

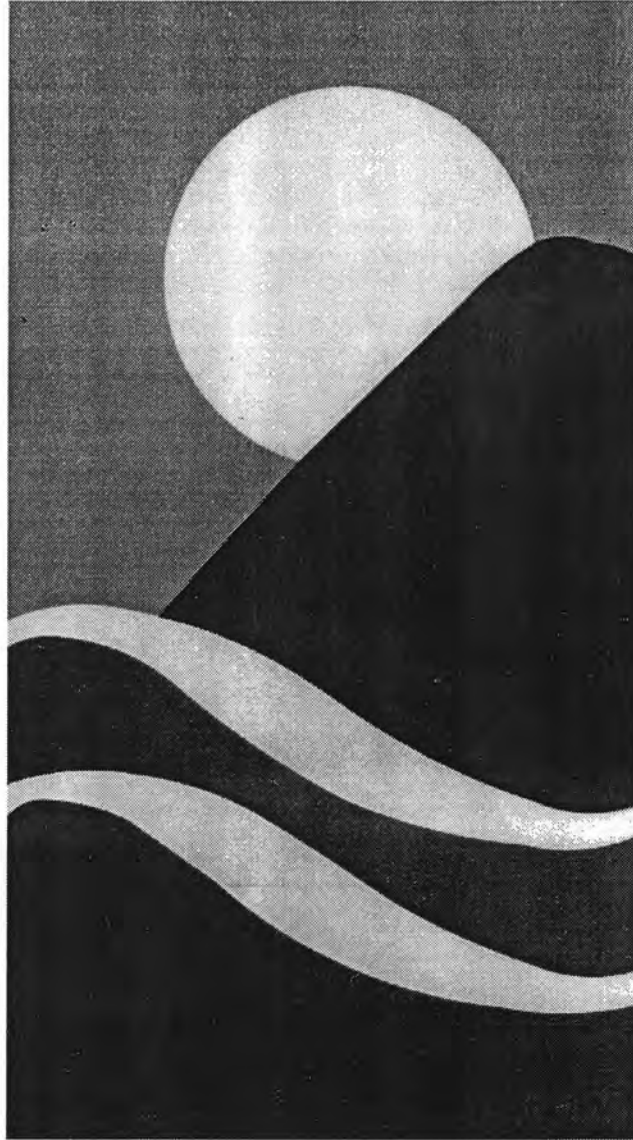


NATURAL ENERGY LABORATORY OF HAWAII
AUTHORITY

1997
Annual Report

Department of Business, Economic Development & Tourism
State of Hawaii

Best Available Copy



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A MISSION OF GROWTH



The NELHA Mission Statement is:

*"To develop and diversify the Hawaii economy
by providing resources and facilities
for energy and ocean-related research, education, and commercial activities
in an environmentally sound and culturally sensitive manner."*



A MISSION OF GROWTH



The WFLA Mission Statement is:

"To develop and expand the Florida economy
by promoting research, education and commercial activities
for energy and ocean-related research, education and commercial activities
in an environmentally sound, an ecologically sensitive manner."

MESSAGE FROM THE CHAIR

This has been a year of strong growth for NELHA. Governor Cayetano noted in his January 21, 1997, State-of-the-State address, "Our biggest challenge is to stimulate the economy and provide more jobs." NELHA's growth has addressed this challenge. The number of tenants increased by 8 percent, while land leased out to tenants increased another 30 percent. The number of people employed by tenants of the laboratory grew by 30 percent to 174. During this fiscal year, nearly half of NELHA's tenants expanded or requested options on additional acreage for future expansion.

The 18th Legislature passed two bills facilitating NELHA's growth. One permitted a retail concession and a tour-related facility to enhance financial support to NELHA and commercialization efforts at the HOST Park. The other expanded NELHA's purpose to include ocean-related research, technology, and industry. In line with this, and through the support of Senator Dan Inouye's office, the National Defense Center of Excellence for Research in Ocean Sciences (CEROS) was moved to NELHA in 1996. In FY97 alone, CEROS funded 16 technical projects for \$5.5 million. In September, an additional \$6.4 million in funding was released to CEROS for the Fiscal Year 1998 technology development program.



Diane Quitiquit

In addition to offering tenants the deep and surface seawater and the best insolation of any coastal location in the United States, NELHA offers businesses a strategic site within one mile of an international airport. This year, the Keahole-Kona International Airport expanded its services as the Kona International Airport, with direct service from Kona to Asia. Tenants now can take advantage of this aspect of international exporting at their doorstep. Cyanotech Corporation and Kona Cold Lobsters Ltd. of NELHA have already capitalized on this benefit.

In fulfilling the ongoing education mission, staff continues to offer a weekly public presentation describing the laboratory and its accomplishments. Approximately 1800 visitors attended these presentations this fiscal year. Also, the West Hawaii Explorations Academy (WHEA), operated through the Department of Education and Konawaena High School, continues its successful integration of school and work programs at NELHA. The September 1997 enrollment will increase to 80 students. This is a 40 percent increase!

The upcoming year is critical. The Board reviewed and approved numerous preliminary concepts for new projects during FY97, so new tenants are anticipated. Projects in the research compound are anticipating commercial expansion into the HOST Park area. Breaking ground in this area is significant. It indicates NELHA's advancement into a final development phase. Preparation is needed for duplication or expansion of NELHA to capitalize on the technological and scientific successes of the past.

The new millennium is fast approaching and the Natural Energy Laboratory of Hawaii is ideally positioned to provide for projects in ocean-related research, education, and commercial activities. I am proud to have had an opportunity to serve as chair of such a distinguished organization that lives on the cutting edge. As my tenure comes to a close, I would like to acknowledge and thank the committed tenants, dedicated staff, supportive community, and all of the others who work together towards the success of NELHA.

Diane S. Quitiquit
Diane Quitiquit
Chairman of the Board

MESSAGE FROM THE EXECUTIVE DIRECTOR

In April 1997 I assumed the role of Executive Director for NELHA. During the prolonged period of transition in leadership during FY97 prior to my appointment, the staff and Board of Directors of NELHA worked cohesively and persevered to maintain the facility's direction and focus while attracting new tenants. I am privileged to have joined this distinguished team of professionals and to participate in the forthcoming years of growth.

Growth at NELHA is measured by multiple means. In FY97 the total contribution of business development at NELHA to the state economy was \$13.6 million in gross revenues with 174 people employed by these private enterprises. We saw nine new business starts and additional expansion by several established tenants. All these contributions moved us closer to the long range goal of greater self-sufficiency for NELHA, a real challenge in these difficult economic times.



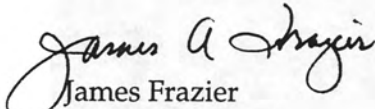
James Frazier

As stated in NELHA's Mission Statement, the charge of contributing to development and diversification of the Hawaii economy must be met with continuing growth of the facility. NELHA has successfully done so through FY97. The original 322 acres of NELH property created by state legislation in 1974 is now filled by a variety of flourishing businesses. Although there have been no tenants to date in the adjacent 550 acres of property at the Hawaii Ocean Science and Technology Park (HOST), future prospects look promising. Discussions continue with a number of businesses interested in exciting new projects here at Keahole. As a result, I am confident that HOST Park will see the initiation of a set of new tenant projects in the coming fiscal year.

To ready the HOST property for tenant occupation, proper permitting, utility infrastructure and expansion planning must be in place. Completion of the seawater system for the HOST Park properties is especially important so that prospective tenants can be assured of seawater delivery. Phase One of the required seawater system expansion was completed in FY97; Phases Two and Three will require further CIP funding. These and other aspects of facility development will continue to be advanced in FY98 to support the impending growth in HOST Park.

The downsizing of NELHA staff during FY96 due to statewide budget cuts meant taking a different approach to ongoing operations, maintenance and expansion in FY97 with fewer resources and a smaller operating budget. In the final analysis, the overall economizing was seen as a positive move in the eyes of the tenants who are naturally sensitive to the cost of operating this unique facility.

The Keahole site is blessed with many natural assets, infrastructure continues to improve, and the dedicated and talented staff are positioned to assist business and the public to make the most of these assets for the betterment of the community. We at NELHA look forward to meeting the many challenges that lie ahead as we move forth in FY98.


James Frazier
Executive Director



DIVERSIFYING HAWAII'S ECONOMY



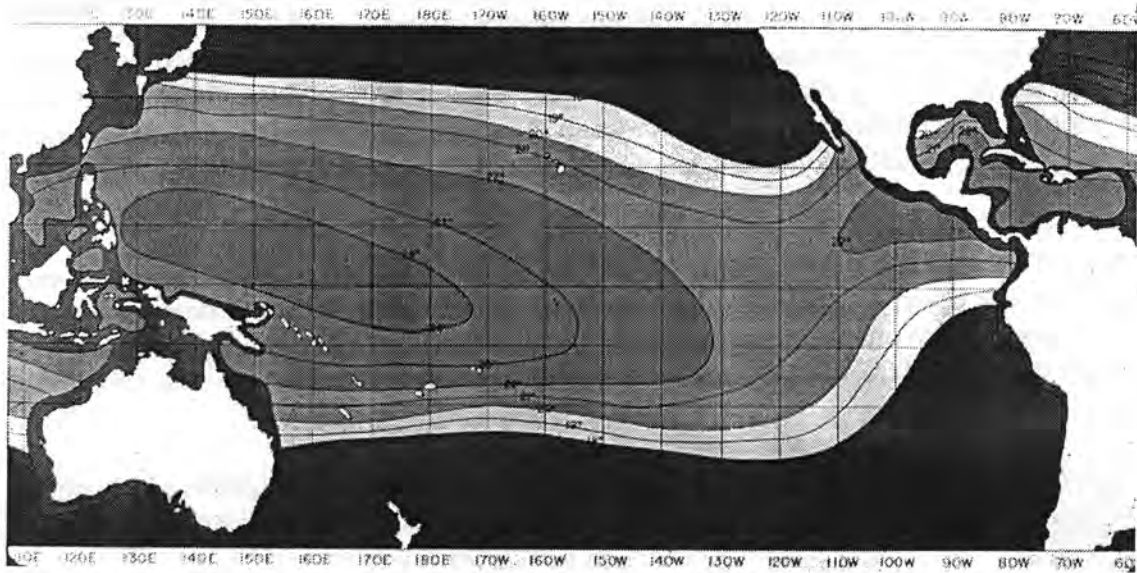
THE HAWAIIAN ECONOMY

DIVERSIFYING HAWAII'S ECONOMY

THE HAWAIIAN ECONOMY

FOSTERING ECONOMIC DEVELOPMENT

The mission of NELHA is to promote economic development and diversification by providing support facilities and infrastructure to its tenants who are utilizing the unique natural resources available at Keahole Point. The only facility worldwide which consistently brings ashore a continuous supply of both warm and cold seawater, NELHA offers its existing and potential tenants a unique setting in which to explore and develop ocean-related research, business and education ventures which capitalize on the findings of science and technology.



The gray shaded areas identify regions in the Pacific where "delta T" or the temperature difference between deep and surface seawaters is sufficiently great to make the OTEC concept feasible.

RESOURCES WHICH MAKE NELHA GLOBALLY UNIQUE

- **COLD DEEP SEAWATER (DSW)** is continuously pumped onshore from 2,000 foot depths just 6,000 feet offshore of the Keahole Point location. The steep slope of the ocean bottom offshore, typical of the bathymetry of geologically youthful islands such as the Big Island, allows close proximity to these deep ocean resources. DSW is available for use in ocean thermal energy conversion (OTEC) projects, aquaculture, coldwater agriculture, low cost cooling, and a host of other applications. The DSW is delivered to tenants at about 43°F (6°C), virtually pathogen-free, and rich in the inorganic nutrients essential to plant growth.
- **WARM SURFACE SEAWATER (SSW)** is also pumped onshore continuously, drawing from an inlet pipe located 600 feet offshore at a depth of 45 feet from the surface and 45 feet above the ocean bottom. The SSW is rated Class AA in water quality and ranges in temperature from 76° to 82°F (24.5° to 27.5°C) year 'round.
- **A LARGE TEMPERATURE DIFFERENCE BETWEEN SSW AND DSW** brought onshore makes NELHA ideal for development of ocean thermal energy conversion technologies. A broad band of oceanic waters in which these conditions exist circles the globe about 23

degrees of latitude to the north and south of the equator. Hawaii is one of the few locations in the developed world that is included in this geographic area near equatorial waters.

- **SOLAR INSOLATION** is consistently high at the NELHA site, with the rate of incoming natural sunshine ranked above that of any other coastal site in the United States. Rainfall is also low, less than 15 inches per year, maximizing days of clear, cloudless skies.

- **PROXIMITY TO AN INTERNATIONAL AIRPORT** allows tenants to export fresh product directly to Asian markets, as well as those of the continental United States and other countries. The Kona International Airport, with the addition of international flights and the appropriate supporting infrastructure, now links Kona directly to Asia. Prior to FY97 all Asia connections needed to be routed through Honolulu; now shippers can bypass this routing, saving valuable time, and sending perishable products directly to their destinations.

- **LOCATION WITHIN A STABLE POLITICAL CLIMATE** is a plus for any business venture weighing options at sites around the world. The access to both cold deep and warm surface seawater in one location, with a sufficient "delta T" to make energy production feasible through OTEC-related technologies, is not available elsewhere in a location as ideal as this.

- **LOCATION WITHIN A FRIENDLY COMMUNITY** is an added benefit to any business which establishes activities here. Schools, hospitals, and all the components of a highly



The Natural Energy Laboratory of Hawaii Authority (NELHA) combines 322 acres at the Natural Energy Laboratory of Hawaii at Keahole Point and to the north (left) with 550 acres of undeveloped property at the Hawaii Ocean Science and Technology (HOST) Park beyond the photograph to the south.

desirable place to live are here in this community. An added plus is the Hawaiian "Aloha Spirit" which is alive and well in Kona, bringing thousands of visitors here again and again from year to year.

APPLICATIONS TO SUPPORT ECONOMIC DEVELOPMENT

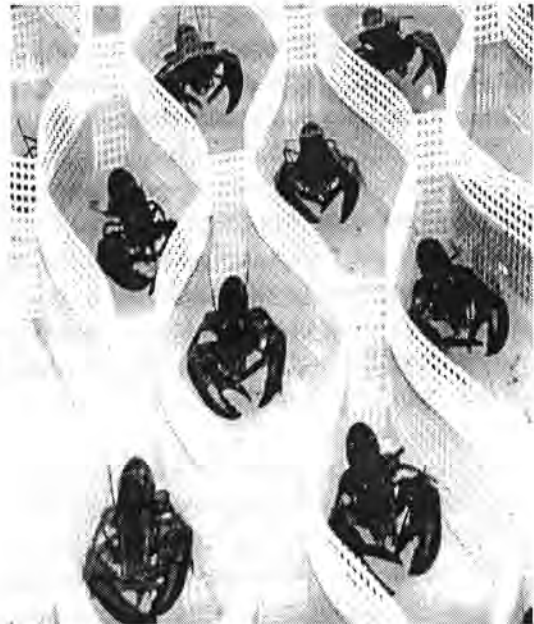
- **COOLING WITH DEEP OCEAN WATER** is a valuable, economically attractive application of the seawater resource at NELHA. One of the most cost-effective applications is for air conditioning. NELHA has saved more than \$15,000 each year in electricity costs since converting its air conditioning systems from traditional to seawater-based. Several NELHA tenants also take advantage of this technology which can be demonstrated using a simple combination of a recycled automobile radiator and a fan, with deep cold seawater as the coolant.

This concept has excellent potential for use where a cluster of developments can collectively be supplied with cold deep seawater from a central supply. The capital expended on such a project could be recouped over a relatively short period of time, making it extremely cost-effective.

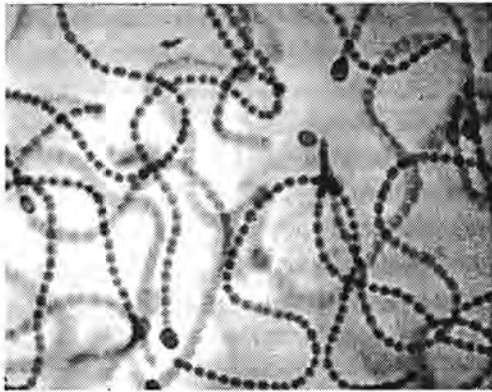
- **ALTERNATIVE ENERGY PRODUCTION** using natural resources is a concept which first inspired the creation of the Natural Energy Laboratory of Hawaii in 1974. Pioneering research on ocean thermal energy conversion components and technologies conducted here in the early years of the facility's development put Keahole on the world map as a leader in this area. Hawaii is located within the tropical band of oceanic waters in which the difference between surface and deep seawaters ("delta T") is sufficiently great to make OTEC an economically feasible energy production method.

The same intense sun that warms the surface waters around Keahole Point also provides a ready source of natural energy that can be converted into usable form through the use of other solar energy technologies such as photovoltaics. NELHA's Keahole Point location and low rainfall combine to make the site ideal for research and development of solar energy technologies.

- **AQUACULTURE PRODUCTS** were recognized as economically profitable co-products of the marine technologies being developed here early in the development of the NELH facility. Aquaculture takes advantage of the abundant supply of cold, clean, nutrient-rich deep seawater, warm surface seawater, and ideal weather



Animals that normally live in temperate climates can be grown in tropical Hawaii using NELHA's unique seawater supply.



Microalgae such as this blue-green algae grow rapidly in the sunny conditions at Keahole.

conditions to create optimum growing environments. Since the aquaculture industry is the fastest growing sector of the federal agriculture program in the U.S., aquaculture as a business is an attractive area of growth for businesses in Hawaii.

Many of the tenants at NELHA are involved in aquaculture enterprises, growing various species of high-value marine or aquatic plants and animals. It is a relatively new industry that is growing in importance as world fisheries are again feeling the pressures of over-harvesting. There will be a growing need for alternative sources to replace or supplement the "wild" catch in the future.

NELHA's unique resources are very well-suited for businesses that wish to capitalize on this market potential. From tropical reef fish culture in warm Keahole seawater to Maine lobster culture in the coldest of Keahole deep seawaters, any combination of temperature regimes may be used to create optimum growing conditions for plants and animals at no extra cost. This compares very favorably with costs of traditional chilling or warming technologies.

Microalgae, microscopic plants, grow extremely fast in idealized conditions that can be easily created at NELHA facilities. Over 30,000 different species have been identified, and only a few have yet been commercially developed, some of which are being cultured by businesses at NELHA. Products from microalgae include food supplements, pigments used in medical tagging and cosmetic products, natural fertilizers, organic mosquitocides, cancer-inhibiting drugs, and many others. Microalgae can also be a vital link in the growout of marine animals in the early stages of life when larvae are microscopic. Companies such as Taylor Resources, Inc. culture large amounts of microalgae to feed clams and oyster spat which eventually will restock clam and oyster beds in the ocean.

Macroalgae are larger marine and aquatic plants, sometimes known as seaweed or sea vegetables. These can be used for food, medicinal, and other purposes. Like microalgae, macroalgae can be grown optimally at Keahole Point, and a number of businesses at NELHA are taking advantage of this opportunity. The low rainfall rate of less than 15 inches per year makes growing marine



Tasty sea vegetables (macroalgae) thrive in mixtures of cold and warm seawater.

plants in onshore ponds or tanks more feasible since the possibility of rainfall dilution of the growing medium is greatly reduced.

- **MARINE BIOTECHNOLOGY** is a burgeoning industry which is just beginning to realize its vast market potential. Both pharmaceutical and nutraceutical products can be obtained through the mass culture of a variety of marine organisms. NELHA provides an ideal location for the development of such an industry, and NELHA-based companies such as Aquasearch Inc. and Cyanotech Corporation are already reaping the benefits of their research and development successes in this area.

- **COLDWATER AGRICULTURE** is a new area of development in which cold deep seawater is used to cool soil temperatures to create unique microclimates in a tropical coastal setting. Test crops at NELHA's Keahole facility have demonstrated immense potential in the manipulation of growing conditions for both temperate and tropical plants to increase and improve yield and shorten growing times. The late Senator Richard Matsuura used the term "blue-green revolution" to describe this new field of agriculture which combines "blue" (ocean) and "green" (agricultural) technologies. He likened it to the "green revolution" of agriculture which increased local production of land-based crops in underdeveloped countries such as India and Thailand several decades ago. Companies such as Common Heritage Corp. are capitalizing on this potential to assist third world countries develop sustainable coastal communities by adapting integrated seawater systems to support food, water, and energy production.



Simple pipes allow cold deep seawater to run into the building air conditioning system at NELHA, saving more than \$15,000 per year in taxpayer dollars.

NELHA TENANTS: 24 REASONS FOR SUCCESS

NELHA was established to serve as a support facility for projects which capitalize on the natural resources offered at Keahole Point. Its mission, *"to develop and diversify the Hawaii economy by providing resources and facilities for energy and ocean-related research, education, and commercial activities in an environmentally sound and culturally sensitive manner"* is being successfully realized thanks to the 24 projects currently housed at the NELHA facility as tenants.

Business ventures involve research, demonstration, and eventual commercialization of products and services developed using natural and other resources at NELHA. The individuals who are involved in the various activities here are true pioneers in this burgeoning area of economic development. Many of them are breaking new ground in alternate energy production, aquaculture, agriculture, and other key areas.

The contribution of NELHA to the state of Hawaii's long term economic goals has been quite significant. NELHA charges its tenants a minimum base rent or two percent of gross sales, whichever is greater. However, more important, is the contribution made by NELHA's tenants directly to the economy. In FY97 alone, gross revenues of NELHA tenants totalled \$13.6 million, capital improvement projects by the tenants at Keahole exceeded \$6 million, and, when standard economic multipliers for revenues and capital improvements were taken into consideration, the economic impact of tenant activities totaled over \$43 million for FY97.

These are momentous times for the State of Hawaii as NELHA moves forward in its development. What began as a bold idea in 1974 when Governor John Burns signed the legislation that created NELHA has become an important part of the state's widespread efforts to diversify its economy. New business ventures in new areas of development do not happen overnight, nor are they for the faint of heart. NELHA has successfully attracted a unique group of tenants who share the entrepreneurial spirit and willingness to take risks to reap the benefits of being on the cutting edge of ocean science and economic development.

AQUASEARCH INC.

Aquasearch Inc. is engaged in the development of proprietary, cost-effective, photobioreactor technology for the industrial cultivation of microalgae, and in research and development of products derived from microalgae. The company was formed in 1989 by a group of scientists at the Scripps Institution of Oceanography in La Jolla, California, and currently utilizes expert scientific advice from some of the world's leading scientists. The initial microalgal product is astaxanthin, a natural pigment which gives shrimp and salmon their characteristic pink color.



Pure strains of selected microalgae species are started as small cultures in laboratory flasks.

During the past fiscal year, Aquasearch has made several excellent developments. Among the highlights, the company received an expanded European patent (to complement its U.S. and other patents) for its process and equipment to grow microalgae in "photobioreactors," it strengthened its management team by welcoming a former VP of Finance for Verifone, Inc., it gained an important strategic partner in Hawaii (C. Brewer) with property for expansion, and it initiated engineering plans to build a large-scale production plant, designed by one of the premier firms in the country.

The company is currently exploring the engineering and technical issues required for significant expansion of its astaxanthin production. In addition, the company believes it has identified several markets in which additional pigments from microalgae might be sold and, based on industry sources, estimates the value of these markets to be in excess of \$500 million annually.

Aquasearch believes that its established research and development capabilities, strategic alliances, market development capabilities and patent protection combine to provide a strong business base. If you have Internet access you can reach Aquasearch's website at <http://www.aquasearch.com>.

BIG ISLAND ABALONE CORPORATION

During FY97 Big Island Abalone Corporation (BIAC) completed its preliminary proposal for a new business venture at Keahole. The NELHA Board of Directors (BOD) approved the project in concept in May 1997, giving BIAC the go-ahead to submit its final proposal and business plan for final approval at the first meeting of the BOD in FY97.

In July of 1997, Big Island Abalone Corporation plans to begin a year-long pilot project to evaluate the feasibility of developing a commercial abalone farm within the HOST Park at the Natural Energy Laboratory of Hawaii Authority. BIAC's project will entail the importation of two species of abalone and a red alga which will be cultured as abalone fodder. BIAC has received preliminary approval from the Hawaii Department of Agriculture, Plant Quarantine Branch, for the importation of these organisms.

Project goals for BIAC in the next year include demonstrating the viability of culturing algae in sufficient quantity to support a commercial abalone farm, validating BIAC's proprietary algae and abalone co-culture system on a commercial scale, and demonstrating the ability to spawn and settle abalone from broodstock. The first broodstock will be shipped to Keahole Point in October or November of 1997.

BIAC intends to negotiate an option for up to 40 acres of land in the HOST Park, and will be developing plans and budgetary information for the development of a commercial abalone farm there. Pending the results of the pilot project, actual operations on this site could begin in the summer of 1998. Critical to BIAC's plans for expansion into the HOST Park is the availability of cold seawater in sufficient quantity to ensure the successful commercial development and expansion of the BIAC farm concept.

BLACK PEARLS INC.

Black Pearls Inc. (BPI) has developed the hatchery technology for black-lip pearl oysters, *Pinctada margaritifera*, to produce valuable black pearls in Hawaii and other islands in the South Pacific. Following successful hatchery development, BPI is now investigating the feasibility of commercial pearl farming in Hawaii. In a joint project with the Aquaculture Development Program, they are clarifying the implementation of the state's ocean leasing laws.

The company has also developed a remote quarantine hatchery system which now allows expansion of pearl farming into many islands in the Pacific. Broodstock are flown to the hatchery, spawned, and the larvae are then reared under state-approved quarantine conditions. Once the spat settle, they are flown back to the farm site. A commercial pearl farm has been established in the Marshall Islands using these remote hatchery methods.

Black Pearls Inc. is also working with an established pearl farm operation in the Philippines to build and operate a gold-lip pearl oyster hatchery there. BPI is also investigating, under a CEROS grant, the use of beneficial bacteria to improve hatchery production which might expand the uses of the DSW resource at NELHA. Further studies are investigating the applicability of non-toxic antifouling materials on ropes and lines to the aquaculture industry and the Department of Defense.

COAST SEAFOODS COMPANY

Coast Seafoods Company (CSC) is a well-established oyster company based in the state of Washington and originally incorporated in 1946. CSC has expanded over the years to become the largest oyster company in the U.S. and has also expanded its successful hatchery division for oyster, clam, and mussel seed.

CSC's continuing expansion now includes a project, currently in the construction phase, located at the Keahole NELHA facility. Their intent is to begin production of oyster and clam seed at this site by early 1998. At completion it will be one of the largest Pacific oyster and Manila clam seed nurseries in the world.

COMMON HERITAGE CORP.

In 1997 the Common Heritage Corp. reorganized its Board of Directors and Bylaws to better carry out its mission of the "management of innovation for the benefit of the Common Heritage." To this end CHC has identified a state of the art "starter system" for such countries as Haiti, the Cape Verde Islands, Curacao, etc. The details appear on the Common Heritage Corp. web page at <http://www.aloha.com/~craven>.

In furtherance of this concept the CHC is constructing a demonstration system which will be dedicated on January 31st, 1998. The system employs deep ocean water sequentially to air condition the CHC office, to generate fresh water by condensation to supplement irrigation, to generate fresh water in a development model of a desalinization device called a "hurricane tower" (patent pending), to cool a chill house, its chill boxes and its food preparation



The "hurricane tower" experiment tested a new method of freshwater production from seawater.

area, to provide cold for the coldwater agriculture of wine grapes, to provide cold for the coldwater agriculture of a wide spectrum of agricultural crops normally grown in non-tropical climates, to provide cold for coldwater agriculture of superior tropical crops, to provide cold for coldwater agriculture landscaping of the facility, to provide cold and nutrients for the aquaculture of sea vegetables, to provide cold and nutrients for the aquaculture of "fruits de mer," and to provide cold for creature comforts (water fountains, coldwater showers, field tents, and other habitat comforts).

In the process of this development, CHC has made significant world class breakthroughs in agriculture. These were identified by the late Senator Matsuura as the "blue-green revolution" and a group of young "Common Heritage missionaries" have identified the CHC facility as the birthplace of the blue-green revolution. It will be so dedicated.

CULTURED TECHNOLOGIES, INC.

Cultured Technologies, Inc. was involved in research of a number of aquaculture species, with primary emphasis on the pearl oyster. The project reached completion during FY97 and planned to end its tenancy at NELHA.



CYANOTECH CORPORATION

Cyanotech Corporation is harnessing the immense potential of microalgae to produce high-value natural products for important market applications worldwide. The Company's current products include *Spirulina Pacifica*™, a nutrient-rich nutritional supplement, NatuRose™, a natural astaxanthin product used in the worldwide aquaculture industry; and phycobiliproteins, which are fluorescent pigments used in the immunological diagnostic market. Cyanotech is also developing microalgal-based products for the biopesticide markets, and it is the only microalgae company in the world to have an ISO 9002 Registered Quality System.

Last year Cyanotech launched commercial production and sales of its natural astaxanthin product, NatuRose™, on an eight-acre site and began construction on an expanded 88-acre facility of NatuRose™ production. Cyanotech also began an active program to commercialize a natural mosquitocide comprised of the blue-green algae and a genetically-introduced soil toxin from *Bacillus thuringiensis* var., *israelensis* (Bti). For more information, Cyanotech Corporation's web page can be reached at www.cyanotech.com on the Internet.



Cyanotech's production ponds are visible evidence of company success and market demand for its microalgae-based products.

HAWAIIAN BRED TROPICALS, INC.

Hawaiian Bred Tropicals is involved in research to investigate breeding techniques for ornamental reef fish. Their success will help to supply the commercial aquarium market, reducing its current pressure on the natural reef population.



Plump, healthy shrimp are High Health Aquaculture's prized products.

HIGH HEALTH AQUACULTURE

High Health Aquaculture's mission is to develop and supply certified pathogen-free broodstock to the world's shrimp hatcheries. They completed their first phase facility that included basic infrastructure (water, air, electrical and security systems) and broodstock rearing tanks. A shrimp reproduction system, installed in FY96, continued to operate.

In addition to completing facility development, the company has been working on developing

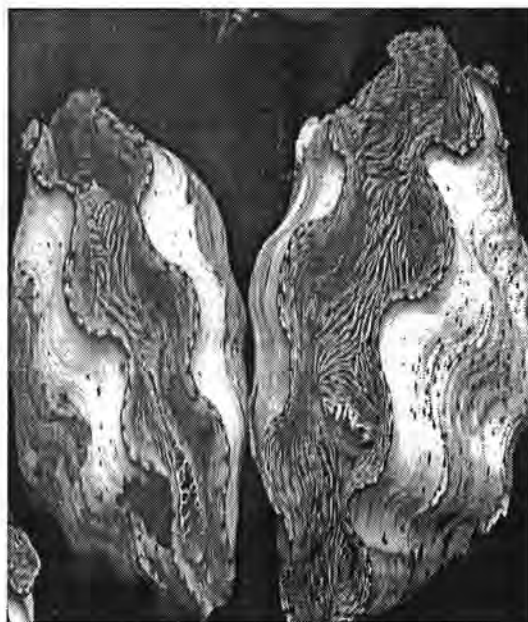
new stocks of pathogen-free shrimp. With the assistance of Dr. Jim Brock, the company has established certified stocks of *P. stylirostris* and *P. vannamei* from the Oceanic Institute. The company's motto is: "Healthy shrimp are profitable shrimp."

INDO-PACIFIC SEA FARMS

Indo-Pacific Sea Farms' (IPSF) mission is to develop and commercialize innovative technologies for sustainable production of reef-dwelling organisms. IPSF's present research and development emphasis is on photosynthetic molluscs and cnidarians, primarily giant tridacnid clams and scleractinian (reef-building) corals. These photosynthetic animals derive nutrition from their association with microscopic algal symbionts called zooxanthellae.

Cultivation requirements for the plant-animal consortium are similar to those of free-living microalgae, and include tropical sunlight, warm surface sea water and a carefully controlled concentration of deep sea water to control temperature and supplement essential inorganic nutrients such as nitrogen and phosphorus. IPSF uses no commercial feeds and produces no seawater pollution with this novel approach.

The products produced by IPSF are currently in demand in the sea food and aquarium industries and also have potential biomedical applications.



Tridacnid clams thrive in the clean water and sunny environment at NELHA.

ISLAND TRADERS

Using the abundant sunshine at Keahole Point, Island Traders produces sun-dried fish jerky. The fish jerky is prepared from locally caught fish, marinated in a "hot-n-spicy" or mild teriyaki seasoning, and dehydrated with the use of specially designed solar drying units. Island Traders is producing its jerky in a shorter time than standard methods and without the use of electricity.

KONA BAY OYSTER & SHRIMP CO.

Kona Bay Oyster & Shrimp Company (KBOSC) produces blue shrimp as well as American and Pacific oysters. KBOSC continues development of work begun by Aquaculture Technology, Inc. to investigate the commercial co-production of marine shrimp and oysters in a symbiotic system.

The KBOSC system design reduces the labor required for operations while increasing product output. This makes a significant difference in projected business development and has contributed to their confidence about the future.

In FY97, KBOSC expanded from a small 0.3 acre experimental facility to a 2.2 acre commercial growout operation and subsequently began marketing tasty blue shrimp to local hotels. The company plans further expansion of their operations and facility at NELHA in FY98.

KONA COLD LOBSTERS LTD.

Kona Cold Lobsters Ltd. (KCL) utilizes the deep cold seawater supplied by NELHA to create a habitat for live Maine lobsters and live Dungeness crabs. KCL imports live lobsters and crabs from the natural fisheries and rejuvenates them in cold seawater holding pens for distribution throughout the Hawaiian Islands and select Asian destinations. Currently KCL services over 50 customers on five Hawaiian Islands, including supermarkets, restaurants, and resorts, meeting their specific size and quantity requirements on a daily basis.



Pure, 10°C deep seawater continuously bathes lobsters in their individual cages which separate the naturally carnivorous animals.

KCL also continues to conduct aquaculture research, growing Maine lobsters with a multidisciplinary plan that includes broodstock, husbandry, nutrition, pathology and habitat design. KCL has successfully bred and raised lobsters from egg to sexual maturity for over 20 years. KCL's long range goal is to become operationally independent of the natural fishery, producing a high-quality Hawaiian-bred Maine lobster for consumer enjoyment.

ONO TAKE INC.

Ono Take Inc. is concluding its research and development phase and is proceeding to the commercial production of *shiitake* and myco-medicinal mushrooms.

Ono Take Inc.'s mission is to cultivate fruiting fungi by certifiable organic methods. Utilizing available agricultural waste, Ono Take Inc. produces highly esteemed *shiitake* (*Lentinula edodes*) and *reishi* (*Ganoderma lucidum*) mushrooms for a growing gourmet and nutraceutical market. The company's waste products are utilized as a high grade agricultural fertilizer.

Working with mushroom mycelium *en masse* empowers Ono Take Inc. and the community with direct economic, ecological, and nutritional benefits. This myco-technology is a perfect example of good environmentalism, good health and good business.

PACIFIC HARVEST

Pacific Harvest has established a Pacific threadfin fish (also known locally as *moi*) culturing facility on a 0.67 acre parcel of land adjacent to the NELHA research compound. The company is building on the research conducted at the Oceanic Institute's (OI) Center for Tropical and Sub-Tropical Aquaculture (CTSA). OI and the State of Hawaii have collaborated to develop intensive hatchery and nursery production techniques for *moi*. Their first focus was to restore juvenile *moi* into the nearshore environment of the Hawaiian Islands where they have been overfished and are now rare. Studies have shown that the restocking efforts have proven successful, with high survival rates of the *moi* in their natural environment.

A second focus of CTSA was to transfer seedstock production technology as well as *moi* eggs and juveniles to private aquaculture farmers. In exchange, farmers were asked to provide technical information, cost data, and market information which would be used to assess the economic and technical feasibility of conducting commercial *moi* aquaculture in Hawaii.

Pacific Harvest is contracting with CTSA to be included in this program, hoping to also take it one step further by creating the first private hatchery production of Pacific threadfin. Both CTSA and Pacific Harvest are looking forward to working together to create a successful venture and partnership.

PICHTR

Pacific International Center for High Technology Research (PICHTR) brought its Open Cycle OTEC demonstration project at Keahole to its final conclusion this past fiscal year. The 210 kW facility had operated for four years.

The primary objective was to acquire experience in the operation of OTEC plants for the production of electricity and desalinated water and to gather life cycle data for the major components (turbine and high speed vacuum compressors). A second objective was to continue dissemination of the acquired knowledge by publishing articles in professional journals and interacting with the general public during tours of the facility.

The experimental work was sponsored by the State of Hawaii and the Federal Department of Energy. The open-cycle OTEC plant produced up to 255 kW of electrical power, using 150 kW to operate itself, with up to 100 kW net power for other uses. It also produced 7,000 gallons of fresh (desalinated) water per day of operation. These set new world records for OTEC.

With funding from the State of Hawaii, PICHTR, the Hawaiian Electric Company, and the Defense Advanced Research Project Agency of the U.S. Department of Defense, PICHTR also completed the construction of a 50 kW closed cycle OTEC experimental apparatus in 1996. This apparatus tested roll-bonded aluminum heat exchangers designed and manufactured by ALGOODS of Canada.

The PICHTR projects contributed vital new information to the OTEC knowledge base and made a significant contribution to the development of OTEC technologies, all of which will make realization of future commercial applications a greater possibility.

ROYAL HAWAIIAN SEA FARMS, INC.

Royal Hawaiian Sea Farms, Inc. (RHSF) has been in business at Keahole since 1987 and commercially produces *limu*, or edible sea vegetables. Sales of these popular nutritious delicacies have consistently reached over a ton per week. A pickled *ogo* (*Gracilaria*) product is being processed under the "Waimanalo Ko-Ko" brand. In addition to *limu*, RHSF also produces salt water tilapia (*Tilapia*) and milkfish (*Chanos*). Intensive applied research is being conducted to investigate the potential of commercially producing edible sea cucumbers (*Stichopus*), the Hawaiian limpet, *opihi* (*Cellana*), and warm water abalone (*Haliotis*).



RHSF has operated for ten years at NELHA's Keahole facility. Their fresh "sea vegetables" are enjoyed in homes and restaurants across the state.

SEATECH CONTRACTING

SeaTech Contracting, Inc. is a general and environmental contracting/marine construction company with an emphasis on commercial diving. They were the first support company to locate at Keahole Point and provide highly skilled services to NELHA, its tenants, and companies in the surrounding area. SeaTech's specialties center around underwater surveys, underwater piping and pumping systems, dredging, drilling and salvage. SeaTech employees have been trained by the Clean Islands Council to handle HAZWOPER First Response oil spills. SeaTech is the only contracting team on the Big Island able to handle hazardous oil spills along the Kona and Kohala coasts.

STATE UNIVERSITY OF NEW YORK MARINE SCIENCE CENTER

Dr. Jeanette Yen of the State University of New York Marine Science Center has been conducting research on the micro-processes involved in the feeding behavior of a type of deep seawater copepod (a small marine crustacean). Her work involves the study of fluid dynamics on a microscale, and relies on the scant supply of experimental organisms that can be found by straining the incoming deep seawater supply at NELHA. Obtaining specimens by this method of collection is far simpler, more economical, less time-consuming, and less damaging to the organisms than the traditional method of collecting deep sea plankton from research vessels.

Living in all the oceans of the world, copepods are a type of marine crustacean which form an important link in the marine food web. They pass nutrients from single-celled plants (phytoplankton) which they eat to populations of larger animals such as fish, for whom they serve as food.

TAYLOR RESOURCES, INC.

Taylor Resources, Inc. is a family-owned and operated shellfish company with its headquarters in Shelton, Washington. Their Manila clam and Pacific oyster facility at NELHA serves as a nursery for only a small segment of the life of the juvenile shellfish. They raise the larvae in their hatchery in Washington state and send them to Hawaii just after they have settled out of their swimming cycle. At this stage the animals are about 250 microns in size. At the NELHA facility, Taylor Resources raises the shellfish up to 5 mm size on screens and in sand raceways. They are then shipped back to the Pacific Northwest for growout.

The cold and the warm seawater provided by NELHA are utilized to achieve the exact temperatures needed for shellfish growout, and the year 'round warm climate allows a year 'round growing season for the shellfish. An expansion of their nursery has been underway, with goals of producing up to 400 million juvenile clams and 10 million juvenile oysters per year.

THERMAL ENERGY STORAGE, INC.

Thermal Energy Storage, Inc. (TESI) of San Diego has demonstrated an innovative and promising new technique for extracting freshwater from seawater by "freeze desalination" at NELHA in FY97. TESI aims to develop a desalination technology for initial use on California's Channel Islands.

Under a cost-sharing agreement with the Federal Bureau of Reclamation, the company has constructed a facility for freeze desalination, in which seawater is frozen and freshwater is obtained when the ice is melted. The key property of water which makes this possible is the crystalline lattice structure of ice molecules which is too small to admit ions of salt. As a consequence, when ice is formed from seawater, it is nearly pure freshwater since the salt is naturally excluded.

Freezing normally requires large amounts of energy, but TESI mixes a chemical with the seawater to form a "clathrate" that has a freezing point of about 45.5°F. Since the water at 2000 foot depths offshore is about 43°F, it can freeze the clathrate with no extra input of energy. In an operational system, the clathrate will be pumped down to ocean depths and the ice crystals will be returned to the ocean surface.

The demonstration at NELHA takes advantage of the existing deep seawater pumping system to provide cold seawater that is pumped through polyethylene heat exchangers in which the clathrate is crystallized. The crystals are then melted in a separate heat exchanger with surface seawater, and the clathrate former is recovered, leaving pure freshwater behind.

Initial experiments at the end of FY97 successfully formed ice crystals from the seawater clathrate for the first time. When these were melted and tested, the process had reduced the salt content by about 98%, approaching salinity levels similar to water from the Colorado River. Further operation is expected to improve the operation to the target level of 98.8% salinity reduction. Experimentation will continue to develop the rest of the process. NELHA affiliate, CEROS, has funded additional experiments to investigate the effects of deep ocean pressures on the process of forming of clathrate ice.

UNIVERSITY OF HAWAII SEA GRANT EXTENSION SERVICE

The Sea Grant College Program of the University of Hawaii at Manoa (UHM) supports long term economic development, stewardship, and responsible use of Hawaii's marine and coastal resources. Sea Grant is a collaborative effort of the public and private sectors that utilizes federal, state and community support.



West Hawaii Agent Sara Peck represents the University of Hawaii Sea Grant Extension Service in the Kona Sea Grant office at the NELHA facility.

As part of the UHM School of Ocean and Earth Science & Technology, the Sea Grant College Program serves a geographic area that includes the Hawaiian archipelago and the U.S.-affiliated Pacific islands. Sea Grant has three components:

- RESEARCH, focusing primarily on the marine and coastal environment
- EXTENSION SERVICE, consisting of informal and formal education and outreach activities
- COMMUNICATIONS, providing creative support and expertise to researchers, extension staff, and management.

The Sea Grant Extension Service works with NELHA facility staff and tenants to improve the effectiveness of community outreach, education and interpretation. The Sea Grant office also makes resource materials and data bases available to tenants and the public upon request.

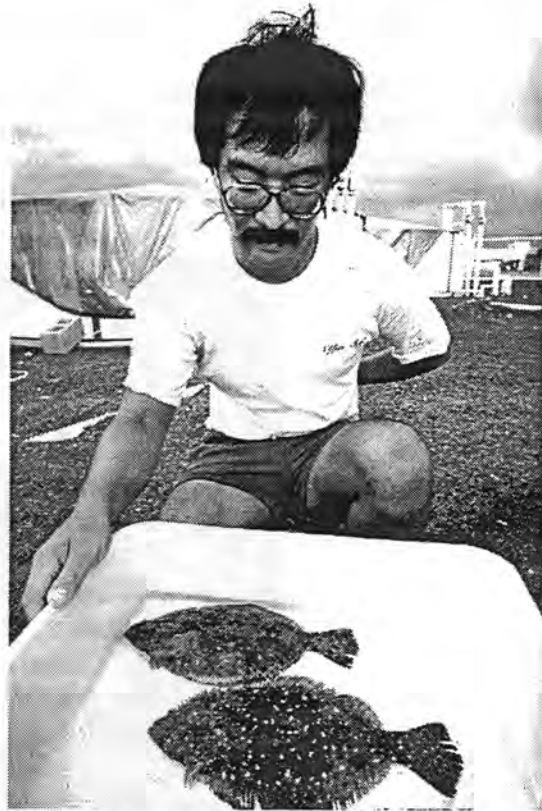
UWAJIMA FISHERIES

Uwajima Fisheries, Inc. (UFI) has developed a facility for growing *hirame*, a flounder highly prized by the Japanese for *sashimi* and *sushi*. Uwajima Fisheries markets their 1.5 to 2 pound *hirame* through a Honolulu distributor who supplies the Oahu *sushi* market and is also beginning to export the product to the West Coast of the U.S. UFI manages the maturation and spawning of their broodstock for year 'round production of eggs.

UFI utilizes the NELHA surface and cold deep seawater for the semi-intensive polyculture of marine shrimp, milkfish and *ogo*. With this system they are currently producing a high quality superior product.

This company has also experimented with white shrimp, *P. vannamei*, utilizing a strict Specific Pathogen Free quarantine protocol. As a result, they are currently marketing certified pathogen-free broodstock throughout the mainland U.S. and Central and South America.

UFI has also experimented in broodstock management, spawning, larval rearing and growout of Pacific threadfin (*moi*). This past fiscal year, the successful growout of *moi* has led to the first stages of commercial production, with the company selling the tasty finfish to local markets.



Hirame is a type of flounder or flatfish which is highly prized in Japan for use as sashimi or in sushi.

WEST HAWAII EXPLORATIONS ACADEMY

The West Hawaii Explorations Academy (WHEA) is an integrative educational program of Konawaena High School. It is sited at and is a tenant of NELHA. The '96-'97 school year is its third program year. Each year more than 50 students, mostly juniors and seniors, spend their entire academic year at NELHA, working on projects related to the resources available at Keahole Point.

Originally designed to address the needs of students who were at risk of dropping out of school, this innovative program has also attracted many college bound students. The observed success with this broad range of interests and abilities is a tribute to WHEA's talented teaching staff.

WHEA acquired significant infrastructure enhancements during this fiscal year. Included in these additions are:

- a 30' x 30' classroom/office constructed by the Department of Education
- a 30' x 40' pavilion-style shop completed with program and community resources
- approximately 600 square feet of concrete slab area was added, and the student reef tank project containing 9600 gallons was completed and plumbed (including a 600 gallon biofilter).

For the 1996-1997 fiscal year, WHEA students initiated and implemented approximately 40 projects. These were wide-ranging, and included: the Aloha Kai presentations to elementary students (over 3000 students and 200 chaperones); a solar car prototype; growing Makaloa on wastewater (sponsored by a collaboration of Bishop Museum, the National Biological Service, and the Amy Greenwell Ethnobotanical Garden); a vog monitoring project; hydroponic and cold-water agriculture efforts; and one commercial and several research aquaculture projects.

The WHEA program is funded by the Department of Education and a four year National Science Foundation grant.

National Defense Center of Excellence for Research in Ocean Sciences



The NELHA Board of Directors oversees the operation of CEROS, setting broad goals, developing policy, and providing guidance for the CEROS program. Not a tenant but an affiliated program administered through DBED&T and NELHA, CEROS programs and management are also reviewed and evaluated by DARPA as the CEROS grantor, with full recognition and encouragement of NELHA. The Kona CEROS office at NELHA was dedicated during FY97.

The 1993 Department of Defense Appropriation Act approved and funded a National Defense Center of Excellence for Research in Ocean Sciences (CEROS). A \$5 million grant provided by the Defense Advanced Research Projects Agency (DARPA) created CEROS for the purpose of conducting research and development activities of interest to the Department of Defense (DoD).

The CEROS technology development programs seeks to identify leading edge, value-added technologies that support DoD requirements, advance innovative concepts and new approaches to technology while fully leveraging existing facilities and infrastructure in Hawaii, and foster potential commercial development. By encouraging participation of Hawaii companies with special expertise that may apply to DoD requirements, CEROS advances the State's goals of expanding technology-based industries. Additionally, CEROS seeks to maximize infrastructure use in Hawaii, thereby leveraging Federal research dollars and expanding efficient use of the resources. Five technical topic areas are identified in the legislation that originally funded CEROS:

- Ocean Environmental Preservation
- New Ocean Platform and Ship Concepts
- Shallow Water Surveillance Technologies
- Ocean Measurement Instrumentation
- Unique Properties of the Deep Ocean Environment

CEROS solicits proposals through annual Broad Agency Announcements. All proposals are evaluated competitively for technical merit, innovation, and value according to criteria published in the solicitations. The CEROS Research Advisory Board determines the best proposals based on the evaluations. Since 1993, CEROS Technology Development programs have funded a total of 66 projects at over \$27.1 million. In September 1997, an additional \$6.4 million in funding was released to DARPA for the CEROS FY98 Technology Development Program.

CEROS procures and supports technical projects that are consistent with its mission for ocean research and technology development. The CEROS mission has five parts:

1. Encourage leading edge research and development
2. Support the Department of Defense
3. Use the exceptional ocean research facilities that exist in Hawaii
4. Involve highly specialized small businesses with recognized expertise in ocean-related research
5. Develop regular access to ocean science expertise at the University of Hawaii.

CEROS FUNDING

The allocation of CEROS funding among the five technical areas totalled over \$29 million over the period from FY93 through FY97.

PROJECT TOTALS (1993-1997)

PROJECT TOPIC AREA	PROJECTS	FUNDING
Shallow Water Surveillance Technologies	20	\$10,262,626
Ocean Environment Preservation	18	\$8,552,959
New Ocean Platform and Ship Concepts	9	\$3,668,643
Ocean Measurement Instrumentation	12	\$2,811,251
Unique Properties of the Deep Ocean Environment	7	\$1,589,419
<i>SUBTOTAL 1</i>		<i>\$26,884,898</i>
Uncommitted Project Funding		\$99,408
Administration		\$1,975,088
Management Reserve		\$354,402
<i>SUBTOTAL 2</i>		<i>\$2,428,898</i>
<i>TOTAL</i>		<i>\$29,313,796</i>

THE YEAR IN REVIEW

NELHA has experienced numerous changes throughout this past fiscal year. The facility welcomed new tenants with diverse projects and new employees with promising skills. Many tenant businesses have grown and expanded, bringing new dimensions to their operations. NELHA and its tenants have been recognized, both locally and out-of-state, for their growth and many contributions.

NELHA BOARD AND STAFF

Leadership of the NELHA Board of Directors (BOD) changed at the beginning of the fiscal year. Diane Quitiquit began her term as Chair and John Corbin Vice-Chair. During the year, former BOD Chair Richard West completed his term on the Board. Former NELHA Executive Director Robert Kihune returned to work with NELHA, this time to fill the vacancy as a Director.

Other changes in NELHA staff occurred as well during FY97. Following the resignation of Dr. Robert Shleser as Executive Director in September 1996, the BOD was tasked with assisting NELHA's Scientific/Technical Program Manager, Dr. Tom Daniel, to fill the role of Acting Executive Director for an eight month period. In April 1997 James Frazier came on board as the new NELHA Executive Director.

The administrative staff cooperated for nine months to cover the tasks of the administrative assistant position which was vacated by Christine Bean in September 1996. Denise Hill



The NELHA Board of Directors, under the leadership of Chair Diane Quitiquit, provided strong support to the NELHA staff during the extended time of transition during FY97.

accepted this position in May, 1997. The dedicated Board of Directors and NELHA staff worked diligently during this fiscal year to cover these vacancies.

Administration was not the only area of NELHA that experienced change. In November of 1996, Jeff Nichols took over in engineering for Scott Oshiro who left in July 1996. In October 1996, Bob Edelmenn began work as utility electrician, a position which had been vacant for almost a year. In spite of all these personnel changes during FY97, the NELHA staff successfully covered their duties as well as filling in as needed with the temporary vacancies.

The NELHA staff earned recognition for their contributions to community efforts to clean up the environment. On March 6, 1997, NELHA was publicly recognized by the County of Hawaii and the Governor's Committee on Ending Litter. This was a result of NELHA's joint sponsorship with the Protect Kohanaiki Ohana for beach clean-up which attracted hundreds of community volunteers.

LEGISLATIVE ACKNOWLEDGMENT

The ongoing efforts of the many NELHA businesses and the supporting services provided by the NELHA staff were acknowledged by the State Legislature this fiscal year. A resolution honoring NELHA for its significant contributions to the State's economy and growing



NELHA Staff proudly accept Legislative award presented by Representative Whalen for their contributions to Hawaii's economic development.

high technology reputation was passed by the Nineteenth Legislature of the State of Hawaii Regular Session of 1997.

This 1997 Legislature also assisted NELHA by passing two bills fostering commercial development at NELHA. One allowed a retail concession and tour activity at NELHA. The other added "ocean-related research, technology, and industry" to NELHA's purpose in its enabling legislation. These measures will further expand the scope of what is possible for future developments at NELHA.

WELCOME NEW TENANTS

Four more enthusiastic new tenants have come to NELHA. Within the research compound, Big Island Abalone recently began their project starting with refining fodder culturing techniques and tank design and constructing and testing of a prototype abalone/algae module. Within the farm compound, Pacific Harvest began construction of their intensive culture system and hatchery/nursery for the production of the Pacific Threadfin (*moi*).

Coming soon will be Coast Seafoods Company who were given approval in concept for a hatchery system including setting and early nursery growing of oyster and clam seed. Marine Bioproducts, Inc. of British Columbia plans to begin the experimental phase of their production of high quality agar, a biomedical culture medium, early in FY98.

CONGRATULATIONS GROWING TENANTS

Business Week magazine named Cyanotech Corporation as one of the fastest growing small companies in the United States in its May 26, 1997, issue. Cyanotech was rated 67th on the list of "100 Hot Growth Companies." This growth was evidenced on November 1, 1996, with the dedication of Cyanotech's latest phase of development, a new 3800 square foot astaxanthin processing plant. At the end of the fiscal year they were gearing up for construction on an additional 90 acres of land to be converted into more production ponds during the coming year.

Other tenants have also had success this past fiscal year. Common Heritage Corp. successfully tested its new "Hurricane Tower" (patent pending) which simulates a hurricane vortex and produces fresh water from sea water. Black Pearls Inc. secured a contract to design, operate, and train staff to take over the operations of a hatchery at an established pearl farm overseas in the Philippines. Kona Bay Oyster & Shrimp Co. significantly expanded their operations and began selling their shrimp during FY97. Many other tenants have also expanded their operations at NELHA.

NELHA EVENTS

NELHA has welcomed numerous visitors during this past fiscal year. Senator Daniel Inouye and Mayor Stephen Yamashiro celebrated the formal opening of the Department of Defense Center of Excellence for Research in Ocean Sciences (CEROS) new offices at NELHA on November 1, 1996. On Saturday, March 15, 1997, NELHA hosted its fifth annual Open House, titled "Keahole Kool." Approximately 500 visitors were given tours guided by NELHA staff. Numerous tenants displayed their products and shared information on their projects for the visitors to enjoy.

The NOVA Group, Inc. used a "micro-tunneling" technology to construct two parallel 66-inch diameter tunnels which extend from a pump station 480 feet onshore to a breakout through the sea floor 570 ft offshore. This shoreline crossing is for the future seawater pipelines which are designed to serve projects in the HOST Park.

NELHA operations staff completed several major tasks during the year. The seawater air conditioning for the buildings in the NELHA compound was totally refurbished. Installation was completed of a 125kW diesel generator and automatic transfer switch to provide emergency electric power to some remote seawater pumps, and the roof was replaced on the Water Quality Laboratory.

It has been a busy and productive year of many changes, many successes. NELHA staff and its tenants can look forward to another exciting period of growth in the coming fiscal year.



The Keahole Lighthouse is a stopping point for facility tours.



ESSENTIAL SUPPORT SERVICES



ESSENTIAL SUPPORT SERVICES

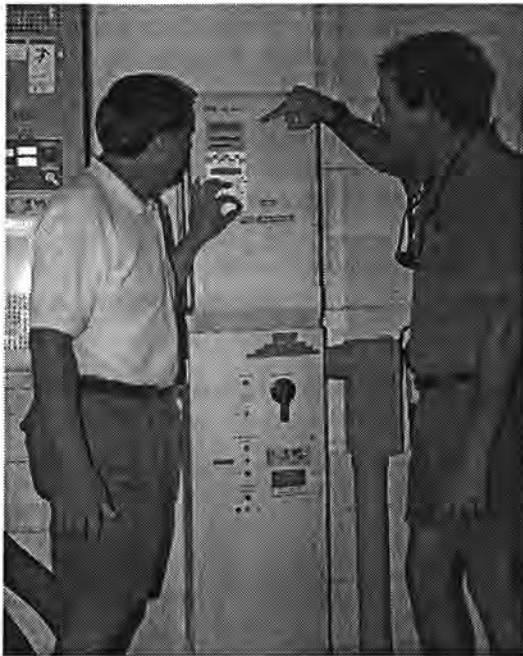
The Operations staff is proud to provide the critical core support for the NELHA facility by managing the operation and maintenance of all NELHA plant and equipment. The most critical responsibility of the Operations Department, central to the uniqueness and success of NELHA as a facility, is the assurance of continuous delivery of deep and surface sea water, electricity, freshwater and other essential services to the tenants. Each and every member of the department is especially dedicated to providing an uninterrupted sea water supply 24 hours a day, 365 days a year.

The staff of the Operations Department includes skilled planners, mechanics, electricians, and maintenance specialists who work cooperatively together to fulfill NELHA's mission. Many of the improvements at NELHA over the years have been completed using the laboratory's internal "self help" philosophy. Staff members are encouraged to combine their talents and trades to complete projects in-house that might otherwise have a higher cost or long delivery dates if pursued through traditional means.

Highlights and accomplishments realized during this fiscal year follow.

IMPROVEMENTS TO SEAWATER SYSTEMS

In keeping with NELHA's goal to keep seawater rates low and the operation as energy efficient as possible, several improvements were made throughout the year to NELHA's surface and deep seawater delivery systems. Work was completed to fully automate each



The seawater delivery systems are fully automated to keep delivery pressures to tenants constant.

distribution system to respond to changes in water pressure. As the demand for seawater fluctuates, pressure rises and falls in the delivery pipeline. A pressure sensor in each pipeline detects these changes and sends a signal to an electronic controller that either speeds or slows the motor(s) driving the seawater pumps. By synchronizing the delivery of seawater to the exact demand of the system, no electricity is wasted and delivery pressures to the tenants are kept constant.

At the southernmost NELHA pump station, the operations staff installed a 125 kW diesel generator and automatic transfer switch to provide emergency electric power to the seawater pumps running at this location. The new generator supports the operation of both the 18-inch deep seawater and the 24-inch surface seawater systems.

An emergency pipeline recovery project was



NELHA staff have multiple areas of expertise, necessary to provide the diverse array of support services to tenants.

staged in May 1997 to remedy a problem encountered with one of the offshore pipelines originally deployed by a former NELHA tenant ten years ago. A 500-foot section of the pipeline had kinked at the edge of the offshore reef and was floating off the seafloor, creating a potential navigation hazard. This pipeline was originally constructed out of material that was later determined to be too thin to withstand the vacuum suction created by the pumps after sustained operation. A thicker-walled 12-inch diameter pipeline had eventually been inserted into the entire length of the main 16-inch delivery pipeline to prevent it from collapsing. Although this inner lining strengthened the pipeline, it also severely reduced its water delivery capacity. During FY97, it was determined that this pipeline would serve no further use as a supplement to NELHA's existing seawater delivery

systems. The decision was made to salvage as much of the material as possible before it became a real hazard to navigation.

Pacific Marine Contracting was contracted to undertake the recovery project and was supported by each member of the Operations Department. The entire 5,400-foot 12-inch diameter pipe sleeve and approximately 1,400 feet of the main pipeline were successfully recovered. The material was cut into manageable lengths and is currently being stored ashore to be available for other uses. The entire recovery project was conducted safely, completed within the projected budget, and deemed an overall success.

OTHER ACCOMPLISHMENTS

During FY97, the metal roof of the Water Quality Laboratory Building was replaced after 17 years of service in the harsh environmental conditions adjacent to the energetic sea. In addition, the seawater air conditioning for the building was also totally refurbished. NELHA saves money by using the deep ocean water to air condition its facilities.

All seven of the chillwater units in the ceiling area were abandoned and replaced with a central ducting and a large air handler unit. The plate heat exchanger outside the building uses the cold seawater to chill freshwater which is pumped into the air cooling system. The new air handler converts the "cold" of the chilled freshwater directly into chilled air and blows it into the building's air conditioning delivery system. This DOW-

chilled system is now far more efficient than traditional systems and virtually maintenance-free.

Four new tenants at NELHA were accommodated with basic start-up services and resource connections to match their requirements. In addition to the tremendous growth undertaken by Cyanotech Corporation in their recent expansion, most of NELHA's other tenants also expanded their operations and kept the NELHA staff busy throughout the year. The Operations staff was right there keeping pace with their demands and helping with the many transitions.

In order to better preserve a part of NELHA's delicate coastal ecology, vehicular access was blocked to approximately one half mile of NELHA shoreline. Public access is still encouraged, although it is now limited to foot traffic. This decision was also prompted by the negative impact of numerous camping violations and the accumulation of trash. The beach vegetation is reestablishing itself and the trees are no longer being cut down for firewood. The NELHA staff has received many positive comments from the public who appreciate the area more now for its natural beauty and solitude. Many people enjoy walking and picnicking in the area without the four wheel drive traffic and the negative impact it brought to the site.

Additionally, as a service to the public who regularly visit the coastal areas on NELHA's property, the public restroom/comfort station building located at Wawaioli Beach Park at the bend in the NELHA access road was completely repainted and refurbished by the Operations staff. New picnic tables, barbecue pits and additional parking areas were also provided for the public to enjoy.

ENGINEERING

PHASE ONE OF HOST PARK SEAWATER SYSTEM COMPLETED

A shoreline crossing was completed in FY97 as Phase One of a new surface and deep seawater supply system designed to serve projects in the HOST Park area. Phases Two and Three, as yet unfunded, will install a deep water pipeline to a depth of 3,000 feet, a surface water intake at an 80-foot depth, and the onshore pumping station required to deliver the valuable seawater throughout the HOST Park.

The shoreline crossing demonstrated an exciting new technology with worldwide applicability for development of OTEC and other uses of warm surface and cold deep seawater. NELHA's contractor, NOVA Group, Inc. of Napa, California, constructed two parallel 66-inch diameter tunnels which extend from 30 feet below sea level in a pump station 460 feet onshore to a breakout through the seafloor 570 feet offshore at a depth of 80 feet.

Unlike previous shoreline crossing projects here, the new installation used, "micro-tunneling" technology in which an autonomous tunneling machine was pushed into a tunnel by large jacks mounted in a dry pit. A 50-foot deep "launching shaft" was constructed about five feet back from the coastline and lined with "sheet piles" so that it could be "de-watered." The contractor completed two tunnels onshore from this launching shaft to a 30-foot deep reception shaft located 460 feet back from the water. Then two offshore tunnels were completed and joined with the onshore sections in the launching shaft. The launching shaft was then back-filled, leaving no permanent disruption at the shoreline.

Though the project took longer than scheduled and cost the contractor much more than expected, NELHA fortunately had a fixed price contract that provided the system for the original contract price. The added time delay was also not a problem since the next phase of the seawater system expansion, the follow-on pipeline installation, is on hold until further CIP funds are allocated and released.

This project not only accomplished its objectives but also demonstrated the potential of micro-tunneling as a preferred, cost-effective, and environmentally benign method for bringing large pipelines through the high energy area between land and sea. Alternative solutions used in earlier Keahole shoreline crossing projects—including above-ground pipelines, trenching and directional drilling—have been found to be much more costly with greater impact on the environment. Micro-tunneling technology allows NELHA to bring large pipelines ashore with no permanent disturbance of the shoreline area. Plans actually call for establishing a public beach park directly over this area.

Phase One of the new seawater system for HOST Park provides the shoreline crossings for two planned pipelines. These will have the capacity to bring ashore the extra large volumes of water required to operate an OTEC plant that could generate enough electricity to pump water to the rest of the NELHA properties. In the next biennium, therefore, NELHA will again be pursuing capital improvement funds from the State Legislature to allow completion of the rest of the planned pipeline system. This will be the most important and long-awaited step towards allowing the full development of NELHA's properties at Keahole Point and HOST Park.

SEAWATER INFRASTRUCTURE PLANNING AND DESIGN

Makai Ocean Engineering, Inc. (MOE) of Waimanalo, Oahu has nearly concluded its continuing engineering services contract with NELHA. Five final tasks have been completed this year:

- 1) Engineering oversight of the NOVA Group, Inc. contract for installation of the micro-tunnel shore crossing for the planned HOST Park 55-inch diameter pipelines. MOE provided consultant engineering services, acting as NELHA's engineer for this project.
- 2) Planning and oversight of the submersible dives required to complete the design of the 55-inch diameter pipelines. MOE personnel served as engineering observers and provided reports on the dives, which were conducted in December 1995.
- 3) Conceptual design of the seawater distribution systems for the HOST Park area. MOE has provided guidance and engineering assistance to the development of plans for distributing the water from the 55-inch diameter pipelines throughout the HOST Park area.
- 4) Review and upgrade design of existing onshore seawater distribution systems. The NELHA onshore seawater distribution systems had grown piecemeal to meet changing demands over the last 15 years, so the existing system was unnecessarily complex and inefficient. MOE engineers worked with NELHA personnel to develop and implement a simpler yet more flexible system, eliminating the header tanks which are no longer needed because of the new variable speed pump drives.
- 5) Review of situation and recommendations for utilization of existing offshore seawater pipelines. MOE has examined alternative uses for the six pipelines (none currently operational) which NELHA acquired following the bankruptcy of Ocean Farms of Hawaii. Though these lines were all installed for pumping deep seawater, their diameters are too small to do so efficiently and several of them have additional mechanical problems. Possible alternatives which MOE investigated include: pumping of surface seawater, back-up to other deep seawater pipes or for discharge of used seawater below the 100 fathom depth where it will have negligible environmental impact. The final report on this task, which incorporates data from the submersible dives conducted in December 1995, is due early in FY98.



The operations staff maintain diverse components of the NELHA facility.

ACCESS ROAD AND UTILITIES DESIGN

Reid and Associates, Inc. of Kailua-Kona went out of business after completing only about 40% of their contract to provide civil engineering design services for the access roads and utilities for the build-out of NELHA's HOST Park area. The contract also included tasks for the final design of NELHA's emergency generator system and for the provision of access and utilities to the presently inaccessible northern section of the NELHA property. None of these tasks were completed, and NELHA was unable to transfer the funds to another contractor, so the remaining funds reverted to the General Fund.



Earth-moving heavy equipment is used in many tasks performed for NELHA tenants as their sites are prepared for occupancy or expansion.

NELHA will now pursue new CIP appropriations to cover the tasks left uncompleted by Reid and Associates. Final design of the access roads and utilities will be accomplished as part of the construction project(s) for their installation. Another effort begun by Reid involves defining and obtaining a Planned Unit Development approval from the County for the HOST Park area. This will allow development more appropriate to a light industrial area rather than the standard subdivision-style rules. Another effort focuses on installation of the emergency generator and a Standby Capacity Agreement whereby HELCO will purchase excess power when needed.

PLUG AND ABANDON (P&A) HGP-A GEOTHERMAL WELL

Under the direction of the NELHA Board of Directors and the State Departments of Land and Natural Resources (DLNR) and Business, Economic Development and Tourism (DBED&T), NELHA has worked toward plugging and abandonment of the HGP-A geothermal well in Pohoiki, Puna. The NELHA Board of Directors determined that the initial P&A plan was inadequate, so NELHA staff have prepared a statement of work for evaluation of that plan and preparation of a satisfactory plan that complies with the DLNR Administrative Rules. Additional Capital Improvement Project funding is being requested to cover the anticipated additional cost of the revised plan.

OCEAN THERMAL ENERGY CONVERSION (OTEC) RESEARCH AND DEVELOPMENT

Since its founding in the 1970s, NELHA has been the world's leading site for OTEC research. Considerable work has been performed at NELHA on both closed- and open-cycle OTEC systems.

CLOSED-CYCLE OTEC. Research sponsored at NELHA in the 1980's by the U.S. Department of Energy demonstrated that aluminum alloys can work well for closed-cycle OTEC heat exchangers and that biofouling of the heat exchangers can be controlled with periodic injection of environmentally benign low concentrations of electrolytically generated chlorine. Subsequent NELHA research and development by ALCAN International, the world's largest aluminum company, investigated advanced aluminum alloys and demonstrated that "roll-bonded" aluminum heat exchangers have the potential to reduce dramatically the manufacturing cost of the large heat exchange surfaces required for closed-cycle OTEC plants.

Starting in 1989, ALCAN developed plans to build a small plant at NELHA to demonstrate the efficacy of the roll-bonded heat exchangers. In 1992 NELHA received a State CIP appropriation to support the purchase of equipment for the project. Shortly thereafter, ALCAN withdrew from the project because of financial constraints. In early 1994, NELHA reached agreement with the Pacific International Center for High Technology Research (PICHTR) to pool funds from the NELHA CIP appropriation (\$725K), Hawaiian Electric Company (\$50K) and PICHTR internal sources (\$460K) to construct and operate the 50 kW plant that ALCAN had proposed. The heat exchanger panels were purchased from former ALCAN subsidiary, ALGOODS, Inc. of Toronto, and Makai Ocean Engineering, Inc. (MOE) of Waimanalo was contracted to provide engineering services to PICHTR for the project. Shortly after the project began, the National Defense Center of Excellence for Research in Ocean Sciences (CEROS) awarded a grant to MOE for collection and analysis of engineering data from the 50 kW plant to develop the design for a proposed 1 MW plant. \$200K of this grant was earmarked to facilitate the data collection for upgrading of the experimental plant and its instrumentation.

The closed-cycle plant construction was completed and shakedown operations began in May 1996. Before the shakedown was completed, after only six weeks of operation, the heat exchangers developed ammonia leaks from corrosion of the aluminum panels. Though these panels were made of the same alloy that had been extensively tested at NELHA over several years by both DOE and ALCAN, they apparently failed because of an incompatibility between the aluminum and the "nitrile" rubber spacers that were used to separate the panels.

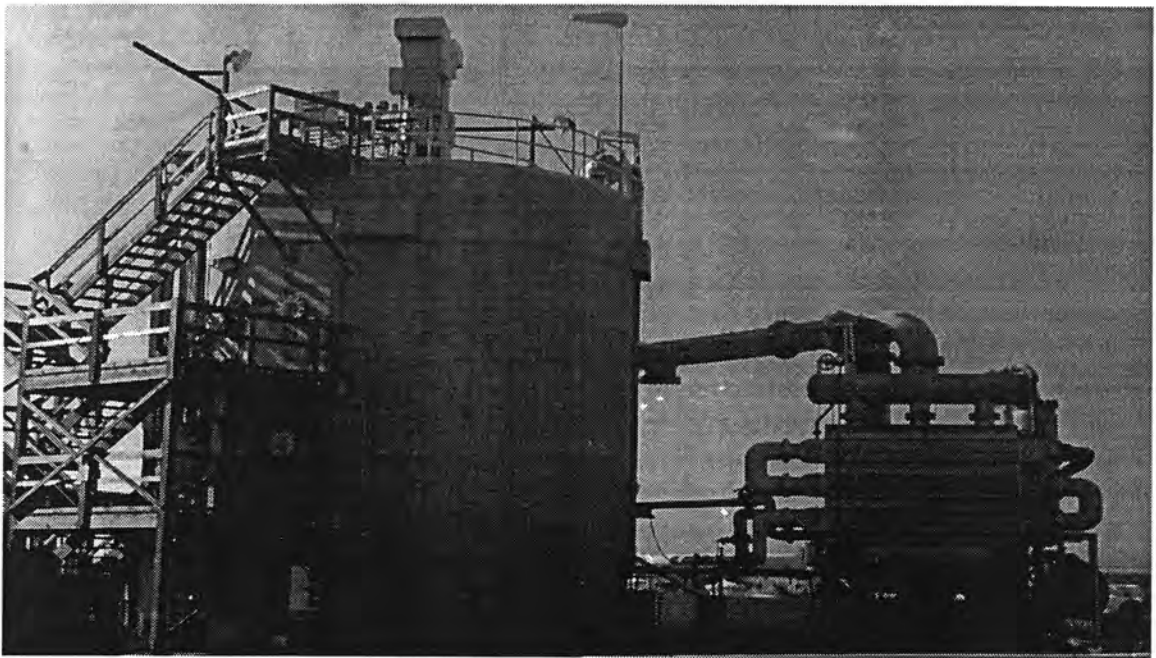
After a year of effort aimed at identifying the source of the problem and devising schemes for refurbishing the old panels, ALGOODS agreed at the end of FY97 to re-manufacture new panels using a different spacing technique. The plant will be reconstructed by PICHTR when the new heat exchangers arrive in March 1998, and MOE will then conduct the six-month operational phase with additional funding provided by CEROS to ensure collection of the data for the 1 MW design.

OPEN-CYCLE OTEC. The U.S. Department of Energy funded open-cycle research at NELHA beginning in about 1986. The Heat and Mass Transfer Scoping Apparatus, constructed in 1988, provided data on the vaporization and condensation of seawater under OTEC conditions that were used in the design of the 210 kW open-cycle plant constructed at NELHA by PICHTR in 1990-91.

This plant, the largest OTEC facility ever constructed, has operated experimentally since 1992, providing important scientific and engineering data for future OTEC designs. Significant results include:

- 1) a large high-speed turbine that works well with the 1/4 psi pressure difference available in an open-cycle system,
- 2) a fluid clutch between the turbine and the generator to allow synchronization for power export,
- 3) development of magnetic bearings to support the very high rotational speeds required for efficient operation of large vacuum pumps,
- 4) production of distilled water from an external surface heat exchanger, and
- 5) development of desalination from a direct contact heat exchanger that uses fresh water pre-chilled by deep seawater in a conventional liquid-to-liquid heat exchanger.

Funding for experimentation with the open-cycle plant has concluded, so PICHTR is preparing to demolish the plant early in FY98.



The most recent Open-Cycle OTEC experiment, a power plant operated by PICHTR for four years, built upon research conducted earlier at NELHA on open-cycle OTEC components. The DOE-funded research contributed valuable data to the growing knowledge base on ocean thermal energy conversion plants.

ANALYTICAL LABORATORY

The Analytical Laboratory collects and disseminates the information needed to protect NELHA's valuable seawater and groundwater resources. This laboratory is well equipped for the task and has established a forward-looking multi-disciplinary environmental monitoring team.

Some highlights of this year's efforts include:

A full year of NELHA's Comprehensive Environmental Monitoring Program (CEMP) was completed, and quarterly reports for the CEMP and the associated National Pollutant Discharge Elimination System (NPDES) permit were submitted as required.

Analytical services were provided to some tenants, as time became available beyond the requirements of the CEMP.

Though reduced funding eliminated the contract work in chemistry and bacteriology for the State Department of Health Blue Waters Monitoring Program, NELHA has negotiated a contract that begins early in FY98 with Department of Transportation Airports Division for sampling and analyses of new groundwater monitoring wells at Keahole Airport.



Water quality monitoring is an important function of the Analytical Laboratory.

MARKETING AND PUBLIC RELATIONS

The primary target markets to which NELHA promotes itself include groups involved in research, demonstration, and commercialization in the fields of aquaculture, alternative energy, biotechnology, ocean instrumentation, and ocean research projects. Organizations which can take advantage of the unique resources at Keahole are asked to consider locating their new business ventures here. Those who can produce niche or high value products have the best chance of becoming successfully competitive on the world market.

NELHA uses a variety of marketing tools, including display ads in industry journals, direct mail, displays and presentations at conferences, television coverage, radio spots, newspaper and magazine articles, networking with industry leaders, electronic web pages, Internet newsgroups and listservs, public presentations, and on-site seminars.

Video tapes introducing NELHA are made available to serious potential tenants and are also being distributed to marine laboratories, universities, and industry organizations across the nation.

The Marketing section provides assistance to potential tenants in locating start-up funding, preparing proposals and business plans, and in obtaining assistance through other state agencies such as the Aquaculture Development Program (DLNR), the Immigrant Investor Program (DBED&T), the Business Action Center (DBED&T), the University of Hawaii at Hilo's Small Business Development Center (UH-SBDC), the Kona-Kohala Chamber of Commerce, the Department of Labor and Industrial Relations, and other organizations.

A Small Business Resource Center at NELHA provides business assistance literature, outlines for business and marketing plans, and provides a computer for tenant and potential tenant use. Information on aquaculture, energy, ocean science, and general business is located in the NELHA library adjacent to the Small Business Resource Center.

Additionally, an informal agreement with the UH-SBDC provides space where their business consulting experts provide free consulting services on site at NELHA. Occasional workshops on doing business in Hawaii are also offered here.

EDUCATIONAL OUTREACH AT NELHA

NELHA's unique blend of resources and the potential these resources offer for experimentation in agriculture, aquaculture and energy conversion sets the stage for a vast array of educational opportunities. Exciting and innovative projects underway at NELHA attract the attention of educators, students, scientists, dignitaries, residents, and tourists. Throughout the year thousands of visitors make their way to Keahole Point to see for themselves the tenants' activities and marvel at the techno-science adventures undertaken by these pioneers.



Tours of NELHA showed visitors live specimens of some of the aquacultured products grown at Keahole Point.

The NELHA staff struggled to meet this high demand in several ways. The marketing section offered one public tour per week, which filled routinely, with between 50 and 60 participants, and serviced some 2500 to 3000 visitors in 1997. Many groups request special tours, on the average of twice a week. Staff members have attempted to provide tours as time allowed, and have hosted at least 700 special tour visitors. Many groups have had to be turned away, however, and have thereby missed the opportunity to hear about the new developments at the NELHA facility.

Through collaboration with UH Sea Grant Extension Service and the West Hawaii Explorations Academy, NELHA has also provided educational tours for thousands of public and private school students from throughout the islands over the last three years. With this program, high school students are trained to teach elementary students about Hawaii's marine ecosystems and describe various tenants' projects. Last year this cross-peer teaching program, known as Aloha Kai, worked with over 3100 visiting students, teachers and

parents. Again, the demand is great, and many teachers requesting an Aloha Kai tour have been turned away, missing a chance to learn about Hawaii's marine environment and NELHA's facility.

CONTRACTS AND PERMITTING

Subleases, Facility Rental Agreements and Facility Use Agreements were negotiated and executed with several different tenants.

Several new negotiated service agreements and contracts were completed for:

- Biota Monitoring
- Security Services
- Janitorial Services
- Revenue Bond Financing
- Animal Health Management and Surveillance
- Offshore Seawater Monitoring Dive Services

The Legislature approved two new Capital Improvement Projects for:

- HOST Park Electrical Upgrades
- HOST Park 8-inch Freshwater Main and Electrical Distribution Upgrades

Several land use permit applications were filed with the County of Hawaii Planning Department, the Department of Land and Natural Resources, the Department of Health, the U.S. Army Corps of Engineers, the Hawaii Coastal Zone Management Office, the Land Use Commission, and the Department of Health.



Support from the Fiscal Office is one of the many behind-the-scenes functions handled by the NELHA Administration.

FISCAL OFFICE

The NELHA fiscal staff works closely with the State of Hawaii Department of Budget and Finance, the Department of Accounting and General Services, and the Department of Business, Economic Development & Tourism to manage the financial resources of NELHA. Also, prior to the set-up of the Kona CEROS offices at the Keahole facility, the NELHA Fiscal Office handled all local requirements for the project. This, in conjunction with the absence of two staff persons due to FY96 budgetary cuts, put added workload on this office. The NELHA fiscal office is especially commended for its efforts to assist the NELHA administrative office through these difficult times.

In addition to responding to the many reporting requirements of the State, the NELHA Fiscal Office was instrumental in assisting the facility through significant budget revisions and the task of working towards the goal of becoming more self-sustaining.

As NELHA moves forward to become increasingly economically self-sustaining, the fiscal staff continues to provide critical data and guidance to help the administration meet its goals.

The Fiscal Office's responsibilities also include day to day management and the oversight of:

- Accounts Payable and Accounts Receivable
- Inventory of Fixed and Movable Assets
- Petty Cash Disbursements
- Purchasing
- Budgeting
- Tracking of General, Special, Federal, and Capital Improvement Funds



FINANCIAL OVERVIEW



FINANCIAL OVERVIEW

STATEMENT OF OPERATIONS

(For the period July 1, 1996 through June 30, 1997)

REVENUES

General Funds

State Funds	\$1,216,876.00
Restrictions	0.00
<i>Subtotal</i>	<i>\$1,216,876.00</i>

Special Funds

Land Use Fees	\$234,735.05
Reimbursables	491,625.62
Interest Received	45,893.17
Vending Machine Sales	266.49
T-Shirt Sales	0.00
Percentage Rents	8,775.35
<i>Subtotal</i>	<i>\$781,295.68</i>

Total Revenues ***\$1,998,171.68***

EXPENDITURES

General Funds

Salaries	\$686,684.85
Kona Operations	467,221.55
Puna Operations	8,763.50
<i>Subtotal</i>	<i>\$1,162,669.90</i>

Special Funds

Operations	<u>\$514,407.00</u>
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Total Expenditures ***\$1,677,076.90***

NELHA FINANCIAL POSITION

Special Fund Balance as of July 1, 1996	\$1,138,656.35
State General Fund Appropriations	1,216,876.00
Prior Year Special Fund Adjustments	1,899.30
Special Fund Revenues	781,295.68
<i>Subtotal</i>	<i>\$3,138,727.33</i>
General Fund Expenditures	\$1,162,669.90
Special Fund Expenditures/Journal Entries	514,407.00
Unrequired G/F Returned to State Treasury/DBEDT	54,206.10
<i>Subtotal</i>	<i>\$1,731,283.00</i>
<i>Ending Special Fund Balance as of June 30, 1997</i>	<i>\$1,407,444.33</i>

INFORMATION FOR PROSPECTIVE TENANTS

STANDARD FORM NO. 64
INFORMATION FOR PROSPECTIVE TENANTS
STANDARD FORM NO. 64

NELHA WEB PAGE

KEAHOLE OCEAN SCIENCE IN THE VIRTUAL WORLD

The Natural Energy Laboratory of Hawaii Authority and its projects are described at the NELHA website on the Internet, the electronic superhighway:

<http://bigisland.com/nelha>

Here visitors can learn about the facility, its mission, and its projects from the comfort of a home or office computer station.

NELHA and some of its tenants as well entered cyberspace in the last few years with their own electronic home pages. The World Wide Web (WWW) provides visitors to web sites not only with textual information but also digitized graphics, illustrations, photographs, and sometimes even soundbytes and video clips. The NELHA web site serves both marketing and educational functions, broadening the facility's public outreach.

The electronic medium has allowed NELHA and its tenants to reach an international audience worldwide. URLs for other NELHA projects include:

http://www.aquasearch.com	Aquasearch, Inc.
http://www.aloha.com/~craven	Common Heritage Corp.
http://www.cyanotech.com	Cyanotech Corporation

SERVICES AVAILABLE TO NELHA TENANTS

OPERATIONS AND MAINTENANCE

- Seawater Systems
- Equipment Rental and Repairs
- Heavy Equipment Operators
- Mechanical Technicians
- Plumbing, Welding
- Metal and Wood Shop
- Fabrications
- Marine Operations

ENGINEERING

- Piping Design
- Site Development
- Computer-Aided Drafting (CAD)
- Utility Design Analysis

ANALYTICAL LABORATORY

- Certified Environmental Laboratory
- Environmental Monitoring Services
- Chemical Analysis
- Microbiological Analysis
- Microbiological Reference Library
- Technical Assistance
- Instrumentation Rental

ADMINISTRATION

- Clerical Support
- Leases and Service Contract Support
- Telecommunications Support
- Fiscal Support
- Graphic Design
- Educational Programs
- Business Development and Marketing Assistance

PROJECT APPLICATION PROCEDURES

NELHA welcomes applications from individuals, businesses, research organizations, and educational facilities desiring to perform research, commercial, or educational activities at Keahole Point. The professional and skilled staff at NELHA apply their scientific and business knowledge to assist tenants during all phases of operation, from research and development to product commercialization. The NELHA staff assists projects through a smooth transition from R&D to fully operational businesses.

PROJECT APPROVAL

Projects that wish to locate at NELHA should follow the procedures outlined in the Project Initiation Packet (PIP). A preliminary proposal is submitted to the NELHA Board of Directors for approval. Projects must fit within the mission of NELHA, utilizing the unique resources available on-site, while not harming the environment. The Board seeks projects that will make significant contributions to the advancement of research, education, or economic development for the region. Research projects require only the preliminary stage of approval. Commercial projects must complete a second stage approval that includes the submission of a business plan and financial projections. Individuals or businesses with an interest in starting a project at NELHA are invited to submit proposals following the outline in the PIP.

INCUBATION FOR START-UP BUSINESSES

NELHA is the only ocean science and technology park of its kind in the world. The objective of the facility is to encourage economic development and diversification through the management of a state-owned facility which leases land and provides services for projects whose operations require the unique resources available at Keahole Point. Through the support NELHA provides to business start-ups, it is incubating the development of new industries that are offering economic alternatives to tourism and traditional agriculture in Hawaii.



APPENDIX



APPENDIX

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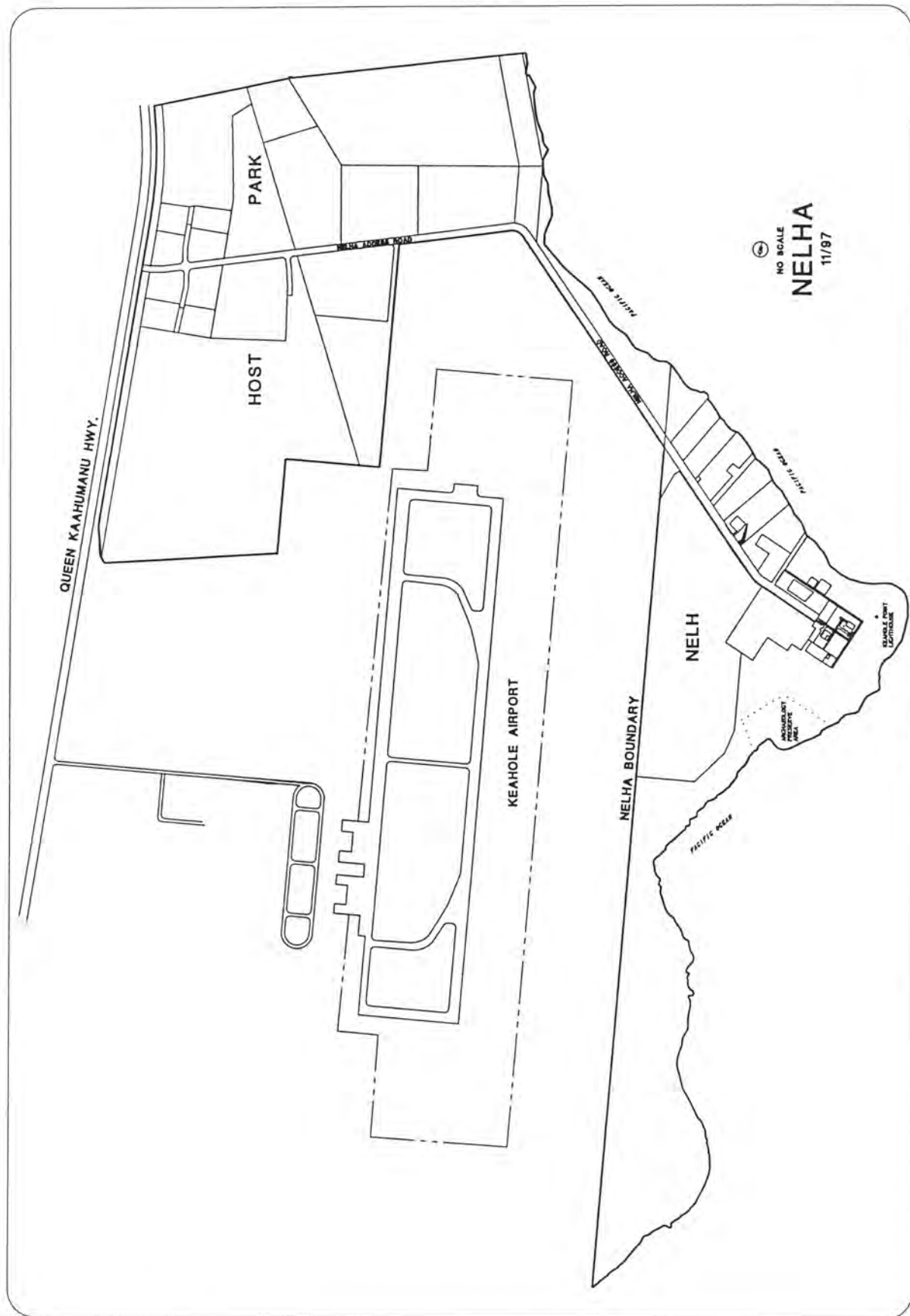
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