plants. Maintenance is minimal and capital equipment lasts far longer. Using 40 years of intensive research into lowering the total life cost of wastewater treatment, Gurney Environmental has the experience and proven track record of successes to provide extremely robust and low CAPEX, OPEX and TOTEX, truly sustainable systems unmatched in the industry. ►►



*The exclusive Accel-o-Fac® wwtp system upgrade allowed for dramatic increases in loading/flow, resolved odour issues and increased sludge digestion for this 2.5 million population city — all at extremely low cost.*

# Scottish Islands Address Local Needs, Restrictions & Budgets with an Aero-Fac® No-Sludge, Low Carbon Footprint WwTP

*No-sludge wastewater treatment centre for islands requires little operator attention and energy.*



*The Aero-Fac® WWTP at Tobermory, Scotland was commissioned for Scottish Water in May 2007. The system features no sludge, low energy, low manpower and maintenance — all important issues for an island wwtp.*

May 2007 saw the commissioning of a specially designed and constructed Aero-Fac® wastewater treatment plant for the very popular tourist town of Tobermory on the Isle of Mull, backdrop for the BBC Children's TV series Balamory.



*Tobermory seafront, known to BBC viewers as the setting of the TV series Balamory.*

Going against the past trend of ever more compact treatment options, Scottish Water decided that at Tobermory *true* sustainability, OPEX, TO-TEX and low carbon footprint should be of more



*Unlike conventional diffused air systems, the 100% stainless steel diffused air system has no moving parts, and requires no routine servicing or maintenance.*

importance than the smallest physical footprint.

Requiring only slightly more land than some traditional activated sludge treatment plants, the Aero-Fac® fully biological process is a low energy, low maintenance wastewater treatment system

that utilises wind power to minimise electricity requirements. The process also has the benefit of eliminating sludge handling, dramatically cutting its environmental impact when compared to more traditional sewage treatment plant options.



*Low pressure, low energy fan blowers require little maintenance and only run when required by loading.*

The plant at Tobermory was Scottish Water's second Aero-Fac® plant and followed the pioneering installation of a similar system at Errol in 2001.

Later in 2008, a third Aero-Fac® plant was built at Bowmore on the nearby island of Islay.

With both the Tobermory and Bowmore plants, Scottish Water significantly reduced the environmental costs of treating sewage



*Unique wind powered aeration/optimisation units keep annual energy costs low.*

by removing the previous requirement, costs and complexities associated with exporting sludge back to the mainland. The plants also

incorporate septage reception centres designed to accommodate septic tank sludge collected from right across the islands.

Both the septic tank sludge and the normal sewage influent biosolids are completely contained and digested within Aero-Fac® eliminating the need for sludge handling and tanker ferry trips back to the mainland. ►►



*The Aero-Fac® plant for Scottish Water was put into service at Tobermory on the Isle of Mull in 2007. The simple installation of aeration modules was easily carried out over the course of a few days.*



# The Aero-Fac® SDS & PTS Sustainable Add-On Treatment Systems

*SDS digests sludge on-site whilst the PTS provides front-end buffer.*

Responding to industry needs to reduce overall operating costs of wastewater treatment, address sludge handling costs and complexities, and provide truly sustainable upgrades for existing mechanical WWTPs, Gurney Environmental offers two advanced systems following multiple years of in-field development and performance testing.

## The Aero-Fac® PTS

The Aero-Fac® PTS (Primary Treatment System) is used for upgrading existing biological filter works. The PTS system is installed in front of an existing works to provide many operational benefits including increased capacity, peak flow handling and total sludge handling and digestion.

As an example, the first Aero-Fac® PTS located in East Harling, Norfolk is now entering year 7 of operation, and has clearly demonstrated the following substantial benefits:

- Improved treatment
- Elimination of sludge handling
- System peak load/flow attenuation
- Shock load protection
- Improved nitrification
- Construction pays for itself in OPEX savings
- Extends existing asset life

## The Aero-Fac® SDS

The Aero-Fac® SDS (Sludge Digestion System) is used for sludge digestion at AS/SBR plants. Handling and disposal of sludge from activated sludge wwp's involves regulation, complexity and high costs. The Aero-Fac® SDS provides extremely low cost on-site handling and digestion of all biosolids, all without dewatering or conditioning, thereby eliminating capital equipment costs and ongoing



*The Aero-Fac SDS in use for 11 years at West Newton. The SDS system provides buffering of large peak flows from the Sandringham visitors centre, and receives and digests all solids from the existing ditch.*



*The Aero-Fac PTS in use for 7 years at East Harling, Norfolk. The PTS system provides primary treatment in front of conventional filters, buffering storm surges and handling all solids.*



*The Aero-Fac® PTS expands the capacity of existing filter works, thereby increasing its useful life, whilst handling and digesting all sludge and attenuating peak flows and loads.*

expense and manpower.

The first Aero-Fac® SDS was constructed at a site at West Newton, Norfolk and has over 11 years of successful operation. Servicing both West Newton and the Royal Estate at Sandringham, flows and loads presented a challenge for wastewater treatment. While the Estate and the village could have a normal population equivalent of 650 residents contributing to the treatment plant, it was the large influx of visitors to the area in the summer months that presented the main concern. The visitors centre can see a throughput of on average 2,000 people

per day during the summer months. With summer events such as the flower show where attendance could be as much as 25,000 over two days, plus weather and other factors playing a role, no one could accurately predict when the influx would suddenly appear. These very popular events were not something the existing mechanical plant could easily be designed to accommodate.

Flows are split between the Aero-Fac® SDS and the existing ditch with surges in loading being diverted to the Aero-Fac® cell, thus allowing a nice, uniform flow to go to the less-flexible ditch. All sludge produced by the ditch is sent to the Aero-Fac® cell for total digestion, which eliminates sludge storage and disposal — including intrusive, noisy and dusty sludge lorry movements to and from the site.



*Sludge and peak flows from the existing ditch are diverted to the Aero-Fac® Sludge Digestion System.*

The addition of the SDS to the existing activated sludge system has provided the following benefits:

- Sludge digestion on site
- Eliminates expensive additional sludge handling
- Eliminates sludge tanker movements
- Lowers carbon footprint
- Saves money and is easy to operate
- Simple to build, and is tried and tested

The PTS and SDS systems build on the decades of proven performance of the main Aero-Fac® total treatment system. Upgrade options such as the PTS and SDS offer water companies and other wastewater treatment operators innovative, cost effective, low carbon footprint *truly* sustainable solutions.

These new systems have been designed, developed and tested in the field in direct response to the needs of the wastewater industry. ►►



Holkham Estate & Village decade-old, almost zero-energy, no sludge, no odour wastewater treatment plant.

## Holkham Estate Mark 10 Years of Low Cost, Odour-free, No Sludge, Sustainable Wastewater Treatment

*Treating own wastewater with no-sludge, no-odour, zero-to-low energy system.*

The Accel-o-Fac® wastewater treatment plant serves the Estate, Victoria Inn and village at Holkham in Norfolk and has been treating sewage since the spring of 2006 with almost no ongoing operating costs of any significance.

Owned by the Earl of Leicester, the Holkham Estate and village includes a thriving hotel, which is very popular with tourists visiting this part of the country. Previously, the village had been served by septic tanks requiring regular emptying. In 2005, the Estate had a choice of either: 1) sending the sewage to the nearby water company's treatment works via pipeline; 2) remain on septic tanks; or 3) treat their own wastewater. The appeal of the unique windpowered Accel-o-Fac® solution was low energy, no sludge or odour, and water of a quality appropriate for either discharge or potential irrigation reuse on the Estate.

After careful consideration of options, the Estate

elects to construct the Accel-o-Fac® wind-powered system to keep ongoing operating and total lifetime expenses (TOTEX) at a minimum. The plant also includes a simple Septic Reception Station to accommodate septic tanks from the Estate.



*Septage reception station for insertion of locally collected septic tanks into the Accel-o-Fac system.*

All septage and solids are transferred to the new Accel-o-Fac® primary cell for treatment and digestion of the sludge. The system is simple, odour free and inexpensive to operate.

One of the key benefits of the system for Holkham was the need for very little operator attention. There has been almost nothing for an operator to do at the plant this last decade short

of mowing the grass in the summer. Equipment maintenance includes inspections every 3-4 months. Not much else is required, making the operator's job truly part time!

Stephen Twyford from the Estate's Land & Property Department commented, "*The installation of the Accel-o-Fac sewage treatment system at Holkham in 2006 enforced our ethos of becoming an environmentally sustainable Estate and Community. The system continues to provide a low cost and low maintenance*



*Holkham Estate, Hotel and Village is located in Norfolk, England.*

*solution to wastewater treatment for Holkham Village with additional capacity for any needed future increase."*

Mr Twyford went on to say, "*The fact that there are no associated sewage odours meant that the system could be located relatively near to the village and, after 10 years of use, no sludge removal has been needed.*"

There was another advantage to this option. By providing a superior, more stabilised effluent, the Accel-o-Fac® system provides irrigation quality water at an extraordinarily low cost.

The Holkham system underscores the true, real-world sustainability of Gurney Environmental treatment systems for the UK and other markets. Elimination of sludge lorries, zero-to-low energy usage, little manpower required, few mechanicals involved — all spells a time-tested, environmentally conscious and truly sustainable method for treatment of wastewater. ►►

1 Bryggen Road, North Lynn Industrial Estate  
King's Lynn, Norfolk PE30 2HZ UK

**GURNEY ENVIRONMENTAL**  
FROM WATER SUPPLY TO WATER RE-USE

A GLOBAL COMPANY

T: +44-(0)1553-776202 • F: +44-(0)1553-776335  
E: info@GurneyEnvironmental.com • W: GurneyEnvironmental.com

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