
Integrated Uses of Biohaven Island Technology for Lake Elsinore and Canyon Lake

Growth of Biohaven Floating Island Technology and Products.

- My association began in 2007 with Floating Island International's Inventor, CEO Bruce Kania and his parent company whose home office and facilities are in Montana.
- Since that time a Western area Licensee located in N. California has been in production for several years. Floating Islands West, CEO Laddie Flock.

Following a Vision

- Having a Manufacturer in California I was able to establish a Distributor/Contractor relation with Floating Islands West to enable projects in California and other Western States. Visions of clean water, good habitat and a beautiful environment are the bonds that have brought together strangers living in different parts of the USA with organizations like LESJWA.

Seek the Critical Path

- While the principals of wetland remediation are becoming more widely known, few have ventured into the realm of the floating wetland. However this is not a new practice, floating plant islands have been fabricated and used by many indigenous people around the globe for millennia. Now it’s our opportunity to turn this practice into a 21st Century Solution.

Biohavens Symbiotic Relationship

- Biohaven Floating Islands are made from recycled plastics and marine foam. They are a floating platform for the growth of wetland plants and host to an Aquatic Cosmos of Micro Biology living inside the matrix as well as in the hanging plant roots. Water Fowl can nest and enjoy the surface above water while fish and other aquatic creatures seek food and shelter below.
- Water borne nutrients are transformed and consumed by the food web as nature intended.

Concentrated Wetland Processes

- Constructed and natural wetlands process water of nutrients and sediment that is carried through an aquascape consisting mostly of bottom area with some objects such as rocks and plant stalks contributing to the overall area where the bio-film or “periphyton” is attached . Biohavens concentrate this effect by the fact that they are three dimensional structures composed of many fibers molded together. This creates a large surface area for the Bio-Film to colonize.

Biohavens Add New Paradigm

- The development and use of Biohaven Floating Islands is an emerging Green Technology. Based on solid natural science principals, they are well founded and proven effective in a variety of situations. Biohavens are above all else exactly what the name implies. A haven where biology and microbiology can thrive. Their exact uses can be designed and fine tuned.

Advantages of a Concentrated Wetland

- Less cost than constructed wetland
- Place in existing water body
- Plant roots take nutrients from water
- Certain plants are hyper accumulators
- Islands can serve specialized functions
- Can be an integral part of other solutions
- Need no plants for basic biological action
- Can be incorporated into any aquatic plan or architecture.

No Man Is An Island

When I first presented Biohaven Floating Islands to the LESJWA board and stake holders I was pleased to find support for a pilot project. Initially the pilot was for the proposed Back Basin project which became destined to be placed on hold. After a time of significant waiting I eventually petitioned the IE Water keeper (the source of funding) and LESJWA to relocate the pilot project into Lake Elsinore

Islands In The Big Cove

- Contracts were drawn and the Islands were delivered to the city yard in the fall of 2009. Last year Spring of 2010 the Islands were planted and launched from the levy and the pilot project had begun.
- From the beginning it was obvious that the wind and wave action was going to be a force to be dealt with. Soon Pelicans discovered the benefits of Floating Islands.

First Year LKEL Pilot Project Report

Launch From The Levy

- The Islands were planted in certified native San Jacinto watershed wetland plants. Eighteen varieties were planted. The levy is on the windward end of the lake where wind driven wave action sometimes pound the shore.

Lake Elsinore Floating Island Project 2010

Project report

Planting, launching, maintaining at anchorage, current status.

Future Focus

Stinnett Enterprise
Marketing and Development
21st Century Solutions

- The Islands were delivered to the levy by the City of Lake Elsinore Lake Department employees on March 22nd . Preparation, planting and launch of the Islands went as follows.
- Wetland and riparian plants were chosen from those used by the Riverside-Corona RCD in their wetland restoration programs. The plants were also purchased from RCRCD. Most of the containers were of a large size so plants had to be divided to fit the Island planting holes, therefore their was an ample supply left over for replacements as necessary.

Planting and Launch of LKEL Project


THE HOME DEPOT
THE HOME DEPOT

Floating Wetland Gardens

Biohaven Floating Island Project for Lake Elsinore

Planting and Launch


Lake Operations
CF 0088 TR

Plants Take To the Lake

At Anchor…”BP”

Two Weeks Old…"BP"

Biohaven Floating Island Project for Lake Elsinore

Wind and Wave Action

Wind and Wave in The Big Cove

- The wind energy coming over the face of the Ortega mountains can build up to a frenzy by the time it reaches the Big Cove.
- Waves also have a long time to build in the main body of the lake before eventually ending their journey on the shores of the levy in the cove.
- Extreme wind driven waves toss the Islands and wash over plants. The edge material planting mix and smaller rocks and gravel wash to the middle. This makes the Island unbalanced so most of the mix has to be redistributed.
- It has been necessary to re-dress the Islands several times. Many of the plants have been replaced after being entirely washed out or buried beneath alluvium.


NO
TRESPASSING
WETLANDS
HABITAT
EXPERIMENT

Maintaining the Islands at Anchorage

- It quickly became apparent that the first challenge of Lake Elsinore during March was the wind. We had installed plastic fencing on the 90’ Island but it also became apparent this would be contra-productive to the likely fact that the Islands would have to be tended from a work boat while at anchorage to repair wind driven wave damage. The other Islands were not fenced and eventually the fence had to be removed from the 90’ Island for that reason.

Wind Driven Waves Toss Island in Surf

Islands Balanced & Redressed After Wind Storm Waves

Pelicans Invade and Occupy Islands

Biohaven Floating Island Project for Lake Elsinore

Paradise Lost


WETLANDS
HABITAT
EXPERIMENT

Biohaven Floating Island Project for Lake Elsinore

FORM FOLLOWS FUNCTION

Wood Structure and Rocks to Protect Plants

Wood Structure and Rocks to Protect Plants

Biohaven Floating Island Project for Lake Elsinore

Restoration Report

Bio-Mimicry of Natures Systems

- Create Habitat for plants and small waterfowl by adding structure such as tree limbs and brush.
- The structure is built to serve several purposes. As a structural base which adds counter balance to the outer edges, helps control erosion and protects plants. Layers of brush can be fastened to this base to further protect plants and small inhabitants of the Island.


ASSING
LANDS
BITAT
RIMENT

Elsinore Storm Island Replacement

- During an extreme Spring storm and wave event in April, the small Island already inundated with Pelicans finally gave way to these extreme stresses and ripped in half.
- The Islands are warranted by the manufacturer for 2 years.
- The replacement Island is an upgrade with 2 additional layers and an integrated Geo-Grid for rigidity and strength. This Island is expected to handle whatever stresses occur in the Big Cove of Lake Elsinore.

Bio-Net Erosion Control

- The Elsinore Storm Island model upgrade incorporates a covering made of Bio-Net erosion control blanket made of 100% Coco fiber and Jute netting with a wildlife friendly Leno weave.
- The outer edges if the island received an extra layer with planting mix in between as well as on top of the Bio-Net. This is expected to help control the erosive effect of waves and wind and keep the planting mix in place.


KNOWING


Operations
CF 0008 TR

One week later

- The Storm Island was upgraded with full habitat protection brush structure installed before the launch.
- One week after the launch I returned to do watering maintenance on the islands when I discovered a beautifully hidden Duck nest with 8 perfect eggs.
- A few days later I returned and photographed the well camouflaged Duck on the nest.

Biohaven Floating Island Project for Lake Elsinore

Pelican Island Report

How to Repel a Pelican Invasion

- One of the most beautiful birds in the world and among the largest.
- Pelicans love to flock together and loaf. They can completely cover an Island and cause it to take on water.
- Pelicans like flat open spaces and don’t like uneven, vertical obstacles such as sticks, limbs and brush. They will mostly avoid the structure placed on the islands and congregate in open spaces if there are any.

Biohaven Floating Island Project for Lake Elsinore

Paradise Restored

Island Restoration Plan

- Following the objectives of protecting the plants and providing multi-species habitat, the Island restoration plan takes shape.
- Methodical addition of structure and the replacement and nurturing of plants until well established is the formula of success being employed.
- Large areas where the Pelicans ripped off the burlap covering will eventually be covered with Bio-Net to protect the matrix and support flora.

Biohaven Floating Island Project for Lake Elsinore

Flora and Fowl Report

Plants are returning to life

- After creating some protective structure and replacing many dead and washed out plants, the Islands are beginning to green up. The Pelicans still visit in small numbers but do not occupy the Islands and flatten the plants as before.
- Ducks and other birds are the primary users being observed on the the islands.

Biohaven Floating Island Project for Lake Elsinore

Paradise Preserved

Adopt an Island

- It has been the pleasure of Stinnett Enterprise to provide the Islands and services necessary to establish the continued presence of Biohaven Floating Islands for habitat and water treatment wetlands in Lake Elsinore.
- In this spirit, Stinnett Enterprise would like to volunteer it’s continued upgrade and maintenance services to get the Islands well established.
- We wish to establish a volunteer program for others interested in contributing to the Islands continued wetland and habitat development and maintenance.

Adopt an Island Program

- Stinnett Enterprise has made a proposal to establish an “Adopt an Island Program”.
- Their would be several elements to the program. Supporters could give money or volunteer services to the program. Legal structure will be provided to allocate the program.
- The “Island Steward Program” would incorporate several disciplines, such as watering and plant maintenance, documentation and testing, building and maintaining habitat.

Biohaven Floating Island Project for Lake Elsinore

Balance and Nature

Working With Nature

- Understanding the balances and perimeters dictated by Nature is to understand the underlying elements of cause and effect in any given situation including economics.
- Lake Elsinore is a beautiful body of water and it's inhabitants are prolific and among the most diverse and interesting on the planet. "Beauty is in the eye of the beholder" they say.
- My vision for Lake Elsinore is cleaner water, good fishery, safe productive habitat for waterfowl.
- Boating and water sports enthusiast, fishing and wildlife interest, birding clubs and eco tourist can all have a vested interest in the future of Lake Elsinore.

End Of Summer Observations

Island Plants That Survived

Structural Observations

- There is evidence that water fowl have been billing and pulling the fabric of the matrix all around the perimeter of the two 150’ Islands.
- This has caused significant erosion undermining the structure.
- Fearing Failure is eminent I call the company for warranty replacement.
- Floating Islands West bring two new ruggedized Islands for replacement, in December.

Winter Solstice 2010

- I planted and prepared the new islands for launch from the levee, however rain and other conditions prevented a timely launch. Heavy rains were rapidly raising the lake level.
- There was a full moon and a 100 yr full eclipse of the moon that seemed to trigger a wild wind and rain storm that devastated the lake and all the Islands except the 90’ Storm Island.
- The new Islands will be replanted and launched in the spring.

Examining Cause and Effect

Every new solution creates a new set of problems!

Conversely

Every new problem creates a new set of solutions!

Causative Factors

- Large birds such as Pelicans negatively impact small Islands
- Waterfowl forage the edges of unprotected Islands doing damage to the matrix
- It is difficult to maintain edge plants and a covering due to wave washout and erosion
- Lake Elsinore Islands need to be designed for max strength and protection to prevent failure.

Curative Factors

- Lake Elsinore needs a large heavy duty Pelican Island designed especially for these beautiful birds. It would be covered with gravel and have a few protected places for rugged plants. This Island would support several hundred Pelicans and process hundreds of pounds of waste per day reducing the effect of raw nitrogen and phosphorus entering the lake directly.

Curative Factors

- Based on the Hypothesis that the Pelicans would be happy to stay on their own Island, this would make plant life easier and better on the general habitat Islands that are fully planted.

- For the best results of establishing plants and a live surface covering on lake Islands, the Islands could to be placed in a protected aquatic nursery environment for a few weeks, until roots take hold.

Most Notable Biohaven Projects

- Singapore
- New Zealand
- Alaska
- Montana
- Oregon
- California
- There are over three thousand Islands in projects around the US and the globe.

Singapore Project

Integrated Uses Of Biohavens

- Living Docks, Floating Walkways , Science Islands
- Islands may be constructed to almost any size
- Islands may be constructed to any design or use
- Passive Islands need natural circulation
- Active Islands power air/water thru Matrix
- The Leviathan 8,000 gal pr min/adjustable pickup tube
- Numerous bird and fish habitat configurations and uses
- Floating Fish Spawning Rack with Fry protection
- Waste Water lagoon remediation and polishing
- Hyper accumulator plants fine tuned to facilitate undesirable element removal at treatment facility or on site wherever specific pollutants are accessible in water.

The Leviathan System

Leviathan®

Bringing Dead Zones Back to Life

It will take a monster to eat a dead zone.

Introducing Leviathan:

- Processes throughputs of up to 8,000 gallons per minute
- Pulls from any depth
- Provides the complete "wetland effect", including aerobic, anaerobic and anoxic microbial nutrient conversion
- Digests benthic-zone carbon deposition
- Operates via grid or off-grid power

Leviathan provides sufficient, concentrated wetland effect to contend with large, nutrient-rich, stratified bodies of water, otherwise known as dead zones, in both freshwater and marine settings.

A standard Leviathan provides over a million square feet of wetland surface area. When combined with circulation provided by a highly efficient low pressure, high volume pump, this wetland machine can move huge volumes of nutrients - nitrates, phosphates and ammonia - as well as carbon into and through the food chain. Without this wetland effect, these same nutrients accumulate in aquatic benthic zones, resulting in stratified water devoid of oxygen.

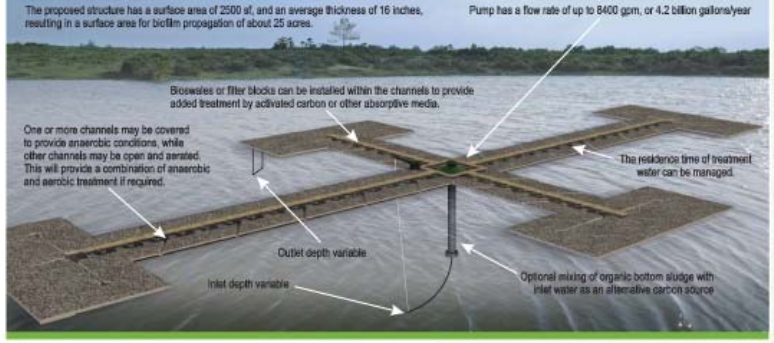
FLOATINGISLANDINTERNATIONAL®

Leviathan®

Bringing dead zones back to life.

With 2500 ft² of top surface and a designable through-the-pump flow rate of up to 8400 gallons per minute, this "wetland workhorse" runs like a machine to expose both point and non-point source nutrients and other contaminants to over 1,000,000 ft² of BioHaven® Floating Treatment Wetland surface area. This high-performance design represents today's state-of-the-art culmination of wetland biomimicry.

A Workhorse of Cutting-Edge Green Technology



As water is drawn into Leviathan's inlet pipe, water from other locations within the waterway will move in to fill the void. Similarly, as water is discharged from the outlet of the system, water will be pushed away from the discharge zone. The flows that do not pass directly through the system's pump are called "induced currents". These currents result in relatively large-scale and slow moving circulation patterns that provide additional vertical and horizontal mixing of the water. The magnitudes of the induced currents are dependent upon site and system specifics, and they can commonly be several times greater than the flow rate of water that goes directly through the pump.

- *If 1,000,000 ft² of wetland surface is not enough to biomediate your nutrient challenge, the Leviathan is modular and can be readily scaled up.*
- *The Leviathan's internal, low pressure, high volume pump system can operate either off the grid or on the grid.*
- *A Leviathan system can be paired with conventional BioHaven Floating Islands. This combination will result in an optimized floating wetland that will enhance fish, wildlife, and native macrophytes while cost-effectively cleaning massive volumes of water.*

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Living Docks and Walkways

Tern Habitat Use
Summer Lake Oregon


Photo provided courtesy of Bird Research Northwest


Photo provided by Bird Research Northwest
www.birdresearchnw.org

Caspian Terns on BioHaven Floating Island (Dutchy Lake, Oregon)
Photo Courtesy of Bird Research Northwest (www.birdresearchnw.org)


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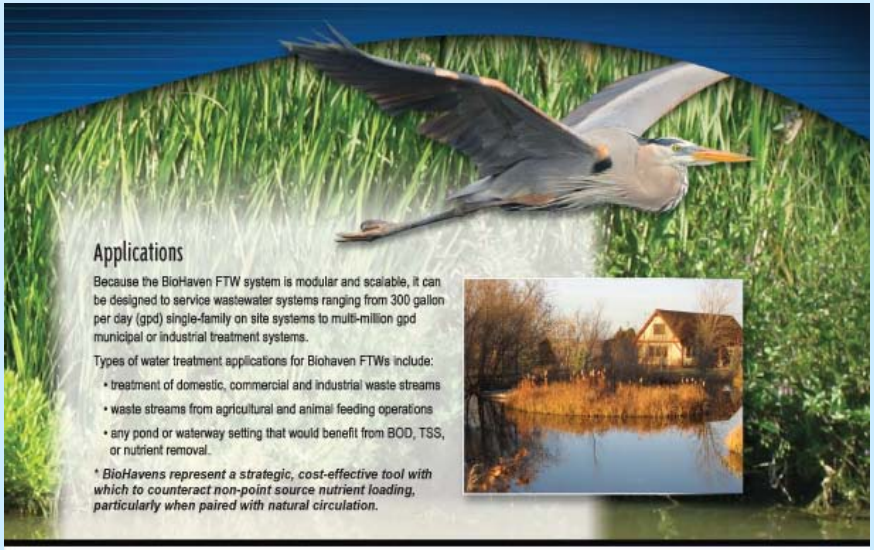
Uses In Waste Water Lagoons



Applications

Because the BioHaven FTW system is modular and scalable, it can be designed to service wastewater systems ranging from 300 gallon per day (gpd) single-family on site systems to multi-million gpd municipal or industrial treatment systems.

Types of water treatment applications for Biohaven FTWs include:

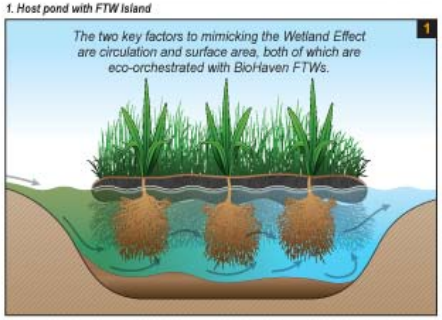
- treatment of domestic, commercial and industrial waste streams
- waste streams from agricultural and animal feeding operations
- any pond or waterway setting that would benefit from BOD, TSS, or nutrient removal.

** BioHavens represent a strategic, cost-effective tool with which to counteract non-point source nutrient loading, particularly when paired with natural circulation.*

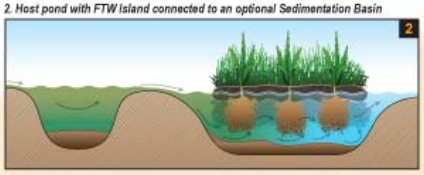
How a Floating Treatment Wetland works

A FTW consists of emergent wetland vegetation growing on a mat or structure floating on the surface of a body of water. The plant stems remain above the water level, while their roots grow down through the buoyant structure and into the water column. In this way, the plants grow in a hydroponic manner, taking their nutrition directly from the water column. Beneath the floating mat, a hanging network of roots, rhizomes and attached biofilm is formed. This hanging root/biofilm network provides an active surface area for biochemical processes, as well as physical processes such as filtering and entrapment. Thus, the general FTW design objective is to maximize the contact between the root/biofilm network and the polluted water passing through the system.

1. Host pond with FTW Island



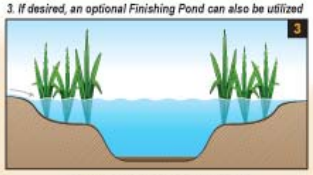
2. Host pond with FTW Island connected to an optional Sedimentation Basin



OPTIONAL SEDIMENTATION BASIN
(course sediment removal)

FLOATING TREATMENT WETLAND
(removal of fine particulates, metals, denitrification)

3. If desired, an optional Finishing Pond can also be utilized



OPTIONAL POND/SURFACE FLOW WETLAND
(final polishing and re-aeration)

BioHaven® Floating Treatment Wetlands (FTW) employ rooted, emergent plants growing through a floating matrix of recycled, non-woven polymer strands to treat wastewater biologically. This treatment occurs as a result of both plant and microbial nutrient uptake.

Versatility and Sustainability

The BioHaven FTW system
provides a concentrated wetland effect by utilizing a buoyant matrix mat (made from recycled plastic) and natural vegetation to mimic what occurs naturally in healthy wetlands around the world. In addition to BOD* and TSS* removal, FTWs can also significantly reduce nitrate, ammonium and phosphate in a waterway. Plants growing hydroponically through the mat utilize these nutrients, and treatment is additionally provided by aerobic and anaerobic bacteria colonizing on the expansive submerged surface area of the floating matrix and among the roots and rhizomes of the plants. The nutrient reduction provided by BioHaven FTWs makes this technology ideally suited for wastewater treatment in a wide range of situations, including those where advanced regulatory discharge permit limits must be met.

The benefit of providing nutrient removal in a wastewater treatment system is decelerated eutrophication, reduced oxygen-taxing nitrification, and reduced growth of nuisance aquatic plants in downstream waters.

BioHaven FTWs are extremely cost-effective when it comes to maintenance and operations. Since the root mass of the FTW vegetation remains fully exposed to the water, they have the advantage of being unaffected by fluctuating water levels that can submerse and adversely stress sediment-rooted vegetation of a conventional constructed wetland. This advantage allows BioHaven FTWs to be built at a fraction of the size of constructed wetlands (since a hydraulic buffer is not needed) while allowing similar treatment efficacy to occur.

Plants on this FTW grew to 8 ft high in one growing season (just imagine what the microbes are doing)!

BioHavens can be applied to new wastewater systems or by retrofit of an existing system. Construction of new FTW systems will include a host pond and island configuration. Retrofit of an existing pond, sewage lagoon, clarification basin, or waterway with the modular BioHaven is readily accomplished.

CUTTING-EDGE GREEN TECHNOLOGY

Don't let the elegant simplicity of these islands fool you. They represent the cutting-edge of the emerging Green infrastructure revolution. By mimicking natural floating islands to harness natural processes to clean our polluted water, they are biomimicry at its best. Independent research studies have verified that BioHaven FTWs effectively remove pollutants from a water body, including nitrates, phosphates, ammonia and toxic metals.

*BOD - Biochemical Oxygen Demand; TSS - Total Suspended Solids

Configurations

A treatment system consisting of BioHaven FTW can be configured in many different ways – as a supplement for an existing wastewater treatment system, in combination with a constructed wetland, or as a stand-alone treatment option.

Inlet facilities direct wastewater towards a strategically placed island(s) located within the host pond. The island(s) is either anchored to the floor of the pond or tethered to the bank. Effluent discharge facilities are installed and configured to maximize hydraulic detention time and clarification of the wastewater flowing through the pond (a multi-level discharge structure often provides the best quality effluent). The host pond piping is also configured to allow independent operation, or series and parallel flow if the system consists of multiple ponds.

The host pond and island(s) are sized to provide the desired level of wastewater treatment. Hydraulic detention time through the pond plays an important role in enhancing the ability of floating islands to provide BOD and TSS removal. The proper determination of island surface area and type of locally-adapted plants to be grown on the island is critical to the success of nutrient removal and/or removal of specific contaminants of concern.

Treatment Efficacy

Lab-scale testing of wastewater treatment efficacy is shown in Table 1 for BOD, nitrate, phosphorus, and ammonium removal per surface area of a BioHaven FTW Island. Sizing of the islands for particular applications are based on these lab results. The basis of design for the BioHaven FTW system is continuously being refined using the results of on-going lab testing and in-field pilot programs.

Table 1: Lab Scale Best Removal of BOD, Nitrate, Phosphate, and Ammonium

Contaminant	Removal Rate (mg/day/ft² island)
BOD	3,000[1]
Nitrate	759[2]
Phosphate	106[3]
Ammonium	759[4]

1 BOD removal extrapolated from preliminary COD lab testing (FW Run 38) using 0.5 times COD removal rates, using artificial wastewater (MSU recipe) with aeration. Temperature 19 degrees C.
2 Nitrate removal rate from tank testing (FW Run 23) using liquid fertilizer and molasses without aeration. Temperature 28 degrees C.
3 Phosphate removal rate from tank testing (FW Run 27) using liquid fertilizer and molasses with aeration. Temperature 25 degrees C.
4 Ammonium removal from test pond experiment (Run 34) using ammonium chloride, liquid fertilizer, calcium carbonate, and molasses. Temperature range 13 – 8 degrees C.

Design Examples

Design examples for treating wastewater using the FTW system from two scenarios are presented below. The design examples demonstrate the approximate sizing of the aerated host pond and floating island components of the BFI system for treating wastewater from a community of 200 and 1,000 persons. Both scenarios assume that the wastewater characteristics are consistent with untreated domestic wastewater with influent loadings as shown in Table 2. The design scenarios assume that the treatment parameters of concern are primarily nitrate, where effluent limits require a 60-percent removal of nitrate; and BOD, where secondary treatment, or an 85-percent BOD reduction, is needed.

Table 2: Influent Wastewater Loadings for 200 and 1,000 persons

Population	Inflow Rate (gpd)[1]	BOD Loading (lbs/day)[2]	Nitrate Loading (lbs/day)[3]	Phosphorus Loading (lbs/day)[4]	Ammonia Loading (lbs/day)[5]
200	16,000	40	6.7	1.4	3.3
1,000	80,000	200	33.4	7.0	16.7

1 Assumes a per capita wastewater flow of 80 gallons per day
2 Assumes a BOD influent concentration of 300 mg/l
3 Assumes a nitrate influent concentration of 50 mg/l
4 Assumes a phosphorus influent concentration of 10.5 mg/l
5 Assumes an ammonia influent concentration of 25 mg/l

The focus in the design examples below is to demonstrate the sizing of the floating island and aerated host pond needed to provide the desired wastewater treatment. Inlet, discharge, and piping facilities and appurtenance are not highlighted here but would also be a part of the BioHaven Floating Island system. The treatment ponds would generally be rectangular configurations with pond length approximately two-times pond width.

Table 3 shows the island size needed to provide 60-percent removal of the influent nitrate and shows the corresponding BOD and phosphate removal by the island with a surface area sized to satisfy the nitrate treatment requirements.

Table 3: BioHaven Floating Island Area for 60% Nitrate Removal

Treatment System Population	Removed Nitrate Load (lbs/day)	Req. BioHaven Island Area for 60% Nitrate Removal (lbs/day)	Island Removed BOD (lbs/d) % of influent	Island Removed Phosphate (lbs/d) % of influent
200	2.64	1,578	10.41/26	0.37/26.3
1,000	13.20	7,889	52.06/26	1.84/26.3

Table 4 shows the required sizing of the aerated host pond and aeration capacity to provide the balance of the BOD remaining after island treatment to achieve 85-percent BOD removal.

Table 4: BioHaven Floating Island Treatment System Sizing

Treatment System Population	Required Detention Time (days)[1]	Host Cell Working Volume (Mgal)[2]	Treatment System Footprint (acres)[3]	Aeration Capacity (HP)[4]
200	11.4	0.18	0.10	2
1,000	11.4	0.91	0.53	7.5

1 Detention time needed for balance of 85-percent BOD removal plus one day hydraulic detention time for quiescent settling zone. Reaction Rate coefficient assumed to be 0.06/day at 14 degrees F (1 degree C).
2 Working volumes as calculated from nominal operating depths of between two-feet and 15-feet for aerated cells.
3 The total footprint of the ponds assumes three to one side slopes, three-feet of freeboard, and a 10-foot wide driving dike around the perimeter of the pond.
4 Aerator requirements equal to 5 horsepower per million gallon treatment pond volume, and/or ability to provide a minimum 2.0 mg/l dissolved oxygen concentration measured two-feet below the water level.

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Demonstrating Treatment of Landfill Leachate using Floating Treatment Wetlands

Project Location: McLean's Pit Landfill, Town of Greymouth, South Island, New Zealand

These floating treatment wetlands (FTW) were the first field-scale application to demonstrate the capabilities of Floating Island International's patented FTW technology to improve quality of landfill leachate. Constructed of post-consumer polymer fibers and vegetated with native plants, FTWs mimic the ability of natural wetlands to clean water by bringing a "concentrated wetland effect" to any water body – in this case, several treatment lagoons (ponds).

Overview: Landfill leachate is a problematic water stream to treat in New Zealand and worldwide. Greymouth is a town of approximately 3,000 people on the South Island. The town identified a need for improved treatment of its municipal landfill leachate, which is a dilute stream because of the area's extremely high annual rainfall (3.5 m or 140 inches).

Because of limited funding, lagoon improvements are being implemented in three stages. In Stage 1, whose initial results are described below, 288 m2 of FTWs were constructed to cover approximately 20% of the lagoon surface in half of the lagoons. In Stage 2, another 288 m2 will be constructed in the other half of the lagoons. In Stage 3, media for biofilm attachment will be added to the primary treatment lagoon that precedes the other lagoons, along with improved aeration, for enhanced nitrification (ammonia removal). The wetland plants being utilized are *Carex virgata* and *Cyperus ustulatus*.

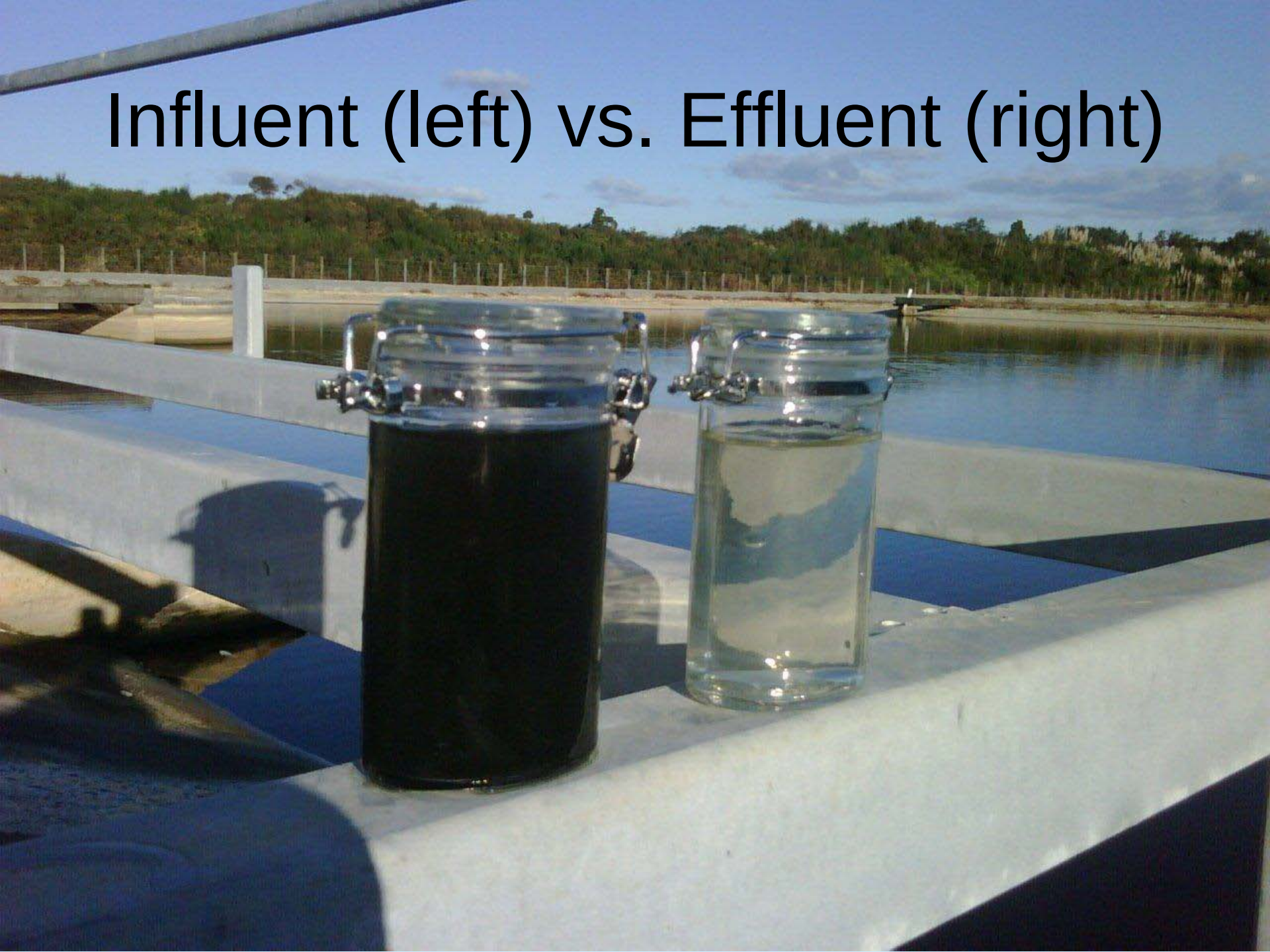
Results: Removal of total suspended solids (TSS) and color has been exceptional, as shown in the results table and first photo. The FTWs are also significantly removing total nitrogen and BOD. Operational data and detailed water quality data are still being collected and analyzed.

Installation Data	
Location	Greymouth, South Island, New Zealand
Parameters Studied	TSS, total nitrogen, BOD
System Type	Lagoon
Floating Treatment Wetland Size	A total of 288 m^2; each of three ponds contains eight modules with 12 m^2 of surface area
Water Source	Landfill leachate
Installation Date	November 2009
Flow Rate	Variable, with highest flows in the winter (rainy season)
Water Body Depth	0.6 m (2 ft)
Water Body Area	Each pond is 40 m x 12 m (131 ft x 39 ft). There are six ponds, with FTW modules in three of them.
Installed Cost	Confidential

Operational Data
Not yet available.

Results		
Parameters	**Floating Island Removal Rate (mg/day/ft^2)**	**Improvement Compared to Pre-Floating Treatment Wetlands**
TSS	160	89%
Total Nitrogen	2000	40%
BOD	685	46%

Influent (left) vs. Effluent (right)




2009/12/12

Integrated Green Solutions

- Identify Need
- Cost effective offset opportunities
- Cooperative overlap
- Cooperative funding
- Green Is Good PR
- “It takes a village” and the support of community leaders and stake holders to effect and maintain positive change.

The Ball Is In Our Court

- This board and stake holders are those in the lead and it is up to us to engage with past, present and future right now. The Earth is sending messages out in the form of climatic change, quakes and huge tsunamis but nothing compares to the damage we inflict on ourselves by clinging to bad practices. By diligently seeking the Critical Path we will be able to move forward. That path should be flanked by ever greening technologies as we proceed to the future. Integrate Living Green Technology Now!

Biohaven Floating Islands

- Natural Wetlands are nature's remediation of flowing water and nutrients from the watershed to lakes and oceans. Constructed Wetlands are Best Available Technology when available land and construction cost are very low. For many applications there is an Emerging Biology Platform being applied directly to the Recipient Water Body as a Floating Treatment Wetland Habitat, therefore the Biohaven Floating Island Technology qualifies as A **B**est **A**vailable **T**echnology and should qualify for **M**aximum **E**xtent **P**racticable standards as well.

Biohaven Floating Island Technologies

- Modular
- Scalable
- Movable
- Adjustable
- Designable
- Tunable
- Green Technology that Beautifies and Enhances the Aquatic Environment in a Multitude of Ways.

Engage In Creative Dialog

- The purpose of this presentation is informational and I hope was interesting.
- The goal is to engage with this Board in constructive dialog about how to incorporate Biohaven technology into Phase two Alternatives. I would like to have a follow up presentation at a subsequent meeting and introduce you to Floating Island West CEO, Laddie Flock. Laddie can share details of other projects and address many issues that might help us proceed.

Team Work Is The Answer

- By June when the outlines for projects are to be submitted, we would like to propose several specific plans of action especially for Canyon Lake. Stinnett Enterprise and Floating Island West would collaborate on the projects so there would be no gaps in communication or performance factors.
- Cooperatively we can all make the difference creating successful projects.