## CALIFORNIA COASTAL COMMISSION

45 FREMONT, SUITE 2000 SAN FRANCISCO, CA 94105-2219 VOICE AND TDD (415) 904-5200 FAX (415) 904-5400



# Th9a

# 9-18-0163 (CARLSBAD AQUAFARMS, INC.)

# MARCH 7, 2019

# **APPENDIX B**

Request for after-the- fact authorization and permit of Carlsbad Aquafarm facilities and operations as disclosed and delineated in the following detailed project description:

#### **Project Description**

The following is a comprehensive description of all aspects of the Carlsbad Aquafarms facilities and operation in and adjacent to the Agua Hedionda Lagoon in Carlsbad, California.

*In-water operations.* The following is a detailed description of the in-water equipment and activities associated with the Carlsbad Aquafarms operations in the Agua Hedionda Lagoon.



In the 55-acre outer pool of the Agua Hedionda Lagoon, located within a 5-acre grow-area as specified in a license agreement between NRG Energy and Carlsbad Aquafarms, Inc., (CAF) and permitted by the California Departments of Fish and Wildlife and Public Health, CAF has deployed 25 rafts for cultivating shellfish, Pacific oysters (*Crassostrea gigas*) and Mediterranean mussels (*Mytilus galloprovincialis*) in suspended culture in the following configuration:

*Floating Oyster Rafts.* Nine (9) 157'-long oyster rafts, in which each raft consists of 150 ball floats rigged in three longlines of 50 ball floats attached in 3' intervals on 5/8" marine grade rope, terminating at 20' spreader bars at each end. Two 75' anchor lines extend from the two terminal ends of the spreader bar to submerged 55-gallon inert, concrete-filled plastic drums, weighing 1,100 pounds. Each anchor is fitted with a pencil float to designate its location. Each ball float supports (10) 24" x 24" x 4" oyster trays with a stainless-steel center post with flat, circular base plate at the bottom and eye-hook at the top to secure the stack of trays to their respective ball float. Each tray holds approximately 100 market-sized 2.5" – 3.5" oysters. The oyster tray stacks disassemble quickly when out of water for harvesting.

*Oyster Grow-Trays.* 24" x 24" x 4" oyster trays are manufactured by DarkSea Industries for the shellfish aquaculture industry and distributed worldwide.



*Oyster Tray Stacks.* Oyster trays stacks are secured with a stainless-steel center post with flat, circular base plate at the bottom and eye-hook at the top attached to ball floats that are rigged on oyster raft longlines.





*Oyster Raft Ball Floats, Grow-trays and Spreader Bar (Photo Courtesy San Diego Union Tribune)* Lagoon water quality and clarity is substantially improved by 500 MGD of shellfish filtration.



Profile View of Carlsbad Aquafarm Oyster Raft Ball Floats in Agua Hedionda Lagoon



Fuzzy Rope





*Oyster Ball Floats, Mussel Barrel Floats and Spreader Bars at Carlsbad Aquafarm, (Photo courtesy of the San Diego Union Tribune).* Carlsbad oyster ball floats and mussel barrel floats have become one of the largest roosting sites for Brown Pelicans and Double-Breasted Cormorants outside the Channel Islands in all Southern California.



#### Mussel Cultured on Growout Rope

Mediterranean mussels are cultured on 10'-long ropes suspended from longlines supported by hundreds of barrel floats rigged on 14 mussel rafts anchored in the Agua Hedionda Lagoon. Approximately 1500 pounds of mussels are harvested weekly at the Carlsbad Aquafarm and locally distributed to popular restaurants and seafood markets, such as Whole Foods in San Diego and Orange Counties. Water clarity is substantially enhanced by shellfish filtration ecosystem services.



Mussel Harvest at the Farm, (Illustration by Thomas Grimm)



Our mussels are harvested in the morning by our seasoned crew working on a 32' x 18' barge fitted with 2-ton hydraulic crane and 250hp Mercury outboard. Longlines holding grow-ropes, heavy with mussel, are lifted out of the lagoon and onto the barge. The crew strips the mussel from the grow-ropes and places them into 4'x4'x'4 totes, which are then transported ashore, unloaded and put through our declumping, washing and depuration process.



Mussel barrel floats in Agua Hedionda Lagoon

*Floating Mussel Spat Collector Lines.* Three 300' mussel spat collector longlines, each consisting of 150 ball floats, in which fuzzy rope is used to procure free swimming juvenile mussel larvae, which set onto the surface of the rope. After the larvae set onto the rope it is stripped from the collector lines and socked onto 10' cultivation ropes used for growout.



Mussel Spat Socking

The target size for socking mussels onto growout lines ranges from 1.0-1.25 inches

Biodegradable cotton mesh comes in a tube. The mussels are put in a hopped and sent to a sock that surrounds 10'-long grow-rope.

As the mussels grow and their byssal thread secures them to the grow-rope, the cotton sock slowly degrades leaving only mussels growing on the rope, where they can feed and grow effectively.

Pictured left, the farm crew foreman, "Freddy" offers hands-on training to "Robert," an intern enrolled at the nearby Mira Costa Community College in Oceanside. Five community college interns have become part-time and full-time employees at the farm.

Carlsbad Aquafarm is the only aquaculture operation in California that supports an aquaculture internship program in which students earn academic credit. Master students from San Diego State have also earned credit by working on extended research projects at Carlsbad Aquafarm.



*Harvest Barge and Crane Retrieving Oyster Trays for Tumbling/*. Carlsbad Aquafarm's 32' x 16' Barge, equipped with a 2-ton Crane and 350hp Mercury outboard motor, retrieves 25 stacks of oyster trays for "tumbling." Oyster tumbling is pictured below.





In the morning hours, shellfish are hoisted from the lagoon, brought ashore and placed into a tumbler - that rotates and sprays the oysters, just as waves naturally tumble wild oysters growing on shorelines. The tumbling process stimulates growth causing the oysters to become meatier.



Tumbling oysters in a spray of seawater cleans the shells, and facilitates oyster shells to form a deeper cup, which is more highly valued in the half-shell oyster market. The deeper shell holds more liquor and is meatier. Carlsbad Aquafarm oysters have the deepest cups of any oyster sold on the west coast.

*Carlsbad Aquafarm Shellfish Hatcheries.* The farm's oyster hatchery produces juvenile oysters for commercial production at the farm, restoration projects with the California State Coastal Conservancy and oyster research at USC. Oyster hatchery techniques at farm follow well-established best practices that are described in many industry publications, FOA aquaculture manuals and scientific research papers.



\*The Southern California Coastal Ocean Observation System (SCCOSS) managed my Scripps Institution of Oceanography operates a number "Burkelators," automated multiplexed seawater sensor arrays designed by Professor Burke Hales Ocean Ecology and Biogeochemistry at Oregon State University, measure seawater alkalinity, partial pressure  $CO_2$  in seawater, dissolved inorganic carbon, aragonite saturation, salinity, and water temperature in the Agua Hedionda Lagoon and other coastal locations.

*Shellfish Hatchery*. The farm hatchery includes a spawning equipment lab that is used for both oysters and mussels. Adjacent rooms include an algae prep room and algae inoculation and cultivation lab.



Pictured above and below, Carlsbad Aquafarm's Shellfish Hatchery. (Illustrations by Thomas Grimm)



*Seawater filtration.* Before it enters the hatchery, seawater is pumped into holding tanks where settling reduces turbidity. The plumbing is designed with a water filtration and treatment system consisting of a combination of sand filters, cartridge filters, and ultraviolet (UV) sterilization. The treated seawater is used for shellfish larval and algal production. Tanks for larval production are circular 250 gallons (946 L) tanks, fitted with bottom drains that allow the hatchery staff to drain water and sieve larvae. An in-floor drain system designed to handle the maximum expected water flow, keeps water off the floor. Shallow rectangular tanks with drain pipes are used to provide nursery space for juvenile oysters. Aeration throughout the hatchery is supplied by a blower dispersing air through overhead PVC piping and tubing to aeration hoses in production tanks.



Additional perspective views shellfish hatchery (Illustrations above and below by Thomas Grimm)



*Algal Culture Methods.* Carlsbad Aquafarms maintains pure algal strains in an incubator kept under standard controlled environment in an air-conditioned lab under strict hygienic control. The pure strain cultures are kept in 10-ml test tubes glass and 100-ml glass Erlenmeyer flasks - filled with 50 ml culture medium- and closed by a sterile stopper. Strain cultures are renewed every week. In the replication process, an inoculum of 0.1-0.2 ml from test tubes or 0.5 to 1 ml from Erlenmeyer flasks are taken from the best culture free of contamination, to inoculate three or four new vessels of the same size to start a new strain. The old culture is then either utilized for upscaling or is discarded. Strain culture vessels are stirred daily by hand, paying attention not to stir bottom debris up.



*Pictured above Christine Steinke, Carlsbad Aquafarm Hatchery Manger in the farm's microalgae lab (Photo courtesy San Diego Union Tribune)* 

*Protocol for test tubes replication.* Test tubes that show the best algal populations are selected and checked microscopically for contaminant organisms by use of a new sterile pipette for each sampling.

#### Standard Operating Procedure for each selected test tube:

- 1. Prepare four sterilized test tubes with cap on a stand;
- 2. Prepare 50 ml of sterilized seawater medium, enriched with the standard nutrients mix.
- 3. Fill each new test tube with 10 ml of seawater medium taken with a graduated pipette;
- 4. With a sterile 1 ml-pipette take 0.5 ml of mature culture from surface of selected test tube;
- 5. Inoculate 0.1 ml of the old culture into each new test tube; be careful to make the drops fall freely into the culture medium without touching the tube walls; with one hand open and close the tube cap; with the other hand handle the pipette; do not mix or agitate the tubes;
- 6. Discard the old culture, if not needed for other replicas, and clean the empty tube;
- 7. Record date and algal species on all new test tubes with a waterproof marker;
- 8. Place the newly inoculated test tubes on a rack in a shelf reserved to pure strain cultures.

*Carlsbad Aquafarm's Selective Breeding Program.* In 2016 Carlsbad Aquafarms joined forces with renown oyster physiologist Donal Manahan and oyster geneticist Dennis Hedgecock based at the USC Wrigley Marine Lab, in a project funded by the Waitt Foundation, to address the need to breed stocks that are resistant to virulent emerging diseases, such as oyster herpes virus (OsHV-1), which has devastated shellfish aquaculture industries in France, New Zealand, and Tasmania; the need to improve production efficiency in the face of competition for coastal habitat and the environmental stresses of growing human population, pollution, and global warming and the need for fast growing native oysters that are resilient to ocean acidification that can help restore native oyster beds in living shoreline bioremediation initiatives being initiated in vulnerable coastal regions of California. Ultimately the overarching goal is the development of high-performing shellfish for regional markets and secure a stable and sustainable supply of shellfish in a rapidly changing world.

The farm's breeding programs capitalize on decades of university-based research and integrate across biological levels, from molecules, to cells, the organism, and the culture environment, providing customized solutions across the spectrum of species and growing environments found along the Pacific coast of North America. The breeding program seeks to improve yield (growth and survival), resilience to environmental stresses and diseases, and other production characteristics, primarily by incorporating advances in crossbreeding and polyploidy into a proprietary broodstock development program. Most importantly, by making scientific breeding a commercially viable business, Carlsbad aquafarm will contribute to the long-term sustainability of shellfish aquaculture.

*Spat Bottle Nursey.* In partnership with USC Wrigley Lab, Carlsbad Aquafarm renovated a 600 sq ft algae production area to include a state-of-the-art oyster spat bottle nursery for growing oyster juvenile seed from post-setting to 2-3 mm size in in bottle upwellers made of 22" diameter plastic rings with mesh attached near the bottom, over which the seed are suspended by the upward flow of water. The nursery includes its own, independent seawater filtration and provisioning system and continuous algae batch culture tanks that feed the spat growing in custom upwelling bottles.



Above: USC Post-doc visits nursery to assess growth rate of next generation of hybrid seed.

Hybrid Seed Grow-out Area



*Hybrid seed are placed in custom grow-baskets in a designated area away from farm's grow -area. Aquaculture interns from MiraCosta Community College assist in basket deployment and cleaning.* 



Professors Manahan and Hedgecock inspect hybrid oysters



Farm Operations Manager shows successful grow-out results



Selected juvenile oyster growth rate far exceeds expectations. Selected oysters from this cohort will be used as next generation broodstock to advance long-term research goals.

*Wet Storage Facility.* Carlsbad Aquafarm's Depuration System serves as a wet storage area.

*Depuration System.* The Carlsbad Aquafarm's depuration system is an essential part of the facility's onshore operations. The Depuration system, as described below, conforms to the National Shellfish Sanitation Program, NSSP, a federal/state cooperative program recognized by the U.S. Food and Drug Administration (FDA) and the Interstate Shellfish Sanitation Conference (ISSC) for the sanitary control of shellfish produced and sold for human consumption. The purpose of the NSSP is to promote and improve the sanitation of shellfish (oysters, clams, mussels and scallops) moving in interstate commerce through federal/state cooperation and uniformity of State shellfish programs. Participants in the NSSP include agencies from shellfish producing and non-producing States, FDA, EPA, NOAA, and the shellfish industry. Other components of the NSSP include program guidelines, State growing area classification and dealer certification programs, and FDA evaluation of State program elements.

The Carlsbad Aquafarm's THE DEPURATION PLANT OPERATIONS MANUAL FOR A FLOW THROUGH DEPURATION AND RECIRCULATION FACILITY has already been provided to the California Coastal Commission.



Pictured left is a flow schematic of the depuration system operating at the Carlsbad Aquafarm. The design conforms to NSSP requirements and is approved by the California Department of Public Health which regularly conducts inspections of the system.



#### DESIGN SPECIFICATIONS OF DEPURATION SYSTEM

Depuration Tanks and Influent and Effluent Locations



The influent location into the depuration operation unit is designated from Aqua Hedionda Lagoon waters, or CAF's Growing Area.

The effluent location from the depuration tanks is designated at the Discharge Pond

#### Process Water System

The process water system, as illustrated above, contains a multiple step process.

- Influent lagoon water enters via pumps that can operate at 150 gallons per minute each
- Lagoon water enters sand filters that can operate at 150 gallons per minute each, and filters out particles at 16 μm
- Pre-process water enters cartridge filters that can operate at 165 gallons per minute each
- Pre-process water finally enters the UV system unit, which contained four large bulbs.
- Process water enters the tanks via spray head bars for depuration of shellfish product



Above: Aquafarm depuration tanks with 7-gpm seawater flow-through and aeration system activated.





Above left: Mussels in depuration. Above right: Empty depuration tanks. Below: Depuration trays holding oysters packed in mesh net. (Photos courtesy of the website "Much abo about fooding")



*Shellfish Containers*. All farm trays and containers used to hold shellfish meet the construction and materials as specified in Section .04 and Section .08 of the Model Ordinance Chapter XV of NSSP.

List of Equipment

- Potable water source for washing
- Mussel sorter to cull and wash
- Carts to hold product above ground
- Pallets to hold completed storage product in chiller



Above: Three intake pipes are deployed on a pier adjacent to the farm. Sparus pumps are used. Specifications regarding the pump's performance parameters are detailed below.

Seawater intake. The following is description of the type, capacity, location, intake rate, and screening for all seawater intakes used as part of onshore operations, including those for product cleaning and sorting as well as shellfish nursery and depuration operations: Three (3) pier-mounted 4-hp Sparus Pumps with intake pipes with 10 mm mesh filters. Intake rate of the pumps is 165 gallons per minute per pumps

*Seawater intake frequency:* As needed to fill orders and loading tanks with each new batch of harvested oysters and mussel (estimated at approximately 2-3 times a week, although there is seasonal variation).



Pumps used by Carlsbad Aquafarm for intaking seawater from the Agua Hedionda Lagoon are Pentair Aquatic Eco-Systems Sparus Pumps with Constant Flow Technology<sup>TM</sup>. Sparus pumps are 3hp, single-phase, 230V, 16 Full Load Amps, 1.32 SF, 3.95 SFHP, 50hz/60hz.

**Pump Features:** 

- Fully-programmable for any flow rate from 20–140 gpm
- On-board keypad for simple programming of desired flow rate
- 3 hp rating. 230V, single-phase, 50hz/60hz
- Ultra efficient permanent magnet TEFC motor
- 2" internally threaded NPT inlet/outlet ports and anti-blocking strainer

basket ensure maximum flow and efficiency

- Easy installation and trouble-free servicing
- IP55-rated enclosure for wet locations and harsh conditions

Sparus Pump with Constant Flow Technology(CFT) will always operate at the slowest speed required to achieve the user-established flow rate; the savings it provides is yours to keep! This pump delivers proven reliability thanks to its saltwater-rated stainless steel internal fasteners and highly robust mechanical seal. Sparus Pump with Constant Flow Technology is a self-priming pump, and it's also suitable for flooded-suction applications.

Approximate product dimensions: 23.4" L x 11" W x 12.6" H.

## Shellfish Harvesting Procedures Prior to Depuration

- 1) All shellfish product is washed and culled with potable water
- 2) Prior to placement into trays, the trays are cleaned and sanitized:
  - Remove slime, feces, and pseudo-feces from tray surfaces utilizing abrasive sponges and potable water with high pressure water
  - Spray entire tray with 100 to 200 ppm chlorine solution and allow to air-dray
  - Store trays in clean area
- 3) Prior to placement into depuration tanks, the tanks must be cleaned and sanitized:
  - Drain and empty tanks to be cleaned.
  - Remove slime, feces, and pseudo-feces from tank surfaces utilizing abrasive sponges and potable water with high pressure water
  - Spray entire tank with 100 to 200 ppm chlorine solution and allow to air-dray
  - Wait a minimum of 15 minutes before flushing all tank surfaces with process water. Clean off undersides and upper tier tanks. The undersides of tanks must not be cleaned if product is present in the bottom tier tank. Tanks must always be flushed just prior to refilling, to ensure all traces of chlorine solution are removed
  - Trays with no more than 30 lbs./dozen of shellfish product, are loaded into tanks
  - Process water from the spray head is turned on to fill the tank and rinse the shellfish at a minimum of 7 gpm (utilize flow gauge/meter to measure gpm)
  - All tanks are tagged with a harvest date, time and batch number for appropriate species
  - All information is placed in the Depuration Batch Sheet and Depuration Plant Performance Index

## Removal of Depurated Product from Process Tank

Purpose: To prepare depurated, cleared, and released shellfish product to the public. Frequency: As needed to fill orders (estimated 2-3 times a week) Procedure:

- Once the shellfish product from the designated batch, depurated for 44 hours or more, is cleared by the designated laboratory and released by CAF, collection from depuration may occur.
- The HACCP Time to Temperature Log is recorded to ensure all orders of shellfish are packed and chilled in under ten hours. The employee must record the ship date, customer, shellfish Batch, weight or count, the start time of pack and the end temperature within the 10-hour window. Temperature and Times are recorded on CAF-Form A. Product not measured within 10 hours, or product above 50 degrees at the 10-hour mark is marked as FAILED on the CAF-Form A and removed from packing and returned to the lagoon.
- Trays of shellfish product from tanks are removed and stacked on top of carts to provide clearance from the ground
- The stacked trays are washed with potable water to remove debris from product. Water drains into discharge pond.
- Shellfish are culled and graded to size for market
- Shellfish are placed in plastic mesh bags by weight (lbs.) or count(dz.) to meet the customer's specifications for the order
- CAF shellfish tags are also placed in the plastic mesh bags to designate batch number and process of completion date (Read: section 6.6 for specifics on shellfish tags)
- Packed shellfish product is placed on pallets located in the chiller to provide clearance from the ground

- If picked up from the farm by the customer or transferred via CAF employee, shellfish product in mesh bags are placed on ice, from a potable water source, concealed in CAF boxes, and placed in the chiller to maintain of temperature of 45 F or less
- If shipped to the customer, shellfish product in mesh bags, are placed into a plastic bag, transferred into an insulated container filled with adequate gel ice packs, and concealed in a box with required shipping labels
- All orders shipped or picked up are placed with a copy of the invoice and packing slip, and the CAF invoice is signed by the customer, if present.
- CAF delivers product in delivery van 3 times per week to local customers. CAF customers pick up product 5 times per week, in small delivery trucks on their existing pick-up routes.

Storage Areas and Facilities. CALAF has (1) 40', (3) 20' and (1) 10' intermodal shipping containers renovated to serve as a storage containers, for wax coating corrugate packaging, algae and shellfish lab materials, such as polyethylene bags and glassware flask and pipettes, aquaculture rigging materials, such as marine grade rope, and basic shop equipment and tools, including a drill press and drill bits, circular saw and blades, battery powered drills, hammers, wrenches, socket sets and various marine grade stainless steel nuts and bolts. Additional gear includes a battery charger, reciprocating saw, come along hoists and straps. The 10' shipping container is used to store gas and diesel fuel in plastic containers for powering boat motors.

*Floating Upwelling Systems.* Carlsbad Aquafarm has installed and operates three (3) custombuilt FLUPSYs (floating upwelling systems) that are used as part of the farm's oyster nursery. The FLUPSYs operate from mid-April through November. The 3 FLUSPY 20' x 7'6" docks are identical in design. Each FLUPSY is equipped with (8) 24" x 24" x 30" upwelling silos. A 3/4hp Powerhouse Ice-Eater pump is used to intake seawater which flows through each of the 24 FLUPSY silos.





Carlsbad Aquafarm FLUPSY docks and support boat (Photo courtesy of much ado about fooding)

Above 3 FLUPSY docks and aquafarm boat powered by 175hp Johnson outboard motor. Each dock uses 55-gallon drums as ballast to maintain proper dock draft for operating. Hoist pipes are anchored to the dock and are used to hoist and service oyster silos.



Carlsbad Aquafarm FLUPSY hoist and oyster silo. (Photo courtesy of San Diego Business Journal)

*Shellfish Nurseries.* As described above, Carlsbad Aquafarm has one oyster nursery, the USC Spat Bottle Nursery. operation onshore, also described above, the farm operates three (3) FLUPSY docks, each with 8 oyster spat silos.



Above: FLUPSY dock oyster silo being hoisted by Matt Steinke, Aquafarm Operations Manager. *Photo courtesy of the San Diego Union Tribune* 



Above: FLUPSY diagram illustrates upwelling method, in which a pump continuously "pulls" seawater through mesh screen positioned at the bottom of two oyster spat silos.

The farm operates a mussel nursery, which includes a 12' x 20' frame structure, plumbed with a washbasin and (8) 7.8' tall x 3' diameter fiberglass vertical cylinders. Fuzzy mussel spat rope is suspended in tank, which are supplied with microalgae to feed the spat.



Above: Mussel Spat Room with 8 fiberglass vertical cylinders used for setting spat onto fuzzy rope. Aeration tubes infuse the tanks with oxygen as part of the nursery life support system for the spat.



Above: Mussel Spat Room with 8 fiberglass vertical cylinders used for setting spat onto fuzzy rope.

*Market*. In California, black mussels are principally sold into the market as live product. Elsewhere in the world, mussels are packaged into a variety of other products: fresh frozen, cooked and frozen (heat-andeat), breaded for frying, and with different sauces. Carlsbad Aquafarm is exploring the market potential of developing and selling value-added products to expand its product line.

*Production Details*. Carlsbad Aquafarm production of mussels is by means of suspension culture. Suspension culture is accomplished using a floating raft system, as described above. Generally, the processes for production follows a path that begins with seed procurement, (wild recruitment and/or purchasing seed on rope), nursery production, socking for final growout, harvesting, processing, and packaging. These activities relating to farm production are described below.

*Seed Procurement.* Seed is collected by wild spat recruitment. The farm also purchases seed from Whiskey Creek, based in Tillamook, Oregon. When collecting wild spat, collector lines with fuzzy rope, or similar materials with high surface area, are set out when competent larvae are available mussel growout line. When larvae that settle on the lines reach appropriate juvenile size, they are stripped from the spat collection lines, cleaned and graded, and prepared for socking and attached to the final growout lines and transferred to the grow-out area and grown until they reach market size, whereupon they are harvested and processed as described below.



Above: Wild Set Mussels on a "Collector Line" supported by ball float. After collector lines are gathered by our crew, using the farm's harvest barge and crane, the lines are stripped, and the mussels cleaned and placed in "socks" and hung on mussel growout lines.



Above: Close-up of Mussel Collector Lines. Below: Agua Hedionda Lagoon Outer Pool Grow-Area







Mussels are loaded onto 1-ton totes and craned ashore and then transported by forklift to the farm's mussel declumper.





*Above: Unloading shellfish.* Oysters are unloaded from barge using a steel frame with pickpoint hooks which are attached to stacks oyster trays. Each stack holds ten trays, where each individual tray holds approximately 5-dozen market sized oysters.

*Below: Sorting Oysters* Trays hold considerably more juvenile oysters than market ready, mature adults. Young oysters are brought to shore, every 5-6 weeks for tumbling and sorting. Afterwards the juvenile oysters are re-trayed, restacked and returned to the growarea. It can take between 12 to 18 months for oysters to reach market size.





*Above: Mussel Declumper Station.* Post-harvest, mussels are placed into the hopper. A screw conveyor moves the mussel into the declumper where mussels, bound together with byssal threads, are separated. The mussels then move down a stainless-steel grating into the sorting and washing station where they are further separated, graded and washed. Below: farm hands sorting, grading and washing mussels in preparation for depuration.

To ensure shellfish stock are thoroughly devoid of biofouling, sediment, or other forms of contamination prior to placement in the depuration tanks they are thoroughly washed and cleaned







Above: The farm's mussel declumper. The declumper is manufactured by CMP, which excels at custom design, layout, fabrication, and installation of various stainless-steel food processing equipment. In addition, CMP offers a wide range of custom stainless-steel fabrication food processing equipment.

CMP holds a number design patents in food processing and is a lead player in mussel processing equipment globally. Carlsbad Aquafarm is working with innovative design and engineering firms such as CMP to design and develop the next generation of stainless-steel aquaculture and shellfish processing equipment that includes new controls and advanced instrumentation, as well as innovations in new process efficiencies, piping, and manufacture.



Above, the process of mussel spat socking. The farm's target size for mussel spat to be socked onto growout lines is in the 1.0-1.25"range. Socking uses biodegradable cotton mesh sleeves. The mussel spat sent down through a hopper and funneled into a cotton mesh sock with a central line, in dropper lengths of 10'. The socked spat lines appear much like a giant sausage. The cotton mesh wrap holds the small mussel spat until they can secure themselves to the central core growout line, as the cotton mesh slowly degrades and dissolves.

*Processing and Packaging.* The farm's standard operating procedures (SOP) in processing mussels, are washing, declumping, depurating, debyssing, grading, and quality control. Separate machines accomplish these tasks. Following washing and declumping, the product is placed in trays in the farm's depuration facility, and subsequently tested as described in detail above. Following a 42-hour depuration period, a batch sample is delivered to Allied Industrial Microbiology Laboratory (AIM Lab) in Vista, for testing, in accordance with NSSP and CDPH regulations. Once the lab results are received and the product is certified as safe for human consumption, the mussels are separated to individuals, of market size, and sent through a debysser machine where their byssal threads removed, and thoroughly cleaned. A quality control step removes mussel that are too small or have broken shells. Product making it into packaging goes through a second quality control step and evaluate breakage- loss rate of the processing equipment. Depending on the purchaser farm mussels are packaged in net bags of 5 or 10 pounds, and placed in larger, lined, wax-coated boxes filled with ice and kept in the farm's walk-in cooler until they are picked up by the buyer or delivered to the buyer.





Above: After mussels are washed, sorted and debyssed they are packed in 5 and 10-pound mesh bags





*Above: Onsite Office & Facilities.* The diagrammatic layout and Google Earth Satellite Image (Nov 8, 2016) show the site plan of the Carlsbad Aquafarm Office and Operation Facilities.





The farm office is in a 40' x 10' office trailer and includes three small offices and a restroom.





*Above: Carlsbad Aquafarm Office and Facilities, street view from service entry road.* Farm facilities from left to right include the following structures: Shellfish Hatchery and Wet Lab and Patio, Algae Prep and Incubation Lab, USC Oyster Spat Nursery, Crew Break Room, Tumbling Station (covered with shade canopy) delivery van (leaving with product) and farm office trailer.

*Below: In the left foreground the NRG/Poseidon Water Discharge Pond is shown.* On average, about 550-750 MGD of water is discharged into the pond and returned to the Pacific Ocean through a jetty channel on the southern end of the outer pool of Agua Hedionda Lagoon.



Above: The Discharge Pond and Twin-Box Culvert through which filtered effluent from NRG Power Station and Poseidon Water is released and returned to the Pacific Ocean, (adjacent to the South Carlsbad State Beach). Carlsbad Aquafarm depuration system discharges approximately 2500 gallons of triple-filtered (sand filter, cartridge filter and UV filter) seawater pumped from the lagoon and released back into the discharge pond each day, representing less than .000003% of the total amount of filtered seawater released into the discharge pond each day.



## Carlsbad Aquafarms' Aquaculture Equipment Installation and Maintenance Activities.

Carlsbad Aquafarms has continuously operated a mussel and oyster farm over the past 30 years by adherence to Best Practices in Suspended Shellfish Aquaculture. Oysters are cultivated by the suspension of mesh trays in deep water, at least 10' above the seafloor, where they are protected from predators, mud, sand and silt. Oysters are periodically tumbled to strengthen and shape their shells to form a deeper cup, stimulate growth and adds firmness to the meats. Which each successive tumbling the oysters are sorted by size and redistributed into additional trays to accommodate their growth and need for more room to grow. Details of oyster hatchery and nursery methods are described in detail in earlier sections of this document.

The farm's suspended shellfish aquaculture for oysters and mussels employs the floating raft culture method, in which longlines, secured to 55-gallon concrete-filled drum-anchors on the seafloor. The anchors were placed by crane from the farm's barge. Ropes from the anchors connect to floating 20'-wide spreader bars on the surface two (2) 10'-long sections of 10"diameter capped PVC pipe. For oyster rafts, spreader bars on either end of the raft are connected by three (3) sets of 5/8"-rope. For mussel rafts, nine (9) sets of ½"-rope on mussel sets. Buoys are braided into the connecting ropes to provide floatation. All rigging is done by hand on shore and deployed by the farm crew using the farm's 18'-skiff powered by a 175hp Johnson outboard motor. into the growing area. Illustrations, photographs and diagrams are provided in earlier sections of the document devoted to shellfish aquaculture methods.

The farm's shellfish aquaculture raft rigging, lines and buoys and inspected daily by the farm crew. This is possible because the farm is just 5-acres in size and furthest raft is less than 1000' from the farm's dock. Any floating debris that may have entered the grow area from the adjacent beach of inner lagoon

pools recreation areas are retrieved by the crew on the skiff and properly disposed of in the farm's dumpster. Raft lines, ropes, and buoys are repaired or replaced as needed. Trays are routinely power-washed during tumbling. Mussel lines are also washed, and any undesirable debris is removed and properly disposed.



Above. Brown Pelican perched on mussel raft spreader bar.

*Planting and harvest activities.* Planting takes place seasonally. Mussel season is the fall and winter, and oyster season is the spring and summer. Mussel planting consists of spat (small mussel) produced on shore in our hatchery or purchased from suppliers approved by California Fish and Wildlife. Spat lines (10'-sections covered with mussel spat) are transported to the growing area via the farm barge and tied onto the raft longline system by hand. After 3-to-5 months, the mussels will have grown to be large

enough to be re-tubed onto several suspended lines. Mussel seed lines are pulled out of the water by crane. Mussel is stripped from the seed ropes by hand and put into a bin. Bins are transferred to shore and mussel seed is re-tubed in the tubing machine. This lowers the bio-density to allow grow out to full market size. The process of mussel spawning, rope seeding, re-tubing, harvesting and processing is described above. Oysters are also spawned and cultured in house and are also purchased from certified hatcheries approved by the California Department of Fish and Wildlife. In cases where oyster or mussel seed is purchased from an outside hatchery an import certificate is obtained from California Fish and Wildlife. The farm's points of contact at California Fish and Wildlife are Dr. James Moore and Dr. James Ray. Records of all imported seed are maintained at the farm's office and CDFW.

FLUPSY silos are nurseries for oyster spat



When oysters reach  $3000\mu$  (3mm), the are placed into one of the 24 silos in the three (3) FLUPSYs (Floating Upwelling System) at the farm and grown out to 20-mm in size. Once this size has been reached, they are removed from the FLUPSY and placed into DarkSea oyster trays for grow out. Oyster trays are stacked vertically, in 10 trays-per-stack, and transferred from shore to barge by forklift and then transported from deck to water by barge crane. Oysters are brought to shore about every 5-6 weeks to be tumbled, cleaned, sorted and re-distributed into more trays based on size.



Above, Christine Steinke, Hatchery Manager, and Foreman, Freddy Hernandez inspect imported oyster seed

*Vessel and Equipment Repair and Maintenance.* Boat engines (barge and boat) are removed from vessel and repaired offsite at boatyard (Oceanside Marine and/or CalKona Marine). The Carlsbad 2015 Ford Transit delivery van is serviced offsite at local Carlsbad Ford service facility. Plumbing and electrical fixtures are serviced and repaired onsite by licensed contractors. Farm debysser, declumper and tumbler, are serviced onsite by the farm's crew. Crew repairs are limited to mechanical component servicing. Electrical components are serviced by licensed electricians. Pumps are serviced and cleaned weekly by crew. Water lines are cleaned via line pigging weekly by crew.

*Nighttime operations.* There are no nighttime operations at the Carlsbad Aquafarm.