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Addendum to the Final Report: Analysis of How Post-harvest Processing Technologies for Controlling *Vibrio vulnificus* Can Be Implemented

Contract No. HHSF22320710273G, Task Order 14

Final Report

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Contents

Tables

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DISCLAIMER

The results presented in this report are based in part on data and information provided by companies that currently manufacture post-harvest processing (PHP) equipment or conduct PHP activities for raw oysters. The use or mention of any trade names, commercial products, or company names in this report does not constitute an endorsement or recommendation for use by RTI International. Furthermore, RTI has no opinion on whether PHP of oysters should be required, nor, if processing was required, on which products should be included in a requirement.

Executive Summary

All results shown in this draft report are preliminary and may be revised following final review of the data and calculations.

In March 2011, RTI International completed a study for the Food and Drug Administration (FDA) analyzing the feasibility and economic impacts of requiring post-harvest processing (PHP) of Gulf state (Alabama, Florida, Louisiana, Mississippi, and Texas) oysters harvested in the summer (April through October) and intended for raw half-shell consumption. In September 2011, the Government Accountability Office (GAO) released a report that reviewed the FDA's and Interstate Shellfish Sanitation Conference's (ISSC's) efforts to reduce illnesses caused by consuming oysters contaminated with *Vibrio vulnificus* bacteria. Among its findings, GAO identified several concerns and data gaps in the March 2011 report.

The purpose of this addendum to the original report was to address specific concerns and data gaps as requested by FDA. Specifically, this addendum more fully estimates the costs of establishing central PHP facilities in the Gulf, includes transportation costs to haul oysters to a central PHP facility, includes costs of insurance on PHP equipment and plant space, and includes costs of validation and verification of PHP processes. Using these additional data, we updated analyses of the per-oyster industry costs, estimated facility closures, and market impacts of PHP requirements. Because most Gulf states will allow intrastate sales of half-shell oysters that have not undergone PHP, the market impacts model was also revised to differentiate between intrastate and interstate sales of Gulf half-shell oysters.

In addition, we revisited the timeline for installing and operating PHP capacity in the Gulf and identified possible financing options for purchasing PHP equipment and facilities.

The key results of the additional analyses are as follows:

- On a per-oyster basis, estimated costs of cool pasteurization and high hydrostatic pressure (HHP) processing range from $0.043 to $0.078 for raw half-shell oysters and –$0.030 to $0.005 for shucked oysters, including annualized capital and annual operating costs.
- The estimated costs of transporting oysters to and from central PHP facilities averages $0.073 cents per oyster, but they would be substantially lower or higher depending on the location of the oyster processor and the actual central PHP facilities (if built).
- Total initial investment costs associated with PHP for Gulf oysters range from $24.0 to $50.8 million, depending on which process is installed; approximately 57 to 82% of these costs would be associated with establishing central PHP facilities.
- Annual costs, including initial investment costs amortized over 20 years for the cool pasteurization process and 10 years for the HHP process, and operating costs, associated with PHP for Gulf oysters range from $11.2 to $13.0 million; approximately 41 to 47% of these costs would be associated with using central PHP facilities and the costs of transporting oysters to these facilities.
- Among the oyster processors that currently do not operate but likely have sufficient capacity to install PHP equipment, nearly all are predicted to close based on current prices. However, prices would likely adjust upward based on the economic model results, thus offsetting some of the costs of PHP.
- Among the smaller oyster processors that would need to rely on a central PHP facility, 40% are predicted to close based on current prices (unless they can sell all of their half-shell oysters intrastate). However, prices are likely to adjust upward based on the economic model, thus offsetting some of the costs of PHP.
- Based on the revised cost estimates, PHP requirements are predicted to result in the following ranges of market effects in the Gulf region, assuming consumers are indifferent between processed and traditional oysters:
  - raw "interstate" half-shell Gulf oysters in the summer
    - 7.9 to 15.4% increase in price

    - 4.2 to 4.3% decrease in volume
  - raw "intrastate" half-shell Gulf oysters in the summer
    - 0.5% decrease to 0.9% increase in price
    - 0.4 decrease to 0.8% increase in volume
  - shucked Gulf oysters in the summer
    - 2.3 decrease to 4.1% increase in price
    - 2.9 to 4.7% increase in volume

  The predicted changes will offset some of the costs of PHP but will not be enough to prevent all closures. In particular, the predicted changes are aggregate changes across all market participants, and individual processors may experience different effects based on their sizes and locations and whether they incur transportation costs to a central PHP facility.

- Interviews with several industry participants confirmed the timeline estimates in the March 2011 report of 2 to 3 years to install and begin operating PHP equipment in the Gulf. Some respondents believed that it would take even less time.
- Based on the interviews and information searches, public financing opportunities for PHP operations and equipment are generally in the categories of tax credits or exemptions, low-interest loans or loan guarantees, or grants from state or federal government. From our interviews with economic development organizations, companies that might be planning to install PHP equipment would be more likely to qualify for assistance if the opportunity involves creating new jobs. However, this varied by region, depending on the type of development the region is trying to encourage.

In summary, if PHP requirements are imposed, some operations would be able to install PHP equipment or use central PHP facilities (if they were constructed), and some opportunities to obtain financing are available. However, the analysis shows that PHP requirements would likely cause the closure of a significant number of oyster processors in the summer unless there is a substantial market for oysters that have not undergone PHP within the state of harvest. Even if PHP services are available through central PHP facilities (or possibly by obtaining PHP services from another operation), approximately 40% of Gulf oyster processors are estimated to become unprofitable and close.

In considering the results of this analysis, it is important to keep in mind that the Gulf oyster industry continues to face ongoing challenges because of the Gulf oil spill and fresh water diversions in 2010, historic flooding of the Mississippi river in the spring of 2011, and red tide along the Texas coast in the fall of 2011. These challenges add to the difficulties in complying with a requirement for PHP because operations are reluctant to invest in facilities and equipment until it is known whether oyster harvests will improve.

1 Introduction

This addendum to the March 2011 report on costs and feasibility of PHP requirements for summer-harvested Gulf half-shell oysters incorporates additional cost data into the analysis and provides additional information on possible financing opportunities for PHP and the timeline for implementation of PHP requirements.

In March 2011, RTI International completed a study for the Food and Drug Administration (FDA) analyzing the feasibility and economic impacts of requiring post-harvest processing (PHP) of Gulf state (Alabama, Florida, Louisiana, Mississippi, and Texas) oysters harvested in the summer (April through October) and intended for raw half-shell consumption. Applicable PHP methods are those that have been determined to reduce *Vibrio vulnificus* to nondetectable levels, including cool pasteurization, cryogenic individual quick freezing (IQF) with extended frozen storage, high hydrostatic pressure (HHP) processing, and low-dose gamma irradiation. Requirements would specifically apply to interstate shipments of oysters harvested from the Gulf, and oysters could be post-harvest processed before or after crossing state lines. Individual Gulf states would decide whether intrastate shipments would also be subject to the requirements if implemented.

In September 2011, the Government Accountability Office (GAO) released a report that reviewed the FDA's and Interstate Shellfish Sanitation Conference's (ISSC's) efforts to reduce illnesses caused by consuming oysters contaminated with *Vibrio vulnificus* bacteria. Among its findings, GAO identified several concerns and data gaps in the March 2011 report. This addendum to the original report addresses specific concerns and data gaps as requested by FDA.

Based on data availability, we conducted the previous analyses using data for 2008. For the revised analyses, we continued to use 2008 data as the baseline for oyster harvest volumes under the assumption that 2008 is generally typical of oyster harvest volumes over the long run. Harvest volumes in the Gulf

remained relatively consistent from 2008 to 2009, increasing by approximately 2 million pounds. This increase was primarily attributable to Louisiana, presumably due to the industry's rebound after Hurricanes Gustav and Ike in 2008.

However, recent events have negatively affected oyster harvest volumes since then, including the Deepwater Horizon oil spill in April 2010 and the historic flooding of the Mississippi River in April and May 2011. Both of these events resulted in numerous harvest area closures and significant death of oysters from fresh water diversions, causing substantial reductions in oyster harvests for 2010 and 2011. Gulf oyster harvests fell in 2010 from over 22 million pounds in 2009 to 15 million pounds in 2010. Again, this decrease was primarily attributable to Louisiana, whose harvest volumes decreased by 8 million pounds, though it was slightly offset by an increase in Texas's production of almost 2.5 million pounds. Although 2011 landings data have not been released yet, we anticipate that Gulf harvest volumes again decreased in 2011. The presence of red tide along the Texas coast forced the closure of all oyster harvest areas for the entire state of Texas just as the fall season was set to begin. These events (freshwater diversions and red tide) will likely reduce oyster harvests for several years into the future. Therefore, in considering the effects of PHP requirements, it is important to keep in mind that additional challenges may be encountered because of lower than typical harvest volumes.

1.1 PROJECT BACKGROUND

Vibrio vulnificus is a naturally occurring bacterium found in seawater along the Gulf, Atlantic, and Pacific Coasts, although it is most prevalent in the warm waters of the Gulf of Mexico. *Vibrio vulnificus* can be transmitted to humans through the consumption of raw shellfish harvested from waters containing the organism. Oysters from the Gulf of Mexico have been recognized as the primary species of molluscan shellfish associated with *Vibrio vulnificus* illnesses in consumers. Although *Vibrio vulnificus* does not normally affect healthy individuals, persons who are immunocompromised, especially those with chronic liver disease, are at greater risk for contracting *Vibrio vulnificus* from oyster consumption. In immunocompromised individuals there is a risk for the organism to invade the bloodstream resulting in potentially

fatal septicemia. Although the annual number of reported *Vibrio vulnificus* illnesses associated with oyster consumption is low, generally in the range of 30 to 35, the incidence of death among those individuals who contract the disease is high, at approximately 50%.

Over the past decade, the federal government has devoted significant resources to reduce foodborne illness from all sources. However, Centers for Disease Control and Prevention (CDC) data show that the national incidence of *Vibrio vulnificus* illness from raw oyster consumption has essentially remained constant. The epidemiological record indicates an annual occurrence of multiple *Vibrio vulnificus* infections associated with consumption of raw oysters from the Gulf of Mexico during April through October, with increasing evidence suggesting that November may be a key month as well. FDA does not believe that current measures aimed at reducing the hazard, but which fall well short of eliminating it, are sufficient. Those efforts are primarily focused on promulgating the requirements for mandatory time from harvest to refrigeration and refrigeration to internal oyster temperature. However, controls such as implementation of time and temperature requirements and educational efforts for consumers and health care providers have not been effective in reducing the risk of *Vibrio vulnificus* illness.

No longer satisfied with the progress being made under the National Shellfish Sanitation Program (NSSP) plan, in October 2009 FDA announced its intent to reformulate its policy on controlling *Vibrio vulnificus* in raw oysters as it relates to the federal *Seafood HACCP Regulation*, 21 CFR Parts 123 and 1240, specifically as it relates to PHP of Gulf oysters during the warm-weather months that are intended for raw consumption. Since making that announcement, FDA heard from Gulf Coast oyster harvesters, state officials, and elected representatives from across the region about the feasibility of implementing PHP or other equivalent controls by the summer of 2011. As a result of these discussions, FDA recognized a need to further examine the process and timing for large and small oyster harvesters to gain access to processing facilities or equivalent controls to address this important public health goal. Therefore, in a second October 2010 statement FDA announced that before proceeding, the Agency will conduct an independent study to assess how PHP or other equivalent controls can be feasibly

implemented in the Gulf Coast in the fastest, safest, and most economical way. In January 2010, FDA commissioned a study to analyze how PHP can be implemented for controlling *Vibrio vulnificus*.

It is important to keep in mind that PHP requirements will apply only to oysters shipped interstate. However, some states may choose to also require PHP for oysters sold within the state (i.e., intrastate shipments). Some proportion of oysters is currently only shipped intrastate, and this proportion may change depending on how each state chooses to implement the requirements.

In 2010, Congress asked the GAO to review FDA and ISSC efforts to reduce illnesses caused by consuming oysters contaminated with *Vibrio vulnificus* bacteria. As part of that effort, GAO studied the findings of the FDA-commissioned study conducted by RTI to examine how PHP can be implemented for controlling the risk of *Vibrio vulnificus* associated with Gulf oysters. In its report the GAO identified several concerns and data gaps specific to the RTI report and their potential impact on the outcome of RTI's findings and conclusions.

1.2 PROJECT OBJECTIVE

The objective of this task order is to conduct additional work to address GAO's concerns regarding the current findings and data limitations of the March 2011 RTI report *Analysis of How Post-Harvest Processing Technologies for Controlling Vibrio vulnificus Can be Implemented* (Muth et al., 2011).

Specifically, FDA requested these additional data:

- costs associated with purchasing land for the expansion of existing oyster facilities and construction of new centralized facilities using the six possible locations identified in the previous analysis (Muth et al., 2011);
- costs associated with new construction of centralized PHP facilities using the six possible locations identified in the previous analysis;
- costs associated with insurance coverage for additional processing plant space and PHP processing equipment;
- costs associated with transporting oysters to and from existing and centralized PHP facilities by industry

members without PHP capability using the six possible locations identified in the previous analysis;[1]

- possible sources and financing opportunities that industry and/or states might be able draw on to assist in financing costs associated with PHP development, such as land purchase, equipment purchase, and equipment installation; and
- the timeline required for activities associated with developing and implementing PHP for private and public operations.

To obtain these data, we will use a combination of publicly available government and nongovernment sources and industry interviews to obtain unpublished data. Because limited time and resources prevented obtaining Office of Management and Budget (OMB) clearance for conducting formal surveys, data collection was limited to no more than nine respondents for each specific list of discussion topics.

Using these data, FDA requested additional analyses as follows:

- Step 1. Update per-oyster cost estimates for installing PHP equipment in private operations and developing central PHP facilities to account for costs of land purchase, new construction of central PHP facilities, insurance costs, and transportation costs.
- Step 2. Update the total industry cost estimates associated with applying PHP to raw half-shell oysters harvested from the Gulf states during the months of April through October (all raw half-shell oysters and only interstate shipments of raw half-shell oysters) using the new cost estimates developed in Step 1.
- Step 3. Update the facility closure analysis using the new cost estimates developed in Step 1.
- Step 4. Revise the economic impact model to account for the allowance by Gulf states for intrastate shipment and sale of untreated oysters and input the new cost estimates developed in Step 1 to estimate new price and quantity impacts.

[1] Based on the previous task order research, it appears unlikely that existing oyster operations with PHP equipment will offer PHP services to other oyster processors. Therefore, the most appropriate assumption for calculating transportation costs is that oyster processors will obtain PHP services from central PHP facilities.

1.3 STATUS OF LEGISLATION REGARDING INTRASTATE SHIPMENTS OF OYSTERS IN THE GULF STATES

As suggested by the discussion above, if a requirement for PHP of oysters were implemented, the economic effects would be affected substantially by whether the Gulf states would allow intrastate shipments of oysters harvested and consumed in the state. The current status of this legislation is as follows:

- Alabama—no current plans for legislation but also has a very limited summer harvest (McCool, 2011).
- Florida—no current plans but the industry might pursue legislation if a requirement were implemented (Palmer, 2011).
- Louisiana—legislation signed into law on October 20, 2011, that allows intrastate transport, sale, and consumption of raw oysters that have not been post-harvest processed (RS 56:437).
- Mississippi—no current plans for legislation but it may be pursued if a requirement were implemented although Mississippi has a very limited summer harvest (Jewell, 2011).
- Texas—legislation signed into law on May 20, 2011, that allows for intrastate transport, sale, and consumption of raw oysters that have not been post-harvest processed (SB 397).

For the purposes of the analysis, we assumed that legislation would be passed in all states by the time that a PHP requirement was implemented.

1.4 ORGANIZATION OF THIS REPORT

The remainder of this report is organized as follows. Section 2 describes the data collection procedures and results of data collection on the additional costs associated with PHP, financing opportunities for PHP, and timeline for implementation of PHP for establishments that currently do not have the capability to apply PHP to Gulf half-shell oysters. Section 3 provides the updated results of the analysis of total industry costs, business closure, and market assessments if PHP of all summer-harvested Gulf oysters intended for the raw half-shell market were required and applied to interstate shipments. Finally, Appendix A lists the broad topics of discussion for each set of interviewees.

2 Supplemental Data on Costs and Feasibility of PHP

In this section, we describe the process we followed to obtain additional cost data associated with PHP of oysters, financing opportunities for central PHP facilities, and the timeline required for installing PHP equipment or establishing central PHP facilities. To develop the cost estimates using the data we obtained, we developed plausible assumptions based on information from the original report or provided by industry participants during interviews for this addendum. In Section 3, we integrate the cost estimates from this section into the updated analysis of total industry costs, potential closures, and market impacts.

2.1 LAND PURCHASE AND NEW CONSTRUCTION COSTS

The updated cost analysis assumes a total cost of $175,000 for land and $266,000 for land preparation for a 2.5-acre lot for a 20,000 square foot central PHP facility.

To estimate land purchase costs and new construction costs associated with establishing central PHP facilities, we relied on real estate Web sites (www.showcase.com and www.costar.com) and information provided by local realtors in Louisiana, economic development organizations, and oyster processors. Note that in developing the cost estimates presented in the March 2011 report, we included the costs of adding square footage to existing establishments to allow for

installation of PHP equipment.[2] However, the entire facility would need to be constructed (or purchased and modified) for central PHP facilities.

To estimate the costs of land associated with establishing central PHP facilities, we assumed that a 1-acre lot would be required for a 7,500 square foot (small) and a 2.5-acre lot would be required for a 20,000 square foot (large) facility including the driveway, parking lot, and loading docks. The cost of land varies substantially depending on whether a particular lot is in a rural, industrial, or urban area and whether the land is waterfront or inland. These factors appear to have a greater influence on the cost of land than the state in which the land is located. Based on the data we obtained, the cost for a 2.5-acre lot in an area that would be suitable for a central PHP facility ranged from approximately $75,000 to $315,000. For the analyses conducted in Section 3, we used the average value of $70,000 for a 1-acre lot or $175,000 for a 2.5-acre lot as the basis of the cost estimation.

In addition to the costs of the land itself, establishing a PHP facility would require site development costs such as installing utilities, a parking lot, a driveway, loading docks, and a detention pond and testing and permitting costs. Using information provided by the Terrebonne Economic Development Authority, we assumed that these costs will total approximately $266,000 for each central PHP facility. This estimate is a lower-bound estimate because there may be other costs such as architectural and engineering, geotechnical reporting,

[2] Although many existing establishments we spoke with have land available to expand their facilities in their current locations, others do not and would need to move their entire operations to allow for installation of PHP equipment. Many different factors affect the viability of a business in a particular location. In the context of this study, it is not feasible to determine which establishments have insufficient land to expand their plants in their existing locations or predict which of those establishments would choose to stop producing half-shell oysters (or possibly only ship half-shell oysters intrastate) in the summer months rather than undergo the considerable expense and business risk of moving their operations.

surveying, civil engineering, and landscaping (Terrebonne Economic Development Authority, 2011).[3]

The cost analysis uses as estimated cost of $150 per square foot for construction costs.

In the March 2011 report, we used an average building cost of $150 per square foot to estimate the total costs of expanding an existing operation to accommodate PHP equipment. The cost of construction varies depending on distance from the coast, the quality of the construction, and the features of the facility (e.g., size and number of coolers, size of office space, ceiling height, and floor reinforcement due to weight of equipment[4]). Based on the data we obtained, estimates of the cost of construction ranged from $45 to $200 per square foot. Because a central PHP facility would require a higher ceiling height for a vertical PHP process or reinforced floors for horizontal processes and coolers for incoming and outgoing product, we believe the cost per square foot is likely on the higher side of the range. Thus, we used the same estimate of $150 per square foot as in the March 2011 report.

2.2 INSURANCE COSTS FOR PLANT EXPANSION AND EQUIPMENT

The updated cost analysis assumes annual insurance costs are 3% of the insured assets.

To estimate the costs of insurance for additional plant space and PHP equipment in existing establishments and for the entire facility and equipment in PHP facilities, we obtained estimates of the annual cost per million dollars of assets from www.eleaseinternational.com, economic development organizations, and oyster processors. Estimating the costs of insurance is particularly challenging because the costs vary substantially depending on location (particularly distance from the coast) and the deductible for the policy. A few processors said that they typically self-insure and, thus, were unable to provide estimates of the costs of insurance.[5]

[3] The cost estimates provided by the Terrebonne Economic Development Authority were as follows: architectural and engineering (8.5%)—$307,000; geotechnical report—$7,000; surveying—$8,000; civil engineering—$40,000; and landscaping—$20,000. However, it is unclear whether establishments would require these services or whether the cost estimates are representative.

[4] For example, the horizontal HHP equipment from Avure requires a 14-inch concrete slab floor due to the weight of the equipment.

[5] In some cases, processors stated they are unable to find a company that will provide insurance coverage; thus, their only option is to self-insure.

Based on the data provided to us, annual insurance costs range from 0.7% to 5% of the value of the insured assets (assuming that an insurance company is willing to provide insurance coverage). For estimating costs of insurance for processors installing PHP equipment and for central PHP facilities, we used a midpoint value of 3% of the value of the insured assets. For example, $1,000,000 in insured assets would result in a $30,000 annual premium.

2.3 TRANSPORTATION COSTS TO CENTRAL PHP FACILITIES

The updated cost analysis uses an estimate of $2.43 per mile and assumes each processor using a central PHP facility would make three round trips per week.

Gulf oyster processing establishments that would need to rely on a central PHP facility to obtain PHP services would incur costs to ship oysters to and from the central facility during the warm-season months. In conducting the geographic information system (GIS) analysis in the March 2011 report, we identified approximate optimal locations for central PHP facilities and obtained estimates of the number of miles (using highway driving distances) from the location of each processing facility to the central PHP facility. To estimate the costs of transporting oysters to obtain PHP services, we needed to estimate the cost per mile for refrigerated truck transportation and make an assumption about the number of round trips that would be made during the summer months to obtain PHP services. In addition, to estimate the transportation cost per half-shell oyster for use in the economic impact model, we needed to estimate the total volume of oysters that would be transported.

To obtain data on the cost per mile for refrigerated truck transportation, we interviewed several oyster processors (both those that operate PHP equipment and those that do not) and a refrigerated truck transportation company in the Gulf region. A couple of the respondents stated an operating cost of $1 per mile for refrigerated truck transportation excluding the amortization costs of the truck itself. The remainder of the respondents who included the full costs of refrigerated truck transportation or the price of providing refrigerated transportation services quoted values ranging from $2.11 to $3.00 per mile with an average value of $2.43 per mile. These estimates are similar to the second quarter 2011 national estimate of $2.54 and the third quarter 2011 national estimate of $2.64 per mile published in the Agricultural Marketing

Service's Agricultural Refrigerated Truck Quarterly (USDA/AMS, 2011).

For each facility that would likely need to rely on a central PHP facility, we assumed that the operation would make three round trips each week from April through October to the closest of the following hypothetical locations identified in the March 2011 report:

- San Antonio, TX 78279
- Bayou La Batre, AL 36509
- New Orleans, LA 70195
- Houma, LA 70361[6]
- St. Augustine, FL 32086
- Apalachicola, FL 32329

We then calculated the operation's total additional costs of transportation as follows:

- Number of trips per year: 7 months × 4 weeks/month × 3 trips/week = 84 trips
- Number of miles per year: 84 trips × 2 × number of miles to central PHP facility
- Costs per year: Number of miles per year × $2.43 per mile

We then calculated transportation costs per oyster by dividing the costs per year by the estimated volume of half-shell oysters shipped interstate from April through October for each facility. As explained later in Section 3.2.1, the resulting average transportation cost estimate is $0.073 per oyster. We assumed that oyster processors would only apply PHP to half-shell oysters intended for interstate shipment based on the expectation that all states would allow intrastate shipments of untreated oysters, which is equivalent to Scenario 2 in the March 2011 report (see Section 1.3 for information regarding the status of state legislation).

For many operations the estimated volume of half-shell oysters shipped interstate is extremely small; thus, it is likely they would discontinue interstate shipments during the summer. Furthermore, because our estimates rely on extrapolated data

[6] Because 70361 represents post office boxes, the closest logical zip code is 70363 for the east side of Houma.

on processing volumes for each facility, an individual operation's costs may differ substantially from our estimated costs.

2.4 VALIDATION AND VERIFICATION COSTS

The updated cost analysis assumes process validation costs of $15,000 and monthly verification costs of $1,000 per month for a typical size process.

Although the statement of work for this task order did not specifically request reevaluating the costs of validation and verification of PHP processes, these costs were mentioned during our supplemental data collection process. Validation costs refer to the one-time costs of validating a process to ensure that it can achieve the required reductions in pathogens after new equipment is installed. Verification costs refer to the periodic testing costs that verify the process is continuing to achieve the required reductions. For the analyses in the March 2011 report, the costs of validation and verification were not explicitly accounted for because they were not identified separately during the industry interviews. However, to ensure completeness of the revised analysis, we requested information on validation and verification from operations currently operating HHP and cool pasteurization equipment.

The information on validation and verification costs varied widely depending on the length of time the equipment had been in place, the number of products tested, and the frequency of verification testing (i.e., whether samples are drawn and tested monthly or quarterly). For updating the analysis, we used the most recent estimates available. Specifically, we assumed validation costs of $15,000 and verification costs of $1,000 per month; these estimates include lab fees and materials costs. Although the total costs for larger processors are not insignificant, when expressed on a per-oyster basis, the incremental costs associated with validation, which is amortized over the length of the equipment life, and verification, which occurs monthly or quarterly, are relatively small.

2.5 FINANCING OPPORTUNITIES

Most of the industry respondents we talked with believe that it would be extremely difficult, if not impossible, to obtain private financing for PHP operations because of the inherent riskiness of oyster production, unknown demand for PHP oysters, and recent events that have decreased oyster harvest volumes. Most of the industry respondents that we spoke to claimed to

have excellent credit but do not believe they can present a valid business plan for PHP based on current oyster market conditions. Thus, public financing options would likely be necessary.

Based on the interviews and information searches we conducted, public financing opportunities are generally in the categories of tax credits or exemptions, low-interest loans or loan guarantees, or grants. Financing opportunities that are available at the federal and state levels are shown in Tables 2-1 and 2-2, respectively. Although some opportunities are ongoing, others might be in response to specific events, such as hurricane recovery (e.g., the nearly expired GO Zone grants). Of the opportunities that were found, they are all funded by the government (U.S. Department of Agriculture [USDA], SBA, National Oceanic & Atmospheric Association [NOAA], and various state agencies). Among our contacts, no one was aware of any nongovernmental funding opportunity.

Based on our interviews with economic development organizations, companies that might be planning to install PHP equipment would be more likely to qualify for assistance if the opportunity involves creating new jobs. However, this varied by region, depending on the type of development the region is trying to encourage.

2.6 TIMELINE FOR IMPLEMENTATION OF PHP

In the March 2011 report, we listed several activities required for installing HHP or cool pasteurization, as detailed in Table 2-3.

Based on the interviews conducted in 2010, we believed the amount of time required would be as follows:

- For private companies installing within an existing or expanded facility for private use—minimum of 2 years
- For establishing a central PHP facility—minimum of 3 years

Table 2-1. Financial Incentives Available at the Federal Level

Type	Name	Web Site	Who is Eligible?	How May Funds be Used?	Maximum Award
Loan	Business & Industry (B&I) Guaranteed Loans	http://www.rurdev.usda.gov/rbs/busp/b&I_gar.htm	A borrower may be a cooperative organization, corporation, partnership, or other legal entity organized and operated on a profit or nonprofit basis. B&I loans are normally available in rural areas, which include all areas other than cities or towns of more than 50,000 people.	a. Business and industrial acquisitions when the loan will keep the business from closing, prevent the loss of employment opportunities, or provide expanded job opportunities b. Business conversion, enlargement, repair, modernization, or development c. Purchase and development of land, easements, rights-of-way, buildings, or facilities d. Purchase of equipment, leasehold improvements, machinery, supplies, or inventory	Maximum $10 million with some exceptions up to $25 million and up to $40 million on rural cooperative organizations that process value-added agricultural commodities
Grant	Rural Cooperative Development Grants	http://www.rurdev.usda.gov/rbs/coops/rcdg/rcdg.htm	Nonprofit organizations and higher education institutions[7]	The primary purpose is to improve the economic condition of rural areas through the development of new cooperatives and improving operations of existing cooperatives.	$225,000 (matching funds required)

(continued)

[7]Universities and cooperatives could establish a PHP operation and thus qualify for this incentive.

Table 2-1. Financial Incentives Available at the Federal Level (continued)

Type	Name	Web Site	Who is Eligible?	How May Funds be Used?	Maximum Award
Grant	Value-Added Producer Grants	http://www.rurdev.usda.gov/rbs/coops/vadg.htm	Independent producers, farmer and rancher cooperatives, agricultural producer groups, and majority-controlled producer-based business ventures	Planning activities and working capital for marketing value-added agricultural products and for farm-based renewable energy	$300,000 for working capital grants; $100,000 for planning grants
Grant	Rural Business Enterprise Grant Program	http://www.rurdev.usda.gov/rbs/busp/rbeg.htm	Rural public entities (towns, communities, state agencies, and authorities), Indian tribes and rural private nonprofit corporations are eligible to apply for funding	Acquisition or development of land, easements, or rights-of-way; construction, conversion, renovation of buildings; plants; machinery; equipment; access streets and roads; parking areas; utilities	No maximum, though average grants range from $10,000 to $500,000
Loan	Small Business Administration (SBA) Small Loan Advantage and Community Advantage Loans	http://www.sba.gov/content/advantage-loan-initiatives	Financial institutions (currently 630 lenders) participating in SBA's Preferred Lender Program. (Small and emerging private businesses are those that will employ 50 or fewer new employees and have less than $1 million in projected gross revenues.)	Capital for small businesses and entrepreneurs in underserved communities	$250,000

(continued)

Table 2-1. Financial Incentives Available at the Federal Level (continued)

Type	Name	Web Site	Who is Eligible?	How May Funds be Used?	Maximum Award
Loan	CDC/504 Loan Program	http://www.sba.gov/content/cdc504-loan-program	Businesses must meet the SBA definition of a small manufacturer and accomplish one of the following: (1) create or retain at least one job per $100,000 guaranteed by the SBA or (2) improve the economy of the locality or achieve one or more public policy goals [sections 501(d)(2) or (3) of the SBI Act].	For the purchase of land, including existing buildings; improvements, including grading, street improvements, utilities, parking lots, and landscaping; construction of new facilities or modernizing, renovating, or converting existing facilities; long-term machinery and equipment.	$4 million
Loan	NOAA Fisheries Finance Program	http://www.nmfs.noaa.gov/mb/financial_services/ffp.htm	Any U.S. citizen	Provides long-term (20 years or less) financing for the cost of construction or reconstruction of fishing vessels, fisheries facilities, aquacultural facilities, and individual fishing quota.	80% of the value of the construction or equipment. Can be used to finance or refinance expenditures.

Table 2-2. Financial Incentives at the State-Level

Type	Name	Web Site	Who is Eligible?	How May Funds be Used?	Maximum Award
Tax abatement	New Markets Tax Credit	http://www.louisianaeconomicdevelopment.com/opportunities/incentives--programs/new-market-tax-credit.aspx	Private-sector investors	May be used as equity for debt financing	39% federal tax credit available through a special federal allocation for the Louisiana Gulf Opportunity Zone. Qualifying projects may leverage the federal program through an additional 25% state tax credit (64% total credit)
Jobs incentive program	Louisiana FastStart	http://www.louisianaeconomicdevelopment.com/opportunities/incentives--programs/louisiana-faststart.aspx	Any company in Louisiana that commits to creating a net of at least 15 new, permanent manufacturing jobs	Offers in-depth employee recruitment and screening with hands-on assessments, as well as customized training for the complete operation	
Jobs incentive program	Louisiana Enterprise Zone	http://www.louisianaeconomicdevelopment.com/opportunities/incentives--programs/enterprise-zone.aspx	A business hiring at least 35% of net, new jobs from one of four targeted groups	Not specified	Provides one-time $2,500 credit per new job. Rebates 4% sales/use tax on materials, machinery, furniture or equipment.

(continued)

Table 2-2. Financial Incentives Available at the State Level (continued)

Type	Name	Web Site	Who is Eligible?	How May Funds be Used?	Maximum Award
Tax abatement	Louisiana Industrial Tax Exemption	http://www.louisianaeconomicdevelopment.com/opportunities/incentives--programs/industrial-tax-exemption.aspx	Available to manufacturers new to the state, as well as new investments and miscellaneous capital additions to existing facilities in Louisiana.	Not specified	Provides 100% property tax abatement for up to 10 years on manufacturer's qualifying capital investments.
Tax abatement	Florida Rural Job Tax Credit Program	http://www.florida-redi.com/Pages/Economic_Development/Rural_Job_Tax_Credit_Program.aspx	Eligible businesses located within 1 of 36 designated Qualified Rural Areas to create new jobs.	Not specified	Ranges from $1,000 to $1,500 per qualified employee and can be taken against either the Florida Corporate Income Tax or the Florida Sales and Use Tax.
Tax abatement	Florida Enterprise Zone	http://www.florida-redi.com/Docs/RuralEZIncentiveMatrix[1].pdf	Eligible businesses located within a designated Florida Enterprise Zone	Not specified	Varies based on program.

Table 2-3. Activities Required for Installing HHP or Cool Pasteurization in Oyster Operations

Private Companies	Central PHP Facilities
▪ Developing plans for expanding the plant or altering the plant layout ▪ Obtaining building permits ▪ Securing financing for construction and purchasing equipment ▪ Constructing the expanded facility ▪ Modifying electrical, natural gas, and water hookups ▪ Purchasing and installing equipment ▪ Validating and verifying the process ▪ Training workers on operation and maintenance of the equipment ▪ Updating the operation's Hazard Analysis and Critical Control Point (HACCP) plan to address PHP ▪ Updating record-keeping systems ▪ Updating product labeling and notifying buyers	▪ Determining the legal and operating structure of the operation ▪ Securing financing for the operation ▪ Identifying a specific property with the intent of modifying an existing facility or building a new facility ▪ Developing plans for expanding and altering an existing facility or building a new facility ▪ Obtaining necessary permits ▪ Constructing the facility and hooking up electrical, natural gas, and water supplies ▪ Purchasing and installing equipment ▪ Validating and verifying the process ▪ Hiring and training workers to operate and maintain the equipment ▪ Preparing a Hazard Analysis and Critical Control Point (HACCP) plan ▪ Conducting test operations ▪ Conducting outreach and education to the industry to develop the clientele

For central PHP facilities, additional time is required beyond the estimate for a private enterprise because of the requirements for determining the type of organization for operating the facility and for identifying an appropriate facility or building on vacant property.

In our most recent set of interviews in 2011, we again asked industry respondents about their estimated timeline for adding HHP or cool pasteurization to their current facilities or starting a new centralized PHP facility. The respondents confirmed the estimates that we presented in the March 2011 report, of 2 to 3 years from the concept phase to being operational. Some estimates were much shorter, if permits could be approved quickly or if land did not need to be purchased.

These estimates assume that some steps will occur concurrently, such as ordering equipment while the building is being constructed, and establishing supplier and customer relationships throughout the process so that operations could begin as soon as the validation studies are complete. One industry participant mentioned that it might take up to 2 additional years to build up the supplier and customer bases so that they are operating at full capacity. In addition, as stated in

the March 2011 report, these estimates assume that the equipment manufacturers could fulfill all orders as they are received and have sufficient staff available to support the delivery and installation of the equipment and the staff training on use of the equipment. It is currently unknown whether the equipment manufacturers could satisfy these needs.

It is important to note that these estimates only apply to operations for which installation of PHP equipment is feasible or operations that could continue to operate profitably using a central PHP facility. In other words, for some operations, the timeline is irrelevant because a longer time frame might not help them overcome feasibility and cost barriers to complying with PHP requirements.

3 Revised Analyses of PHP Requirements

This section presents the results of the revised analyses using the cost information described in Section 2. Specifically, we revised the per-oyster cost estimates for installing PHP equipment in private operations and developing central PHP facilities to account for costs of land purchase, new construction of central PHP facilities, insurance costs, validation and verification costs, and transportation costs. Using these estimates, we revised the estimates of total industry costs for complying with PHP requirements and the estimates of the numbers of facilities that might close in response to the requirements. Finally, we revised the economic impact model to account for two separate half-shell oyster markets in the Gulf for untreated intrastate shipments and treated interstate shipments.

3.1 PER-OYSTER AND TOTAL GULF INDUSTRY PHP COST ESTIMATES

This section provides the revised estimates of the per-oyster costs for the cool pasteurization and HHP processing using the cost data and assumptions described in Section 2 and the estimates of the costs of establishing, operating, and using central PHP facilities. These estimates are then incorporated into the estimated total industry costs of complying with PHP requirements.

3.1.1 Cool Pasteurization Per-Unit Costs

Table 3-1 provides the throughput estimates and revised estimates of total costs and per-unit costs associated with two process sizes for the cool pasteurization process based on a

Table 3-1. Throughput Assumptions and Revised PHP Costs for the Cool Pasteurization Treatment Process: 2,080 Operating Hours per Year
Costs include the annualized plant expansion and equipment costs and the annual operating costs.

	Small Process	Large Process
Annual throughput assumptions		
Half-shell oysters	2,700,000	21,840,000
Shucked oysters	1,800,000	14,560,000
Total oysters	4,500,000	36,400,000
Total shell-weight pounds	1,800,000	14,560,000
Total sacks	18,000	145,600
Total cost estimates		
Total plant expansion and capital equipment costs	$102,710	$514,732
Total annual operating costs, including banding costs and yield increases for shucked oysters	$142,634	$920,288
Per-unit cost estimates		
Per half-shell oyster	$0.056	$0.049
Per shucked oyster	−$0.004	−$0.011
Per sack	$8.00	$6.25

Assumptions:

- Each 100-pound sack holds 250 oysters.
- 60% of oysters are sold to the half-shell market and 40% are sold to the shucked market.
- Half-shell oysters incur banding costs of $0.015 per oyster.
- Shucked oysters have labor savings of $0.03 per oyster.
- Plant expansion has a 20-year life and equipment has a 20-year life.
- Interest rates for bank loans to processors are 7%.
- Annual insurance costs are 3% of total capital equipment and plant costs.

2,080-hour annual operating schedule. These estimates can be compared with the previous estimates in Table 4-1 of the March 2011 report (Muth et al., 2011). The revised estimates reflect the following changes:

- Addition of process validation costs estimated to be $15,000 (amortized over the 20 years of equipment life)
- Annual insurance costs assuming 3% of the equipment and plant expansion costs
- Annual verification costs estimated to be $12,000

If the process is applied to both half-shell and shucked oysters, the resulting per-oyster PHP costs, including amortized capital equipment and installation costs and annual operating costs, are $0.056 per half-shell oyster and −$0.004 per shucked oyster for the small process and $0.049 per half-shell oyster

and −$0.011 per shucked oyster for the large process. Thus, compared with the March 2011 report, the changes in the estimated per-oyster costs are less than half of a cent for the small process and less than one-tenth of a cent for the large process.

3.1.2 HHP Per-Unit Costs

Table 3-2 provides the throughput estimates and revised estimates of total costs and per-unit costs associated with four process sizes for the HHP process based on a 2,000-hour annual operating schedule, and Table 3-3 provides the corresponding estimates based on a 4,800-hour annual operating schedule. These estimates can be compared with the previous estimates in Tables 4-2 and 4-3 of the March 2011 report (Muth et al., 2011). The revised estimates reflect the following changes:

- Addition of process validation costs estimated to be $15,000 (amortized over the 10 years of equipment life)
- Annual insurance costs assuming 3% of the equipment and plant expansion costs
- Annual verification costs estimated to be $12,000

If the process is applied to both half-shell and shucked oysters, the resulting per-oyster PHP costs, including amortized capital equipment and installation costs and annual operating costs, range from $0.055 to $0.78 per half-shell oyster and from −$0.018 to $0.005 per shucked oyster for the 2,000 hours per year operating schedule and from $0.043 to $0.053 per half-shell oyster and from −$0.030 to −$0.020 per shucked oyster for the 4,800 hours per year operating schedule. Compared with the March 2011 report, the changes in the estimated per-oyster costs are at most eight-tenths of a cent per oyster with most differences at three-tenths of a cent per oyster or less. The changes are somewhat larger than for the cool pasteurization process because the value of the capital equipment is substantially larger; thus, annual insurance charges are much greater.

Table 3-2. Throughput Assumptions and Revised PHP Costs for the HHP Process: 2,000 Operating Hours per Year

Costs include the annualized plant expansion and equipment costs and the annual operating costs.

	100 L Horizontal	320 L Vertical	350 L Horizontal	687 L Horizontal
Annual throughput assumptions				
Half-shell oysters	3,960,000	16,200,000	18,000,000	21,000,000
Shucked oysters	2,640,000	10,800,000	12,000,000	14,000,000
Total oysters	6,600,000	27,000,000	30,000,000	35,000,000
Total shell-weight pounds	2,640,000	10,800,000	12,000,000	14,000,000
Total sacks	26,400	108,000	120,000	140,000
Total cost estimates				
Total plant expansion and capital equipment costs	$1,295,000	$2,065,000	$2,421,500	$3,125,000
Total annual operating costs, including banding costs and yield increases for shucked oysters	$323,198	$713,512	$784,455	$973,755
Per-unit cost estimates				
Per half-shell oyster	$0.078	$0.056	$0.055	$0.057
Per shucked oyster	$0.005	−$0.017	−$0.018	−$0.016
Per sack	$12.24	$6.61	$6.54	$6.96

Assumptions:

- Each 100-pound sack holds 250 oysters.
- 60% of oysters are sold to the half-shell market and 40% are sold to the shucked market.
- Half-shell oysters incur banding costs of $0.03 per oyster.
- Shucked oysters have labor savings of $0.03 per oyster and increased yields equivalent to $0.013 per oyster.
- Plant expansion has a 20-year life and equipment has a 10-year life.
- Interest rates for bank loans to processors are 7%.
- Annual insurance costs are 3% of total capital equipment and plant costs.

Table 3-3. Throughput Assumptions and Revised PHP Costs for the HHP Process: 4,800 Operating Hours per Year
Costs include the annualized plant expansion and equipment costs and the annual operating costs.

	100 L Horizontal	320 L Vertical	350 L Horizontal	687 L Horizontal
Annual throughput assumptions				
Half-shell oysters	15,840,000	38,880,000	43,200,000	50,400,000
Shucked oysters	6,336,000	25,920,000	28,800,000	33,600,000
Total oysters	22,176,000	64,800,000	72,000,000	84,000,000
Total shell-weight pounds	8,870,400	25,920,000	28,800,000	33,600,000
Total sacks	88,704	259,200	288,000	336,000
Total cost estimates				
Total plant expansion and capital equipment costs	$1,295,000	$2,065,000	$2,421,500	$3,125,000
Total annual operating costs, including banding costs and yield increases for shucked oysters	$383,390	$905,752	$1,079,655	$1,169,755
Per-unit cost estimates				
Per half-shell oyster	$0.053	$0.043	$0.044	$0.043
Per shucked oyster	-$0.020	−$0.030	−$0.029	−$0.030
Per sack	$5.88	$3.49	$3.75	$3.48

Assumptions:

- Each 100-pound sack holds 250 oysters.
- 60% of oysters are sold to the half-shell market and 40% are sold to the shucked market.
- Half-shell oysters incur banding costs of $0.03 per oyster.
- Shucked oysters have labor savings of $0.03 per oyster and increased yields equivalent to $0.013 per oyster.
- Plant expansion has a 20-year life and equipment has a 10-year life.
- Interest rates for bank loans to processors are 7%.
- Annual insurance costs are 3% of total capital equipment and plant costs.

3.1.3 Total Gulf Industry PHP Costs

To calculate revised estimates of total industry costs of implementing PHP for all Gulf oysters in the summer, we recalculated the costs of establishing and operating central PHP facilities, including land purchase and preparation costs, construction costs for the entire facility, and transportation costs of shipping oysters from each processor location to its closest hypothetical central PHP facility. We also recalculated the costs of installing and operating PHP processes in establishments that may be large enough to install their own equipment. We present the results of these calculations below.

Table 3-4 presents the cost estimates for central PHP facilities based on the assumptions and data presented in Section 2. The GIS analysis results in the March 2011 report provided the estimated required PHP volumes for each central PHP facility (see Table 4-5). For the cool pasteurization process, five of the six locations identified in Scenario 2 (only half-shell oyster shipped interstate are processed) would require the large size equipment, and the remaining location could use the small size equipment, assuming it was run multiple shifts per day. In this case, the estimated cost of establishing a central PHP process is $1.4 million for the small size equipment and $3.7 million for the large size equipment. For the HHP process, five of the six locations identified in Scenario 2 would require at least the 320 L equipment,[1] and the remaining location could use the 100 L equipment. In this case, the estimated cost of establishing a central PHP process is $2.4 million for the 100 L equipment and $5.3 million for the 320 L equipment.

For oyster processors that would use the central PHP facility, the cost of obtaining services include the per-oyster annualized initial investment costs and operating costs. If small facilities processed 8 million half-shell oysters per year and the large facilities processed 28.6 million half-shell oysters per year (the average volume required across the five large locations), the annualized initial investment cost would be in the range of $0.013 to $0.21 per oyster. Adding the initial investment costs to the per-oyster operating costs of $0.039 to $0.054, which were derived in calculating the estimates presented in Tables 3-1 through 3-3 provides an estimated total service charge for PHP of half-shell oysters. For the small processes, the resulting estimate is approximately $0.07 to $0.09 per oyster. In contrast, for the large processes, the resulting estimate is approximately $0.06 per half-shell oyster for either process, identical to the estimated $0.06 per-oyster cost of irradiation services presented in the March 2011 report, and within a range of estimates cited by the American Pasteurization Company for providing toll processing services

[1] The 350 L or 687 L equipment would also meet the volume requirements for the five locations, but we assumed the 320 L equipment would be used because of the lower initial investment costs.

Table 3-4. Estimated Costs of Central PHP Facilities Using Most Likely Equipment Sizes

	Cool Pasteurization Process		HHP Equipment	
	Small	**Large**	**100 L**	**320 L**
Land costs[a]	70,000	175,000	70,000	175,000
Construction costs[b]	1,125,000	3,000,000	1,125,000	3,000,000
Site development and permitting costs[c]	99,750	266,000	99,750	266,000
Equipment and installation	72,710	237,232	1,100,000	1,870,000
Validation costs	15,000	15,000	15,000	15,000
Total cost per facility	1,382,460	3,693,232	2,409,750	5,326,000
Annualized initial investment costs[d]	134,703	360,718	280,966	593,188
Per-oyster annualized initial investment costs[e]	0.016	0.012	0.035	0.021
Per-oyster operating costs for half-shell oysters[f]	0.054	0.048	0.052	0.039
Per-oyster average transportation costs[g]	0.073	0.073	0.073	0.073
Total per-oyster costs for half shell oysters	0.143	0.133	0.160	0.133

[a] Land cost estimates are based on a 1 acre (small) or 2.5 (large) acre lot. Depending on location, costs might range from $30,000 to $105,000 per acre.

[b] Construction cost estimates assume a 7,500 square foot (small) or 20,000 (large) square foot industrial building with cooler space and office space. Cost per square foot was assumed to be $150.

[c] Site development costs include activities such as installing utilities, parking, loading dock, and detention pond.

[d] Initial investment costs are annualized using a 7% interest rate, 20 years for land and the plant, and 10 years (cool pasteurization) or 20 years (HHP) for equipment.

[e] Per-oyster annualized initial investment costs were calculated assuming 8 million (small) or 28.6 million (large) half-shell oysters would be processed each year during warm weather months.

[f] Operating costs are based on the data used to develop the estimates shown in Tables 3-1 through 3-3; actual operating costs will vary depending on the actual production volume of the facility.

[g] Transportation costs were calculated as a weighted average over all oysters that would be transported assuming $2.43 per mile.

for other types of food products (Wabiszewski and Zaja, 2011).[2]

In addition to the cost of PHP services, an oyster processor using a central PHP facility would also incur transportation costs. Based on the set of assumptions described in

[2] American Pasteurization Company is a private company that provides toll processing services using HHP for a variety of products in its facility in Milwaukee, Wisconsin. Its current facility does not process oysters and would likely not be able to process oysters because of its location and because it is designed to process packaged products.

Section 2.3, transportation costs average $0.073 per oyster. Thus, the total cost of obtaining PHP services is about $0.13. However, for an individual facility, the costs might vary substantially based on the distance to a central PHP facility.

For the establishments that appear to have sufficient product volume to allow installation of PHP equipment, we used the same assumptions regarding the optimal size equipment and operating schedule as in the March 2011 report. We then applied the revised costs of capital equipment and installation and the revised operating costs corresponding to Tables 3-1 through 3-3 to determine each operation's costs of complying with PHP requirements. In calculating the total costs, we assumed that the operations that would install PHP equipment in their establishments would apply the process only to half-shell oysters intended for interstate shipment. In contrast to the March 2011 report, we assumed that operations that newly install PHP equipment would only post-harvest process half-shell oysters intended for interstate shipment. We also assumed operations that already operate PHP equipment would not change the volume of oysters that are currently post-harvest processed with the exception of one plant that would need to install additional equipment.[3]

By adding the costs for oyster processors that we assume would need to obtain PHP services through a central PHP facility (including transportation costs) and have sufficient volumes to allow installation of PHP equipment within their operations, we obtained the following revised total estimated costs of PHP:

- $24.0 million in initial investment costs and $11.2 million in annual costs if all newly installed PHP equipment used the cool pasteurization process broken down as follows:
  - Central PHP facilities: $19.8 million in initial investment costs and $5.3 million in annual costs
  - Private facilities: $4.2 million in initial investment costs and $5.9 million in annual costs
- $50.8 million in initial investment costs and $13.0 million in annual costs if all newly installed PHP

[3] With the exception of this one plant, all of the operations that currently post-harvest process oysters appear to be post-harvest processing a sufficient volume to accommodate all of their interstate shipments, if not more.

equipment used the HHP process broken down as follows:

- Central PHP facilities: $29.0 million in initial investment costs and $5.3 million in annual costs
- Private facilities: $21.8 million in initial investment costs and $7.7 in annual costs

Compared with the March 2011 report, the initial investment costs are about four times greater for the cool pasteurization process and about one and a half times greater for the HHP process, and the annual costs are about one-third greater for the cool pasteurization process and about two-thirds greater for the HHP process. Note that the annual cost estimates increased due to the additional costs included in the analysis but some of these increased costs were offset by the change in how the costs were calculated for operations that would operate PHP equipment within their facilities. Specifically, we based the revised annual cost estimates on the assumption that operations would only post-harvest process half-shell oysters intended for interstate shipment.

3.2 REVISED BUSINESS CLOSURE ASSESSMENT FOR PHP REQUIREMENTS

Using the revised cost estimates, we updated the analysis of business closures using similar procedures as in the March 2011 report. Specifically, we calculated the costs of PHP relative to the revenues of each oyster processing establishment and then compared the cost ratio with a profit ratio of 4.8%.[4] For establishments that appear to be large enough to install PHP equipment or for establishments that would need to rely on a central PHP facility, we calculated the cost ratio assuming that only half-shell oysters shipped interstate would be post-harvested processed.

The revised results of the closure analysis are shown in Table 3-5; these results can be compared with Table 5-1 in the March 2011 report. Of the 11 establishments that might be large enough to install PHP equipment, we estimate that the costs of the processes would exceed the profits for 9 or 10 of them (assuming that prices do not adjust in response to PHP requirements). Of the remaining 122 establishments that are

[4] As noted in the March 2011 report, the 4.8% profit ratio estimate was obtained from Robert Morris and Associates.

Table 3-5. Revised Results of Closure Analysis: Number of Establishments and Number of Employees Affected

Results assume that market prices will not change as a result of PHP requirements. However, to the extent that prices increases, the number of closures would be less than estimated here.

	Estimated No. of Establishments	Estimated Total No. of Employees
Baseline (pre-oil spill)[a]	137	3,790
Establishments currently with sufficient summer PHP capacity to treat all half-shell oysters shipped interstate[b]	4	680
Establishments with sufficient volume to install PHP for summer oysters[c]	11	670
Establishments with insufficient volume to install PHP for summer oysters	122	2,440
Establishments with negative annual profits if adopt PHP:[d]		
– Establishments with sufficient volume to install PHP	9–10	530
– Establishments relying on central PHP facility	49	270

[a] The baseline number of establishments represents the number of shellstock shippers, repackers, and shucker-packers operating prior to the 2010 oil spill that are believed to handle shellstock oysters.

[b] One establishment that applies IQF to nearly all its volume of oysters was included in the estimate of establishments with sufficient summer PHP capacity under the assumption that it would not change its operation in response to PHP requirements.

[c] The number of establishments that might be large enough to install PHP equipment is an upper-bound estimate because it is based on the total volume of oysters processed rather than only the estimated volume of half-shell oysters shipped interstate.

[d] Annual costs exceeding 4.8% of sales were assumed to result in negative annual profits given profit ratios for the industry. The ranges of estimates result from whether the cool pasteurization or HHP process is used.

likely not large enough to install PHP equipment, we estimate that the costs of using a central PHP facility, including transportation costs, would exceed the profits of 49 establishments (again, assuming that prices do not adjust in response to PHP requirements). Based on the estimated number of employees for these 49 establishments, they appear to be among the smallest establishments operating in the Gulf. Compared with the results in the March 2011 report, the predicted number of closures with the revised cost estimates more than doubled.

3.3 REVISED MARKET ASSESSMENT FOR PHP REQUIREMENTS

As mentioned above, the business closure assessment assumed no changes in market prices in response to PHP requirements. However, based on economic theory, market prices would

adjust to the extent that oyster processors are able to pass along at least some of the costs of PHP to their buyers. Thus, the purpose of the economic model is to determine the extent to which oyster prices would change in response to PHP requirements. If prices increase in response to PHP requirements, a greater number of establishments might remain profitable despite the increased costs.

We modified the model used for the March 2011 report to account for the revised per-oyster costs presented in Section 3.1 and to allow for two separate markets for Gulf half-shell oysters—the intrastate market (estimated to be 32% of the half-shell market in the baseline) and the interstate market (estimated to be 72% of the market in the baseline). The revised baseline is shown in Table 3-6.

In separating the Gulf half-shell oyster market into two separate markets, we assumed no substitution between "interstate" oysters that have undergone a PHP process and "intrastate" oysters that have not within the Gulf region (that is, cross-price elasticities of supply and demand of zero). Furthermore, for the cross-price elasticities of demand between "intrastate" Gulf oysters and half-shell oysters in other regions, we also used a value of zero because there would be no trade between these two markets. For the cross-price elasticities of demand between "interstate" Gulf oysters and half-shell oysters in the Pacific and Atlantic regions, we retained the same value as in the March 2011 report of 0.40.[5] In all other cases, we applied the same supply elasticities and own-price elasticities of demand for "interstate" and "intrastate" Gulf half-shell oysters as we previously used for all Gulf half-shell oysters.

We ran the model assuming that operations with PHP equipment will process all half-shell interstate oysters and all shucked oysters (including current operations with PHP equipment and operations assumed to be large enough to install PHP equipment), and operations assumed to rely on

[5] A recent publication by Dedah, Keithly, and Kazmierczak (2011) confirms the assumption that oyster products from different regions (i.e., Gulf, Chesapeake, and Pacific) are gross substitutes.

Table 3-6. Revised Baseline Wholesale Oyster Industry Data: Average Summer Month for April–October, 2008

	U.S. Total	Atlantic (including East Coast Florida)	Gulf (with West Coast Florida)	Northeast	Pacific
Half-shell interstate volume (output)		*25%*	*37%*	*90%*	*20%*
Meat-weight (pounds)	766,761	14,029	530,219	80,831	141,682
Shellstock weight (pounds)	19,200,000	400,000	13,300,000	2,000,000	3,500,000
No. of oysters	44,380,514	876,813	33,138,688	5,051,938	5,313,075
Half-shell intrastate volume (output)			*23%*		
Meat-weight (pounds)	329,595	—	329,595	—	—
Shellstock weight (pounds)	8,200,000	—	8,200,000	—	—
No. of oysters	20,599,688	—	20,599,688	—	—
Shucked volume (output)		*75%*	*40%*	*10%*	*80%*
Meat-weight (pounds)	1,191,007	42,088	573,209	8,981	566,729
Shellstock weight (pounds)	29,800,000	1,100,000	14,300,000	200,000	14,200,000
No. of oysters	60,269,714	2,630,500	35,825,563	561,313	21,252,338
Shellstock volume (input)					
Meat-weight (pounds)	2,287,363	56,117	1,433,023	89,812	708,411
Shellstock weight (pounds)	57,100,000	1,400,000	35,800,000	2,200,000	17,700,000
No. of oysters	125,249,914	3,507,313	89,563,938	5,613,250	26,565,413
Half-shell price[a] (output)					
Per meat-weight pound	$10.53	$12.44	$9.38	$28.50	$7.10
Per oyster	$0.18	$0.20	$0.15	$0.46	$0.19
Shucked price (output)					
Per meat-weight pound	$6.43	$8.71	$7.50	$19.95	$4.97
Shellstock price (input)					
Per meat-weight pound	$3.42	$6.98	$2.89	$11.21	$3.23
Per oyster	$0.07	$0.10	$0.05	$0.23	$0.09
Half-shell revenue[a]	$11,544,629	$174,521	$8,065,055	$2,303,684	$1,005,942
Shucked revenue	$7,658,175	$366,586	$4,299,068	$179,171	$2,816,643
Shellstock cost	$8,303,128	$349,048	$4,170,097	$1,279,821	$2,514,859
No. of Plants					
Shucker-packers	288	76	102	68	42
Shellstock shippers	1,122	275	116	436	295

[a] In the baseline, the half-shell price was assumed to be the same for oysters shipped intrastate or interstate; thus, the baseline revenue generated from selling half-shell oysters was calculated based on the total half-shell volume multiplied by the half-shell price.

Assumptions:

- For summer months, we assumed 4 pounds of meat per 100-pound sack of 250 oysters except in the Pacific, where we assumed 4 pounds of meat per 150 oysters.
- Mark-ups were assumed to be 200% for half-shell oysters and 140% for shucked oysters relative to the shellstock price.

Sources:

Average shellstock volumes and prices were calculated from NMFS harvest data.
Number of plants was calculated from the ISSC-L excluding operations that are distribution companies (numbers include operations that may not handle oysters).

central PHP facilities will only obtain services for half-shell interstate oysters. The costs of complying with PHP requirements, therefore, differ between the two types of operations because operations with PHP equipment will benefit from reduced costs of producing shucked oysters, and operations relying on central PHP facilities will incur transportation costs to the central PHP facility. In running the model, we used weighted average[6] cost changes for "interstate" half-shell and shucked oysters in the Gulf region for the minimum and maximum cost scenario as follows:

- Minimum cost scenario—PHP costs of $0.053 per "interstate" half-shell oyster and –$0.026 per shucked oyster[7]
- Maximum cost scenario—PHP costs of $0.088 per "interstate" half-shell oyster and $0.004 per shucked oyster[8]

As in the March 2011 report, we assumed that consumers would be indifferent between post-harvest processed and traditional oysters; therefore, demand would not increase or decrease in response to PHP requirements.

Based on these model inputs, the estimated aggregate changes in key market variables are shown in Table 3-7. The estimated changes are greater than in the March 2011 report because of the higher estimated costs of PHP.

In considering these results, it is important to keep in mind that the model estimates aggregate effects. Individual oyster processors, based on their size and location, may experience substantially different effects. In particular, smaller processors relying on central PHP facilities will incur higher costs as a result of transportation costs, but the predicted market adjustments are an average over processors relying on central

[6] In the baseline, the estimated market share for establishments that currently have PHP equipment or are assumed to be large enough to install PHP equipment is 86%, and the estimated market share for the remaining establishments that are assumed to use a central PHP facility is 14%.

[7] The minimum weighted average cost estimate for "interstate" half-shell oysters is calculated as 0.86 * 0.043 + 0.14*(0.043 + 0.073), and the weighted average cost estimate for shucked oysters is calculated as 0.86 * (−0.030) + 0.14 * 0.0.

[8] The maximum weighted average cost estimate for "interstate" half-shell oysters is calculated as 0.86 * 0.078 + 0.14 * (0.078 + 0.073), and the weighted average cost estimate for shucked oysters is calculated as 0.86 * 0.005 + 0.14 * 0.0.

PHP facilities and those installing PHP equipment within their establishments.

Table 3-7. Estimated Changes in Key Market Variables Resulting from PHP Requirements in Summer Months

	Minimum Cost Scenario	Maximum Cost Scenario
PHP Costs	$0.053 per "interstate" half-shell oyster; –0.026 per shucked oyster	$0.088 per "interstate" half-shell oyster; $0.004 per shucked oyster
Raw "interstate" half-shell Gulf oysters	7.9% change in price –4.2% change in quantity	15.4% change in price –4.3% change in quantity
Raw "intrastate" half-shell Gulf oysters	–0.5% change in price –0.4% change in quantity	0.9% change in price 0.8% change in quantity
Shucked Gulf oysters	–2.3% change in price 4.7% change in quantity	4.1% change in price 2.9% change in quantity
Harvested Gulf shellstock oysters	0.4% change in price 0.2% change in quantity	–0.5% change in price –0.3% change in quantity
Other regions (Atlantic, Pacific, and Northeast)	0.4 to 2.5% change in half-shell oyster quantities –0.1 to –0.8% change in shucked oyster quantities	1.2 to 5.1% change in half-shell oyster quantities 0.7 to 1.7% change in shucked oyster quantities

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Appendix A: Discussion Topics for Oyster Interviews

This appendix contains the discussion guides that were used to obtain information used to guide the study as follows:

- List of Questions for ISSC
- List of Questions for State Agencies
- List of Questions for PHP Processors
- List of Questions for Oyster Processors without PHP
- List of Questions for Toll Processor
- List of Questions for Economic Development Organizations

In all cases, no more than nine respondents were interviewed with each of the unique set of questions.

List of Questions for ISSC

- Which states have passed legislation allowing for intrastate shipments of raw half-shell oysters that have not undergone PHP?
- Are any of the state agencies considering establishing their own central PHP facilities?
- Are you aware of any public financing resources that might be available for establishing PHP facilities?

List of Questions for State Agencies

- Has your state government passed legislation that will allow for intrastate shipments of raw half-shell oysters that have not undergone PHP? If yes, please send the citation for the actual legislation.
- Are you aware of opportunities within or outside of the state for processing establishments to receive grants for purchasing PHP equipment?
- Do any organizations in your state have plans for establishing central PHP facilities?

List of Questions for PHP Processors

- When you began PHP, did you need to acquire additional land for expansion?
  - If yes, what was the cost?
  - If no, do you know the average cost of land in your area?
- When you began PHP, did you need to expand your facility?
  - If yes, what were the construction costs?
  - If no, do you know average construction costs for your area?
- Do you insure your PHP equipment? If yes, what is your coverage and annual premium?
- What are the per mile transportation costs for refrigerated transport of oysters?
- How many oysters can be transported on one truck?
- How much time is required for each activity involved in establishing PHP? Please include time for obtaining financing and permits, purchasing and preparing the land, constructing the facility, and ordering and installing PHP equipment.
- If you received a grant to construct your PHP facility, can you please supply information on the grant that you received? For example, who funded the grant, how did you apply for the grant, what portion of costs are covered by the grant, etc.

List of Questions for Oyster Processors without PHP

- Have you given any consideration to whether you might install PHP equipment for use in the summer?

- Do you have space within your plant to install PHP equipment?
- If space is not available, is land available to expand the plant?
- How would you obtain financing to purchase the equipment?
- Do you have a sense of what it would cost you to insure the equipment?
- Do you have a sense of how long it would take you to install the equipment from the time that you initially begin planning to actually operating the equipment?

List of Questions for Toll Processor

- What is the history behind the establishment of the facility?
- What products does your facility process?
- What technologies are used for processing?
- How does the toll operation work?
- How many producers use your services?
- How much do producers pay for toll processing services?

List of Questions for Economic Development Organizations

- What are the average land costs for 2.5 acres of industrial land in your area?
- What are the average construction costs for a 20,000 square foot facility in your area?
- Do you have a sense of how much it would cost to insure PHP equipment worth approximately $2 million?
- What financial opportunities are available for someone who wants to start a new PHP business or expand their current business to include PHP? Please include grants, loans, employee assistance programs, tax incentives, etc.
- How long would it take an oyster business to begin a PHP operation, including obtaining financing and permits, purchasing and preparing the land, constructing the facility, and ordering and installing PHP equipment?