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District**  
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**EXECUTIVE DIRECTOR:** Larry Oetker

## Humboldt Bay Master Water Intakes: Project Description (v8; updated 12/9/22)

Note: This document updates and replaces the Project Description dated 10/21/22.

### 1. Overview

The Humboldt Bay Harbor, Recreation and Conservation District (District) proposes to modernize and operate two formerly used bay-water intake systems in Humboldt Bay and install new pumps, piping, and meters to deliver bay water to existing and future District tenants. Improvement of the water intakes is part of a long-term District program to develop facilities for use by aquaculture tenants. The water intakes are located approximately one-half mile apart along the Samoa Channel at the Redwood Marine Terminal II (RMT II) Dock and Red Tank Dock (Figure 1). The intake systems were operated by a pulp mill from around 1966 until the mill was closed in 2008. Salt water from the intakes will be used by District tenants and other entities for aquaculture and other allowable uses. The proposed project includes bay water withdrawal and pumping to manifolds at specific upland points that will be connected to by future water users. The two intakes will be operated and managed as a single system as they both feed into a common manifold and distribution system. They will be designed such that one intake can operate alone while the other intake is offline for maintenance. However, under typical conditions both intakes will be operated continuously and simultaneously, cooperatively feeding into the common distribution system.

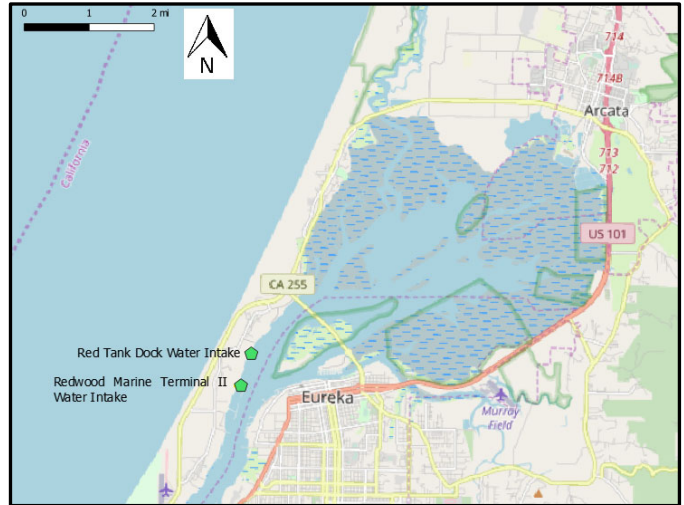


Figure 1: Location of proposed water intakes in Humboldt Bay, California.

Currently, industrial water (raw untreated water from the Mad River) is supplied to the area by Humboldt Bay Municipal Water District through the Town of Samoa. However, it is expected that the Town of Samoa industrial water connection will be discontinued in 2022. The proposed project includes installation of industrial water lines. Water from the industrial lines could also be used for fire suppression. As described below, the industrial water lines will share a trench with the bay water lines.

Based on informal consultation with agencies, the Harbor District has identified habitat restoration opportunities to offset any reduction in the bay’s biological productivity that will result from water withdrawal and entrainment of aquatic larvae. Habitat restoration work will be phased in conjunction with the phasing of water withdrawal quantities.

The proposed bay water intake upgrades, industrial water line, and habitat restoration projects are further described below.

### 2. Water Intake Uses and Controls of Water Intake Volumes

Water will only be supplied to users that operate in compliance with approved permits. This could be users with existing approved permits or future users that receive approved permits. For instance, the Harbor District has existing Coastal Development Permits CDP-16-049 and 17-041 that are approved by the County of Humboldt for Redwood Marine Terminal II, each of which could withdrawal water once the intake system is permitted and constructed. As outlined in those Coastal Development Permits, Coastal Dependent Industrial Uses, Aquaculture, and Coastal Related Uses have



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

priority over interim uses. The process for reviewing potential new uses is outlined in the RMT II Permit Compliance Flowchart (see Attachment A).

The volume of water to withdrawn will occur in three phases:

- Phase I: Intake of bay water between 0 to 694 gpm.
- Phase II: Intake of bay water between 695 to 1,250 gpm.
- Phase III: Intake of bay water between 1,251 to 8,250 gpm.

For those tenants that require baywater, the District will require each of those tenant to pay for a specific set amount of intake water in their lease. They will not be required to use the total volume of water that they pay for, but they will be required to reserve and pay for that set amount. The District will then manage each subsequent lease to ensure that the District never leases more water than the total permitted amount. For example, tenant #1 could lease 90% of the total permitted amount, tenant #2 could lease 6% of the total permitted amount, and tenant #3 could lease 4% of the total permitted amount. Each tenant will reserve and pay for their allocated volume and no tenant will be given access to water beyond their allocation. Thus, in this example, the only way that the intake system could possibly reach the maximum intake volume would be if all three tenants simultaneously utilized their respective maximum intake allocations. Also, continuing with this example, imagine a scenario in which tenant #2 terminates their lease. This would leave 6% of the total permitted volume available for the District to reallocate to a new tenant. If a new tenant only wanted 1% instead of 6%, then there would be capacity for a fourth tenant to use 5% of the total permitted volume.

It is important to note that if any one tenant does not fully utilize their allocated maximum amount in any given period of time, then the overall system will not reach the maximum permitted amount during that specific period of time. Tenants will not be able to exceed their own allocated amount regardless of how much water their neighboring tenants happen to be utilizing at the time. If tenant #1 stops operations for one week, their unused portion of water will not automatically become available to tenant #2. Instead, that portion of water would not be withdrawn that week. It is possible that a tenant will seek to adjust their lease to reserve a smaller amount of water, which could be followed by a different tenant seeking to adjust their lease to reserve an equivalent larger amount of water. But, such adjustments will require lease adjustments and explicit adjustments to allocated volumes of water within each lease.

Under any scenario of combinations of users, the District will manage the collective suite of leases to ensure that the District never leases more water than the total permitted amount. In other words, each tenant's connection to the intake system will be metered and monitored by the District and no tenant will be allowed by the District to exceed the allocation assigned to them in their respective lease agreement. In addition, the District will require each tenant to acquire all required permits (including CDPs) prior to initiating operations. This is all consistent with how the District manages the outfall system.

Regarding control of water volume through mechanical systems: The combination of pumps at either intake will be manifolded together and discharged into a single pipe. The pipe will have a flow meter that will provide information back to a programmable logic controller (PLC) set to control the variable frequency drives on each pump and adjust the speed of the pumps to keep the flow rate below the maximum design flow for the intake screens, thereby limiting the flow rates.



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

### 3. Improvements to Water Lines

A bay water line will provide water from the RMT II Dock and Red Tank Dock water intakes to manifolds directly south of Red Tank Dock, at RMT II and at the proposed Nordic Aquafarms<sup>1</sup> project site. Aquaculturists and other users will connect to the manifolds to receive bay water. Potential users include shellfish, seaweed, and finfish farmers. The bay water line and industrial water line will be buried in trenches except at one location where they will surface to cross a stormwater feature and also where the bay water line will be mounted on the edges of Red Tank Dock and RMT II Dock. The industrial water line will extend from the Red Tank to the RMT I manifold then south to the Nordic Aquafarms manifold (Figure 2). Hydrants will be installed along the line approximately every 500'. For details regarding the trench alignment and proximity to ESHA, see Figures 3 through 6 and Attachment B.

### 4. Bridge Across Stormwater Feature

As shown in Figure 2, the water lines cross an existing drainage swale ("stormwater feature") that drains stormwater runoff to Humboldt Bay (see Image 1 and Figure 6). The swale is connected to the bay through a culvert that passes through a small earthen berm. There are two structures on the landward side of the berm including a small metal pedestrian bridge crossing. This small crossing bridge is degraded and will be removed. There is also a larger metal pedestrian bridge and piping manifold with associated platform. The bridge associated with the stormwater feature is shown in the image on right. The Coastal Commission approved a replacement of this bridge through CDP E-11-029 for Taylor Mariculture. Per page 8 of the staff report associated with that CDP, the approved project description includes "...the installation of a pre-fabricated 80-foot long one-lane vehicle bridge across the culvert to the north of the Berth Two pier. Bridge installation requires several small footings in areas of existing asphalt." In compliance with that approved CDP, the District intends to install a new one-lane vehicle bridge (see Figure 6 and Attachment B). The new bay water piping and new industrial water piping will be attached to the new bridge in a similar setup as the existing piping manifold.



Figure 2: Location of bay water intakes, bay water piping and industrial water piping.

of the staff report associated with that CDP, the approved project description includes "...the installation of a pre-fabricated 80-foot long one-lane vehicle bridge across the culvert



Image 1: Existing stormwater feature to be replaced





<sup>1</sup> Nordic Aquafarms (a private company) is proposing a finfish aquaculture facility at the site and would likely be one of the bay water users.





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### EXPLANATION

-  **BAYWATER INTAKES (E)**
-  **CULVERTS (E)**
-  **COAST WILLOW-STORMWATER FEATURE (E)**
-  **BAY WATER PIPE, SUSPENDED FROM DOCK (P)**
-  **INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)**
-  **INDUSTRIAL WATER PIPE TRENCH (P)**
-  **BAY WATER PIPE TRENCH (P)**
-  **PIPELINE TRENCH BUFFER (10 FT)**
-  **STORMWATER INFRASTRUCTURE (P)**
-  **OSPREY NESTS (2021)**
-  **ESTUARINE TIDAL WETLAND**
-  **ESTUARINE TIDAL WETLAND**
-  **COASTAL WETLAND**
-  **COASTAL DUNE WILLOW THICKET/WAX MYRTLE SCRUB**
-  **STORMWATER FEATURE**
-  **STUDY AREA**



FOR PLANNING PURPOSES ONLY

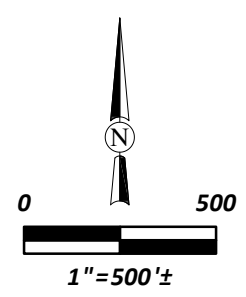


IMAGE SOURCE: OCM, ULTRACAM, 2019
















Humboldt Bay Harbor, Recreation, & Conservation District  
 RMT I Water Intakes CDP, Response to Comments  
 Eureka, California

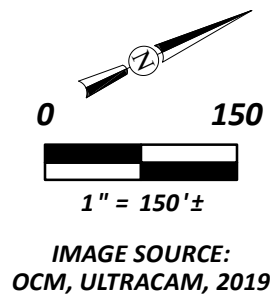
**Habitat & ESHA Map Overview**  
 July 2022 - 016240.005

**Figure 3**



**EXPLANATION**

-  BAYWATER INTAKES (E)
-  CULVERTS (E)
-  COAST WILLOW-STORMWATER FEATURE (E)
-  BAY WATER PIPE, SUSPENDED BY DOCK (P)
-  INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)
-  INDUSTRIAL WATER PIPE TRENCH (P)
-  BAY WATER PIPE TRENCH (P)
-  PIPELINE TRENCH BUFFER (10 FT)
-  STORMWATER INFRASTRUCTURE (P)
-  OSPREY NESTS (2021)
-  ESTUARINE TIDAL WETLAND
-  ESTUARINE TIDAL WETLAND
-  STUDY AREA



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Humboldt Bay Harbor, Recreation, & Conservation District  
 RMT I, Water Intakes CDP, Response to Comments  
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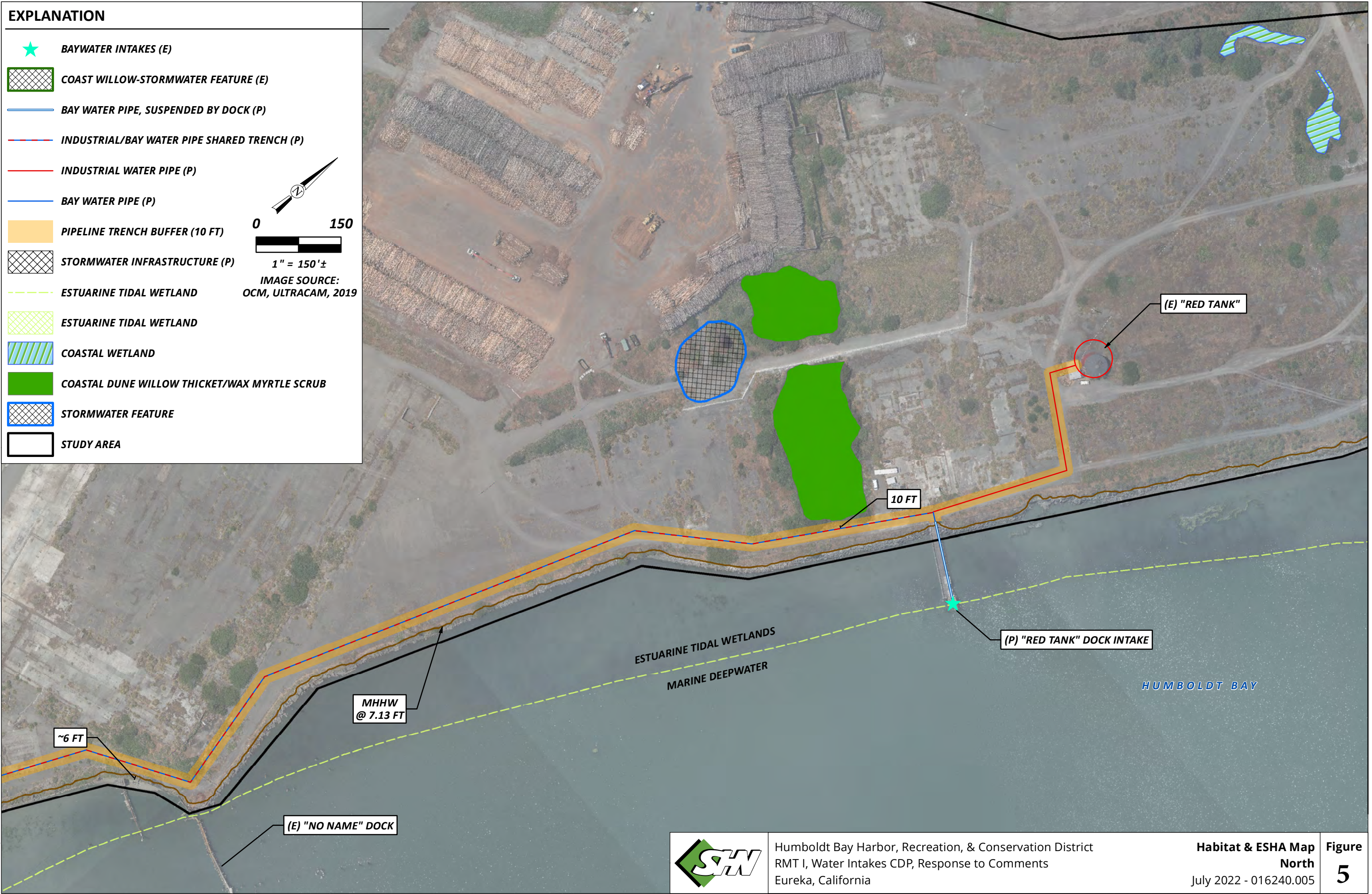
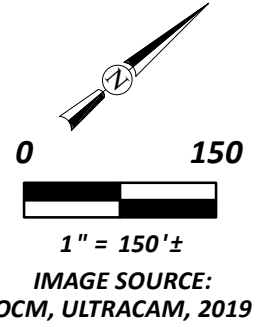
**Habitat & ESHA Map**  
**South**  
 July 2022 - 016240.005

**Figure**  
**4**



**EXPLANATION**

-  BAYWATER INTAKES (E)
-  COAST WILLOW-STORMWATER FEATURE (E)
-  BAY WATER PIPE, SUSPENDED BY DOCK (P)
-  INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)
-  INDUSTRIAL WATER PIPE (P)
-  BAY WATER PIPE (P)
-  PIPELINE TRENCH BUFFER (10 FT)
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-  COASTAL WETLAND
-  COASTAL DUNE WILLOW THICKET/WAX MYRTLE SCRUB
-  STORMWATER FEATURE
-  STUDY AREA









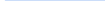




Humboldt Bay Harbor, Recreation, & Conservation District  
 RMT I, Water Intakes CDP, Response to Comments  
 Eureka, California

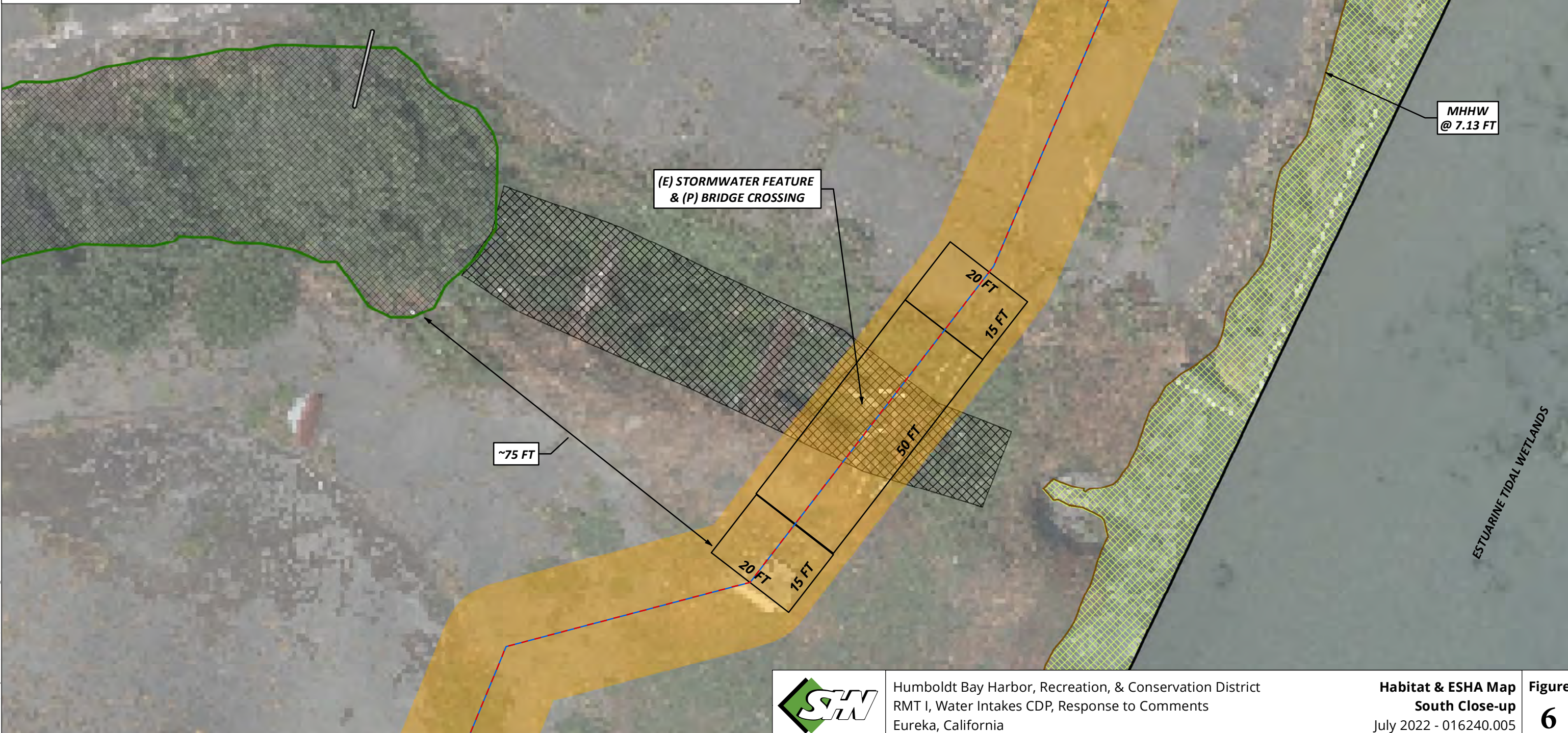
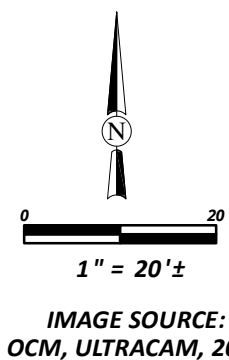
**Habitat & ESHA Map North**  
 July 2022 - 016240.005

**Figure 5**



**EXPLANATION**

-  **BAYWATER INTAKES (E)**
-  **CULVERTS (E)**
-  **COAST WILLOW-STORMWATER FEATURE (E)**
-  **INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)**
-  **INDUSTRIAL WATER PIPE (P)**
-  **BAY WATER PIPE (P)**
-  **PIPELINE TRENCH BUFFER (10 FT)**
-  **STORMWATER INFRASTRUCTURE (P)**
-  **ESTUARINE TIDAL WETLAND**
-  **ESTUARINE TIDAL WETLAND**
-  **STUDY AREA**



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Humboldt Bay Harbor, Recreation, & Conservation District  
RMT I, Water Intakes CDP, Response to Comments  
Eureka, California

**Habitat & ESHA Map**  
**South Close-up**  
July 2022 - 016240.005

**Figure**  
**6**



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

### 5. Trench Details

The industrial water line will have a maximum outside diameter of 12". The bay water line will range from 18"-36" maximum outside diameter. Diagrams 1 through 3 show the outside pipe diameter and volume of water that will travel through different sections of the bay water line. Diagrams 1 through 3 show the design for different trench segments (i.e., areas where there are two pipes or one pipe in the trench). The maximum width of ground impacts will be 19' in sections where both pipes occur and 17' where only one pipe occurs.

There is an existing walkway across the stormwater feature (see Figure 2 and Image 1). The two pipes will be attached to the replacement structure described above and in Attachment B.

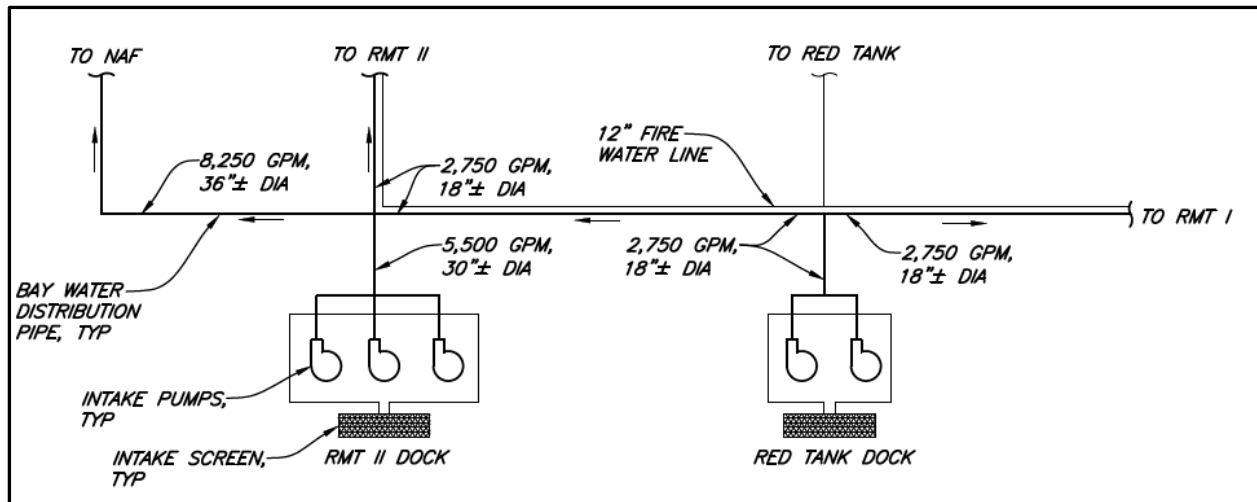


Diagram 1: Pipe diameter and volume of water that will travel through different sections of the bay water line.

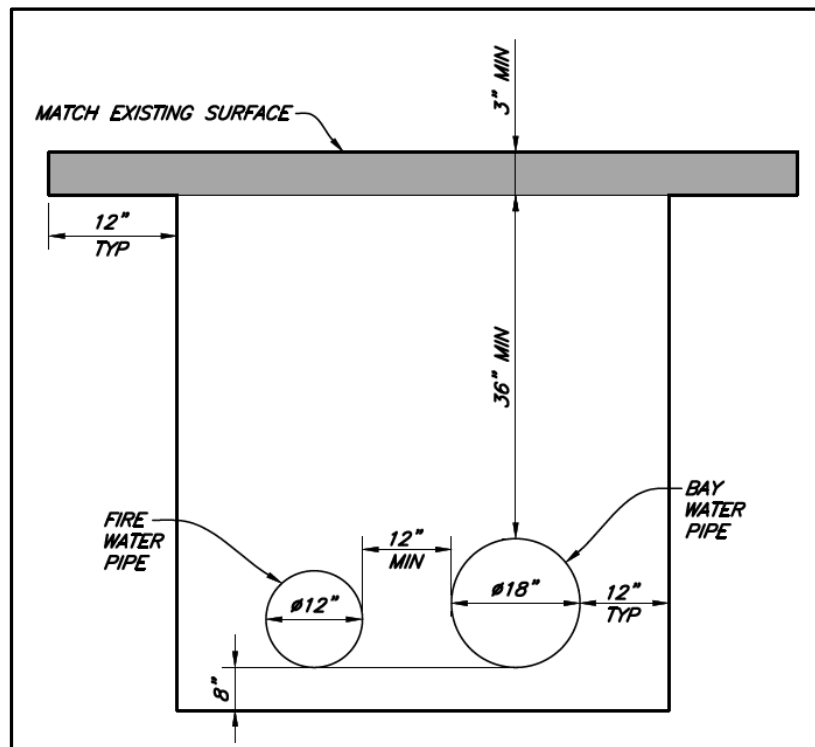


Diagram 2: Conceptual trench details in areas where the bay water line and industrial water line will occur.



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

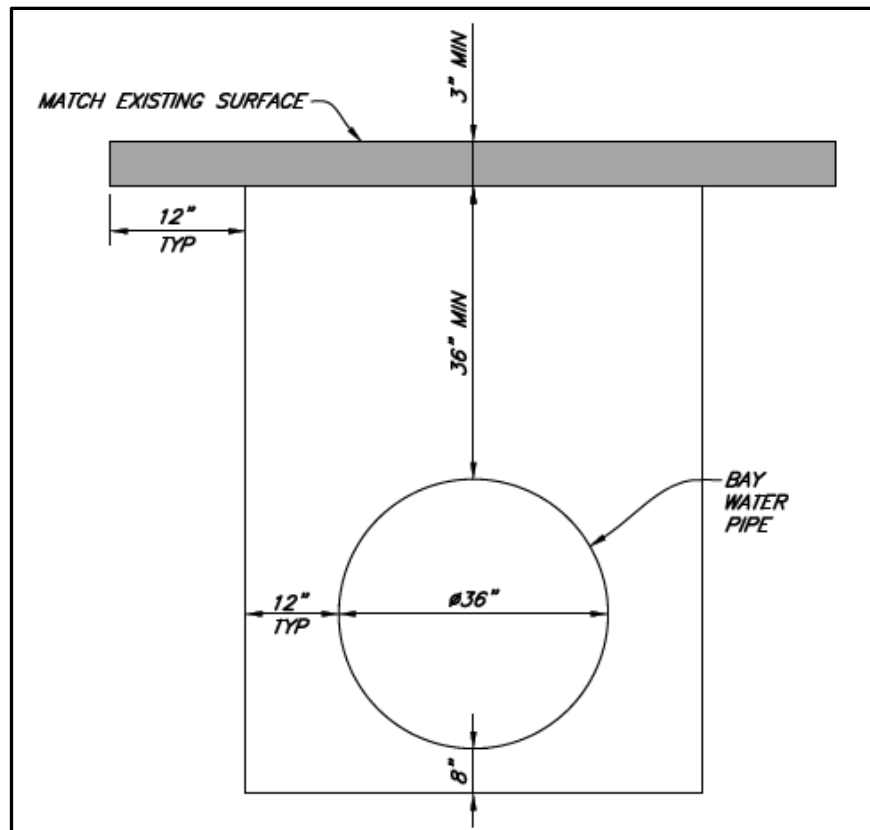


Diagram 3: Conceptual trench detail in the area where only the 36" bay water line will occur.

### 6. Improvements to Water Intakes

Existing water intake structures ("sea chests") at the two sites will be improved. Appendix R of the DEIR ("[Humboldt Bay Intake Screen Conceptual Designs, Redwood Marine Terminal II and Red Tank Dock, Samoa, California – Revision 03.](#)") describes the water intakes, pumps, intake screens, and overall structure orientations that will be used to minimize impacts to aquatic resources. Figures 1 and 2 above show the location of the intakes and proposed bay water and industrial water piping. Images 2 through 6 below are pictures of existing infrastructure that will be modified at each intake site.

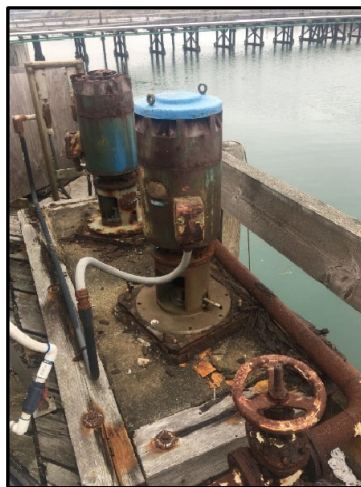


Image 2: Existing water intake pumps at the Redwood Marine Terminal II Dock. These will be replaced.



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)



*Image 3: Existing wooden sea chest at the Redwood Marine Terminal II Dock. This sea chest will continue to be utilized.*



*Image 4: Existing water intake screen at the Redwood Marine Terminal II Dock. This screen will be replaced.*



*Image 5: Existing concrete sea-chest and screens at the Red Tank Dock. This sea chest will continue to be utilized; the screens will be replaced.*



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)



Image 6: Existing concrete sea-chest at the Red Tank Dock. This sea chest will continue to be utilized.

### 7. Intake Screens Cleaning and Maintenance

The bay water intake screens will be periodically cleaned and maintained per the “Preliminary Baywater Intake Cleaning and Maintenance Plan” (see Attachment C).

### 8. Avoiding Potential Eelgrass Impacts

Eelgrass will be avoided during installation and maintenance of the intake systems. A qualified biologist will be present on-site to help monitor and avoid impacts to eelgrass while work is being performed in areas that may impact eelgrass habitat. Installation and maintenance activities shall comply with the “Eelgrass Protection Plan” associated with Coastal Development Permit 9-16-0204 (Humboldt Bay Mariculture Pre-Permitting Project, Starbird Mariculture).

Gilkerson (2008) found the maximum depth capable of supporting eelgrass in north Humboldt Bay was -1.3 m MLLW. The depths at the proposed RMT II and Red Tank dock water intakes are -4.5 m MLLW and -1.8 m MLLW, respectively. The depth of the RMT II intake prohibits growth of eelgrass, but the depth at Red Tank dock is only slightly greater than the maximum growing depth. The intake at Red Tank is within the area evaluated under the Humboldt Bay Harbor District Coastal Development Permit 9-16-0204 Subtidal Mariculture Pre-permitting project. An associated Environmental Impact Report (SCH #2013062068) was certified by the Harbor District which included eel grass surveys prepared by Thomas Gast and Associates and impact analysis. An active mariculture lease (Starbird) with a site-specific eel grass protection plan includes the area where the Red Tank intake is proposed to be located. Condition 8 of this permit requires:

*Eelgrass Protection. Prior to the initiation of installation activities for aquaculture gear or mooring piles, the Harbor District shall submit for Executive Director review and approval a plan showing that all such activities and associated structures or infrastructure (including pilings,*

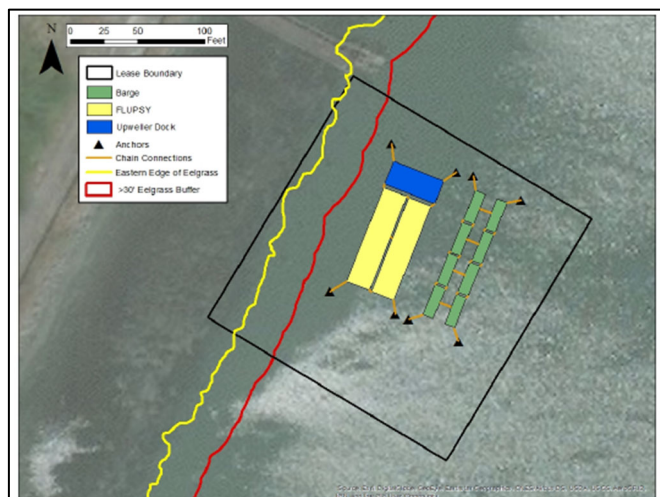


Figure 2. Proposed layout of Starbird Mariculture operations in relation to mapped eelgrass. Eelgrass mapping was conducted by Thomas Gast and Associates (see Attachment 1).

Figure 7: A copy of Figure 2 from the "Humboldt Bay Mariculture Pre-Permitting Project Eelgrass Protection Plan" associated with CDP 9-16-0204



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

*moorings, anchors, longlines, surface rafts, FLUPSYs) shall remain a minimum of 30-feet away from the outside edge of any eelgrass bed within or adjacent to the three subtidal aquaculture sites. This report shall include a map of all eelgrass within each subtidal site and a 50-foot perimeter outside. The map shall be based on the results of an eelgrass survey carried out consistent with the timing and methodology guidelines of the National Marine Fisheries Service's California Eelgrass Management Program. Areas with depths greater than twice the minimum expected eelgrass growing depth in Humboldt Bay are exempt from this survey requirement.*

To implement that Condition 8, the District prepared the "Humboldt Bay Mariculture Pre-Permitting Project Eelgrass Protection Plan" (see Attachment D). The Red Tank intake will be required to comply with this same Eel Grass Protection Plan. Also note from Figure 2 of that Plan (see Figure 7 of this Project Description) that the end of Red Tank Dock is beyond the "eastern edge of eelgrass" and therefore the intake structure will be outside of mapped eel grass.

In addition to the information outlined above, the District has prepared a custom Eelgrass protection plan for this project (see Attachment E).

### 9. **Aquatic Species Entrainment and Habitat Restoration**

Harbor District staff has had informal consultations with staff from agencies regarding potential environmental effects of the proposed water intakes. Based on the consultations, the Harbor District will implement habitat restoration to offset the reduction in biological productivity that will be caused by entrainment of aquatic larvae from water withdrawal. The need to offset the impact on biological productivity is based on California Ocean Plan<sup>2</sup> requirements for desalination plant water intakes. For more information on this topic, see:

- The following Appendices of the "Draft Environmental Impact Report: Samoa Peninsula Land-based Aquaculture Project, County of Humboldt, Planning Department, 17 December 2021" (a.k.a. "DEIR for Nordic Aquafarms"):
  - Appendix N: Tenera Environmental (12/13/21). [The Use of Piling Removal for Mitigating Effects of Entrainment Losses to Longfin Smelt and Other Fishes Resulting from Operation of the Proposed Samoa Peninsula Intakes in Humboldt Bay.](#)
  - Appendix P: Tenera Environmental (5/13/21). [Empirical Transport Modeling of Potential Effects on Ichthyoplankton Due to Entrainment at the Proposed Samoa Peninsula Master Bay Water Intakes.](#)
  - Appendix Q: Tenera Environmental (7/14/21). Empirical Transport Modeling of Potential Effects on Ichthyoplankton Due to Entrainment at the Proposed Samoa Peninsula Bay Water Intakes: [Addendum 1: Longfin Smelt.](#)
- Attachments to this Project Description:
  - Attachment F: CDFW (1/3/22). Memorandum of Understanding: Section 2081(A) Take Permit for The Humboldt Bay Intake Entrainment Study.
  - Attachment G: Tenera Environmental (1/5/22). Project Implementation Plan for Ichthyoplankton Collection at the Samoa Peninsula Water Intakes.

### 10. **Entrainment**

The water intakes are designed to avoid impingement of all aquatic species and entrainment of juvenile and adult aquatic species, by meeting design criteria related to screen mesh, water approach velocity and other parameters. It is expected that only non-special status aquatic larvae will be entrained. Tenera (Attachments G and H) developed a model to estimate entrainment impacts of the proposed water intakes on larvae. Tenera predicts that the portion of larvae in Humboldt Bay that will be entrained is 0.0207% or less (see Attachment H). However, Tenera likely provides an overestimate of larval impacts because:

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<sup>2</sup>State Water Resources Control Board (2015). California Ocean Plan as amended effective January 28, 2016, to address desalination facility water intakes.



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

1. The model assumes even distribution of larvae throughout Humboldt Bay. However, the intakes are located at a site with strong currents and high salinity near the entrance of the bay. It is expected that larvae of most fish species are more concentrated in parts of the bay where they are subject to less tidal action and currents. Additionally, larvae of some species (e.g., longfin smelt (*Spirinchus thaleichthys*)) are not associated with the high water salinities at the water intakes.
2. The model was developed based on a water intake screen slot (mesh) size of 1.75 mm, but based on comments received from the California Coastal Commission the slot size has been reduced to 1.0 mm. The 1.0 mm slot size will further reduce larvae entrainment.

As requested by Coastal Commission staff, the Harbor District has begun to collect field data on larvae abundance in Humboldt Bay to validate the Tenera (5/13/21) model's assumption that larvae are evenly distributed in the bay (or less concentrated near the water intakes). This one-year study will be completed in December of 2022 with the complete report anticipated to be available in January or February of 2023 (see Attachment G). The Harbor District is actively pursuing a Coastal Development Permit, Clean Water Act Permits and a Harbor District Permit before conducting the field work. The permit(s) may include conditions that, prior to exceeding 1,250 gallons per minute (gpm) of water withdrawal, larvae sampling in the bay will be conducted to validate model assumptions regarding larvae distribution. On 1/3/22, CDFW entered into an MOU with Tenera to conduct sampling for this purpose (see Attachments F and G).

### 11. Habitat Restoration

Habitat mitigation will occur as outlined in section 2.4.7 (page 2-56) of the DEIR, Mitigation Measure BIO-6a (Protection of Longfin Smelt) of the DEIR, and as supported by Appendix J (below).

The Harbor District will complete compensatory off-site habitat restoration activities to (1) offset a small reduction in the Humboldt Bay's biological productivity as a result of entrainment of non-special status larval species, and (2) compensate for the potential take of longfin smelt (LFS) larvae during the operation of the two sea chests. Compensatory off-site habitat restoration will include pile removal. Compensatory off-site habitat restoration will be implemented in associated with the phased withdrawal of water through the two water intakes as follows:

- Phase I.
  - Volume: This Phase includes intakes between 0 to 694 gpm.
  - Impact Mitigation: Consistent with other intake permits to withdraw Bay water, and with the project design features incorporated into the project, the effects of this small amount of water withdrawal are considered de minimis and habitat restoration to offset impacts to bio-productivity are not necessary.
  - Timing: Water withdrawal for up 694 gpm is expected to begin after all permits are approved and all conditions of approval of all agencies are met.
- Phase II.
  - Volume: This Phase includes intakes between 695 to 1,250 gpm.
  - Impact Mitigation: The Harbor District will compensate for project-related impacts to Longfin Smelt (LFS) by implementing the revised FEIR version of Mitigation Measure BIO-6a (Longfin Smelt Mitigation), which consists of "habitat creation or enhancement to provide Longfin Smelt spawning, rearing, or nursery habitat capable of producing the number of Longfin Smelt larvae lost to entrainment." The mitigation measure goes on to provide an estimate of impact and a formula for calculating the area of mitigation required.
  - Timing: Water withdrawal at this level will not begin until after Phase II mitigation is completed and Phase II Conditions of Approval are satisfied.
  - Timing: Regardless of tenant/user, the District will not initiate this Phase II of withdrawal until the associated mitigation and conditions of approval are met. In addition, the District will not allow any collective combination of tenant(s)/user(s) to exceed 1,250 gpm unless/until additional permits are acquired.
- Phase III.





## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

- Volume: This Phase includes intakes between 1,251 to 8,250 gpm.
- Pre-mitigation Studies: Prior to withdrawing bay water at Phase III levels, the District will complete an Entrainment Study as approved by CDFW via MOU (see Attachment F and G) and as outlined in:
  - CDFW (1/3/22). Memorandum of Understanding: Section 2081(A) Take Permit for The Humboldt Bay Intake Entrainment Study. See Attachment F.
  - Tenera Environmental (1/5/22). Project Implementation Plan for Ichthyoplankton Collection at the Samoa Peninsula Water Intakes. See Attachment G.
- Impact Mitigation:
  - The Harbor District will compensate for project-related impacts to biological productivity by removing up to 988 creosote piles and 151 crossbeam supports attached to the pilings.
  - The location of these piles/crossbeams is the Kramer Dock site as outlined in Attachment E (Humboldt Bay Master Water Intakes Project, Kramer Dock Pile Removal, Eelgrass Protection Plan and Compensation for Potential Loss of Biological Productivity; 8/15/22).
  - The pile/crossbeam removal will serve as compensatory restoration for biological productivity foregone as a result of the water intakes. This is intended to create space for eelgrass (*Zostera marina*) habitat while enhancing a larger tidal habitat area, and in turn, supporting biological productivity. Per Attachment K, this will also remove an estimated 308 tons of potentially toxic creosote-soaked wood from the bay. The piles collectively have a surface area of 30,660 square feet that is exposed daily to the water column of the bay. As outlined in Attachment I, the total habitat restoration area is 2.69 acres.
  - Benefits from reduced light penetration and replacement of natural substrate are subsequent beneficial impacts to submerged aquatic vegetation. There will also be more natural bay substrate for benthic organisms that live in the bay mud. In addition, some aquatic species such as Pacific herring spawn on hard surfaces, including old dock pilings. Studies performed on creosote coated pilings have shown detrimental effects on embryonic development of herring eggs, even on pilings that were 40 years old (Vines, 2000). For more information on the benefits of pile removal, see EIR appendix N by Tenera as it builds on previously developed rationale for why piling removal is appropriate for APF mitigation. Therefore, removal of the pilings would eliminate any potential impacts to organisms that may come in contact with the pilings. Therefore, removal of the pilings would eliminate any potential impacts to organisms that may come in contact with the pilings. Accordingly, the removal of the Kramer Dock pilings and restoration to more natural conditions will improve the biological productivity of the Bay.
  - Removal of the creosote treated piles is expected to have water quality benefits. The removal of creosote piles and braces is proposed to offset the small reduction in the Humboldt Bay's biological productivity as a result of entrainment of non-special-status larval species. This is consistent with Appendix N of the Nordic EIR (The Use of Piling Removal as Method for Mitigating Effects of Entrainment Losses to Longfin Smelt and Other Fishes Resulting from Operation of the Proposed Samoa Peninsula Intakes in Humboldt Bay, Tenera December 13, 2021; Tenera Environmental 2021c, DEIR Appendix N).
  - This action is consistent with the "compensatory off-site restoration" outlined in the Final EIR for the Nordic project.
- Impact Mitigation Location: The District will utilize the location described in Attachment I for the off-site restoration and will utilize the BMPs outlined in Attachment J. These BMPs are designed to avoid impacts to eelgrass as well as to prevent the potential mobilization of contaminants into the Bay.
- Secondary Use of Impact Mitigation Site:
  - Exhibit 1 of Attachment I (Kramer Dock Habitat Restoration Memorandum) displays "Piling removal areas 2 and 4," both of which are reserved for use as "barge landing sites" after pile removal.



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

- The planned barge landing sites are each 150 ft wide locations reserved to be used as barge access to South Depot Road. The District forecasts that these sites can be used periodically as barge access landing sites without disturbing eelgrass. Note that the methodology used to remove the piles includes the use of equipment operating from a barge. Per Attachment J (Pile Removal Methods and Best Management Practices), the barge associated with the removal of piles would be approximately 80' X 100' with a 4' draft and would be moved with a small tugboat and "neither the barge nor the tug will anchor during the removal process." During the pile removal process, the barge will operate "...at a tide of sufficient elevation to float the barge and tugboat... without scarring the mudflats or injuring eelgrass." In addition, "grounding of the barge will not be permitted."
- The District anticipates that the same methodology and Best Management Practices may be deployed in the future (following pile removal) to allow for barge landings at these two sites. The restored eelgrass beds will not be affected by future barges as they would be floating above the eelgrass beds.
- This same concept of barge unloading in this same location was applied for in CDP Application 04-12-19S for the TerraGen Humboldt Onshore Wind Project. In that application, the applicant sought to use this site to unload large wind turbine components (such as wind turbine blades). The barges were to have shallow drafts and to be deployed at the site at tides that were sufficiently high enough to float the barge above eelgrass beds. The components would have been unloaded onto the land, where they would have been shipped by vehicle to their destination. This site was selected because it is the only feasible location to unload large loads south of Eureka. For instance, unloading a two-hundred-foot-long wind turbine blade in Eureka may be feasible, but transporting such a long load through the streets of Eureka to get to the Fortuna area would be impractical. Such a route would also require transiting under (or around) the US 101 underpasses and on/off ramps in southern Eureka, which could be impractical for large/tall loads. However, unloading long/large/tall loads at the Kramer Dock site provides a much more reasonable access point and transport corridor to US 101 south and avoids the underpasses and on/off ramps in southern Eureka. The plan was to use this site for these purposes using barges in such a way as to have no impact to eelgrass.
- The District is anticipating that similar demands may occur in the future and that similar methodologies may be utilized without any impacts to eelgrass. Thus, the District is anticipating full mitigation credit for pile removal in "Piling removal areas 2 and 4," both of which are reserved for use as "barge landing sites" after pile removal. Note that the District does not have any specific planned barge landings and is not aware of any planned or forecasted uses, though the District does intend to reserve these areas for such use if the need ever arises.
- Other than mitigation and two limited barge landing sites, the District does not have any planned uses for the proposed mitigation area. As explained above, any barge landings would be conducted in such a way that impacts to eelgrass would be avoided. Thus, the District expects that the site will effectively function as mitigation.
- BMPs to Avoid Mobilization of Contaminants at Mitigation Site:
  - To minimize the potential for impacts, the District has developed the document "Pile Removal Methods and Best Management Practices to Avoid Impacts to Eelgrass and to Avoid Mobilization of Contaminants" (Attachment J).
  - To reduce the risk of mobilizing sediment and any potential contaminants that may be present during creosote-treated wood pile removal, the District will use methods designed to minimize disturbance and implement industry-established best management practices (BMPs). Vibratory extraction is the preferred method of piling removal because it causes the least disturbance to the seabed and it typically results in the complete removal of the piling from the aquatic environment (EPA 2016). BMPs to be implemented include but are not limited to: use of a floating



## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

boom to control debris, having proper containment on the barge for removed piles, controlling sediments and turbidity and preventing them from re-entering the water column, and characterization of piles for proper disposal. A detailed summary of methods and BMPs for the Kramer Dock piling removal is provided in Appendix J.

- Creosote is a registered pesticide mixture that is comprised primarily of Polycyclic Aromatic Hydrocarbons (PAHs) by weight (90%). Creosote on the surface of the pilings leach contaminants to the aquatic environment through a weathering process in which individual chemical constituents are adsorbed, evaporated, photo-oxidized or dissolved. Leaching rates of contaminants from creosote-treated wood are variable and greatest during the first few years after placement (SFEI, 2010).
- The accumulation of PAHs in sediment tends to be localized and is subject to degradation that varies based on site specific conditions. Factors that influence the rate of contaminant degradation include saline content in water, water exchange through currents, and bioavailability. Previous studies have demonstrated over time that PAH concentrations do not reach a problematic level in sediment (SFEI, 2010).
- The Kramer Dock piles are over 50 years old. Leached contaminants previously present in the sediment are further expected to have degraded to levels of insignificance. The District is unable to identify sediment testing as part of EPA or NOAA guidance, and has not been made aware of this requirement for other California port piling removal projects. Based on these conditions, current findings, and modeling completed for aquatic impacts from treated wood pile In San Francisco Bay, the District does not intend to conduct sediment testing following piling removal.
  - Timing: If necessary, the Harbor District will consult with other regulatory agencies to further develop details of the habitat restoration prior issuance of permits required for pile removal.
  - Timing: Water withdrawal at this level will not begin until after Phase III restoration is completed and Phase III Conditions of Approval are satisfied.
  - Timing: Regardless of tenant/user, the District will not initiate this Phase III of withdrawal until the associated mitigation and conditions of approval are met. In addition, the District will not allow any collective combination of tenant(s)/user(s) to exceed 8,250 gpm unless/until additional permits are acquired.

### Attachments

- A. HBHRCD (2/2/19). RMT II Permit Compliance Flowchart.
- B. SHN (7/19/22). Baywater Intake System Pipeline Trench and EHSA Analysis; Response to Continued Review of Coastal Development Permit (CDP) Application No. 1-21-0653.
- C. SHN (1/13/21). Humboldt Bay Intake Screens Preliminary Operation and Maintenance Description, Redwood Marine Terminal II and Red Tank Dock, Samoa, California.
- D. HBHRCD (1/30/18). Eelgrass Protection Plan (from Humboldt Bay Mariculture Pre-Permitting Project Starbird Mariculture).
- E. SHN (8/15/22). Humboldt Bay Master Water Intakes Project, Kramer Dock Pile Removal, Eelgrass Protection Plan and Compensation for Potential Loss of Biological Productivity.
- F. CDFW (1/3/22). Memorandum of Understanding: Section 2081(A) Take Permit for The Humboldt Bay Intake Entrainment Study.
- G. Tenera Environmental (1/5/22). Project Implementation Plan for Ichthyoplankton Collection at the Samoa Peninsula Water Intakes.
- H. SHN and Tenera Environmental (7/18/22). Humboldt Bay Water Intakes and Tidal Dynamics.
- I. GHD (1/27/22). Kramer Dock Habitat Restoration Memorandum.
- J. HBHRCD (1/16/22). Pile Removal Methods and Best Management Practices to Avoid Impacts to Eelgrass and to Avoid Mobilization of Contaminants.
- K. GHD (4/5/22). Kramer Dock Pile Removal Quantities.





## Humboldt Bay Master Water Intakes: Project Description (updated 7/20/22)

- L. County of Humboldt (9/29/22). CEQA Notice of Determination: Environmental Impact Report – Nordic Aquafarms California, LLC – Land-based Aquaculture Project & Coastal Development Permit & Special Permit.
- M. SHN (11/15/22). Mitigation and Monitoring Plan for the Humboldt Bay Master Water Intakes Project.
- N. H.T. Harvey Associates (12/92/22). Memorandum in response to concerns about effects of water intake operations by the Sea Chests on juvenile salmonid critical habitat.

### Other Studies/Reports That Can Be Provided Under Separate Cover Upon Request

- Biological Assessment (SHN 2022).
- Phase I reports.
- SHN (9/20/20). Biological and Habitat Assessment report.
- SHN (9/20/20). Wetland Assessment.

### Referenced Studies/Reports from the “Samoa Peninsula Land-based Aquaculture Project DEIR and FEIR”

- Link to FEIR and DEIR: <https://humboldt.gov/3218/Nordic-Aquafarms-Project>
- Appendix R of the DEIR
  - SHN (8/6/21). Humboldt Bay Intake Screen Conceptual Designs, Redwood Marine Terminal II and Red Tank Dock, Samoa, California – Revision 03. [For a copy of this report, see: “Draft Environmental Impact Report: Samoa Peninsula Land-based Aquaculture Project, County of Humboldt, Planning Department, 17 December 2021” Appendix R.]
  - Link: <https://humboldt.gov/DocumentCenter/View/102332/Appendix-R---Sea-Chest-Screen-Conceptual-Design-PDF>
- Appendix N of the DEIR
  - Tenera Environmental (12/13/21). The Use of Piling Removal for Mitigating Effects of Entrainment Losses to Longfin Smelt and Other Fishes Resulting from Operation of the Proposed Samoa Peninsula Intakes in Humboldt Bay.
  - Link: <https://humboldt.gov/DocumentCenter/View/102328/Appendix-N---Tenera-Piling-Removal-Mitigation-PDF>
- Appendix P of the DEIR
  - Tenera Environmental (5/13/21). Empirical Transport Modeling of Potential Effects on Ichthyoplankton Due to Entrainment at the Proposed Samoa Peninsula Master Bay Water Intakes.
  - Link: <https://humboldt.gov/DocumentCenter/View/102330/Appendix-P---Tenera-Final-Report-PDF>
- Appendix Q of the DEIR
  - Tenera Environmental (7/14/21). Empirical Transport Modeling of Potential Effects on Ichthyoplankton Due to Entrainment at the Proposed Samoa Peninsula Bay Water Intakes: Addendum 1: Longfin Smelt.
  - Link: <https://humboldt.gov/DocumentCenter/View/102331/Appendix-Q---Tenera-Addendum-PDF>

### Other References

- EPA (2016). Region 10 EPA, Best Management Practices for Piling Removal and Placement in Washington State
- Humboldt Bay Harbor, Recreation and Conservation District (2021). “Humboldt Bay Master Water Intakes Project Description.
- NOAA (October 12, 2009). The Use of Treated Wood Products in Aquatic Environments: Guidelines to West Coast NOAA Fisheries Staff for Endangered Species Act and Essential Fish Habitat Consultations in Alaska, Northwest and Southwest Regions.
- San Francisco Estuary Institute (December 2010). Removal of Creosote-Treated Pilings and Structures from San Francisco Bay.
- Vines et al. (2000). The Effects of creosote-derived compounds on development of Pacific Herring. Aquatic Toxicology 51.



## **Attachment A**

### **Humboldt Bay Harbor District (2/2/19). RMT II Permit Compliance Flowchart.**

Redwood Marine Terminal II  
Lease Permit Compliance Flow  
Chart CDP 16-049 and 17-041

Lease Application  
with Operations  
Plan Received By  
District

District Submits  
Operations Plans to  
County

Planning Director Review

- CDP-16-049
- CDP-17-041
- CDI Development Regulations
- Interim Use Sites Review 313-104.1
- No Development

Operation Plan  
Not Approved

Deny Use

Use  
Requires  
a CDP

Use Not  
Allowed

Operation Plan  
Approved

Other Allowable Uses

District Authorized to  
Execute Lease

No Term Limit

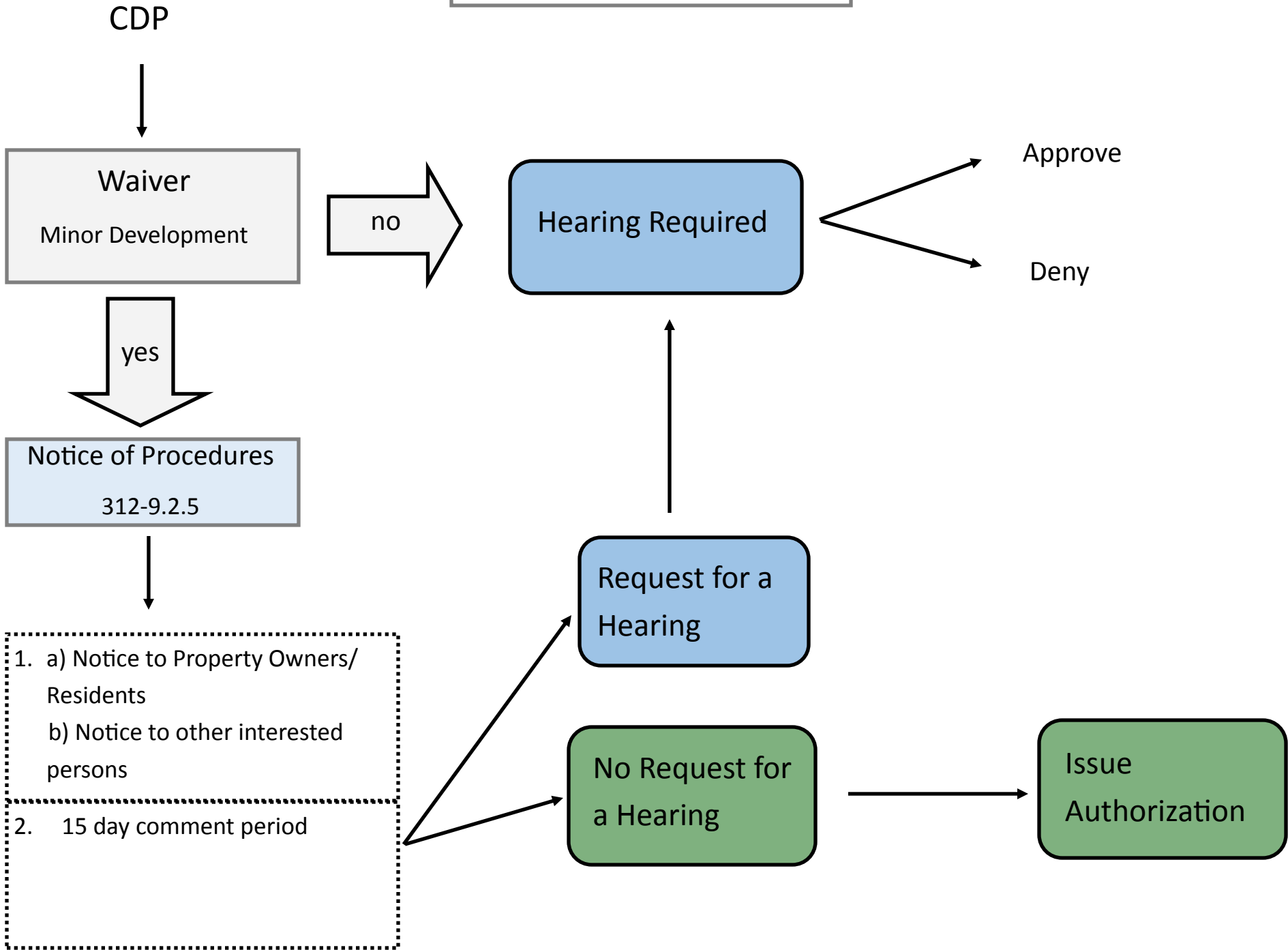
Interim Use

District Authorized to  
Execute Lease

7-10 Year Term Limit



Principally Permitted Use



Interim Conditionally Permitted Use

Submittal of a Use Permit and Coastal Development Permit  
313-104.1.3.4

Review for Compliance  
313-104.1

If Denied

Denied with No Hearing

If Approved

Submittal of a Development Plan  
313-104.1.3.8

Review for Compliance  
313-104.1

Waiver

No

Yes

Hearing Required  
104.1.4

Approve

Deny

Approve Interim Conditionally Permitted Use

## Conditionally Permitted Use

Coastal Dependent Industrial  
(CDI) Development Regulations

Submittal of a Use Permit and  
Coastal Development Permit

313-104.1.3.4



Assuming CDP 16-049 and CUP 16-062 is Approved  
Redwood Marine Terminal II  
Permit Compliance

Lease Application  
Received

Submit Operations  
Plans to County

Review by County

- CDP-16-049
- CUP-16-062
- CDI Development Regulations
- Interim Use Sites Review 313-104.1

Planning Director Action

Deny Use

Use Requires a  
CUP/CDP  
Amendment

Use Not  
Allowed

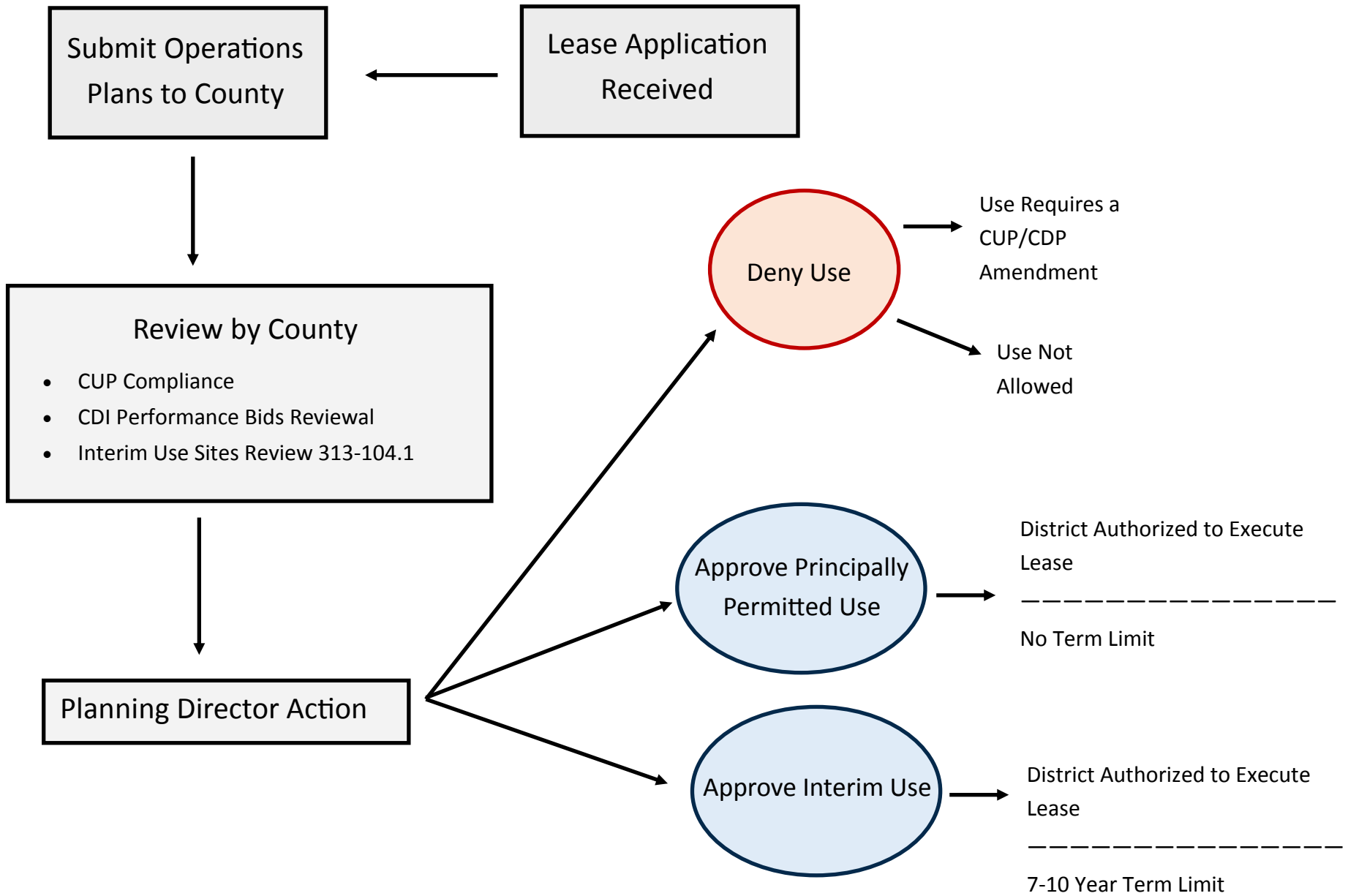
Approve Principally  
Permitted Use

District Authorized to Execute  
Lease  
-----  
No Term Limit

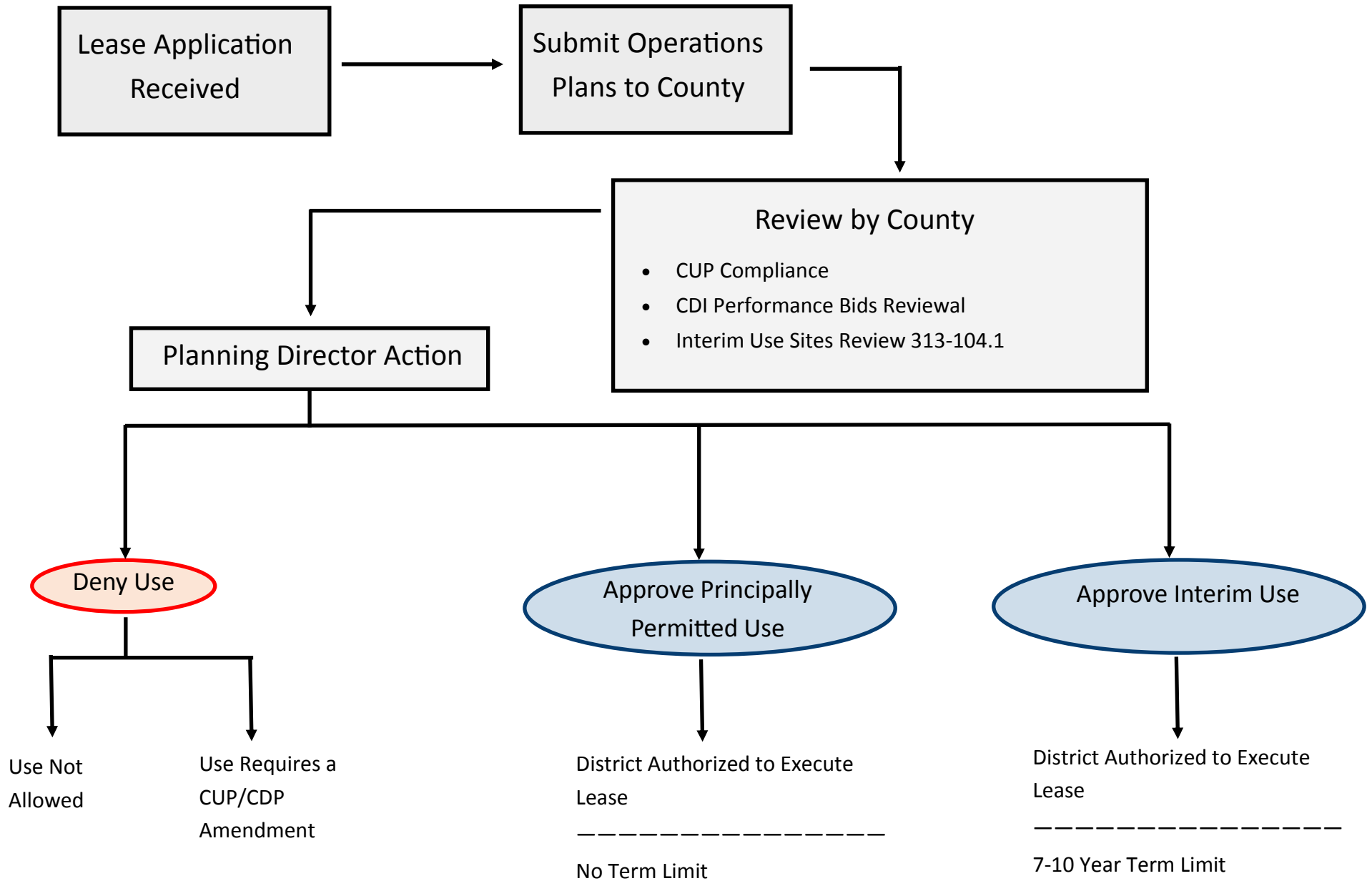
Approve Interim Use

District Authorized to Execute  
Lease  
-----  
7-10 Year Term Limit

# RMT II Permit Compliance



# RMT II Permit Compliance



## **Attachment B**

**SHN (7/19/22). Baywater Intake System Pipeline  
Trench and EHSA Analysis; Response to Continued  
Review of Coastal Development Permit (CDP)  
Application No. 1-21-0653.**



Reference: 016240.005

July 19, 2022

Rob Holmlund, Development Director  
Humboldt Bay Harbor, Recreation, and Conservation District  
601 Startare Drive  
Eureka, CA 95501

**Subject: Baywater Intake System Pipeline Trench and ESHA Analysis; Response to Continued Review of Coastal Development Permit (CDP) Application No. 1-21-0653**

Dear Rob Holmlund:

SHN has developed this response to the California Coastal Commission (CCC) letter dated February 22, 2022, regarding impacts to Environmentally Sensitive Habitat Areas (ESHA), and other biological resources within the alignment for a proposed water intake pipeline. The CDP application is part of the Humboldt Bay Harbor, Recreation, and Conservation District project to modernize and operate two formerly used bay water intake systems at Redwood Marine Terminal II and Red Tank Dock.

## Introduction

A Biological and Habitat Assessment report (SHN, 2020a) and a Wetland Assessment (SHN, 2020b) were previously prepared for a majority of the project site in September 2020, prior to the development of a project description. ESHA and sensitive species habitat have been identified and mapped adjacent to the proposed water intake piping alignment (Figures 1, 2, and 3). The following information is intended to satisfy the CCC request for a biological report that:

















- (i) evaluates the proposed pipeline infrastructure project in relation to sensitive species and habitats in the project area;
- (ii) provides a biological determination of minimum buffers necessary to protect the resources of the sensitive habitat areas from significant disruption of habitat values;
- (iii) evaluates the adequacy of any proposed buffers less than the recommended minimum buffers;
- (iv) provides a description of the specific mitigation measures and BMPs that will be provided to avoid and/or minimize adverse environmental effects of construction of the proposed pipeline infrastructure adjacent to sensitive habitats and coastal waters; and provides a description/map of the proposed bridge infrastructure relative to sensitive habitats, evaluates impacts, and describe BMPs, avoidance, and minimization measures to limit adverse environmental effects of construction of the proposed bridge infrastructure adjacent to sensitive habitats and coastal waters.





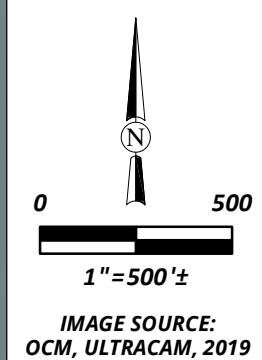
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### EXPLANATION

-  **BAYWATER INTAKES (E)**
-  **CULVERTS (E)**
-  **COAST WILLOW-STORMWATER FEATURE (E)**
-  **BAY WATER PIPE, SUSPENDED FROM DOCK (P)**
-  **INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)**
-  **INDUSTRIAL WATER PIPE TRENCH (P)**
-  **BAY WATER PIPE TRENCH (P)**
-  **PIPELINE TRENCH BUFFER (10 FT)**
-  **STORMWATER INFRASTRUCTURE (P)**
-  **OSPREY NESTS (2021)**
-  **ESTUARINE TIDAL WETLAND**
-  **ESTUARINE TIDAL WETLAND**
-  **COASTAL WETLAND**
-  **COASTAL DUNE WILLOW THICKET/WAX MYRTLE SCRUB**
-  **STORMWATER FEATURE**
-  **STUDY AREA**



FOR PLANNING PURPOSES ONLY
















Humboldt Bay Harbor, Recreation, & Conservation District  
 RMT I Water Intakes CDP, Response to Comments  
 Eureka, California


**Habitat & ESHA Map Overview**  
 July 2022 - 016240.005

**Figure 1**




**EXPLANATION**

-  BAYWATER INTAKES (E)
-  CULVERTS (E)
-  COAST WILLOW-STORMWATER FEATURE (E)
-  BAY WATER PIPE, SUSPENDED BY DOCK (P)
-  INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)
-  INDUSTRIAL WATER PIPE TRENCH (P)
-  BAY WATER PIPE TRENCH (P)
-  PIPELINE TRENCH BUFFER (10 FT)
-  STORMWATER INFRASTRUCTURE (P)
-  OSPREY NESTS (2021)
-  ESTUARINE TIDAL WETLAND
-  ESTUARINE TIDAL WETLAND
-  STUDY AREA



0 150



1" = 150'±

IMAGE SOURCE:  
OCM, ULTRACAM, 2019



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Humboldt Bay Harbor, Recreation, & Conservation District  
RMT I, Water Intakes CDP, Response to Comments  
Eureka, California

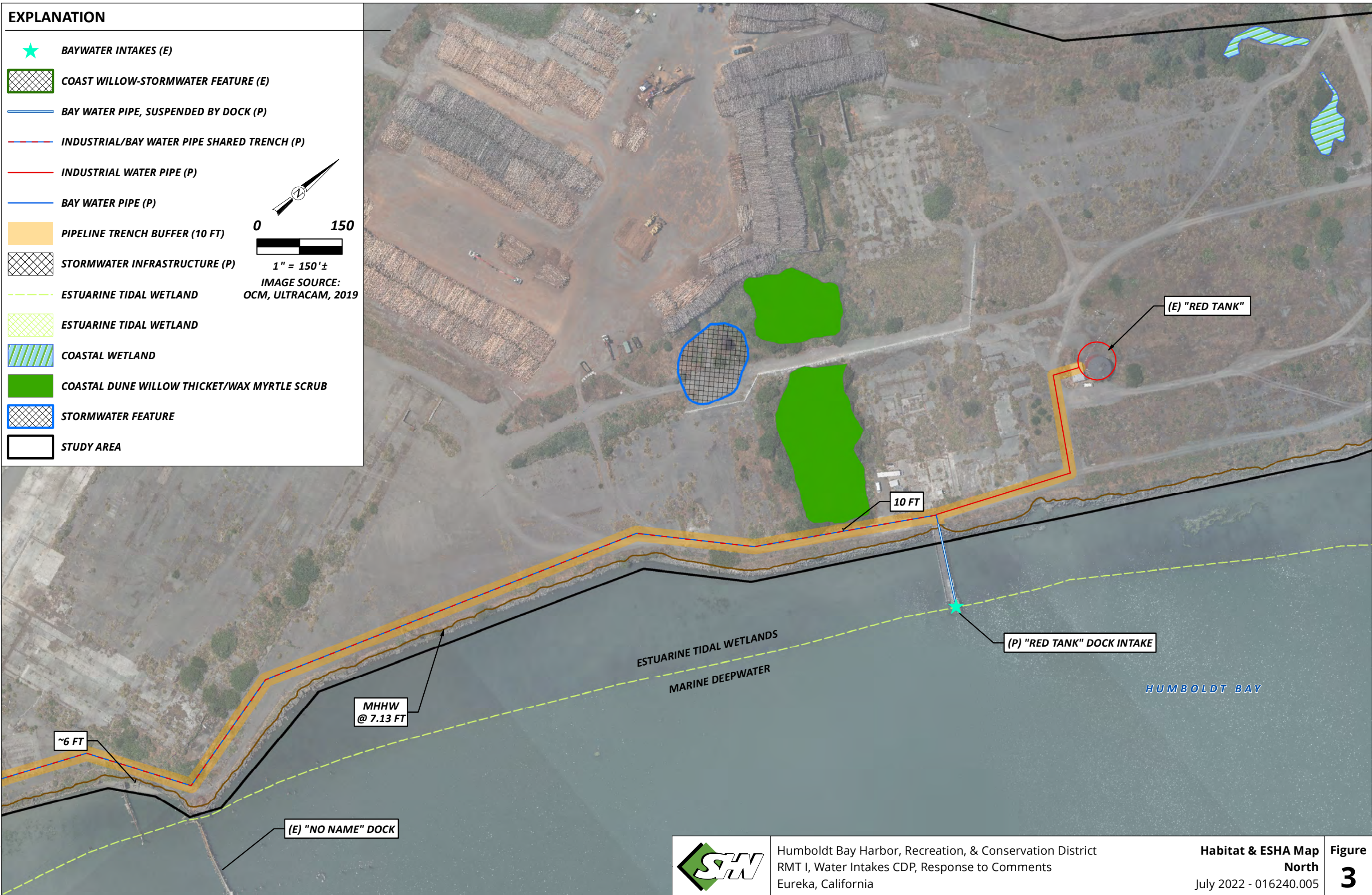
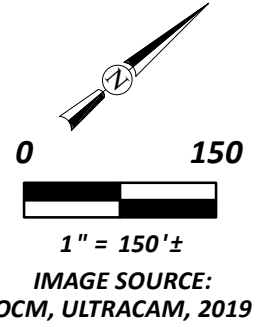
**Habitat & ESHA Map**  
**South**  
July 2022 - 016240.005

**Figure**  
**2**



**EXPLANATION**

-  BAYWATER INTAKES (E)
-  COAST WILLOW-STORMWATER FEATURE (E)
-  BAY WATER PIPE, SUSPENDED BY DOCK (P)
-  INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)
-  INDUSTRIAL WATER PIPE (P)
-  BAY WATER PIPE (P)
-  PIPELINE TRENCH BUFFER (10 FT)
-  STORMWATER INFRASTRUCTURE (P)
-  ESTUARINE TIDAL WETLAND
-  ESTUARINE TIDAL WETLAND
-  COASTAL WETLAND
-  COASTAL DUNE WILLOW THICKET/WAX MYRTLE SCRUB
-  STORMWATER FEATURE
-  STUDY AREA



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Humboldt Bay Harbor, Recreation, & Conservation District  
 RMT I, Water Intakes CDP, Response to Comments  
 Eureka, California

**Habitat & ESHA Map North**  
 July 2022 - 016240.005

**Figure 3**



## Methods

Existing documentation of special-status species and sensitive habits were used to analyze the temporary impacts of the proposed project implementation. Sources include the previously prepared Biological and Habitat Assessment (SHN, 2020a) and Wetland Assessment (SHN, 2020b); the Nordic Aquafarms California, LLC Land-based Aquaculture Project Draft EIR (Humboldt County, 2021); and the Humboldt Bay Master Water Intakes Project Description (HBHRCD, 2022). In addition, a field visit was conducted on March 4, 2022 by SHN Senior Biologists Joseph Saler and Gretchen O'Brien to verify current site conditions within the pipeline infrastructure footprint.

## Results

### Existing Conditions

The majority of the pipeline alignment will be sited within asphalt and concrete paved vacant industrial land (Figure 1). These areas consist of large expanses of asphalt with little to no vegetation. Cracks in pavement or old foundations are typically dominated by invasive species, the most common being pampas grass (*Cortaderia jubata*). The southern portion of the alignment occurs immediately east and south of the former pulp mill infrastructure (Attachment 1, photos 1, 2, 4 and 5). This area is characterized by compacted gravel and invasive herbaceous species cover (Appendix 1, photo 3). As such, the majority of the pipeline installation and construction-related activities will not result in impacts to sensitive species or ESHA. Two ESHA were identified within the vicinity of the proposed pipeline alignment. Both of the ESHA consisted of coast willow thickets and are described below.

### ESHA

Coastal dune willow thickets (*Salix hookeriana* Shrubland Alliance) occupy two isolated locations adjacent to the proposed water intake piping alignment. The coast dune willow thickets are composed of a mix of coast willow, wax myrtle, and to a lesser extent, Pacific willow. Areas with a higher dominance of wax myrtle greater than 50 percent cover in the canopy more closely resemble wax myrtle scrub (*Morella californica* Shrubland Alliance). These areas are intermixed with the more widespread dominance of coast willow and are mapped as wax myrtle/coast willow shrublands (Figures 2, 3, and 4).












Coastal dune willow thickets and mixed wax myrtle scrub are closely associated with old foundations, concrete low spots with drainage inlets, debris and soil spoil piles, and industrial stormwater features. Many of the areas with wax myrtle and coast willow canopy cover do not meet the one-parameter wetland definition on account of dominance by invasive upland species in the understory, concrete in the soil, and the well-drained nature of the site. It is well documented that coast willow dune thickets are a "disturbance-related" vegetation community (Sawyer, 2009), and the occurrences of this vegetation community within the project area reflect past disturbance rather than natural conditions (SHN, 2020a).

The proposed pipeline trench will not result in direct impacts to coastal willow thickets or other ESHA as proposed. The proposed pipeline will pass adjacent to two coast willow thickets along the length of the pipeline. The coast willow thicket adjacent to the proposed alignment in the south is restricted to an excavated swale constructed for stormwater conveyance from surrounding industrial lands. Soils are





**EXPLANATION**

-  **BAYWATER INTAKES (E)**
-  **CULVERTS (E)**
-  **COAST WILLOW-STORMWATER FEATURE (E)**
-  **INDUSTRIAL/BAY WATER PIPE SHARED TRENCH (P)**
-  **INDUSTRIAL WATER PIPE (P)**
-  **BAY WATER PIPE (P)**
-  **PIPELINE TRENCH BUFFER (10 FT)**
-  **STORMWATER INFRASTRUCTURE (P)**
-  **ESTUARINE TIDAL WETLAND**
-  **ESTUARINE TIDAL WETLAND**
-  **STUDY AREA**

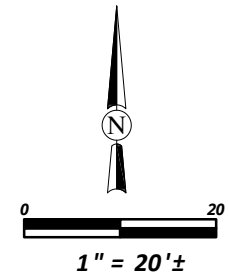
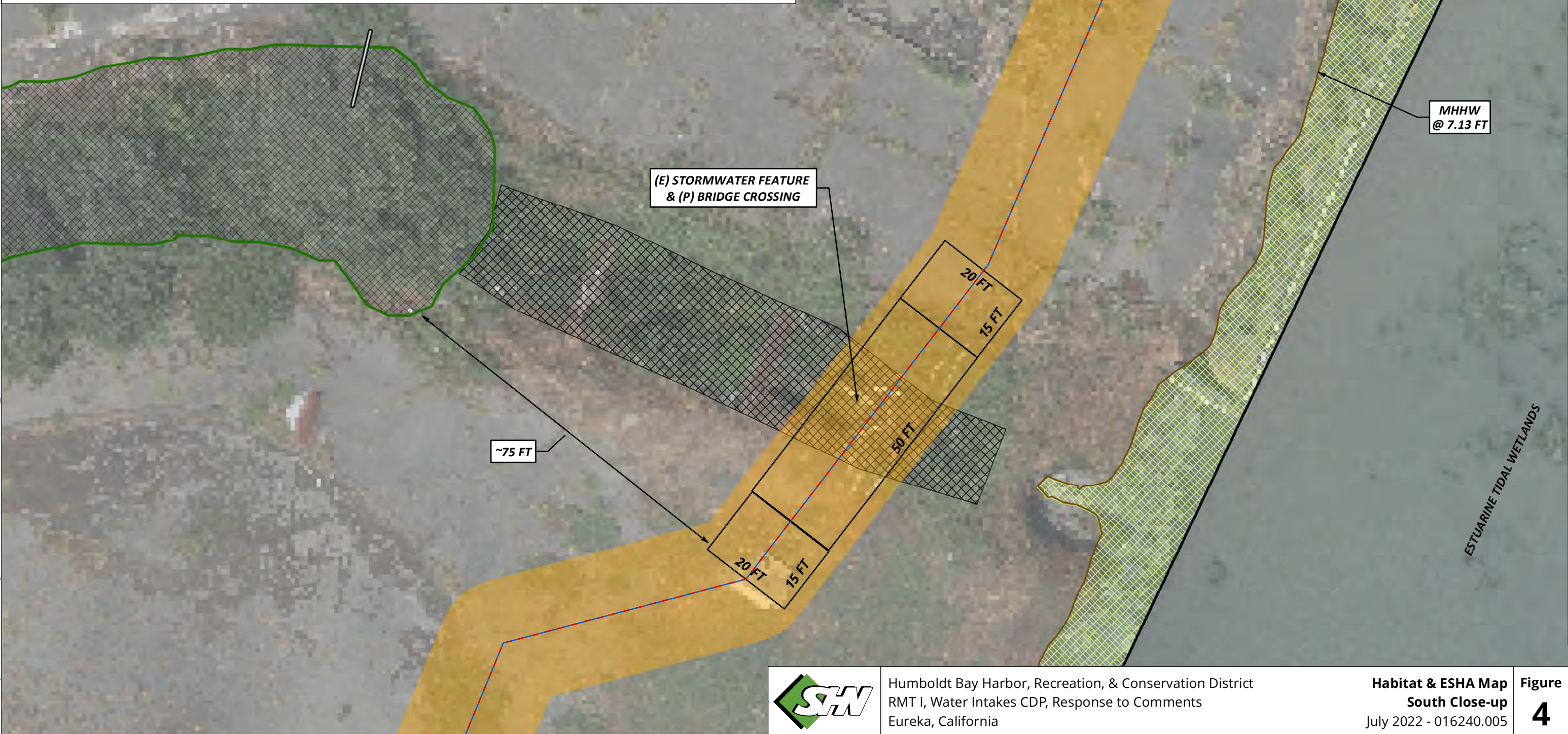


IMAGE SOURCE:  
OCM, ULTRACAM, 2019



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Humboldt Bay Harbor, Recreation, & Conservation District  
RMT I, Water Intakes CDP, Response to Comments  
Eureka, California

**Habitat & ESHA Map**  
**South Close-up**  
July 2022 - 016240.005

**Figure**  
**4**



mostly intact and uncompacted, and invasive species dominance is restricted to the edge of the feature. The coast dune willow thicket follows the stormwater swale into the paved industrial areas and may represent a wildlife movement corridor into areas that would otherwise be inaccessible.

The majority of this stormwater feature is dominated by coast willow thicket (see Figures 2 and 4 and Appendix 1, photo 6); however, the easternmost portion of the feature contains weirs, pedestrian bridges, and retaining walls, and does not have willow cover and is not considered ESHA (Appendix 1, photos 7-9). It is in this area that the proposed pipeline will be sited and will be attached to a bridge for support. The stormwater detention feature at this location is between 33 and 36 feet from top of bank to top of bank. The proposed pipeline and bridge over the existing stormwater feature will be positioned outside of the ESHA boundaries. No tree removal or disturbance of soil within the coast willow thicket would occur as a result of the proposed pipeline. In addition, appropriate avoidance measures and BMPs, as described below in BMPs, Avoidance, and Mitigation Measures, will be in place during construction. The nearest disturbance will be at the location of the proposed bridge abutment within existing pavement approximately 75 feet from the edge of the coast willow and approximately 15 feet back from the top of bank. The banks of this feature are predominantly vegetated with non-native species and are not classified as ESHA. The functionality of the ESHA for wildlife movement is not expected to change post-construction, as access to the potential movement corridor will not be restricted after the proposed construction is complete; therefore, the 75-foot setback from coast willow is considered adequate.

The coast willow thicket in the northern portion of the alignment exists within the footprint of former milling facilities and has developed in the years since closure (see Figure 3 and Appendix 1, photos 10 and 11). The proposed pipeline will be sited within the footprint of an existing asphalt road that exists 10 feet east of the coast willow thicket. No tree removal or disturbance of soil within the coast willow thicket would occur as a result of the proposed pipeline. In addition, appropriate avoidance measures and BMPs, as described below in BMPs, Avoidance, and Mitigation Measures, will be in place during construction. The habitat value of the ESHA along the proposed pipeline alignment is degraded on account of the past use, current industrial remnants, invasive species dominance, and isolation from intact habitat. It is restricted to the former mill foundation with asphalt and compacted soils present. English ivy and other invasive plant species are present in the understory. The willow thicket is isolated from other vegetated areas by vast areas of asphalt, which limits wildlife movement into the willow thicket. There is no functional relationship of the proposed area for the piping and the adjacent patches of ESHA; therefore, the 10-foot setback is considered adequate to avoid impacts to the ESHA.

The two ESHAs present within the immediate vicinity of the proposed pipeline alignment will not be directly impacted by the project. As proposed, the pipeline will remain outside of ESHA and will stay within the footprint of existing hard surfaces. The recommended buffer for this project is to maintain the same setback as exists between the hard surfaces and the ESHA, with no encroachment allowed into the adjacent ESHA, including any soil, stormwater, worker, or equipment incursion, that could occur during construction. High-visibility temporary construction fencing should be installed prior to the commencement of construction to clearly demarcate the edge of ESHA and act as a barrier to accidental incursion. Proper soil containment and stormwater BMPs will ensure that ESHA remains unimpacted during construction.



The following measures are recommended to minimize potential impacts associated with the installation of the proposed pipeline:

- Install high visibility temporary construction fencing along the edge of ESHA where it is adjacent to the proposed pipeline.
- Post construction, grade disturbed soils to pre-project condition,
- Use native herbaceous seed mix in areas where soils are not gravel or asphalt.
- Use weed-free straw to cover exposed spoils
- Follow BMPs detailed the end of this report to reduce erosion and habitat degradation.

### **Proposed Set-back Justification**

With the establishment of a temporary construction fence and implementation of proper soil and stormwater BMPs, the existing development setbacks are deemed adequate for the following reasons:

- The ESHA adjacent to the proposed pipeline alignment are low-quality examples of coast dune willow thickets and their occurrence is dependent on anthropogenic disturbance and manipulation of the site.
- Past use and legacy development from past industrial use isolates the ESHA on site and invasive species occurrences further reduce the habitat value of these features. Coast willow is a disturbance-adapted species and not expected to be affected by the installation of the pipeline.
- The ESHA adjacent to the proposed pipeline alignment is surrounded by development, and the pipeline will not encroach any closer to the ESHA than the existing asphalt and hard surfaces.
- Following completion of construction, the location of the pipeline should be indistinguishable from the surrounding area at the northern ESHA, and the proposed new bridge will be constructed outside of the swale and extent of coast willow, with bridge abutments to be sited within existing pavement. Furthermore, the pipeline and supporting bridge will improve conditions within the stormwater swale by removing industrial equipment from the swale, allowing for better wildlife movement as the proposed bridge will be constructed above the top of bank.
- Installation of temporary construction fencing will minimize incursion into the ESHA during construction and maintain the coast willow thickets in the same condition as they are prior to construction.
- Implementation of the mitigation measures described below will further reduce impacts to adjacent coast willow thicket ESHA.

Throughout the entire extended project area with the associated Nordic Aquafarms proposed development, mitigation measures are in place for any loss of Sensitive Natural Communities, as detailed in BIO-7a in the Mitigated Negative Declaration prepared for the projects (County of Humboldt, 2021).



## Special-status species

### Plants

Seasonally appropriate surveys for special-status plants occurred in April, May, and June 2020 (SHN 2020a). No special-status plants were detected in the Humboldt Bay Water Intakes Study Area. This is likely a result of intensive historical development and use of the site and the remaining impacts from that development, as well as the dominance of exotic herbaceous species within large portions of the study area. Special-status plant species will not be impacted by the proposed water intake piping project.

### Animals

Construction and ground disturbance required for the piping infrastructure is within proximity to existing Osprey nests. Construction within 500 feet of the osprey nests, as well as nests of other bird species, would occur outside the nesting bird season if feasible. If construction within 500 feet the osprey nests or other nests were to occur during the nesting bird season, a buffer and biological plan would be required with the approval of the Planning and Building Department and in consultation with California Department of Fish and Wildlife (DFW; County of Humboldt, 2021).

## BMPs, Avoidance, and Minimization Measures

As described in Mitigation Measure BIO-7b in the DEIR prepared for the projects (Humboldt County, 2021), prior to issuance of any permits, the following BMPs will be applied:

- Orange net or other appropriate fencing shall be placed around the 35-foot ESHA setback or at the limit of the Fire Road encroachment. The fencing shall remain in place throughout the construction period to prevent vehicles, equipment, or materials from entering the ESHA.
- The grading plans for the project site shall design finished pad grades to not result in grade changes at the edge of the buffer or fire road within the ESHA buffer.
- Erosion control materials (for example, silt fencing) shall be utilized to isolate the area of ground disturbance from the Humboldt Bay shoreline during construction.

In addition, the project shall be required to obtain a General Construction Stormwater Discharge stormwater pollution prevention plan (SWPPP; see Mitigation Measure HWQ-1). SWPPP requirements would minimize and avoid water quality impacts to Humboldt Bay from construction-generated erosion and stormwater by establishing erosion control measures during construction (for example, silt fences), minimization of vegetation removal, and avoidance of work during heavy rainfall. These requirements include the following:

- Construction activities shall be scheduled and sequenced to minimize the areal extent and duration of site disturbance at any time.
- Drainage from outside the construction area shall be directed away from or around the site through use of berms, ditches, or other structures to divert surface runoff.
- Install weed-free fiber rolls, straw-wattles, coir logs, silt fences, or other effective devices along locations where water drains off the construction site.



- All graded slopes shall receive slope protection measures such as fiber rolls, drainage ditches, or erosion control fabrics to minimize the potential for concentrated surface runoff to cause erosion.
- Implement wind erosion or dust control procedures consisting of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. The contractor may choose to cover small stockpiles or areas as an alternative to applying water or other dust palliatives.
- Control water application rates to prevent runoff and ponding. Repair leaks from water trucks and equipment immediately.
- Hazardous materials shall be stored in areas protected from rain, provide secondary containment and must be a minimum of 100 feet from any wetland or Environmentally Sensitive Habitat Area.
- Implement the following hazardous materials handling, storage, and spill response practices to reduce the possibility of adverse impacts from use or accidental spills or releases of contaminants:
  - Conduct all refueling and servicing of equipment more than 100 feet from any wetland or Environmentally Sensitive Habitat Area with absorbent material or drip pans underneath to contain spilled fuel. Collect any fluid drained from machinery during servicing in leak-proof containers and deliver to an appropriate disposal or recycling facility.
  - Prevent raw cement; concrete or concrete washings; asphalt, paint, or other coating material; oil or other petroleum products; or any other substances that could be hazardous to aquatic life from contaminating the soil or surface water.
- In the event dewatering is determined to be necessary, the following steps shall be taken:
  - Prepare a dewatering plan prior to excavation.
  - Impound dewatering discharges in sediment retention basins or other holding facilities to settle the solids and provide treatment prior to discharge to receiving waters as necessary to meet Basin Plan water quality objectives.

## Conclusion

The proposed project is sited with the least environmental impact possible to ESHA and sensitive species. Consistent with the Humboldt Bay Area Plan—Local Coastal Plan, the project will not disrupt habitat value or significantly degrade habitat in the area with the above BMPs, avoidance, and mitigation measures in place.



Rob Holmlund  
Final CDP Application Response  
July 19, 2022  
Page 7

Please call me at 707-822-5785 or email me at [gobrien@shn-engr.com](mailto:gobrien@shn-engr.com) if you have any questions.

Sincerely,

SHN



Gretchen O'Brien  
Senior Wildlife Biologist

GAO:ame:cet

Attachments: 1. Project Site Photos, March 2022

c. w/Attach.: Rob Holmlund, Development Director, HBHRCD

## References

County of Humboldt. (2021). Draft Environmental Impact Report (DEIR) for the Nordic Aquafarms California, LLC – Coastal Development Permit and Special Permit application (Case Number PLN-2020-16698). December 2021.

Humboldt Bay Harbor, Recreation, and Conservation District (HBHRCD). (2022). Humboldt Bay Master Intakes: Project Description. 1/28/2022.

Sawyer, G. O., T. Keeler-Wolf, and J. Evans. (2009). A Manual of California Vegetation, Second Edition. Sacramento, CA:CNPS Press.

SHN. (2020a). Biological and Habitat Assessment Redwood Marine Terminal 1, Samoa Peninsula. September 2020.

---. (2020b). Wetland Assessment, Redwood Marine Terminal 1, Samoa Peninsula. September 2020.





Photos

1



**Photo 1:** Looking northeast across the southern extend of the proposed pipeline. Compacted gravel soils and non-native species dominant. Does not meet dune mat vegetation community at this location. Photo taken March 4, 2022.



**Photo 2:** Looking east within area of southern pipeline alignment. Compacted gravel soils and non-native species dominant. Does not meet dune mat vegetation community at this location.



Photo taken March 4, 2022.



**Photo 3:** Representative vegetation composition within the southern portion of the proposed alignment. No asphalt, but highly compacted gravels present with high invasive species cover (English plantain (*Plantago lanceolata*), six weeks grass (*Festuca myuros*), and subterranean clover (*Trifolium subterraneum*)). Photo taken March 4, 2022.



**Photo 4:** Southern pipe alignment looking north. Compacted gravel soils. Photo taken March 4, 2022.







**Photo 5:** Current aquiculture related use of the southern portion of the pipe alignment looking north. Photo taken March 4, 2022.



**Photo 6:** Stormwater swale showing one of three pedestrian bridges looking north. Note edge of willow canopy at bridge signifying the edge of ESHA. Photo taken March 4, 2022.





**Photo 7:** Existing stormwater detention facilities looking northeast. ESHA is not present at this location. Pipeline and bridge alignment would likely pass over here. Photo taken March 4, 2022.



**Photo 8:** Closeup at existing stormwater detention infrastructure. Note weirs, screening, and overflow pipes. Photo taken March 4, 2022.





**Photo 9:** Close up at middle pedestrian bridge looking NE. Pipeline and bridge alignment would likely pass between this bridge and overflow pipe visible in the upper right corner. Photo taken March 4, 2022.



**Photo 10:** Typical conditions throughout the majority of the pipeline alignment. Note expansive areas of asphalt. Photo looking south taken on March 4, 2022.





**Photo 11:** Looking north at the proposed pipeline alignment as it passes the northern coast dune willow thicket. Note the road which will be the location of the pipeline, passes east of the coast dune willow thicket. Photo taken March 4, 2022.

**EXPLANATION**

 BAY WATER PIPE

 INDUSTRIAL WATER PIPE

TO RED TANK DOCK

COAST WILLOW

STORMWATER  
FEATURE

(P) APPROACH RAMP

(P) BRIDGE

(P) APPROACH RAMP

TO RMT II

ESTUARINE TIDAL WETLAND

**FOR PLANNING  
PURPOSES ONLY**

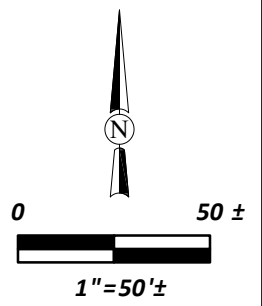


IMAGE SOURCE: NAIP/USDA CONUS PRIME

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HBHRCD  
Humboldt Bay Intake Screens  
Samoa, California

Preliminary Stormwater Feature  
Crossing Bridge Layout  
SHN 016240.005

January 2022

BayIntake\_Bridge\_Plan

Figure

## **Attachment C**

**SHN (1/13/21). Humboldt Bay Intake Screens  
Preliminary Operation and Maintenance  
Description, Redwood Marine Terminal II and Red  
Tank Dock, Samoa, California.**





Reference: 016240.005

March 9, 2022

Larry Oetker  
Humboldt Bay Harbor, Recreation, and Conservation District  
601 Startare Dr.  
Eureka, CA 95501

**Subject: Humboldt Bay Intake Screens Preliminary Operation and Maintenance Description, Revision 1, Redwood Marine Terminal II and Red Tank Dock, Samoa, California**

Larry Oetker:

SHN is submitting this preliminary operation and maintenance (O&M) description, at your request, describing proposed/recommended O&M for two intake screens located at Redwood Marine Terminal II (RMT II) and "Red Tank" Dock (RTD) in Samoa, California. The screens will be owned and operated by the Humboldt Bay Harbor, Recreation, and Conservation District (District).

This document is intended to serve as a preliminary description of O&M tasks and should be updated once the project design has been completed and again when operation of the system has begun and actual conditions are better understood. For additional detail on the proposed design conditions, please see letter dated August 6, 2021, entitled *Humboldt Bay Intake Screen Conceptual Designs, Redwood Marine Terminal II and Red Tank Dock, Samoa, California-Revision 03* by SHN.

This revision (Revision 1) to the O&M description includes updated elevations for RMT II Dock based on recent field survey.

## System Description

Two similar intake screen systems will be installed at RMT II and Red Tank Dock (Appendix 1, Figures 1-6). The screens must be constructed and operated to meet or exceed requirements to prevent entrainment and impingement (E&I) of wildlife. Each screen will consist of a cylindrical screen face constructed of stainless steel or other corrosion resistant material. The screen mesh will be permanently attached to a flange that will mount to a flat plate and will create a seal around the intake structure openings. The intake structures must be sealed to prevent E&I through orifices and openings other than the intake screen faces. Water will be drawn out of each intake structure by vertical turbine pumps, and the screens will prevent wildlife from entering the structure and being captured by the pumps.

Each screen will include a self-cleaning mechanism consisting of either pressurized air or mechanical brushes (see Attachment 2 for an example manufacturer's O&M for a tee screen with pressurized air



cleaning system). Pressurized air systems will introduce short bursts of pressurized air into the interior of the screens, pushing debris and material that has accumulated on the screen faces off into the surrounding water. Mechanical brush screens will continuously or periodically scrape the screen face surface either by rotating the brushes around the outer face of the screen, or by rotating the screen with the brushes fixed in one position.

The flat plate the screens are mounted to, which creates a seal around the intake structure openings, will rest inside of two vertical c-channels. The screens will have lifting lugs attached that will allow the screens to be raised up out of the water from a lifting crane located on top of the structure. Screens can be lifted up to the surface of the dock and intake structure for inspection and maintenance.

Vertical turbine intake pumps will consist of motors that will be installed on top of the intake structure at the dock level, a vertical driveline and intake pipe, and pump intake bowls (impellers) located beneath the water surface inside the intake structures. The discharge pipe from each pump will be connected to a distribution system for distribution to various locations along the waterfront.

Pump motors, air compressors, screen brush motors, lifting hoists, and sensors will require power at each site.

## Operational Constraints

### Flow Rate

See Appendix 1, Figure 2 for conceptual flow diagram.

- RMT II: The maximum design flow rate of 5,500 gallons per minute (gpm) shall not be exceeded at any time.
- RTD: The maximum design flow rate of 2,750 gpm shall not be exceeded at any time.

### Vertical Position

See Appendix 1, Figures 4 and 6 for conceptual elevations of each intake.

Note: All elevations are in reference to the North American vertical datum, 1988 (NAVD88).

### RMT II

- The RMT II Sea Chest is a wooden structure supported by vertical wood piles and horizontal 6 inch (in.) by 16 in. horizontal members, and enclosed by 4 in. by 12 in. wood planks. The structure inside dimensions are approximately 8 ft. 2 in. wide by 8 ft. 6 in. long, and approximately 17 ft. 6 in. deep.
- Top Clearance: Maintain 18 inches (in.) clear water above the screen face during operation, at a minimum (unless otherwise specified by screen manufacturer). MLLW elevation is -0.34 feet (ft) such that, at a minimum, the top face of the screen should be located below -1.84 ft.



- Bottom Clearance: maintain 18 in. clear water below the screen face during operation, at a minimum (unless otherwise specified by screen manufacturer). The bottom of the existing intake structure is located at an elevation of approximately -5.1 ft. The bay bottom measured near the face of the intake structure at the time of this writing is approximately -11.1 ft. With the new screen mounted at the lowest elevation of the intake structure, approximately 6.0 ft of clear water will remain below the bottom of the new screen.

## **RTD**

- The Red Tank Dock intake structure is a concrete sea chest approximately 6 ft. 1 in. wide by 9 ft. 4 in. long, and 16 ft. deep to the bay mud. It is uncertain as to whether the bottom of the interior of the structure is concrete or bay mud. When measured, the mud accumulated inside the structure was approximately 1 ft. 6 in. higher than the bay mud outside the structure. The concrete walls and top slab are approximately 12 in. thick.
- Top Clearance: Maintain 12 inches of clear water above the screen face during operation, at a minimum (unless otherwise specified by screen manufacturer). MLLW elevation is -0.34 ft such that, at a minimum, the top face of the screen should be located below -1.34 ft.
- Bottom Clearance: maintain 12 inches of clear water below the screen face during operation, at a minimum (unless otherwise specified by screen manufacturer). The bay bottom measured near the face of the intake structure at the time of this writing is approximately -5.9 ft such that the bottom of the screen should be located at or above -4.9 ft.

## **Head (Water Level) Differential**

The self-cleaning mechanisms shall be initiated when the head differential measured as the difference in water level inside and outside the structures exceeds 0.1 ft above the baseline differential. The baseline differential shall be established as the difference in water level inside and outside the structures when the pumps are operating at full design capacity with the screen completely clean and free of any pore obstructions. Screen manufacturers should provide an estimate of what the baseline differential will be and what can be field verified.

There will be headloss due to friction as water passes through the screens such that the water level will be lower inside the intake structures compared with the ambient bay water level outside the structures. As material builds up on the screens and the pores decrease in opening size, the head differential will increase (the level inside the structures will decrease compared with outside the structures due to increased friction). Once this differential increases to 0.1 ft or more above the baseline, the self-cleaning mechanism must be initiated.

As the frequency of self-cleaning increases because the screens cannot be cleaned sufficiently by the self-cleaning mechanisms and the 0.1 ft head differential is exceeded more frequently, manual cleaning should be initiated. The frequency of manual cleaning may need to be adjusted after the screens have become operational.





## Operation

### Startup Pre-Inspection

1. Inspect and Clean Screen
  - a. Visually inspect the screen for debris or excessive obstruction of pores by aquatic growth or eelgrass.
  - b. Remove loose debris manually prior to proceeding with startup.
  - c. Raise screen and remove attached growth if necessary prior to proceeding with startup.
  - d. Ensure that the screen is in place over the opening of the intake structure and that all seals are in place and seated securely. Record and repair any deficiencies.
  - e. Ensure that the screen is securely attached to pressurized air piping (if applicable).
2. Inspect and Service the Air Compressor (if applicable)
  - a. Visually inspect the air compressor, pressure tank, and pressurized air piping and valves. Record and repair any deficiencies.
  - b. Drain water from compressor pressure tank.
  - c. Check lubricant levels. Repair any deficiencies.
  - d. Visually inspect air cleaner, replace as needed.
3. Inspect and Service Mechanical Brush Mechanisms (if applicable)
  - a. Visually inspect the brushes and brush motors. Repair any deficiencies.
  - b. Remove any debris from brushes that may reduce the efficiency of the cleaning mechanism.
4. Inspect and Service Pump Motors and Hoist Motors (if applicable)
  - a. Visually inspect pump motors. Repair any deficiencies.
  - b. Check lubricant levels (if applicable), check inspection service logs, and record frequency of maintenance.
5. Inspect level, pressure, and flow instruments.
  - a. Visually inspect water level instrumentation and ensure its free of debris that may affect level measurements. Record water levels. Confirm that water levels are not below the lowest water level recommended.
  - b. Visually inspect water pressure sensors and ensure in place and functional.
  - c. Visually inspect flow meters and ensure in place and functional. Record totalized flow.
6. Verify that end-user(s) is ready to receive water.
7. Open/close valves as needed to supply water to desired location in distribution system.



## Startup

1. Select manual or automatic operation mode on air compressor cleaning system control panel (as applicable).
  - a. START air compressor cleaning system.
2. Select manual or automatic operation mode on mechanical brush cleaning control panel (as applicable).
  - a. START mechanical brush cleaning system.
3. Select manual or automatic operation mode on pump control panel (as applicable).
  - a. START one pump at a time (as applicable). Allow 1-2 minutes after pump start before starting each additional pump for pressure to equalize in the system.
4. Verify that level sensors are functioning and manually record water levels and head differential. Manually verify water levels are correct and accurate. Note whether head differential is greater than previous record and whether manual cleaning may be necessary.
5. Verify that pressure sensors are functioning and manually record pressures.
6. Verify that flow meters are functioning and manually record flow rates once all pumps are running. Confirm that flows do not exceed maximum capacity of screens.

## Post-Startup Inspection

1. Inspect pumps; note any abnormal vibration or heat.
2. Inspect pump water seal (if applicable).
3. Inspect piping, valves, and appurtenances for leaks. Note minor leaks. Stop the system and repair major leaks.
4. Confirm with end-user that flow is sufficient.
5. Confirm that pressurized air or mechanical brush cleaning systems are functioning properly.

## Shutdown

1. STOP pumps.
2. STOP pressurized air or mechanical brush cleaning system.
3. Record date/time of shutdown and totalized flow rate.

## Maintenance

### Manual Screen Cleaning

1. Lockout/tagout pumps and air compressor or mechanical brush systems.





2. Visually inspect lifting chain(s) and/or cable(s). Confirm that they are connected to the appropriate lifting lugs and secured to the lifting hoist. Confirm that they are not corroded or loose. Manually pull on chains and/or cables to test for strength. Confirm that hoist is secured to overhead support.
3. Lift screen very slowly ensuring that the screen does not bind in the vertical guide rails. If binding occurs, adjust tension on lifting chains/cables until screen raises smoothly. Do not exert excessive force on screen or damage to guide rails may occur and will have to be manually removed and repaired.
4. Raise screen until accessible for manual cleaning. Photograph and record accumulation on screen and note time since last service.
5. Use pressure washer to remove debris and growth on screen. If pressure washing is not sufficient, use manual scrapers or brushes to remove remaining material until screen is free of debris and growth and all pores are clear.
6. Inspect interior of screen for additional debris/growth and clean as above.
7. Inspect pressurized air distribution system or mechanical brush system and service as needed.
8. Lower screen back into place slowly. Prevent binding as above.

## **Intake Structure Integrity Test**

Note: this test should be performed at high tide.

1. Lift and remove screen from structure.
2. Place blank face plate in vertical guide channels and lower into place, sealing the intake structure opening.
3. Pump water from intake structure as low as possible. This may be accomplished with a small submersible pump.
4. Observe and note any leakage of bay water into structure. Repair any deficiencies.

## **Intake Structure Cleaning**

Note: This should be done periodically to remove accumulated sediment from the structures prior to when sediment rises to within 1 ft below the bottom of the pumps. This may be done by following the instructions above for "Intake Structure Integrity Test," removing sediment from the interior after the blank face plate is in place and water has been removed. Or this may be accomplished with the screen in place, using a small suction dredge.

Cleaning with water removed:

1. Pull pump motors and pumps.
2. Remove sediment using a vacuum suction system by lowering the vacuum suction hose into the holes for the pumps (similar to a vactor truck system).
3. Replace pumps and motors.



Rob Holmlund

**Humboldt Bay Intake Screens Preliminary Operation and Maintenance Description, Revision 1**

March 9, 2022

Page 7

Cleaning with screens in place:

1. Pull pump motors and pumps.
2. Remove sediment using a small dredge suction pump by lowering the suction hose into the holes for the pumps.
3. Note that suction flow rate must be recorded to ensure it does not exceed the maximum design capacity of the screens.

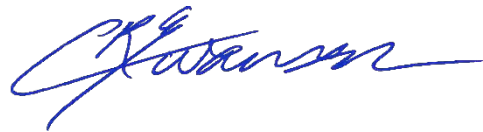
Please call us at (707) 441-8855 if you have any questions.

Sincerely,

**SHN**



Mike Foget, PE  
Senior Engineer



Chuck Swanson, EIT  
Staff Engineer

MKF:CRS:ame

c. w/Attach.: Rob Holmlund, HBHRCD  
Chris Mikkelsen, HBHRCD

Appendices: 1. Figures  
2. Manufacturer O&M

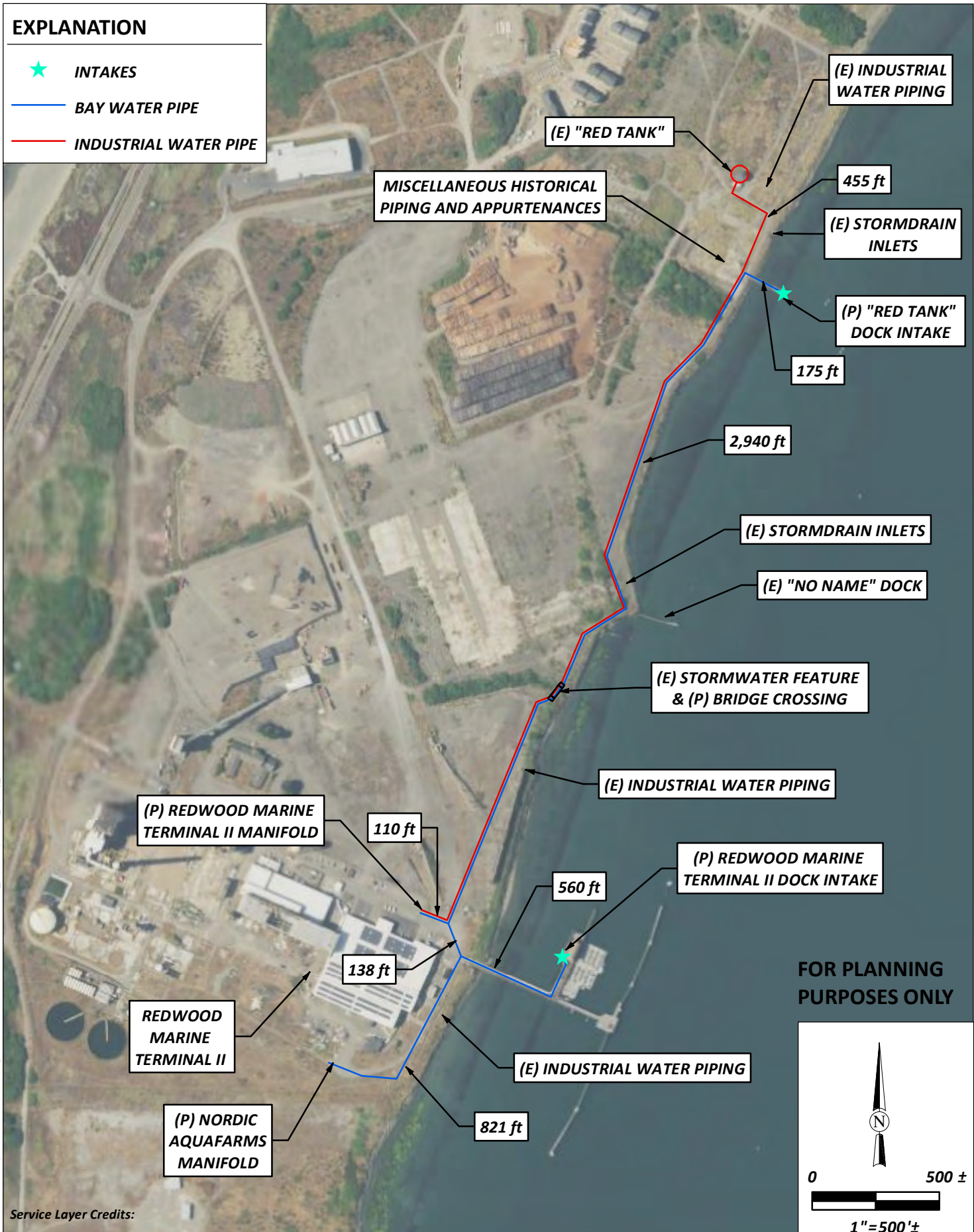




# Figures **1**

**EXPLANATION**

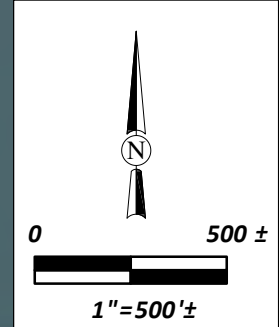
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- BAY WATER PIPE
- INDUSTRIAL WATER PIPE




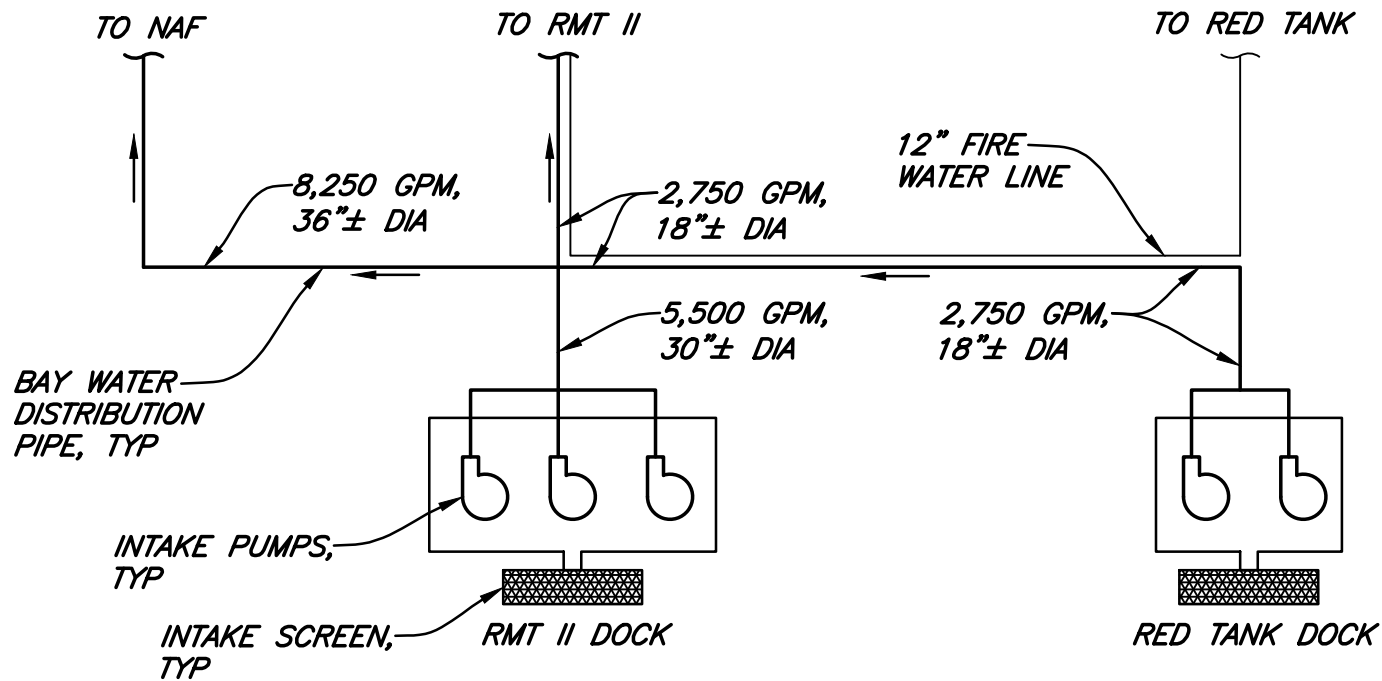
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Service Layer Credits:

**FOR PLANNING PURPOSES ONLY**



	HBHRCD Humboldt Bay Intake Screens Samoa, California	Preliminary Site Plan SHN 016240.005
	January 2022	BayIntake_Piping_SitePlan



HBHRC  
Humboldt Bay Intake Screens  
Samoa, California

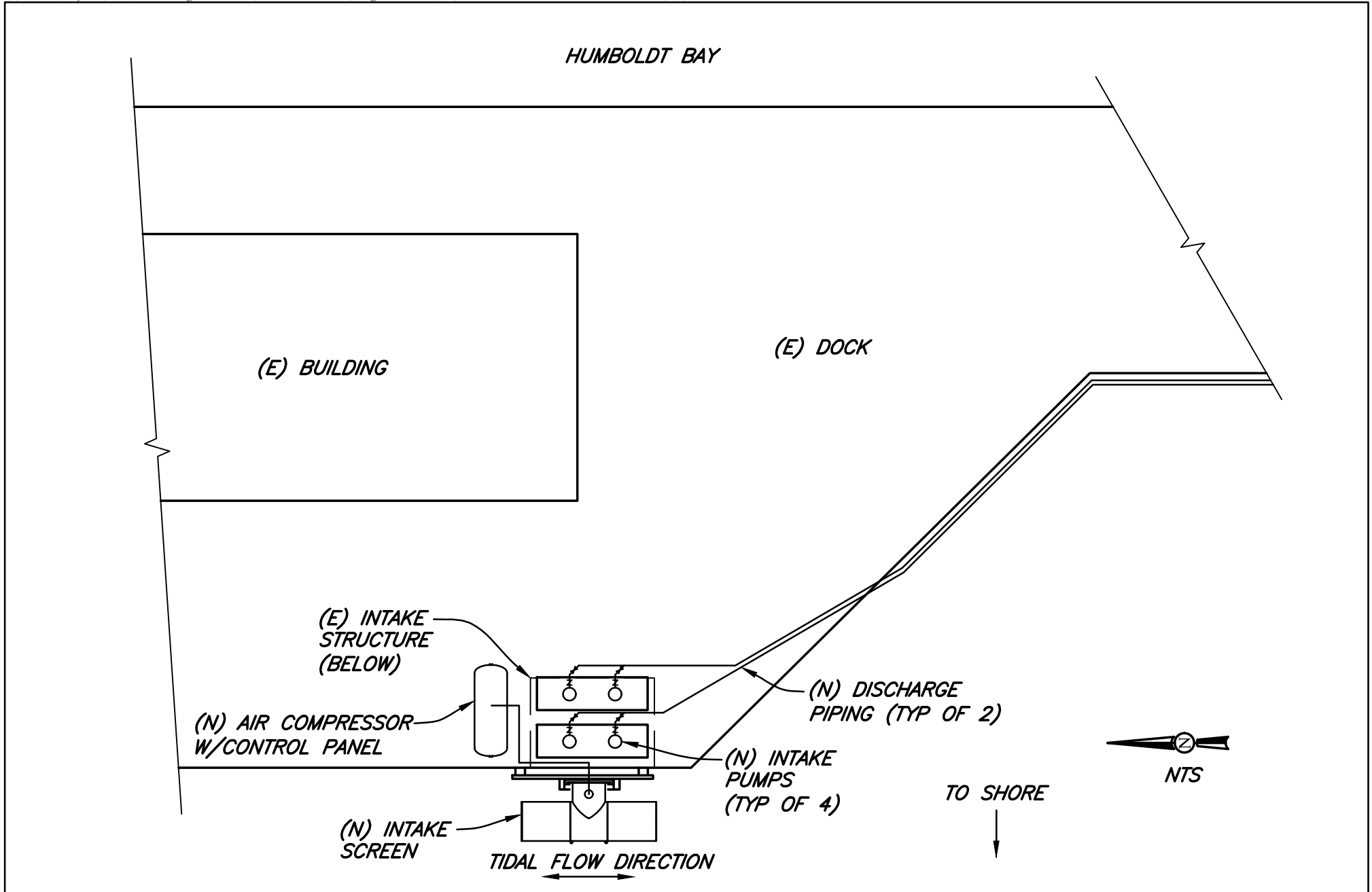
Humboldt Bay Intake  
Piping Diagram  
SHN 016240

November 2021

016240-005-INTAKE-WATER-DIAG

Figure 2





HBHRCD  
Humboldt Bay Intake Screens  
Samoa, California

RMT II Intake Screen  
Conceptual Site Plan  
SHN 016240.005

January 2022

016240-005-SEA-CHEST-INTAKE

Figure 3

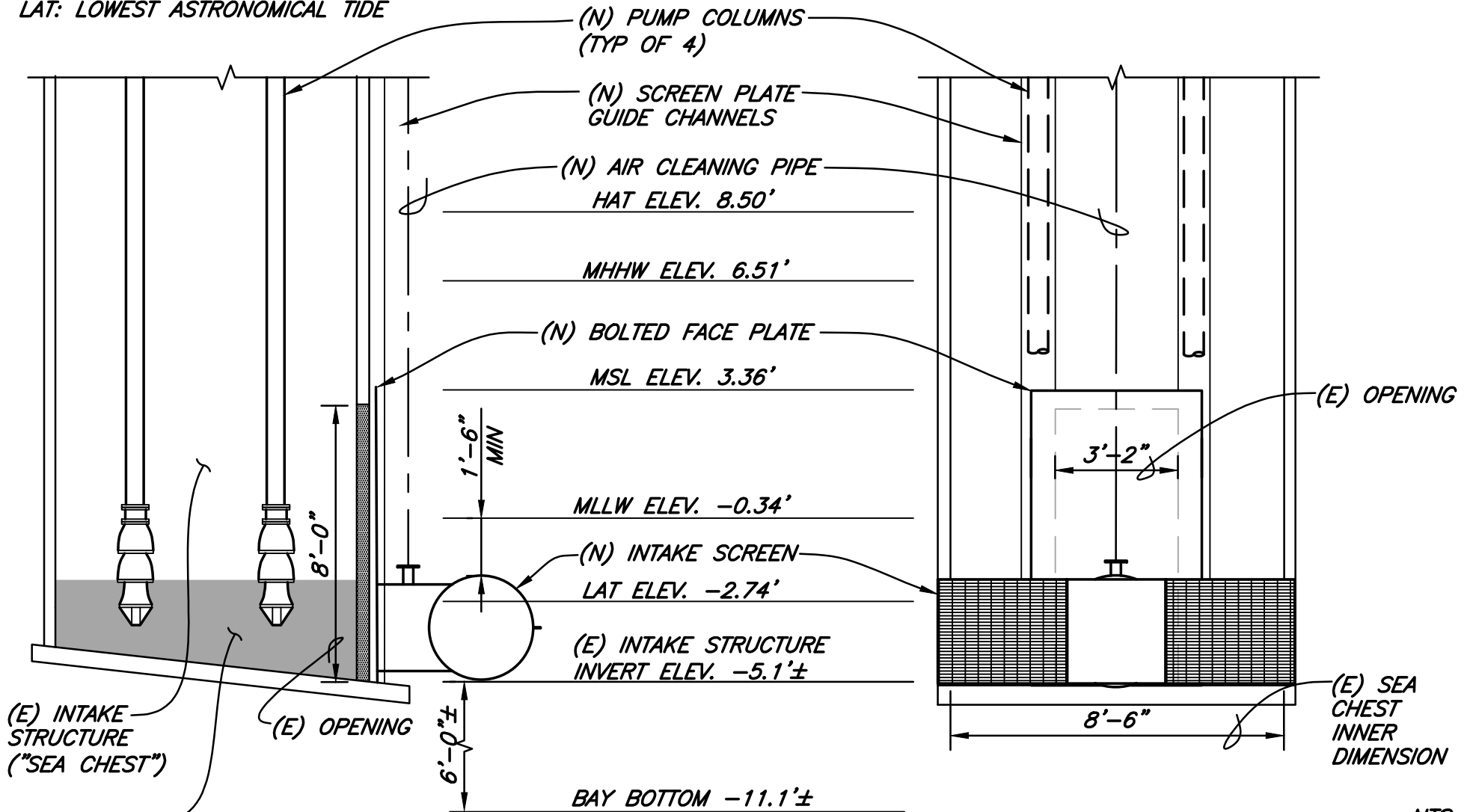
**DEFINITIONS**

HAT: HIGHEST ASTRONOMICAL TIDE  
 MHHW: MEAN HIGHER HIGH WATER  
 MSL: MEAN SEA LEVEL  
 MLLW: MEAN LOWER LOW WATER  
 LAT: LOWEST ASTRONOMICAL TIDE

TOP OF DOCK ELEV. 17.4'

**NOTES**

ELEVATIONS IN REFERENCE TO NORTH AMERICAN VERTICAL DATUM OF 1988



NTS

APPROXIMATE DEPTH OF SEDIMENTATION



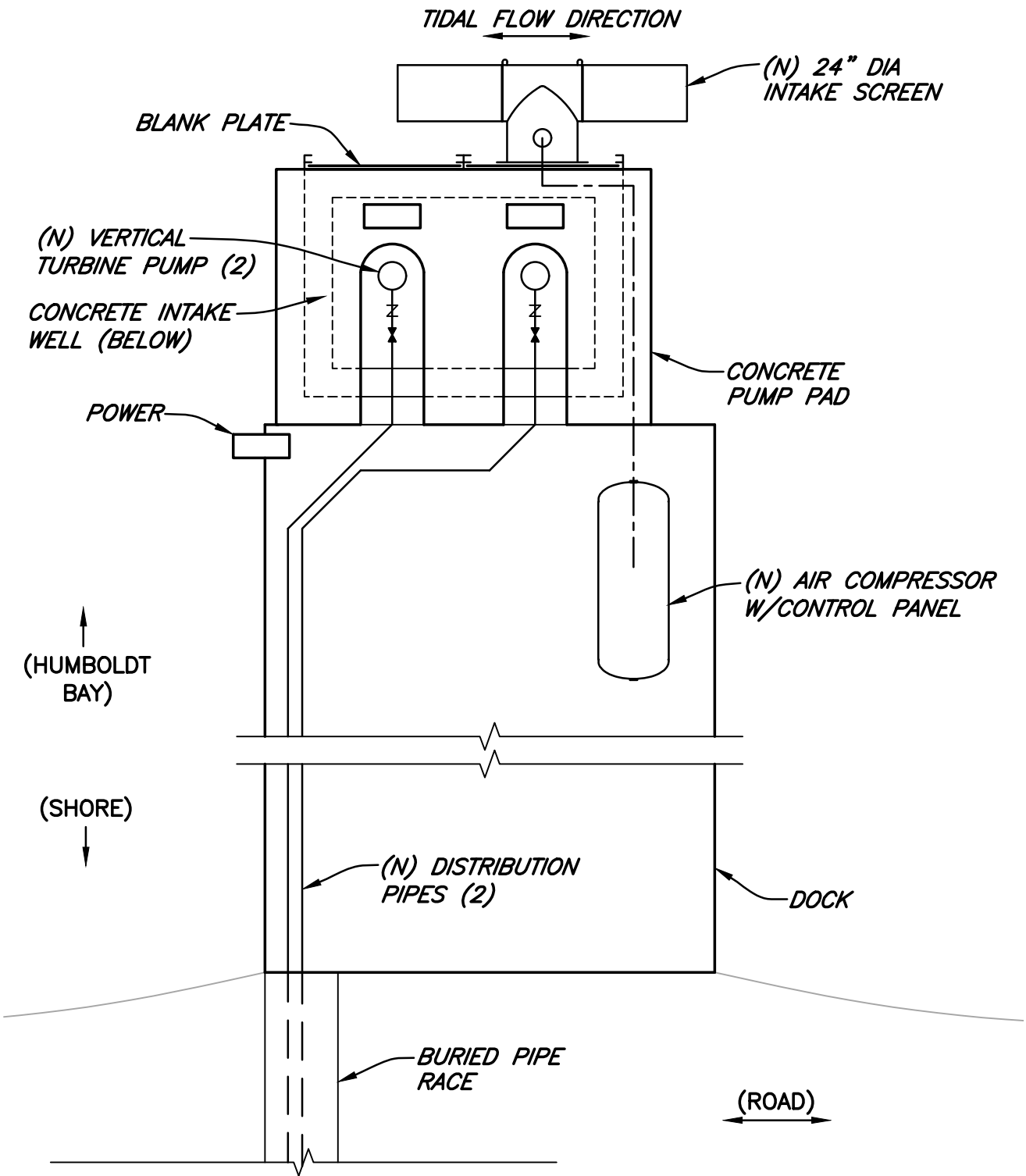
HBHRCD  
 Humboldt Bay Intake Screens  
 Samoa, California

RMT II Intake Screen  
 Conceptual Elevations  
 SHN 016240.005

March 2022

016240-005-SEA-CHEST-INTAKE

Figure 4



**PLAN**  
NTS



\\Fireka\Projects\2016\016240-Engr-HBHRCD\005-Intake-Screen\Dwgs-SA\VED.1/12/2022 2:57 PM CSWANSON, PLOTTED: 1/12/2022 2:59 PM, SWANSON, CHUCK



HBHRCD  
Humboldt Bay Intake Screens  
Samoa, California

Red Tank Dock Intake Screen  
Conceptual Site Plan  
SHN 016240.005

January 2022

016240-005-RED-TANK-DOCK-INTAKE

Figure 5

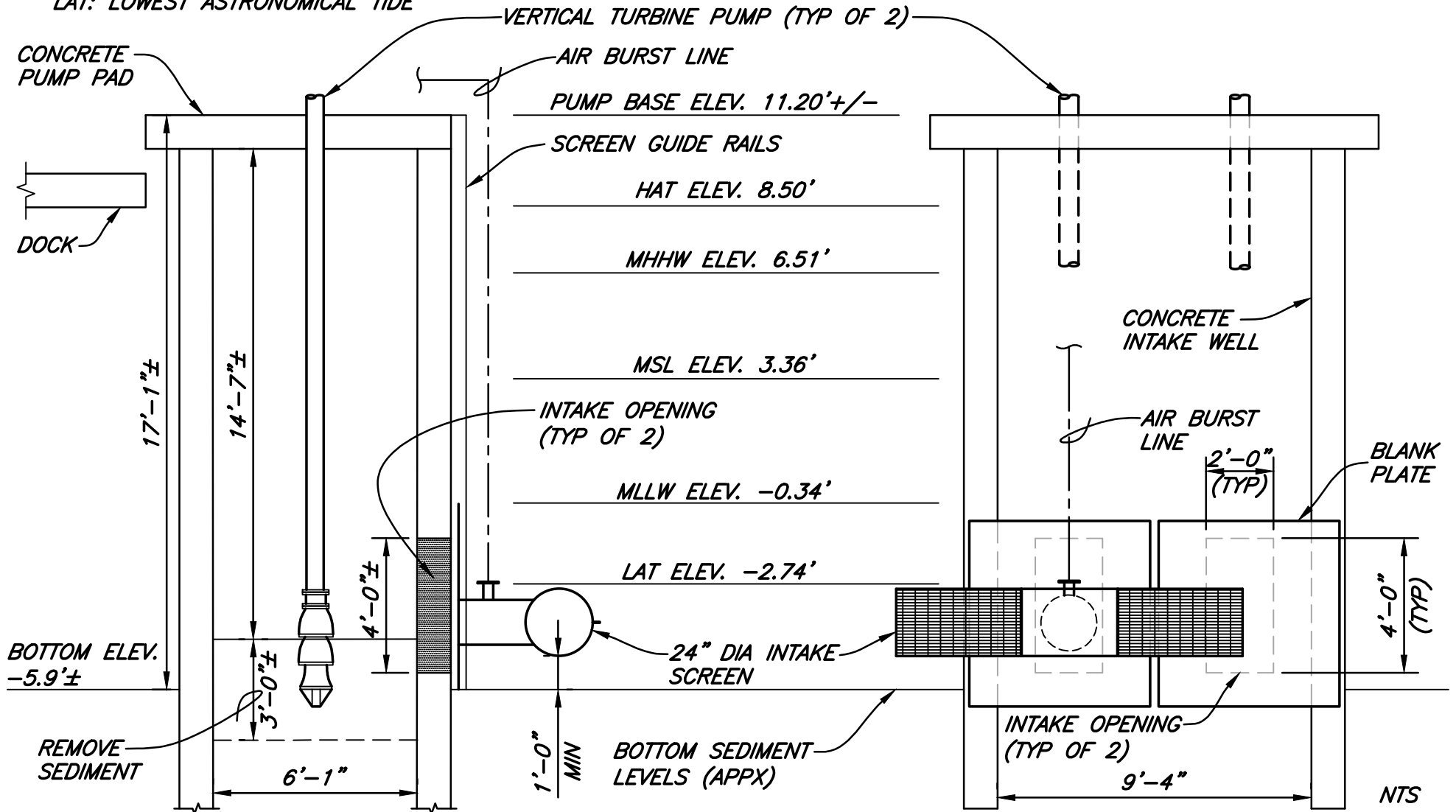



**DEFINITIONS**

HAT: HIGHEST ASTRONOMICAL TIDE  
 MHHW: MEAN HIGHER HIGH WATER  
 MSL: MEAN SEA LEVEL  
 MLLW: MEAN LOWER LOW WATER  
 LAT: LOWEST ASTRONOMICAL TIDE

**NOTES**

ELEVATIONS IN REFERENCE TO NORTH AMERICAN VERTICAL DATUM OF 1988



	HBHRCD Humboldt Bay Intake Screens Samoa, California		Red Tank Dock Intake Screen Conceptual Elevation SHN 016240.005	
	March 2022	016240-005-RED-TANK-DOCK-INTAKE	Figure 6	

**Manufacturer O&M**

**2**



**Hendrick Screen Company**

Cutting Edge Metal Solutions

Owensboro, KY

**Operation  
and  
Maintenance Instructions**

Hendrick Intake Screen  
For  
CF Industries Nitrogen, LLC  
Donaldsonville, LA



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**Contractor:** CF Industries  
39018 Highway 3089  
Donaldsonville, LA  
Phone: (225) 474-4628

**Supplier:** Hendrick Screen Company  
3074 Medley Road  
P.O. Box 22075  
Owensboro, KY 42304-2075  
Phone: (270) 685-5138  
Fax: (270) 685-1729

**Engineer:** Lanier & Associates Consulting Engineers, Inc.  
4101 Magazine St.  
New Orleans, LA 70155  
Phone: (504) 895-0368

## Introduction

Your contractor has installed the 42-inch Tee-intake screens. The discharge is a circular 30-in. outlet thru a rectangular flange. The screens were designed to slide vertically along a 4-inch guide rail, and lock in place with two handles located at the top of the guide rails. The locks are to keep the screen from floating during the air burst cycle.

Each screen is designed to permit the flow of 9,000 GPM at a maximum through-slot velocity of 0.5 fps of water through a clean screen. The screen wire and supports are made with 90/10 Copper Nickel; the remainder of the screen is made of 304 s.s.

## Operation

The screen should be protected from collision with boats and floating debris. After installation, no additional hands-on contact is required for the screen, except as noted in the Maintenance section.

All operation of the screen in separating debris from your water supply is passive, and should not require attention of an operator, with the exception of a few general cautionary procedures:

- ♦ Always maintain the flow rate through the screen at 0.5 feet per second, or less. Velocity higher than this may prevent small fish from escaping the approach current moving toward the screen, and a fish kill may result.
- ♦ Attention should be directed toward general debris conditions in the area of the screen. Heavy rafts of leaves, pine needles or man-made debris may cause temporary plugging of parts of a screen, which in turn may cause localized, high through-slot velocity. In extreme cases, this local, high velocity may cause a vortex to form, entraining large amounts of air in the water passing through the screen. In rare instances, the entrained air may not dissipate before reaching the impellers of a high-speed turbine pump. The resulting cavitation may cause damage to the impellers.
- ♦ In general, because passive intake screens have no moving parts and are subjected to little stress under normal operating conditions, and only slightly more during airburst cleaning cycles, periodic inspections may be neglected and considered by the operator as unnecessary expense. We recommend, however, for screens located in a navigable stream, visual inspections annually, either by closed circuit television or a diver. Screens located in quiet reservoirs or lake environments will need inspection less frequently.



### Air-Burst Cleaning (When Applicable)

Screens containing air burst piping are designed and constructed to be cleaned periodically by the action of a high-energy burst of compressed air directed through the air manifolds located at the invert of each screen. See separate section in O&M Manual for Air-Burst System.

While you have considerable funds invested in the air package to provide the clean air used to scour the screens, a receiver full of air is relatively cheap to produce. You should feel free to use the air liberally in order to maintain the screen surfaces as free of debris as possible.

Whether you have chosen automatic or manual operation of the air system, some precautions are in order:

- ♦ Post signs or other warnings to small craft that may be in the area of the screen when the Air-Burst system is activated. A high-energy burst could overturn a rowboat or other small craft.
- ♦ Maintain your oil filters regularly. Oil entering a body of water is harmful to aquatic life and is highly visible.

### Other Maintenance

- ♦ If you have elected to install a chemical feed system to help prevent bio-fouling of the screen surface and chlorine is a component of your chemical feed, make certain that high concentrations of chlorine do not impinge upon the screen wire surface. The tapered wire may be subject to corrosion or stress cracking of some welds in the presence of the chlorine ion.
- ♦ If screens are located in a body of water subject to infestation by Zebra mussels or other occluding biota, maintain a close visual watch on the screens and call for cleaning by divers, or other approved methods, in a timely manner.

## Screen Removal

The screens are designed to be mounted with a guide rail system in order that they may be removed, for inspection, repair, cleaning or replacement. The screens are locked in place with a handle which connects to a cam lock at the top of the screen flange. The locking handle must be in the up position to allow the screens to be lowered or raised. Failure to properly position the handles could result in damage to the guide rails and the screens. Once the screens are lowered completely, to lock the screens in place, the handle must be placed in the down position. The intent of the locking handles is to hold the (screen) air burst connection together and to prevent the screen from “floating” during an air burst cycle. During the air burst cycle, it is normal for there to be some leakage at the air burst piping connection.

Should it become necessary to hoist a screen from the water,

- Before attempting to move a screen, be sure you are thoroughly familiar with the operation of the crane installed for this purpose. Read the manual and make several trial runs. **MAKE CERTAIN THAT THE SAFE HOISTING CAPACITY OF THE CRANE IS GREATER THAN THE WEIGHT OF THE SCREEN.** When shipped from the factory, the net weight of the screen was estimated to be approximately 1,920 pounds.
- When you are comfortable with the operation of the crane, attach cable clevises to the provided lifting lugs provided on the screen. A diver may be required for this operation. A suitable sling with a lifting ring (not included) may make this attachment easier. Draw the hoisting line taut and mark the line at an accessible reference point. You will need this reference to determine if the screen is back in place when you lower it after servicing.
- Ease into the load, being careful to determine if the screen is locked in place by debris, or if the guide plate is binding. A diver observing the screen may be required at this point.
- Do not exceed the hoisting capacity during this operation; if the crane is not so equipped, you may want to install a strain gauge on the main hoisting cable.
- Once you have determined that the screen is free, slowly withdraw it, being careful that it does not bind in the guide rails.
- When service is completed, replace the screen; take care that the screen is seated in the same position as you removed it from. Again, a diver may be required to confirm this.

**Hendrick Screen Company**  
**Limited Manufacturer's Warranty**

**Warranty No: 08801**

**Hendrick Screen Company ("Company")** warrants to the original purchaser, **CF Industries Nitrogen, LLC, ("Customer")** whose address is **39018 Highway 3089, Donaldsonville, LA 70346** that the products or components ("Goods") purchased under Purchase Order(s) No. **153142** will be free from defects in workmanship and materials for a period of **24** months from the following date: **March 31, 2014**.

**What is Not Covered:**

This warranty covers only reasonable and ordinary use of the Goods in the geographic jurisdiction of the Customer or at some other location as specified on the Purchase Order. Defects and damages resulting from the Customer, its agents, or assignees due to mishandling, abuse, faulty installation, incorrect manufacturing specifications, faulty design and engineering, neglect, or natural disasters such as fire, flood, and storms will not be covered by this Warranty. Goods that have been altered or re-manufactured or goods repaired prior to Company authorization are excluded from this Warranty. Excluded from this Warranty are foregone or missed revenues and profits, extraordinary expenses, consequential damages, liquidated damages or insurance claims due to business interruptions or work stoppages. This warranty is non-transferrable.

**How to Make a Warranty Claim**

An authorized representative of the Customer must contact the Company's customer service department at 1-270-685-5138 between the business hours of 8:00 AM to 5:00 PM Central Time-U.S., Monday through Friday, excluding U.S. holidays, at which time the Company will validate the existence of the Warranty and instruct the customer as to what next step is required. In many instances, written notification by an authorized Company representative will be required describing the defect or condition along with supporting photographs or similar documents such as an engineering or inspection report.

**Remedy:**

The Company, at its sole discretion, will determine if the Customer's Goods are covered under this Warranty. Upon satisfying Warranty claims, the Company will repair or replace, at its option, the Goods, exclusive of installation charges, engineering fees, freight charges, duties and taxes, legal fees, and any and all post-production expenses, unless otherwise specified in this Warranty. The Company reserves the right to visually inspect damaged Goods directly or through its agents prior to initiating a repair or replacement. The Company will, to the best of its ability supply replacement Goods to original specifications but reserves the right to substitute raw materials and components at its discretion and upon sufficient written documentation that substituted materials are suitable for replacement Goods. Upon replacement of the defective Goods, Customer is responsible for de-installation, removal, or disposal of those Goods at Customer's expense.



THIS WARRANTY AND REMEDY ARE EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, OR FITNESS FOR A PARTICULAR PURPOSE. SOME LAWS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES. IF THESE LAWS APPLY, THEN ALL EXPRESS AND IMPLIED WARRANTIES ARE LIMITED TO THE WARRANTY PERIOD IDENTIFIED ABOVE. UNLESS STATED HEREIN, ANY STATEMENT OR REPRESENTATIONS MADE BY ANY OTHER PERSON OR FIRM ARE VOID. IN NO EVENT SHALL COMPANY OR ITS AFFILIATEES BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF INABILITY TO USE GOODS WHETHER RESULTING FROM BREACH OF WARRANTY OR ANY OTHER LEGAL THEORY. COMPANY AND ITS AFFILIATES SHALL BE LIABLE FOR DAMAGES NOT TO EXCEED THE ORIGINAL COST OR REPLACEMENT VALUE OF THE GOODS.

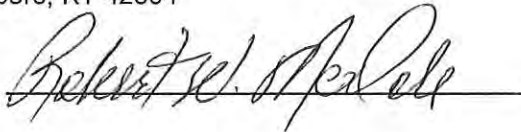
**Additional Modified Warranty Terms:**

1. **TBD**

**Company:**

Hendrick Screen Company  
3074 Medley Road  
Owensboro, KY 42304

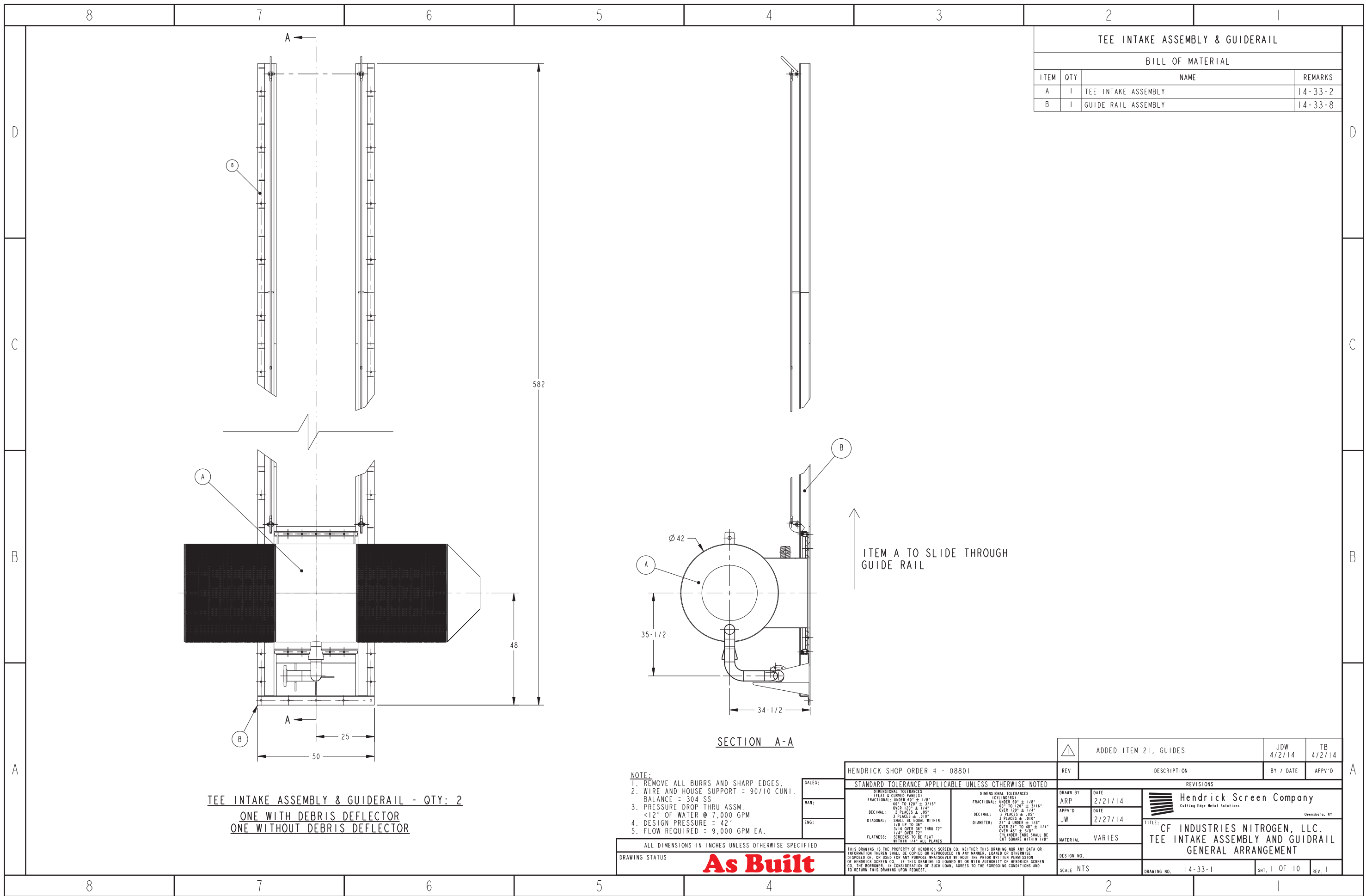
By:



**Robert W. McDole**

Title: **Vice President & General Manager**

/HSCProductWarranty 5-2014



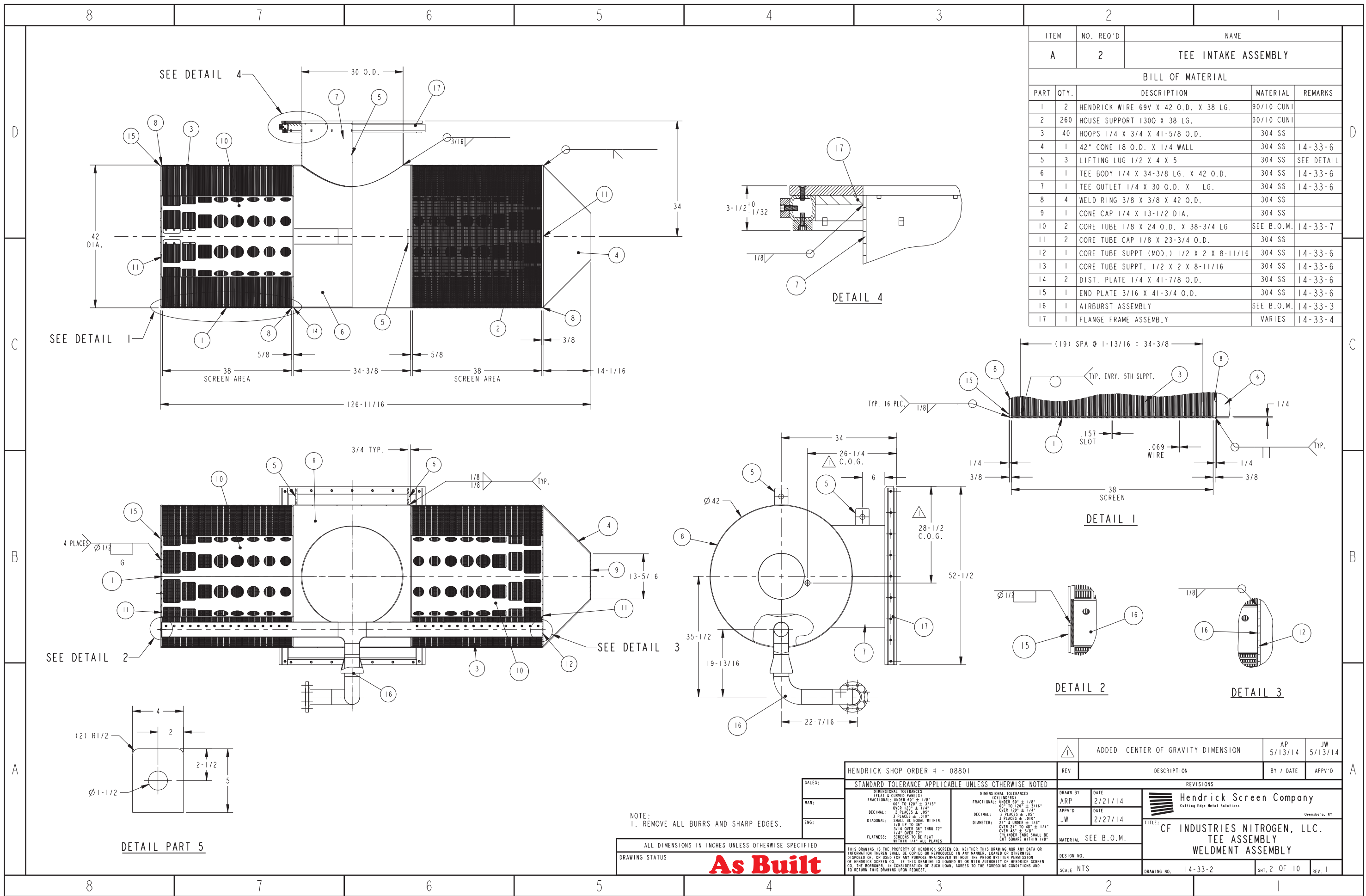
TEE INTAKE ASSEMBLY & GUIDERAIL			
BILL OF MATERIAL			
ITEM	QTY	NAME	REMARKS
A	1	TEE INTAKE ASSEMBLY	14-33-2
B	1	GUIDE RAIL ASSEMBLY	14-33-8

TEE INTAKE ASSEMBLY & GUIDERAIL - QTY: 2  
 ONE WITH DEBRIS DEFLECTOR  
 ONE WITHOUT DEBRIS DEFLECTOR

- NOTE:
1. REMOVE ALL BURRS AND SHARP EDGES.
  2. WIRE AND HOUSE SUPPORT = 90/10 CUNI.  
BALANCE = 304 SS
  3. PRESSURE DROP THRU ASSM.  
<12" OF WATER @ 7,000 GPM
  4. DESIGN PRESSURE = 42'
  5. FLOW REQUIRED = 9,000 GPM EA.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
 DRAWING STATUS **As Built**

HENDRICK SHOP ORDER # - 08801		REV	ADDED ITEM 21, GUIDES	JDW 4/2/14	TB 4/2/14
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		DESCRIPTION	BY / DATE	APPV'D	
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60" = 1/8" 60" TO 120" = 3/16" OVER 120" = 1/4" DECIMAL: 2 PLACES = .05" 3 PLACES = .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN .1/4" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60" = 1/8" 60" TO 120" = 3/16" OVER 120" = 1/4" DECIMAL: 2 PLACES = .05" 3 PLACES = .010" DIAMETER: OVER 24" TO 48" = 1/4" OVER 48" = 3/8" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"	REVISIONS DRAWN BY: ARP DATE: 2/21/14 APPV'D: JW DATE: 2/27/14 MATERIAL: VARIES	Hendrick Screen Company Cutting Edge Metal Solutions Oneasboro, KY TITLE: <b>CF INDUSTRIES NITROGEN, LLC.          TEE INTAKE ASSEMBLY AND GUIDRAIL          GENERAL ARRANGEMENT</b>	
DESIGN NO.		SCALE: NTS	DRAWING NO. 14-33-1	SHT. 1 OF 10	REV. 1



ITEM	NO.	REQ'D	NAME	
A	2		TEE INTAKE ASSEMBLY	
BILL OF MATERIAL				
PART	QTY.	DESCRIPTION	MATERIAL	REMARKS
1	2	HENDRICK WIRE 69V X 42 O.D. X 38 LG.	90/10 CUNI	
2	260	HOUSE SUPPORT 1300 X 38 LG.	90/10 CUNI	
3	40	HOOPS 1/4 X 3/4 X 41-5/8 O.D.	304 SS	
4	1	42" CONE 18 O.D. X 1/4 WALL	304 SS	14-33-6
5	3	LIFTING LUG 1/2 X 4 X 5	304 SS	SEE DETAIL
6	1	TEE BODY 1/4 X 34-3/8 LG. X 42 O.D.	304 SS	14-33-6
7	1	TEE OUTLET 1/4 X 30 O.D. X LG.	304 SS	14-33-6
8	4	WELD RING 3/8 X 3/8 X 42 O.D.	304 SS	
9	1	CONE CAP 1/4 X 13-1/2 DIA.	304 SS	
10	2	CORE TUBE 1/8 X 24 O.D. X 38-3/4 LG	SEE B.O.M.	14-33-7
11	2	CORE TUBE CAP 1/8 X 23-3/4 O.D.	304 SS	
12	1	CORE TUBE SUPPT (MOD.) 1/2 X 2 X 8-11/16	304 SS	14-33-6
13	1	CORE TUBE SUPPT. 1/2 X 2 X 8-11/16	304 SS	14-33-6
14	2	DIST. PLATE 1/4 X 41-7/8 O.D.	304 SS	14-33-6
15	1	END PLATE 3/16 X 41-3/4 O.D.	304 SS	14-33-6
16	1	AIRBURST ASSEMBLY	SEE B.O.M.	14-33-3
17	1	FLANGE FRAME ASSEMBLY	VARIABLES	14-33-4

HENDRICK SHOP ORDER # - 08801		AP	JW
REV	DESCRIPTION	BY / DATE	APPV'D
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS	
SALES:	DRAWN BY	DATE	 Hendrick Screen Company Cutting Edge Metal Solutions Oneesboro, NY
MAN:	APPV'D	DATE	
ENG:	MATERIAL	SEE B.O.M.	TITLE:
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60" ± 1/8" 60" TO 120" ± 3/16" OVER 120" ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .015" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60" ± 1/8" 60" TO 120" ± 3/16" OVER 120" ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .015" DIAMETER: OVER 24" TO 48" ± 1/4" OVER 48" ± 3/8" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"	
NOTE: 1. REMOVE ALL BURRS AND SHARP EDGES.		TITLE: <b>CF INDUSTRIES NITROGEN, LLC.</b> <b>TEE ASSEMBLY</b> <b>WELDMENT ASSEMBLY</b>	
ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED DRAWING STATUS: <b>As Built</b>		DESIGN NO.	SCALE NTS
THIS DRAWING IS THE PROPERTY OF HENDRICK SCREEN CO. NEITHER THIS DRAWING NOR ANY DATA OR INFORMATION HEREIN SHALL BE COPIED OR REPRODUCED IN ANY MANNER, LOANED OR OTHERWISE DISPOSED OF, OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE PRIOR WRITTEN PERMISSION OF HENDRICK SCREEN CO. IF THIS DRAWING IS LOANED BY OR WITH AUTHORITY OF HENDRICK SCREEN CO. THE BORROWER, IN CONSIDERATION OF SUCH LOAN, AGREES TO THE FOREGOING CONDITIONS AND TO RETURN THIS DRAWING UPON REQUEST.		DRAWING NO.	SHT. 2 OF 10
		REV. 1	

NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

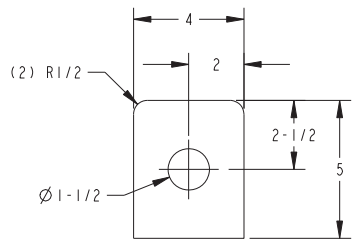
ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
DRAWING STATUS: **As Built**

ADDED CENTER OF GRAVITY DIMENSION  
AP 5/13/14 JW 5/13/14

REV DESCRIPTION BY / DATE APPV'D

Hendrick Screen Company  
Cutting Edge Metal Solutions  
Oneesboro, NY

CF INDUSTRIES NITROGEN, LLC.  
TEE ASSEMBLY  
WELDMENT ASSEMBLY  
DRAWING NO. 14-33-2 SHT. 2 OF 10 REV. 1



DETAIL PART 5

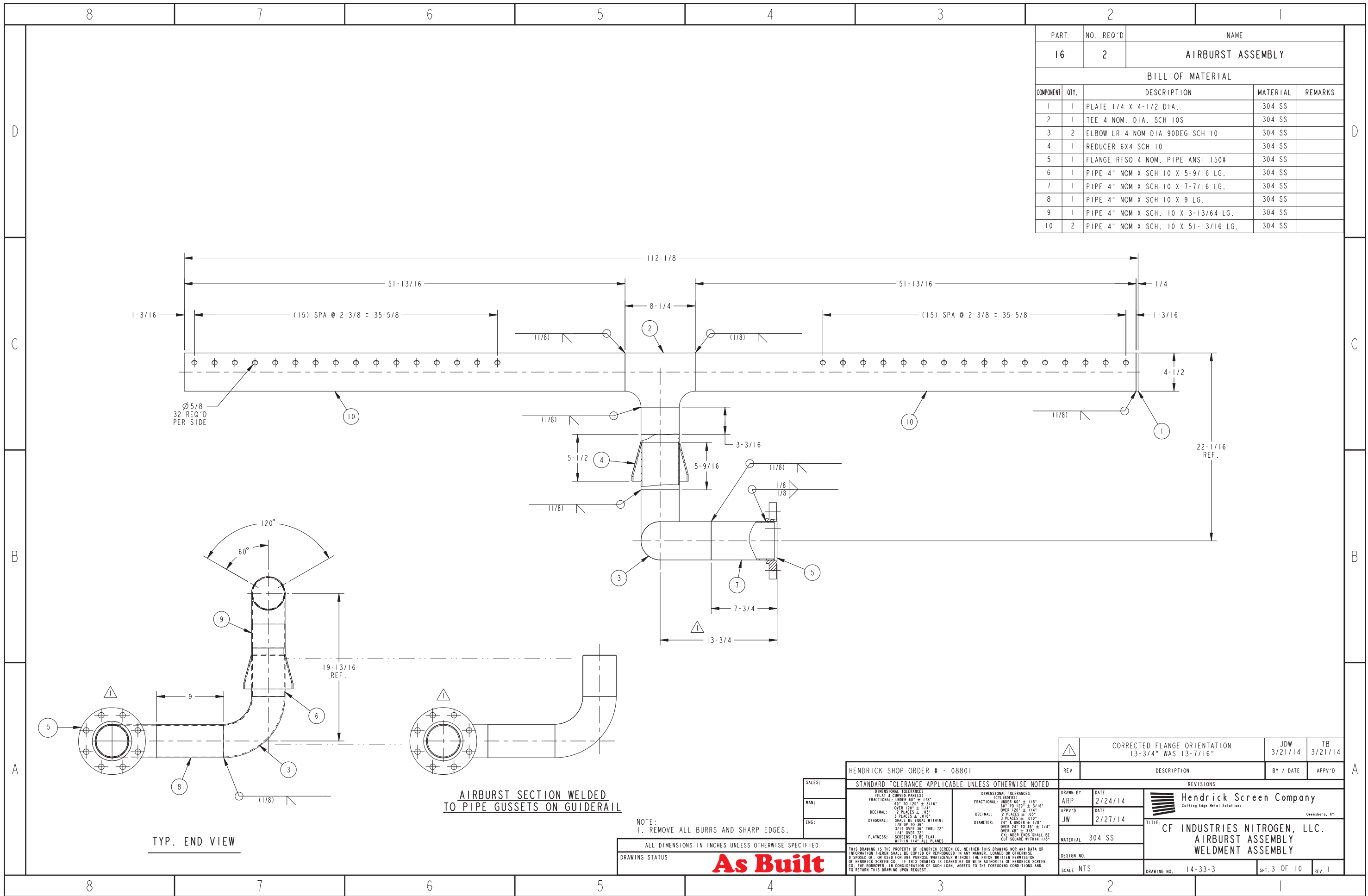
DETAIL 4

DETAIL 1

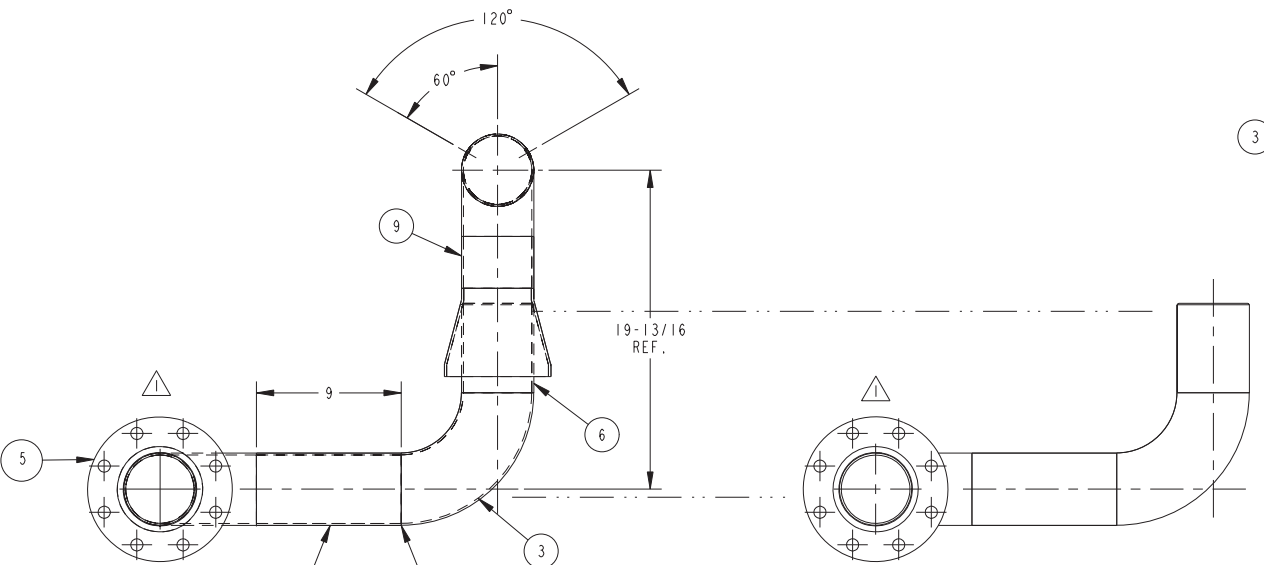
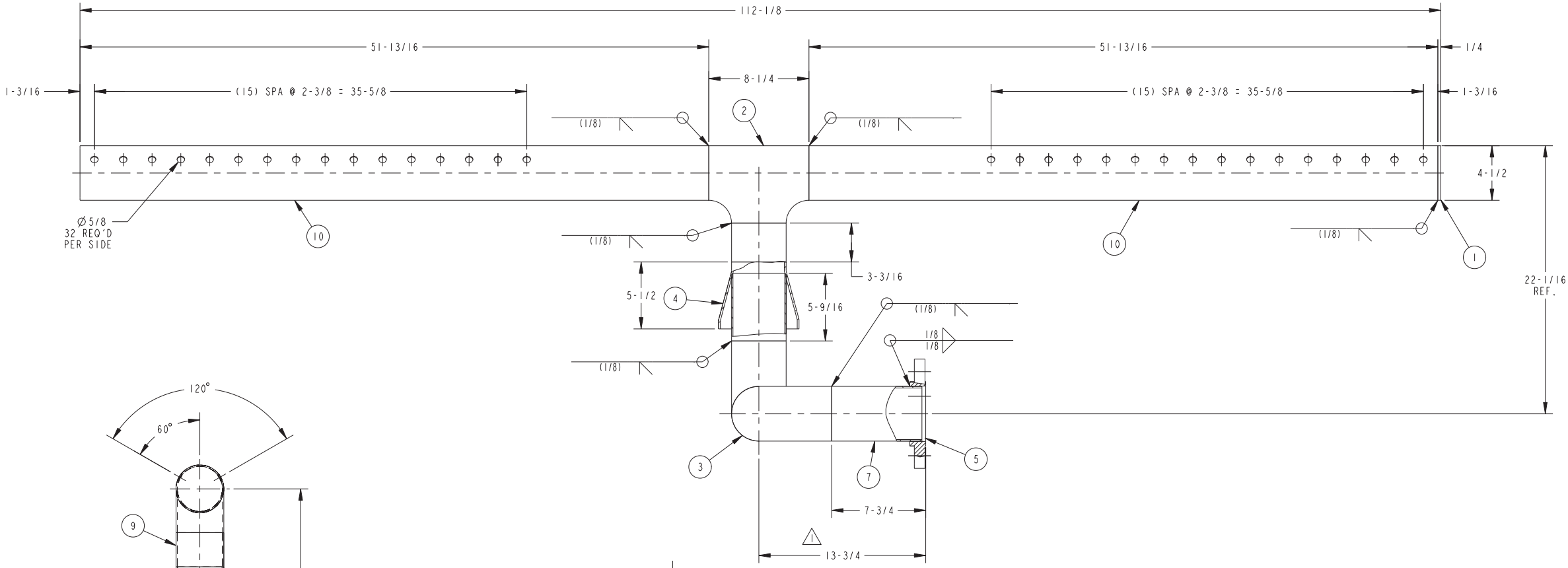
DETAIL 2

DETAIL 3





PART	NO. REQ'D	NAME		
16	2	AIRBURST ASSEMBLY		
BILL OF MATERIAL				
COMPONENT	QTY.	DESCRIPTION	MATERIAL	REMARKS
1	1	PLATE 1/4 X 4-1/2 DIA.	304 SS	
2	1	TEE 4 NOM. DIA. SCH 10S	304 SS	
3	2	ELBOW LR 4 NOM DIA 90DEG SCH 10	304 SS	
4	1	REDUCER 6X4 SCH 10	304 SS	
5	1	FLANGE RFSO 4 NOM. PIPE ANSI 150#	304 SS	
6	1	PIPE 4" NOM X SCH 10 X 5-9/16 LG.	304 SS	
7	1	PIPE 4" NOM X SCH 10 X 7-7/16 LG.	304 SS	
8	1	PIPE 4" NOM X SCH 10 X 9 LG.	304 SS	
9	1	PIPE 4" NOM X SCH. 10 X 3-13/64 LG.	304 SS	
10	2	PIPE 4" NOM X SCH. 10 X 51-13/16 LG.	304 SS	



AIRBURST SECTION WELDED TO PIPE GUSSETS ON GUIDERAIL

NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
DRAWING STATUS **As Built**

HENDRICK SHOP ORDER # - 08801		REV	DESCRIPTION	BY / DATE	APPV'D
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS			
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60° ± 1/8" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60° ± 1/8" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAMETER: OVER 24" TO 48" ± 1/4" OVER 48" ± 3/8" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"		CORRECTED FLANGE ORIENTATION 13-3/4" WAS 13-7/16" JDW 3/21/14 TB 3/21/14	
SALES:	MAN:	ENG:	DRAWN BY	DATE	APPV'D
			ARP	2/24/14	JW
MATERIAL 304 SS			DESIGN NO.		
SCALE NTS			DRAWING NO. 14-33-3		
			SHT. 3 OF 10		
			REV. 1		

**Hendrick Screen Company**  
Cutting Edge Metal Solutions  
Owensboro, KY

**CF INDUSTRIES NITROGEN, LLC.**  
AIRBURST ASSEMBLY  
WELDMENT ASSEMBLY



8

7

6

5

4

3

2

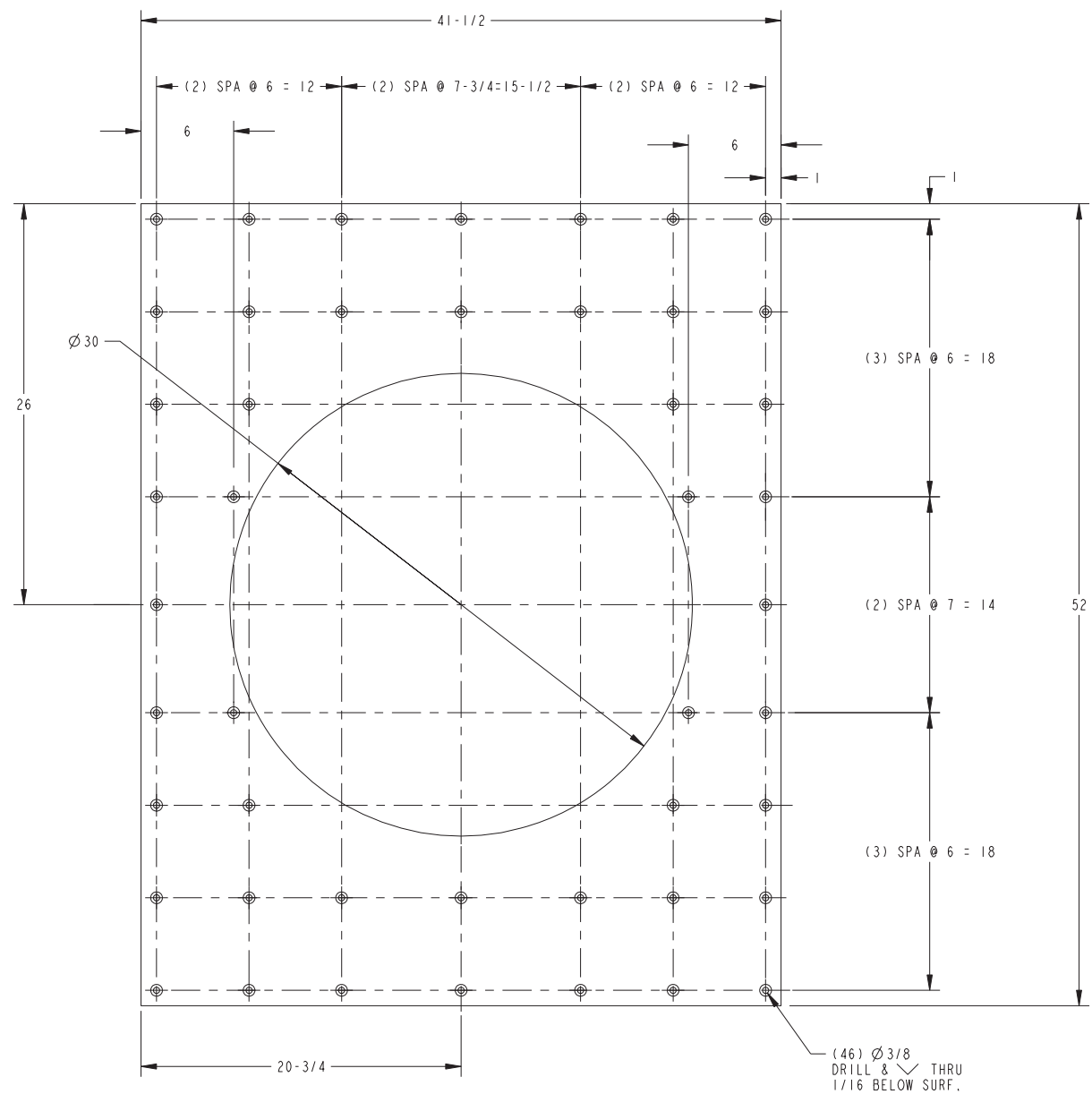
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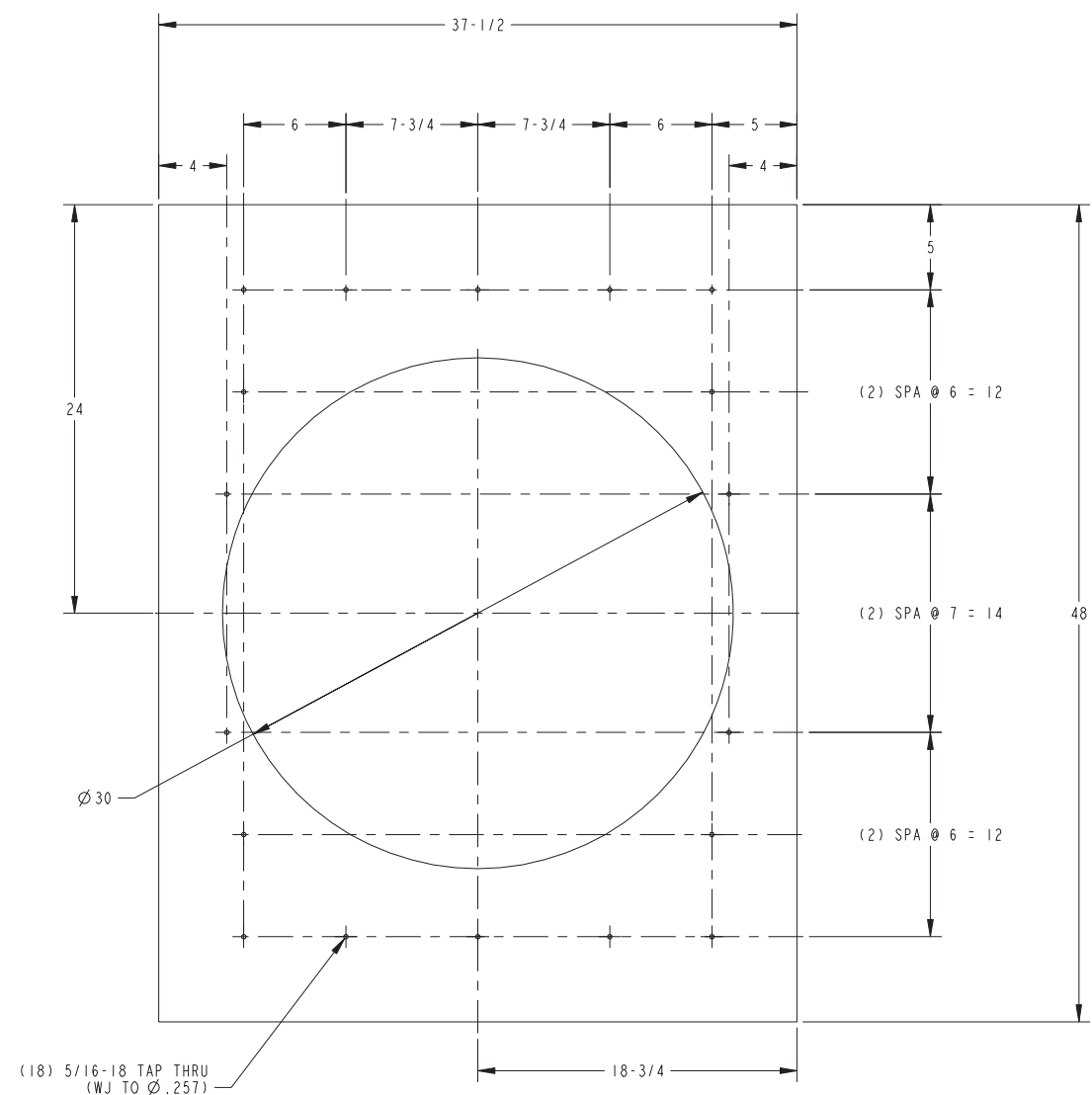
C

B

A



DETAIL COMP. 9 - UHMW  
SHEET 14-33-4

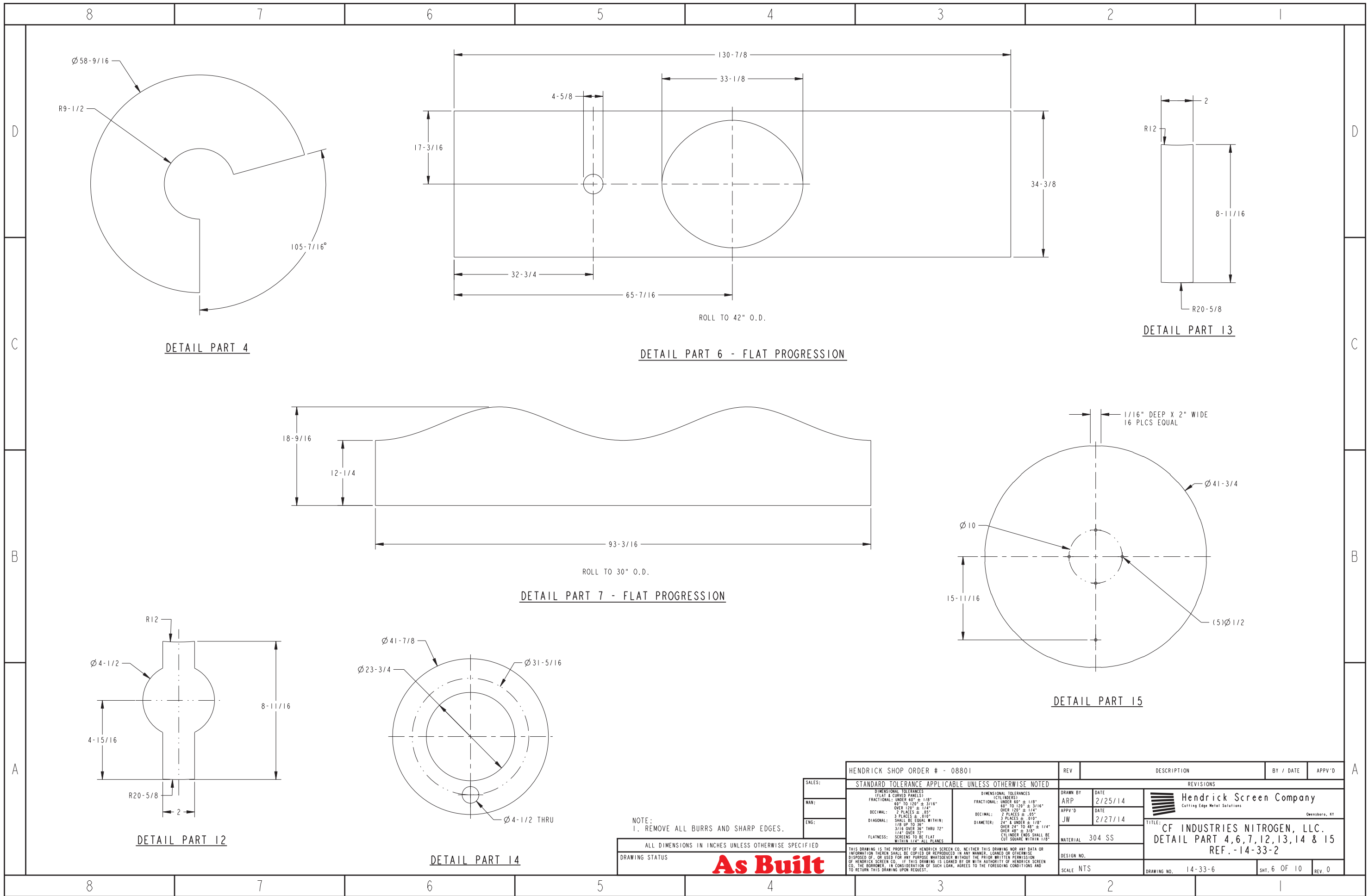


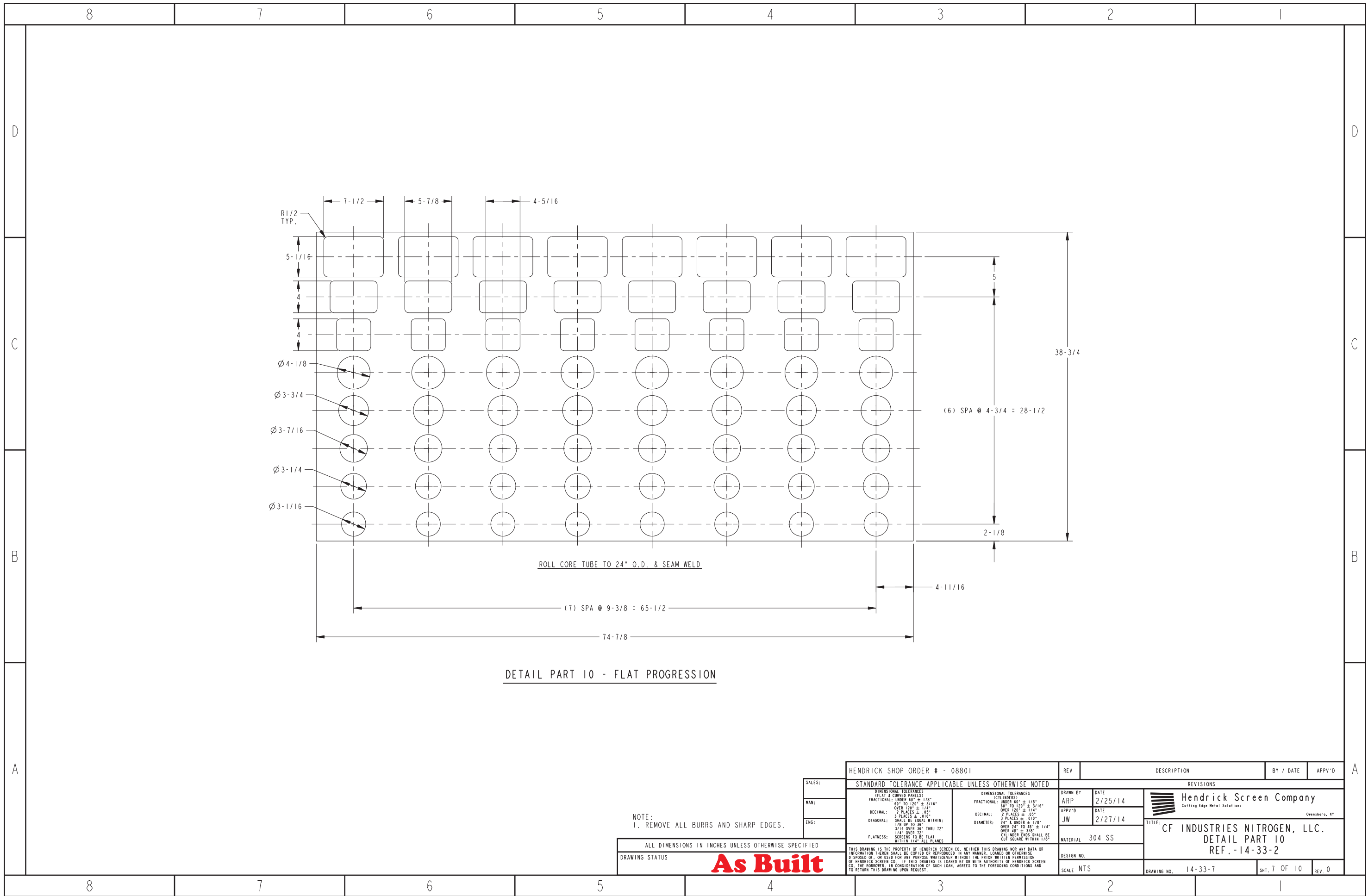
DETAIL COMP. 5 - 304SS  
SHEET 14-33-4

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
DRAWING STATUS **As Built**

HENDRICK SHOP ORDER # - 08801		REV	DESCRIPTION	BY / DATE	APPV'D
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS			
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60° ± 1/16" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60° ± 1/16" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAMETER: 24" & UNDER ± 1/16" OVER 24" TO 48" ± 1/4" OVER 48" ± 3/16" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"		DRAWN BY: ARP DATE: 2/25/14 APPV'D: JW DATE: 2/27/14 MATERIAL VARIES	
THIS DRAWING IS THE PROPERTY OF HENDRICK SCREEN CO. NEITHER THIS DRAWING NOR ANY DATA OR INFORMATION HEREIN SHALL BE COPIED OR REPRODUCED IN ANY MANNER, LOANED OR OTHERWISE DISPOSED OF, OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE PRIOR WRITTEN PERMISSION OF HENDRICK SCREEN CO. IF THIS DRAWING IS LOANED BY OR WITH AUTHORITY OF HENDRICK SCREEN CO. THE BORROWER, IN CONSIDERATION OF SUCH LOAN, AGREES TO THE FOREGOING CONDITIONS AND TO RETURN THIS DRAWING UPON REQUEST.		<b>Hendrick Screen Company</b> Cutting Edge Metal Solutions Oneesboro, KY		TITLE: CF INDUSTRIES NITROGEN, LLC. DETAIL COMP. 9 & 5 REF. - 14-33-4	
SCALE: NTS		DRAWING NO. 14-33-5		SHT. 5 OF 10	
				REV. 0	





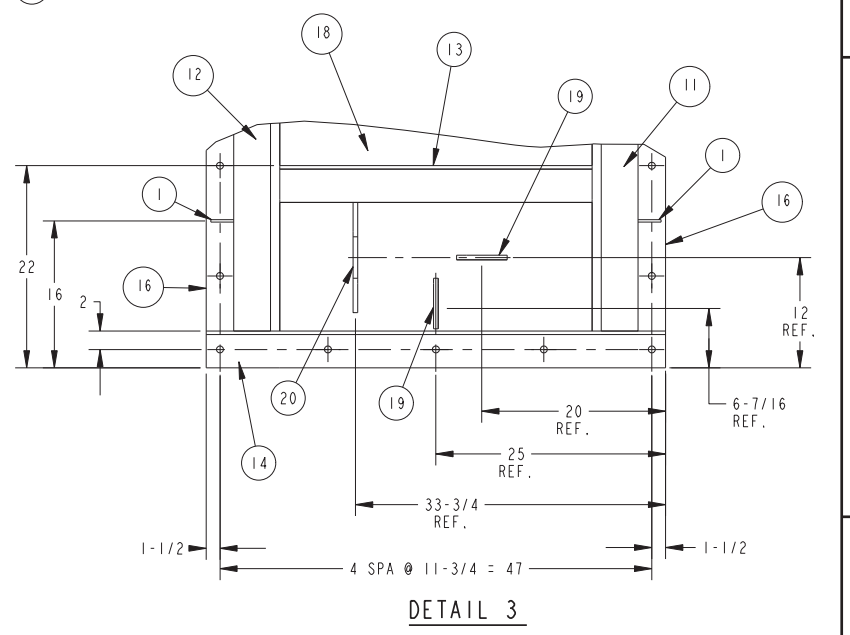
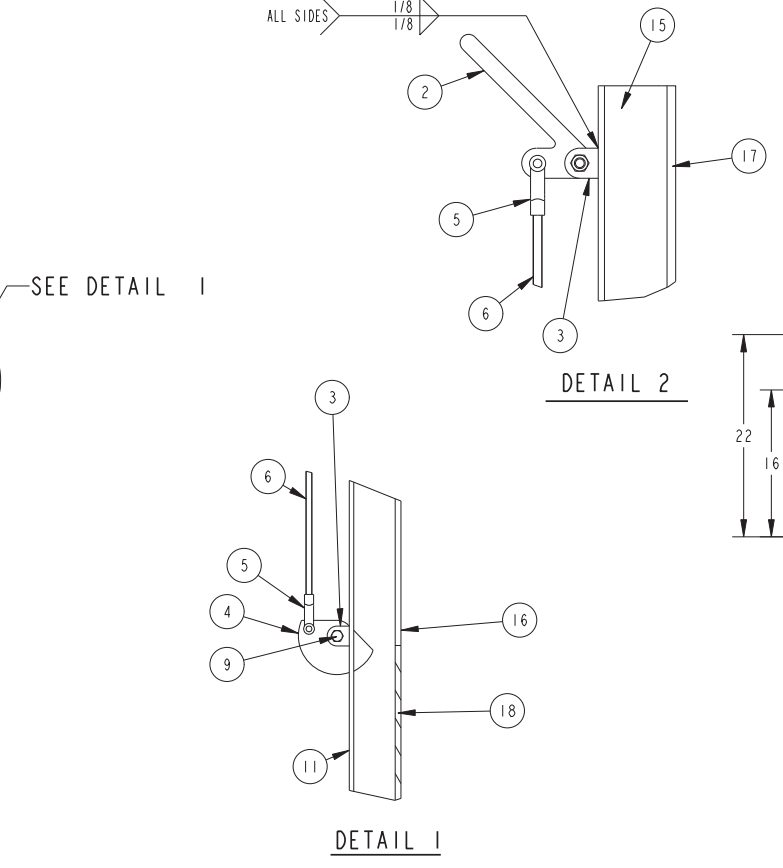
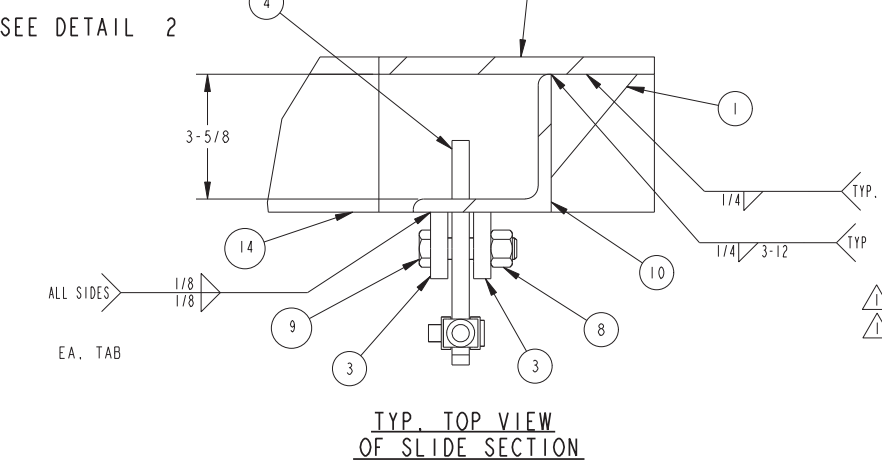
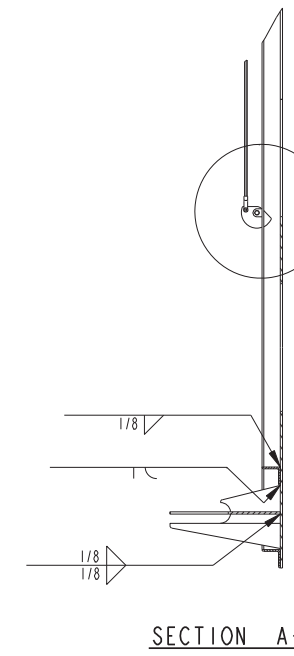
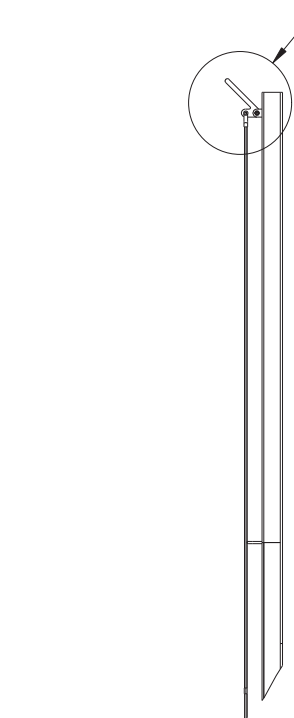
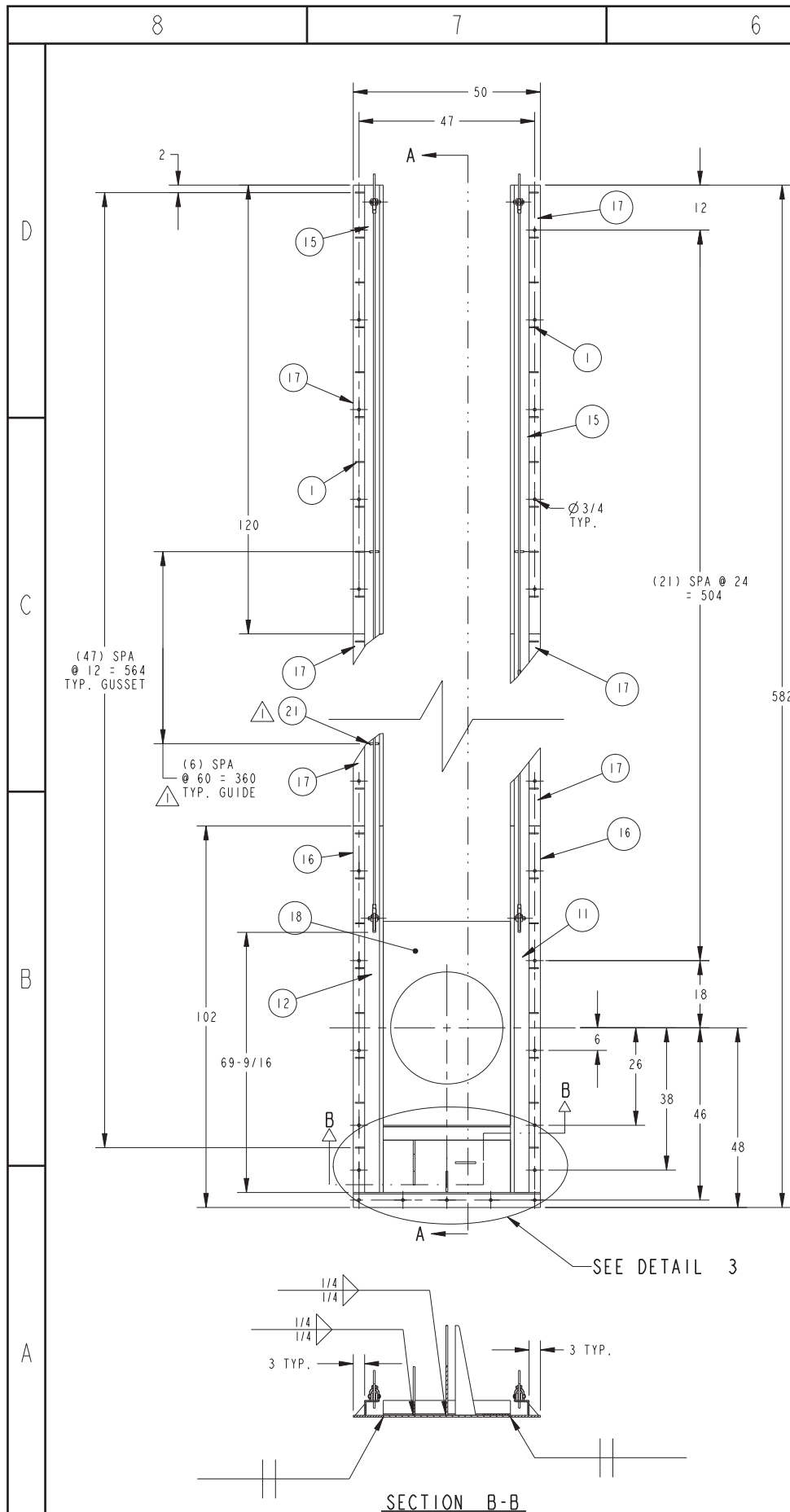


DETAIL PART 10 - FLAT PROGRESSION

NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
DRAWING STATUS **As Built**

SALES:		HENDRICK SHOP ORDER # - 08801		REV	DESCRIPTION	BY / DATE	APPV'D		
MAN:		STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS					
ENG:		DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60° ± 1/16" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60° ± 1/16" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAMETER: OVER 24" TO 48" ± 1/4" OVER 48" ± 3/16" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"		DRAWN BY ARP 2/25/14	DATE 2/25/14	Hendrick Screen Company Cutting Edge Metal Solutions Owensboro, KY	
		THIS DRAWING IS THE PROPERTY OF HENDRICK SCREEN CO. NEITHER THIS DRAWING NOR ANY DATA OR INFORMATION HEREIN SHALL BE COPIED OR REPRODUCED IN ANY MANNER, LOANED OR OTHERWISE DISPOSED OF, OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE PRIOR WRITTEN PERMISSION OF HENDRICK SCREEN CO. IF THIS DRAWING IS LOANED BY OR WITH AUTHORITY OF HENDRICK SCREEN CO. THE BORROWER, IN CONSIDERATION OF SUCH LOAN, AGREES TO THE FOREGOING CONDITIONS AND TO RETURN THIS DRAWING UPON REQUEST.		TITLE: CF INDUSTRIES NITROGEN, LLC. DETAIL PART 10 REF. - 14-33-2		MATERIAL 304 SS			
		DRAWING STATUS		DESIGN NO.	SCALE NTS	DRAWING NO. 14-33-7	SHT. 7 OF 10		
							REV. 0		



ITEM	NO.	REQ'D	NAME	
B	2		GUIDE RAIL ASSEMBLY	
BILL OF MATERIAL				
PART	QTY.	DESCRIPTION	MATERIAL	REMARKS
1	96	SUPPORT GUSSET 1/4 X 2-1/2 X 3	304 SS	
2	2	LIFT HANDLE 1/2	304 SS	14-33-9
3	8	HINGE TAB 1/2 X 1-15/16 X 1-3/4	304 SS	14-33-9
4	2	HINGE PLATE 1/2 X 6-3/4 O.D.	304 SS	14-33-9
5	4	FORGED CLEVIS ROD 1/2-20, 3" LG.	304 SS	
6	8	ROD 1/2 X 123-3/4 LG THREADED BOTH ENDS 3"	304 SS	
7	6	COUPLING NUT 1/2"-13, 1-1/4 X 5/8	304 SS	
8	4	3/4-10 HEX NUT	304 SS	
9	4	3/4-10 X 2-1/2 HEX HD CAP BOLT	304 SS	
10	6	ANGLE 3/8 X 4 X 4 X 120 LG.	304 SS	
11	1	ANGLE 3/8 X 4 X 4 X 120 LG. w/ HINGE SLOT	304 SS	
12	1	ANGLE 3/8 X 4 X 4 X 120 LG. w/ HINGE SLOT (OPP HAND)	304 SS	
13	1	ANGLE 3/8 X 4 X 4 X 34 LG.	304 SS	
14	1	ANGLE 3/8 X 4 X 4 X 50 LG.	304 SS	14-33-9
15	2	ANGLE 3/8 X 4 X 4 X 98 LG.	304 SS	
16	2	PLATE 1/2 X 8 X 102 LG.	304 SS	14-33-9
17	8	PLATE 1/2 X 8 X 120	304 SS	14-33-9
18	1	PLATE 1/2 X 34 X 76-1/2	304 SS	14-33-9
19	2	PLATE GUSSET 1/2 X 6 X 24	304 SS	14-33-10
20	1	PLATE GUSSET 1/2 X 12 X 12-1/4	304 SS	14-33-10
21	14	GUIDE 1/2 DIA X 3 TALL	304 SS	

NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED

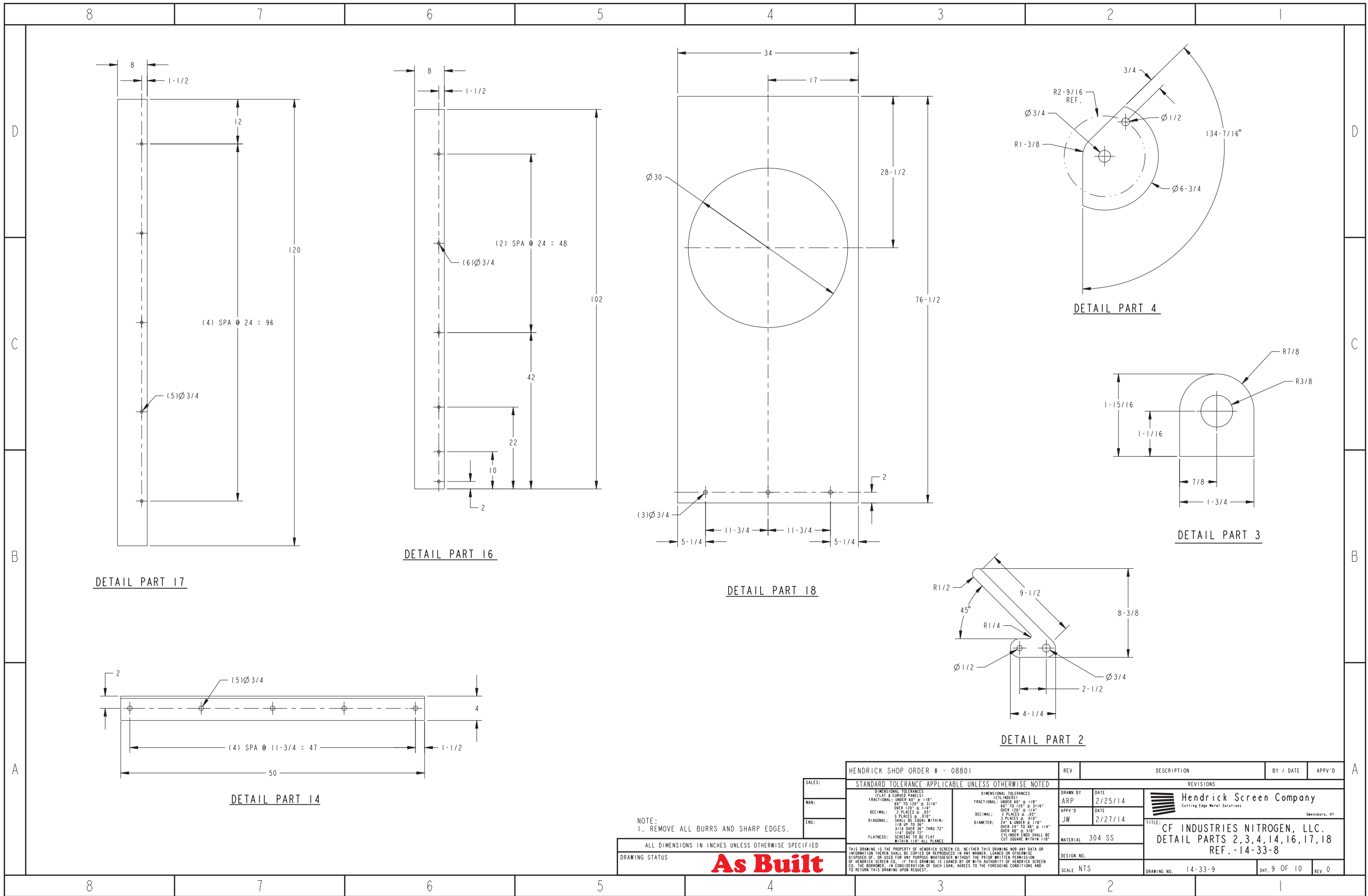
DRAWING STATUS

**As Built**

SALES:		HENDRICK SHOP ORDER # - 08801	
MAN:		STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED	
ENG:		DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60° = 1/16" 60° TO 120° = 3/16" OVER 120° = 1/4" DECIMAL: 2 PLACES = .05" 3 PLACES = .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES	
DRAWN BY:		DATE	
APP'D:		DATE	
MATERIAL:		304 SS	
DESIGN NO.:		SCALE NTS	

ADDED ITEM 21, CHANGED 8 & 9 FROM 5/8 TO 3/4	JDW 4/2/14	TB 4/2/14
REV	DESCRIPTION	BY / DATE
APP'D	REVISIONS	APP'D
TITLE: CF INDUSTRIES NITROGEN, LLC. GUIDERAIL ASSEMBLY WELDMENT DETAIL		
DRAWING NO.:	14-33-8	SHT. 8 OF 10
SCALE:	NTS	REV. 1

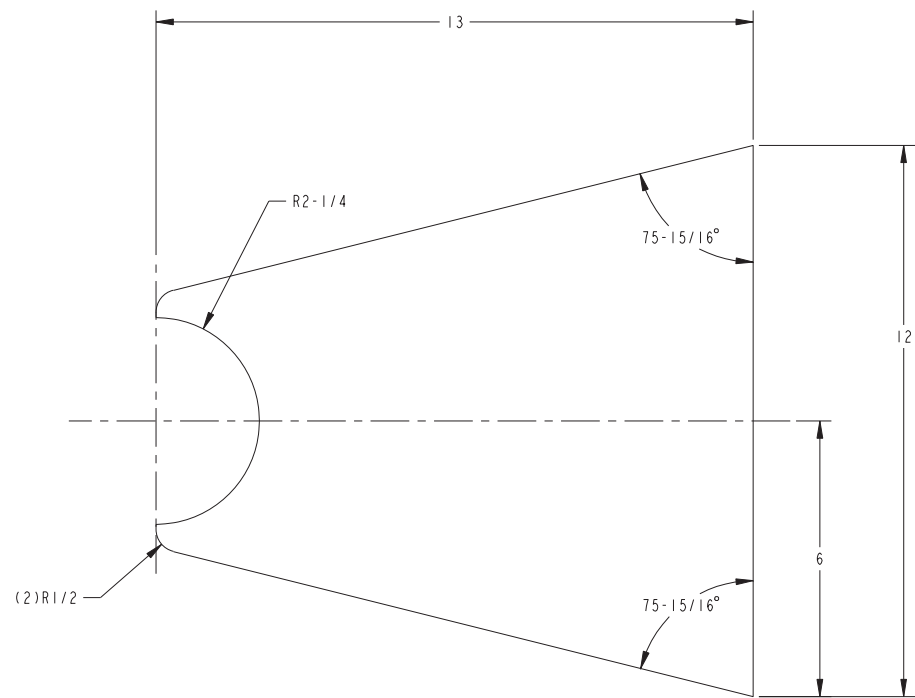




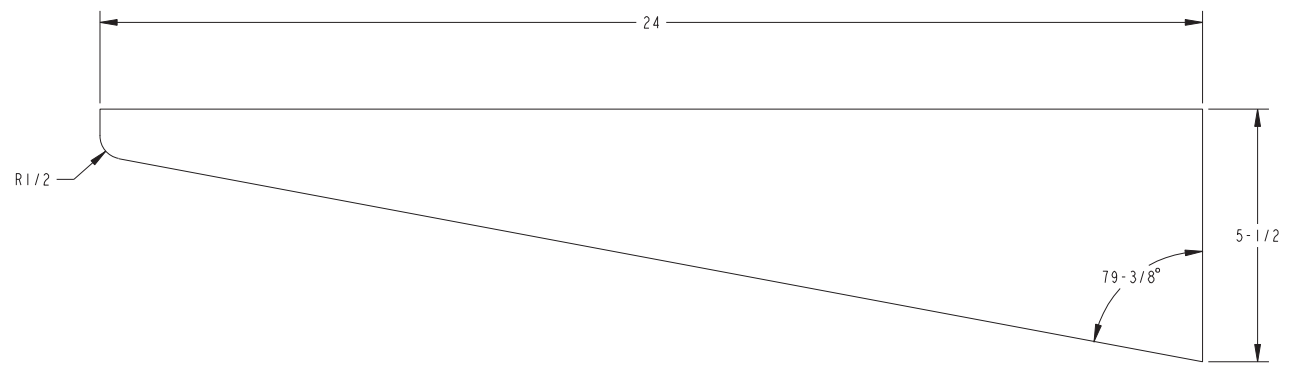
NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
DRAWING STATUS **As Built**

HENDRICK SHOP ORDER # - 08801		REV	DESCRIPTION	BY / DATE	APPV'D
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS			
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60° ± 1/8" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60° ± 1/8" 60° TO 120° ± 3/16" OVER 120° ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .010" DIAMETER: 24" & UNDER ± 1/8" OVER 24" TO 48" ± 1/4" OVER 48" ± 3/8" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"		DRAWN BY: ARP DATE: 2/25/14 APPV'D: JW DATE: 2/27/14 MATERIAL: 304 SS	
THIS DRAWING IS THE PROPERTY OF HENDRICK SCREEN CO. NEITHER THIS DRAWING NOR ANY DATA OR INFORMATION HEREIN SHALL BE COPIED OR REPRODUCED IN ANY MANNER, LOANED OR OTHERWISE DISPOSED OF, OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE PRIOR WRITTEN PERMISSION OF HENDRICK SCREEN CO. IF THIS DRAWING IS LOANED BY OR WITH AUTHORITY OF HENDRICK SCREEN CO. THE BORROWER, IN CONSIDERATION OF SUCH LOAN, AGREES TO THE FOREGOING CONDITIONS AND TO RETURN THIS DRAWING UPON REQUEST.		TITLE: CF INDUSTRIES NITROGEN, LLC. DETAIL PARTS 2, 3, 4, 14, 16, 17, 18 REF. - 14-33-8		DRAWING NO. 14-33-9 SHT. 9 OF 10 REV. 0	



DETAIL PART 20



DETAIL PART 19

NOTE:  
1. REMOVE ALL BURRS AND SHARP EDGES.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED

DRAWING STATUS

**As Built**

HENDRICK SHOP ORDER # - 08801		REV	DESCRIPTION	BY / DATE	APPV'D
STANDARD TOLERANCE APPLICABLE UNLESS OTHERWISE NOTED		REVISIONS			
DIMENSIONAL TOLERANCES (FLAT & CURVED PANELS) FRACTIONAL: UNDER 60" ± 1/8" 60" TO 120" ± 3/16" OVER 120" ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .015" DIAGONAL: SHALL BE EQUAL WITHIN: 1/8" UP TO 36" 3/16" OVER 36" THRU 72" 1/4" OVER 72" FLATNESS: SCREENS TO BE FLAT WITHIN 1/24" ALL PLANES		DIMENSIONAL TOLERANCES (CYLINDERS) FRACTIONAL: UNDER 60" ± 1/8" 60" TO 120" ± 3/16" OVER 120" ± 1/4" DECIMAL: 2 PLACES ± .05" 3 PLACES ± .015" DIAMETER: OVER 24" TO 48" ± 1/4" OVER 48" ± 3/8" CYLINDER ENDS SHALL BE CUT SQUARE WITHIN 1/8"		DRAWN BY: ARP DATE: 2/26/14 APPV'D: JW DATE: 2/27/14 MATERIAL: 304 SS	
THIS DRAWING IS THE PROPERTY OF HENDRICK SCREEN CO. NEITHER THIS DRAWING NOR ANY DATA OR INFORMATION HEREIN SHALL BE COPIED OR REPRODUCED IN ANY MANNER, LOANED OR OTHERWISE DISPOSED OF, OR USED FOR ANY PURPOSE WHATSOEVER WITHOUT THE PRIOR WRITTEN PERMISSION OF HENDRICK SCREEN CO. IF THIS DRAWING IS LOANED BY OR WITH AUTHORITY OF HENDRICK SCREEN CO. THE BORROWER, IN CONSIDERATION OF SUCH LOAN, AGREES TO THE FOREGOING CONDITIONS AND TO RETURN THIS DRAWING UPON REQUEST.		Hendrick Screen Company Cutting Edge Metal Solutions Owensboro, KY		TITLE: <b>CF INDUSTRIES NITROGEN, LLC.</b> <b>DETAIL PARTS 19 &amp; 20</b> <b>REF. - 14-33-8</b>	
DESIGN NO.		SCALE: NTS		DRAWING NO. 14-33-10	SHT. 10 OF 10
REV. 0					



**Hendrick Screen Company**

Cutting Edge Metal Solutions

# **IOM MANUAL**

**FOR**

**L & A**

# **AIRBURST SYSTEM**

# **HS21791**

**BUILT BY**

**KING MECHANICAL SPECIALTY**

3074 Medley Road ~ Owensboro KY 42304  
Phone: 270-685-5138 Fax: 270-685-1729 ~ [www.hendrickscreenco.com](http://www.hendrickscreenco.com)



**Compressor:**

15 hp Ingersoll-Rand reciprocating, splash lubricated, 460 volt /3 phase 60 hz TEFC motor with low oil safety switch, air cooled after-cooler, Model 7100x15 will pump up receiver from 0-150 psig in approximately 18 minutes.

**Receivers:**

One 660 gallon vertical ASME coded 200 psig with auto drain, safety valve, shipped with shop primer, receiver to be painted in the field.

**Small 3 gallon receiver** for valve actuation, with check valve, safety valve, pressure gauge, mechanical drain and filter regulator on the outlet.

**Valves:**

Two – 4 inch lug style butterfly valves rated for 200 psig, with a pneumatic actuator, limit switches and 120 vac direct mounted solenoid with manual override.

**Control Panel:**

The control panel shall include at least:

- \*NEMA 4x enclosure.
- \*System On-Off switch, removes control power.
- \*Off Auto switch for each compressor.
- \*Motor starter/overload relay and fuses for compressor.
- \*Auto Off Manual Switch for each valve.
- \*Lamps for valve position indication.
- \*Step down transformer.
- \*Low oil warning light.
- \*Selectable Manual push button operation.
- \*Adjustable backwash cycle timer.
- \*Interlock to prevent backwash when receiver does not have adequate air pressure.
- \*Dry contacts to initiate a backwash for each valve
- \*KMS logic using PLC or relays.

Receiver and valves will ship separate to be assembled in the field. Compressor, control panel, and small receiver will be mounted on a skid.

**System Description:**

The Back wash is initiated by a system timer. Once initiated, the system requests that Pump One shut down. Once signal is received that pump one is shut down, a 30 second delay with a dry contact output is initiated. After the delay, the valve is opened and held open for a programmed period of time. When the back wash is done the signal to shut down pump one will be removed. Once the compressor pumps the receiver back up (READY) screen 2 will be cleaned following the same procedure.

Back wash can also be initiated with a contact closure for each valve. Again the same sequence will be used.

A manual backwash is also provided. Once the backwash is initiated using the push button the same sequence will be followed.

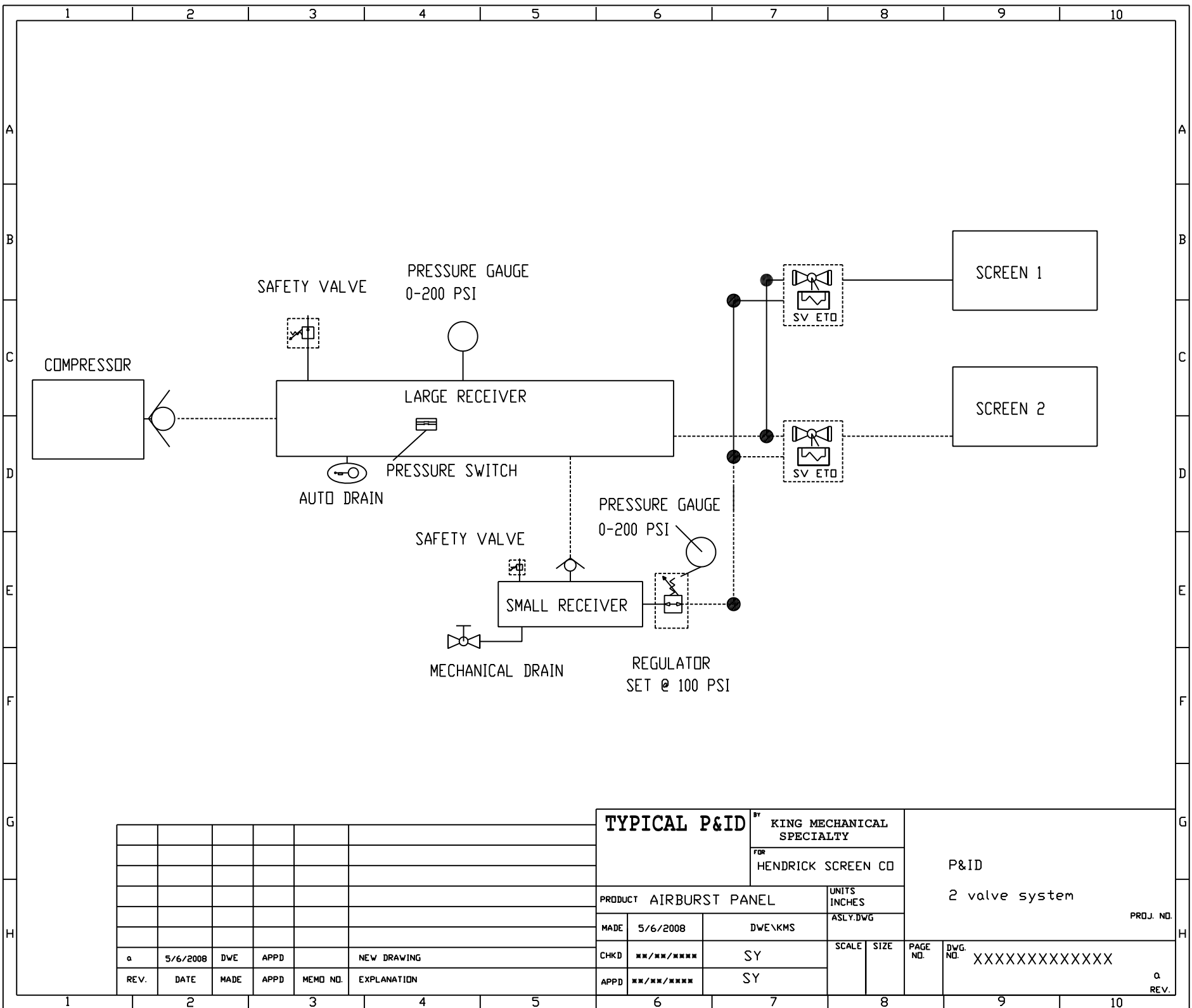
- 1- Request an appropriate pump shut down
- 2- Verify pump is shut down
- 3- Initiate 30 second delay
- 4- Open backwash valve for programmed period of time
- 5- Remove request to shut down pump
- 6- Wait for another request to backwash

A backwash cannot be accomplished without adequate air pressure (READY) and verification that the pump is shut down.

## L & A No. 9173 BOM

Qty	Part Number	Description
1	7100X15	15 hp basemount compressors, low oil switch,460/3/60 ODP motor,air cooled after cooler startup kit
1	A21642117200	660gallon 200psi vertical receiver , primed to be painted in the field with 4" flange
1	6010DCM01-KM165	200 psi safety valve
1	45-1279AS-02L 200#	Pressure gauge
1	SAC120	IPAC auto drain
2	221225115319	4" DEMCO 200psi lug style butterfly valve
2	077-104U005004M	Kinetrol Actuator
2	SC8551-120vac	ASCO solenoid with adapter
2	KMS	Hardware
1	Misc	Check valve, small receiver ect.
1	KMS	Control panel NEMA 4X

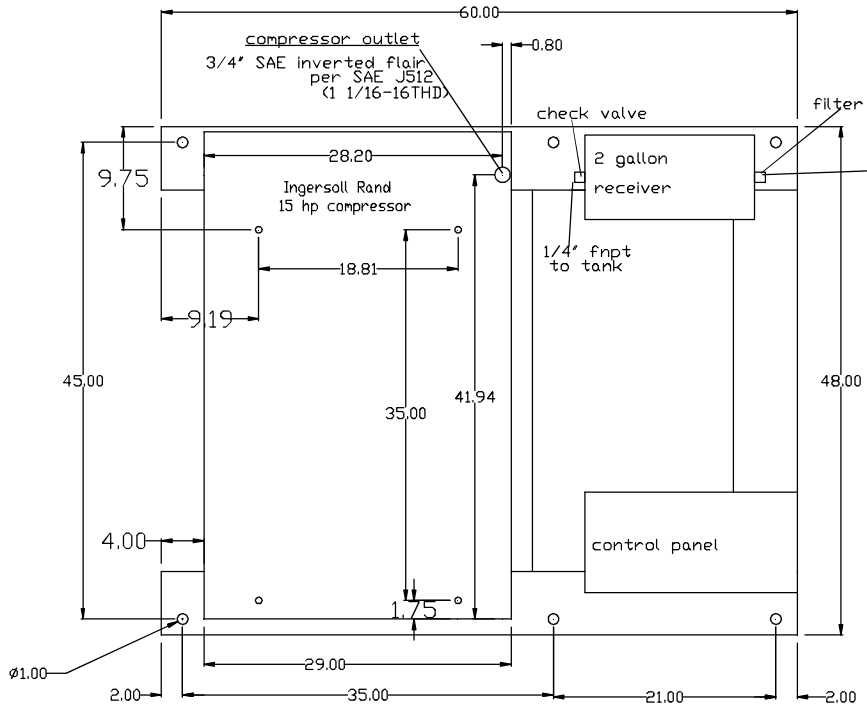




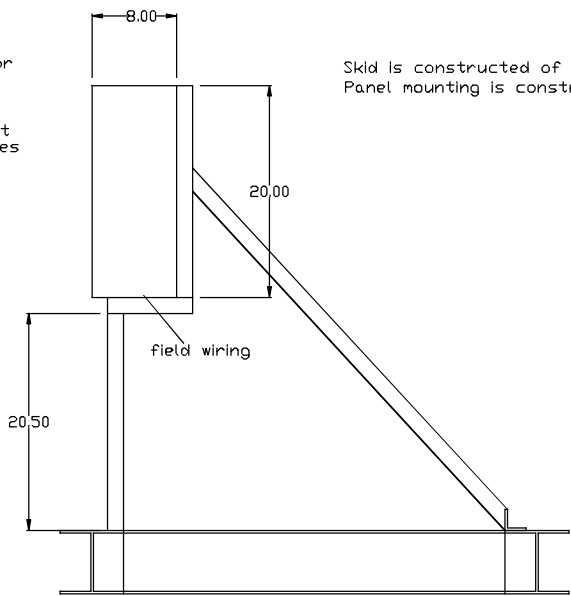
REV.	DATE	MADE	APPD	MEMO NO.	EXPLANATION
a	5/6/2008	DWE	APPD		NEW DRAWING

<b>TYPICAL P&amp;ID</b>		BY KING MECHANICAL SPECIALTY	
		FOR HENDRICK SCREEN CO	
PRODUCT	AIRBURST PANEL	UNITS	INCHES
MADE	5/6/2008	ASLY	DWG
CHKD	***/**/****	SCALE	SIZE
APPD	***/**/****	PAGE NO.	DWG. NO.
			XXXXXXXXXXXXXXXX

P&ID		2 valve system	
		PROJ. NO.	
		a REV.	



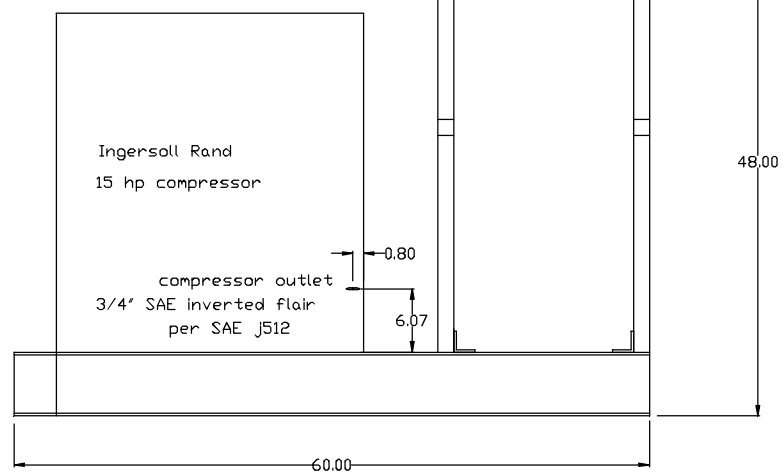
TOP VIEW



END VIEW

Skid is constructed of W6-15# H-beam  
Panel mounting is constructed of 1 1/2" square tubing.

Dimensions are for reference only and must be verified in the field  
See compressor drawing in submittal for outlet position  
Compressor will be wired to the controlpanel  
Field wiring is to enter at the bottom of the enclosure  
See wiring diagrams for required circuits  
See P&ID for piping connections



FRONT VIEW

REV.	DATE	MADE	APPD	MEMO NO.	EXPLANATION
c	6/25/2014	DWE	APPD		changes per engineers comments
b	4/23/2014	DWE	APPD		changes per engineers comments
a	3/5/2014	DWE	APPD		NEW DRAWING

<b>L&amp;A No. 9173</b>		BY <b>KING MECHANICAL SPECIALTY</b>		<b>GENERAL LAYOUT</b>			
		FOR HENDRICK SCREEN CO PD HS21791					
PRODUCT	Compressor Skid	UNITS INCHES				PROJ. NO.	
MADE	6/5/2014	ASLY.DWG					
CHKD	*/*/*/****	SY	SCALE	SIZE			
APPD	*/*/*/****	SY	PAGE NO.	DWG. NO.	HS21791-1		

# 7100V

 Ref: 9820.00  
 Sheet: 118  
 Date: 07 Feb. 2005  
 Cancels: 11 May 2004

## Engineering Data

<b>Bore:</b> 5.5" & 3"	<b>Min RPM:</b> 750	<b>Aircooled Aftercooler CTD:</b> 25° F
<b>Stroke:</b> 4"	<b>Max RPM:</b> 1100	(Package performance)
<b>Inlet Size:</b> 1.5" NPT	<b>Sheave OD:</b> 18"	<b>Number of Belts:</b> 2
<b>Discharge Size:</b> 1" NPT	<b>Sheave PD:</b> 17.5"	<b>Belt Section:</b> B

Performance						Nameplate Amp Ratings				
Bare	Motor HP	PSI	RPM	ACFM	BHP	200-3-60	230-3-60	460-3-60	575-3-60	
7100V	15	75	1100	51.6	13.5	44.9	39	19.5	15.6	
7100V	15	125	1100	50.5	15.1					
7100V	15	175	1100	50.0	16.3					

## Bare Pump Detailed Specifications

**FRAME**—The 100% cast iron frame is designed to support the overhung crankshaft. Cylinders bolt directly to the cast iron frame. Frame is completely sealed yet allows for maximum accessibility.

**CRANKSHAFT**—A unique overhung design supported by two heavy duty ball bearings with replaceable crankpin bushing. Entire shaft is balanced with an integral counterweight to insure smooth operation.

**CONNECTING RODS**—Solid one-piece design. These simple, easy to maintain rods can be used only with an overhung crankshaft. Crankpin bushing inside the rod is precision ground requiring no alignment.

**CYLINDERS**—These are 100% cast iron, separately cast and individually bolted to the frame in a V-type configuration. The cylinders are precision honed for low oil carryover. Radial fins on the cylinders help remove heat and ensure 360 degree cooling of the cylinders.

**PISTONS**—Precision balanced low pressure aluminum and high pressure cast iron pistons provide smooth operation.

**RINGS**—There are four piston rings for sealing compression and oil control. The taper faced compression ring and beveled oil scraper ring provide quick seating. Two, three-piece oil control rings maintain proper lubrication on cylinder wall. Precision honing used in conjunction with the ring stack up means low oil carryover.

**FLYWHEEL**—The cast iron fan type flywheel forces a "cyclone" air blast to provide cooling for the deep finned cylinders and multi-finned copper tube intercooler. The flywheel is balanced to keep vibration to a minimum.

**INTERCOOLER**—Two stage compressors use an intercooler. The intercooler between stages is of finned copper tube construction to provide maximum cooling area. It is located directly in the flywheel air blast to remove the heat of compression between stages. This keeps running temperatures and power needs to a minimum, ensuring high air delivery for horsepower expended. The intercooler is provided with a relief valve to prevent over-pressurization.

**LUBRICATION**—Splash lubrication of running parts is simple and reliable. Lubrication dippers are integral with connecting rods and cannot come loose.

**INLET FILTER**—The filter has a durable canister with a dry type 10 micron inlet filter/silencer as standard.

**VALVES**—Efficient combination valve design is utilized. Inlet valves consist of finger valves which allow maximum air flow. Discharge valves are large bore ring valves which provide maximum efficiency. Valve plate is easily removed for maintenance.

**OIL SIGHT GLASS**—Indicates visible oil level at all times.

## Simplex Detailed Specifications

~~**BASE**—The compressor and motor are aligned on a heavy steel base.~~

~~**RECEIVER**—Receiver mounted units are ASME, National Board coded, and include pressure gauge, drain valve, service valve, and relief valve.~~

## Options Only Detailed Specifications

**“E”-SERIES STARTER (MTD. & WIRED) -SIMPLEX UNITS—**“E”-Series starters provide full voltage control of electric motors. They include thermal relays which protect the motor windings from harmful currents and resultant temperature rise caused by overloaded motor, low line voltage or stalled motor. Fused control circuit, on/off switch, reset button and NEMA 1 enclosure (UL & CSA approved) included.

**START-UP KIT—**Each start-up kits contains all the parts needed to correctly start up and maintain the compressor for the first year of operation. Kits include All Season Select lubricant (quantity dependent upon sump capacity), replacement filter element(s), MSDS sheet for lubricant, and (1) proof of warranty decal. The All Season lubricant is specifically formulated to protect and preserve the air compressor pump. All Season Select Lubricant can operate up to 2000 hours (under normal operating conditions) between oil changes. Use of All Season Select lubricant from start-up throughout the first 2-years of operation provides for a full **2-YEAR PUMP WARRANTY**, less consumables.

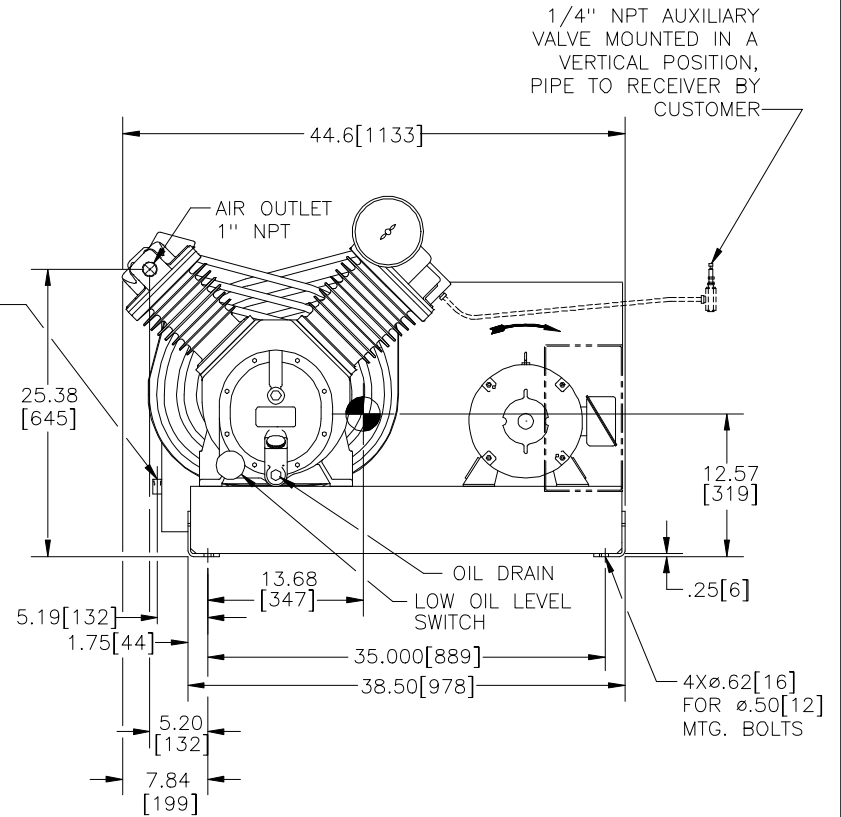
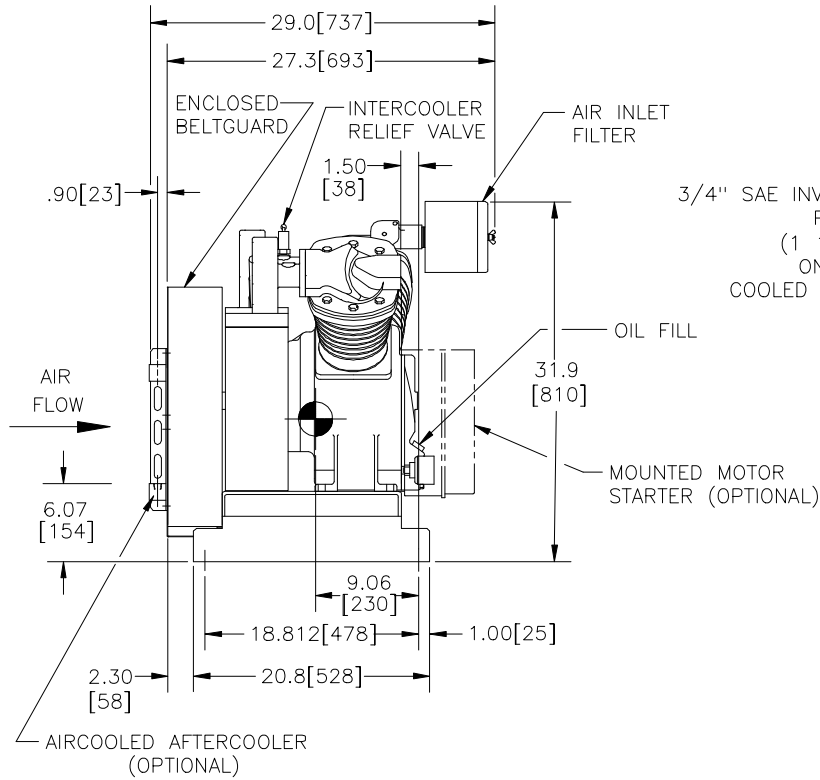
**INSTALL KIT—**Each install kit contains all the parts needed to correctly mount and install the compressor. Kits include a three (3) foot braided hose with NPT swivel connectors (size matches connection on compressor), vibration pads and foundation anchor bolts. The Install kit is specifically designed to ease installation of the air compressor and to protect and preserve the receiver tank. Use of the Install kit at initial start-up warrants the receiver tank for five (5) years, less package related components.



NOTES:

1. FOUNDATION OR FLOOR MUST BE LEVEL AND SUPPORT ALL FEET EQUALLY, IF NECESSARY SHIM OF GROUT THE FOURTH FOOT.
2. THE COMPRESSOR ARRANGEMENT BELOW IS SHOWN WITH THE MAJOR ACCESSORY ITEMS. ADDITIONAL ACCESSORY ITEMS ARE AVAILABLE, BUT WILL NOT INCREASE EXISTING DIMENSIONS UNLESS OTHERWISE NOTED.
3. FOUNDATION BOLTS SHOULD PROJECT THRU NUTS AT LEAST 1/2"[13] TO ALLOW FOR LEVELING.

4. ALLOW AT LEAST 12.00"[305] CLEARANCE MINIMUM ON ALL SIDES FOR PROPER AIR CIRCULATION.
5. APPROXIMATE NET WEIGHT: 700 LBS.[318kg]
6. ALL UNSPECIFIED TOLERANCES: XXX = ±.12[3]  
XX = ±.25[6]  
X = ±.50[13]
7. DIMENSIONS IN [ ] ARE MILLIMETER DIMENSIONS UNLESS OTHERWISE SPECIFIED.



APPROVED FOR:		SIZE: _____	JOB: _____ SPEC: _____	<p>PROPRIETARY NOTICE</p> <p>THIS DOCUMENT CONTAINS CONFIDENTIAL AND TRADE SECRET INFORMATION, IS THE PROPERTY OF INGERSOLL-RAND COMPANY, AND IS GIVEN TO THE RECEIVER IN CONFIDENCE. THE RECEIVER BY RECEIVING AND RETENTION OF THIS DOCUMENT ACCEPTS THE DOCUMENT IN CONFIDENCE AND AGREES THAT EXCEPT AS AUTHORIZED IN WRITING BY INGERSOLL-RAND COMPANY, IT WILL (1) NOT USE, THE DOCUMENT OR ANY COPY THEREOF; OR THE CONFIDENTIAL OR TRADE SECRET INFORMATION THEREIN; (2) NOT COPY THE DOCUMENT; (3) NOT DISCLOSE TO OTHERS EITHER THE DOCUMENT OR THE CONFIDENTIAL OR TRADE SECRET INFORMATION THEREIN; AND (4) UPON COMPLETION OF THE NEED TO RETAIN THE DOCUMENT, OR UPON DEMAND, RETURN THE DOCUMENT, ALL COPIES THEREOF, AND ALL MATERIAL DERIVED THEREFROM.</p> <p>Copyright © 1992 Ingersoll-Rand Company All Rights Reserved</p> <p>WARNING: The export or reexport of this drawing or a product produced by this drawing is subject to U.S. Export Administration Regulations and other applicable governmental restrictions or regulations.</p>	<p>THIRD ANGLE PROJECTION</p> <p>SCALE 1/8"=1"</p>	<p><b>INGERSOLL-RAND Co.</b></p> <p>RECIPROCATING COMPRESSOR DIVISION SMALL COMPRESSOR BUSINESS UNIT CAMPBELLSVILLE, KY</p>
IR ORDER NO. _____	CUSTOMER: _____	MODEL: _____	ITEM: _____ CONTRACTOR: _____		DATE _____	REF. 7100X10/15, H7100X10/15
CUSTOMER ORDER NO. _____	PER: _____ DATE: _____	PISTON DISPLACEMENT: _____	ARCH.ENGR.: _____		DRAWN G.D.LEVI	TITLE GENERAL ARRANGEMENT
		SPEED RPM: _____	MTR. H.P./KW: _____ MTR. ENCL.: _____		CHECKED _____	SIZE C DWG NO. GA2207000
		DISCHARGE PRESSURE RATING: _____	MTR. VOLTS: _____ PH: _____ HZ: _____	DSN. APP _____	REV 06	
		ACTUAL DELIVERY: _____	STARTER TYPE: _____	ENGR. APP _____	SHEET 1 OF 1	
		REGULATION: _____				

## Installation, Operation and Maintenance Instructions for Standard Two-Stage Lubricated Air Compressors (Electric Motor and Gasoline Engine Models Up to 30 Horsepower)

**IMPORTANT INFORMATION! READ AND FOLLOW THESE INSTRUCTIONS. RETAIN FOR REFERENCE.**

### SAFETY

#### DEFINITIONS

- △ **DANGER** WILL cause DEATH, SEVERE INJURY or substantial property damage.
- △ **WARNING** CAN cause DEATH, SEVERE INJURY or substantial property damage.
- △ **CAUTION** WILL or CAN cause MINOR INJURY or property damage.

#### GENERAL SAFETY PRECAUTIONS

- △ **DANGER** **INTAKE AIR.** Can contain carbon monoxide or other contaminants. Will cause serious injury or death. Ingersoll-Rand air compressors are not designed, intended or approved for breathing air. Compressed air should not be used for breathing air applications unless treated in accordance with all applicable codes and regulations.
- △ **WARNING** **HAZARDOUS VOLTAGE.** Can cause serious injury or death. Disconnect power and bleed pressure from the tank before servicing. Lockout/Tagout machine. Compressor must be connected to properly grounded circuit. See grounding instructions in manual. Do not operate compressor in wet conditions. Store indoors.  
**MOVING PARTS.** Can cause serious injury. Do not operate with guards removed. Machine may start automatically. Disconnect power before servicing. Lockout/Tagout machine.
- HOT SURFACES.** Can cause serious injury. Do not touch. Allow to cool before servicing. Do not touch hot compressor or tubing.
- HIGH PRESSURE AIR.** Bypassing, modifying or removing safety/relief valves can cause serious injury or death. Do not bypass, modify or remove safety/relief valves. Do not direct air stream at body. Rusted tanks can cause explosion and severe injury or death. Drain tank daily or after each use. Drain valve located at bottom of tank.
- △ **CAUTION** **RISK OF BURSTING.** Use only suitable air handling parts acceptable for pressure of not less than the maximum allowable working pressure of the machine.

### GENERAL INFORMATION

#### INTRODUCTION

This manual provides safe and reliable instructions for the installation, operation and maintenance of your Ingersoll-Rand air compressor. Carefully read this manual before attempting to operate or perform any maintenance. If you are uncertain about any

of the instructions or procedures provided in this manual, contact Ingersoll-Rand. We recommend you retain this manual, and all publications provided with your air compressor, in a location which is accessible to all personnel who operate and service your compressed air equipment.

#### APPLICATION

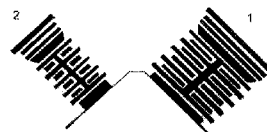
Ingersoll-Rand's standard two-stage lubricated air compressors are single-acting, air-cooled machines. Typical compressors are furnished as compact, self-contained, air receiver tank mounted units that are automatically regulated and driven by an electric motor or gasoline engine. An air-cooled aftercooler, low oil level shutdown switch and automatic drain valve are among the optional accessories that can be furnished. Bare compressor pumps and baseplate-mounted units are also available.

These compressors may be used for a variety of compressed air application up to 250 PSIG (17.5 kg/cm<sup>2</sup>). Application of these compressors as either a primary or supplementary source of air is virtually unlimited in industrial plants, service stations and auto repair shops. Supplementary service includes such uses as furnishing air at pressure not carried in regular shop lines, air at isolated locations, and standby service for air when larger compressors are shut down.

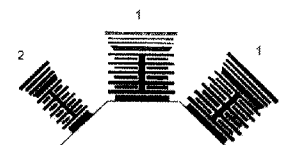
#### TWO-STAGE OPERATION

Two-stage compressors consist of one or two first-stage cylinders with the same bore size and one second-stage cylinder with a smaller bore size.

*Typical Two-Stage, Two Cylinder Unit*



*Typical Two-Stage, Three Cylinder Unit*



The basic principle of operation is as follows: On the suction stroke of the first-stage piston(s), air at atmospheric pressure enters the cylinders through the inlet filter(s) and then the inlet valves located in the head. On the compression stroke of the first-stage piston(s), the air is compressed to an intermediate pressure and discharged through the discharge valve(s) into common manifold(s). From the manifold(s) the air passes through the intercooler tubes, where the heat of first-stage compression is removed. On the suction stroke of the second-stage piston this cooled air enters the second-stage cylinder through the inlet valve. The compression stroke of the second-stage piston compresses the air to the final discharge pressure and forces it out through the discharge valve into the receiver tank or system. If cooling of the discharge air is required,

an air-cooled aftercooler should be installed between the compressor discharge and the receiver tank or system.

For maintaining the receiver tank or system air pressure within predetermined limits, the compressor may be operated with automatic start & stop control or constant speed control regulation. The type of regulation used depends upon the application.

## ADDITIONAL REFERENCES

Unless otherwise stated, dimensions, weights and measurements are provided in standard U.S. measure followed in parentheses by the metric conversion. Any torque values given are stated in inch or foot pounds followed by the Newton-meter equivalent in parentheses. Electrical characteristics are given in voltage-phase-hertz.

## RECEIPT & INSPECTION

Ensure adequate lifting equipment is available for unloading and moving the unit to the installation site.

**NOTE** Lifting equipment must be properly rated for the weight of the unit.

**CAUTION** Lift the unit by the shipping skid only. Do not use the motor lifting eye to lift the entire unit. The motor lifting eye is for removing the motor from the unit only.

**CAUTION!** Do not work on or walk under the unit while it is suspended.

*Use suitable lifting equipment (i.e. forklift) to lift and transport the unit to the installation site. Ensure the lifting equipment, straps, etc. are capable of supporting the weight of the unit.*



Before signing the delivery receipt, inspect for damage and missing parts. If damage or missing parts are apparent, make the appropriate notation on the delivery receipt, then sign the receipt. Immediately contact the carrier for an inspection.

All material must be held in the receiving location for the carrier's inspection.

Delivery receipts that have been signed without a notation of damage or missing parts are considered to be delivered "clear." Subsequent claims are then considered to be concealed damage claims. Settle damage claims directly with the transportation company.

If you discover damage after receiving the unit (concealed damage), the carrier must be notified within 15 days of receipt and an inspection must be requested by telephone with confirmation in writing. On concealed damage claims, the burden of establishing that the unit was damaged in transit reverts back to the claimant.

Read the unit nameplate to verify it is the model ordered, and read the motor nameplate to verify it is compatible with your electrical conditions. Make sure electrical enclosures and components are appropriate for the installation environment.

## INSTALLATION

### SELECTING A LOCATION

**ELECTRIC MOTOR UNITS.** For most electric motor units, select a relatively clean and dry well-lighted indoor area with plenty of space for proper ventilation, cooling air flow and accessibility. Provide 1,000 cubic feet of fresh air per 5 horsepower. Locate the unit at least 15 inches (38 cm) from walls, and make sure the main power supply is clearly identified and accessible.

Unless the electrical components of the unit are specially protected for outdoor use, do not install an electric motor unit outdoors or in an area that will expose the electrical components to rain, snow or sources of appreciable moisture.

#### WARNING FOR UNITS EQUIPPED WITH ELECTRIC DRAIN VALVE

**WARNING** The electric drain valve incorporates arcing or sparking parts, such as snap switches, receptacles and the like that tend to produce arcs or sparks and, therefore, when located in a garage, the compressor should be in a room or enclosure provided for the purpose, or the electric drain valve should be 18 inches (457 mm) or more above the floor.

**GASOLINE ENGINE UNITS.** For gasoline engine units, keep the engine at least 3 feet (1 m) away from building walls and other equipment. Install the unit in a location with plenty of space for proper ventilation, cooling air flow and accessibility. Do not install or operate a gasoline engine unit in a confined area.

**AMBIENT TEMPERATURE CONSIDERATIONS.** Ideal operating temperatures are between 32°F and 100°F (0°C and 37.8°C). If temperatures consistently drop below 32°F (0°C), install the compressor in a heated area. If this is not possible, you must protect safety/relief valves and drain valves from freezing. If temperatures are consistently below 40°F (4.4°C), consider installing an external crankcase heater kit, especially if the compressor has difficulty starting.

**CAUTION** Never operate the compressor in temperatures below -15°F (-26.1°C) or above 125°F (51.0°C).

**HUMID AREAS.** In frequently humid areas, moisture may form in the pump and produce sludge in the lubricant, causing running parts to wear out prematurely. Excessive moisture is especially likely to occur if the unit is located in an unheated area that is subject to large temperature changes.

Two signs of excessive humidity are external condensation on the pump when it cools down and a "milky" appearance in petroleum lubricant.

You may be able to prevent moisture from forming in the pump by increasing ventilation, operating for longer intervals or installing an external crankcase heater kit.

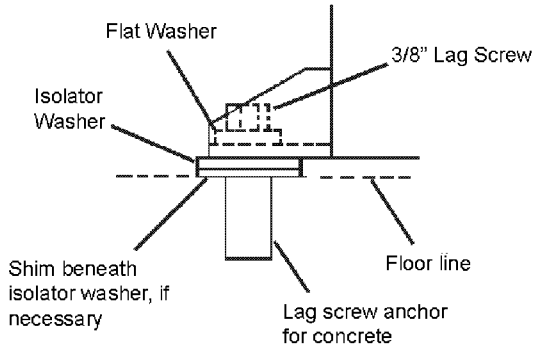
**NOISE CONSIDERATIONS.** Consult local officials for information regarding acceptable noise levels in your area. To reduce excessive noise, use vibration isolator pads (**except on Models 2000 and 2000P**) or intake silencers, relocate the unit or construct total enclosures or baffle walls.

### MOUNTING

**WARNING** Remove the unit from the skid before mounting.

**ELECTRIC MOTOR UNITS.** Bolt the unit to a firm, level foundation (such as a concrete floor). Do not bolt uneven feet tightly to the foundation, as this will cause excessive stress on the receiver tank. Use metal shims under the "short" feet if necessary. **DO NOT USE VIBRATION ISOLATOR PADS ON MODELS 2000 AND 2000P.**

### Typical Permanent Mounting (Customer Supplied Hardware)



**GASOLINE ENGINE UNITS.** Bolt the unit to a firm, level foundation. Do not bolt uneven feet tightly to the foundation, as this will cause excessive stress on the receiver tank. Use metal shims under the "short" feet if necessary. Gasoline engine units mounted on truck beds must be fastened securely without applying excessive stress on the receiver tank. We recommend installing a vibration isolator kit with gasoline engine models.

### INSTALLING REMOTE AIR INLET PIPING

**CAUTION** Do not operate the unit without air inlet filtration.

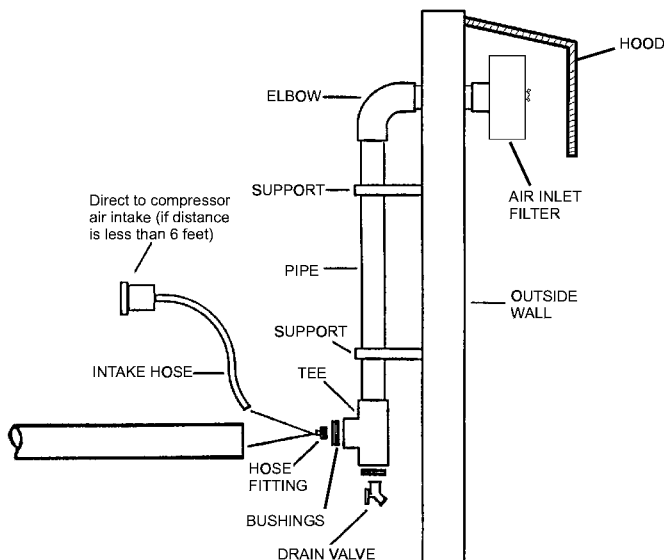
If the air around the unit is relatively free of dirt, install the air inlet filter at the inlet connection at the pump. If the air is dirty, pipe the filter to a source of clean air. Use PVC plastic tubes for remote inlet piping. Do not use black pipe or galvanized pipe, as these promote sweating and rust. Consider installing an in-line type filter for ease of cleaning and replacement. Make the line as short and direct as possible and as large, or larger, than the diameter of the inlet connection on the pump. Do not install piping with a diameter lower than that of the pump intake.

Increase the pipe diameter one size for every 10 feet (3 m) of length or every 90° bend. Make sure the piping is adequately braced.

If you pipe the filter outdoors, cover it with a hood to prevent the entrance of rain or snow.

Heavy duty filter elements and filtration equipment are available for fine airborne dust, such as cement and rock dust.

### Typical Remote Air Inlet Piping.



### INSTALLING DISCHARGE PIPING

**WARNING** Do not use plastic pipe, soldered copper fittings, rubber hose, or lead-tin soldered joints anywhere in the compressed air system.

**CAUTION!** If you will be using synthetic compressor lubricant, all downstream piping material and system components must be compatible. Refer to the following material compatibility list. If there are incompatible materials present in your system, or if there are materials not included in the list, contact Ingersoll-Rand for recommendations.

#### SYNTHETIC COMPRESSOR LUBRICANT MATERIAL COMPATIBILITY LIST

##### SUITABLE

Viton®, Teflon®, Epoxy (Glass Filled), Oil Resistant Alkyd, Fluorosilicone, Fluorocarbon, Polysulfide, 2-Component Urethane, Nylon, Delrin®, Celcon®, High Nitrile Rubber (Buna N. NBR more than 36% Acrylonitrile), Polyurethane, Polyethylene, Epichlorohydrin, Polyacrylate, Melamine, Polypropylene, Baked Phenolics, Epoxy, Modified Alkyds  
(® indicates trademark of DuPont Corporation)

##### NOT RECOMMENDED

Neoprene, Natural Rubber, SBR Rubber, Acrylic Paint, Lacquer, Varnish, Polystyrene, PVC, ABS, Polycarbonate, Cellulose Acetate, Low Nitrile Rubber (Buna N. NBR less than 36% Acrylonitrile), EPDM, Ethylene Vinyl Acetate, Latex, EPR, Acrylics, Phenoxy, Polysulfones, Styrene Acrylonitrile (San), Butyl

##### NOTE

All compressed air systems generate condensate which accumulates in any drain point (e.g. tanks, filters, drip legs, aftercoolers, dryers). This condensate contains lubricating oil and/or substances which may be regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

**GENERAL REQUIREMENTS.** The piping, fittings, air receiver tank, etc. must be certified safe for at least the maximum working pressure of the unit. Use hard-welded or threaded steel or copper pipes and cast iron fittings that are certified safe for the unit's discharge pressure and temperature. **DO NOT USE PVC PLASTIC IN THE COMPRESSED AIR DISCHARGE LINE.** Use pipe thread sealant on all threads, and make up joints tightly to prevent air leaks.

**CONDENSATE DISCHARGE PIPING.** If installing a condensate discharge line, the piping must be at least one size larger than the connection, as short and direct as possible, secured tightly and routed to a suitable drain point or waste container. Condensate must be disposed of in accordance with local, state, and federal laws and regulations.

**WARNING** If an aftercooler, check valve, block valve, or any other restriction is added to the compressor discharge, install a properly-sized ASME approved safety/relief valve between the compressor discharge and the restriction.

### INSTALLING ELECTRICAL WIRING (ELECTRIC MOTOR UNITS)

**WARNING** Electrical installation and service should be performed by a qualified electrician who is familiar with all applicable local, state and federal laws and regulations.

**GENERAL.** The motor rating, as shown on the motor nameplate, and the power supply must have compatible voltage, phase and hertz characteristics.

**WIRE SIZE.** The electrical wiring between the power supply and electric motor varies according to motor horsepower and other factors. Install adequately sized power leads to protect against



excessive voltage drop during start-up. Refer to the National Electric Code (NEC) for information on selecting the proper wire size and securing electrical connections. If you connect additional electrical equipment to the same circuit, consider the total electrical load when selecting the proper wire size. **DO NOT USE UNDERSIZE WIRE.**

If wire size information is not available, the wire sizes shown in the following wire selection chart can be used as a safe guide, if the distance does not exceed 50 feet (15.3 m). For longer distances, consult and electrical contractor or the local electric company for recommendations.

MOTOR HP	SINGLE PHASE		THREE PHASE			
	115V	230V	200V	230V	460V	575V
1	12	14	14	14	14	14
1.5	10	14	14	14	14	14
2	8	14	14	14	14	14
3	8	12	14	14	14	14
5	4	8	10	12	14	14
7.5		6	8	10	14	14
10			8	8	12	14
15			4	6	10	10
20			3	4	8	10
25			1	2	6	8
30			0	1	6	8

**MAGNETIC STARTER.** If the motor installed on your unit has a motor reset button, it does not require a magnetic starter. If the motor does not have this button and the unit does not have a factory-installed starter, install a magnetic starter with thermal overload protection. Follow the manufacturer's instructions for installation. Ingersoll-Rand cannot accept responsibility for damages arising from failure to provide adequate motor protection.

**FUSES.** Refer to the NEC to determine the proper fuse or circuit breaker rating required. When selecting fuses, remember the momentary starting current of an electric motor is greater than its full load current. Time-delay or "slow-blow" fuses are recommended.

**PRESSURE SWITCH.** On units without a factory-installed pressure switch, wire a pressure switch in accordance with the appropriate wiring schematic in the DIAGRAMS section of this manual. Mount the pressure switch in accordance with the manufacturer's recommendations. The connecting line to the receiver tank must be as short and direct as possible, and certified safe for at least the maximum working pressure of the unit.

## CONNECTING A BATTERY (GASOLINE ENGINE UNITS) \_\_\_\_\_

**NOTE** If you will be making connections to a remote battery, the engine on the compressor unit must be equipped with an alternator.

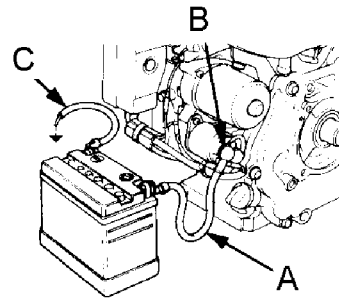
**BATTERY.** A 12 volt battery with a minimum current rating of 250 CCA (cold cranking amps) and minimum ampere-hour rating of 24 Ah should be sufficient for cranking most electric start engines.

**BATTERY CABLES.** Refer to the following table for size and length recommendations.

Cable Size (GA)	Maximum Length
6	5' (1.5 m.)
4	7'-2.5" (2.1 m.)
2	12' (3.6 m.)

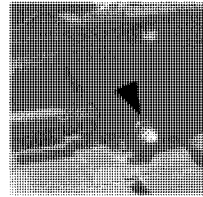
### CONNECTION PROCEDURES:

1. Connect the battery positive (+) cable (A) to the starter solenoid terminal (B).

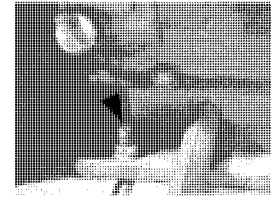


2. Connect the battery negative (-) cable (C) to the bolt shown in the following illustration. Secure the wire in place by screwing a suitably-sized nut onto the bolt and down onto the terminal.

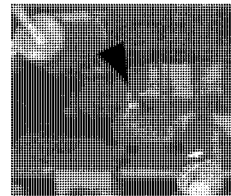
**Kohler**



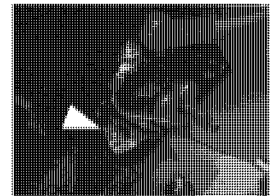
**Honda**



**Kawasaki**



**Ingersoll-Rand**



3. Connect the battery positive (+) cable (A) to the battery positive (+) terminal.
4. Connect the battery negative (-) cable to the battery negative (-) terminal.
5. Coat the terminals and cable ends with corrosion-preventive grease.

**⚠ WARNING** Remove the cable from the negative (-) side of the battery before servicing.

Refer to the engine manufacturer's instructions for more information.

## FUEL PUMP INSTALLATION (GASOLINE ENGINE UNITS) \_\_\_\_\_

Some engines use an optional fuel pump to supply gasoline to the engine directly from a vehicle's onboard fuel system. Install the fuel pump within 12 inches (30 cm) of the bottom surface of the vehicle's fuel tank. Protect the pump from contamination by installing a fuel isolation valve and an inline filter between the pump fuel system.

## COMPRESSOR LUBRICATION \_\_\_\_\_

**⚠ CAUTION** Do not operate without lubricant or with inadequate lubricant. Ingersoll-Rand is not responsible for compressor failure caused by inadequate lubrication.

**SYNTHETIC COMPRESSOR LUBRICANT.** Ingersoll-Rand recommends All Season T30 Select synthetic lubricant from start-up. See the WARRANTY section for extended warranty information.

**ALTERNATE LUBRICANTS.** You may use XL-300 or a comparable petroleum-based lubricant that is premium quality, does not contain detergents, contains only anti-rust, anti-oxidation, and anti-foam agents as additives, has a flashpoint of 440°F (227°C) or higher, and has an auto-ignition point of 650°F (343°C) or higher.

See the petroleum lubricant viscosity table below. The table is intended as a general guide only. Heavy duty operating conditions require heavier viscosities. Refer specific operating conditions to Ingersoll-Rand for recommendations.

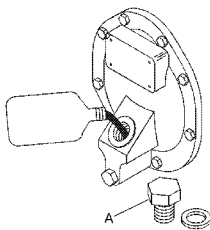
Temperature Around Compressor		Viscosity @ 100°F (37.8°C)		Viscosity Grade	
°F	°C	SUS	Centistokes	ISO	SAE
< 40	< 4.4	150	32	32	10
40-80	4.4-26.7	500	110	100	30
80-125*	26.7-51.0*	750	165	150	40

\* = For Models 2000 and 2000P, use Ingersoll-Rand XL-740HT Compressor Oil in temperatures above 100°F (37.7°C).

If you use a petroleum-based compressor lubricant at start-up and decide to convert to All Season T30 Select later on, the pump must be decarbonized and flushed before conversion. Contact Ingersoll-Rand for more information.

**FILLING PROCEDURES:**

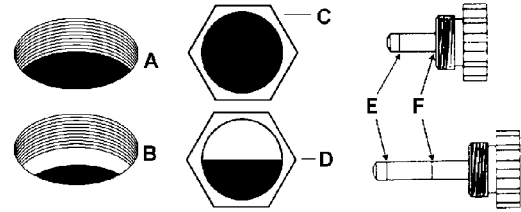
1. Unscrew and remove the oil fill plug.
  2. Fill the crankcase with lubricant.
  3. Replace the oil fill plug **HAND TIGHT ONLY**.
- △ **CAUTION** Do not remove the oil fill plug while the compressor is running.



Refer to the following table for crankcase capacity.

Model	Crankcase Capacity
2340	28 oz. (827 ml.)
2475	41 oz. (1212 ml.)
2545	73 oz. (2158 ml.)
7100	80 oz. (2365 ml.)
15T, 2000, 2000P	144 oz. (4258 ml.)

Use one of the following methods illustrated to determine when the crankcase is full.



**A = FULL level at bottom thread of oil fill opening on units without sight glass or dipstick.**

**B = ADD level below bottom thread of oil fill opening on units without sight glass or dipstick.**

**C = FULL level on units with sight glass.**

**D = ADD level on units with sight glass.**

**E = ADD level on units with dipstick.**

**F = FULL level on units with dipstick.**

**LOW OIL LEVEL SWITCH**

A float activated low oil level switch may be installed to protect your unit against damage due to insufficient compressor oil level. Low oil level in the compressor crankcase causes the switch contacts to open, thus shutting the unit down until the proper oil level has been restored.

Proper protection against low oil level depends on proper adjustment of the low oil level switch. During the initial run, stop the unit and drain one quart of oil from the compressor crankcase into a suitable clean container. Listen for the switch to click or check the switch with a continuity tester.

The float sometimes gets cocked or stuck during shipping. If the float is cocked or stuck, open the disconnect switch, drain the remaining oil, remove the crankcase cover and then free the float. Reassemble and then reuse the same oil.

**NOTE** If the float is cocked in the low position, the unit cannot start.

**OPERATION**

**INTERMITTENT DUTY FORMULA**

Units operating above 200 PSIG are to be operated according to the "Intermittent Duty Formula."

**INTERMITTENT DUTY FORMULA**

**Pump-up time should not ordinarily exceed thirty (30) minutes or be less than ten (10) minutes. Shutdown periods between cycles of operation should be at least equal to the pump-up time. Note: When the compressor is regulated by constant speed control, the shutdown period is the time the compressor is operating unloaded.**

A pump-up time limit with the following cool-down period is recommended to protect the valves and heads against stabilized high operating temperatures, which could rapidly build up carbon in these areas.

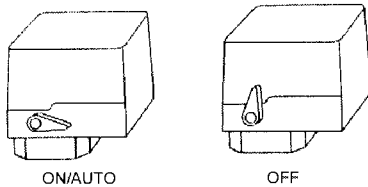
All inquiries for high-pressure compressor application where the "use" cycle differs from the "Intermittent Duty Formula" should be referred to Ingersoll-Rand.

**START-UP (ELECTRIC MOTOR DRIVEN MODELS)**

1. Close the service valve.

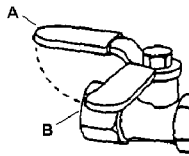
- Release any remaining tank pressure by slowly opening the manual drain valve.
- Close the manual drain valve and apply power to the compressor. If the pressure switch is equipped with an "ON/AUTO-OFF" lever, flip the switch to the "ON/AUTO" position. If the unit is equipped with a control panel "ON/OFF" switch, move the switch to the "ON" position.

#### Typical Pressure Switch Lever (If Equipped)



- Slowly open the service valve.

#### Typical Service Valve (A = Open, B = Closed)



**CAUTION** Unusual noise or vibration indicates a problem. Do not continue to operate until you identify and correct the source of the problem.

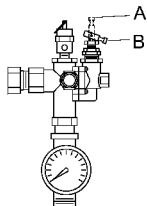
**NOTE** Ensure the direction of rotation is correct per the arrow on the motor. If the rotation is incorrect on three-phase units, interchange any two of the three leads.

### START-UP (GASOLINE ENGINE UNITS)

**WARNING** Do not operate gasoline engine units in an enclosed area.

- Release any remaining tank pressure by slowly opening the manual drain valve.
- Turn on the engine gasoline supply.
- Put the choke in the "on" position.
- Close the service valve and put the unloader lever in the "unload" (A) position for Kawasaki and Honda engine driven models, or the "load" (B) position for Kohler engine driven models.
- Start the engine, release the choke, and allow the engine to warm up for two to three minutes.
- Return the unloader lever to the "load" (B) position on Kawasaki and Honda engine driven models.

#### Typical Unloader (A = Unload, B = Load)



**NOTE** Turn the gasoline supply off when the compressor is not being used.

**NOTE** Some gasoline engine driven compressors require 5-8 break-in hours of operation before reaching full capacity and speed.

### COMPRESSOR CONTROLS

**AUTOMATIC START & STOP CONTROL.** This type of control applies to electric motor driven models under 10 horsepower.

**NOTE** Automatic Start & Stop Control is intended for use when the motor will start no more than 6 times per hour.

When the receiver tank pressure reaches the factory pre-set maximum pressure (usually 175 PSIG), the pressure switch stops the unit. When the receiver tank pressure drops below the factory pre-set minimum (usually 135 PSIG), the pressure switch resets and restarts the unit.

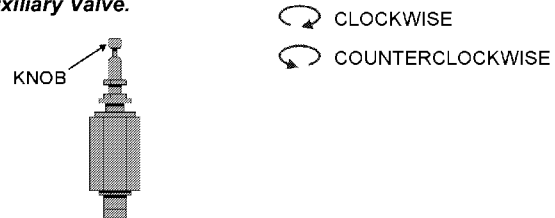
**CONSTANT SPEED CONTROL.** This type of control applies to gasoline engine units.

When the receiver tank pressure reaches the factory pre-set maximum pressure (usually 175 PSIG), the unloader slows down the engine and the unit stops pumping. When the receiver tank pressure drops to the factory pre-set minimum (usually 145 PSIG), the unloader resets, the engine returns to full speed, and the unit resumes pumping.

**DUAL CONTROL.** This type of control applies to electric motor units over 10 horsepower. Select either automatic start and stop control or constant speed control by adjusting the knob on the auxiliary valve. For automatic start and stop control, turn the knob on the auxiliary valve fully clockwise to disable the auxiliary valve. The pressure switch will then start and stop the unit.

**NOTE** For dual control models, automatic start and stop is preferred.

#### Auxiliary Valve.



Select constant speed control if the unit restarts in less than 10 minute intervals or runs more than 40 minutes per hour. Turn the knob fully counterclockwise to run the unit continually. When the receiver tank pressure reaches 170 PSIG, the unit runs but does not pump.

**NOTE** The auxiliary valve is factory pre-set at 5 PSIG lower than the factory pressure switch setting.

**CAUTION** Running unloaded for more than 20 minutes per hour or more than 15 minutes continually with the use of constant speed control will cause oil pumping and should be avoided.

### PRESSURE SWITCH ADJUSTMENT

**WARNING** High voltage is present at the pressure switch contacts when the power supply is connected. Disconnect, lock and tag main power supply before making adjustments.

**CAUTION** Do not adjust the pressure switch to exceed the maximum discharge pressure of the unit.

**NOTE** Adjust the pressure switch only if adjustments are absolutely necessary.

**CUT-IN & CUT-OUT.** The cut-out (compressor shut-down) is the pressure at which the switch contacts open, and the cut-in (compressor restart) is the pressure at which the switch contacts close. See COMPRESSOR CONTROLS.

**ADJUSTMENT CONTROLS.** All pressure switches have a range adjustment control (A). Some pressure switches also have a differential adjustment (B) control. On switches without a differential

adjustment control, the span between cut-in and cut-out pressure levels switches is factory set for  $40 \pm 4$  PSIG and cannot be adjusted.

**NOTE** Some pressure switches are equipped with an on-off lever used to open and close the electrical contacts inside the switch. **THIS LEVER IS NOT A DIFFERENTIAL ADJUSTMENT CONTROL.** The pressure switches with the on-off lever do not have a differential adjustment control.

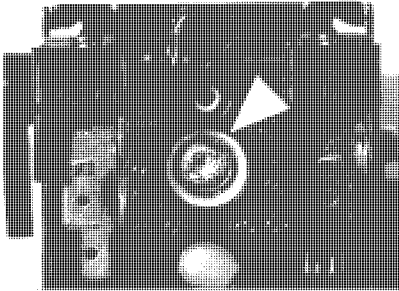
#### ADJUSTMENT PROCEDURES (SWITCHES WITHOUT DIFFERENTIAL ADJUSTMENT CONTROL):

1. Remove the pressure switch cover.
2. Adjust the range by turning the range adjustment screw clockwise (in) to increase the cut-out point or counter-clockwise (out) to decrease the cut-out point.

**NOTE:** One full turn changes the setting approximately 2 PSIG.

3. Replace cover, reconnect power supply and start the compressor.
4. Note the pressure gauge reading at which the compressor cuts out.
5. Repeat adjustment procedure if necessary.

#### *Pressure Switch Range Adjustment.*



#### ADJUSTMENT PROCEDURES (SWITCHES WITH DIFFERENTIAL ADJUSTMENT CONTROL):

1. Remove the pressure switch cover.
2. Set the cut-in pressure with the range adjustment nut. Turn the nut clockwise (in) to increase the pressure or counter-clockwise (out) to decrease the pressure.

**NOTE:** One full turn changes the setting approximately 2 PSIG.

3. Set the cut-out pressure with the differential adjustment. Turn the differential adjustment nut clockwise (in) to increase the pressure or counter-clockwise (out) to decrease the pressure.

**NOTE:** One full turn changes the setting approximately 2 PSIG.

4. Replace the cover, reconnect the power supply and start the unit.
5. Note the pressure gauge reading at which the unit cuts out.
6. Repeat the adjustment procedure if necessary.

The minimum possible differential is approximately 20% of cutout pressure. It is advisable to have as wide a differential as possible to avoid frequent starting and stopping of the unit. Note the pressure gauge reading at which the unit cuts-out and re-establish this point if necessary.

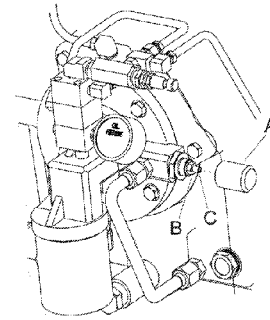
Note the interaction between the range and differential adjustments, i.e., if the cut-out is increased, the differential will also increase, or if the differential is narrowed, the cut-out will be reduced, etc. These factors must be considered when adjusting the switch and compensated for accordingly.

#### OIL PRESSURE ADJUSTMENT (MODEL 2000P)

For pressure lubricated compressors, the oil pressure should be checked upon start-up by observing the oil pressure gauge. The acceptable operating range is 15-40 psig. It is normal for the oil pressure to vary slightly with oil temperature. Compressors equipped with an optional low oil pressure shutdown system will automatically shut down if the oil pressure drops below 10 psig.

The oil pump is equipped with an adjustable pressure regulator which may be reset if conditions warrant. Refer to the following illustration and instructions:

1. Use an adjustable wrench to remove the knurled cover for the valve on the right side of the oil pump housing (A).
2. Loosen the retaining nut (B) with a 7/16" wrench such that the threaded rod (C) is free to rotate.
3. Using a 1/8" hex key, adjust the threaded rod to the desired setting. Turning the rod clockwise increases the oil pressure setting, and turning the rod counterclockwise decreases the oil pressure.
4. When the oil pressure is set, tighten the retaining nut and replace the knurled cover.



#### STARTING UNLOADING SYSTEM

The starting unloading feature exists on certain models. The purpose of the system is to relieve cylinder pressure when the unit stops, permitting it to start against a light load. A light load increases the life of the driver and belts and also reduces the possibility of tripping the overload relay. The system operates in the following manner:

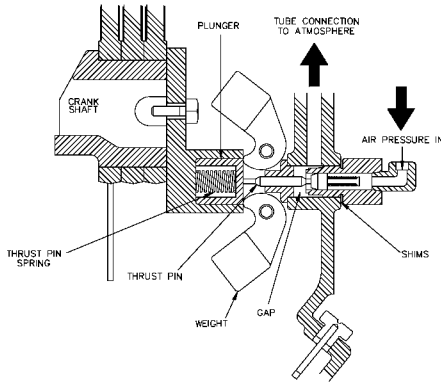
The centrifugal unloader is attached to the end of the crankshaft as shown in the following illustrations.

When the unit starts, centrifugal force acts upon the unloader weights and they swing outward. This permits the plunger and thrust pin to move inward and the pilot valve to close. The escape path to atmosphere for the cylinder pressure is now closed and the compressor pumps air in a normal manner.

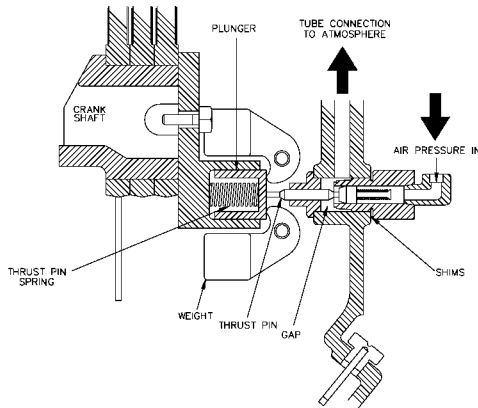
When the unit stops, the weights retract, permitting the thrust pin spring to move the plunger and thrust pin outward. The thrust pin opens the pilot valve and the trapped air pressure escapes from the cylinder and intercooler through a passage in the frame end cover, through the unloader tube and to atmosphere through the inlet filter/silencer.



### Position of weight and thrust pin when unit is operating.



### Position of weight and thrust pin when unit is stopped.

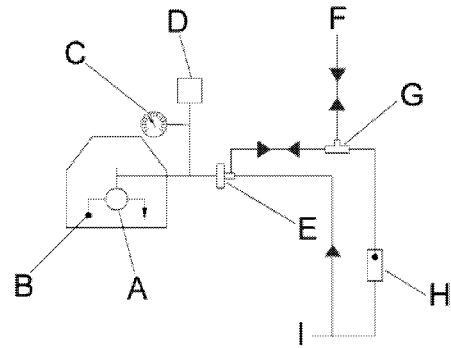


## STARTING UNLOADING SYSTEM (PRESSURE LUBRICATED MODELS)

Pressure lubricated compressors use a hydraulic unloader system to provide loadless starting. This system has the added feature of providing emergency unloading should oil pressure be lost during compressor operation.

The hydraulic unloader circuit bypasses the auxiliary valve (H) to direct control air to the head unloaders when oil pressure is lost. This circuit is controlled by the hydraulic unloader valve (E), a normally open valve that closes on rising oil pressure. During compressor operation, the oil pressure holds the hydraulic unloader valve closed. Head unloader actuation is controlled by the auxiliary valve.

When oil pressure is lost, either due to compressor shutdown or to a lubrication problem during compressor operation, the hydraulic unloader opens, actuating the head unloaders (F). This action will either vent the shut down compressor in preparation for the next start-up or release compression load to minimize damage if oil pressure is lost while the compressor is running.



A = Oil Pump

B = Oil Filter

C = Oil Pressure Gauge

D = Oil Pressure Switch

E = Hydraulic Unloader Valve

F = Head Unloaders

G = Shuttle Valve

H = Auxiliary Valve

## PILOT VALVE ADJUSTMENT

If the pilot valve tube line is excessively hot, it is a good indication that the pilot valve is leaking and adjustment is required.

To adjust the pilot valve, proceed as follows:

1. Stop the unit and disconnect and tag the electrical supply main switch to prevent accidental start-up.
2. Remove the pilot valve tube and the tube fittings.
3. Remove the pilot valve body and all existing shims.
4. Screw the pilot valve body back into the frame end cover (without any shims) until contact with the thrust pin is felt. Advance the pilot valve body 1/4 to 1/2 turn more.

If contact with the thrust pin cannot be felt, the following steps may be necessary to locate the contact point:

1. Insert a small instrument (punch, rod, nail, etc.) into the end of the pilot valve until it contacts the valve stem.
2. While still inserted in the pilot valve, make a mark on the instrument even with the outside edge of the pilot valve body.
3. Keeping the instrument pressed lightly against the valve stem, screw the pilot valve body into the frame end cover. When the mark on the instrument starts moving out away from the edge of the pilot valve body, contact has been made with the thrust pin.
4. Advance the pilot valve body 1/4 to 1/2 turn more and proceed with step five.
5. Measure the gap between the pilot valve body and the frame end cover.
6. Remove the pilot valve body and add enough shims to fill the gap measured in step five.
7. Screw the pilot valve body back into the frame end cover until the body is tight on the shims.
8. Reconnect the pilot valve tube and tube fittings.

## BREATHER/UNLOADER BY-PASS

The breather/unloader by-pass tube lines eliminates air pressure build-up in the compressor frame by providing a passage for the air to escape through the inlet unloader (if opened) or (if closed) through the check valve, therefore, by-passing the inlet unloader and escaping to atmosphere through the inlet filter/silencer.

## OIL CONSUMPTION CHECK

A rule of thumb in determining a "passing grade" for oil consumption is to consider consumption at or above 50 horsepower-hours per ounce to be acceptable.

The formula is as follows:

$$\frac{\text{Horsepower} \times \text{Hours of Operation}}{\text{Ounces of Oil Used}} = \text{Horsepower Hours per Ounce}$$

To apply this formula, consider the size of the machine. In the following example, a 5 horsepower compressor uses 2 ounces of oil every 20 hours of operation.

$$\frac{5 \text{ Horsepower} \times 20 \text{ Hours of Operation}}{2 \text{ Ounces of Oil Used}} = 50 \text{ Horsepower Hours per Ounce}$$

The compressor in the example passes the oil consumption test.

**NOTE** New or rebuilt compressor pumps will discharge higher than normal amounts of oil until the piston rings are seated (approximately 100 operating hours).

## MAINTENANCE

**△ WARNING** Before performing maintenance, release air pressure from the system and disconnect, lock and tag the main power supply or disconnect the wire from the engine spark plug.

**NOTE** All compressed air systems contain maintenance parts (e.g. lubricating oil, filters, separators) which are periodically replaced. These used parts may be, or may contain, substances that are regulated and must be disposed of in accordance with local, state, and federal laws and regulations.

**NOTE** Take note of the positions and locations of parts during disassembly to make reassembly easier. The assembly sequences and parts illustrated may differ for your particular unit.

**NOTE** Any service operations not explained in this manual should be performed by an authorized service representative.

**NOTE** Reference the engine owner's manual for engine care information.

**NOTE** The following maintenance schedule has been developed for typical applications. Maintenance intervals should be shortened in harsher environments.

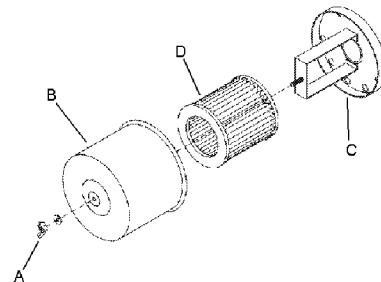
## MAINTENANCE SCHEDULE

Daily or Before Each Operation	<ul style="list-style-type: none"> <li>● Check for oil leaks.</li> <li>● Check lubricant level. Fill as needed.</li> <li>● Drain receiver tank condensate (if automatic draining device is not provided). Open manual drain valve and collect and dispose of condensate accordingly.</li> <li>● Check for unusual noise and vibration.</li> <li>● Ensure beltguards and covers are securely in place.</li> <li>● Ensure engine (if supplied) is filled with fuel and lubricant according to the manufacturer's recommendations.</li> <li>● Ensure area around compressor is free from rags, tools, debris, and flammable or explosive materials.</li> <li>● Check system oil pressure on pressure lubricated models while compressor is hot.</li> </ul>
Weekly	<ul style="list-style-type: none"> <li>● Observe operation of safety/relief valves while the compressor is running. Replace safety/relief valves that do not operate freely.</li> <li>● Inspect air filter element(s). Clean if necessary.</li> </ul>
Monthly	<ul style="list-style-type: none"> <li>● Inspect for air leaks. Squirt soapy water around joints during compressor operation and watch for bubbles.</li> <li>● Check tightness of screws and bolts. Tighten as needed.</li> <li>● Inspect drive belts. Adjust if necessary.</li> <li>● Clean exterior.</li> </ul>
3/500 *	<ul style="list-style-type: none"> <li>● Change petroleum lubricant while crankcase is warm.</li> </ul>
6/1000 *	<ul style="list-style-type: none"> <li>● Drain compressor oil and clean oil sight glass</li> <li>● Replace oil filter and change lubricant (if necessary) on pressure lubricated models.</li> </ul>
12/2000 *	<ul style="list-style-type: none"> <li>● Install maintenance pak — or —</li> <li>● Change synthetic lubricant while crankcase is warm.</li> <li>● Replace filter element.</li> </ul>

\* indicates months/operating hours, whichever occurs first.

## FILTER INSPECTION & CLEANING

1. Unscrew and remove the wing nut (A) securing the filter housing (B) to its base (C).
2. Remove the filter housing and withdraw the old filter element (D). Clean the element with a jet of air or vacuum.
3. Replace the filter element and housing, securing it in place with the wing nut previously removed.



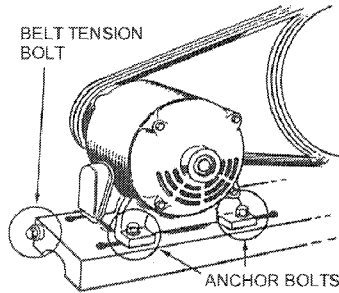
## OIL CHANGE

1. Remove the oil drain plug (A) and allow the lubricant to drain into a suitable container.
2. Replace the oil drain plug.
3. Follow the filling procedures in OPERATION section.

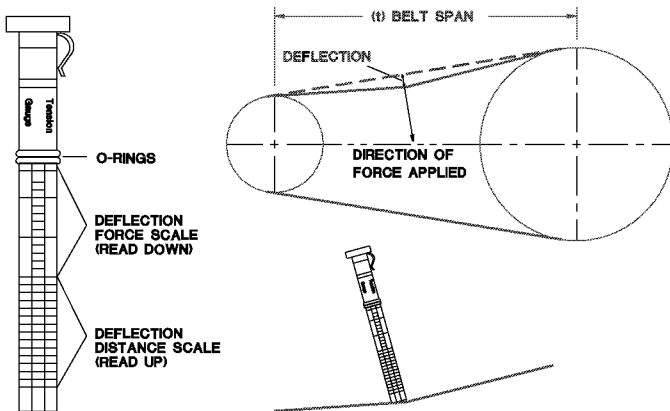
## BELT ADJUSTMENT

**CHECKING BELT TENSION.** Check belt tension should be occasionally, especially if looseness is suspected. New belts must also be properly tensioned upon installation.

**TENSIONING BELTS.** Belt tensioning can be achieved by loosening the motor or engine anchor screws, pushing the motor or engine away from the pump, and retightening the motor or engine anchor screws. Some units are equipped with a belt tensioning bolt that, when turned, pulls the motor or engine away from the pump. Otherwise, the motor can be easily moved by placing a prying tool beneath it. A commercially available spreader or other belt tensioning device can also be helpful.



Follow the procedures outlined below to correctly set and measure belt tension on electric motor and gas engine models including 2340, 2475, and 2545 (with "A" belt type only). Refer to the following illustration for a visual representation.



1. Lay a straight edge across the top outer surface of the belt drive from pulley to sheave.
2. At the center of the span, perpendicular to the belt, apply pressure to the outer surface of the belt with a tension gauge. Force the belt

to the deflection indicated in the BELT TENSION TABLE in the DIAGRAMS & TABLES section. Compare the reading on the tension gauge to the table.

Follow the procedures outlined below to correctly set and measure tension on 7.5 through 30 horsepower models 2545, 7100, 15T and 2000 with "B" and "C" belt types.

1. Measure the span length (t) of the drive.
2. Determine the amount of deflection (in inches) required to measure deflection force (in pounds) by multiplying the span length (t) by 1/64. For example, a 32" span length multiplied by 1/64 equals 1/2" of deflection required to measure deflection force.
3. Lay a straight edge across the top outer surface of the belt drive from pulley to sheave.
4. At the center of the span, perpendicular to the belt, apply pressure to the outer surface of the belt with a tension gauge. Force the belt to the predetermined deflection calculated in step 2. Compare the reading on the tension gauge to the BELT TENSION TABLE in the DIAGRAMS & TABLES section.

Ensure the pulley and sheave are properly aligned and the motor anchor screws are adequately retightened prior to restarting the compressor.

**⚠ CAUTION** Improper pulley/sheave alignment and belt tension can result in motor overload, excessive vibration, and premature belt and/or bearing failure.

To prevent these problems from occurring, ensure the pulley and sheave are aligned and belt tension is satisfactory after installing new belts or tensioning existing belts.

## TANK INSPECTION

The life of an air receiver tank is dependent upon several factors including, but not limited to, operating conditions, ambient environments, and the level of maintenance. The exact effect of these factors on tank life is difficult to predict; therefore, Ingersoll-Rand recommends that you schedule a certified tank inspection within the first five years of compressor service. To arrange a tank inspection, contact Ingersoll-Rand.

If the tank has not been inspected within the first 10 years of compressor service, the receiver must be taken out of service until it has passed inspection. Tanks that fail to meet requirements must be replaced.

**⚠ WARNING** Failure to replace a rusted air receiver tank could result in air receiver tank rupture or explosion, which could cause substantial property damage, severe personal injury, or death. Never modify or repair tank. Obtain replacement from service center.

## TROUBLESHOOTING

PROBLEM	CHECK POINT
Abnormal piston, ring or cylinder wear	4, 8, 9, 19, 28, 35
Air delivery drops off	1, 6, 15, 16, 18, 19, 29
Automatic drain valve leaks or does not drain automatically	16
Auxiliary valve chatters or leaks around stem	23, 24
Broken intercooler or aftercooler tubes	36
Compressor does not come up to speed	2, 6, 12, 15, 21
Compressor is slow to come up to speed	26, 27, 33, 34
Compressor runs excessively hot	3, 14, 15, 22
Compressor will not unload cycle	23, 24, 26
Compressor will not unload when stopped	26, 33
Excessive noise during operation	2, 6, 15, 16, 21, 27, 32
Excessive starting and stopping	5, 11, 16, 32, 40
Knocks or rattles	2, 15, 17, 19, 20, 21
Lights flicker or dim when running	12, 13
Moisture in crankcase or "milky" appearance in petroleum lubricant or rusting in cylinders	9, 10
Motor overload trips or draws excessive current	5, 6, 12, 13, 14, 15, 16, 19, 20, 21, 34
Oil in discharge air (oil pumping)	4, 7, 9, 18, 19, 25, 35
Oil leaking from shaft seal	25
Safety/relief valve "pops"	1, 5, 29, 30
High interstage pressure	30
Low interstage pressure	31
Engine cranks slowly or will not start	6, 14, 37, 38
Motor will not start	12
Engine will not start	39
Oil Leaks	41
Low Oil Pressure	42, 43, 44, 46
Excessive oil pressure fluctuations (> 5 psi)	42, 43, 44, 45, 46



CHECK POINT	POSSIBLE CAUSE	POSSIBLE SOLUTION
1	Clogged or dirty inlet and/or discharge line filter.	Clean or replace.
2	Loose beltwheel or motor pulley, excessive end play in motor shaft or loose drive belts.	Check beltwheel, motor pulley, crankshaft, drive belt tension and alignment. Repair or replace as required.
3	Inadequate ventilation around beltwheel.	Relocate compressor for better air flow.
4	Lubricant viscosity too low.	Drain existing lubricant and refill with proper lubricant.
5	Air leaks in air discharge piping.	Check tubing and connections. Tighten joints or replace as required.
6	Lubricant viscosity too high.	Drain existing lubricant and refill with proper lubricant.
7	Lubricant level too high.	Drain excess lubricant.
8	Lubricant level too low.	Add lubricant to crankcase to proper level.
9	Detergent type lubricant being used.	Drain existing lubricant and refill with proper lubricant.
10	Extremely light duty cycles.	Run compressor for longer duty cycles.
11	Compressor located in damp or humid location. Pressure switch differential too narrow.	Relocate compressor or install crankcase heater kit. Adjust pressure switch to increase differential, if differential adjustment is provided. Install pressure switch with differential adjustment feature if differential adjustment is desired.
12	Improper line voltage.  Wiring or electric service panel too small. Poor contact on motor terminals or starter connections. Improper starter overload heaters.	Check line voltage and upgrade lines as required. Contact electrician. Install properly sized wire or service box. Contact electrician. Ensure good contact on motor terminals or starter connections. Install proper starter overload heaters. Contact electrician.
13	Poor power regulation (unbalanced line).	Contact power company.
14	Drive belts too tight or misaligned.	Adjust belts to proper tension and alignment.
15	Compressor valves leaky, broken, carbonized or loose.	Inspect valves. Clean or replace as required. Install Valve/Gasket Step Saver Kit..
16	Automatic drain valve clogged, leaking or defective.	Inspect valve and clean, repair or replace as required.
17	Carbon build-up on top of piston(s).	Clean piston(s). Repair or replace as required.
18	Piston rings damaged or worn (broken, rough or scratched). Excessive end gap or side clearance. Piston rings not seated, are stuck in grooves or end gaps not staggered.	Install Ring/Gasket Step Saver Kit.  Adjust piston rings.
19	Cylinder(s) or piston(s) scratched, worn or scored.	Repair or replace as required.
20	Connecting rod, piston pin or crankpin bearings worn or scored. Loose bearing spacer on crankshaft.	Inspect all. Repair or replace as required. Install Bearing/Connecting Rod Step Saver Kit.
21	Defective ball bearings on crankshaft or motor shaft.	Inspect bearings and replace if required. Install Bearing/Connecting Rod Step Saver Kit.
22	Wrong beltwheel direction of rotation.	Check motor wiring for proper connections. Reverse two leads on three-phase motors.
23	Leaking, broken or worn inlet unloader parts.	Inspect parts and replace as required.
24	Auxiliary valve dirty or seats worn.	Inspect parts. Clean, adjust or replace as required.
25	Crankshaft seal worn or crankshaft scored.	Replace seal. Install shaft sleeve if required. Install Bearing/Connecting Rod Step Saver Kit.
26	Leaking or maladjusted centrifugal pilot valve.	Replace pilot valve o-ring. Adjust pilot valve.
27	Leaking check valve or check valve seat blown out.	Replace check valve.
28	Extremely dusty atmosphere.	Install remote air inlet piping and route to source of cleaner air. Install more effective filtration.
29	Defective safety/relief valve.	Replace.
30	High pressure inlet valve leaking.	Inspect, clean or repair as required.
31	Low pressure discharge valve leaking.	Inspect, clean or repair as required.
32	Automatic start and stop mode is not suitable for air demand.	Adjust auxiliary valve for constant speed operation.
33	Pressure switch unloader leaks or does not work.	Realign stem or replace.
34	Ambient temperature too low.	Install crankcase heater kit. Convert to All Season T30 Select lubricant. Relocate compressor to warmer environment.
35	Worn cylinder finish.	Deglaze cylinder with 180 grit flex-hone.
36	Beltwheel out of balance, tubes not braced or secured, wrong pulley speed.	Check vibration level, change pulley or beltwheel if required, tighten tube clamps.
37	Engine not grounded properly.	Ground battery to engine as recommended.
38	Gasoline exceeds storage time or contains water.	Replace gas, add fuel stabilizer.
39	No fuel in tank. Fuel valve closed. Low oil pressure.	See manufacturer's instructions for refueling. Open fuel valve. See manufacturer's instructions.
40	Excessive condensate in receiver tank.	Drain receiver tank with manual drain valve or install automatic drain valve.
41	Loose fittings/elbows/connectors	Re-torque fittings per specified torque requirements
42	Maladjusted or defective oil pressure regulator valve	Adjust valve to proper setting Replace regulator valve
43	Maladjusted or defective hydraulic unloader valve	Replace hydraulic unloader valve assembly
44	Defective oil pressure gauge	Replace gauge
45	Oil foaming in crankcase	Drain existing lubricant, thoroughly clean crankcase, replace lubricant
46	Debris or other obstruction blocking oil flow	inspect/clean all oil passages

## DIAGRAMS & TABLES

### FASTENER TORQUE TABLE

	2340	2475	2545	7100	2000 & 2000P
High Pressure Head Bolts	75	75	75	75	120
Low Pressure Head Bolts	75	75	75	75	120
Cylinder Flange Bolts	30	50	50	50	50
Frame Cover Bolts	17	17	17	20	20
Shaft Cover Bolts	17	17	17	20	50
Crankpin Cap Screws	5.5	11	11	12-15	—
Unloader Cover Screws	—	—	11	11	—
High Pressure Inlet Valve Screws	11-15 LB-IN	11-15 LB-IN	11-15 LB-IN	5.5	36 LB-IN
Low Pressure Inlet Valve Screws	11-15 LB-IN	25-30 LB-IN	25-30 LB-IN	5.5	36 LB-IN
High Pressure Outlet Valve Screws	11-15 LB-IN	11-15 LB-IN	11-15 LB-IN	26	36 LB-IN
Low Pressure Outlet Valve Screws	25-30 LB-IN	25-30 LB-IN	25-30 LB-IN	26	36 LB-IN
Beltwheel Bolt	33	60	60	113	80
High Pressure Head Center Bolts	—	—	10	—	—
Low Pressure Head Center Bolts	—	—	14-16	—	—
Unloader Guide Mounting Screw	—	—	—	—	25
Low Oil Level Switch Baffle Screw	—	—	—	—	5
Head Center Acorn Nuts	—	—	—	—	7
Pilot Valve	—	—	—	—	25
Unloader Body Assembly	—	—	—	—	25
Bearing/Unloader Housing Bolts	—	—	—	—	25
Valve Plate Studs	—	—	—	—	7

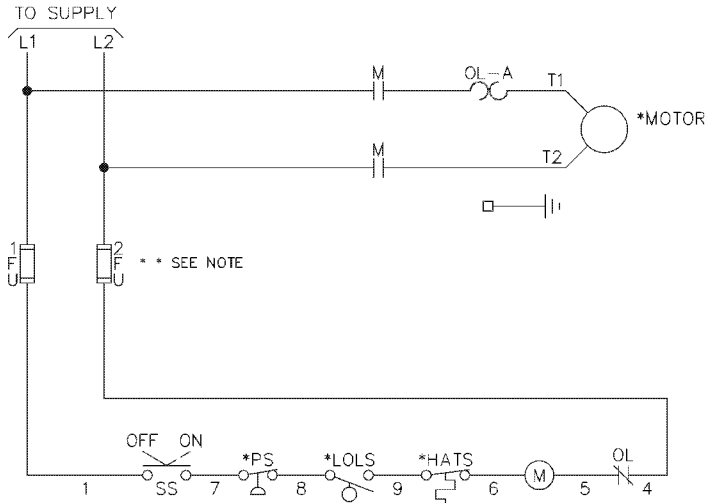
**NOTE** Tighten all fasteners evenly using a cross pattern in two stages.

### BELT TENSION TABLE

MODEL	DEFLECTION (IN.)	TENSION (LB.)	BELT TYPE	HORSEPOWER	TENSION AT 1/64" DEFLECTION PER INCH OF SPAN
2340 (14" Span)	0.25	4.9 - 7.1			
2340 (19" Span)	0.29	4.9 - 7.1	B	7.5	7.0 - 10.0
2475 (14" Span)	0.25	4.9 - 7.1		10-15	8.0 - 12.0
2475 (19" Span)	0.29	4.9 - 7.1	C	20	12.0 - 18.0
2475F/X11GH	0.34	5.5 - 8.0		25-30	14.0 - 21.0
2475F/X9/11GK	0.25	11.25 - 13.0	5V	25-30	
2475N5 (14.5" Span, Cogged belt)	0.23	4.5 - 6.5			
2545 (A Groove)	0.29	4.9 - 7.1			

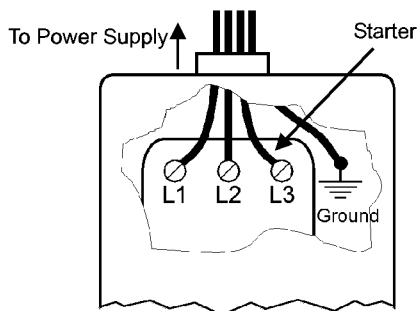
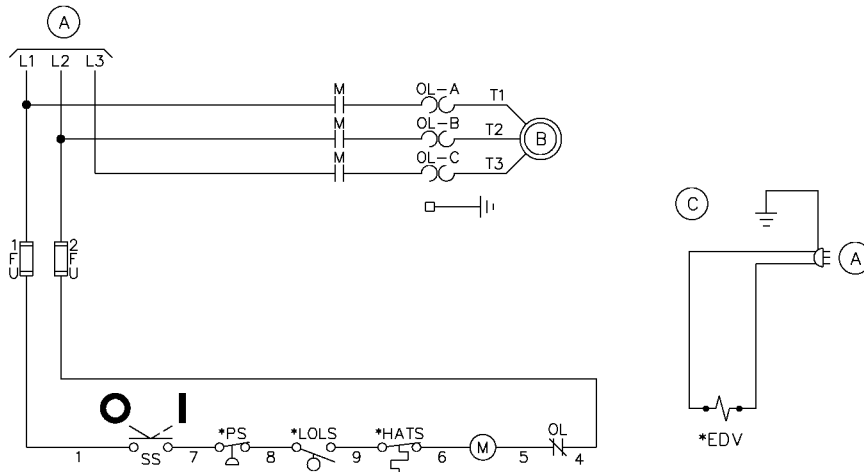
**ELECTRICAL WIRING DIAGRAMS**

Single Phase Wiring



A	To supply
C	Wiring for optional electric drain valve
EDV	Electric drain valve
T	Supply Line Terminal
L	Load Terminal
FU	Control Circuit Fuse
HATS	High Air Temperature Switch (#)
LOLS	Low Oil Level Switch (#)
M	Motor Starter Coil
OL	Motor Starter Overload
PS	Pressure Switch
SS	Selector Switch (#)
*	Alternate wiring for converting 3 phase starter to 1 phase application
(#)	= if provided

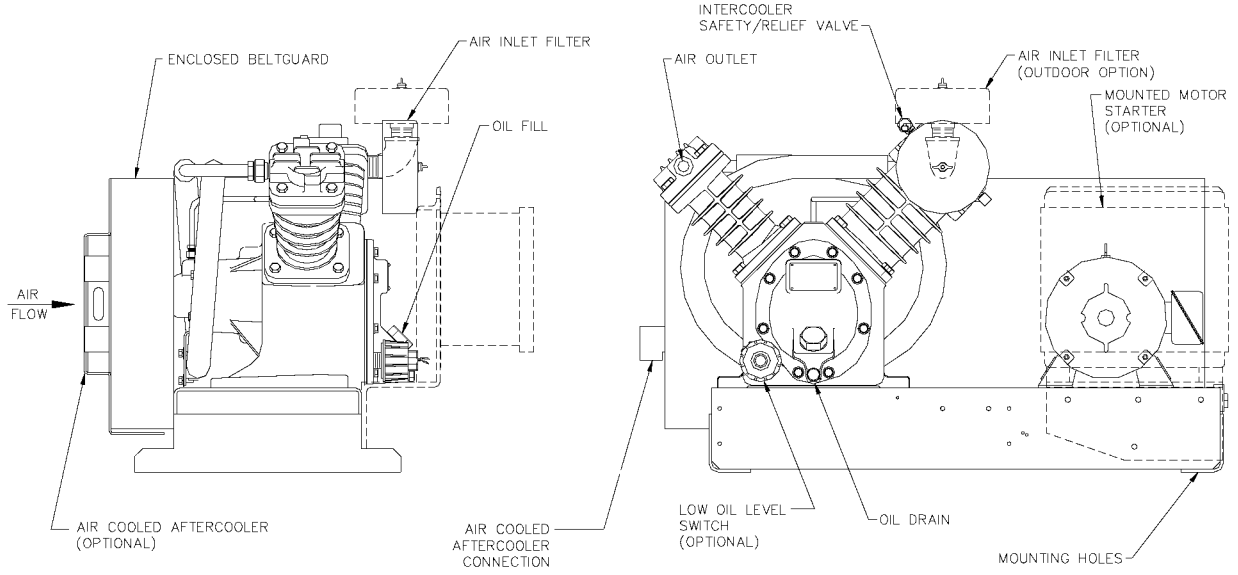
Three Phase Wiring



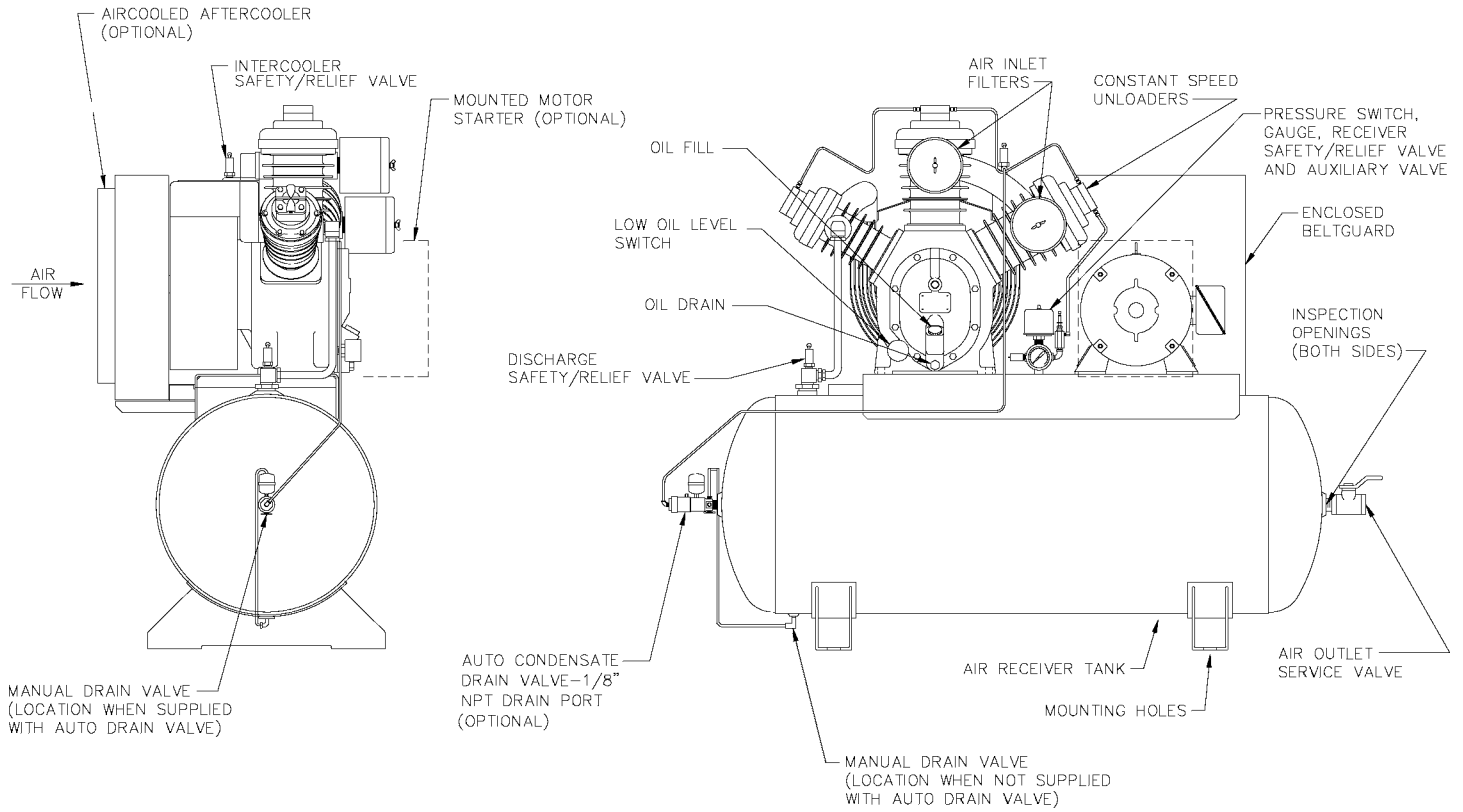
**NOTE** On units requiring a starter, connect line power to the starter. do not connect line power to the pressure switch.

- Connect ground wire to ground lug
- L3 used for 3-phase motors & starters only

**Typical Baseplate Unit**



**Typical Horizontal Simplex Unit**







## WARRANTY

Ingersoll-Rand Company warrants that the Equipment manufactured by it and delivered hereunder shall be free of defects in material and workmanship for a period of twelve (12) months from the date of placing the Equipment in operation or eighteen (18) months from the date of shipment, whichever shall occur first. The foregoing warranty period shall apply to all Equipment, except for the following: (A) Compressors that are operated solely on All Season T30 Select synthetic compressor lubricant will have their bare compressor warranted for the earlier of twenty-four (24) months from the date of initial operation or thirty (30) months from the date of shipment. (B) Replacement parts will be warranted for six (6) months from the date of shipment. Should any failure to conform to this Warranty be reported in writing to the Company within said period, the Company shall, at its option, correct such nonconformity by suitable repair to such Equipment, or furnish a replacement part F.O.B. point of shipment, provided the purchaser has installed, maintained and operated such equipment in accordance with good industry practices and has complied with specific recommendations of the Company. Accessories or equipment furnished by the Company, but manufactured by others, shall carry whatever warranty the manufacturer conveyed to Ingersoll-Rand Company and which can be passed on to the Purchaser. The Company shall not be liable for any repairs, replacements, or adjustments to the Equipment or any costs of labor performed by the Purchaser without the Company's prior written approval.

The Company makes no performance warranty unless specifically stated within its proposal and the effects of corrosion, erosion and normal wear and tear are specifically excluded from the Company's Warranty. In the event performance warranties are expressly included, the Company's obligation shall be to correct in the manner and for the period of time provided above.

THE COMPANY MAKES NO OTHER WARRANTY OF REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

Correction by the Company of nonconformities, whether patent or latent, in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the Company and its Distributors for such nonconformities with respect to or arising out of such Equipment.

## LIMITATION OF LIABILITY

THE REMEDIES OF THE PURCHASER SET FORTH HEREIN ARE EXCLUSIVE, AND THE TOTAL LIABILITY OF THE COMPANY, ITS DISTRIBUTORS AND SUPPLIERS WITH RESPECT TO CONTRACT OR THE EQUIPMENT AND SERVICES FURNISHED, IN CONNECTION WITH THE PERFORMANCE OR BREACH THEREOF, OR FROM THE MANUFACTURE, SALE, DELIVERY, INSTALLATION, REPAIR OR TECHNICAL DIRECTION COVERED BY OR FURNISHED UNDER CONTRACT, WHETHER BASED ON CONTRACT, WARRANTY, NEGLIGENCE, INDEMNITY, STRICT LIABILITY OR OTHERWISE SHALL NOT EXCEED THE PURCHASE PRICE OF THE UNIT OF EQUIPMENT UPON WHICH SUCH LIABILITY IS BASED.

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**Questions? Parts? Service?**

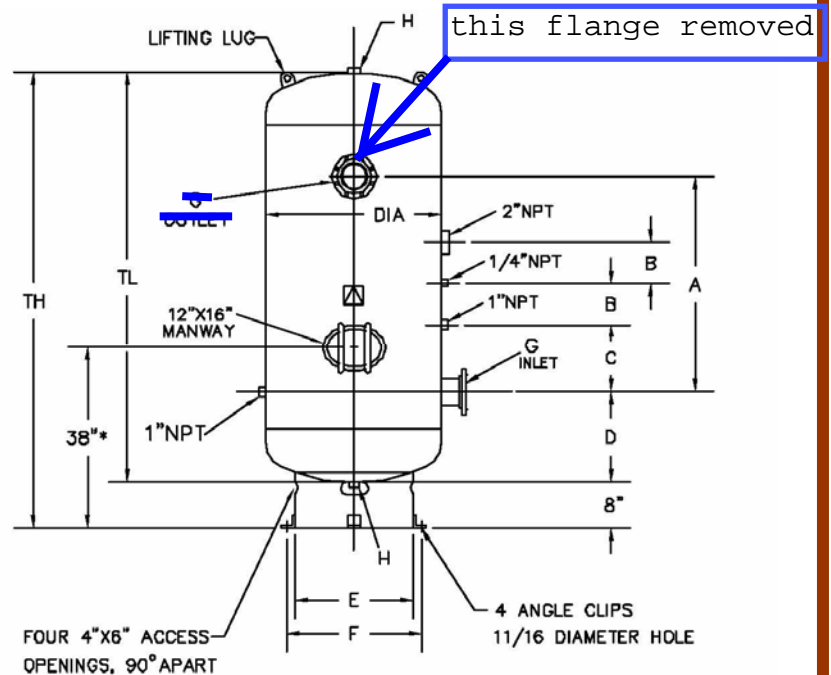
**1-800 AIR SERV**

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# Large Vertical Industrial Air Receivers 660 - 5000 Gallons



**Description:** Large Vertical Industrial Air Receiver

**Specifications:** Built to ASME Code Section VIII  
National Board Registered  
Carbon Steel  
Basing Support

PART #	PRESSURE (PSI)	DESCRIPTION				DIMENSIONS (INCHES)						OPENINGS		WT (LBS)
		GAL	DIA	TL	TH	A	B	C	D	E	F	G	H	
A21642117150	200	660	42	117	125	77	16	26	20	33	36	3 FLG	3/4 NPT	1397
A21648144150	165	1060	48	144	152	96	16	26	24	39	42	6 FLG	3/4 NPT	2110
A21654166150	165	1550	54	166	174	114	16	26	26	39	42	6 FLG	3/4 NPT	2815
A21660190150	165	2200	60	190	198	136	16	26	26	45	48 1/2	6 FLG	3/4 NPT	3740
A21660220150	165	2560	60	220	228	168	16	26	26	45	48 1/2	6 FLG	3/4 NPT	4243
A21666214150	150	3000	66	214	222	158	16	26	28	49	52 1/2	6 FLG	3/4 NPT	6492
A21672228150	150	3800	72	228	236	168	16	26	30	55	59 3/8	6 FLG	3/4 NPT	6996
A21684229150	150	5000	84	229	237	168	16	26	30 1/2	67	70 1/2	6 FLG	3/4 NPT	7642

- **Type 1279 Duragauge® pressure gauge (4½" dial size only)**
- **Standard stainless steel rotary geared movement with Teflon coated gears and bearings**
- **Easily adjustable, self-locking micrometer pointer**
- **100 standard psi and metric ranges, five standard systems**

The solid-front Ashcroft® phenolic case gauge is truly an industry first. Offered in 4½" size only, weather-proof, hermetically sealed or liquid-filled versions. The weatherproof gauge is easily field converted to a hermetically sealed or liquid-filled gauge with a special kit. The kit is described on page 166. Molded threads at the front and rear of the case provide axial seals with the use of threaded rings. The ring is glass-filled polypropylene. In the weather-proof version, the pressure relief back is polypropylene, fastened with stainless steel screws.



**BOURDON SYSTEM SELECTION**

Ordering Code	Bourdon Tube & Tip Material <sup>(1)</sup> (all joints TIG welded except "A") <sup>(1)</sup>	Socket Material	Tube Type	Range Selection Limits (psi)	NPT Conn. <sup>(2)</sup>
A	Grade A Phosphor Bronze Tube-Brass Tip, Silver Brazed	Brass	C-Tube	12/1000	½
B	4130 alloy steel	1019 steel	C-Tube	15/1500	½
			Helical	2000/5000	½
R	316 stainless steel	1019 steel	C-Tube	12/1500	½
			Helical	2000/20,000	½
S	316 stainless steel	316 stainless steel	C-Tube	12/1500	½
			Helical	2000/20,000	½
P <sup>(3)</sup>	K Monel	Monel 400	C-Tube	15/1500	½
			Helical	2000/30,000	½ <sup>(4)</sup>

(1) For selection of the correct bourdon system material, see the media application table on page 172.  
 (2) Optional connections available: ¼ NPT where ½ NPT is standard.  
 (3) Use for applications where NACE standard MR-01-75 is specified.  
 (4) 30,000 psi range supplied with ¼ high pressure connection, ½ NPT optional.

**STANDARD RANGES**

Pressure psi	Compound psi
0/15	30" Hg/15 psi
0/30	30" Hg/30 psi
0/60	30" Hg/60 psi
0/100	30" Hg/100 psi
0/160	30" Hg/150 psi
<b>0/200</b>	30" Hg/300 psi
0/300	
0/400	
0/600	
0/800	
0/1000	
0/1500	
0/2000	
0/3000	
0/5000	
0/10,000	
0/20,000	
0/30,000	

**NOTE:**  
Equivalent standard kg/cm<sup>2</sup>, and kPa metric ranges are available.

45-1279AS 02L 0/200 PSI

**TO ORDER THIS 1279 DURAGAUGE:**

Select: 45 1279 RS\* 04L XXX 0/2000 psi

- Dial size—4½" \_\_\_\_\_
- Case type—1279 \_\_\_\_\_  
Ring—threaded reinforced polypropylene
- Bourdon system selection ordering code \_\_\_\_\_
- Connection—¼ NPT (02), ½ NPT (04), Lower (L), Back (B) \_\_\_\_\_
- Optional features—see page 98 \_\_\_\_\_
- Standard pressure range \_\_\_\_\_
- Accessories—see pages 162-169 \_\_\_\_\_

(\*) "S" denotes solid front case design



# DRAIN TRAPS

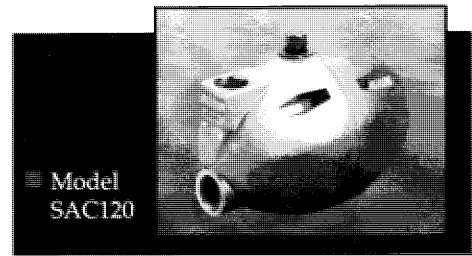
## The IPAC Advantage

In any compressed air system, condensate and oil which accumulates in separators, receiver tanks and filters must be removed to prevent it from entering compressed air lines. The removal of this contaminant ensures efficient operation of all pneumatic equipment. IPAC Drain Traps are designed and built to provide continuous and reliable operation with minimum maintenance.

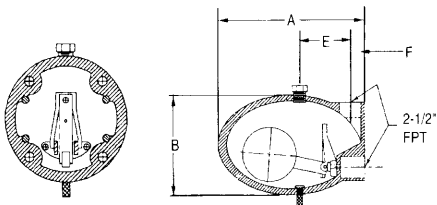
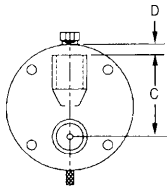
## Automatic Drain Traps

Designed for the special requirements of compressed air systems, IPAC Automatic Drain Traps use the float/lever principle as a fail-safe method to prevent air loss. The float lever action provides a high closing pressure against the valve seat, while providing a positive opening when the float reaches the discharge level. Condensate is discharged horizontally, preventing the build-up of solid particles on the valve.

### Model SAC120\*



- Die cast aluminum body
- 230 PSIG
- 1/2 " NPT
- 1.9 lbs.



CONDENSATE DISCHARGE CAPACITIES - GALLONS/HR.

Working Pressure (PSI)	25	50	75	100	125	150	175	200	230
<b>SAC120</b>	63	89	112	128	142	156	170	180	190

DIMENSIONAL DATA

Model	(Inches)					
	A	B	C	D	E	F
<b>SAC120</b>	6.1	4.1	2.7	.34	2.0	.34

For further information, please contact:

**In the USA**  
 IPAC, Inc.  
 2107 Liberty Drive  
 Niagara Falls, NY 14304  
 Phone (716) 283-6464  
 Fax (716) 283-1911

**In Canada**  
 IPAC, Inc.  
 2180 Dunwin Drive, Unit 7  
 Mississauga, Ontario L5L 1C7  
 Phone (905) 828-5530  
 Fax (905) 828-5018 or  
 1-800-387-1930



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---

## SAC120BAVO Drain Trap Installation & Maintenance Instructions

The SAC120BAVO is designed for the draining of unwanted accumulations of condensation from any collection point in a compressed air system.

### INSTALLATION

Caution: Compressed air can be dangerous. Before attempting to install the drain, be certain that the pressure vessel on which the drain will be installed is completely depressurized.

The drain should not be installed in areas that are exposed to freezing temperatures. Be certain that the air system pressure does not exceed the 250 PSI working pressure of the drain. The inlet temperature should not exceed 180° F.

Connecting the drain to the air system should be done by using one of the recommended installation diagrams shown herein.

Install the drain as close to the source to be drained as possible. The drain trap must always be installed lower than the bottom of the vessel to be drained. If the trap is not installed below the vessel, the level of liquid in the vessel will be at the same level of liquid as the connecting drain pipe. If flexible tubing is used on the discharge, be certain it is properly fastened to prevent it from whipping when the drain discharges the condensation.

The SAC120 will accept condensation through the 1/2" NPT inlet port which is located on the tip of the drain. In order to insure that condensate will enter the drain, an external vent line should be installed. The vent line allows the air that is contained in the drain to escape as the water enters. The vent line should be installed down stream from the vessel that is being drained or directly to the vessel (shown). This will insure that the air in the reservoir will properly exit as the condensation fills the drain and replaces the air. The vent line should be installed in the 1/4" inlet located on top of the drain. Though not shown, the use of shut-off valves, unions and by-pass valves is recommended.

The SAC120 comes with a connecting nipple with an internal balancing tube that will allow the drain to be installed directly to the bottom of the vessel that is to be drained. However, in order for this to work, the nipple has to be installed directly to the vessel without any additional piping. This will generally eliminate the need for an external vent line as stated above.

A manual valve is located on the bottom of the drain for depressurizing the vessel. Turn clockwise to open.

The SAC120 may be used to automatically bleed entrapped air pockets from enclosed water circulation systems. Simply invert the SAC120 and install it upside-down on the highest point. It will allow the system to fill and, will automatically close when the water lifts the internal float.

IPAC, INC.  
2107 Liberty Drive  
Niagara Falls, New York 14304  
Telephone (716) 283 6464  
Fax (716) 283 1911

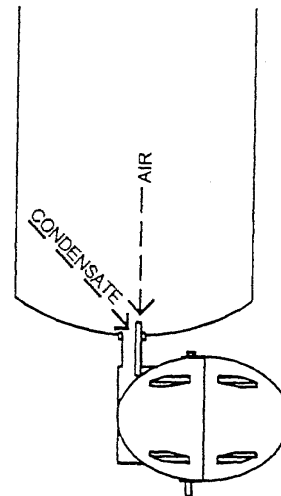
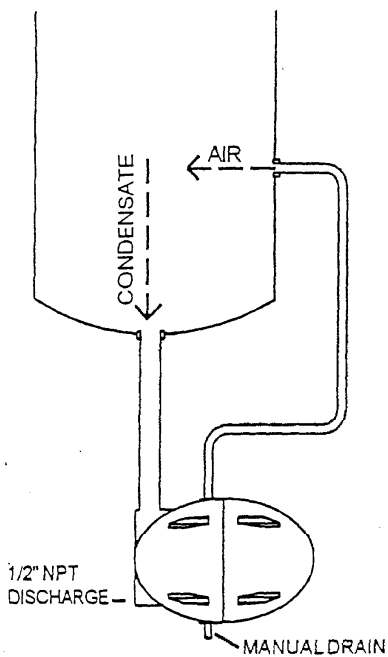
### Maintenance

During the first few days of installation, it is probable that any rust or dirt in the system will enter the drain trap and could impair its efficiency. It is recommended that the trap is opened and cleaned after several days of operation. Usually, once a year maintenance is sufficient due to the exclusive manual drain valve which should be opened weekly to check proper operation and to urge the trap of condensate, dirt and rust.

When the manual valve is opened, the trap should discharge about a 1/2 pint of condensate. If the quantity is significantly more, the trap is not functioning properly and should be disassembled and cleaned.

Note: the automatic discharge valve seat is made of oil resistant rubber and is reversible. By simply inverting the seat and its support plate, the useful life of the valve seat is increased by 100%.

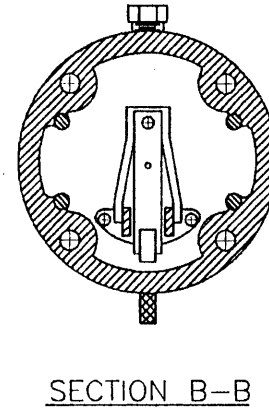
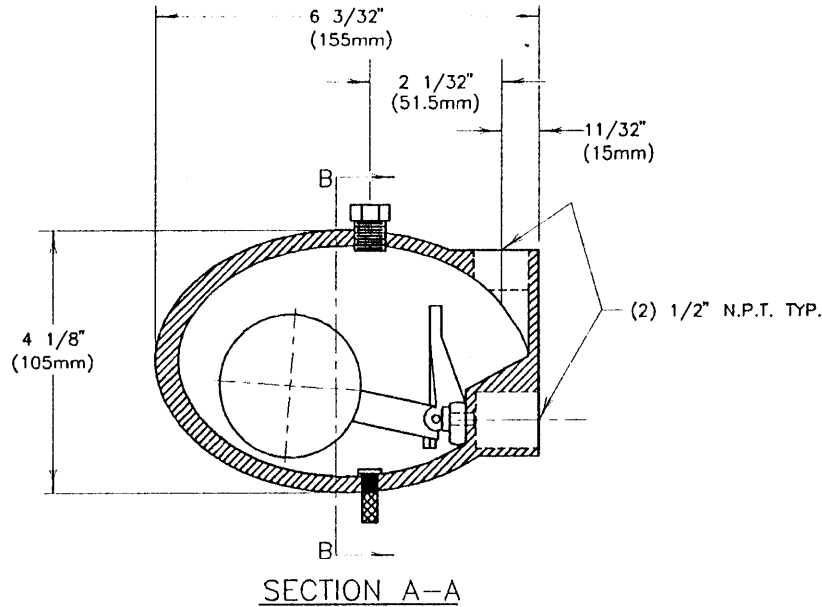
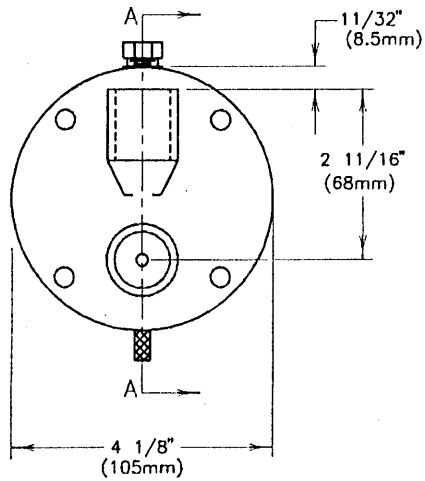
### Installation Diagrams



AUTOMATIC AIR VENT FOR CLOSED LOOP WATER SYSTEMS

IPAC, INC.  
2107 Liberty Drive  
Niagara Falls, New York 14304  
Telephone (716) 283 6464  
Fax (716) 283 1911

REV	REVISION DESCRIPTION	BY	DATE
E	REFORMATTED FOR CAD	JML	10/30/96

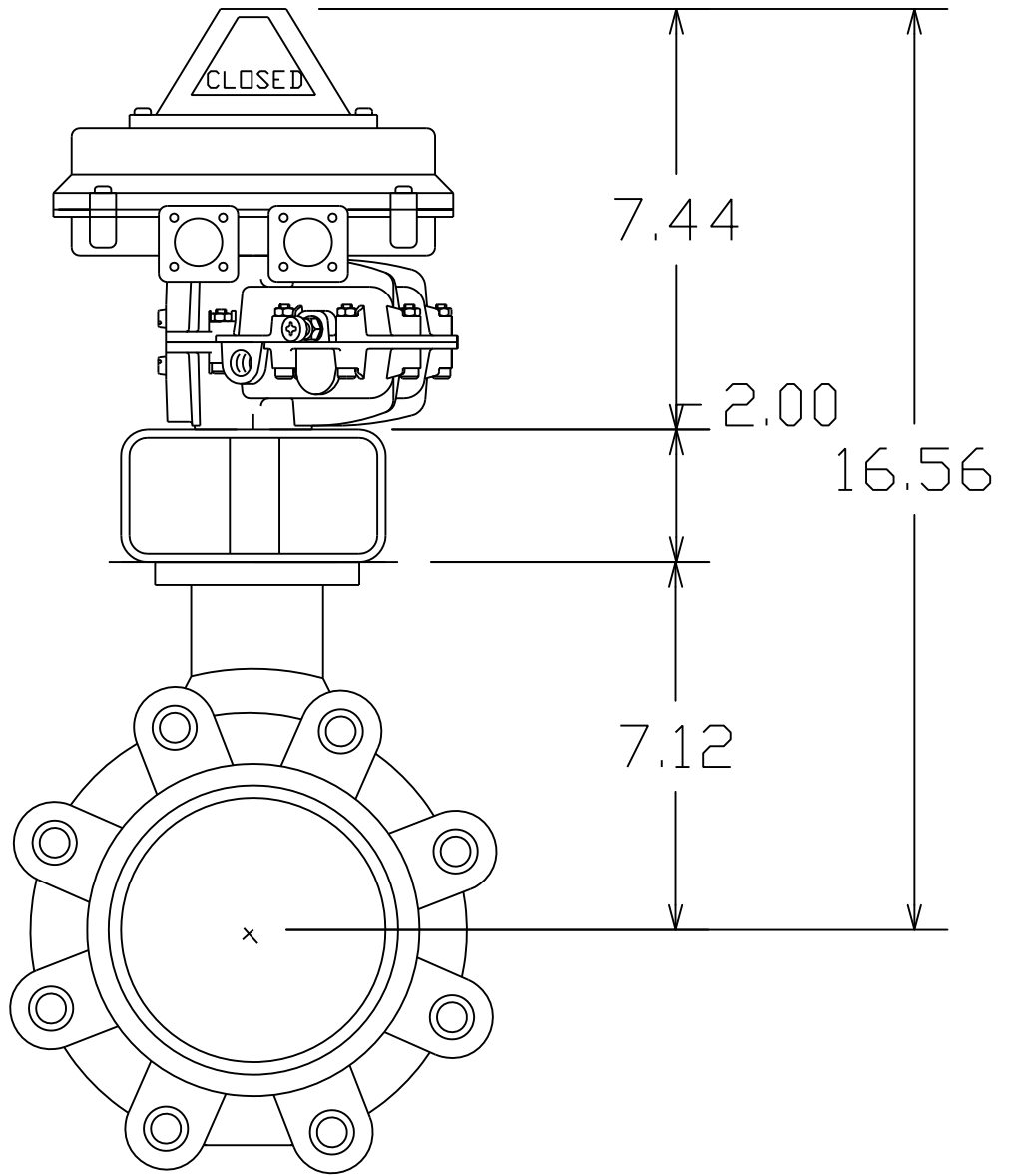


**NOTES:**

1. BODY MATERIAL TO BE ALUMINUM
2. MAXIMUM TEMPERATURE RATING OF 155°F
3. MAXIMUM WORKING PRESSURE OF 250 PSIG
4. COUNTRY OF ORIGIN TO BE CAST INTO HOUSING

ITEM	QUANTITY	PART DESCRIPTION	PART NUMBER	MATERIAL
THIS DRAWING AND INFORMATION IT CONTAINS IS THE PROPERTY OF IPAC, INC. THIS DRAWING IS NOT TO BE COPIED, REPRODUCED OR DISCLOSED WITHOUT THE WRITTEN APPROVAL OF IPAC, INC.		<p align="center"><b>IPAC</b> INC. NIAGARA FALLS, NY 14304</p>		
DO NOT SCALE DRAWING—TOLERANCE ON DIMENSIONS UNLESS OTHERWISE SPECIFIED IS FRACTIONAL ±1/32 DECIMAL ±.010		SCALE: NTS	NAME: CAU	CHK: -
			DATE: 11/12/93	DATE: -
CAD REFERENCE CODE		MODEL	TITLE	DRAWING NUMBER
09980101		SAC 120	1/2" DRAIN TRAP	B-0998-101
				REV. E





					<b>XXX .</b> BY KING MECHANICAL SPECIALTY FOR HENDRICK SCREEN CO PD HS		4" DEMCO KINETROL 077-104 PROJ. NO.					
					PRODUCT AIRBURST PANEL MADE 7/18/2011 DWE\KMS CHKD **/**/**** SY APPD **/**/**** SY		UNITS INCHES ASLY.DWG SCALE SIZE PAGE NO. DWG. NO.		4" backwash valve a REV.			
REV.	DATE	MADE	APPD	EXPLANATION	1	2	3	4	5	6	7	8
a	7/18/2011	DWE	APPD	NEW DRAWING								

Acclaimed as the most durable of all resilient-seated butterfly valves in the industry, this valve excels in a wide variety of applications.

Cast in both wafer and tapped-lug patterns in a wide variety of material choices, DEMCO butterfly valves feature a one-piece body for minimum weight and maximum strength. The unique stem hole design in the disc ensures a dry stem journal, and the hard-backed seat (2" - 36") allows ease of installation, reliable operation, and is field-replaceable without special tools. DEMCO butterfly valves are available in sizes 2" thru 48".

Engineered for long-term, maintenance-free performance, DEMCO butterfly valves are commonly selected for a variety of applications spanning a wide range of industries:

- Chemical and petrochemical
- Agriculture
- Oil and gas drilling and production
- Food and beverage
- Water and waste water
- Cooling towers (HVAC)
- Power
- Mining and materials
- Dry bulk handling
- Marine and government

**Features/Benefits**

**Bi-directional sealing**

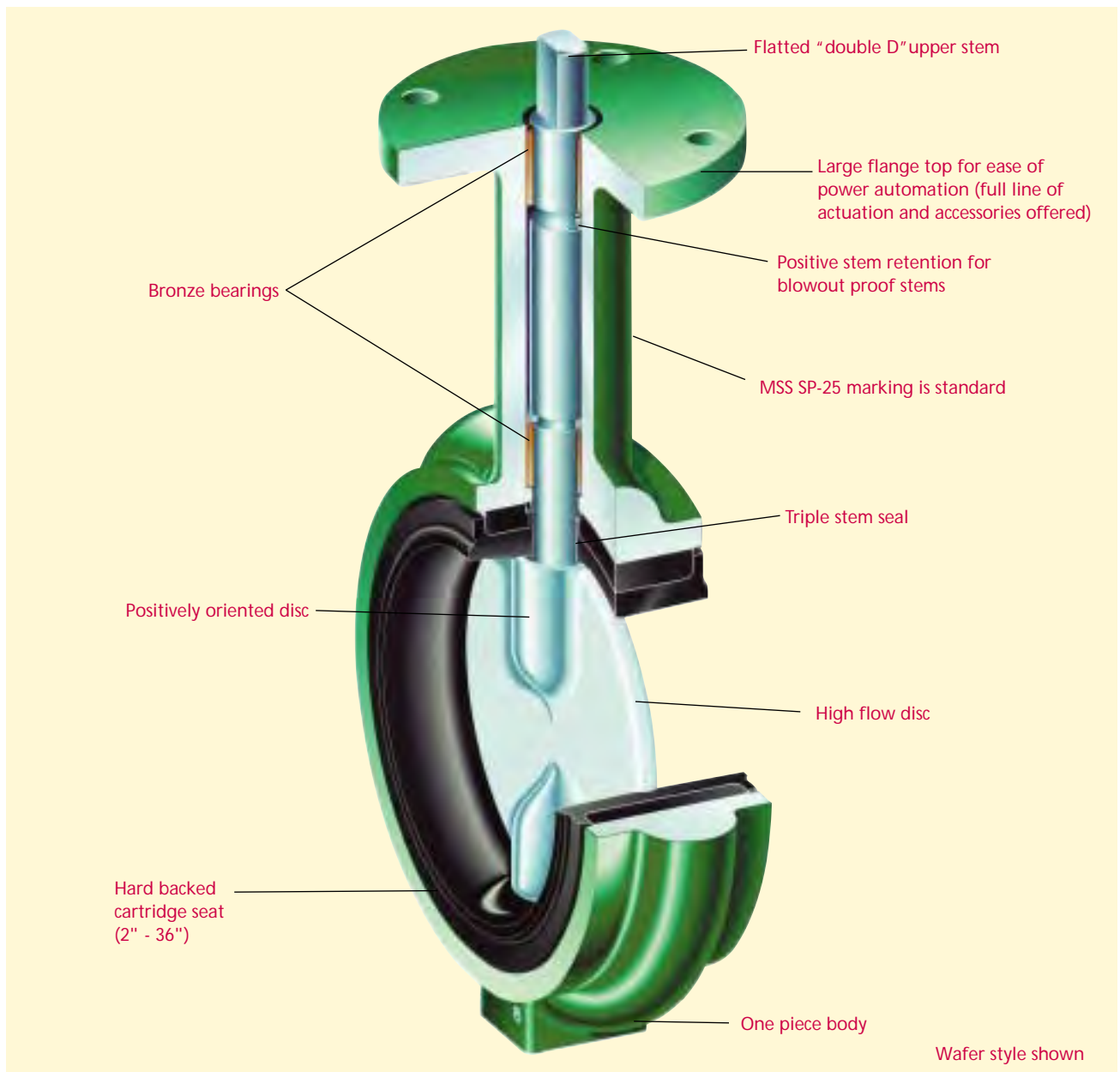
This valve provides bi-directional sealing at full-rated pressure with identical flow from either direction.

**Integral flange seal**

Molded into the edge of the seat is an integral flange seal which accommodates ANSI weld neck, slip-on, threaded and socket flanges as well as "stub end" type C flanges.

**ANSI class 150 rating**

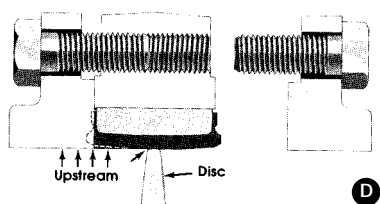
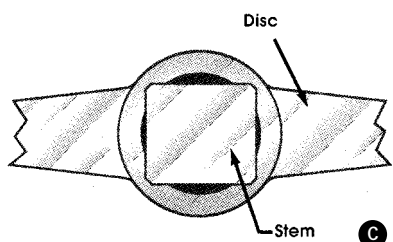
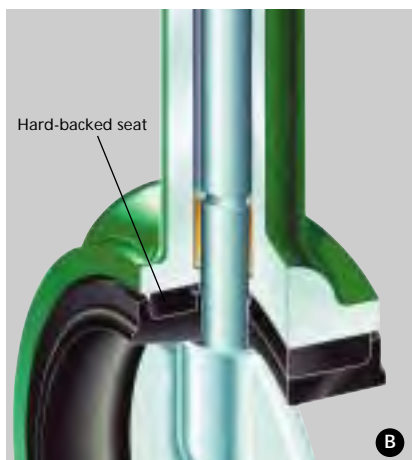
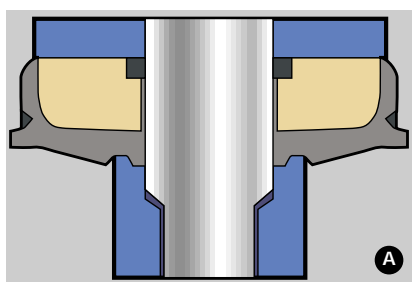
Body rating is ANSI class 150 (285 psi non-shock). Wafer body diameters are



designed to self-center in ANSI 150 flange patterns.

**Multiple pressure ratings**

Three drop tight pressure ratings are offered for 2" to 12" sizes. The standard shut off pressure rating is 200 psi, but 285 and 50 psi shut off ratings are also available. And, where drop tight closure is not required and minimal torque is desired, a throttling rated valve is available. Both the 50 psi and throttling ratings allow for smaller actuators, which can significantly reduce overall installation cost in automated applications. The



14" to 48" size valves are available in 150 and 50 psi drop tight shut off ratings as well as throttling.

**A Dry stem journal eliminates potential for leakage**

The DEMCO disc is uniquely designed with a continuous annular raised land around the stem hole and disc edge which presses into the seat flat at every angular position. The resilient seat presses back with a higher specific force than the line pressure, preventing leakage to the stem. In addition, two O-ring ribs are provided in the seat stem bore creating a triple stem seal.

In competitive stem seal designs with boot seats, a seal is accomplished by an interference "squeezing" on the stem or an O-ring in the stem journal. The potential for leakage behind the seat is high for this competitive design. As the disc wipes the seat, elongation of the stem seal area allows leakage to collect behind the seat. This condition is eliminated by DEMCO's dry stem journal and hard-backed seat.

**B Hard-backed cartridge seat (2"- 36")**

The DEMCO cartridge seat is constructed by permanently bonding a resilient elastomer to a rigid backing ring. In addition to superior sealing integrity, this design: 1) makes valve installation easier because no special precautions are required for disc position. This is especially advantageous when installing valves with fail closed actuators; 2) eliminates high

torque and premature failure caused by elastomer distortion as found in other non-rigid seat designs; 3) simplifies seat replacement because it is slip fitted into the body, with no need for special tools.

**C Positively oriented disc**

Proper orientation of the stem/disc connection is assured by the rectangular drive. In 2" - 24" size valves, the disc is permitted to float on the stem to perfectly center in the valve seat. This design enhances drop tight sealing and prolongs service life.

**D End-of-line service**

Lug body valves may be used in end-of-line service, with downstream piping removed. (Only weld neck or socket flanges can be used for this service.) Since upstream pressure is excluded between the flange and the seat face by the exclusive DEMCO flange seal design, there is no effective force to slide the seat downstream. DEMCO 2" - 12" Lug Butterfly Valves are suitable for liquid service up to 200 psi with downstream piping removed (150 psi 14" - 36").

Lug body valves are recommended for isolation of pumps, control devices or other system components which may need to be removed for repair or replacement. Lug valves are also suitable for installation at points from which piping expansion may proceed. Such valves are normally blanked with blind flanges, to protect the exposed seats until new piping is attached.

**SPECIFICATIONS**

**Sizes**

2" - 48"

**Body type and style designations**

Long neck NE-C and NF-C: 2" - 48", 2" - 36" wafer / lug, 42" - 48" flanged.

Short neck NE-I, and NE-I Sanitary:

2" - 12" wafer / lug.

NE-IT Teflon: 2" - 10" wafer / lug.

NE-D: 2" - 12" wafer / lug.

Marine: 2" - 24" wafer / lug.

**Pressure rating**

2" - 12": 0 (Throttling), 50, 200 and 285 psi

2" - 10" NE-I: 150 psi

14" - 48" 0, 50 and 150 psi

**Operating Temperatures**

-30°F to +300°F (-34°C to +204°C)

depending on seat material selection and application (see page 30)

**Standard Material Options**

Bodies: Iron, steel, stainless steel and bronze

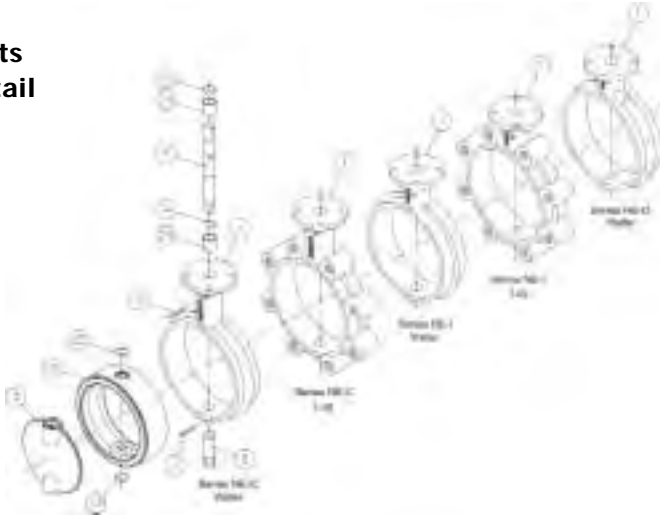
Discs: Nickel plated ductile iron, bronze and stainless steel

Stems: 416 and 316 stainless steel

Seats: Buna N, EPT, Viton, Neoprene

\*Many more options available (see how to order, pages 6-8 and 29-30 or consult factory)

Parts Detail



Ref. No.	Req'd	Component Description	Material
1	1	Body	*
2	1	Seat	*
3	1	Disc	*
4	1	Upper Stem	*
6	1	Lower Stem	*
7	2	Spring Pin	Stainless Steel
14	1	Retainer	Stainless Steel
22	1	Top O-Ring	Buna-N
23	†	Stem O-Ring	Buna-N
24	2	Bearing	Bronze

\* See **How to Order** for material choices/styles. Complete material specs on pages 29 and 30. † 4 req'd. for throttling valves only.

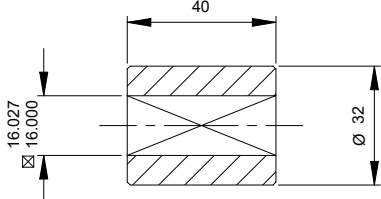
How to Order (example: 6" NE-C, 200PSI, Wafer, Standard trim with handle 22124-1215311)

X X X X X	-	X	X	X	X	X	X
Base Part Number		Body Configuration	Body Material*	Stem Material	Disc Material	Seat Elastomer	Actuation
NE-C/NE-I/NEI-T		NE-C (Longneck)	NE-C, NE-I & NE-D	NE-C, NE-I & NE-D	NE-C, NE-I & NE-D <sup>(7)</sup>		Handle
Wafer 1		Ductile Iron (lug) 1	416 SS 1	316 SS 2	Buna-N 31		10 Position Lkg. 1 <sup>(4)</sup>
Lug 5		Cast Iron (wafer) 2	316 SS** 2	Monel <sup>(6)</sup> 3	Black Neoprene 32		Throttling Mem./Stop 2 <sup>(4)</sup>
NE-D		NE-I & NE-I Sanitary	Monel <sup>(6)</sup> 3	Aluminum Bronze 4	Hypalon <sup>(6)</sup> 33		Square Nut 5
Wafer 1		Ductile Iron (NE-I, wafer only) 1	NEI-T	Ductile Iron Nickel Plated 5	Viton <sup>(6)</sup> 34		2 Position Lkg. 6 <sup>(4)</sup>
		Aluminum Bronze 3	316 SS Vented*** 2	PVF Coated Ductile Iron <sup>(1)</sup> 6	Natural Rubber 36		10 Position Sanitary (NEI-T only) 8
		Carbon Steel (NE-I only) 4	316 SS Solid*** 9	Alloy 20 <sup>(2)</sup> 7	White Neoprene 37		None 9
		Aluminum (NE-I, wafer only) 5	NE-I Sanitary	Hastelloy "C" <sup>(6)</sup> 8	ETM-30230 01		10 Position Lkg. Corrosion resistant K
		ENC Coated Ductile Iron 6	316 SS** 2	NEI-T & NE-I Sanitary	Fluorosteam 02		2 Position Lkg. Corrosion resistant L
		Stainless Steel 8		316 SS/PVF Coated (NEI-T only) 0	Peroxide Cured Food Grade EPT 03		Throttling/Mem. stop Corrosion resistant M
		NE-D		316 SS Polished <sup>(3)</sup> 2	Peroxide Cured Buna-N 04		Gear Operators <sup>(5)</sup>
		Ductile Iron 1		316 SS Tumbled <sup>(3)</sup> 5	Sulfur Cured Food Grade EPT 05		Hand Wheel A
		NEI-T		Alloy 20 (NEI-T only) 7	NEI-T		Crank (2"-12" only) B
		Ductile Iron Wafer-Shortneck Lug-Longneck 1		Hastelloy "C" (NEI-T only) 8	Buna-N/Teflon <sup>(6)</sup> 31		Chain Wheel C
		Gray Iron (longneck wafer) 2		316 SS Unpolished <sup>(3)</sup> 9	Peroxide Cured EPT/Teflon <sup>(6)</sup> 35		Square Nut D
		Aluminum Bronze 3			Sulfur Cured EPT/Teflon <sup>(6)</sup> 05		Bare Shaft E
		Carbon Steel 4			NE-I Sanitary All Seats Food Grade		
		Aluminum (wafer only) 5			Buna-N 31		
		Stainless Steel 8			Black Neoprene 32		
					Viton 34		
					EPT 35		
					White Neoprene 37		
					Sulfur Cured EPT 05		

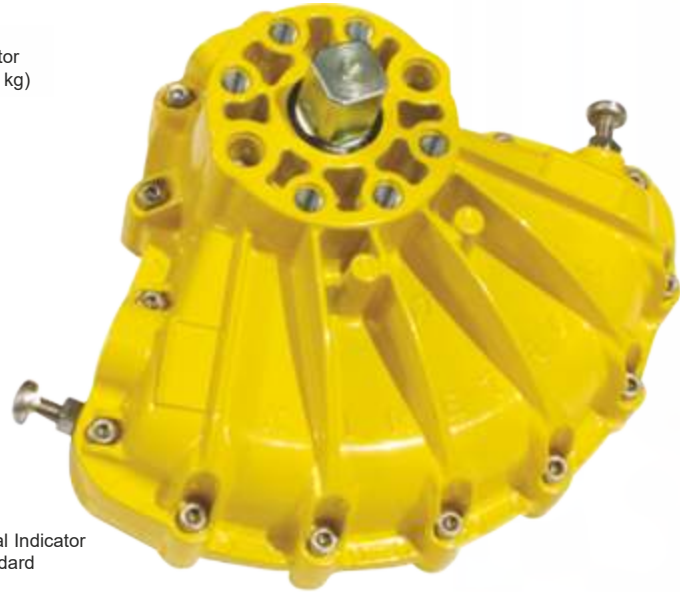
\*Standard coating is green enamel; other coatings available on request.  
 \*\*17-4 PH SS for 8"-12" upper stem only.  
 \*\*\*Except 17-4 PH upper 8" & 10".  
 1. 200 psi only.  
 2. Except 285 psi.  
 3. Polished-ground to # 4 dairy finish, Tumbled-vibratory finish to remove "as cast" surface, Unpolished-"as cast" surface

4. When these options used with NE-I Sanitary butterfly valves, handles will be bronze with SS parts and fasteners.  
 5. Gear operator recommended for 8"-12" sizes in all series.  
 6. See material trademark note on page 32.  
 7. Other seat options available (consult factory).

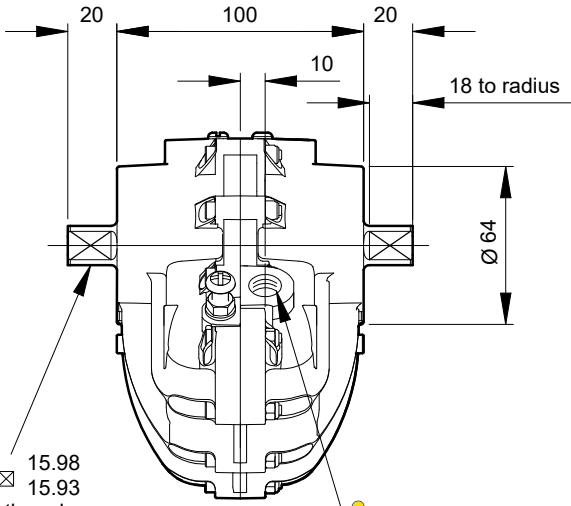




Standard Coupling  
(supplied with actuator  
weight 0.37 lbs/0.17 kg)



Visual Indicator  
Standard

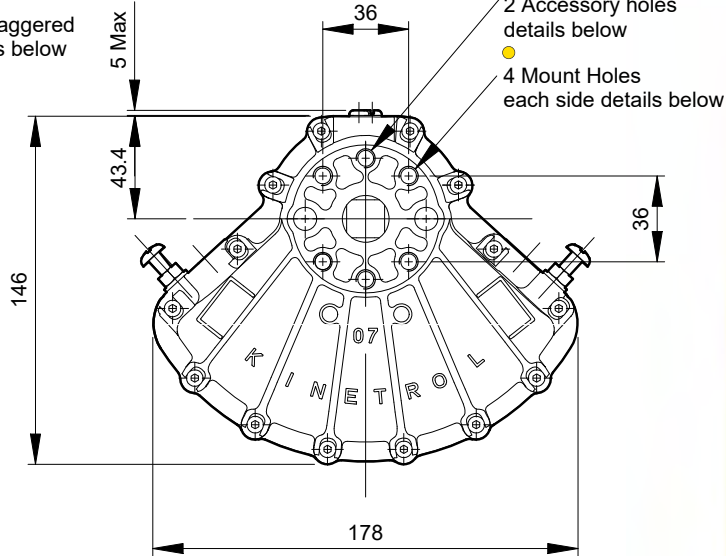


15.98  
15.93  
Both ends  
shown at centre  
of travel

2 Air ports staggered  
thread details below

**Air Port/Mount Hole Details**

Model	Air Ports	Mount Holes & Accessory Mount Holes
074-100	G <sup>1</sup> / <sub>4</sub>	4 x M8 x 16 deep on 50.9 PCD 2 x M8 x 16 deep on 50.8 PCD
077-100	1/4 NPT	4 x 5/16 UNC -18 x 0.63" deep on 2.00" PCD 2 x 5/16 UNC -18 x 0.63" deep on 2.00" PCD



**Specification**

**Output Torque**

1080 lbf ins/124 Nm  
at 100 psi/7 bar

**Angle of Travel  
(adjustable)**

80° - 100°  
(restricted travel  
versions available)

**Displaced Volume**

18.3 in<sup>3</sup>/300 cm<sup>3</sup>

**Finish**

Epoxy stove enamel

**Weight**

6.91 lb/3.13 kg  
(excluding coupling)

For further information  
see General  
Specification on  
page 47.

**Options**

- Fail safe spring return units - clockwise or counter clockwise see pages 3-5
- Limit switch boxes for open/close indication - various switches for hazardous areas see pages 7-10
- AP pneumatic positioner - full range of options see pages 15/16
- EL electropneumatic positioner - full range of options see pages 13/14
- Integral solenoid valve see page 18
- P3 on/off positioner full range of options including hazardous area see pages 19-21
- Clear Cone position monitor see page 18
- 180° model see pages 23/24
- Female drive and mounting details to DIN 3337 and ISO 5211 see page 48
- ISO adaptor see page 6
- G<sup>3</sup>/<sub>8</sub> or 3/8 NPT air port option available - contact Kinetrol
- Spring to centre see page 22
- Geared manual override see page 44
- Code identification see page 57
- Torque outputs see pages 55/56
- See pages 48-50 for English dimensions and dimensions of spring options
- High temperature / Low temperature options see page 47



## limit switch units

- Provide reliable open/close indication
- All units sealed to IP65/NEMA 4
- Precision die-cast, zinc alloy boxes
- Two easily adjustable strikers
- Available for all models except OMO and 01
- Cable entry threads  
*Optional ISO M20x 1.5, Din pg 13.5 and 1/2"-14NPS. See page 32 for full details of coding*
- Discrete limit switch boxes available with latchable or non - latchable handles.  
*(contact Kinetrol for details)*



### Resistive load ratings for standard microswitches:

VOLTAGE	RESISTIVE LOAD
125 V ac	15A
250 V ac	15A
Up to 12 V dc	15A
up to 24 V dc	10A
up to 48 V dc	3A
up to 250 V dc	0.25A

### Multiplication factors for non-resistive loads:

Steady state tungsten lamp load	x 0.1
Steady state inductive load	x 0.2
Peak inductive load	x 1.0

## standard switches

- **Code-004**  
With 2 microswitches wired for SPDT.  
NB 02/03 and positioner models wired for SPST (normally open unless otherwise specified). May be used in zone 0 with intrinsically safe supply.
- **Code-007**  
With 4 microswitches wired for DPDT.  
NB not applicable to 02/03 and positioner models.

## optional switches



- **Code-001**  
2 intrinsically safe inductive proximity sensors for hazardous areas to Zone 0.



- **Code-002**  
2 pneumatic switches with inlet adaptors for 4mm i/d tube.



- **Code-005**  
2x2 wire proximity sensors 20-260 volts AC, normally open.

- **Code-006**  
2x2 wire proximity sensors 5-60 volts DC, normally open, with LED switch status indicators.



- **Code-003**  
Certificated unit to EEx e II T6 for hazardous areas to Zone 1.

INSTALLATION DIMENSIONS see page 36

# KINETROL

## INSTALLATION INSTRUCTIONS

## TYPE UNIVERSAL LIMIT SWITCH BOX

SUITABLE FOR DIRECT MOUNT TO KINETROL

ACTUATORS SIZE RANGE: 03 TO 14

& DISCRETE MOUNT OPTION

SWITCH TYPE: 004

1. Remove temporary threaded plugs.
2. Customer to supply and fit cable glands to maintain IP54 Environmental Protection. Second conduit entry can be plugged using a suitable IP66 plug or ordered from Kinetrol with plug already fitted.
3. Connect cable terminals as required (wiring diagram shown below).

#### 4. Materials of construction:

- Main body & lid - Zinc alloy (Mazak 3) diecast epoxy painted.
- Gasket - Cork.
- Terminal strip - Gemin (KRG).
- Switch cables - PVC coated copper
- Rubber seals - NBR. (Other mat'ls available on request)
- Shaft - Zinc plated mild steel.
- Switch body & plunger - Glass filled nylon 6.6.
- Switch contacts - Fine silver

#### 5. Operating conditions:

- Minimum operating time: 20ms.
- Maximum angle of travel: 110°
- Vibrating conditions: 4G @ 100Hz
- Ambient temperature range: -40°C to +80°C.
- Ensure operating loads given opposite are not exceeded.

Resistive load ratings for standard microswitches:

VOLTAGE	RESISTIVE LOAD
125 V ac	15 A
250 V ac	15 A
Up to 12 V dc	15 A
Up to 24 V dc	10 A
Up to 48 V dc	3 A
Up to 250 V dc	0.25 A

Multiplication factors for

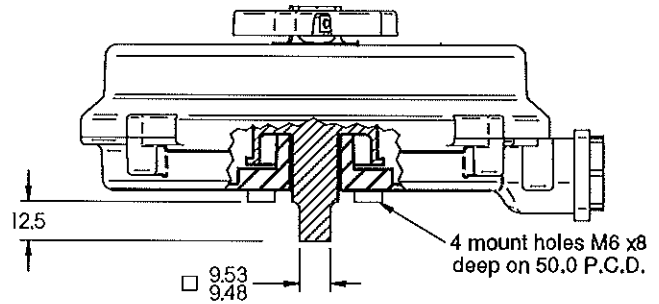
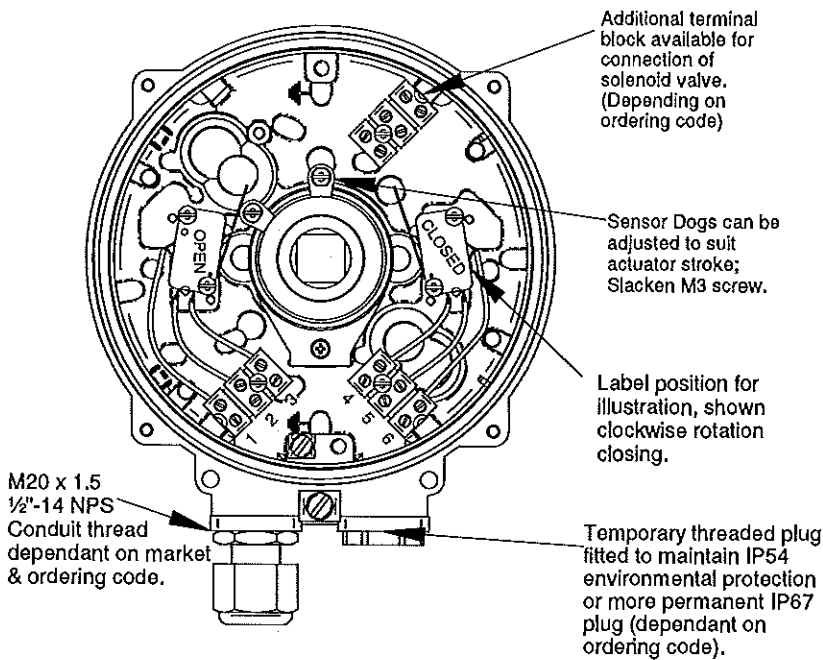
non-resistive loads:

Steady state tungsten lamp load: X 0.1

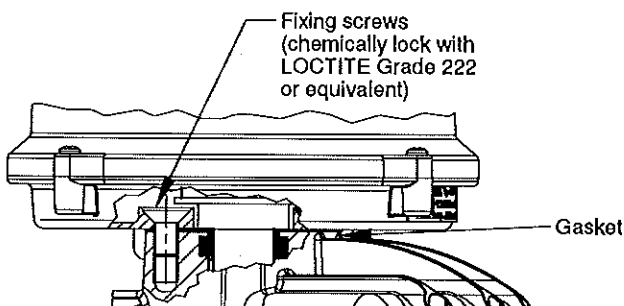
Steady state inductive load: X 0.2

Peak inductive load: X 1.0

6. If direct mount units supplied separately this box must be kept sealed in its polythene bag during storage. The box must be assembled correctly to the appropriate Kinetrol actuator. The fixing screws and gasket are provided. Only use replacement parts supplied by Kinetrol. Assemble as shown below.
7. Discrete mount units: Discrete mount units are designed to be bracket mounted to the actuator and are fitted with either a male Kinetrol square or a namur VDI/VDE interface shaft. Ensure mounting arrangement does not apply side or end load to the switch box shaft.
8. Open/Closed label supplied loose - to be fitted by user in desired position.

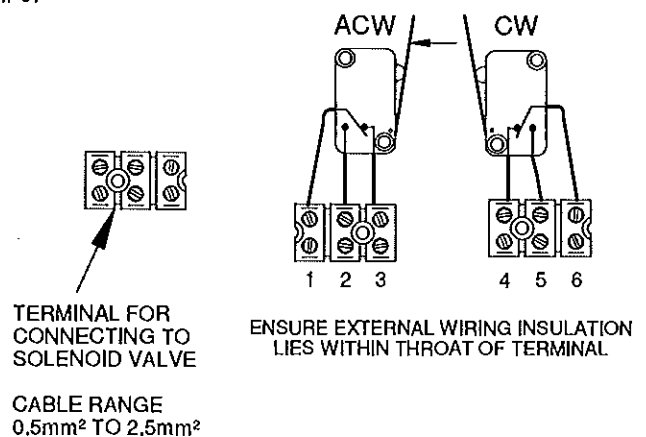


DISCRETE MOUNT BOX OPTION SHOWN WITH KINETROL SQ. IT CAN ALSO BE FITTED WITH DISCRETE SHAFT TO VDI/VDE 3845.



Kinetrol Direct Mount Option

### WIRING DIAGRAM



KF-433 09/10

INDEX : H:\Drawing Office Docs. master KF WI TD etc\Current KF masters

AR 4901

## Features

- Compact spool valve convertible from 3/2 to 5/2
- NAMUR mount construction
- Standard manual operator
- DIN, Watertight and Explosionproof solenoids available
- Single and dual solenoid constructions
- Mountable in any position
- Vents air from spring side of actuator to prevent corrosion of actuator

## Construction

Valve Parts in Contact with Fluids	
Body	Black Anodized Aluminum
Spring	Phosphate treated black steel
Shading Coil	Copper
Seals	NBR + PUR
Core and Core Tube	Stainless Steel / Brass
End Covers and Plate	6/6 glass filled PA/FV
Spool	Aluminum
Internal Parts	Zamak, Steel, CA

## Electrical

Standard Coil and Class of Insulation	Enclosure Type	Watt Rating and Power Consumption				Spare Coil Part Number	
		DC Watts	AC Watts	VA Holding	VA Inrush	AC	DC
F	SC	3	2.5	3.5	6	400125	400125
F	SC	6.9	5	7	15	43004649	43004647
F	EF	6.9	6.3	7	10.1	266762	270007
F	WT	6.9	6.3	7	10.1	266763	270008

**Standard Voltages:** SC: 24, 120, 240 Volts AC, 50-60 Hz; 12, 24, 120 Volts DC.  
 WT and EF: 24/50-60HZ, (120/60, 110-120/50)①, (240/60, 220-240/50)② Volts AC;  
 6, 12, 24, 120 Volts DC.  
 ① Order as 120/60, 110/50  
 ② Order as 240/60, 220/50

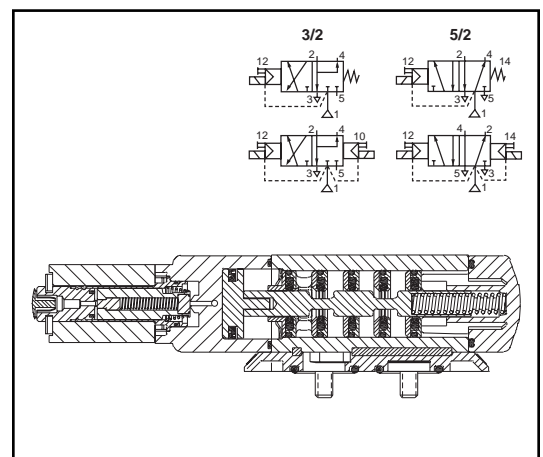
## Solenoid Enclosures

**Standard: - Prefix**

**SC** = IP65 type DIN (open frame) per 46244

**WT** = Combination General Purpose and Watertight Types 1, 2, 3, 3S, 4, and 4X

**EF** = Combination Explosionproof and Watertight Types 3, 3S, 4, 4X, 6, 5P, 7, 9 Class I, Div. 1 (Groups A - D) and Class II, Div. 1 Type 9 (Groups E-G)



VALVE AUTOMATION

## Nominal Ambient Temp. Ranges

**SC:** AC/DC: 5°F to +140°F (-15°C to 60°C)

**EF:** AC: 5°F to +104°F (-15°C to 40°C)

DC: 5°F to +77°F (-15°C to 25°C)

**WT:** AC: 5°F to +140°F (-15°C to 60°C)

DC: 5°F to +77°F (-15°C to 25°C)

**Note:** For temperatures below 32°F (0°C) moisture-free air must be used.

Refer to Engineering Section for details.

## Approvals

**SC** (2.5W and 3W only) UL recognized component, CSA certified.

**WT:** UL recognized component, CSA certified.

**EF:** UL and CSA listed solenoid.

Meets applicable CE directives.

SIL 3 capable per IEC 61508 on normally closed single solenoid. Third party certification provided by EXIDA.

Refer to Engineering Section for details.



**Specifications (English units)**

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi)		Fluid Temperature °F (for single and dual solenoid)			Single Solenoid PFD <sub>AVG</sub> = 3.3 x 10 <sup>-3</sup>	Dual Solenoid	Const. Ref.	Watt Rating/ Class of Coil Insulation	
			Min.	Max.	Min.	Max. AC	Max. DC				Catalog Number	Catalog Number
<b>OPEN FRAME DIN COIL</b>												
1/4 ①	1/4	.86	30	150	5	140	140	SC8551A001MS	SC8551A002MS	1	2.5	3
1/2	1/2	3.7	30	150	-15	140	140	SC8553A001MS	SC8553A002MS	2	5	6.9
<b>WATERTIGHT ENCLOSURE</b>												
1/4 ①	1/4	.86	30	150	5	140	77	WT8551A001MS	WT8551A002MS	1	6.3	6.9
1/2	1/2	3.7	30	150	-15	140	77	WT8553A001MS	WT8553A002MS	2	6.3	6.9
<b>EXPLOSIONPROOF ENCLOSURE</b>												
1/4 ①	1/4	.86	30	150	5	104	77	EF8551A001MS	EF8551A002MS	1	6.3	6.9
1/2	1/2	3.7	30	150	-15	104	77	EF8553A001MS	EF8553A002MS	2	6.3	6.9

① 1/8 inch NPT exhausts.

**Specifications (Metric units)**

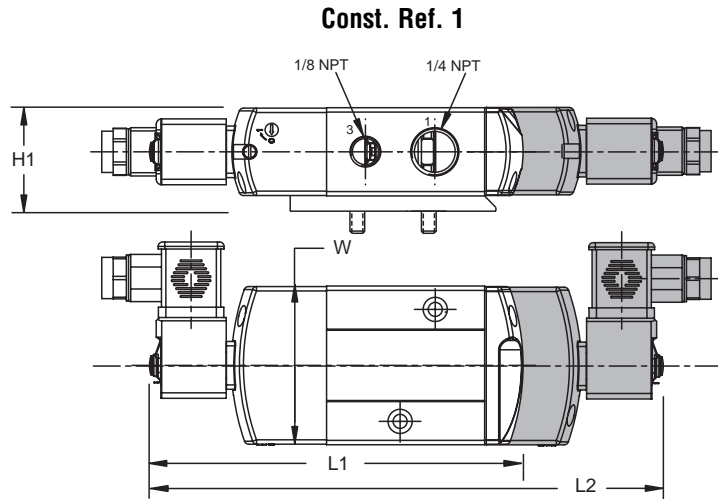
Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar)		Fluid Temperature °C (for single and dual solenoid)			Single Solenoid PFD <sub>AVG</sub> = 3.3 x 10 <sup>-3</sup>	Dual Solenoid	Const. Ref.	Watt Rating/ Class of Coil Insulation	
			Min.	Max.	Min.	Max. AC	Max. DC				Catalog Number	Catalog Number
<b>OPEN FRAME DIN COIL</b>												
1/4 ①	6.4	.7	2	10	-15	60	60	SC8551A001MS	SC8551A002MS	1	2.5	3
1/2	13	3.15	2	10	-25	60	60	SC8553A001MS	SC8553A002MS	2	5	6.9
<b>WATERTIGHT ENCLOSURE</b>												
1/4 ①	6.4	.7	2	10	-15	60	25	WT8551A001MS	WT8551A002MS	1	6.3	6.9
1/2	13	3.15	2	10	-25	60	25	WT8553A001MS	WT8553A002MS	2	6.3	6.9
<b>EXPLOSIONPROOF ENCLOSURE</b>												
1/4 ①	6.4	.7	2	10	-15	40	25	EF8551A001MS	EF8551A002MS	1	6.3	6.9
1/2	13	3.15	2	10	-25	40	25	EF8553A001MS	EF8553A002MS	2	6.3	6.9

① 1/8 inch NPT exhausts.

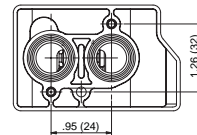
## Dimensions inches (mm)

Series	8551
NPT	1/4
L1	5.47 (139)
L2	7.56 (192)
H1	1.30 (33)
W	1.77 (45)

**NOTE: Valve shown with CM22  
DIN terminal coil and connector.  
Connector sold separately.**

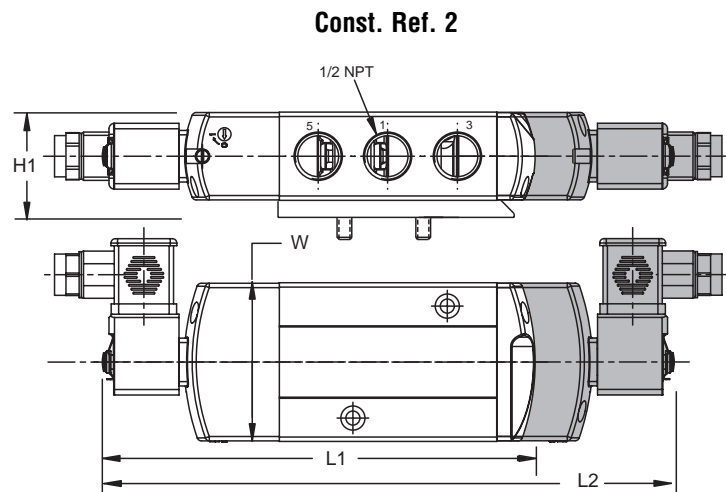


**8551 NAMUR Footprint**

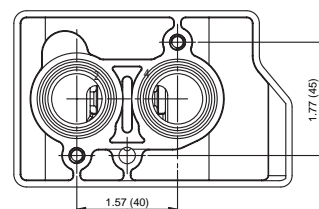


Series	8553
NPT	1/2
L1	7.76 (197)
L2	10.25 (260)
H1	1.94 (49)
W	2.85 (72)

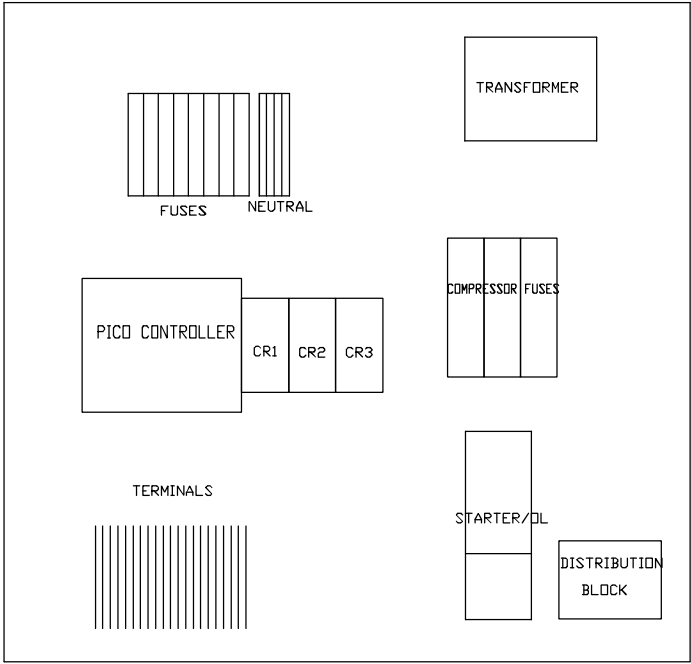
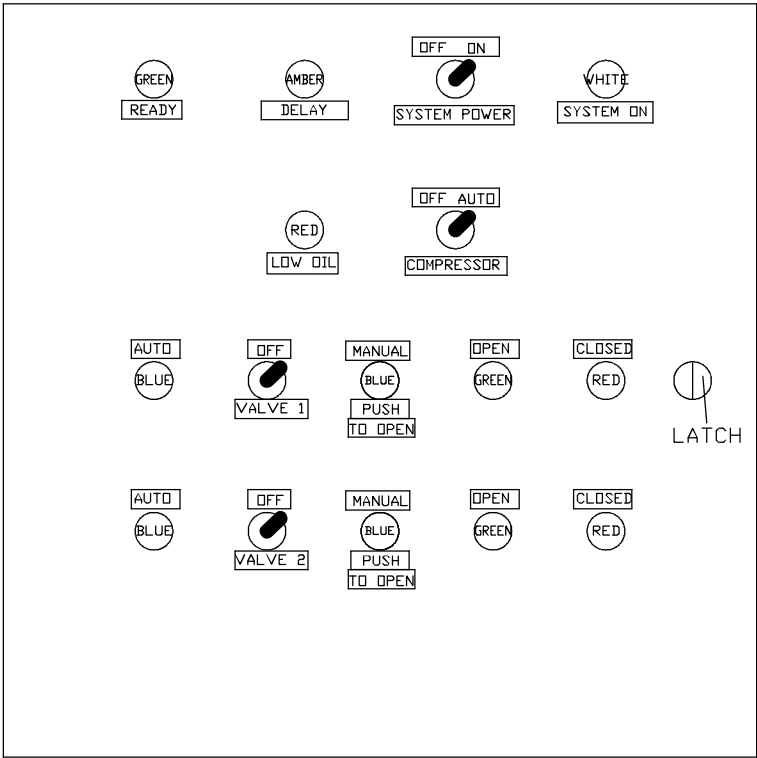
**NOTE: Valve shown with CM22  
DIN terminal coil and connector.  
Connector sold separately.**



**8553 NAMUR Footprint**



**VALVE  
AUTOMATION**



HOFFMAN "CONCEPT" NEMA 4X  
ENCLOSURE  
20X20X8

LEGEND	
	LAMP
	SELECTOR SWITCH
	PUSH BUTTON
	LIGHTED PUSH BUTTON

a	3/5/2014	DWE	APPD		NEW DRAWING
REV.	DATE	MADE	APPD	MEMO NO.	EXPLANATION

HENDRICK SCREEN COMPANY CUTTING EDGE METAL SOLUTIONS					
PROJECT <b>L&amp;A No. 9173</b>			PO# <b>HS21791</b>		
PRODUCT AIRBURST PANEL				UNITS INCHES	
MADE	3/5/2014	DWE\KMS		ASLY.DWG	
CHKD	**/**/****	SY		SCALE	SIZE
APPD	**/**/****	SY		PAGE NO.	DWG. NO.

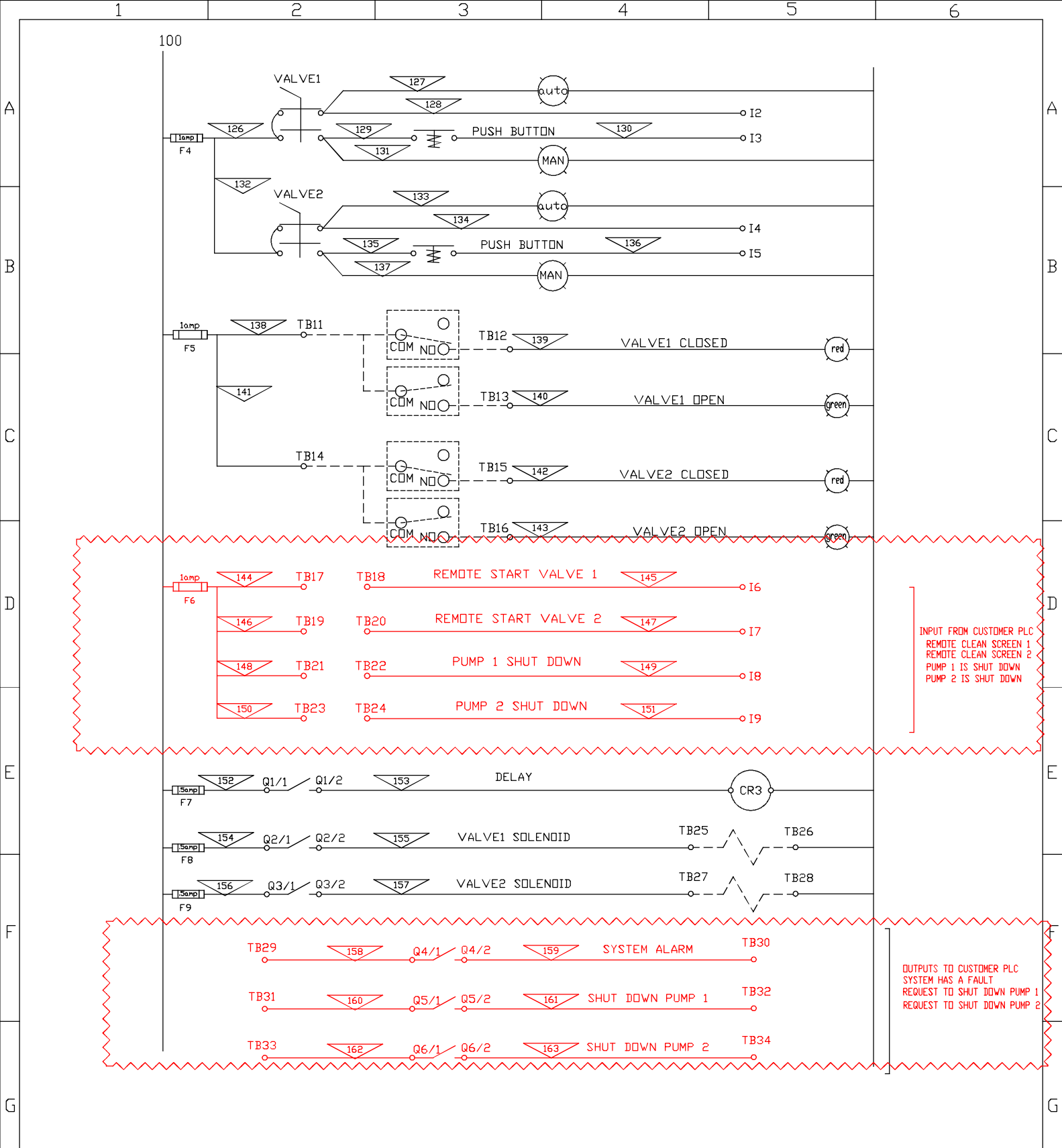
DOOR LAYOUT			
PROJ. NO.			
<b>HS21791-2</b>			
a REV.			

## HS21791 BOM

Qty	Part Number	Description
1	CSD20208SS	20X20X8 Hoffman enclosure
1	CP2020	Hoffman back panel
1	1497CBASXON-3	Control transformer 460-120 130va
2	FNQR-1.25	Primary fuses
1	FNQR-1 8/10	Secondary fuse
1	100-C23D16	Contacteur
1	193-ED1EB	Bimetalic overload relay
1	1492FB3J30-L	3-pole fuse holder
3	JTD-30	25 amp tpe CC fuses
3	700HC14A1	Relay
3	700HN128	Relay base
2	800FPM22	2-position switch
2	800FP-SM32	3-position switch
2	800FPLF6	Blue pb operator
6	800FX10	Contact block
6	800FALP	Plastic latch
2	800FN5B	Blue intigrated led
2	800FPP6PN5B	Blue lamp
3	800FPP4PN5R	Red lamp
3	800FPP3PN5G	Green lamp
1	800FPP5PN5Y	Yellow lamp
1	800FPP7PN5W	White lamp
1	1760-L18AWA-EX	PICO controller
9	1492WFB4	Fuse block terminal
45	1492J4	Feed through terminal
4	1492EAJ35	End anchors
8	1492EBJ3	End barrier
6	G1x2WH6	1x2 panduit
6	C1WH6	Panduit cover
1	GBK5	Ground bar
1	199DR1	Din rail
10	GMA500MA	Fuse
5	GMA1A	Fuse
1	1492-PDM3141	3-pole power block
1	1492-PCB9	Cover
3	SAMI7N	Covers







INPUT FROM CUSTOMER PLC  
 REMOTE CLEAN SCREEN 1  
 REMOTE CLEAN SCREEN 2  
 PUMP 1 IS SHUT DOWN  
 PUMP 2 IS SHUT DOWN

OUTPUTS TO CUSTOMER PLC  
 SYSTEM HAS A FAULT  
 REQUEST TO SHUT DOWN PUMP 1  
 REQUEST TO SHUT DOWN PUMP 2

**L&A No. 9173**

BY **KING MECHANICAL SPECIALTY**

FOR HENDRICK SCREEN CO  
 PD HS21791

WIRING DIAGRAM

PRODUCT AIRBURST PANEL

UNITS INCHES

PROJ. NO.

MADE 3/5/2014

DWE/KMS

ASLY.DWG

b 7/22/2014 MLK APPD DRAWN AS BUILT

CHKD \*\*/\*\*/\*\*\*\*

SY

SCALE

SIZE

PAGE NO.

DWG. NO.

HS21791-WD2

APPD \*\*/\*\*/\*\*\*\*

SY

b REV.

H

H

# CONCEPT® Stainless Steel Type 4X Wall-Mounted Enclosures



## Application

The CONCEPT stainless steel enclosure, with its streamlined design and Type 4X rating, is a perfect fit for mounting electrical or high-tech electronic equipment in a variety of indoor and outdoor settings. It is typically used in the following areas where corrosion-resistant protection is needed: food processing plants, pharmaceutical manufacturing facilities, petrochemical plants, pulp and paper processing, and water treatment facilities.

## Construction

- Manufactured from 16 or 14 gauge Type 304 or 316L stainless steel
- Seams continuously welded and ground smooth
- Minimum-width body flange provides maximum door opening
- Body flange trough excludes liquids and contaminants
- Panel mounting studs fit optional CONCEPT panels and other accessories
- Mounting holes in back of body for direct mounting or for optional external mounting brackets
- Type 304 stainless steel hidden hinges promote clean aesthetic appearance
- Standard full-access door opening
- Doors are interchangeable and easily removable by pulling captive hinge pins
- Provision on door (except window door style) for thermoplastic data pocket
- Provision on door (except window door style) for optional doorstop kit
- Quarter-turn latches (or a 3-point latch system on larger enclosures) furnished with flush slotted insert. Optional handles or inserts are available.
- Seamless foam-in-place gasket provides oiltight and dusttight seal against contaminants
- Self-grounding latch system with double seal provides maximum protection against leakage
- Bonding provision on door. Grounding stud on body.
- Furnished hardware kit consists of panel-mounting nuts, panel-grounding hardware, and sealing washers for wall-mounting holes
- Installation instructions for enclosure and accessories are provided

## Finish

Enclosures are unpainted. Door and body have smooth #4 brushed finish. Optional mild steel panels are painted white. Optional conductive panels are available.

## Industry Standards

Mounting brackets required to meet UL/CSA external mounting requirements.

UL 508A, File No. E61997: Type 3R, 4, 4X, and 12

NEMA/EEMAC Type 3R, 4, 4X, 12, and 13

CSA File No. 42186: Type 4, 4X, and 12

VDE IP66

IEC 60529, IP66

Meets Type 3RX requirements

## Patents

This product covered by the following patents:

US 360,345

DE 9405854.7

US 5,509,703

US 5,666,695

Other patents pending.

## Accessories

Corrosion Inhibitors  
Data Pocket  
DIN3 Rails  
Door Stop Kit  
Lighting Kits  
Mounting Brackets  
Panels  
Panels, NEMA  
Terminal Block Kit Assembly  
Thermal Accessories

## Data Pockets for Solid Door Enclosures

- No pocket when enclosure B dimension = 12.00 in. (305mm)
- Small pocket when enclosure A dimension <30.00 in. (762mm) and B dimension is between 12 in. (305mm) and 20.00 in. (508mm)
- Large pocket when enclosure A dimension >30.00 in. (762mm) and B dimension is >20.00 in. (508mm)

## Modification Services Program

You can customize this product to your unique requirements by specifying from these options:

- Enclosure height, width, depth
- Holes and cutouts in body, doors, subpanels
- Tapped holes in subpanels
- Fasteners, mounting channel in enclosure and subpanel
- Mounting (adds and deletes)
- Doors
- Subpanels
- Thermal management (louvers, fans, filters)
- Windows
- Standard accessories
- Drip shield

To order, contact your local Hoffman sales representative.

*NOTE: For information about modifications outside the scope of the Modification Services program, contact your Hoffman sales representative.*

# CONCEPT® Stainless Steel Type 4X Wall-Mounted Enclosures

## Standard Sizes CONCEPT® Stainless Steel Single-Door Wall-Mount Enclosures

Catalog Number	A x B x C in. (mm)	Stain- less Steel Type	Door Ga.	Body Ga.	CONCEPT Panel Catalog Number	Conductive Panel Catalog Number	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Latch (qty)	Latch (style)	J (in.)	J (mm)
CSD12126SS	12.00 x 12.00 x 6.00 (305 x 305 x 152)	304	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	1/4-turn	6.00	152
CSD12126SS6	12.00 x 12.00 x 6.00 (305 x 305 x 152)	316L	16	16	CP1212	CP1212G	10.20 x 10.20	259 x 259	10.50 x 10.50	267 x 267	1	1/4-turn	6.00	152
CSD16126SS	16.00 x 12.00 x 6.00 (406 x 305 x 152)	304	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	1/4-turn	8.00	203
CSD16126SS6	16.00 x 12.00 x 6.00 (406 x 305 x 152)	316L	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	1/4-turn	8.00	203
CSD16166SS	16.00 x 16.00 x 6.00 (406 x 406 x 152)	304	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	1/4-turn	8.00	203
CSD16166SS6	16.00 x 16.00 x 6.00 (406 x 406 x 152)	316L	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	1/4-turn	8.00	203
CSD20166SS	20.00 x 16.00 x 6.00 (508 x 406 x 152)	304	16	16	CP2016	CP2016G	18.20 x 14.50	462 x 361	18.50 x 14.50	470 x 368	1	1/4-turn	10.00	254
CSD20166SS6	20.00 x 16.00 x 6.00 (508 x 406 x 152)	316L	16	16	CP2016	CP2016G	18.20 x 14.50	462 x 361	18.50 x 14.50	470 x 368	1	1/4-turn	10.00	254
CSD20206SS	20.00 x 20.00 x 6.00 (508 x 508 x 152)	304	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
CSD20206SS6	20.00 x 20.00 x 6.00 (508 x 508 x 152)	316L	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
CSD16128SS	16.00 x 12.00 x 8.00 (406 x 305 x 203)	304	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	1/4-turn	8.00	203
CSD16128SS6	16.00 x 12.00 x 8.00 (406 x 305 x 203)	316L	16	16	CP1612	CP1612G	14.20 x 10.20	361 x 259	14.50 x 10.50	368 x 267	1	1/4-turn	8.00	203
CSD16168SS	16.00 x 16.00 x 8.00 (406 x 406 x 203)	304	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	1/4-turn	8.00	203
CSD16168SS6	16.00 x 16.00 x 8.00 (406 x 406 x 203)	316L	16	16	CP1616	CP1616G	14.20 x 14.20	361 x 361	14.50 x 14.50	368 x 368	1	1/4-turn	8.00	203
CSD16208SS	16.00 x 20.00 x 8.00 (406 x 508 x 203)	304	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	1/4-turn	8.00	203
CSD16208SS6	16.00 x 20.00 x 8.00 (406 x 508 x 203)	316L	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	14.50 x 18.50	368 x 470	1	1/4-turn	8.00	203
CSD20168SS	20.00 x 16.00 x 8.00 (508 x 406 x 203)	304	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	1/4-turn	10.00	254
CSD20168SS6	20.00 x 16.00 x 8.00 (508 x 406 x 203)	316L	16	16	CP2016	CP2016G	18.20 x 14.20	462 x 361	18.50 x 14.50	470 x 368	1	1/4-turn	10.00	254
CSD20208SS	20.00 x 20.00 x 8.00 (508 x 508 x 203)	304	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
CSD20208SS6	20.00 x 20.00 x 8.00 (508 x 508 x 203)	316L	16	16	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
CSD24168SS	24.00 x 16.00 x 8.00 (610 x 406 x 203)	304	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	1/4-turn	12.00	305
CSD24168SS6	24.00 x 16.00 x 8.00 (610 x 406 x 203)	316L	16	16	CP2416	CP2416G	22.20 x 14.20	564 x 361	22.50 x 14.50	572 x 368	1	1/4-turn	12.00	305
CSD24208SS	24.00 x 20.00 x 8.00 (610 x 508 x 203)	304	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	1/4-turn	12.00	305
CSD24208SS6	24.00 x 20.00 x 8.00 (610 x 508 x 203)	316L	16	16	CP2420	CP2420G	22.20 x 18.20	564 x 462	22.50 x 18.50	572 x 470	1	1/4-turn	12.00	305
CSD24248SS	24.00 x 24.00 x 8.00 (610 x 610 x 203)	304	14	16	CP2424	CP2424	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	1/4-turn	5.00	127
CSD24248SS6	24.00 x 24.00 x 8.00 (610 x 610 x 203)	316L	14	16	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	1/4-turn	5.00	127
CSD30248SS	30.00 x 24.00 x 8.00 (762 x 610 x 203)	304	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	1/4-turn	5.00	127
CSD30248SS6	30.00 x 24.00 x 8.00 (762 x 610 x 203)	316L	14	16	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	1/4-turn	5.00	127
CSD30308SS	30.00 x 30.00 x 8.00 (762 x 762 x 203)	304	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	1/4-turn	5.00	127
CSD30308SS6	30.00 x 30.00 x 8.00 (762 x 762 x 203)	316L	14	14	CP3030	CP3030G	28.20 x 28.20	716 x 716	28.50 x 28.50	724 x 724	2	1/4-turn	5.00	127
CSD36248SS	36.00 x 24.00 x 8.00 (914 x 610 x 203)	304	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	1/4-turn	5.00	127
CSD36248SS6	36.00 x 24.00 x 8.00 (914 x 610 x 203)	316L	14	16	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	1/4-turn	5.00	127
CSD36308SS	36.00 x 30.00 x 8.00 (914 x 762 x 203)	304	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	1/4-turn	5.00	127
CSD36308SS6	36.00 x 30.00 x 8.00 (914 x 762 x 203)	316L	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	1/4-turn	5.00	127

Corrosion-Resistant Enclosures

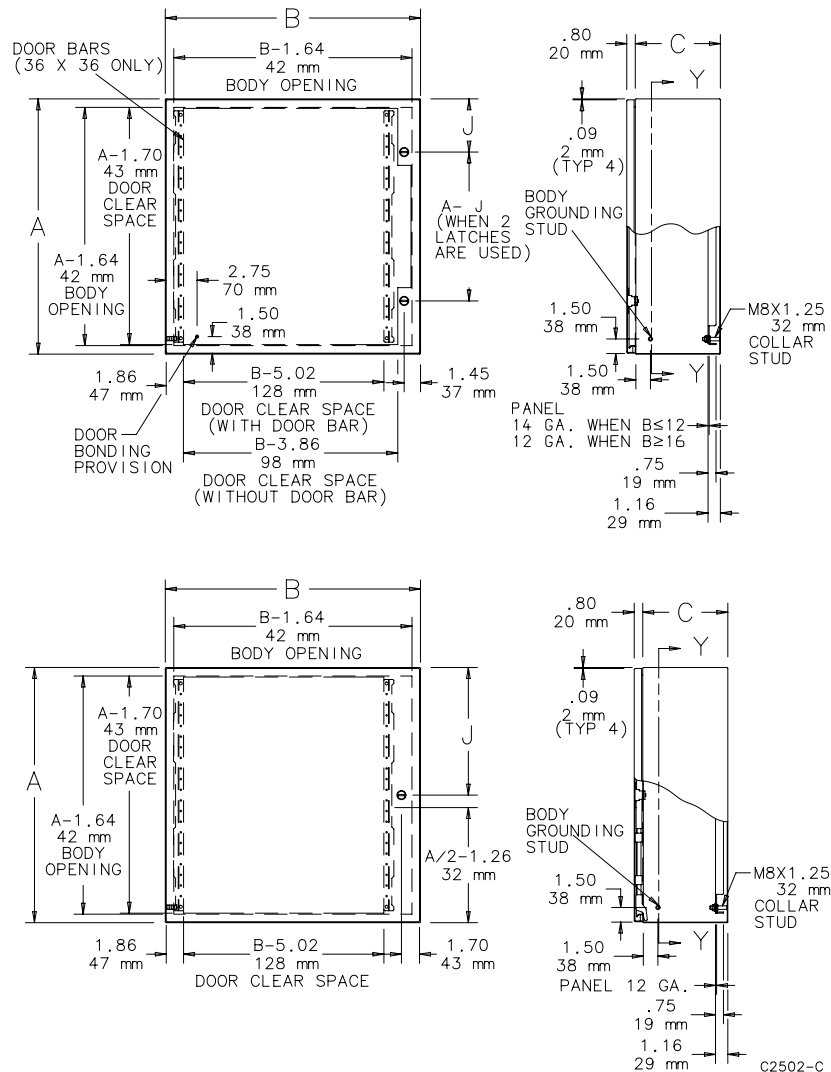
# CONCEPT® Stainless Steel Type 4X Wall-Mounted Enclosures

## Standard Sizes CONCEPT® Stainless Steel Single-Door Wall-Mount Enclosures (Cont.)

Catalog Number	A x B x C in. (mm)	Stain- less Steel Type	Door Ga.	Body Ga.	CONCEPT Panel Catalog Number	Conductive Panel Catalog Number	Panel Size D x E (in.)	Panel Size D x E (mm)	Mounting G x H (in.)	Mounting G x H (mm)	Latch (qty)	Latch (style)	J (in.)	J (mm)
<b>CSD202012SS</b>	20.00 x 20.00 x 12.00 (508 x 508 x 305)	304	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
<b>CSD202012SS6</b>	20.00 x 20.00 x 12.00 (508 x 508 x 305)	316L	14	14	CP2020	CP2020G	18.20 x 18.20	462 x 462	18.50 x 18.50	470 x 470	1	1/4-turn	10.00	254
<b>CSD242412SS</b>	24.00 x 24.00 x 12.00 (610 x 610 x 305)	304	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	1/4-turn	5.00	127
<b>CSD242412SS6</b>	24.00 x 24.00 x 12.00 (610 x 610 x 305)	316L	14	14	CP2424	CP2424G	22.20 x 22.20	564 x 564	22.50 x 22.50	572 x 572	2	1/4-turn	5.00	127
<b>CSD302412SS</b>	30.00 x 24.00 x 12.00 (762 x 610 x 305)	304	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	1/4-turn	5.00	127
<b>CSD302412SS6</b>	30.00 x 24.00 x 12.00 (762 x 610 x 305)	316L	14	14	CP3024	CP3024G	28.20 x 22.20	716 x 564	28.50 x 22.50	724 x 572	2	1/4-turn	5.00	127
<b>CSD362412SS</b>	36.00 x 24.00 x 12.00 (914 x 610 x 305)	304	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	1/4-turn	5.00	127
<b>CSD362412SS6</b>	36.00 x 24.00 x 12.00 (914 x 610 x 305)	316L	14	14	CP3624	CP3624G	34.20 x 22.20	869 x 564	34.50 x 22.50	876 x 572	2	1/4-turn	5.00	127
<b>CSD363012SS</b>	36.00 x 30.00 x 12.00 (914 x 762 x 305)	304	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	1/4-turn	5.00	127
<b>CSD363012SS6</b>	36.00 x 30.00 x 12.00 (914 x 762 x 305)	316L	14	14	CP3630	CP3630G	34.20 x 28.20	869 x 716	34.50 x 28.50	876 x 724	2	1/4-turn	5.00	127

Purchase panels separately.

Optional NEMA style steel and stainless steel panels require conversion kit catalog number CCPM4.



**Corrosion-Resistant  
Enclosures**



# 100-C, 4-Pole Contactors – 9...85A

The 100-C line of MCS contactors has now expanded its offering of 4-pole contactors. With the addition of the new 100-C40 and 100-C90, we are able to offer 4-pole contactors through 85A (AC-3), 130A (AC-1). They are available in various configurations of N.O. and N.C. power poles with AC or DC coil control.

## Features

- Contactor range from 9...85A in three frame sizes
  - 100-C09...C23 – 45 mm wide
  - 100-C40 – 59 mm wide
  - 100-C90 – 95 mm wide
- AC and DC coil control
- Common accessories with other 100-C contactors
- IP2X finger protection
- Provisions for adding two conductors per terminal
- Meets IEC, CE, UL and CSA standard requirements



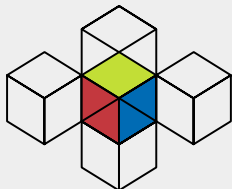
## Applications

Four pole contactors are ideal for applications where switching a neutral, in addition to 3-phase power, is required. They are also used in lighting circuits, resistive heating and dynamic braking applications.

## Product Selection

$I_e$	Ratings for Switching AC Motors											Contact Configuration, Main Pole		Cat. No.
	AC-2, AC-3													
	[A]	3 $\phi$ kW (50 Hz) $\bullet$					Hp (60 Hz)					N.O.	N.C.	
AC-3	AC-1	230V	400V/415V	500V	690V	1 $\phi$		3 $\phi$ $\bullet$						
						115V	230V	200V	230V	460V	575V			
9	32	3	4	4	4	1/2	1-1/2	2	2	5	7-1/2	4	0	100-C09 $\otimes$ 400
												3	1	100-C09 $\otimes$ 300
												2	2	100-C09 $\otimes$ 200
12	32	4	5.5	5.5	5.5	1/2	2	3	3	7-1/2	10	4	0	100-C12 $\otimes$ 400
												3	1	100-C12 $\otimes$ 300
												2	2	100-C12 $\otimes$ 200
16	32	5.5	7.5	7.5	7.5	1	3	5	5	10	15	4	0	100-C16 $\otimes$ 400
												3	1	100-C16 $\otimes$ 300
												2	2	100-C16 $\otimes$ 200
23	32	7.5	11	13	10	2	3	5	7-1/2	15	15	4	0	100-C23 $\otimes$ 400
												3	1	100-C23 $\otimes$ 300
												2	2	100-C23 $\otimes$ 200
37	75	11	18.5/20	20	18.5	3	5	10	10	25	30	4	0	100-C40 $\otimes$ 400
												2	2	100-C40 $\otimes$ 200
												4	0	100-C90 $\otimes$ 400
85	130	25	45	55	45	7-1/2	15	25	30	60	50	4	0	100-C90 $\otimes$ 400
												2	2	100-C90 $\otimes$ 200

$\bullet$  Three-phase ratings only apply to contactors with at least three N.O. power poles.



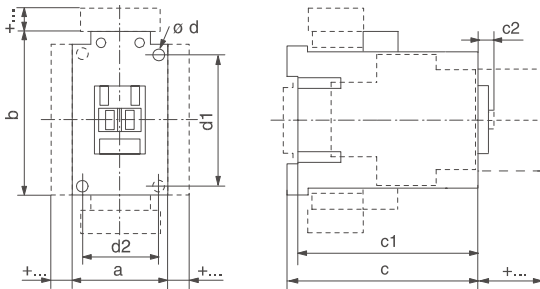
**MCS**  
PLUS

## ⊗ Coil Voltage Code

The Cat. No. as listed is incomplete. Select a coil voltage code from the table below to complete the Cat. No.  
Example: 120V, 60 Hz: **Cat. No. 100-C09**⊗**400** becomes **Cat. No. 100-C09D400**.

V HZ	24	110	120	200-220	208	208-240	220-230	230	240	277	380	380-400	400	400-415	440	480	500	550	600				
50 Hz	K	D	-	L	-	-	F	-	T	-	-	N	-	G	B	-	M	C	-				
60 Hz	J	-	D	-	H	L	-	-	A	T	E	-	-	-	-	B	-	-	C				
50/60Hz	KJ	-	-	-	-	-	-	KF	-	-	-	-	KN	-	-	-	-	-	-				
<b>DC Voltages</b>												<b>12</b>	<b>24</b>	<b>48</b>	<b>110</b>	<b>115</b>	<b>125</b>	<b>220</b>	<b>230</b>	<b>250</b>			
100-C09...C40												Standard			ZQ	ZJ	ZY	ZD	ZP	ZS	ZA	ZF	ZT
												with Integrated Diode			-	DJ	-	-	-	-	-	-	-
100-C90												with Integrated Diode			DQ	DJ	DY	DD	DP	DS	DA	DF	DT

**Dimensions** Dimensions are shown in millimeters (inches). Dimensions are not intended for manufacturing purposes.



### AC Contactors

Cat. No.	a	b	c	c1	c2	∅d	d1	d2
<b>100-C09...100-C23</b>	45 (1-25/32)	81 (3-3/16)	80.5 (3-11/64)	75.5 (2-31/32)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
<b>100-C40</b>	59 (2-21/64)	81 (3-3/16)	100.5 (3-61/64)	95.5 (3-49/64)	6.5 (1/4)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	45 (1-25/32)
<b>100-C90</b>	95 (3-47/64)	122 (4-51/64)	117 (4-39/64)	111.5 (4-25/64)	8.5 (21/64)	4 - 5.4 (4 - 7/32)	100 (3-15/16)	55 (2-11/64)

### DC Contactors

Cat. No.	a	b	c	c1	c2	∅d	d1	d2
<b>100-C09Z...100-C16Z</b>	45 (1-25/32)	81 (3-3/16)	106.5 (4-3/16)	101.5 (4)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
<b>100-C23Z</b>	45 (1-25/32)	81 (3-3/16)	123.5 (4-55/64)	118.5 (4-43/64)	6 (15/64)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	35 (1-3/8)
<b>100-C40Z</b>	59 (2-21/64)	81 (3-3/16)	144.5 (5-11/16)	139.5 (5-1/2)	6.5 (1/4)	2 - 4.5 (2 - 3/16)	60 (2-23/64)	45 (1-25/32)
<b>100-C90D</b>	95 (3-47/64)	122 (4-51/64)	117 (4-39/64)	111.5 (4-25/64)	8.5 (21/64)	4 - 5.4 (4 - 7/32)	100 (3-15/16)	55 (2-11/64)

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## Bulletin 193 E1 Plus Solid-State Overload Relays

### Overload Relays

		Cat. No. 193-ED1_B, 193-EE_B, and 592-EE_T	Cat. No. 193-EE_D, and 592-EE_C	Cat. No. 193-EE_E, and 592-EE_D	Cat. No. 193-EE_F\$	Cat. No. 193-EE_G	Cat. No. 193-EE_H
<b>Main Circuits</b>							
Rated Insulation Voltage (U <sub>i</sub> )		690V AC			1000V AC		
Rated Impulse Strength (U <sub>imp</sub> )		6 kV AC			6 kV AC		
Rated Operating Voltage (U <sub>e</sub> ) IEC/UL		690V AC/600V AC			1000V AC/600V AC		
Rated Operating Frequency		50/60 Hz (sinusoidal)			50/60 Hz (sinusoidal)		
Terminal Cross-Sections	Terminal Type						
	Terminal Screws	M5		M8	Lug		
Flexible-Stranded with Ferrule	Single Conductor Torque	2.5...16 mm <sup>2</sup> 2.5 N•m	2.5...16 mm <sup>2</sup> 2.5 N•m	4...35 mm <sup>2</sup> 24 N•m	—	—	—
	Two Conductor Torque	2.5...10 mm <sup>2</sup> ‡ 3.4 N•m	2.5...10 mm <sup>2</sup> ‡ 3.4 N•m	4...25 mm <sup>2</sup> 4 N•m	—	—	—
Coarse-Stranded/Solid	Single Conductor Torque	2.5...25 mm <sup>2</sup> 2.5 N•m	2.5...25 mm <sup>2</sup> 2.5 N•m	4...50 mm <sup>2</sup> 4 N•m	16...150 mm <sup>2</sup> 28 N•m	—	—
	Two Conductor Torque	6...16 mm <sup>2</sup> ‡ 3.4 N•m	6...16 mm <sup>2</sup> ‡ 3.4 N•m	4...35 mm <sup>2</sup> 4 N•m	—	25...185 mm <sup>2</sup> 28 N•m	70...240 mm <sup>2</sup> 45 N•m
	Four Conductor Torque	6...16 mm <sup>2</sup> ‡ 3.4 N•m	6...16 mm <sup>2</sup> ‡ 3.4 N•m	4...35 mm <sup>2</sup> 4 N•m	—	—	70...240 mm <sup>2</sup> 45 N•m
Stranded/Solid	Single Conductor Torque	14...6 AWG 22 lb•in	14...6 AWG 22 lb•in	12...1 AWG 35 lb•in	6...300 MCM 250 lb•in	—	—
	Two Conductor Torque	14...6 AWG‡ 30 lb•in	14...6 AWG‡ 30 lb•in	6...2 AWG 35 lb•in	—	4...350 MCM 250 lb•in	2/0...500 MCM 400 lb•in
	Four Conductor Torque	14...6 AWG‡ 30 lb•in	14...6 AWG‡ 30 lb•in	6...2 AWG 35 lb•in	—	—	2/0...500 MCM 400 lb•in
Pozidriv Screwdriver Size		2	2	—	—	—	—
Slotted Screwdriver (mm)		1 x 6	1 x 6	—	—	—	—
Hexagon Socket Size (mm)		—	—	4	8	8	8
<b>Control Circuits</b>							
Rated Insulation Voltage (U <sub>i</sub> )		690V AC					
Rated Impulse Strength (U <sub>imp</sub> )		6 kV AC					
Rated Operating Voltage (U <sub>e</sub> ) IEC/UL		690V AC / 600V AC					
Rating Designation		B600					
<b>Rated Operating Current I<sub>e</sub></b>		<b>N.O./N.C.</b>					
AC-15	12...120V	3/2					
	220...240V	1.5/1.5					
	380...480V	0.75/0.75					
	500...600V	0.6/0.6					
Thermal Current I <sub>the</sub>		5 A					
Contact Reliability		17V, 5 mA					
Screw Terminal Cross Sections	Terminal Screw	M3					
Flexible-Stranded with Ferrule	Single Conductor Torque	0.5...2.5 mm <sup>2</sup> 0.55 N•m			—		
	Two Conductor Torque	0.25...1.5 mm <sup>2</sup> 0.55 N•m			0.2...0.75 mm <sup>2</sup> 0.55 N•m		

Coarse-Stranded/Solid	Single Conductor Torque	0.5...4 mm <sup>2</sup> 0.55 N•m	
	Two Conductor Torque	0.2...2.5 mm <sup>2</sup> 0.55 N•m	0.2...1.5 mm <sup>2</sup> 0.55 N•m
Stranded/Solid	Single Conductor Torque	24...10 AWG 5 lb•in	
	Two Conductor Torque	24...12 AWG 5 lb•in	22...16 AWG 5 lb•in
Screwdriver Size (mm)		#1 Pozidriv/0.6 x 3.5 slotted	
<b>Cage Clamp Cross-Sections</b>			
Flexible-Stranded with Ferrule		0.25...1 mm <sup>2</sup>	
Coarse-Stranded/Solid		0.2...1.5 mm <sup>2</sup>	
Stranded/Solid		24...14 AWG	

‡ For multiple conductor applications, the same style and size of wire must be used.

§ Cat. Nos. 193-EEGF and 193-EEVF follow Cat. No. 193-EE\_E specifications.

### 3-Pole Terminal Blocks

Cat. No. 100-DTB180	Cat. No. 100-DTB420
(A) 6...1/0 AWG, 16...50 mm <sup>2</sup> (B) 6 AWG...250 MCM, 16...120 mm <sup>2</sup> 90...110 lb•in, 10...12 N•m	(2) 4 AWG...600 MCM, 25...240 mm <sup>2</sup> 180...220 lb•in, 20...25 N•m

### Terminal Lug Kits

Cat. No. 100-DLE110	Cat. No. 100-DL180	Cat. No. 100-DL420	Cat. No. 100-DL630	Cat. No. 100-DL860
Lug: 6...2/0 AWG, 16...70 mm <sup>2</sup> 90...110 lb•in, 10...12 N•m Terminal: 13/32 in., 10 mm 150 lb•in, 17 N•m	Lug: 6 AWG...250 MCM, 16...120 mm <sup>2</sup> 90...110 lb•in, 10...12 N•m Terminal: 1/2 in., 13 mm 275 lb•in, 16 N•m	Lug: 2 AWG...350 MCM, 375 lb•in, 42 N•m Terminal: 11/16 in., 17 mm 140 lb•in, 16 N•m	Lug: 2/0 AWG...500 MCM, 70...240 mm <sup>2</sup> 400 lb•in, 45 N•m Terminal: 3/4 in., 19 mm 600 lb•in, 68 N•m	Lug: 2/0 AWG...500 MCM, 70...240 mm <sup>2</sup> 400 lb•in, 45 N•m Terminal: 3/4 in., 19 mm 600 lb•in, 68 N•m

## Environmental Ratings

Ambient Temperature	Storage Operating	-40...+85 °C (-40...+185 °F) -20...+60 °C (-4...+140 °F)
Humidity	Operating Damp Heat	5...95% Non-condensing per IEC 68-2-3 and IEC 68-2-30
Vibration (per IEC 68-2-6)		3 G
Shock (per IEC 68-2-27)		30 G
Max. Altitude		2000 m
Pollution Environment		Pollution Degree 3
Degree of Protection		IP20

## Protection

Type of Relay	Ambient Compensated, Time Delay, Phase Loss Sensitive	
Nature of Relay	Solid-State	
Trip Rating	120% FLA	
Trip Class	Type ED	10
	Type EE	10, 15, 20, 30
Reset Mode	Type ED	Manual
	Type EE	Automatic or Manual
Electromagnetic Compatibility		
Electrostatic Discharge Immunity	Test Level	8 kV Air Discharge, 6 kV Contact Discharge
	Performance Level	1 § ‡
RF Immunity	Test Level	10 V/m
	Performance Level	1 § ‡
Electrical Fast Transient/Burst Immunity	Test Level	4 kV
	Performance Level	1 § ‡
Surge Immunity	Test Level	2 kV (L-E), 1 kV (L-L)
	Performance Level	1 § ‡

§ Performance Criteria 1 requires the device under test (DUT) to experience no degradation or loss of performance.

‡ Environment 2.

## General

	Cat. No. 193-ED1_B, 193-EE_B	Cat. No. 193-EE_D	Cat. No. 193-EE_E
Standards	UL508, CSA C22.2 No. 14, NEMA ICS 2-1993 Part 4, EN 60947-4-1, EN 60947-5-1		
Certifications	CE, cULus, C-Tick, CCC		
Approximate Weights (unpackaged)	0.25 kg (0.55 lb)	0.25 kg (0.55 lb)	0.52 kg (1.06 lb)

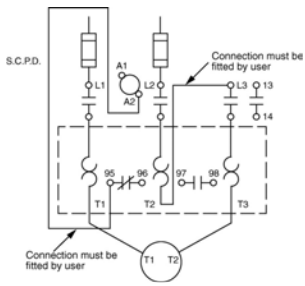
## External Current Transformers (for use with cat. nos. 193-EE\_Z)

The user shall provide one current transformer (CT) for each motor phase, and shall connect the CT's secondary leads to the appropriate E1 Plus overload relay power terminals, as shown in current transformer's wiring diagrams. The CT shall have the appropriate ratio (refer to the product nameplate or product description). Additionally, the CT shall be selected to be capable of providing the required VA to the secondary load, which includes the E1 Plus overload relay burden at the rated secondary current and the wiring burden. Finally, the CT shall be rated for protective relaying to accommodate the high inrush currents associated with motor startup, and shall have an accuracy of  $\pm 2\%$  over its normal operating range. Typical CT ratings include (Instrument Transformers, Inc. – Model #23 or equivalent):

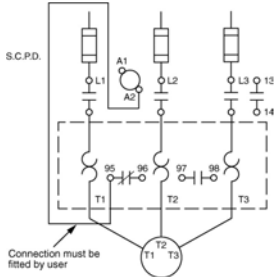
ANSI (USA)	Class C5B0.1
CSA (Canada)	Class 10L5
IEC (Europe)	5 VA Class 5P10

## Wiring Schematic

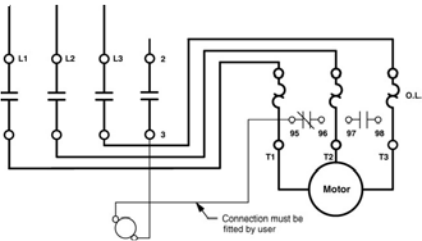




Typical Wiring for 1-Phase IEC Applications



Typical Wiring for 3-Phase IEC Applications

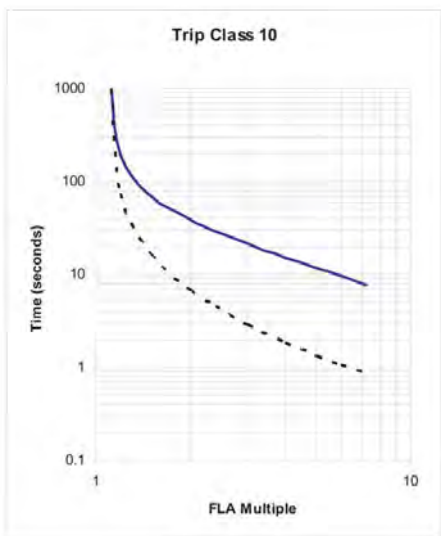


Typical Wiring for NEMA Applications

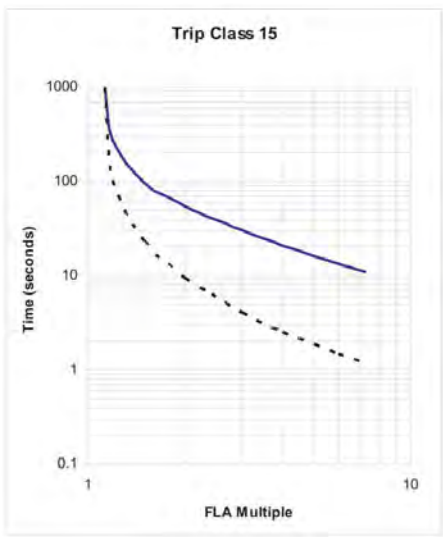
## Trip Curves

Typical reset time for 193-EE devices set to automatic reset mode is 120 seconds.

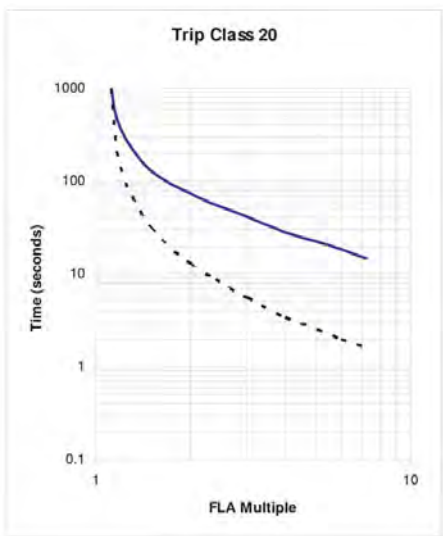
### Trip Class 10



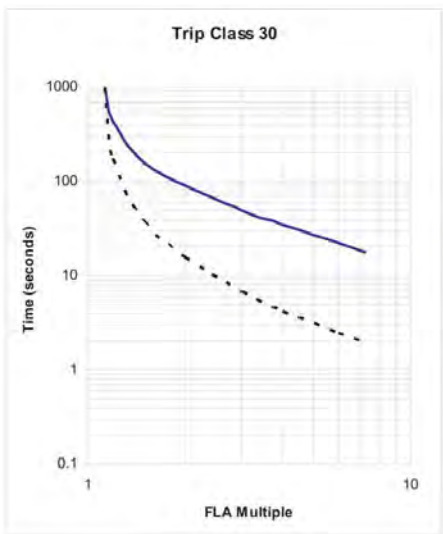
### Trip Class 15



**Trip Class 20**



**Trip Class 30**



**Trip Curve Legend:** Cold Trip —————  
 Hot Trip - - - - -

# Interposing Relays

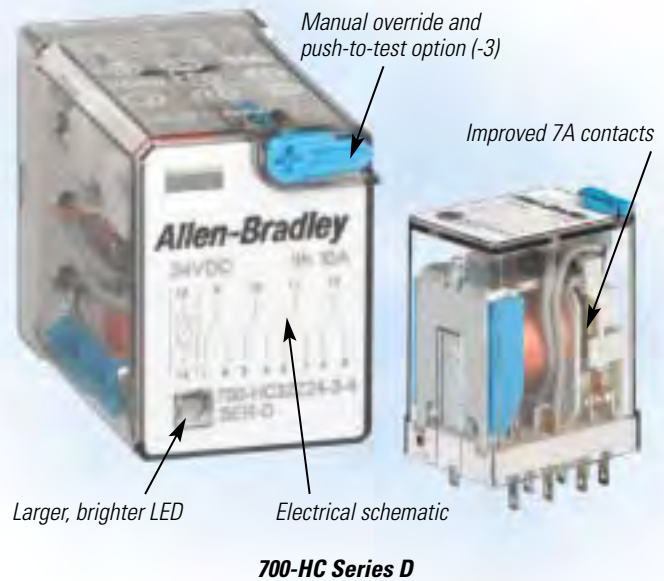
## *New Cost-Saving Relay Design*

### **Bulletin 700-HC, 700-HP, 700-A**

Rockwell Automation is introducing a new and improved Allen-Bradley 700-HC "Ice Cube" General Purpose Relay. This 4-pole plug-in relay has been redesigned to meet your low energy switching application needs. Along with the 700-HC, Allen-Bradley is offering a new, space-saving 700-HP printed circuit board (PCB) "Pin" style relay.

#### **700-HC Series D**

- Cost-reduced design
- Improved low-energy switching capability
- Increased the  $I_{th}$  switching capability from 5 A ... 7 A
- Designed the same Allen-Bradley relay family appearance on faceplate
- Incorporated manual override lever (-3 option) with the existing push-to-test button
- New 700-HC Series A, 2-pole, 10 A version is now available with silver contacts



#### **700-HP PCB "Pin" Style**

- PCB or socket mountable
- 5 mm Pin spacing available in a 2-pole, 8 A design

#### **700-A Plug and Play Modules**

- Module mounted within sockets
- Available as surge suppression, timing and LED modules
- Modules compatible with 700-HN104 socket (for 700-HC relay)
- Modules compatible with 700-HN123 socket (for 700-HP relay)
- Modules compatible with 700-HN153 socket (for 700-HB relay)



**700-HP PCB "Pin" Style**



**700-A Plug and Play Module**

#### **Coil and Contact Suppression Sockets**

- 700-HN104 (for 700-HC relay), 700-HN123 (for 700-HP relay)
- 12 A, 300V AC rating
- Able to insert optional plug and play 700-A modules

Specification Overview					
Catalog Number		700-HC		700-HP	
<b>Electrical</b>					
<b>Pilot Duty Rating</b>		NEMA C300, R300			
<b>Rated Thermal Current <math>I_{th}</math></b>		4-pole 7 A		2-pole 10 A	
<b>Contacts</b>	Inductive 120V AC 240V AC	▶ ◀ 15 A 7.5 A	◀ ▶ 1.5 A 0.75 A	▶ ◀ 15 A 7.5 A	◀ ▶ 1.5 A 0.75 A
	DC	24V DC, 7 A		24V DC, 10 A	
<b>Permissible Coil Voltage Variation</b>		80 ... 110% of Nominal Voltage at 50 Hz 80 ... 110% of Nominal Voltage at 60 Hz 80 ... 110% of Nominal Voltage at DC		80 ... 110% of Nominal Voltage at 50 Hz 80 ... 110% of Nominal Voltage at 60 Hz 73 ... 150% of Nominal Voltage at DC	
<b>Min. Permissible Contact Ratings</b>		700-HC14 = 10V, 1 mA 700-HC22 and 700-HC24 = 10V, 10 mA		700-HP32 = 300 mW (5V, 5 mA) 700-HPX = 50 mW (5V, 5 mA)	
<b>Coil Consumption ± 10%</b>		50 Hz		60 Hz	
<b>AC Coils</b>	Inrush	2.2 VA		1.6 VA	
	Sealed	1.3 VA		1.1 VA	
<b>DC Coils</b>		1.0 W		0.5 W	
<b>Design Specification/Test Requirements</b>					
<b>Electrical</b>					
<b>Dielectric Withstand Voltage</b>		1600V AC		2000V AC	
<b>Pole-to-Pole</b>		1600V AC		5000V AC	
<b>Contact to Coil</b>		1600V AC		—	
<b>Contact to Frame</b>		1600V AC		—	
<b>Electrical Life</b>		100,000 min.			
<b>Mechanical</b>					
<b>Degree of Protection (Open Type) IEC 529</b>		IP 20 (Guarded Terminal Sockets)			
<b>Mechanical Life Operations</b>		20 x 10 <sup>6</sup> (AC) 50 x 10 <sup>6</sup> (DC)		10 x 10 <sup>6</sup> (AC) 20 x 10 <sup>6</sup> (DC)	
<b>Switching Frequency Operations</b>		1800/hr.			
<b>Coil Voltages</b>		See Overview/Product Selection			
<b>Operating Time (ms)</b>	Max Pickup	10		15	
	Max. Dropout	15		12	
<b>Maximum Operating Rate</b>		16 OPS/seconds			
<b>Environmental</b>					
<b>Temperature</b>	Operating	-30 ... +55° C (-22 ... +131° F)		-40 ... +85° C	
	Storage	-55 ... +85° C (-67 ... +185° F)		-45 ... +100° C	
<b>Altitude</b>		2000 m (6560 ft)			
<b>Construction</b>					
<b>Insulating Material</b>		Molded High Dielectric Material			
<b>Enclosure</b>		Transparent Dust Cover			
<b>Contact Material</b>		Silver Nickel, (AgNi) Silver Nickel + Gold Plating (AgNi + Au)			
<b>Terminal Markings on Socket</b>		In accordance with ENSO 0005			
<b>Sockets</b>		700-HN103, -HN128, -HN104		700-HN123	
<b>Certifications and Approvals</b>		cULus Listed, cURus certified, IMQ, ABS, RINA, CE Marked			
<b>Conformity to Standards</b>		EN 60947 -4-1, EN 60947 -5-, IEC 947, CSA 22.2, UL 508			

[www.rockwellautomation.com](http://www.rockwellautomation.com)

#### Corporate Headquarters

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# The Time-saving Product Line

Quick Selection, Superior Design, Fast Mounting

Bulletin 800F



**Allen-Bradley**

**Rockwell  
Automation**



## Superior Design

The 800F line is designed and manufactured to meet demanding performance specifications. Using state-of-the-art solid modeling techniques and finite element analysis, every component built into 800F Push Buttons is optimized for durability and performance.

### Durable Materials

- 800FP operators are made of industrial grade thermoplastic for superior chemical resistance.
- 800FM operators are constructed of tough die cast zinc alloy, finished with chromate plating.

### Switching Safety

- Rigid teeth inside all 800F selector switches provide positive detent which assures they will not hang-up between positions.
- Our constant energy solution adds an additional layer of protection to assure switching safety. Vibration will not cause a change in state.

## Fast Mounting

Allen-Bradley Push Buttons are designed for easy 1-person mounting and removal.



**Contact Block**  
Snap down color-coded contact blocks

**Latch +**

**Mounting ring +**

**Legend plate + (optional)**

**Operator +**



Rotating latch collar for easy mounting and removal.

### Worldwide Solutions

- Designed to meet worldwide standards.
- UL Listed, CSA Rated, CE Marked, Third party approval: KEMA.
- Operator caps, legend plates and inserts available with international symbols, foreign languages, and custom markings.

### Dependable Sealing

- Our dependable sealing allows us to offer IP 66 and Type 4/13 across the 800F product line.
- Diaphragm seals are used on most linear travel devices. These seals flex with operation of the button and life/performance are not dependent on lubrication.
- K-seals are used on rotating devices such as twist-to-release E-stops. These seals offer dual wiping action that provides high pressure sealing performance.

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# Screw Connection Terminal Blocks

## Fuse Blocks

	1492-H...		1492-WFB4...	
Dimensions are not intended to be used for manufacturing purposes. Note: Height dimension is measured from top of rail to top of terminal block.				
	3.20" (81.3 mm)		2.0" (50.7 mm)	
<b>Specifications</b>	Single-circuit fusible terminal block with or without fuse indication.		Single-circuit fuse block with or without fuse indication.	
<b>Certifications</b>		<b>CSA</b>	<b>IEC</b>	
<b>Voltage Rating</b>	H6/WFB4	300V AC/DC	500V AC/DC	300V AC/DC
	H5/WFB424	10...57V AC/DC		10...57V AC/DC
	H4/WFB4250	100...300V AC		85...264V AC
<b>Maximum Current</b>	12 A		15 A	15 A *
<b>Wire Range (Rated Cross Section)</b>	#30... #12 AWG	0.5... 4 mm <sup>2</sup>	#22... #12 AWG	0.5... 4 mm <sup>2</sup>
<b>Wire Strip Length</b>	0.38 in (9.7 mm)		0.31 in (8 mm)	
<b>Recommended Tightening Torque</b>	3...7 lb•in (0.3...0.8 Nm)		5.0...5.6 lb•in (0.6 Nm)	
<b>Density (Blocks per ft/meter)</b>	33 pcs/ft (109/m)		38 pcs/ft (125/m)	
<b>Housing Temperature Range</b>	-40...+195 °F (-40...+90 °C)		-40...+195 °F (-40...+90 °C)	
<b>Indicator Type</b>				
H6/WFB4	Non-Indicating		Non-Indicating	
H5/WFB424	Red LED		Red LED	
H4/WFB4250	Neon		Neon	
<b>Leakage Current</b>				
H6/WFB4	—		—	
H5/WFB424	2 mA @ 24V		2 mA @ 24V	
H4/WFB4250	2 mA @ 300V		2 mA @ 300V	
<b>Fuse Size (Not Supplied)</b>	1/4 in x 1-1/4 in		5 x 20 mm	
<b>Terminal Blocks</b>	<b>Cat. No.</b>	<b>Pcs/Pkg</b>	<b>Cat. No.</b>	<b>Pcs/Pkg</b>
Black No-indication	1492-H6	25	1492-WFB4	50
Color: Black w/LED	1492-H5	25	1492-WFB424	50
Black w/Neon	1492-H4	25	1492-WFB4250	50
<b>Accessories</b>	<b>Cat. No.</b>	<b>Pcs/Pkg</b>	<b>Cat. No.</b>	<b>Pcs/Pkg</b>
<b>Mounting Rails:</b>				
1 m Symmetrical DIN (Steel)	199-DR1	10	199-DR1	10
1 m Symmetrical DIN (Aluminum)	1492-DR5	10	1492-DR5	10
1 m Hi-Rise Sym. DIN (Aluminum)	1492-DR6	2	1492-DR6	2
1 m Angled Hi-Rise Sym. DIN (Steel)	1492-DR7	2	1492-DR7	2
3 ft Scored A-B Rail	1492-N1	20	—	—
3 ft Rigid A-B Rail	1492-N22	20	—	—
3 ft High Rise A-B Rail	1492-N44	2	—	—
Standoff Brackets (Use Every 12 in)	1492-N25	2	—	—
End Barrier	1492-N37	50	Not Required	—
<b>End Anchors and Retainers:</b>				
Screwless End Retainer	1492-ERL35	20	1492-ERL35	20
DIN Rail — Normal Duty	1492-EAJ35	100	1492-EAJ35	100
DIN Rail — Heavy Duty	1492-EAHJ35	50	1492-EAHJ35	50
A-B Rail — Heavy Duty	1492-N23	10	—	—
Side Jumpers (1Pole/1m)	1492-N49	10	1492-SJFB8-10	10
Side Jumper — 10-pole Insulated	1492-SJS	10	—	—
<b>Other Accessories:</b>				
Partition Plate	—	—	1492-PPSL3	50
Group Marking Carrier	1492-GM35	25	1492-GM35	25
<b>Marking Systems:</b>				
Snap-In Marker Card — For Base Block	1492-MS8X12 (56/card)	5	1492-MS8X12 (56/card)	5
	1492-MS8X9 (56/card)	5	1492-MS8X9 (56/card)	5
For Handle	1492-MS8X12 (56/card)	5	1492-MS8X9 (56/card)	5
Adhesive Labels	1492-ALHFB (50/sheet)	1	1492-ALHFB (50/card)	1
Individual Marker Tabs (single char.)	—	—	1492-MP (10/stick) †	10

\* IEC standards for 5 x 20 mm fuses do not include ratings above 6.3 A.

† Cat. no. is incomplete. See pages 81 and 82.

# Screw Connection Terminal Blocks

## Standard Feed-Through Blocks

	1492-J3				1492-J4				1492-J6			
Dimensions are not intended to be used for manufacturing purposes. Note: Height dimension is measured from top of rail to top of terminal block.												
<b>Specifications</b>	Feed-Through Terminal Block				Feed-Through Terminal Block				Feed-Through Terminal Block			
<b>Certifications</b>		<b>CSA</b>	<b>IEC</b>	<b>EEx e II</b>		<b>CSA</b>	<b>IEC</b>	<b>EEx e II</b>		<b>CSA</b>	<b>IEC</b>	<b>EEx e II</b>
<b>Voltage Rating</b>	600V AC/DC		800V AC/DC	550V AC/DC	600V AC/DC		800V AC/DC	750V AC/DC	600V AC/DC		800V AC/DC	550V AC/DC
<b>Maximum Current</b>	25 A	20 A	24 A	21 A	35 A	32 A	28 A	28 A	50 A	41 A	36 A	36 A
<b>Wire Range (Rated Cross Section)</b>	30... 12 AWG	26... 12 AWG	2.5 mm <sup>2</sup>	2.5 mm <sup>2</sup> (20... 14 AWG)	22... 10 AWG	4 mm <sup>2</sup>	4 mm <sup>2</sup>	4 mm <sup>2</sup> (20... 12 AWG)	20... 8 AWG	6 mm <sup>2</sup>	6 mm <sup>2</sup> (20... 10 AWG)	6 mm <sup>2</sup> (20... 10 AWG)
<b>Wire Strip Length</b>	0.39 in (10 mm)				0.39 in (10 mm)				0.47 in (12 mm)			
<b>Recommended Tightening Torque</b>	3.7...7.1 lb•in (0.4...0.8 Nm)				4.4...8.8 lb•in (0.5...1.0 Nm)				7.1...12.4 lb•in (0.8...1.4 Nm)			
<b>Density (Blocks per ft/meter)</b>	59 per ft/196 per meter				49 per ft/163 per meter				37 per ft/123 per meter			
<b>Housing Temperature Range</b>	-58...+248 °F (-50...+120 °C)				-58...+248 °F (-50...+120 °C)				-58...+248 °F (-50...+120 °C)			
<b>Terminal Blocks</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>
<b>Color:</b>	Gray	1492-J3		100	1492-J4	1492-J4		100	1492-J6	1492-J6		100
	Red	1492-J3-RE		100	1492-J4-RE	1492-J4-RE		100	1492-J6-RE	1492-J6-RE		100
	Blue	1492-J3-B		100	1492-J4-B	1492-J4-B		100	1492-J6-B	1492-J6-B		100
	Black	1492-J3-BL		100	1492-J4-BL	1492-J4-BL		100	1492-J6-BL	1492-J6-BL		100
	Green	1492-J3-G		100	1492-J4-G	1492-J4-G		100	1492-J6-G	1492-J6-G		100
	Yellow	1492-J3-Y		100	1492-J4-Y	1492-J4-Y		100	1492-J6-Y	1492-J6-Y		100
	Orange	1492-J3-OR		100	1492-J4-OR	1492-J4-OR		100	1492-J6-OR	1492-J6-OR		100
	Brown	1492-J3-BR		100	1492-J4-BR	1492-J4-BR		100	1492-J6-BR	1492-J6-BR		100
	White	1492-J3-W		100	1492-J4-W	1492-J4-W		100	1492-J6-W	1492-J6-W		100
<b>Accessories</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>	<b>Cat. No.</b>			<b>Pcs/Pkg</b>
<b>Mounting Rails:</b>	199-DR1			10	199-DR1			10	199-DR1			10
1 m Symmetrical DIN (Steel)	1492-DR5			10	1492-DR5			10	1492-DR5			10
1 m Symmetrical DIN (Aluminum)	1492-DR6			2	1492-DR6			2	1492-DR6			2
1 m Hi-Rise Sym. DIN (Aluminum)	1492-DR7			2	1492-DR7			2	1492-DR7			2
1 m Angled Hi-Rise Sym. DIN (Steel)	1492-EBJ3			50	1492-EBJ3			50	1492-EBJ3			50
<b>End Barriers</b>	Gray	1492-EBJ3		50	1492-EBJ3	1492-EBJ3		50	1492-EBJ3	1492-EBJ3		50
	Blue	1492-EBJ3-B		50	1492-EBJ3-B	1492-EBJ3-B		50	1492-EBJ3-B	1492-EBJ3-B		50
	Yellow	1492-EBJ3-Y		50	1492-EBJ3-Y	1492-EBJ3-Y		50	1492-EBJ3-Y	1492-EBJ3-Y		50
<b>End Anchors and Retainers:</b>	1492-ERL35			20	1492-ERL35			20	1492-ERL35			20
Screwless End Retainer	1492-EAJ35			100	1492-EAJ35			100	1492-EAJ35			100
DIN Rail — Normal Duty	1492-EAHJ35			50	1492-EAHJ35			50	1492-EAHJ35			50
DIN Rail — Heavy Duty	1492-CJJ5-10			20	1492-CJJ6-10			20	1492-CJJ8-10			20
<b>Jumpers:</b> *	1492-CJJ5-10			20	1492-CJJ6-10			20	1492-CJJ8-10			20
Screw Center Jumper — 10 pole	1492-CJJ5-4			50	1492-CJJ6-4			50	1492-CJJ8-4			50
Screw Center Jumper — 4 pole	1492-CJJ5-3			50	1492-CJJ6-3			50	1492-CJJ8-3			50
Screw Center Jumper — 3 pole	1492-CJJ5-2			50	1492-CJJ6-2			50	1492-CJJ8-2			50
Screw Center Jumper — 2 pole	1492-CJLJ5-50			10	1492-CJLJ6-41 (41-pole)			10	—			—
Plug-in Center Jumper — 50 Pole	1492-CJLJ5-10			20	1492-CJLJ6-10			20	—			—
Plug-in Center Jumper — 10 Pole	1492-CJLJ5-9			20	—			—	—			—
Plug-in Center Jumper — 9 Pole	1492-CJLJ5-8			20	—			—	—			—
Plug-in Center Jumper — 8 Pole	1492-CJLJ5-7			20	—			—	—			—
Plug-in Center Jumper — 7 Pole	1492-CJLJ5-6			20	—			—	—			—
Plug-in Center Jumper — 6 Pole	1492-CJLJ5-5			20	—			—	—			—
Plug-in Center Jumper — 5 Pole	1492-CJLJ5-4			60	1492-CJLJ6-4			60	—			—
Plug-in Center Jumper — 4 Pole	1492-CJLJ5-3			60	1492-CJLJ6-3			60	—			—
Plug-in Center Jumper — 3 Pole	1492-CJLJ5-2			60	1492-CJLJ6-2			60	—			—
Plug-in Center Jumper — 2 Pole	1492-SJ5B-24			50	—			—	—			—
Insulated Side Jumper — 24 Pole	1492-SJ5B-10			50	—			—	—			—
Insulated Side Jumper — 10 Pole	1492-T1			1	1492-T1			1	1492-T1			1
Screw Type Jumper Notching Tool	1492-EBJ16			20	1492-EBJ16			20	1492-EBJ16			20
<b>Other Accessories:</b>	1492-TPS23			20	1492-TPS23L			50	1492-TPS23L			50
Partition Plate	1492-TP23			20	1492-TP23			20	1492-TP23			20
Test Plug Socket	1492-TPJ5			25	1492-TPJ6			25	—			—
Test Plug (Stackable)	1492-EWPJ5			25	1492-EWPJ5			25	1492-EWPJ8			50
Electrical Warning Plate	1492-GM35			25	1492-GM35			25	1492-GM35			25
Group Marking Carrier	1492-M5X12 (144/card)			5	1492-M6X12 (120/card)			5	1492-M7X12 (108/card)			5
<b>Marking Systems:</b>	1492-M5X5 (200/card)			5	1492-M6X5 (200/card)			5	1492-M8X5 (160/card)			5
Snap-in Marker Cards												




\* Use of Center Jumpers may affect spacings, requiring derating of terminal blocks. See page 77 for details.

## Power Terminal Blocks

### Bul. 1492-PD Open-Style

#### Mini Blocks
















- Rated at 600V AC/DC, 115 A; these blocks offer high current-carrying capacity in a very small package to save on panel space
- Two configurations available: 3-pole feed-through with 1 line opening and 1 load opening per pole; 3-pole power distribution with 1 line opening and 4 load openings per pole
- Insulating material max. temperature: 257 °F (125 °C)
- UL 1059 approval E 40735, Guide XCFR2

Amperage	No. of Poles	Line			Load			High Fault Short-Circuit Current Ratings Available	Flexible Copper Wire Connections	Mini Block	Power Block Cover
		Connector Diagram	Wire Range AWG (mm <sup>2</sup> )	Wires per Pole	Connector Diagram	Wire Range AWG (mm <sup>2</sup> )	Wires per Pole			Cat. No.	Cat. No.
115	3		#2...14 (35...2.5)*	1		#2...14 (35...2.5)*	1	Yes	Yes	1492-PDM3111	1492-PBC9
	3		#2...14 (35...2.5)*	1		#10...18 (6...0.75)	4	Yes	Yes	1492-PDM3141	1492-PBC9

\* Wire openings rated for #2-14 AWG are multiple wire rated: (2) #8 CU Str, (2) #10 CU Str, (2) #12 CU Str, and (2) #14 CU Str.

### Open-Style Power Distribution and Splicer Blocks (with Aluminum or Copper Connectors)

- Rated at 600V AC/DC, 115...760 A
- 1- and 3-pole configurations
- 1 or 2 line openings per pole, 1, 2, 4, 6, 8, or 12 load openings per pole
- Insulating material max. temperature: 302 °F (150 °C)
- UL 1059 approval E 40735, Guide XCFR2

Amperage	No. of Poles	Line			Load			High Fault Short-Circuit Current Ratings Available	Flexible Copper Wire Connectors	Cat. No.▲	Power Block Cover
		Connector Diagram	Wire Range AWG (mm <sup>2</sup> )	Wires per Pole	Connector Diagram	Wire Range AWG (mm <sup>2</sup> )	Wires per Pole			Cat. No.	Cat. No.
115	1		#2...14 (35...2.5)*	1		#2...14 (35...2.5)*	1	Yes	Yes	1492-50Y	1492-PBC4
	3		#2...14 (35...2.5)*	1		#2...14 (35...2.5)*	1	Yes	Yes	1492-50X	1492-PBC1
150	3		1/0...#14 (50...2.5)	1		1/0...#14 (50...2.5)	1	—	Yes	1492-PD3C111	1492-PBC1
175	1		2/0...#14 (70...2.5)	1		2/0...#14 (70...2.5)	1	Yes	Yes	1492-100Y	1492-PBC4
	1		2/0...#14 (70...2.5)	1		1/4" Tap w/ Binding Screw	1	Yes	Yes	1492-50YF	1492-PBC4
	3		2/0...#14 (70...2.5)	1		2/0...#14 (70...2.5)	1	Yes	Yes	1492-100X	1492-PBC1
	3		2/0...#14 (70...2.5)	1		1/4" Tap w/ Binding Screw	1	Yes	Yes	1492-50 XF	1492-PBC1
	3		2/0...#14 (70...2.5)	1		#4...14 (25...2.5)‡	4	Yes	Yes	1492-PD3141	1492-PBC1

## PICO CONTROLLER

### *Pico Controllers*

Product Overview

The Pico™ family of nano-PLCs is our smallest, most economical controller offering, performing simple logic, timing, counting, and real-time clock operations. Splitting the difference between a timing relay and a low-end PLC, Pico is ideal for relay replacement applications, simple control applications such as building and parking lot lighting, and applications in which cost is a primary design issue.



### *Benefits*

- *Small Size*—The Pico controller is smaller than some relays, saving panel space and system cost.
- *Simplicity*—Pico is designed with ease of use in mind. All programming and data adjustments can be made using the on-board keypad and LCD display.
- *Flexibility*—You choose from twenty-two 120/240V ac, 12V dc, 24V dc, and 24V ac models that can all be mounted on a DIN rail, on-machine, or in-panel. The built-in 8A relay outputs can drive a range of electrical components.
- *Economy*—Pico controllers without on-board keypad, LCD display, or real-time clock let you select the level of functionality required for your application.

### *Product Design*

Pico can be either DIN-rail or panel mounted, or mounted directly on your machine. Pico controllers offer the following control capabilities:

- 8 or 12 inputs (up to 24 inputs with I/O Expansion Block).
- 4, 6, or 8 outputs (up to 16 outputs with I/O Expansion Block).
- 4 soft inputs controlled by the available on-board keypad.
- 16 internal bits for intermediate data storage.
- 16 timers.
- 16 counters (includes 2 frequency counters and 2 high-speed counters).
- 8 real-time clock instructions.
- 16 analog compare instructions (12V dc, 24V dc, or 24V ac units only).
- 16 text display screens.

Depending on which Pico controller you use, Expansion I/O modules can provide up to 40 I/O points.

### *Specifications*



Memory Size	
All controllers	512 instructions
Power Supply Input Voltage	
120 / 240V ac controllers	85...264V ac, 50 / 60Hz
24V ac controllers	20.4...26.4V ac
24V dc controllers	20.4...28.8V dc
12V dc controllers	10.2...15.6V dc
Input Voltage Range	
120 / 240V ac controllers	79...264V ac
24V ac controllers	14...26.4V ac
24V dc controllers	15...28.8V dc
12V dc controllers	8...15.6V dc
Relay Output Current	8A resistive 3A inductive
Analog Input (dc and 24V ac controllers only)	0...10V dc, ±2% of actual value
Accuracy of Real Time Clock	±5 seconds/day (typical)
Dimensions (HxWxD), Approx.	
12-point controllers	90 x 71.5 x 58 mm (3.54 x 2.81 x 2.28 in)
18- and 20-point controllers	90 x 107.5 x 58 mm (3.54 x 4.23 x 2.28 in)
Shipping Weight	
1760-L12xxx	0.2 kg (0.44 lb)
1760-L18xxx	0.3 kg (0.66 lb)
1760-L20xxx	0.3 kg (0.66 lb)
Operating Temperature	-25...55 °C (-13...131 °F)
Storage Temperature	-40...70 °C (-40...158 °F)
Operating Humidity	5...95% (without condensation)
Shock (IEC 60068-2-27)	18 shocks (semi-sinusoidal 15 g / 11 ms)
Vibration (IEC 60068-2-6)	10...57 Hz (constant amplitude 0.15 mm) 57...150 Hz (constant acceleration 2 g)
Certifications <sup>↖</sup>	UL, CE, CSA, C-Tick, Class I, Division 2 Hazardous Location

<sup>↖</sup> When product is marked. See the Product Certification link at [www.ab.com](http://www.ab.com) for Declarations of Conformity, Certificates, and other certification details.

## Programming

### Using the Keypad

Pico controllers, with on-board keypad and LCD display, can be programmed entirely from the front keypad. Models without the keypad and LCD display are programmed by using PicoSoft programming software or by installing a pre-programmed memory module.

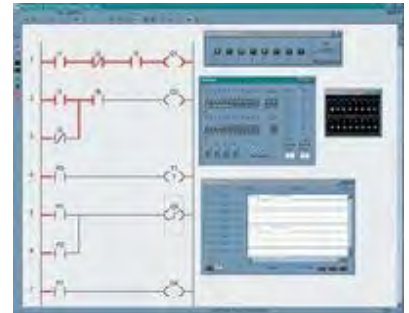
Pico controllers can contain 128 program rungs. Each rung may contain three input instructions and one output instruction. The instruction set includes:

- Input Instructions—examine-on and examine-off.
- Output Instructions—output enable (OTE), set (latch), reset (unlatch), and flip-flop (alternating on/off).
- Timer Instructions—on-delay, off-delay, single pulse, flashing.
- Counter Instructions—count up, count down.
- Real-time Clock Instructions—turn on or off based on time-of-day and day-of-week (models with real-time-clock only).
- Analog Compare Instructions—greater than or less than a setpoint or each other (12V dc, 24V dc, or 24V ac units only).
- Text Display Instructions—display messages, timers, counters, etc. on the LCD display.

### Using PicoSoft Programming Software

PicoSoft programming software (1760-PICOSOFT) lets you create, edit, store, upload, download, and test programs for Pico controllers. This software:

- Provides an easy-to-use programming interface.
- Lets you connect a Pico controller to your PC using the PC to Pico interface cable (1760-CBL-PM02).



With a Pico controller connected to your PC, you can:

- Compare a program in your PC with the program installed on the Pico controller.
- View the status of inputs and outputs in your program for the Pico controller.
- Test your program with the Pico controller.

Download PicoSoft software free of charge from the Pico web site or order PicoSoft software on CD (1760-PICOSOFT) for a nominal fee.

Cat. No.	Description
1760-PICOSOFT	PicoSoft Programming Software (for standard Pico only)
1760-PICOSOFTPRO	PicoSoft Pro Programming Software (for standard Pico and Pico GFX)
1760-CBL-PM02	Programming Cable, PC to standard Pico Processor

### Pico Controllers

Select Pico controllers for up to 20 I/O points. Add a Pico Expansion I/O module for up to 40 I/O points.

Cat. No.	Line Power	Input Voltage Category	Number of Inputs (Digital)	Number of Outputs	Analog	Pico Variation
1760-L12AWA	120 / 240V ac	120V ac	8	4 relay	—	—
1760-L12AWA-NC	120 / 240V ac	120V ac	8	4 relay		no real-time clock

1760-L12AWA-ND	120 / 240V ac	120V ac	8	4 relay		no display
1760-L18AWA-EX	120 / 240V ac	120V ac	12	6 relay		I/O expandable
1760-L18AWA-EXND	120 / 240V ac	120V ac	12	6 relay		I/O expandable, no display
1760-L12NWN	24V ac	24V ac	8↔	4 relay	2 (0...10V dc)	—
1760-L12NWN-ND	24V ac	24V ac	8↔	4 relay		no display
1760-L18NWN-EX	24V ac	24V ac	12↔	6 relay	4 (0...10V dc)	I/O expandable
1760-L18NWN-EXND	24V ac	24V ac	12↔	6 relay		I/O expandable, no display
1760-L12DWD	12V dc	12V dc	8↔	4 relay	2 (0...10V dc)	—
1760-L12DWD-ND	12V dc	12V dc	8↔	4 relay		no display
1760-L18DWD-EX	12V dc	12V dc	12↔	6 relay	4 (0...10V dc)	I/O expandable
1760-L18DWD-EXND	12V dc	12V dc	12↔	6 relay		I/O expandable, no display
1760-L12BBB	24V dc	24V dc	8↔	4 transistor	2 (0...10V dc)	—
1760-L12BBB-ND	24V dc	24V dc	8↔	4 transistor		no display
1760-L12BWB	24V dc	24V dc	8↔	4 relay		—
1760-L12BWB-NC	24V dc	24V dc	8↔	4 relay		no real-time clock
1760-L12BWB-ND	24V dc	24V dc	8↔	4 relay		no display
1760-L18BWB-EX	24V dc	24V dc	12↔	6 relay	4 (0...10V dc)	I/O expandable
1760-L18BWB-EXND	24V dc	24V dc	12↔	6 relay		I/O expandable, no display
1760-L20BBB-EX	24V dc	24V dc	12↔	8 transistor		I/O expandable
1760-L20BBB-EXND	24V dc	24V dc	12↔	8 transistor		I/O expandable, no display

↔ Two to four of the digital dc inputs can be use as 0...10V dc analog inputs. These inputs can be used as either digital or analog, not both. For example, you could use 2 analog inputs plus 10 digital inputs on the 1760-L18DWD-EX.

## Pico I/O Modules

### Pico Expansion I/O Modules

Pico Expansion I/O modules connect to the side of the controller and can be used with Pico or Pico GFX-70 controllers. Expansion I/O modules include an expansion module connector. Replacement connectors can be ordered separately.

Cat. No.	Input Voltage Category	Number of Inputs (Digital)	Number of Outputs
1760-IA12XOW6I	120/240V ac	12	6 isolated relay
1760-IB12XOB8	24V dc	12↔	8 transistor
1760-IB12XOW6I	24V dc	12↔	6 isolated relay
1760-OW2	—	—	2 relay
1760-RPLCONN	Expansion Module Connector - Replacement		

↔ Four of the digital dc inputs can alternately be used as 0...10V dc analog inputs. These inputs can be used as either digital or analog, not both. For example, you could use 4 analog inputs plus 8 digital inputs.

## Accessory Products

# Documentation

## »L&A LOGIC.e60«

1760-L18AWA-E...  
LA



Customer:  
Customer Doc. No.:

HENDRICK SCREEN

Order No.:  
Factory No.:  
Document No.:

HS21791  
KMS

Author:  
Editor:  
Checked:  
Creation Date and Time:  
Last Changed:  
Print Date and Time:

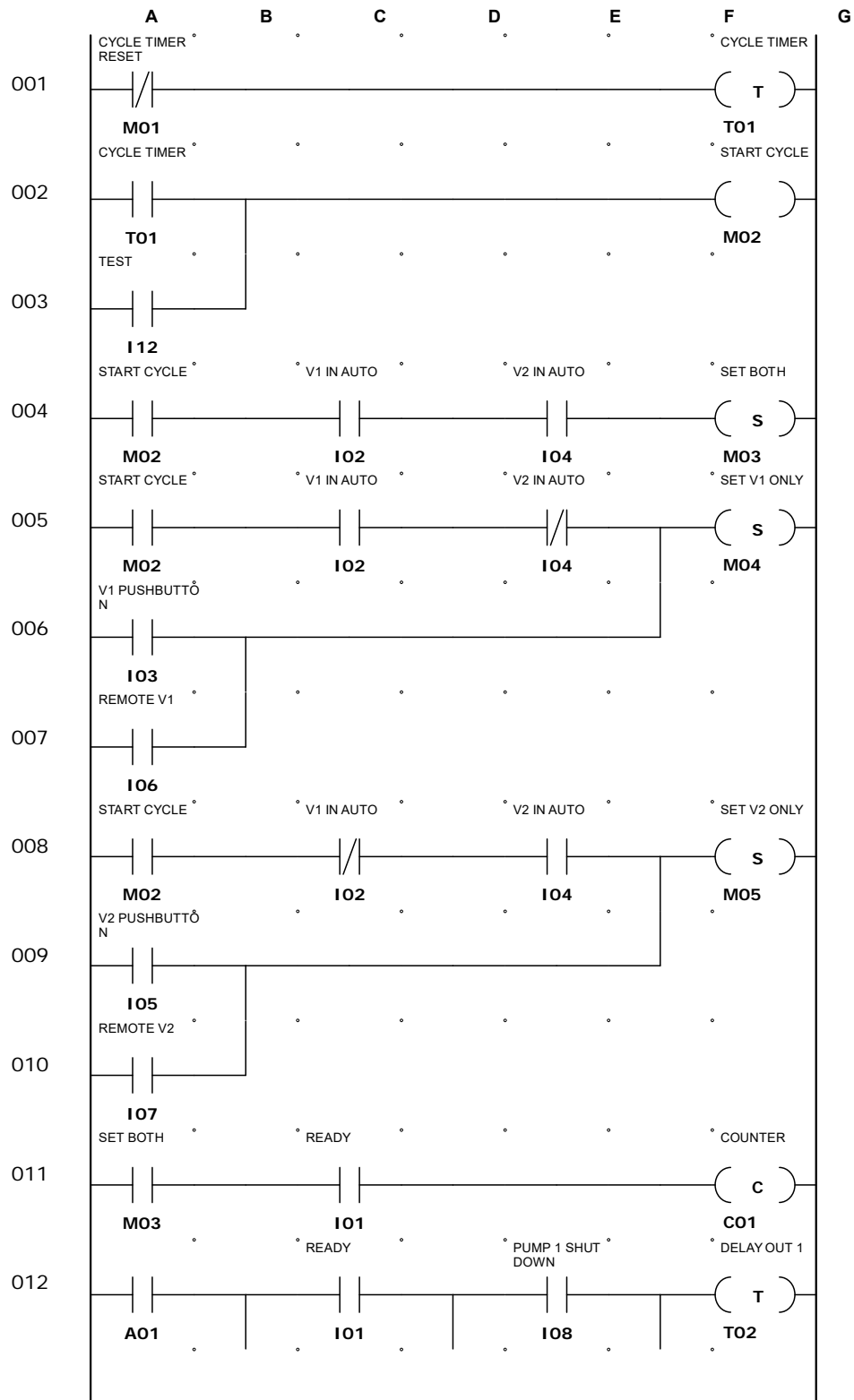
MLK  
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7/21/2014 8:13:06 AM  
7/22/2014 1:50:42 PM

Device Information:

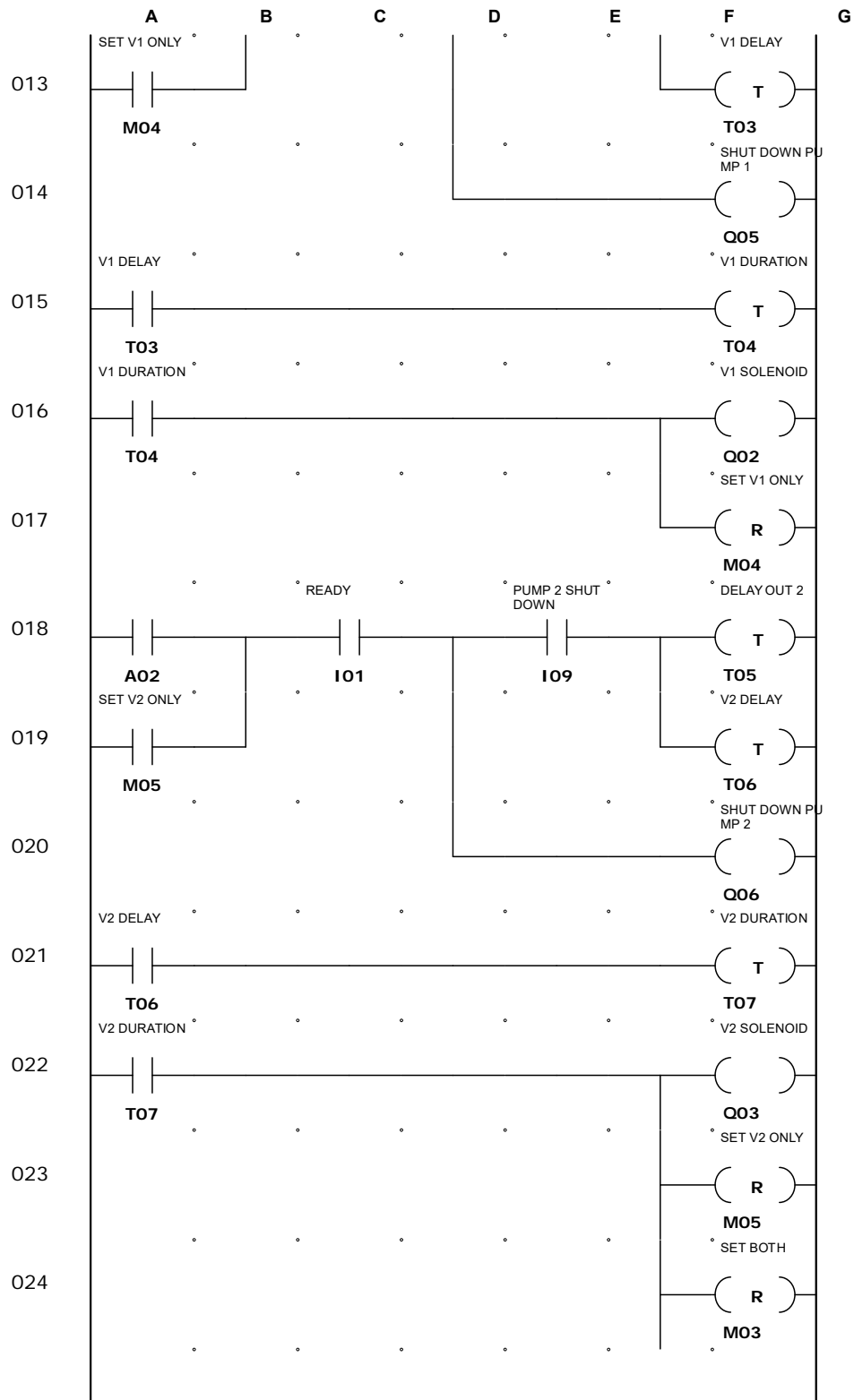
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**Device Type:** 1760-L18AWA-EX ser.B  
**Device version:** 01- xxxxxxxxxxxx  
**Program Name:** »L&A«  
**I Debounce:** off  
**P Buttons:** off  
**Card Mode:** off  
  
**Retention:** M9 - M12: off M13 - M16: off  
N9 - N16: off C5 - C7: off  
C8: off C13 - C16: off  
D1 - D8: off T7: off  
T8: off T13 - T16: off  
  
**Daylight Saving Time:** off  
  
**Password:** off  
**Cycle time:** 0 ms

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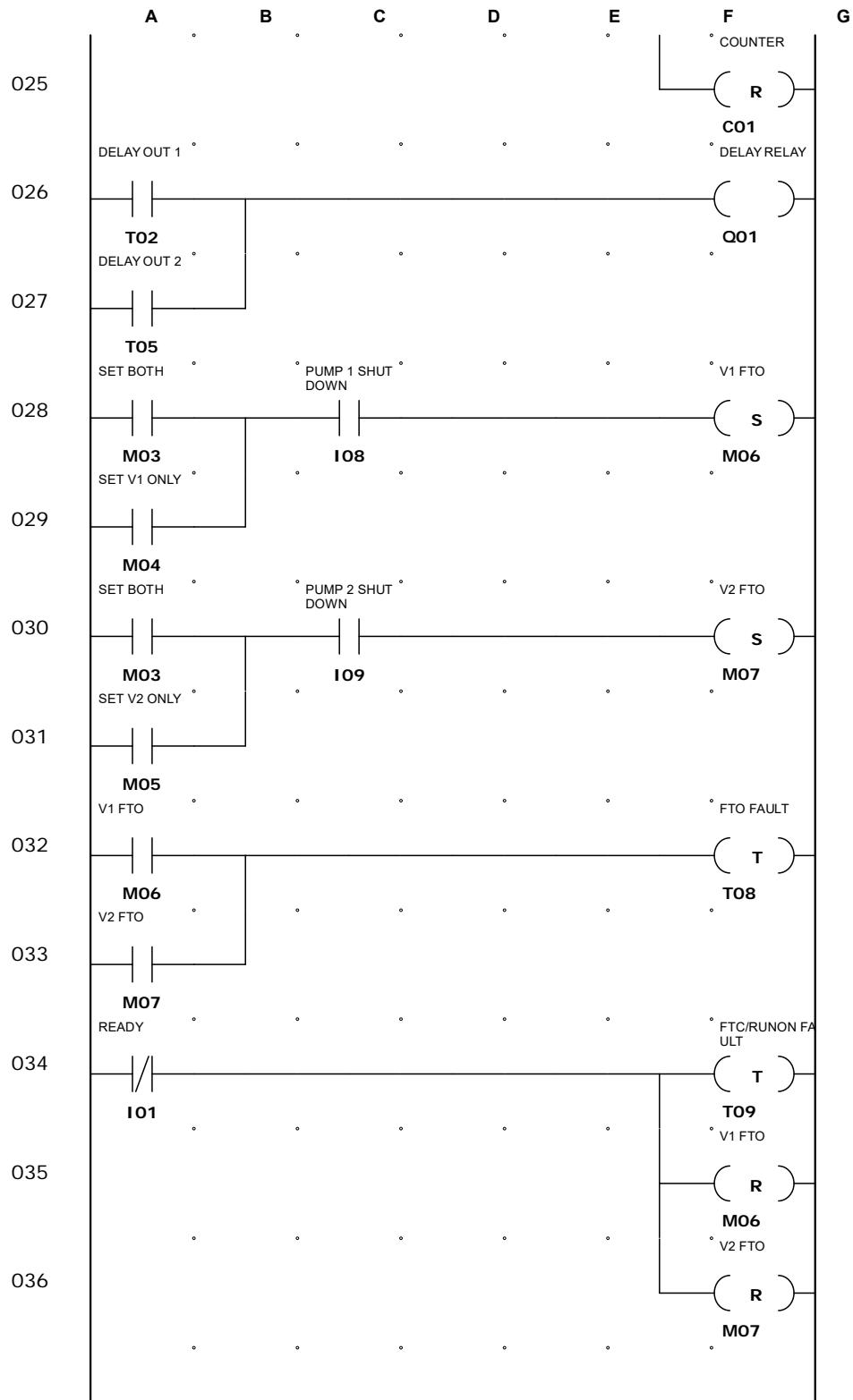




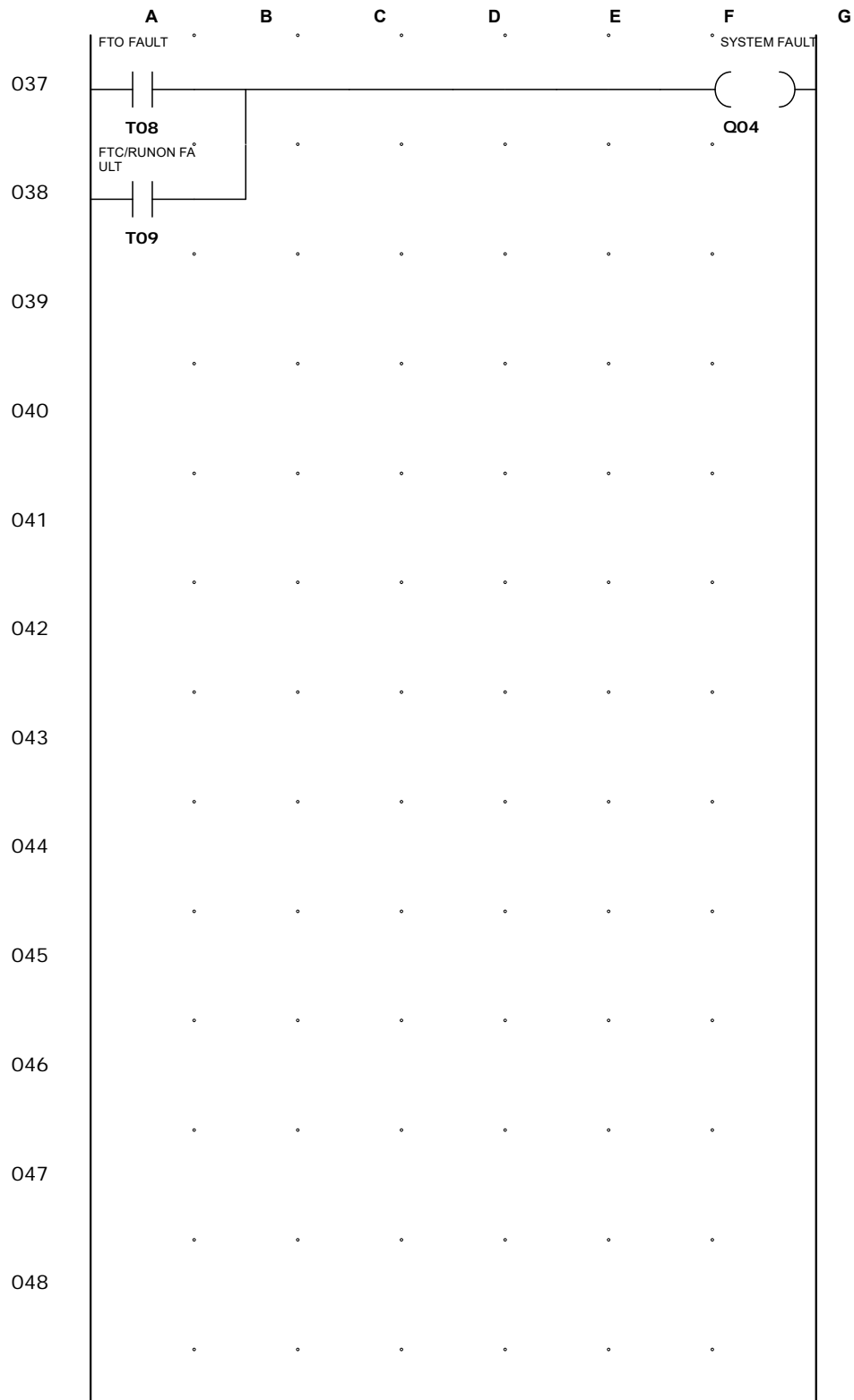
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				NET-ID:	-

Function block parameters

A 1:  
 Parameter display = On  
 Mode: I1 = I2  
 Comparison value 1: C1  
 F1 - Gain factor for I1: Off  
 Comparison value 2: 0001  
 F2 - Gain factor for I2: Off  
 OS - Offset for value I1: Off  
 HY - Switch hysteresis for value I2: Off

T 1 (On-delayed)  
 Parameter display = On  
 I1: 24 h : 00 min

A 2:  
 Parameter display = On  
 Mode: I1 = I2  
 Comparison value 1: C1  
 F1 - Gain factor for I1: Off  
 Comparison value 2: 0002  
 F2 - Gain factor for I2: Off  
 OS - Offset for value I1: Off  
 HY - Switch hysteresis for value I2: Off

T 2 (Single pulse)  
 Parameter display = On  
 I1: 0 min : 30 s

C 1: (N)  
 Parameter display = On  
 Setpoint =C1

T 3 (On-delayed)  
 Parameter display = On  
 I1: 0 min : 30 s

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				NET-ID:	-



Function block parameters

T 4 (Single pulse)  
 Parameter display = On  
 I1: 0 min : 05 s

T 7 (Single pulse)  
 Parameter display = On  
 I1: 0 min : 05 s

T 5 (Single pulse)  
 Parameter display = On  
 I1: 0 min : 30 s

T 8 (On-delayed)  
 Parameter display = On  
 I1: 0 h : 01 min

T 6 (On-delayed)  
 Parameter display = On  
 I1: 0 min : 30 s

T 9 (On-delayed)  
 Parameter display = On  
 I1: 0 h : 25 min

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		L&A HS21791 AIRBURST			Author:	MLK
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Operand	Comment	Circuit Con.
I01	READY	011C, 012C, 018C, 034A
I02	V1 IN AUTO	004C, 005C, 008C
I03	V1 PUSHBUTTON	006A
I04	V2 IN AUTO	004E, 005E, 008E
I05	V2 PUSHBUTTON	009A
I06	REMOTE V1	007A
I07	REMOTE V2	010A
I08	PUMP 1 SHUT DOWN	012E, 028C
I09	PUMP 2 SHUT DOWN	018E, 030C
I12	TEST	003A
Q01	DELAY RELAY	026G
Q02	V1 SOLENOID	016G
Q03	V2 SOLENOID	022G
Q04	SYSTEM FAULT	037G
Q05	SHUT DOWN PUMP 1	014G
Q06	SHUT DOWN PUMP 2	020G
M01	CYCLE TIMER RESET	001A
M02	START CYCLE	002G, 004A, 005A, 008A
M03	SET BOTH	004G, 011A, 024G, 028A, 030A
M04	SET V1 ONLY	005G, 013A, 017G, 029A
M05	SET V2 ONLY	008G, 019A, 023G, 031A
M06	V1 FTO	028G, 032A, 035G
M07	V2 FTO	030G, 033A, 036G
C01	COUNTER	011G, 025G
T01	CYCLE TIMER	001G, 002A
A01		012A
T02	DELAY OUT 1	012G, 026A
A02		018A
T03	V1 DELAY	013G, 015A
T04	V1 DURATION	015G, 016A
T05	DELAY OUT 2	018G, 027A
T06	V2 DELAY	019G, 021A
T07	V2 DURATION	021G, 022A
T08	FTO FAULT	032G, 037A
T09	FTC/RUNON FAULT	034G, 038A

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			L&A HS21791 AIRBURST	Author:	MLK
				Sheet:	9 of 9
				NET-ID:	-

## Change Parameters

Pico allows you to change function relay parameters such as timer and counter setpoints without having to call up the circuit diagram. This is possible regardless of whether Pico is running a program or is in Stop mode.

1. Press Ok to switch to the main menu.
2. Start the parameter display by selecting PARAMETER.

```
T3 Л    S +
T8 X    M:S +
C4 N    +
O3      +
O2      +
A1 EQ   +
A3 LT   +
```

A complete parameter set is shown. In the example, these are the parameters for a timing relay T1.

The following requirements must be fulfilled for a parameter set to be displayed:

- A function relay must have been included in the circuit diagram.
- The parameter set has been enabled for access, indicated by the '+' character at the bottom right of the display.

Use the PARAMETER menu to access and modify accessible parameter sets. Parameter sets for which access is not enabled are not displayed. Pico therefore allows you to protect parameters with the use of a password. You can enable or disable parameter access using the parameter '+' or '-' characters respectively in the circuit diagram.

```
T3 Л    S +
I1 02.030
I2 05.000
T:
```

1. Use up or down arrows to scroll through the parameter sets. The cursor must be located on the identifier of the function relay, in this case T3.
2. Press Ok.
3. Use up or down arrows to select the parameter required.
4. Change the values for a parameter set:
  - press Ok to enter the Entry mode.
  - use left and right arrows to change decimal place.
  - use up and down arrows change the value of a decimal place
  - Ok Save parameter or Esc Retain previous setting.
5. Press Esc to leave the parameter display.

The parameter display is opened via the PARAMETER menu. '?' coil terminals for counters and timers are not displayed here, even if they have been programmed.

### Variable Parameters for Function Relays

You can modify the relay parameters used in the circuit diagram in three different ways:

- All circuit diagram parameters can be adjusted in Stop mode via the circuit diagram.
- Setpoints can be modified in Run mode via the circuit diagram.
- Setpoints can be modified via the PARAMETER menu.

The following setpoints can be modified

- The timer setpoints for timing relays
- The counter setpoints of counter relays
- The day and ON/OFF times of time switches
- The comparison setpoint of analog comparators.

In Run mode, Pico operates with a new setpoint as soon as it is modified in the parameter display and saved.

### Example: Modify Switching Times for Outside Lighting

The outside lighting of a building is automatically switched on from 19:00 to 23:30 (7:00 pm to 11:30 pm) Mondays to Fridays in the Pico program.

⊖1	A	15:21	+
D		MO-FR	
ON		19:00	
OFF		23:30	

The parameter set for the time switch function relay 1 is saved in channel 'A' and looks like this.

The outside lighting is now required to also turn on between 19:00 and 22:00 on Saturdays.

1. Select PARAMETER from the main menu.

The first parameter set is displayed.

2. Use up or down arrows to scroll through the parameter sets until channel A of time switch 1 is displayed.

⊖1	B	15:21	+
D		--	
ON		00:00	
OFF		00:00	

3. Press the up arrow to select the next empty parameter set, in this case channel B of time switch 1.

The current time is 15:21.

```

⊖1 B 15:21 +
D   SA
ON  00:00
OFF 00:00

```

4. Change the value for the day interval from MO to SA:
  - Left and right arrows move between the parameters
  - Up and down arrows change value.
  - Press Ok to save.

```

⊖1 B 15:21 +
D   SA
ON  19:00
OFF 00:00

```

5. Set the switching on time to 19:00.
6. Set the switching off time to 22:00.
7. Press Ok.

```

⊖1 B 15:21 +
D   SA
ON  19:00
OFF 22:00

```

- Pico saves the new parameters. The cursor remains in the contact field on channel identifier 'B'.
8. Press Esc to leave the parameter display.

The time switch will now also turn on at 19:00 on Saturdays and switch off at 22:00.

## Set Date, Time, and Daylight Saving Time

If the clock is not set yet or if Pico is powered on after the battery backup time has been exceeded, the clock starts with the setting SA 0:01 01.05.2004. The Pico clock operates with date and time so the hour, minute, day, month and year must all be set.

```

SET CLOCK
SUMMER TIME

```

### TIP

Pico uses military time, so 1:00 p.m. is 13:00, 7:30 p.m. is 19:30, etc.

```

HH:MM: 18:24
DD.MM: 01.05
YEAR : 2004

```

1. Select SET CLOCK from the main menu.
 

This opens the menu for setting the time.
2. Select SET CLOCK and press Ok.
3. Set the values for day, time, month and year.
  - Left and right arrows move between the parameters
  - Up and down arrows change the value of a parameter
4. Press Ok to save the day and time or Esc to retain the previous setting
5. Press Esc to leave the time setting display.



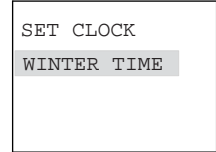
## Change Between Winter/Summer Time (Daylight Saving Time)

The clock can be toggled between winter and summer time (daylight savings time) using the cursor buttons.

1. Select SET CLOCK from the main menu.

This opens the menu for setting the time.

2. Select menu item WINTER TIME or SUMMER TIME as required.



### *Change to Winter Time*

Pico displays SUMMER TIME as the next possible option if winter time is already set.

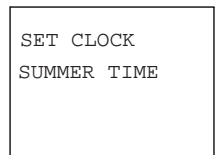
Otherwise select WINTER TIME and press Ok.

Pico sets the clock one hour back, e.g. from 17:43 Sunday to 16:43 Sunday. The display then shows SUMMER TIME.

### *Change to Summer Time*

Select SUMMER TIME and press Ok.

Pico sets the clock one hour forward, e.g. from 12:30 Wednesday to 13:30 Wednesday.



The display then shows WINTER TIME.

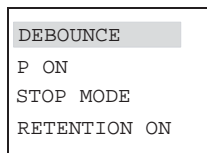
The weekday is not changed automatically with the time. If you change the time around midnight you must change the weekday as well.

## Activate Debounce (Input Delay)

Input signals can be evaluated by Pico with a debounce delay. This enables the trouble-free evaluation of switches and push-buttons subject to contact bounce.

In many applications, however, very short input signals have to be monitored. In this case, the debounce function can be turned off.

1. Press Del and Alt to call up the System menu.
2. Select the System menu. If Pico is password-protected you cannot open the System menu until you have removed the password.
3. Set the Debounce mode using the menu items DEBOUNCE OFF/ DEBOUNCE ON.



## **Attachment D**

**Humboldt Bay Harbor District (1/30/18). Eelgrass Protection Plan (from Humboldt Bay Mariculture Pre-Permitting Project Starbird Mariculture).**

# Humboldt Bay Mariculture Pre-Permitting Project

## Starbird Mariculture: Eelgrass Protection Plan

### Introduction

Through the Humboldt Bay Mariculture Pre-Permitting Project (Pre-Permitting Project), the Humboldt Bay Harbor, Recreation and Conservation District (District) has retained regulatory approvals for shellfish culture at specific sites in Humboldt Bay. The District will lease the pre-permitted sites to private shellfish growers who will conduct culture under the District's permits. The District has issued a Humboldt Bay Harbor District Permit and certified the Final Environmental Impact Report (FEIR) (SCH# 2013062068) for the Pre-Permitting Project and has received regulatory approvals from the California Coastal Commission, North Coast Regional Water Quality Control Board and US Army Corps of Engineers. The California Coastal Commission's Coastal Development Permit for the project (Application #9-16-0204, hearing date 11/4/16) includes the following project condition:

**Condition 8: Eelgrass Protection.** Prior to the initiation of installation activities for aquaculture gear or mooring piles, the Harbor District shall submit for Executive Director review and approval a plan showing that all such activities and associated structures or infrastructure (including pilings, moorings, anchors, longlines, surface rafts, FLUPSYs) shall remain a minimum of 30-feet away from the outside edge of any eelgrass bed within or adjacent to the three subtidal aquaculture sites. This report shall include a map of all eelgrass within each subtidal site and a 50-foot perimeter outside. The map shall be based on the results of an eelgrass survey carried out consistent with the timing and methodology guidelines of the National Marine Fisheries Service's California Eelgrass Management Program. Areas with depths greater than twice the minimum expected eelgrass growing depth in Humboldt Bay are exempt from this survey requirement.

Starbird Mariculture is proposing shellfish culture within one of the Pre-Permitting Project sites. Following is a description of Starbird Mariculture's proposed project and measures that will be taken to avoid eelgrass consistent with Condition 8 above.

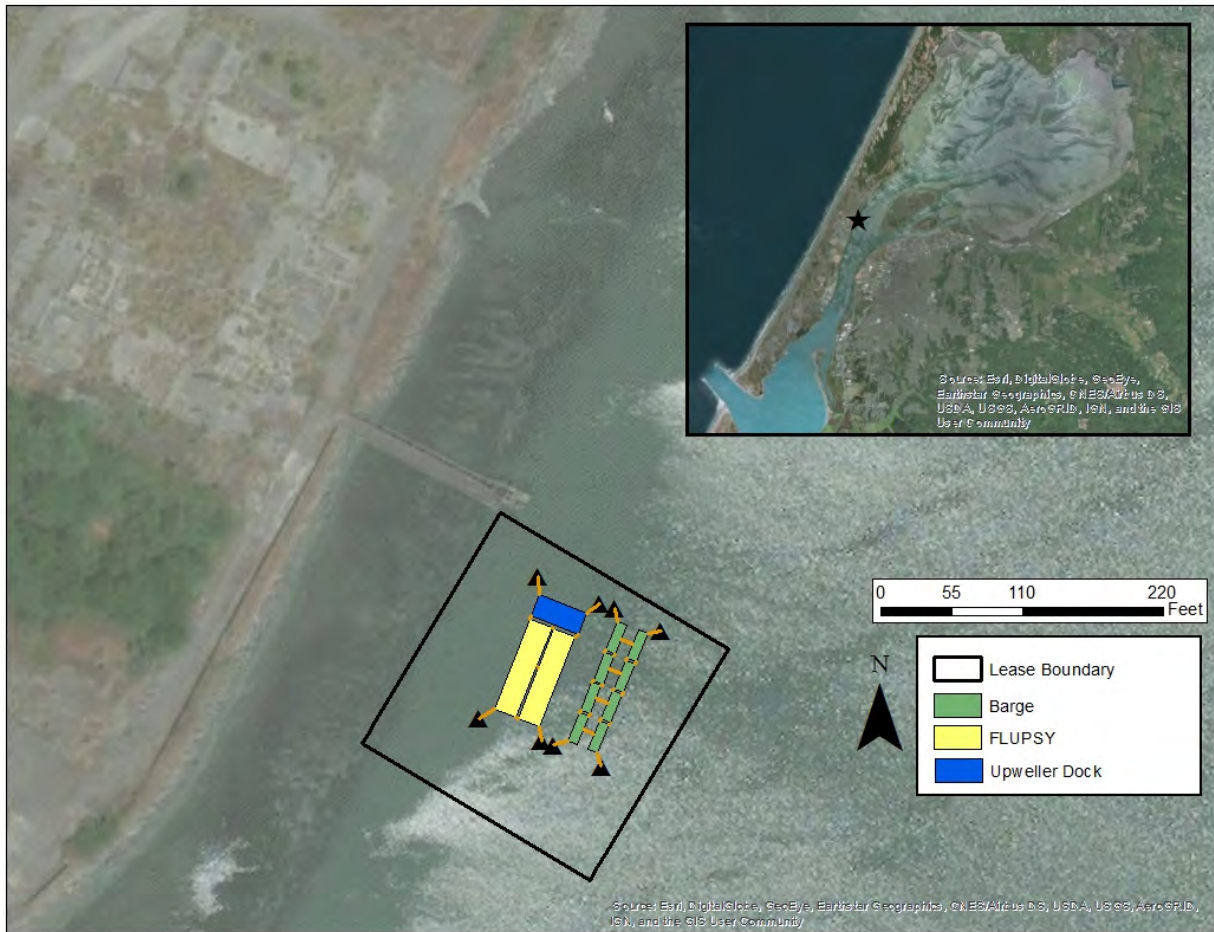
### Starbird Mariculture Project Description

Starbird Mariculture will utilize the 1-acre lease area shown in Figures 1 and 2 as a nursery for Kumamoto oysters (*Crassostrea sikamea*), Pacific oysters (*C. Gigas*) and Manila clams (*Venerupis philippinarum*). Culture will occur on the following structures:

- **Two 18' x 75' floating upwelling systems (FLUPSY).** The FLUPSYs will provide a constant stream of water to maturing shellfish seed. The seed will be contained in bins that are supported within an aluminum frame in the water column.
- **One 18'x40' upweller dock.** The upweller dock will hold four upwelling tanks that will be pumped to by a five hp pump.

The two FLUPSYs and the upweller dock will be connected with chain and secured with four 10 sf cement anchors.

- **Eight 8'x24' barges.** The barges will serve to mature shellfish seed that will be suspended into the water column on trays. Water will move through the trays passively with tides and currents. The barges will be connected with chain and secured with four 10 sf cement anchors.

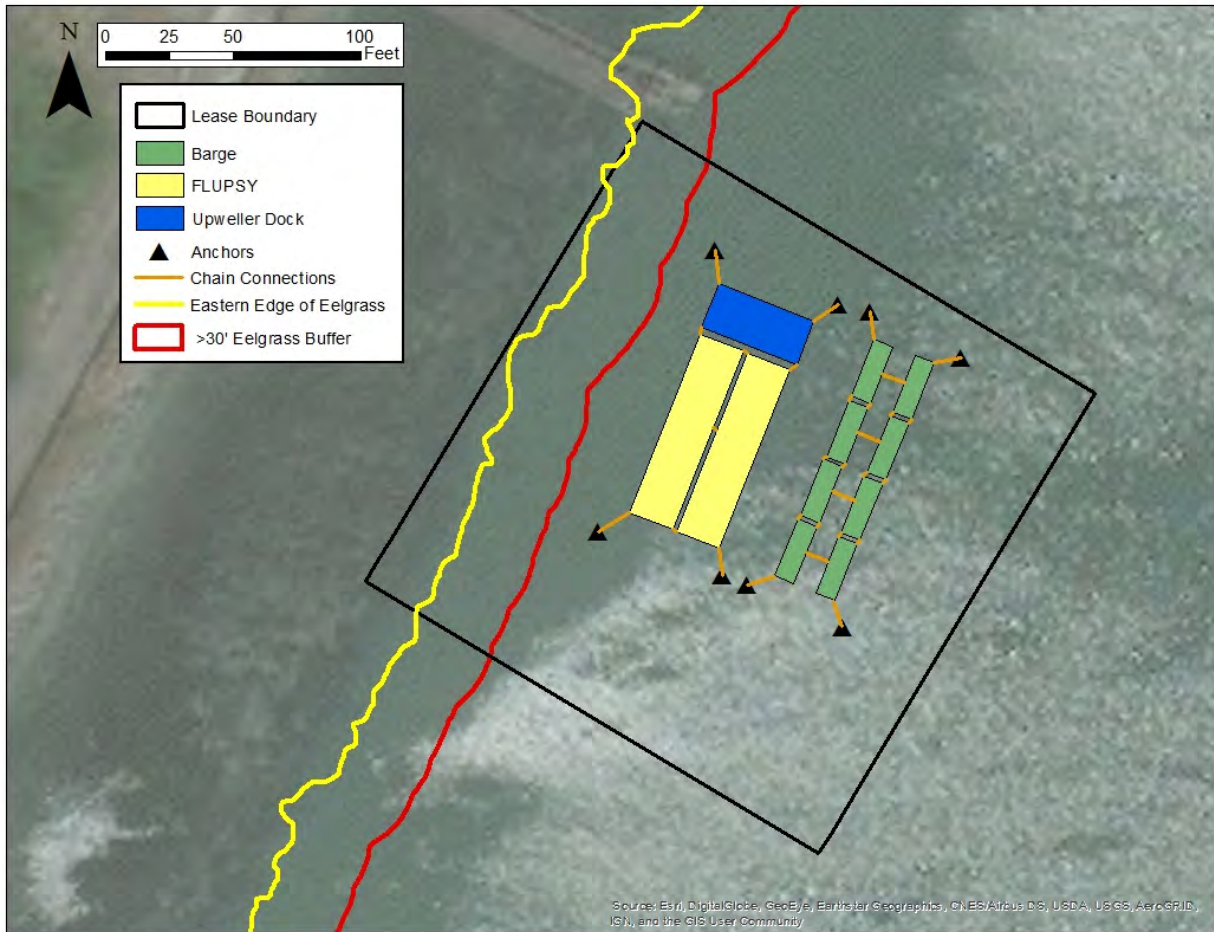


**Figure 1. Location of proposed Starbird Mariculture operations in Humboldt Bay, California.**

#### **Eelgrass Avoidance**

Eelgrass surveys at the proposed Starbird Mariculture site and other sites were conducted by Tom Gast and Associates<sup>1</sup> (Attachment 1). The layout of proposed culture equipment at the site was purposefully designed to completely avoid eelgrass by >30' as shown in Figure 2. Additionally, the following eelgrass avoidance measure has been made a condition of Starbird Mariculture's District lease for culture at the site: *Boats will typically not encroach into the area with mapped eelgrass or the eelgrass buffer area, so as to avoid eelgrass. Only at high tides when eelgrass is completely submerged below the depth of boat hulls and propellers, boats may move into the area with mapped eelgrass and the eelgrass buffer area.*

<sup>1</sup> Thomas Gast and Associates. 2017. Memo # 20171009HBHRCD. Sites 1 and 3 Humboldt Bay Eelgrass Survey (Attachment 1).



**Figure 2. Proposed layout of Starbird Mariculture operations in relation to mapped eelgrass. Eelgrass mapping was conducted by Thomas Gast and Associates (see Attachment 1).**



# **Attachment 1**

## **Eelgrass Survey Report**



**Memo # and Date:** 20171009HBHRCD, First Draft October 10, 2017

**Project:** Sites 1 and 3 Humboldt Bay Eelgrass Survey

**Client:** Humboldt Bay Harbor, Recreation, and Conservation District

**Office:** 601 Startare Drive  
Eureka, California

---

**Submitted by:** Thomas Gast & Associates Environmental Consultants  
P.O. Box 1137  
Arcata, CA 95518

**Contact Person:** Thomas Gast, Principal Scientist  
**Phone:** 707-822-8544  
**Email:** [tgast@tgaec.com](mailto:tgast@tgaec.com)  
**Website:** [www.tgaec.com](http://www.tgaec.com)





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## Introduction

Thomas Gast & Associates Environmental Consultants (TGAEC) was asked by the Humboldt Bay Harbor, Recreation, and Conservation District (HBHRCD) to conduct an eelgrass (*Zoster marina*) boundary survey at the proposed Humboldt Bay floating shellfish facilities at Sites 1 and 3 for pre-permitting the floating shellfish aquaculture (Figure 1). HBHRCD plans to pre-permit these sites for floating shellfish nursery rafts and macro algae culture in order to facilitate the use by shellfish farmers. Eelgrass grows at -3.1 feet to +1.4 feet elevation MLLW (Mean Lower Low Water, Gilkerson 2008). The rafts will be over deeper water, but adjacent to the shallower water with eelgrass habitat. The California Coastal Commission (CCC) issued a permit (application # 9-16-0204) with conditions including that a survey of the eelgrass be completed of the area within and adjacent to the Sites showing the eelgrass boundary and a 30 foot buffer. The survey was completed consistent with the California Eelgrass Mitigation Policy and Implementation Guidelines (2014).



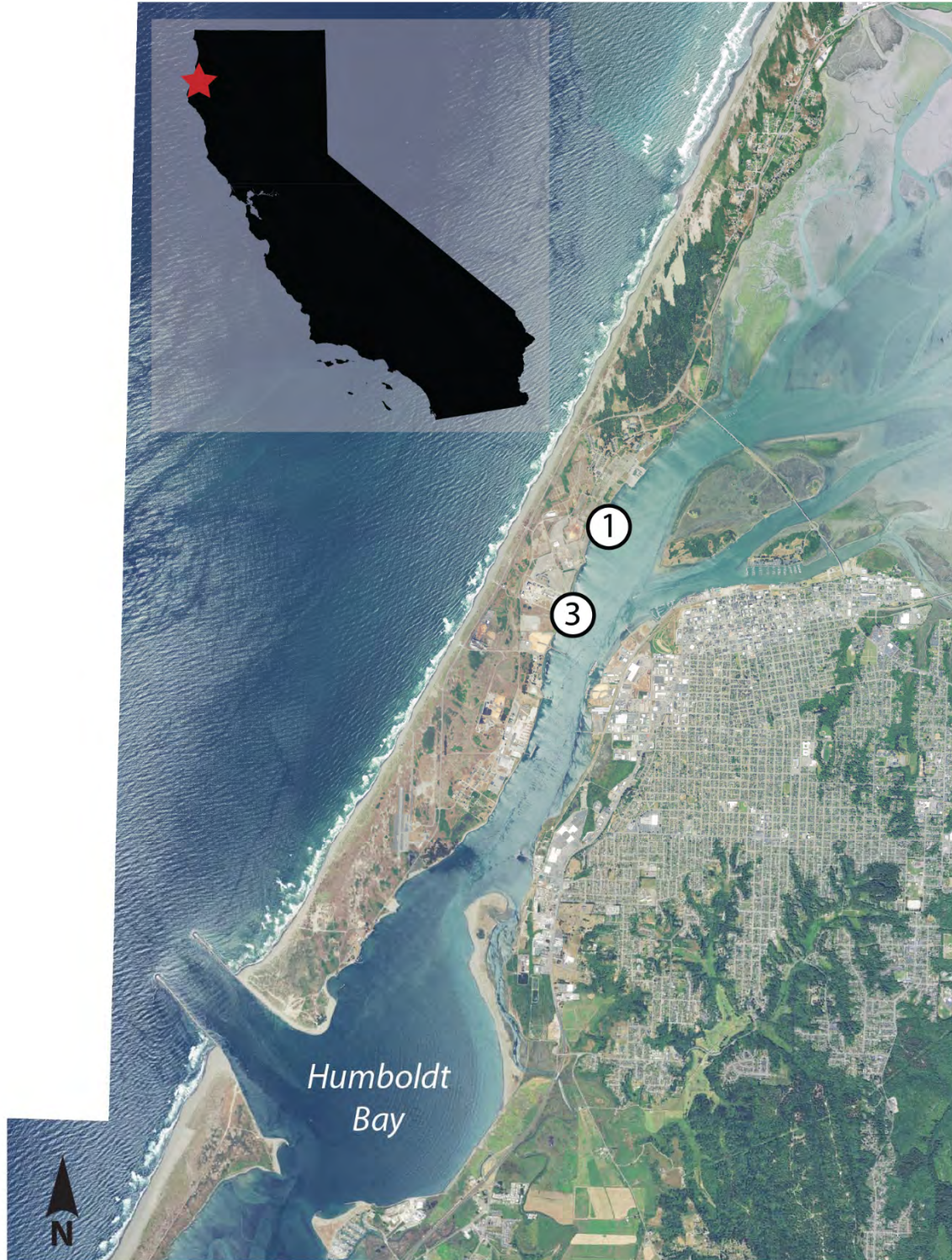


Figure 1. Location of Sites 1 and 3.







## Methods

### Sidescan Sonar Survey

An initial sidescan sonar survey of Sites 1 and 3 was conducted at high tide. Sidescan sonar produces rich images of the bottom and waterborne objects, including eelgrass. A high quality GNSS differential heading antenna was used to position and orient the sidescan sonar images. Both the antenna and the sonar were fixed to the survey vessel with the transducer at a fixed depth below the surface and the antenna mounted directly over the sonar at a fixed height. The water level is tracked at the entrance to Humboldt Bay by the NOAA Water Level Station 9418767. Additionally an RTK GNSS network antenna was used to track the survey vessel's position and elevation during the survey.

The sidescan instrumentation was set to 800 kHz with a horizontal detection limit of 20 to 25 meters on both sides of the vessel. Downscan data was collected directly under the vessel. Positional data was collected in NAD 83. Sonar images were viewed real time and logs were saved to an SD card. Sonar images were post-processed, geo-referenced, and overlaid on an aerial image. Each image was examined for eelgrass and positional correctness.

### Low Tide Reconnaissance and Ground-Truthing

#### *Reconnaissance Survey*

A low tide reconnaissance survey at a predicted minus tide was conducted to visually confirm the eelgrass bed boundaries and to verify positional correctness of the boundaries. Most eelgrass beds in Humboldt Bay can be seen at a minus tide, with the leaves either at or near enough to the surface to create a dark shadow. The survey vessel was used to allow the biologist to visually confirm the eelgrass presence and spot check the boundary position with an RTK network GNSS antenna.

## Results

### Sidescan Sonar Survey

#### *Sites 1 and 3*

A sidescan sonar survey was conducted by Tom Gast aboard the TGAEC survey vessel Seawolf on June 19, 2017 at a 7.4 foot Mean Lower Low Water (MLLW) high tide (Figure 2). Sonar logs were recorded of all areas of Sites 1 and 3. Figure 3 depicts a georeferenced sonar image of the Site 3 eelgrass.





Figure 2. The TGAEC survey vessel Seawolf used for the sidescan sonar survey.



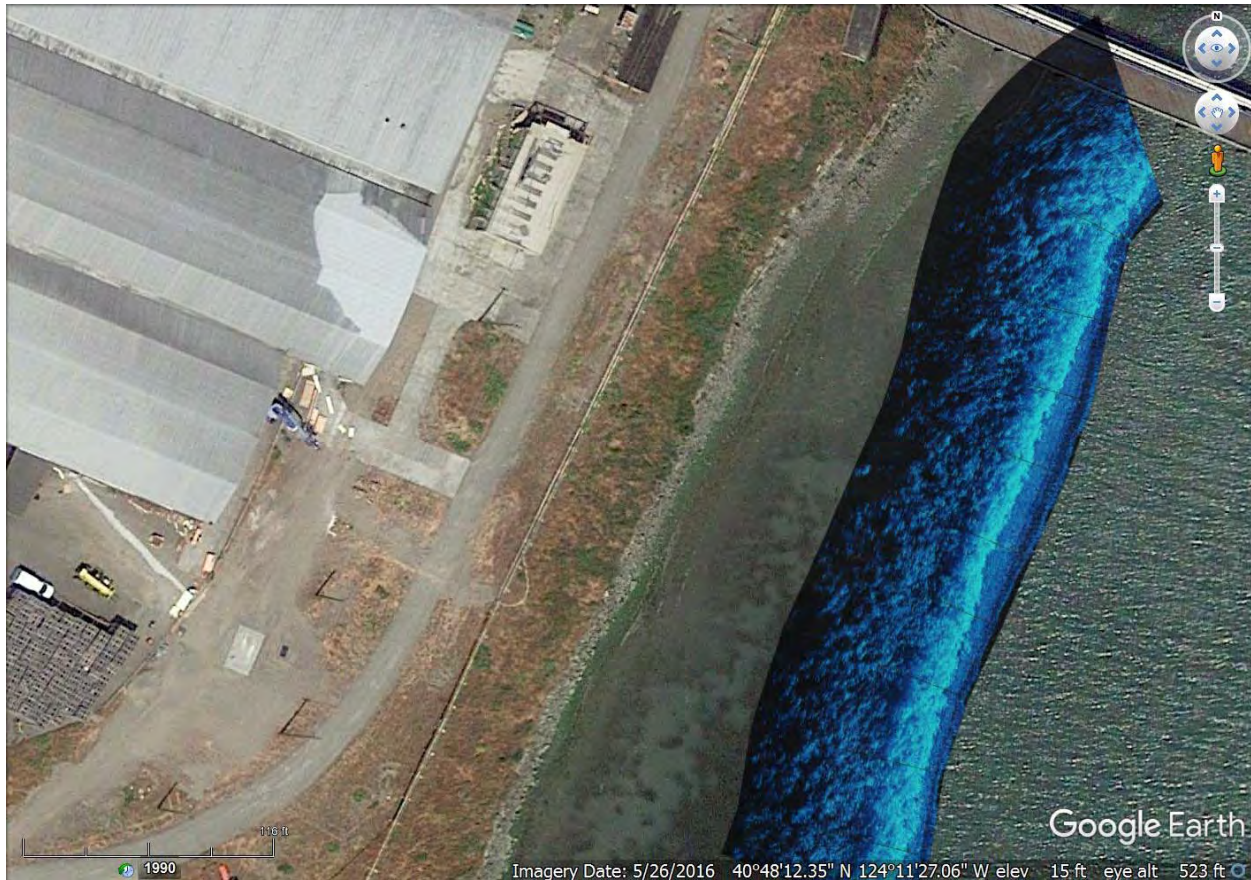


Figure 3. Insonification image of Site 3 collected on June 20, 2017.

## Low Tide Reconnaissance and Survey

### *Reconnaissance Survey*

Tom Gast and a TGAEC intern conducted the low tide reconnaissance survey on June 24, 2017 at a predicted low tide of -2.1 (MLLW). Most of the eelgrass beds were exposed and all of the eelgrass identified from the sonar survey was visible (Figure 4). The field crew measured the eelgrass boundary locations at individual points with an RTK network-corrected GNSS antenna. The centimeter level accuracy of the RTK positions facilitated correcting minor (sub-meter) discrepancies between the sonar-determined eelgrass boundary and the RTK positions.





Figure 4. The Site 3 eelgrass bed boundary is easily discernable at the minus 2.1 (MLLW) tide. Most of the eelgrass was exposed during the low tide reconnaissance survey.

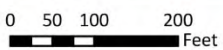
### Eelgrass Boundary and Buffer Zone Maps

The eelgrass bed boundaries and 30 foot buffer zones are shown on the maps in Figures 5-8. Figures 5 and 6 show Site 1 and Figures 7 and 8 show Site 3. Only the eelgrass boundaries adjacent to the Sites 1 and 3 were surveyed (the green line on the maps). The shoreward extent of the eelgrass was neither required nor surveyed. The brown areas on the maps are intended to show the approximate extent of the eelgrass beds, but since the shoreward extent was not surveyed, the brown area does not represent actual spatial coverage of the eelgrass.

Site 1 has a pier and a floating dock is proposed at the end of the pier (Figure 6). Site 3 has a shoal resulting from the reduced water velocities caused by the pier finger extending to the northeast. The pier finger slows the tidal current, allowing sediment to settle out. The shoal is at an elevation conducive to eelgrass growth (Figure 8).



# Humboldt Bay Harbor District Site 1







-  Site Boundary
-  Eelgrass
-  Eelgrass 30' Buffer
-  Eelgrass Shoreward Extent (Not Surveyed)







Figure 5. Site 1 eelgrass boundary.

### Humboldt Bay Harbor District Site 1 Inset Map



Figure 6. Inset of the pier area in Site 1 with a 10' x 20' dock.





# Humboldt Bay Harbor District Site 3



0 50 100 200 Feet

- Site Boundary
- Eelgrass
- Eelgrass 30' Buffer
- Eelgrass Shoreward Extent (Not Surveyed)



Figure 7. Site 3 eelgrass bed boundaries.







### Humboldt Bay Harbor District Site 3 Inset Map



Figure 8. Inset of shoal area eelgrass bed in Site 3.



## References

Gilkerson W. 2008. A spatial model of eelgrass (*Zostera marina*) habitat in Humboldt Bay, California. Master's Thesis. Humboldt State University, Arcata, California.

National Marine Fisheries Service. 2014. California eelgrass mitigation policy and implementing guidelines. NOAA Fisheries West Coast Region.



## **Attachment 2**

**Thomas Gast & Associates  
Supplemental Memo –  
February 26, 2018**





**Memo # and Date:** 20180226HBHRC, First Draft October 10, 2017, Response #1  
02/26/18

**Project:** Sites 1 and 3 Humboldt Bay Eelgrass Survey

**Client:** Humboldt Bay Harbor, Recreation, and Conservation District,  
ICF

**Office:** 601 Startare Drive  
Eureka, California

---

**Submitted by:** Thomas Gast & Associates Environmental Consultants  
P.O. Box 1137  
Arcata, CA 95518

**Contact Person:** Thomas Gast, Principal Scientist  
**Phone:** 707-822-8544  
**Email:** [tgast@tgaec.com](mailto:tgast@tgaec.com)  
**Website:** [www.tgaec.com](http://www.tgaec.com)





## Summary

Thomas Gast & Associates Environmental Consultants (TGAEC) performed an eelgrass boundary survey at Sites 1 and 3 for the Humboldt Bay Harbor, Recreation, and Conservation District (The District) in June, 2017. Memo 20171009HBHRCD (The Memo) reported the results of the survey. TGAEC was asked by ICF's Adam Wagshal (The District's consultant) to respond to California Coastal Commission's Cassidy Teufel's questions about the Humboldt Bay Site 1 and Site 3 eelgrass surveys. Ms. Teufel asked: "Also, are there additional sections of the survey report that you could provide showing the sidescan data and ground-truthing work carried out on the rest of the areas? Is there more that can be provided showing that the survey was carried out consistent with the CEMP (for example, the survey methods described on pages 8 through 11)?"

## Responses

**Question 1: Are there additional sections of the survey report that you could provide showing the sidescan data and ground-truthing work carried out on the rest of the areas?**

The sidescan sonar data was recorded during the survey and processed using desktop software to produce a mosaic of georectified, overlapping images. Each individual image is examined for eelgrass presence. Each point will have multiple layers of images with a varying degree of bottom vegetation visibility (e.g. the eelgrass shows up better closer to, but not directly under, the survey vessel). Figure 3 of The Memo was provided to show several of the sidescan images and what the eelgrass looks like in the image. There are multiple layers of survey data for that location and each was examined to determine if there was additional eelgrass seaward of the boundary. Figure 1 is a depiction of the Site 3 eelgrass boundary, the ground-truthing points, and some of the sonar images. Note that the eelgrass boundary in the Northern area were determined by additional images from a different survey track than shown. This track is shown because it covers the majority of the boundary. Individual ground-truthing points are also shown. Each point was taken on the boundary of the eelgrass bed with the GNSS RTK antenna using the California Real Time Network correction.





**Figure 1. Site 3 eelgrass boundary, ground-truthing points, and the left images of one survey track. Note that the eelgrass boundary in the northern area was determined by a different survey track.**

**Question 2: Is there more that can be provided showing that the survey was carried out consistent with the CEMP (for example, the survey methods described on pages 8 through 11)?**

The California Eelgrass Mitigation Policy and Implementation Guidelines, October 2014 (CEMP) describes the appropriate methodologies for surveying eelgrass in order to create quality maps. This survey followed those parameters; however, due to the limited objective of this eelgrass survey (delineate the seaward boundary of the eelgrass beds) parameters pertaining to the density and shoreward extent are not applicable.

1. Survey method: An acoustic survey was used due to the large area of potential sub-tidal habitat. The results of the acoustic survey indicated that the seaward boundary of the eelgrass could be also visually determined at a minus tide. Besides the known shoal area in Site 1, there were no other shoal areas or eelgrass growing outside of the beds associated with the shoreline. This is consistent with other North Bay eelgrass surveys. Ground-truthing with precision network RTK GNSS at a minus tide confirmed the eelgrass boundary.





2. Spatial Distribution: The seaward eelgrass bed boundary was determined and a 30 meter buffer zone delineated per the District's permit.
3. The Aerial Extent is not applicable since we were only delineated the shoreward boundary.
4. The Percent Vegetated Cover is not applicable since there will be no impacts to the beds.
5. The Turion Density is not applicable since there will be no impacts nor mitigation.
6. Eelgrass Mapping: The eelgrass boundary was mapped in UTM, NAD83, Zone 10 and the shape files provided in ArcGIS format. Producing a bathymetric chart was not part of the scope of work for this survey; however, the network RTK ground-truthing provided accurate elevations (MLLW) for the seaward eelgrass boundaries. The range of elevation for the boundary along the shore ranged from -0.51 m to -1.11 m. For the isolated shoal area in Site 3, the boundary elevation ranged from -.83 m to -1.69 m. These depths are generally consistent with maximum North Bay depths, with the Site 3 shoal area boundary deeper than the maximum North Bay depth of -1.3 m reported by Gilkerson (2008).
7. Survey Period: The survey was conducted within the period of active growth for eelgrass.
8. Reference Site: No reference site is required since the survey is intended to inform The District on the area in which floats can be located without impacting eelgrass.

## References

Gilkerson W. 2008. A spatial model of eelgrass (*Zostera marina*) habitat in Humboldt Bay, California. Master's Thesis. Humboldt State University, Arcata, California.

National Marine Fisheries Service. 2014. California eelgrass mitigation policy and implementing guidelines. NOAA Fisheries West Coast Region.



## **Attachment 3**

**Thomas Gast & Associates  
Email Correspondence –  
March 30, 2018**



**From:** [Thomas Gast](mailto:Thomas.Gast@tgaec.com)  
**To:** [Teufel, Cassidy@Coastal](mailto:Teufel.Cassidy@Coastal.ca.gov)  
**Cc:** [Larry Oetker](mailto:Larry.Oetker@Coastal.ca.gov); [Wagschal, Adam](mailto:Wagschal.Adam@Coastal.ca.gov)  
**Subject:** Re: Starbird Mariculture - Eelgrass Avoidance Plan  
**Date:** Friday, March 30, 2018 1:15:11 PM

---

Cassidy,  
Attached are the mosaics of Sites 1 and 3. We do not look at the images like this since the images overlap and obscure the whole picture. We process each image (the blue outlines) individually for eelgrass presence. I assume you wanted to verify the coverage and this shows the coverage, but looks bad since the images overlap so much. Tom

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*"In matters of style, swim with the current; in matters of principle, stand like a rock."  
Thomas Jefferson*

On Fri, Mar 30, 2018 at 12:22 PM, Teufel, Cassidy@Coastal  
<[Cassidy.Teufel@coastal.ca.gov](mailto:Cassidy.Teufel@coastal.ca.gov)> wrote:

Hi Tom –

Thanks for the quick response, this is really helpful. Would it be possible to share with me those mosaics you created for the two sites?

Thanks again,

Cassidy

**From:** Thomas Gast [mailto:[tgast@tgaec.com](mailto:tgast@tgaec.com)]  
**Sent:** Friday, March 30, 2018 12:16 PM  
**To:** Teufel, Cassidy@Coastal  
**Cc:** Larry Oetker; Wagschal, Adam  
**Subject:** Re: Starbird Mariculture - Eelgrass Avoidance Plan

Cassidy,

We acoustically surveyed the entire areas of Sites 1 and 3 with the sidescan sonar. I am including the figures that show the areas we surveyed (Blue Boxes). We created a mosaic of sidescan images covering the entire areas of both sites and examined them for eelgrass presence. The only eelgrass within the Sites 1 and 3 is shown on the attached figures.

We did monitor the depth and collect bathymetry data for the Sites 1 and 3 as part of the sidescan sonar survey, but our scope of work did not include processing the depth data. Also we conducted a low tide survey (minus 2') subsequent to the sonar survey.

All sonar identified eelgrass was visible and no additional eelgrass or shoals were found. Shoal areas show up prominently in the sidescan imagery and that is the reason I can definitively state that there are no other shoal areas.

Let me know if you have any additional questions or need clarification. Tom

Thomas Gast

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*"In matters of style, swim with the current; in matters of principle, stand like a rock."  
Thomas Jefferson*

On Fri, Mar 30, 2018 at 11:33 AM, Teufel, Cassidy@Coastal  
<[Cassidy.Teufel@coastal.ca.gov](mailto:Cassidy.Teufel@coastal.ca.gov)> wrote:

Hi Tom –

Thanks for your help wrapping this up and apologies for all the follow-up questions. I need to make sure our files are complete and include sufficient justification that this CDP condition has been met so I'm hoping you could provide a bit more clarity on how much of these two sites you were able to survey. Please take a look at the questions below and provide a response:

1. Please clarify if/how the other areas within the two sites were surveyed. The response you provided to the first question in your 2/26 memo was helpful but focused on the areas for which you previously provided data rather than info about the remainder of the sites (i.e. if the survey included the entirety of the two sites or was instead focused on the known shoal area and eelgrass bed parallel to the shoreline).


2. In the response to question 2 in your 2/26 memo, there's a statement that "Besides the known shoal area in Site 1, there were no other shoal areas or eelgrass growing outside of the beds associated with the shoreline." Please clarify how you determined that no other shoaled areas or eelgrass existed in Site 1 (i.e. was a bathymetry map of Site 1 reviewed? was all of Site 1 acoustically surveyed? etc.). Please also provide any information, survey results or data you used to support this determination.

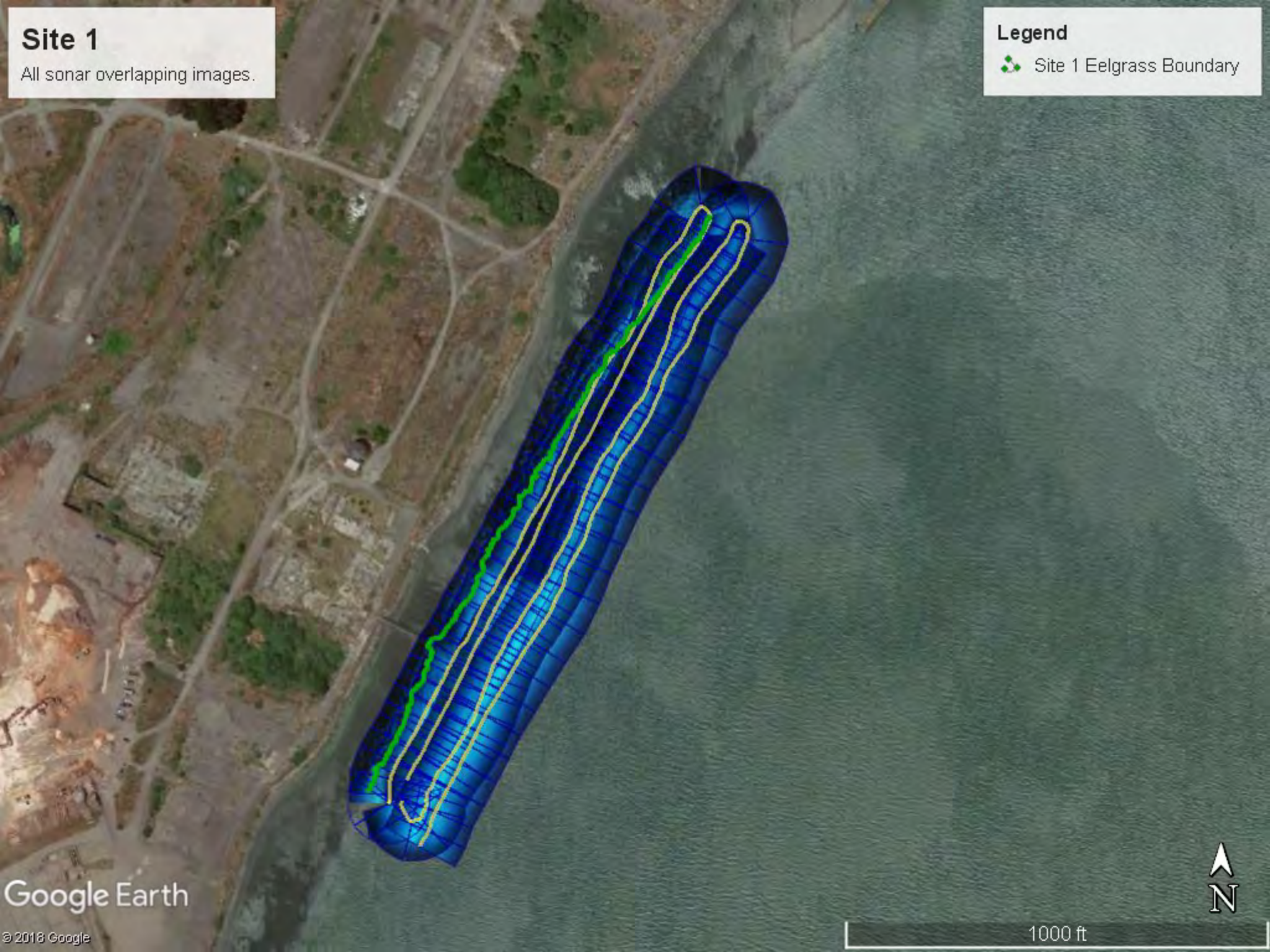
Thanks again,

# Site 1

All sonar overlapping images.

## Legend

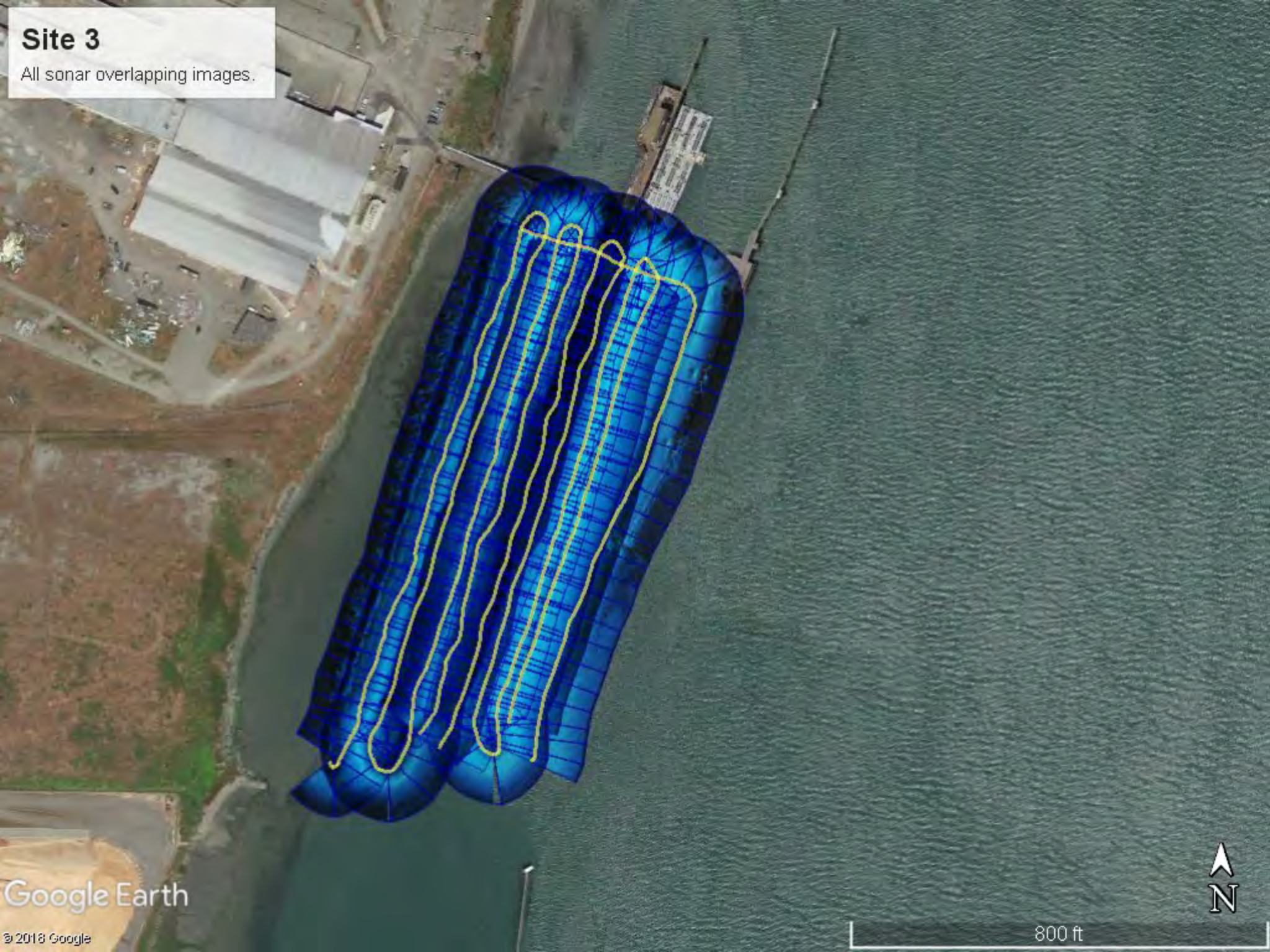
 Site 1 Eelgrass Boundary





### Site 3

All sonar overlapping images.



## **Attachment 4**

**Adam Wagschal (ICF)  
Email Correspondence –  
March 30, 2018**



**From:** [Wagschal, Adam](#)  
**To:** [Teufel, Cassidy@Coastal](mailto:Teufel, Cassidy@Coastal)  
**Cc:** [Larry Oetker](#)  
**Subject:** RE: Starbird Mariculture - Eelgrass Avoidance Plan  
**Date:** Friday, March 30, 2018 2:28:49 PM

---

Hi Cassidy,

Harbor District staff is meeting with several private shellfish growers regarding potential leases at the pre-permitted sites. It is not certain when the terms of individual leases will be finalized. The leases include culture descriptions which are needed to develop the eelgrass avoidance plans. When multiple leases are finalized around the same time it may be possible to develop one eelgrass avoidance plan that covers these leases. This would be ideal. However, it is possible that each lease will require its own eelgrass avoidance plan.

Eelgrass avoidance plans will be provided by the potential lessee(s) to the Harbor District for review/revision and then sent from Harbor District staff (or representatives) to Coastal Commission staff for review/revision or approval.

Please let me know if this answers your question about this process or if you have recommendations to improve it.

Thank you, Adam

---

**From:** Teufel, Cassidy@Coastal [mailto:Cassidy.Teufel@coastal.ca.gov]  
**Sent:** Friday, March 30, 2018 11:06 AM  
**To:** Wagschal, Adam <Adam.Wagschal@icf.com>  
**Subject:** RE: Starbird Mariculture - Eelgrass Avoidance Plan

Hi Adam –

Sorry, I was confused about where we left this and should have followed up with you before now.

To speed thing up, would it be ok if I contacted Mr. Gast to request clarification on a couple items? I'll also include my questions here in case you'd prefer to pass them along directly and convey his responses to me:

1. Please clarify if/how the other areas within the two sites were surveyed. The response he provided to the first question in his latest memo was helpful but focused on the areas for which he'd previously provided data and didn't really provide what I was looking for – info about the remainder of the sites.
2. In the response to question 2 in the latest memo, there's a statement that "Besides the known shoal area in Site 1, there were no other shoal areas or eelgrass growing outside of the beds associated with the shoreline." Please clarify how it was determined that no other shoaled areas or eelgrass existed in Site 1 (i.e. was a bathymetry map of Site 1 reviewed? was all of Site 1 acoustically surveyed? etc.). Please also provide any information, survey results or data used to support this determination.

Finally, as a follow-up to our conversation about the avoidance plan for Site 2 and additional future avoidance plans, I think it would be helpful if you could provide a narrative description of the process that the Harbor District proposes to use for developing and submitting these plans for review.

the requirements of Special Condition 8 so I thought you'd be sending more. For example, are you also planning to provide the survey results for Site 2 and the avoidance plans for the other proposed cultivation operations? **Eelgrass surveys have not been completed for Site 2 yet and there is not currently a proposed lease for this site. Leases will be phased in as private farmers determine their specific methods and negotiate terms with the District. Because we don't know specific methods for future leases, eelgrass avoidance plans will also need to be phased. We could provide an eelgrass avoidance plan for all the sites, but it would not have the level of detail that we provided for Starbird Mariculture's site. For example, we would not know the specific dimensions of culture equipment. My understanding is that you would like to see this level of detail.**

Also, are there additional sections of the survey report that you could provide showing the sidescan data and ground-truthing work carried out on the rest of the areas? Is there more that can be provided showing that the survey was carried out consistent with the CEMP (for example, the survey methods described on pages 8 through 11)? **Please see Tom Gast's responses to these questions in the attachment.**

Thanks,  
Cassidy

---

**From:** Wagschal, Adam [<mailto:Adam.Wagschal@icf.com>]  
**Sent:** Thursday, February 15, 2018 9:27 AM  
**To:** Teufel, Cassidy@Coastal  
**Cc:** 'Larry Oetker'  
**Subject:** RE: Starbird Mariculture - Eelgrass Avoidance Plan

Hi Cassidy,

I'm just following up on the Eelgrass Avoidance Plan we submitted. Have you found time to review it? If not, do you know when you might be able to get to it?

Thanks, Adam

---

**From:** Wagschal, Adam  
**Sent:** Sunday, February 04, 2018 8:27 PM  
**To:** 'Teufel, Cassidy@Coastal' <[Cassidy.Teufel@coastal.ca.gov](mailto:Cassidy.Teufel@coastal.ca.gov)>  
**Cc:** 'Larry Oetker' <[larryoetker@gmail.com](mailto:larryoetker@gmail.com)>  
**Subject:** Starbird Mariculture - Eelgrass Avoidance Plan

Hi Cassidy,

I attached a draft eelgrass avoidance plan for Starbird Mariculture. This would be the first farm in the Pre-Permitting Program. Let me know if you have questions or recommendations.

Thank you, Adam



**Adam Wagschal** | Senior Biologist and Regulatory Specialist  
[Adam.Wagschal@icf.com](mailto:Adam.Wagschal@icf.com) | [icf.com](http://icf.com)  
820 Wiley Court, Arcata, CA 95521 USA | 1.707.496.2088 mobile

## **Attachment E**

**SHN (8/15/22). Humboldt Bay Master Water Intakes Project, Kramer Dock Pile Removal, Eelgrass Protection Plan, and Compensation for Potential Loss of Biological Productivity.**



Reference: 016240.005

August 15, 2022

Rob Holmlund, AICP  
Humboldt Bay Harbor, Recreation, and Conservation District  
601 Startare Drive  
Eureka, CA 95501

**Subject: Humboldt Bay Master Water Intakes Project, Kramer Dock Pile Removal, Eelgrass Protection Plan and Compensation for Potential Loss of Biological Productivity**

Dear Rob Holmlund:

## Introduction and Project Objectives

The Humboldt Bay Water Intakes Project is being implemented by the Humboldt Bay Harbor, Recreation, and Conservation District (Harbor District; County of Humboldt, 2022). This project will modernize and operate two former bay-water intake systems in Humboldt Bay and will install new piping to deliver bay water to existing and future Harbor District tenants, as described in the Draft Environmental Impact Report (DEIR; SCH 2021040532; County of Humboldt, 2021), which includes this pile removal project conditioned by the project's regulatory approvals from the Harbor District, California Coastal Commission, North Coast Regional Water Quality Control Board, and U.S. Army Corps of Engineers. These conditions include the removal of 988 piles at the previous Kramer Dock along the Humboldt Bay shoreline near Fields Landing. Removal of these piles will create new benthic habitat that will mitigate for loss of biological productivity caused by fish species entrainment, as a result of the operation of the water intake systems as outlined in Section 2.4.7 (pages 2-56) of the DEIR. The EIR was certified by the Humboldt County Planning Commission on August 4, 2022.

The need to offset the impact on biological productivity is based on Section 30231 of the California Coastal Act, California Ocean Plan requirements for desalination plant water intakes, and a Memorandum of Agreement among regulatory agencies during environmental review of applications for proposed seawater desalination facilities. Additionally, Section 3.14 of the Humboldt Bay Area Plan (consistent with Section 13142.5 (b) of the Ocean Plan) outlines requirements that the best available site, design, technology, and mitigation measures feasible shall be used to minimize the intake and mortality of all forms of marine life. The water intakes are designed to avoid impingement of all aquatic species and entrainment of juvenile and adult aquatic species, by meeting design criteria related to screen mesh, water approach velocity, and other parameters and avoiding potential significant impacts to biological productivity. It is expected that only non-special status aquatic larvae will be entrained, except a small amount of Longfin Smelt larvae is estimated at up to 200 larvae per year.



SHN, Tenera Environmental, and the Harbor District prepared a technical memorandum for the Humboldt Bay Water Intakes. According to that technical memorandum, based on daily tidal dynamics and using the source water volume estimates, the daily losses to any larval populations in Humboldt Bay subject to entrainment would be expected to be less than 0.018%, even under maximum intake flow during Phase III of its operation and the most conservative source water volume estimate at Mean Sea Level (SHN, Tenera, Harbor District, 2022). As explained in this technical memorandum, entrainment losses estimated based solely on the ratio of the intake volume to source water volume are likely to be highly conservative, especially due to the design of the intake screens and their placement in an area of Humboldt Bay where they will be subject to strong sweeping velocities on ebb and flood tides.

Nine hundred eighty-eight (988) creosote-treated pilings and 151 creosote-treated cross-beam supports, attached to the pilings, are proposed for removal at Kramer Dock as compensatory restoration for biological productivity foregone as a result of the water intakes project. This is intended to create space for eelgrass (*Zostera marina*) habitat while enhancing a larger tidal habitat area, and in turn, supporting biological productivity. The removal of creosote piles and braces is proposed to offset a small reduction in the Humboldt Bay's biological productivity as a result of entrainment of non-special-status larval species. Following implementation, the Harbor District intends to maintain ownership of the property and oversee follow-up monitoring and maintenance activities associated with the restoration.

The California Regional Water Quality Control Board (RWQCB) requires submittal and approval of a plan describing mitigation for the mortality of all forms of marine life. Plans shall include project objectives, site selection, site protection instrument (the legal arrangement or instrument that will be used to ensure the long-term protection of the compensatory mitigation project site), baseline site conditions, a mitigation work plan, a maintenance plan, a long-term management plan, an adaptive management plan, performance standards and success criteria, monitoring requirements, and financial assurances. This document has been organized in the same format as is required by the RWQCB.

This Plan is not a mitigation plan but is rather a companion document for the pile removal effort developed to compensate for the loss of biological productivity and is intended to minimize impacts to eelgrass that might otherwise occur during pile removal activities for habitat improvement. This will ensure no net loss in eelgrass function consistent with the California Eelgrass Mitigation Policy (NOAA, 2014).

## **Project Location, Site Selection, and Baseline Site Conditions**

The piling removal project proposed by the Harbor District as compensatory restoration for the reduction of biological productivity is located along the eastern shore of the South Bay portion of Humboldt Bay (See Exhibit 1 in Attachment 1). The abandoned pilings were previously part of a structure referred to as the Kramer Dock and extend over an area of approximately 2 acres of shoreline. At the upcoast end of the abandoned dock, the pilings are more numerous and extend further out from the shoreline, while at the downcoast end they only extend a short distance from the shore. All of the pilings have been cut off and extend various lengths above the surface of the water.





Eelgrass is a sensitive, natural community that occurs in Humboldt Bay and in proximity to the pile removal location. According to an eelgrass mapping study in Humboldt Bay, the vicinity of the Kramer Dock had continuous eelgrass bed coverage (Gilkerson, 2008); however, eelgrass distribution fluctuates and can expand, contract, disappear, and recolonize areas within suitable environments (NOAA, 2014). Pile removal would benefit eelgrass in Humboldt Bay by creating additional eelgrass habitat and would, therefore, self-mitigate for temporary impacts to eelgrass that may occur during pile removal activities.

Within the overall 2.69-acre habitat restoration area, there are two, 150-foot-wide sections that will be used as barge access. Barge access locations were selected based on a previously used location and access to South Depot Road. Eelgrass exists among some of the wood piles at elevations ranging from approximately -2 feet to 1 foot (North American vertical datum, 1988 [NAVD88]; See Attachment 1, Figure 3).

At the request of California Department of Fish and Wildlife (CDFW), field measurements and desktop analyses were conducted to evaluate the weight, surface area, and volume of piles and cross beams to be removed at the Kramer Dock site. The proposed mitigation and compensatory restoration results in the removal and disposal of 1,139 creosote-treated piles and beams, totalling 23,650 cubic feet (ft<sup>3</sup>); 308 tons; and 96,530 square feet (ft<sup>2</sup>) from Humboldt Bay (GHD, 2022).

The piles and cross beams exhibited a faint smell of petroleum product and are all assumed to have been treated with creosote, as was common for piers, docks, and floats for more than a century. Creosote is derived from coal tars and is made up of hundreds of thousands of chemical compounds with various forms of polynuclear aromatic hydrocarbons (PAHs) accounting for up to 90% of the creosote mixture. Even very low levels of leaching of PAHs from the weathered pilings in Humboldt Bay may still represent a risk to fishes and other marine organisms (Tenera, 2021). These toxins can accumulate in tissues of mollusks and other benthic invertebrates that do not metabolize as efficiently. An increase in concentration can result within organisms with higher fat content, this phenomenon is known as bioaccumulation. Reproduction may be inhibited, or death may occur. For some fish species, sediment contamination is linked to adverse impacts such as reproductive impairment, suppressed immune function, liver lesions, and fin abnormalities. In addition, embryonic development of the Pacific herring has been shown to be negatively affected by diffusible components of weathered creosote pilings (Washington State Department of Natural Resources, 2019).

## Site Protection Instrument and Financial Assurance

Regulatory requirements of the California Coastal Commission, North Coast Regional Water Quality Control Board, California Department of Fish and Wildlife, and U.S. Army Corps of Engineers ensure the long-term protection of the compensatory restoration and mitigation project site.

The Harbor District is a public agency and subject to public agency regulations. Once permits are approved, the Harbor District will work within its overall budget to commit funds to the construction of the project. The Harbor District will not begin the bidding process until project funds are committed. Then, the Harbor District will conduct a standard public-agency competitive construction bid process. Through that bid process, the Harbor District will be able to confirm the actual project costs and will



reconcile those costs with committed Harbor District funds. As per all standard public agency contracting procedures, the Harbor District will require a bid bond, a performance bond, and 10% retention of all progress payments until project completion.

## Mitigation Work Plan

Pile removal will be conducted from shore and/or from a barge. A crane with a boom carrying a vibratory hammer and timber clamp will be used to remove the piles. Piles that break off above the bottom will be reattached to the vibratory hammer and removed. If a pile cannot be fully extracted, it will be cut off 1 foot below the mudline using a saw. Piles located closer to shore would likely be removed using equipment on land during low tidal periods, whereas piles further offshore would likely require removal with equipment operating from a barge. Under current conditions, the pilings likely provide some wave energy dissipation along the shoreline and the existing eelgrass beds have adapted to these conditions. Unarmored portions of the adjacent shoreline show varying degrees of erosion likely caused by tide and wind waves. Pile removal may alter the nearshore hydraulic characteristics of shoreline erosion, but the project does not include removal of the old retaining wood wall, which will continue to protect the shoreline (County of Humboldt, 2022).

Removal with barge: The crane referenced above would be on a barge. The barge would be approximately 80 feet X 100 feet with a 4-foot draft and would be moved with a small tugboat. After being placed on the barge, the piles would be transferred to land and then transported to and disposed of at an appropriate upland location.

Removal from shore: The crane referenced above would operate from the shore immediately adjacent to the bay. The piles would be transported to and disposed of at an appropriate upland location.

Schedule: The Harbor District will complete the mitigation and restoration projects prior to operation of the intake structures. This is anticipated to be within 2 years of permit approval.

## Maintenance Plan and Best Management Practices

The following best management practices (BMP) will be followed:

**PART 1** A Harbor District staff member or representative will be present to ensure that these BMPs are adhered to.

**PART 2** Neither the barge nor the tug will anchor during the project. The barge may attach to existing piles to maintain its position.

- a. Piles will be removed during a tide of sufficient elevation to float the barge and tugboat adjacent to the piles being removed without scarring the mudflats or injuring eelgrass.
- b. Grounding of the barge is not permitted.
- c. A floating containment boom shall be installed and maintained around each pile being removed to collect any debris, including debris floating below the surface but not sinking to the bottom, and weighted plastic mesh (similar to orange construction fencing) will be attached to the boom



- and extended across the area surrounding the pile. If debris sinks to the bottom, then it shall be removed by a diver.
- d. Any equipment used shall be without leaks of any coolant, hydraulic fluid, transmission fluid, or petroleum products. All equipment shall be checked before use in order to certify that there are no fluid leaks. A spill response kit, including oil absorbent pads, shall be onsite to collect any petroleum product accidentally released.
  - e. Crane excavator and tug operators shall be experienced with vibratory pile removal.
  - f. The crane or excavator operator shall break the soil/pile bond prior to pulling in order to minimize pile breakage and sediment adhesion.
  - g. Piles shall be removed slowly to limit sediment disturbance.
  - h. Piles shall not be hosed off, scraped, or otherwise cleaned once they are removed from the sediment.
  - i. Piles shall be placed in a containment area on the barge to capture sediment attached to the piles.
  - j. The containment area shall include a structure around the perimeter, which precludes sediment or contaminated water from reentering the bay.
  - k. Holes left in the sediment by the removed pilings will not be filled. They are expected to naturally fill.
  - l. Piles and debris shall be removed from the barge and moved to a designated site for disposal preparation in such a manner as to prevent water quality impacts. Prior to disposal, the piles and debris will be stored on paved areas, covered with tarps, and surrounded by a soil erosion boom in order to prevent potential leaching or discharge of debris or contaminated material.
  - m. All removed piles or portions of piles shall be disposed of at an authorized facility. Piles or portions of piles shall not be re-used in Humboldt Bay or along shoreline areas.
  - n. Land operations shall not be conducted in wetlands in proximity to the staging site.

## Long-Term Management Plan

A long-term management plan is not required as part of this Plan. Pile removal is intended to allow for the natural re-colonization of aquatic organisms, including eelgrass, in the space created by the removal of the piles, compensating for the potential loss of biological productivity resulting from the water intake project. Eelgrass will be avoided using the measures described above to minimize impacts to eelgrass during pile removal.



## Adaptive Management Plan

Working with tidal fluctuation, equipment will work from land when possible and from a floating barge when land access is not possible. Piles that break off above the bottom will be reattached to the vibratory hammer and removed. If a pile cannot be fully extracted, it will be cut off one foot below the mudline using a saw. If debris sinks to the bottom, then it shall be removed by a diver. Any eelgrass observed within the vicinity of a broken pile will be avoided during mud removal and cutting of the pile one foot below the soil surface. This includes avoiding trampling eelgrass during on the ground work when access the broken piles and when conducting the actual removal. The contractor shall provide the location of all the broken and cut piles using a GPS unit.

## Performance Standards

In addition to the BMPs listed above, performance standards will be consistent with requirements of the California Coastal Commission, North Coast Regional Water Quality Control Board, and U.S. Army Corps of Engineers. Implementation of compensatory restoration would be consistent with the North Coast Regional Water Quality Control Board Basin Plan and would not conflict with the 303(d) listing for Humboldt Bay. Removal of creosote piles is supported by both the Basin Plan and 303(d) listing, as pollutant removal would occur (County of Humboldt, 2021). Benefits to the removal of old and derelict pilings reported by Tenera (2021) will include:

- reduced substrate for introduced species;
- reduced shading of the bottom of the water column;
- reduced toxic effects of creosote and other contaminants;
- reduced restrictions to flow and sediment movement;
- restoration, re-creation, or realignment of intertidal mudflats, sand flats, rock, and shellfish, eelgrass, and macroalgal beds;
- reduced navigational hazards; and
- improved aesthetics.

## Monitoring Requirements

The Harbor District proposes to monitor eelgrass in the pile removal areas using photo documentation before and after pile removal efforts with a combination of drone and ground-based photo points at low tide approximately one week before pile removal and again in the same photo point locations approximately one week after pile removal.

Success will be reported based on visual representation of the listed benefits above. Additionally, a minimum of 10 before and after photos from the same location shall be taken of eelgrass populations within the action area. These photos will be used to document the success of the Eelgrass Protection Plan and the avoidance of impacts to eelgrass for submittal to the RWQCB.



## Conclusion

Depressions around the base of piles are common and are most likely the result of increases in the speeds of ambient currents around the piles that pull away sediment. In an area where there are numerous piles closely spaced, such as the abandoned Kramer Dock, this effect would likely be expected to severely limit growth of eelgrass and submerged vegetation in the area with the piles in place. Therefore, the removal of a piling results in the restoration of a much larger area than just the area occupied by the piling (Tenera, 2021). Pile removal is intended to provide creation of available space for eel grass habitat while enhancing a larger tidal habitat area with the removal of creosote piles and braces. Removal of the piles in the water will restore the habitat to support aquatic vegetation, such as eelgrass, and associated invertebrates and fishes and result in the removal of creosote-laden piles out of Humboldt Bay.

Implementation of this Plan will result in reduced impacts to eelgrass currently occurring within the action area and will allow for the documentation of the avoidance of eelgrass during pile removal. The enhanced habitat and expansion of area available for eelgrass growth should more than compensate for minor impacts to eelgrass occurring during the pile removal effort. Following pile removal, eelgrass currently occurring within the action area will be able to freely colonize the newly available habitat and will support increased biological productivity in this area of Humboldt Bay.

If you have any questions or comments, please call me at 707-822-5785 or email me at [gobrien@shn-engr.com](mailto:gobrien@shn-engr.com).

Sincerely,

**SHN**



Gretchen A. O'Brien  
Senior Wildlife Biologist

GAO:ame

## Attachment

1. Kramer Dock Memo





## References

County of Humboldt. (December 17, 2021). "Draft Environmental Impact Report. Nordic Aquafarms California, LLC Land-based Aquaculture Project.". County of Humboldt:Eureka, CA.

---. (January 28, 2022). "Humboldt Bay Master Water Intakes: Project Description. V5". County of Humboldt:Eureka, CA.

GHD. (April 5, 2022). Technical Memorandum. "Pile and Cross Beam Removal Quantities." Eureka, CA:GHD.

Gilkerson, Whelan. (May 2008). "A Spatial Model of Eelgrass (*Zostera marina*) Habitat in Humboldt Bay, California." Masters Thesis, Cal Poly Humboldt. CPH:Arcata, CA.

National Oceanic and Atmospheric Administration (NOAA). (October 2014). California Eelgrass Mitigation Policy and Implementing Guidelines. NOAA Fisheries West Coast Region. NR:NOAA.

SHN, Teneral Environmental, and the Humboldt Bay Harbor, Recreation, and Conservation District. (July 18, 2022). Technical Memorandum. "Humboldt Bay Water Intakes." Eureka, CA:SHN.

Tenera Environmental. (December 13, 2021). "The Use of Piling Removal for Mitigating Effects of Entrainment Losses to Longfin Smelt and Other Marine Resources Resulting from Operation of the Proposed Samoa Peninsula Intakes in Humboldt Bay." NR:Tenera.

Washington State Department of Natural Resources. (October 2019). Science of Creosote. NR:State of Washington.



**Kramer Dock  
Memo**

**1**

# Memorandum

27 January 2022

<b>To</b>	Rob Holmlund (Humboldt Bay Harbor, Recreation and Conservation District)		
<b>From</b>	Brett Vivyan & Jeremy Svehla (GHD)		
<b>Reviewed By</b>	Misha Schwarz	<b>Tel</b>	707 267 2275
<b>Subject</b>	Suitability of Kramer Dock Site for Bay Water Intake Project Compensatory Off-site Restoration and Mitigation	<b>Project no.</b>	11225550

## Introduction

The Humboldt Bay Harbor, Recreation and Conservation District (HBHRCD) parcel APN 307-101-002 is located along the shoreline in Fields Landing, at the end of South Bay Depot Road (Exhibit 1). The property extends into the bay, north and south of South Bay Depot Road. The northern section includes a parking lot, boat ramp, structures and the southern section is largely undeveloped with a gravel trail along the shoreline. Rows of in-water pilings that historically supported the Kramer Dock (Figure 1) and a retaining wall span the shoreline of the parcel (Figure 2).

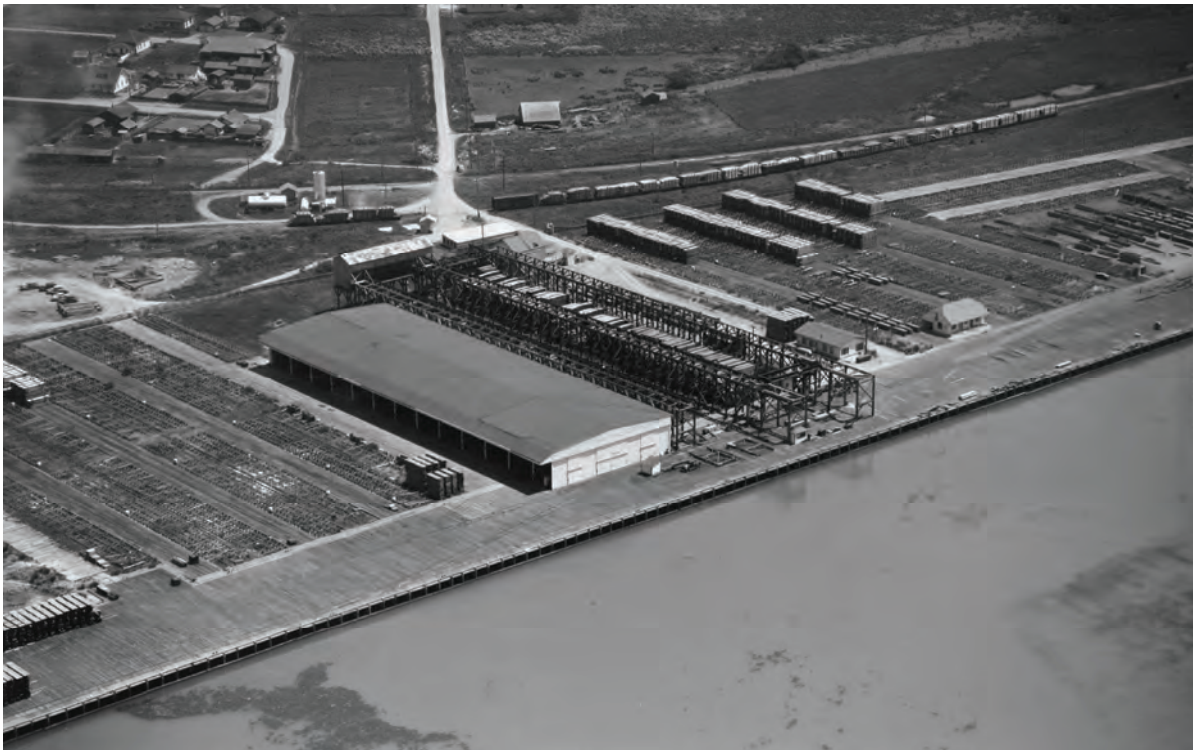


Figure 1. 1947 aerial photo showing former Kramer Dock and supporting piles (Humboldt Room 1947).



*Figure 2. Photo of representative shoreline erosion at project site. Photo source: Stillwater Sciences, 2016*

As a part of the eel grass mitigation planning process for the Fisherman's Channel Dredging Project in 2016, mitigation concepts were developed for the project shoreline that included measures to create eel grass habitat (Stillwater Sciences, 2016). The Fisherman's Channel Dredging Project did not move forward, as such the 2016 design concepts were not implemented. Since 2016, the HBHRCD has considered other multi-benefit approaches to habitat enhancement at the site.

The purpose of this memo is to present a habitat enhancement concept that builds on previous efforts and address feedback received from the California Coastal Commission. HBHRCD intends to implement eel grass and habitat enhancements along the shoreline of APN 307-101-002 to restore and improve natural processes and ecosystem functions that will provide habitat for essential fish habitat (EFH). Following implementation, HBHRCD intends to maintain ownership of the property and oversee follow-up monitoring and maintenance activities associated with the restoration.

## **Proposed Enhancements**

Eel grass and habitat enhancements may be achieved through the removal of creosote pilings and associated support structures used for the former Kramer dock. As shown in Exhibit 1, the total habitat restoration areas is 2.69 acres, and contains a total of 988 creosote treated pilings, and 151 cross beam supports, attached to the pilings. The pilings and cross beam supports were part the former Kramer dock have been identified along the shoreline (Exhibit 1).



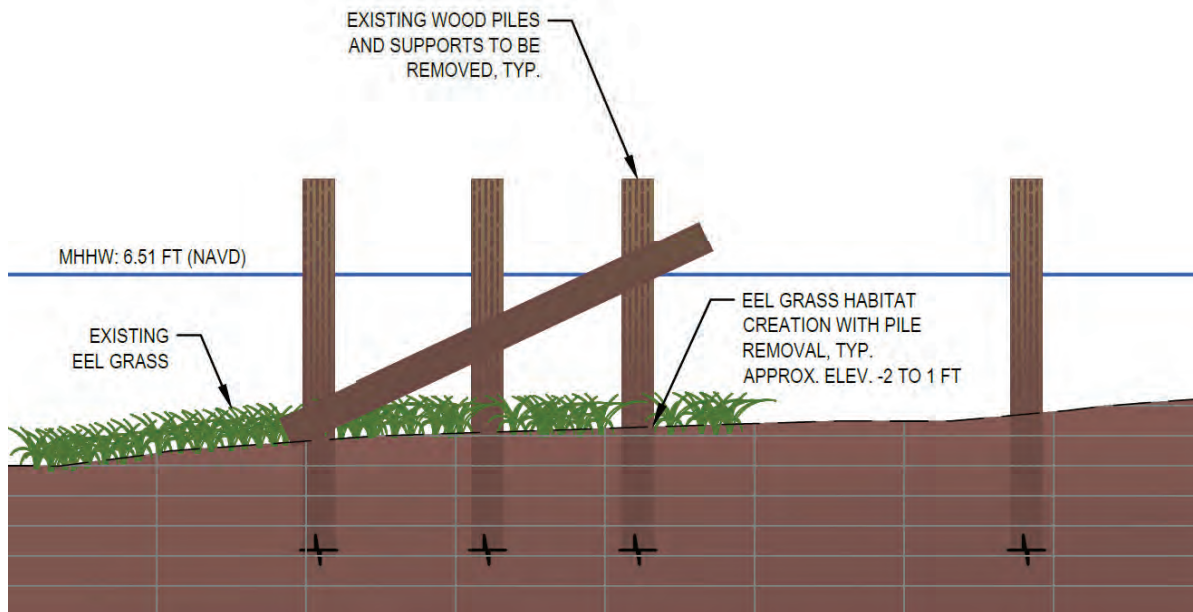


Figure 3 Typical pile removal section.

The general area containing pilings in which habitat restoration will occur is comprised of five sub-areas. Within the overall 2.69 habitat restoration area are two 150 ft wide sections that will be used as barge access. Barge access locations were selected based on a previously used location and access to South Depot Road. Existing eel grass exists among the some of the existing wood piles at elevations ranging from approximately -2 ft to 1 ft (NAVD 88).

Pilings would be removed using various methods including but not limited to a vibratory hammer, excavator, or cut-off at a minimum of 1 foot below bed elevation. Pilings located closer to shore would likely be removed from equipment operation on land during low tidal periods whereas piles further off-shore would likely require removal with equipment operating from a barge. Under current conditions, the pilings likely provide some wind wave energy dissipation along the shoreline and the existing eel grass beds have adapted to these conditions. Unarmoured portions of the adjacent shoreline show varying degrees of erosion likely caused by tide and wind waves. Piling removal may alter the nearshore hydraulic characteristics of shoreline erosion, but the project does not include removal of the old retaining wood wall which will continue to protect the shoreline.

## Conclusions and Next Steps

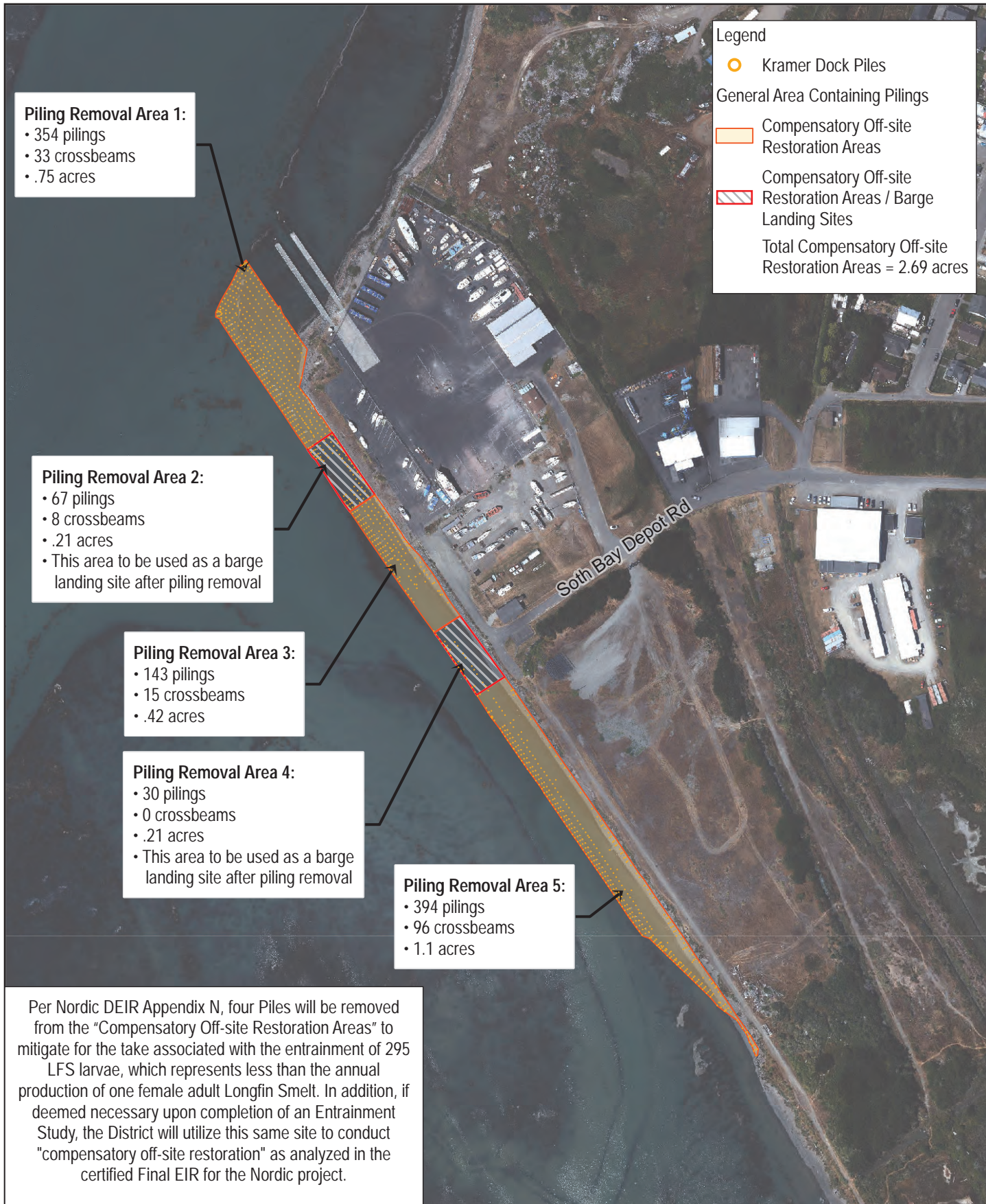
The concept presented in this memo provides creation of available space for eel grass habitat while enhancing a larger tidal habitat area with the removal of creosote piles and braces. The following next steps are recommended:

- Obtain Agency concurrence with this plan
- Develop Construction Documents for the removal of piles
- Develop Regulatory Approval Documents and Monitoring/Maintenance Plan



## References

1. Stillwater Sciences, 2016. Fields Landing Shoreline Stabilization – Preferred Approach and Alternatives Descriptions. Technical Memorandum. Arcata, CA
2. Humboldt State University Library, Humboldt Room Historic Photos



**Legend**

- Kramer Dock Piles
- General Area Containing Pilings
- Compensatory Off-site Restoration Areas
- Compensatory Off-site Restoration Areas / Barge Landing Sites

Total Compensatory Off-site Restoration Areas = 2.69 acres

**Piling Removal Area 1:**

- 354 pilings
- 33 crossbeams
- .75 acres

**Piling Removal Area 2:**

- 67 pilings
- 8 crossbeams
- .21 acres
- This area to be used as a barge landing site after piling removal

**Piling Removal Area 3:**

- 143 pilings
- 15 crossbeams
- .42 acres

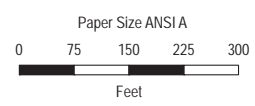
**Piling Removal Area 4:**

- 30 pilings
- 0 crossbeams
- .21 acres
- This area to be used as a barge landing site after piling removal

**Piling Removal Area 5:**

- 394 pilings
- 96 crossbeams
- 1.1 acres

Per Nordic DEIR Appendix N, four Piles will be removed from the "Compensatory Off-site Restoration Areas" to mitigate for the take associated with the entrainment of 295 LFS larvae, which represents less than the annual production of one female adult Longfin Smelt. In addition, if deemed necessary upon completion of an Entrainment Study, the District will utilize this same site to conduct "compensatory off-site restoration" as analyzed in the certified Final EIR for the Nordic project.



Baywater Intake CDP Application No. 1-21-0653

Project No. 11225550  
Revision No. 5  
Date Jan 2022

**Compensatory Off-site Restoration Areas  
at Kramer Dock**

**EXHIBIT 1**

## **Attachment F**

**CDFW (1/3/22). Memorandum of Understanding:  
Section 2081(A) Take Permit for The Humboldt Bay  
Intake Entrainment Study.**



State of California – Natural Resources Agency  
DEPARTMENT OF FISH AND WILDLIFE  
Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[www.wildlife.ca.gov](http://www.wildlife.ca.gov)

*GAVIN NEWSOM, Governor*  
*CHARLTON H. BONHAM, Director*



January 3, 2022

Gery Cox  
Tenera Environmental  
141 Suburban Suite A2  
San Luis Obispo, CA 93401  
[gcox@tenera.com](mailto:gcox@tenera.com)

Dear Mr. Cox:

**SECTION 2081(A) TAKE PERMIT FOR THE HUMBOLDT BAY INTAKE  
ENTRAINMENT STUDY**

Enclosed you will find an electronic copy of the Section 2081(a) Memorandum of Understanding for the above referenced Project, which has been digitally signed by the Department. Please read the permit carefully, sign the acknowledgement, and return the original no later than 30 days from Department signature. You may return a hard copy of the permit via mail to:

Corianna Flannery  
619 2<sup>nd</sup> Street  
Eureka, CA 95501

Alternatively, you may return an electronic copy of the permit with digital signature to [Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov). Digital signatures shall comply with Government Code section 16.5.

You are advised to keep the original signature permit in a secure location and distribute copies to appropriate project staff responsible for ensuring compliance with the conditions of approval of the permit. Note that you are required to comply with certain conditions of approval prior to initiation of subject activities. Additionally, a copy of the permit must be maintained in the field and made available for inspection by CDFW staff when requested.

**The permit will not take effect until the MOU is signed by both parties.** If you wish to discuss these instructions or have questions regarding the permit, please contact Corianna Flannery, Environmental Scientist, at (707) 499-0354.

Sincerely,

A handwritten signature in black ink, appearing to read "Craig Shuman".

Craig Shuman D. Env  
Regional Manager  
Marine Region

Gery Cox  
Tenera Environmental  
January 3, 2022  
Page 2

ec: Becky Ota, Environmental Program Manager  
Department of Fish and Wildlife  
[Becky.Ota@wildlife.ca.gov](mailto:Becky.Ota@wildlife.ca.gov)

Eric Wilkins, Senior Environmental Scientist Supervisor  
Department of Fish and Wildlife  
[Eric.Wilkins@wildlife.ca.gov](mailto:Eric.Wilkins@wildlife.ca.gov)

Corianna Flannery, Environmental Scientist  
Department of Fish and Wildlife  
[Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov)





## DEPARTMENT OF FISH AND WILDLIFE

Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[www.wildlife.ca.gov](http://www.wildlife.ca.gov)



**Expiration Date: January 31, 2023**

## **MEMORANDUM OF UNDERSTANDING REGARDING TAKE OF LONGFIN SMELT AND COHO SALMON UNDER THE CALIFORNIA ENDANGERED SPECIES ACT**

This Memorandum of Understanding (MOU) pursuant to Fish and Game Code section 2081, subdivision (a) is made and entered into by and between Gery Cox, Hilanea Wilkinson, Brianna Phillips, and Andrew Harmer of Tenera Environmental and the California Department of Fish and Wildlife (CDFW). The purpose of this MOU is to lawfully authorize incidental take (as defined by Fish & Game Code, §86) of Longfin Smelt (*Spirinchus thaleichthys*) and Coho Salmon (*Oncorhynchus kisutch*), for scientific purposes pursuant to the California Endangered Species Act (CESA; Fish & Game Code, §2050 et. Seq.; Calif. Code Regs. tit. 14, §28.06).

The California Fish and Game Commission listed Longfin Smelt as threatened on April 9, 2010 and Coho Salmon as endangered (populations south of Punta Gorda) and threatened (populations north of Punta Gorda to the Oregon border) on March 30, 2005, pursuant to CESA. These species are the "Covered Species" for the purposes of this MOU. These listings include individuals located in waters where the Permittees will collect samples while sampling in waters of Humboldt Bay and nearby offshore waters.

CESA prohibits the take of any species of wildlife designated by the Commission as an endangered, threatened or candidate species. Fish and Game Code section 86 defines take as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." Fish and Game Code section 2081, subdivision (a) allows CDFW to authorize take and possession of endangered, threatened, and candidate species for scientific, educational or management purposes.

This MOU authorizes the Permittees to possess adult, juvenile, and larval Longfin Smelt and Coho Salmon for scientific purposes pursuant to Fish and Game Code, section 2081, subdivision (a). For purposes of this MOU, Gery Cox of Tenera Consulting is the Principal Permittee.

CDFW encourages research by qualified investigators that may enhance the conservation and management of candidate, threatened or endangered species. The Permittees must possess a valid CDFW-administered Scientific Collecting Permit. The Permittees propose to conduct sampling within Humboldt Bay to assess potential entrainment of listed species from two proposed water intakes. As Longfin Smelt and Coho Salmon may be taken during these activities, the Permittees have requested an MOU to possess these species during the sampling activities.

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## Methods

CDFW agrees with the methods in the corresponding Scientific Collecting Permit. Samples will be collected at both intake locations to characterize entrainment and six source water stations located throughout the Bay. The sampling at each sampling location will involve towing a bongo frame that has two 0.71 m (2.3 ft) diameter openings. Each opening is equipped with a 335 µm mesh plankton net, cod end (collection bucket) and calibrated flowmeter. The frame and nets will be lowered from the surface to a depth within approximately one meter (3.3 ft) from the seabed and towed back to the surface at a speed of between one and two knots. The plankton nets will be towed until a target water volume ranging from 10,567-13,209 gallons of seawater per net has been filtered. This target volume will be determined in the field by flowmeters attached to the nets. At the completion of each tow, the frame and nets will be retrieved from the water and the collected material will be rinsed into the cod end attached to the end of the nets. The contents of each net will be transferred into a single labeled jar and preserved in either a 5–10% buffered formalin-seawater solution or 95% Ethanol. Each survey will be conducted during one daytime cycle and one nighttime cycle to characterize potential diel variation. There will be a total of 16 samples per survey (192 total samples for the project).

## Sampling Locations, Methods and Dates

Sampling Location	Sampling Gear	Sampling Schedule
Humboldt Bay	Ichthyoplankton Net Tows	Year Round (monthly)

## Authorized Take Level of Longfin Smelt (*Spirinchus thaleichthys*)

Requested Take Activity	Developmental Stage	Total Capture	Expected Direct Mortality	Unintentional Mortality
Ichthyoplankton Net Tows	Adult (>85 mm FL)	1	0	1
Ichthyoplankton Net Tows	Juvenile (>20- <84 mm FL)	20	20	0
Ichthyoplankton Net Tows	Larval (<20 mm FL)	100	100	0

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### Authorized Take Level of Coho Salmon (*Oncorhynchus kisutch*)

Requested Take Activity	Developmental Stage	Total Capture	Expected Direct Mortality	Unintentional Mortality
<i>Ichthyoplankton Net Tows</i>	Juvenile	1	0	1

The total capture and expected direct mortality are cumulative through the duration of the permit. If either the total catch or direct mortality are met or exceeded, the Permittee **must immediately suspend operation** and notify the MOU contact, identified below, as soon as possible but no later than one calendar day. After either total or direct mortality take level is exceeded, the applicant may resume operation only upon written approval of the Marine Region Regional Manager, or his designee.

### Specific Conditions

The following provisions shall apply in addition to Federal Endangered Species Act 4(d) Rule and CDFW's Scientific Collecting Permit requirements:

- 1) Authorized methods of take are limited to ichthyoplankton net tows as identified in the corresponding Scientific Collecting Permit.
- 2) Juvenile and adult Longfin Smelt and Coho Salmon shall be handled with extreme care and kept in cool aerated water to the maximum extent possible during sampling and processing procedures. Adequate circulation and replenishment of water in holding units are required. The transfer of both species shall be conducted using a sanctuary net that holds water during the transfer to prevent the added stress of an out-of-water transfer. When using gear that captures a mix of species, listed species shall be processed first and released as soon as possible to minimize the duration of handling stress.
- 3) No intentional lethal take of adult Longfin Smelt or Coho Salmon is authorized. A thorough effort should be made to identify all juvenile and adult true smelt (Osmerids) collected while in the field. Any unidentified juvenile or adult Osmerids that perish in the field shall be preserved for later identification. The Principal Investigator is responsible for ensuring that all preserved Osmerids are enumerated, identified to species, and measured. All identified juvenile and adult Longfin Smelt should be transferred to 95% Ethanol and labeled with all pertinent sample data (i.e., project, date, time, location, length, water temperature, etc.) and sent directly to the CDFW MOU contact listed below.
- 4) All samples collected during the months of January, February, March, and April must be preserved in 95% Ethanol for genetic preservation of larvae Longfin

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Smelt. During all other sampling months, samples can be preserved in a formalin solution.

- 5) All juvenile and adult fish that are incidentally captured during ichthyoplankton net tows shall be released underwater while the vessel is stationary. Releasing fish from a vessel underway shall only be conducted when trying to avoid predation on listed species by piscivorous birds and/or marine mammals.
- 6) Western River Lamprey, *Lampetra ayresi*, are considered a Species of Special Concern within the state of California. If Western River Lamprey are captured, the Permittee shall report the encounter to CDFW on each day individual fish are captured. The daily report shall include the approximate location of the capture, tidal stage, time of day, fish length, and sex if possible.

### **General Conditions**

- 1) Each Permittee, operating under the authority of this MOU, is responsible for the actions of non-permitted individuals assisting them while conducting sampling activities.
- 2) During fish handling/sampling using the Authorized Gear, at least one of the Permittees must be on site.
- 3) A copy of this permit will be in possession of the Permittees when the permitted activity is undertaken.
- 4) The provisions of this permit may be amended by CDFW with reasonable notice to the Permittees.
- 5) This permit may be revoked if there is failure to follow activities and conditions in this MOU.

### **Reporting**

- 1) On days in which adult or juvenile Covered Species or Species of Special Concern are collected, a daily report shall be submitted to the CDFW MOU contact information below outlining the species collected and any other relevant environmental conditions encountered at the time of collection.
- 2) All samples shall be processed and reported to the Department within four weeks of collection, prior to the next sampling event. The Permittee shall report the number of Longfin Smelt larvae caught, date, size, time of day, and location for each individual caught. The report shall also contain specific information about all other species observed including the number of unidentified Osmerids awaiting DNA analysis.

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- 3) The results of the unidentified Osmerid DNA analysis and final quality control checks shall be reported as soon as possible in order to maintain an accurate total of the number of covered species captured.
- 4) An annual summary report shall be submitted to CDFW. The report shall include a summary of all species captured and contain specific information on the number of Longfin Smelt and Coho Salmon caught during the research surveys and collections. The annual summary report shall contain the following specific information: type of Covered Species caught, number of Covered Species caught, date, size, time of day, and location for each individual covered species caught. The report shall also include a description of the general health of each Covered Species when released. These reports shall be due to the CDFW MOU contact listed below within 30 calendar days of the expiration date of this CESA MOU.

Failure to submit the information outlined above may be cause for immediate revocation of this MOU, preclude renewal of this MOU, or may impact the eligibility of responsible parties to renew or secure subsequent California Scientific Collecting Permits or CESA MOUs.

### **Responsible Parties**

All terms, conditions, and obligations of this MOU shall be binding upon each of the Permittees listed. Notwithstanding California Civil Code section 1431 or any other provision of law, each Permittee is jointly and severally liable for performance of all terms, conditions, and obligations of this MOU. Any failure by one or more Permittees to comply with any term, condition, or obligation set forth in this MOU shall be deemed a failure to comply by all Permittees.

### **MOU Contacts**

Principal Permittee:

Gery Cox  
Tenera Environmental  
141 Suburban Suite A2  
San Luis Obispo, CA 93401  
805-541-0310  
[gcox@tenera.com](mailto:gcox@tenera.com)

CDFW MOU Contact:

Corianna Flannery  
California Department of Fish and Wildlife, Marine Region  
619 2<sup>nd</sup> Street  
Eureka, CA 95501  
(707) 499-0354  
[Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov)



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Tenera Environmental  
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**Effective Date and Termination**

This MOU shall commence on the date of execution and, unless amended, will terminate on January 31, 2023.

If there are substantial changes in conditions, including changes in study methodology, changes in study location or changes in conditions that may affect other fish and wildlife resources, CDFW may, at its discretion, amend or terminate this MOU.

**Amendments**

Amendments to this MOU, including renewals, may be proposed by either party and shall become effective when both parties sign a written modification to this document.

**Disclaimer**

CDFW shall incur no fiscal obligation under this MOU.

THE PARTIES HAVE EXECUTED THIS MOU TO BE IN EFFECT AS OF THE DATE LAST WRITTEN BELOW.


**Department of Fish and Wildlife**

  
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Date: 1/3/2022

Craig Shuman, D. Env.  
Regional Manager, Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[Craig.Shuman@wildlife.ca.gov](mailto:Craig.Shuman@wildlife.ca.gov)

**Principal Permittee**

DocuSigned by:  
  
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\_\_\_\_\_

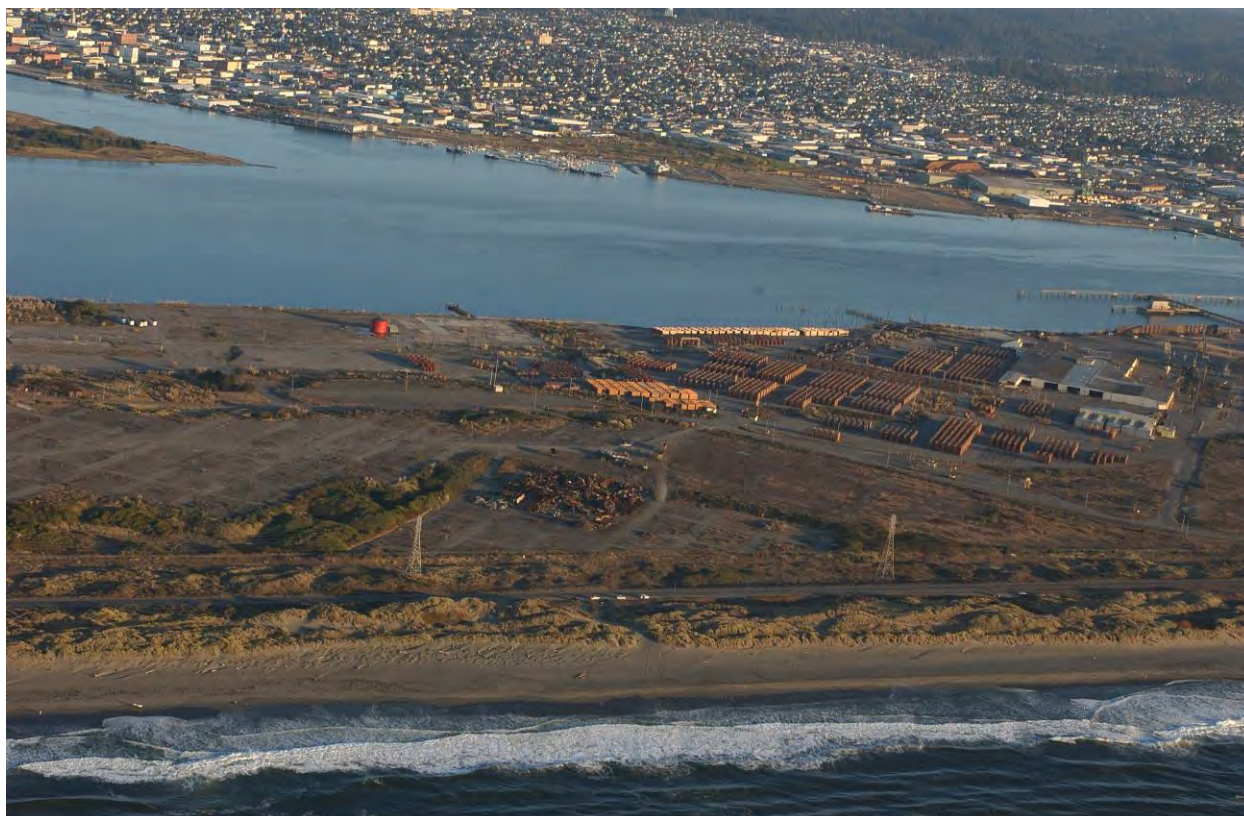
Date: 1/3/2022

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## **Attachment G**

**Tenera Environmental (1/5/22). Project  
Implementation Plan for Ichthyoplankton  
Collection at the Samoa Peninsula Water Intakes.**

# Project Implementation Plan for Ichthyoplankton Collection at the Samoa Peninsula Water Intakes



**January 5, 2021**

Document SLO2021-021

***Prepared for:***

Humboldt Bay Harbor, Recreation, and  
Conservation District  
601 Startate Drive  
Eureka, CA 95501

***Prepared by:***

Tenera Environmental  
141 Suburban Rd., Suite A2  
San Luis Obispo, CA 93401



## 1.0 Introduction

This implementation plan describes the methods to complete an assessment on the potential for impacts to marine organisms to occur due to the operation of two proposed seawater intakes which will support aquaculture and a variety of other uses in Humboldt Bay, California. The two intakes will be owned and operated by the Humboldt Bay Harbor, Recreation, and Conservation District (the District). The design and operation of intakes in ocean and estuarine waters in California are required to minimize effects on marine life due to impingement and entrainment. Impingement occurs when larger organisms are trapped against screening systems commonly used at intake openings; and entrainment occurs when small planktonic organisms, including the eggs and larvae of fishes (ichthyoplankton) and invertebrates, pass through the screens into the system. Intakes, such as the ones proposed for this project, can be designed with screens and intake velocities that almost eliminate any effects due to impingement. Therefore, the impact assessment for this study will focus solely on the effects of entrainment. The potential impacts due to entrainment at the proposed intake locations will be evaluated using the Empirical Transport Model (ETM) (Steinbeck et al. 2007), a modeling approach that has been used on larger intake systems throughout California and is the standard approach in California for assessing impacts due to power plant and desalination plant ocean intakes.

A preliminary assessment of the effects of the intakes using a modified ETM approach was completed for the initial permitting of the project (Initial ETM Assessment<sup>1</sup>). The process included a California Environmental Quality Act (CEQA) assessment on the effects of the intakes, which determined the effects to be “less than significant”. To complete the permitting for the two intakes, the District is being required to complete an assessment compatible with recent provisions for open ocean intakes associated with desalination plants adopted as an amendment to the California Ocean Plan (Desalination Amendment).<sup>2</sup>

The intake of seawater and discharges into ocean waters<sup>3</sup> in California are regulated under the provisions of the California Ocean Plan, which was most recently updated in 2019.<sup>4</sup> The two intakes are not subject to regulation under the Federal Clean Water Act (CWA) Section 316(b) that applies to industrial cooling water (Section 316(b)),<sup>5</sup> but California State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB) members and staff have generally recommended 316(b)-type studies be conducted for seawater intakes. Prior to adopting the Desalination Amendment to the 2019 Ocean Plan, seawater intakes for desalination plants were required to conduct studies similar to those required for power plant intakes under Section 316(b) based on State Water Code Section 13142.5(b), which requires that

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<sup>1</sup> Tenera Environmental Inc. (Tenera). 2021. Empirical Transport Modeling of Potential Effects on Ichthyoplankton Due to Entrainment at the Proposed Samoa Peninsula Water Intakes. Submitted to Humboldt Bay Harbor Recreation and Conservation District. Document ESLO2021-002.0 dated May 13, 2021.

<sup>2</sup> Amendment to the Water Quality Control Plan for the Ocean Waters of California (Ocean Plan) to address effects associated with the construction and operation of seawater desalination facilities (Desalination Amendment). Adopted May 6, 2015 by the State Water Resources Control Board.

<sup>3</sup> Ocean water includes coastal estuaries and coastal lagoons.

<sup>4</sup> California Ocean Plan. Water Quality Control Plan. Ocean Waters of California. California State Water Resources Control Board. Revised 2019.

<sup>5</sup> Section 316(b) applies to existing power generating, manufacturing, industrial facilities designed to withdraw more than 2 mgd and use at least 25% of the water for cooling purposes.



industrial installations using seawater for cooling, heating, or industrial processing use the best available site, design, technology, and mitigation measures feasible to minimize the intake and mortality of all forms of marine life. The ETM modeling approach proposed for use in this study complies with the design of studies on the effects of entrainment under Section 316(b), the Desalination Amendment, and under Section 13142.5(b).

The proposed study will only provide an assessment on the potential effects of entrainment, as the intake systems were designed with a very low through-screen velocity and small slot openings that should eliminate any concerns regarding the effects of impingement. The proposed study is designed to use sampling and analysis methods consistent with other studies at coastal power plants and desalination plants in California completed over the past several years.

## 1.1 Facility Description

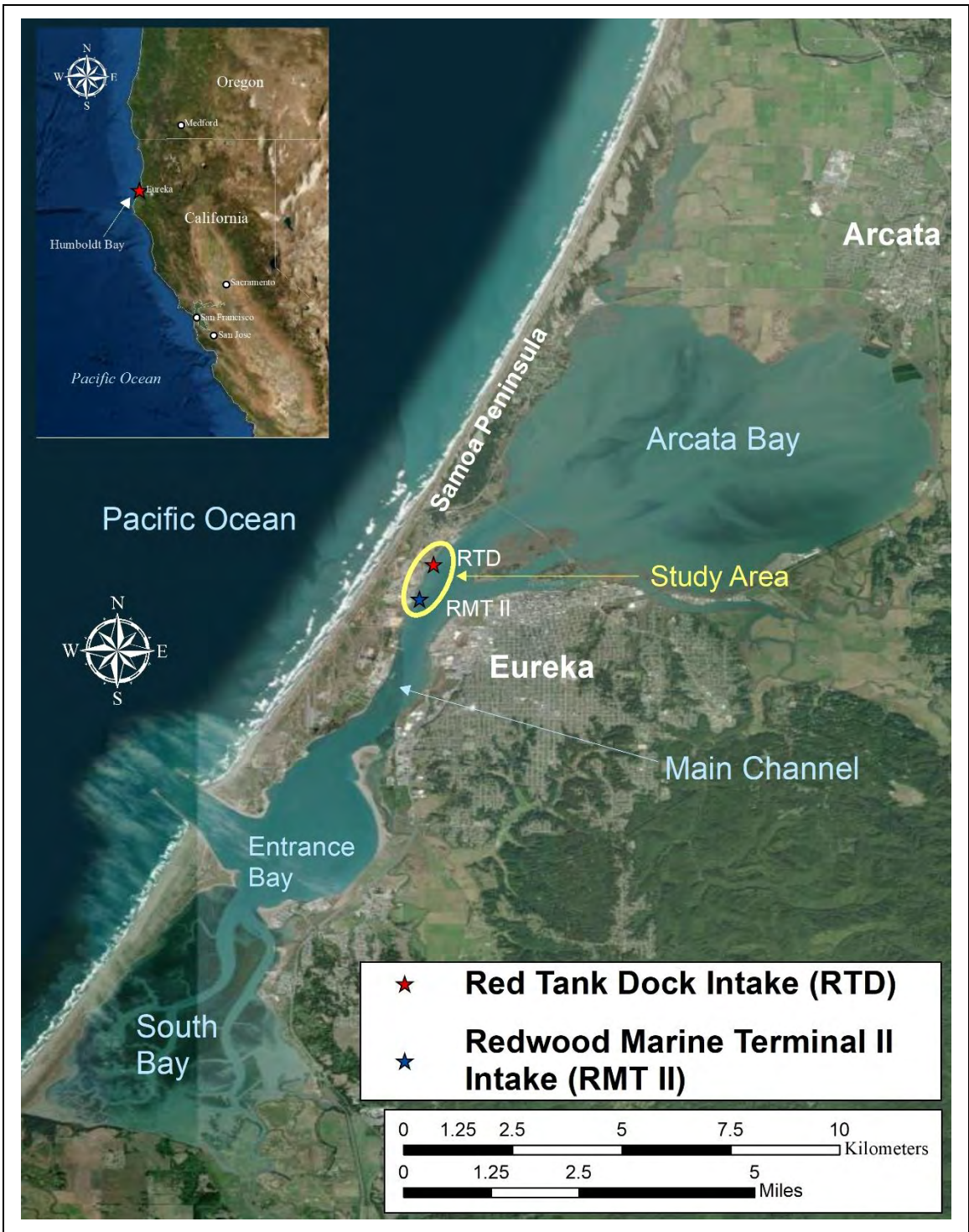
The two proposed intakes will be located at the Redwood Marine Terminal II Dock (RMT II) and the Red Tank Dock (RTD) which are located on the eastern shore of the Samoa Peninsula approximately 3.8 mi (6 km) from the entrance to the bay (**Figure 1**). The Samoa Peninsula is west of the City of Eureka in Humboldt County, California and east of the Pacific Ocean. The two intakes are located at the north end of the Main Channel where it starts to bifurcate around Tuluwat Island before opening into Arcata Bay (**Figure 2**). The distance between the two intake locations on the peninsula is approximately 0.5 mi (0.8 km).

The proposed intake design capacities are 5,500 gallons per minute (gpm) for the RMT II intake and 2,750 gpm for the RTD intake for a total capacity of 8,250 gpm (31.2 m<sup>3</sup> per minute) or 11.9 million gallons per day (mgd) (44,970 m<sup>3</sup> per day). The proposed intakes will replace existing intake structures located on docks that extend into Humboldt Bay at the two locations. The expanded capacity provided by these new intakes is intended to support a variety of tenants at the two locations. For example, there are proposed finfish, shellfish and seaweed culture operations that would utilize bay water from the intakes.

The following sections of this Plan provide further details on the methods for obtaining data on the composition and abundances of marine organisms potentially entrained by the intakes. Section 2.0 presents information on the proposed ichthyoplankton sampling including quality assurance and control measures.

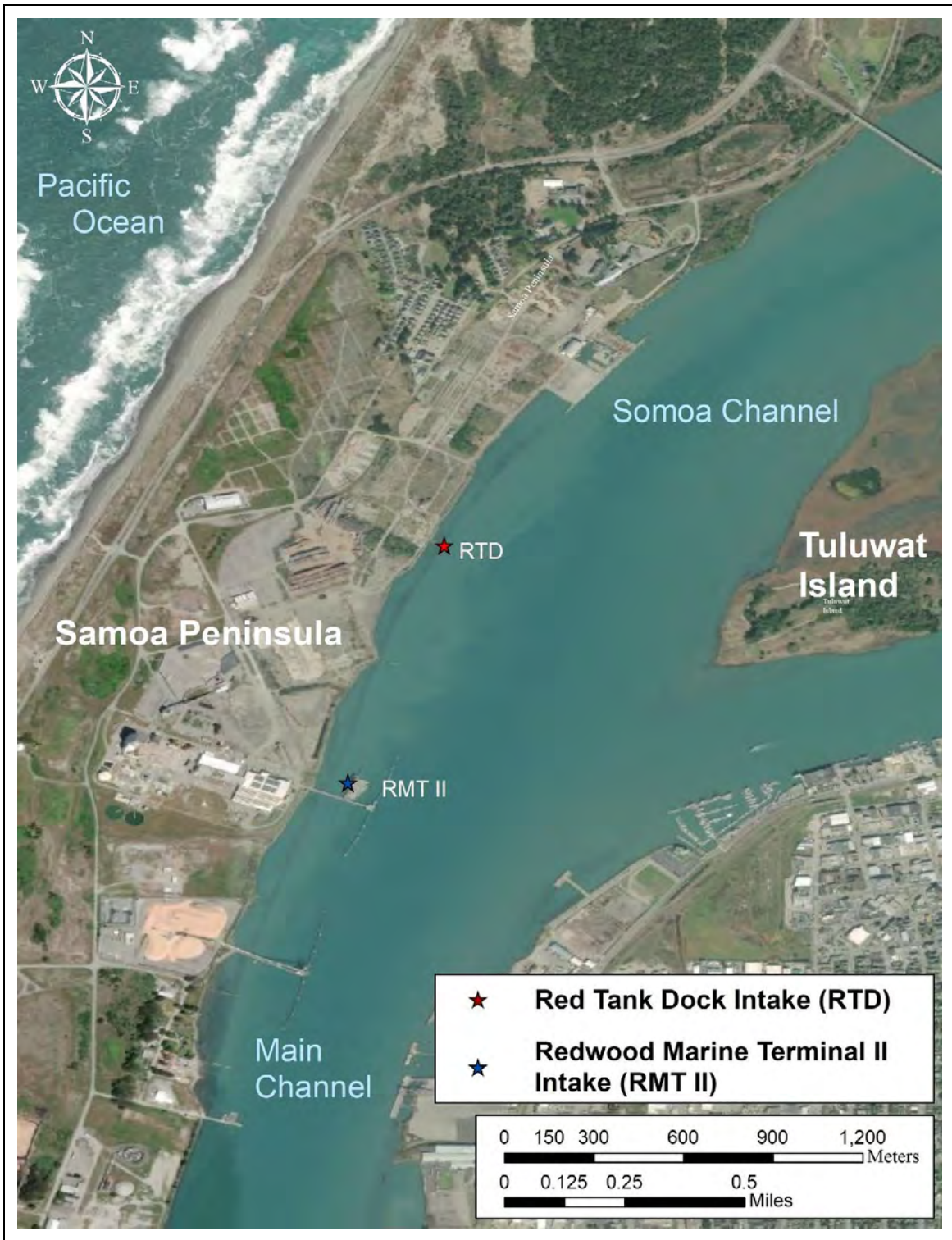






**Figure 1.** Map showing the locations of the two intakes on the eastern shore of the Samoa Peninsula along Humboldt Bay and the four areas of the Bay: Arcata Bay, Main Channel, Entrance Channel, and South Bay.





**Figure 2.** Detailed map showing locations of Redwood Marine Terminal II (RMT II) and the Red Tank Dock (RTD) intakes on the eastern shore of the Samoa Peninsula.





## 2.0 Ichthyoplankton Sampling

The purpose of the entrainment sampling is to provide data for estimating the composition and abundance of ichthyoplankton entrained by the proposed intakes. The sampling is designed to provide estimates of the abundance, taxonomic composition, diel periodicity, and seasonality of ichthyoplankton potentially entrained through the screens at the intakes. The data from the sampling will be used to estimate the concentration of the fish larvae entrained which can then be extrapolated to estimate the numbers of organisms entrained based on actual, design, or projected water volumes. The concentrations of organisms in the source water subject to entrainment vary on several temporal scales (e.g., hourly, daily, and monthly), due to ocean conditions and other factors, while the rate of water flow varies with facility operations and can change at any time. More thorough sample collection and processing procedures are included in **Appendices A** and **B**, respectively.

Plankton sampling for this project will occur in an area where there exists the potential for take of longfin smelt (*Spirinchus thaleichthys*), coho salmon (*Oncorhynchus kisutch*), and western river lamprey (*Lampetra ayresi*) which are species respectively listed as threatened, endangered, and a species of special concern. It is extremely important to note that in addition to the conditions listed on the project's Scientific Collecting Permit (**Appendix C**), sample collection and processing will be performed according to conditions set forth under a Memorandum of Understanding (MOU, **Appendix D**) issued by CDFW for this project.

### 2.1 Sample Collection

The methods used for sample collection are similar to those developed and used by the California Cooperative Oceanic and Fisheries Investigation (CalCOFI) in their larval fish studies (Smith and Richardson 1977), and subsequently used in other recent intake assessments in California (e.g., Tenera 2005). Samples will be collected once a month starting in either December 2021 or January 2022 and continue for a period of 12 months, for a total of 12 surveys. The sampling at each sampling location will involve towing a bongo frame that has two 0.7 m (2.3 ft) diameter openings. Each opening is equipped with a 335  $\mu\text{m}$  mesh plankton net, codend (collection bucket), and calibrated flowmeter. The frame and nets will be lowered from the surface to a depth within approximately one meter (3.3 ft) from the seabed and towed back to the surface at a speed of between one and two knots. The nets will be lowered and raised until the target volumes of 40 to 50  $\text{m}^3$  (10,567–13,209 gal) per net are collected. Samples will be collected at eight sampling locations; locations at both intakes will be sampled to characterize entrainment (Stations HB ES1–2), and six source water stations (Stations HB SW1–6) located in the four regions of the Bay (**Figure 3**). Three of the source water stations are located in Arcata Bay, the region of the Bay with the largest surface area and most varied range of habitats. The final location of the source water stations will be determined after consulting with local experts on the biology and hydrodynamics of the Bay.

The plankton nets will be towed until a target volume ranging from 40 to 50  $\text{m}^3$  (10,567–13,209 gal) seawater per net has been filtered. This target volume will be determined in the field by flowmeters attached to the nets. Prior to and after each tow, the flowmeter counter values will be recorded on sequenced waterproof datasheets to allow for calculation of the volume of water



filtered by each net. At the completion of each tow, the frame and nets will be retrieved from the water and the collected material will be rinsed into the codends attached to the end of the nets. During the months of January–April, the contents of both nets will be transferred into a single labeled jar and preserved in 95% undenatured ethanol to allow verification of the identification of all unidentified fish larvae using DNA that are in the taxonomic family Osmeridae which includes Longfin Smelt. The DNA analysis will be conducted by the research laboratory of Dr. Sean Lema at California Polytechnic State University, San Luis Obispo. The samples collected during the other months will be preserved in a solution of 5–10% buffered formalin-seawater solution. Each survey will be conducted during one daytime cycle and one nighttime cycle to characterize potential diel variation. Samples will be collected at all of the stations during each cycle (**Table 2**). An instrument will be used to collect data on temperature and salinity at each station during sampling. Long-term continuous data on other water parameters are available from the instrumentation maintained by CeNCOOS inside Humboldt Bay.

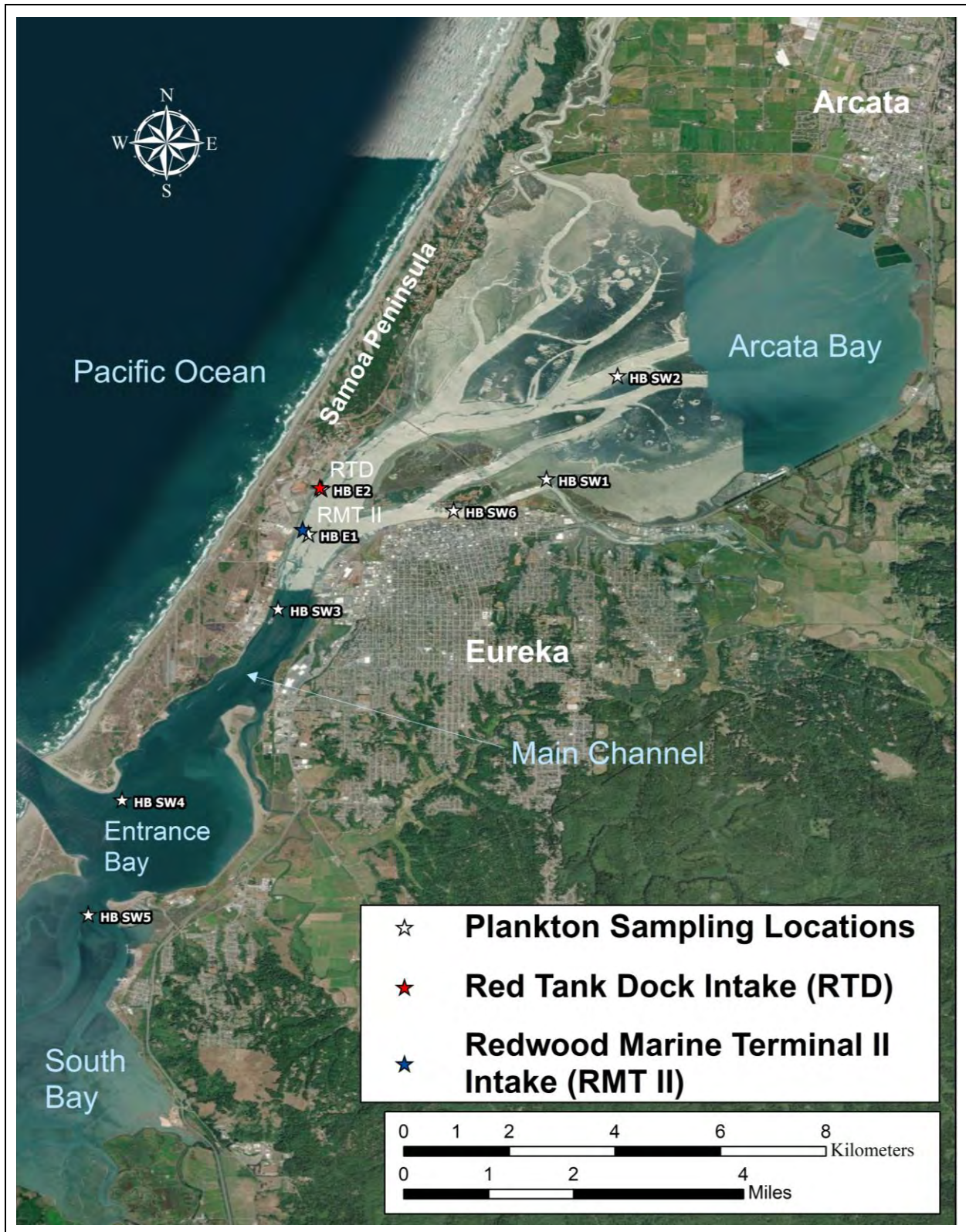
The sampling and processing done for previous entrainment studies at power plants in California where the intake screens are typically fitted with 3/8 in. (9 mm) traveling screens included the assumption that larvae or juvenile fishes with notochord lengths (NL) of 30 mm (1.2 in.) or larger were not subject to entrainment. While these fish and larvae were collected and their number recorded, the data were not included in the entrainment estimates or ETM analyses. The use of a slot opening of 1 mm (0.04 in.) at the Humboldt Bay intakes will reduce entrainment of larger larvae. Therefore, we will assume that larvae with a NLs of 25 mm (0.98 in.) or larger would not be subject to entrainment. All larval and juvenile fishes collected during the sampling with NLs of 25 mm (0.98 in.) and larger will be identified, length (NL or total length depending on life stage) measured or estimated, and then returned to the bay as gently and as soon as possible as required in the Section 2081(a) Memorandum of Understanding for the project issued by the California Department of Fish and Wildlife on January 3, 2021 (CDFW MOU) for the potential take of larval and juvenile Longfin Smelt (*Spirinchus thaleichthys*), and Coho Salmon (*Oncorhynchus kisutch*).

**Table 1.** Summary of the number towed plankton surveys and samples to be collected at entrainment and source water stations.

Station	Basis for Number of Samples per Survey	Total Number of Samples per Survey	Number of Surveys	Total Number of Samples per Year
HB E1*	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB E2*	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW1	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW2	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW3	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW 4	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW5	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
HB SW6	1 rep x 2 cycles (1 day cycle + 1 night cycle)	2	12	24
<b>Totals</b>		<b>16</b>		<b>192</b>

\* Samples from the two entrainment stations will be processed separately but composited for analysis using the ETM.





**Figure 3.** Map of the currently proposed entrainment and source water sampling stations. Sampling locations are subject to change based on consultation from local biologists and oceanographers.





## 2.2 Ichthyoplankton Sample Processing

Samples from the field will be shipped to the Tenera laboratory in San Luis Obispo. After at least 72 hours, the samples originally preserved in 5–10% buffered formalin-seawater solution will be transferred into a solution of 70–80% ethanol preservative; the samples initially preserved in 95% ethanol will remain in that preservative during processing. When samples are particularly dense the Folsom plankton splitter may be used to further divide samples into smaller, more manageable subsamples representing  $\frac{1}{2}$ ,  $\frac{1}{4}$ , or some other fraction of the original composite sample. As required in the CDFW MOU for the potential take of larval and juvenile Longfin Smelt, the entire volumes of the samples collected from December–April will need to be processed. This is required to ensure an accurate count of Longfin Smelt take from the sampling is recorded. Processing will consist of examining the collected material under a dissecting microscope and removing and counting all of the fish eggs and larvae. The eggs and larvae will be placed in labeled vials and then identified to the lowest possible taxonomic level. The developmental stage of fish larvae (yolk-sac, preflexion, flexion, postflexion, transformation) will also be recorded.

Fish specimens that are not able to be identified to the species level will be identified to the lowest taxonomic classification possible. Myomere counts (muscle segments) and pigmentation patterns are commonly used to identify the larval fishes; however, this can be problematic for some species. For example, several species of the Gobiidae family of fishes<sup>6</sup> share similar characteristics during early life stages, making identification to the species level uncertain (Moser 1996).

The taxonomic identification of all unidentified Osmeridae larvae and Longfin Smelt will be verified using DNA. The DNA analysis will be conducted by the research laboratory of Dr. Sean Lema at California Polytechnic State University, San Luis Obispo.

Notochord length and head capsule dimensions will be measured for a representative number of larval fish from each survey using a video capture system and image analysis software. The length data will be used to estimate the age of larvae and the period of time that they are subject to entrainment. The length and head capsule measurements of larvae with NLs of less than 25 mm (0.98 in.) will be used to determine the size of the larvae from each species that would not be subject to entrainment.

The approach used to calculate the period of time that that larvae for each taxon are exposed to entrainment has evolved over time based on results of entrainment studies in California. Results of early studies used the average and maximum lengths of the larvae to calculate a range of estimates for each taxon. The lengths of the larvae collected for most species show a large variation in hatch length with the published hatch lengths for many taxa being much larger than a large percentage of the data, in some cases greater than the average length of the measured larvae. For example, using a small sample size of 47 larvae, the variation in hatch length of Pacific Sardine varied from 2.57–4.18 mm (Garrido et al. 2015), whereas the variation in hatch

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<sup>6</sup> The Gobiidae are the taxonomic category of fishes that includes all the species of gobies, which are small fishes that can be abundant in bays, estuaries, and nearshore areas.



length cited in Moser (1996) was 3.5–3.8 mm. The site-specific larval durations will be calculated by dividing the difference between a computed size at hatching and the size at the 95th percentile or the size of the maximum entrainable larvae based on head capsule dimensions by a larval growth rate obtained from the literature. The duration of the egg stage will be added to this value for species with planktonic eggs, such as Northern Anchovy.

The size at hatching will be estimated as follows:

$$\text{Hatch Length} = (\text{Median Length} + 1^{\text{st}} \text{ Percentile Length})/2.$$

This calculated value was used because of the large variation in size among larvae smaller than the average length. This calculation assumes that the length frequency distribution is skewed towards smaller-sized larvae and usually resulted in a value close to the hatch size reported in the literature (e.g., Moser 1996). This assumption will be checked for each of the taxa analyzed using published estimates of hatch size.

To be consistent with the ETM that provides estimates of entrainment effects that are less subject to interannual variation in abundance, the goal of determining the length of time that the larvae are exposed to entrainment should be to provide an unbiased estimate that is also representative of the larger population. Bootstrapping can be used to provide unbiased estimates of the values used in calculating the number of days that the larvae of each taxon are exposed to entrainment. This statistical procedure may provide a better representation of the sampling distribution and variation of the population. Random samples of 100 length measurements (or the number of measurements available for each taxon) will be drawn with replacement for each taxon being analyzed 1000 times. The random samples will be proportionally allocated based on the fractions of the population present in the source water. Statistics calculated from the bootstrap samples will be used to calculate estimates used in calculating the period of time larvae were exposed to entrainment.

The data on NL will also be important in determining the proportion of larvae subject to entrainment for certain species that may not be able to tolerate salinity conditions in that area of the Bay. This will be important for Longfin Smelt, a species listed as threatened under the California Endangered Species Act.<sup>7</sup> As explained in the Addendum on Longfin Smelt provided for the Initial ETM Assessment, small larvae of this species have limited tolerances of salinities greater than 10–12 psu and would not survive the salinities levels that are close to seawater (~32 psu) that normally occur in the area of the intake. The larvae are likely dead at the time of collection when salinities are at these levels and should not be included in the ETM analyses from the study.

Data on head capsule dimensions will be important in identifying larvae that would not be susceptible to entrainment. This will be determined using the width and depth of the head capsule for the larvae, which should be a conservative approach to determine which size larvae would not be entrained by the one mm slot openings used on the intake screens for the project. Tenera has measurements for thousands of fish larvae and has developed mathematical models that provide the relationship between larval fish length and head capsule dimensions for most of

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<sup>7</sup> <https://wildlife.ca.gov/Conservation/Fishes/Longfin-Smelt>. Viewed February 12, 2021.



the fishes likely to be collected during the study. The analyses associated with these models have been used in previous studies at desalination plants and in the development of the Desalination Amendment. Following the collection of the samples, we will determine if additional data on head capsule measurements from the collected samples are necessary.

The ETM calculations will be completed using the both the unadjusted entrainment estimates and entrainment estimated adjusted based on NL or head capsule dimensions. The reduction in entrainment effects resulting from the use of the one mm screens at the intakes can be approximated by comparing the two estimates. These estimates would be important to consider in evaluating the ETM results, and in calculating any mitigation required for the project.

Laboratory data will be recorded on preprinted data sheets formatted for entry into a computer database for analysis and archiving. All data will be recorded on sequenced data sheets, entered into an Access® computer database, and then verified for accuracy against the original data sheets.

### **2.3 Data Management and Quality Assurance/Quality Control**

A QA/QC program will be implemented for the field and laboratory components of the study. The field survey procedures will be reviewed with all personnel prior to the start of the study and all personnel will be given printed copies of the procedures. A detailed training of the field sampling staff at the start of the project will be conducted to ensure that field sampling procedures are being implemented properly. In addition to ongoing training and periodic review of sampling procedures, quality control assessments will be completed throughout the study to ensure that the field sampling continues to be conducted properly.

A detailed QA/QC program will also be applied to all laboratory processing. The laboratory procedures will be reviewed with all personnel prior to the start of the study. All personnel will be given printed copies of the procedures. The laboratory processing initially involves the removal of larvae from the samples, which is performed by a team of sorters, and then the identification of larvae to the lowest taxonomic level, which is performed by specialist taxonomists. Separate QA/QC procedures have been developed for sorters and taxonomists.

During the initial training period for each sorter, their first ten samples will be re-sorted by a designated quality control (QC) sorter. During re-sorting, sorters will fail QA/QC standards if they miss more than one of the target organisms when the total number of larvae in the sample is less than 20. For samples with 20 or more larvae the sorter must maintain a sorting accuracy of 90%. After a sorter has sorted ten consecutive samples with greater than 90% accuracy, the sorter will have one of their next ten samples randomly selected for a QA/QC check. If the sorter fails to achieve an accuracy level of 90%, their next ten samples will be re-sorted by the QC sorter until they meet the required level of accuracy. If the sorter maintains the required level of accuracy, one of their next ten samples will be re-sorted by QC personnel.

A similar QA/QC program will be implemented for the taxonomists identifying the organisms in the samples. During the initial training period for each taxonomist, their first ten samples will be completely re-identified by a designated QA/QC taxonomist. Taxonomists are required to maintain a 95% identification accuracy level for these first ten samples. After the taxonomist has



identified ten consecutive samples with greater than 95% accuracy, the taxonomist will have one of their next ten samples checked by a QA/QC taxonomist. If the taxonomist maintains an accuracy level of 95%, then they will continue to have one of ten samples checked by a QA/QC taxonomist. If a taxonomist falls below this level, then the next ten consecutive samples the taxonomist has identified will be checked for accuracy. Samples will be re-identified until ten consecutive samples meet the 95% criterion. Identifications will be verified with taxonomic voucher collections maintained by Tenera.

## 2.4 Source Water Modeling

Tenera will work with local physical oceanographers, researchers, and experts from other institutions to determine the most appropriate hydrodynamic model for the Bay based on the model used in the Initial ETM Assessment. The ETM methodology estimates the number of larvae that are entrained as a proportion of a source water population. Seasonal variation in fish age and ocean current patterns is accounted for in the model. This source water population is defined as the total population of larval fishes that could potentially be entrained. All of the larval fishes that will be entrained by the intakes will likely be very early-stage larvae because of the small 1.0 mm openings used on the screens at the intakes. As a result of the early developmental stages of these larvae, they are assumed to be passively transported by the tidal currents inside the Bay. The source water area can also be used to estimate appropriate mitigation for the project using the Area of Production Foregone (APF) based on the potential spawning habitat associated with the species collected during entrainment.

## 2.5 Reporting

Quarterly reports will be submitted to update project management on the status of the field sampling and laboratory processing. A final draft Intake Assessment Report will be submitted within 90 days of the final sample collection for review and this report will be finalized within 30 days of receiving comments from project management.

The final report will present the results of the ETM-based intake assessment and will include estimates of APF for the fishes targeted for analysis using the ETM. The APF methodology is not a necessary outcome of the ETM but has been utilized by regulatory agencies to estimate the mitigation required to provide for replacement of habitat necessary to compensate for entrainment losses. The APF does not equate to the potential significance of entrainment based on the ETM estimates of  $P_M$ . The use of APF should be limited to species associated with identified habitats in the source water that can be targeted for restoration.



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# Appendix A Sample Collection Procedures



# Standard Operating Procedures for Zooplankton Collection



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**APPENDIX A Equipment and Supply List**

**ATTACHMENTS**

- ATTACHMENT A** Tenera Chain of Custody Form  
**ATTACHMENT B** Notification of Intent to Collect for Scientific Purposes Form  
**ATTACHMENT C** Field Data Sheet Example  
**ATTACHMENT D** Zooplankton Net Flowmeter Calibration Log

## INTRODUCTION

Zooplankton encompass an array of macro and microscopic animals and includes holoplankton, meroplankton, and ichthyoplankton. Zooplankton species play a vital role in the marine food chain. The herbivorous zooplankton feed on phytoplankton and in turn constitute an important food item to animals in higher trophic levels, such as fish. The occurrence and abundance of ichthyoplankton (fish eggs and fish larvae) facilitate the location of probable spawning and nursery ground of fishes. Zooplankton are ubiquitous. The success of zooplankton estimation and productivity largely depends upon the use of correct methodology which involves collection of samples, fixation, sorting, identification, length analysis, and preservation. The detailed procedures on field sample collection and fixation are given in this manual.

## RESPONSIBILITIES

The Project Manager is responsible for:

- verifying that all staff working on the project have read and understand these procedures;
- ensuring adherence to all vessel requirements (safety, etc.) during surveys;
- designing and implementing the Quality Assurance/Quality Control Program in accordance with written procedures;
- maintaining these procedures and ensuring that any approved changes made to the procedures are understood and implemented by field personnel and recorded in Section 16.0 of this procedure.

The Field Biologist/Supervisor is responsible for:

- ensuring that the California Department of Fish and Game (CDFG) Scientific Collecting Permits are valid and that CDFG has been notified regarding the sampling;
- ensuring that plant personnel are contacted prior to sampling according to this procedure;
- ensuring that plankton samples are collected in accordance with written procedures;
- verify that procedures have been followed during sample collection and that sampling has been conducted safely;
- ensuring that all the necessary supplies, sampling equipment, and safety equipment (lifejackets, fire extinguisher, radios, etc.) are available and in proper working order.

Field Biologists are responsible for:

- reading and understanding these procedures;
- ensuring all on-board and pump station sampling, sample handling, labeling, and sample fixation/preservation activities related to zooplankton tows and pump collection are in accordance with these procedures;
- Understanding and implementing all QA/QC requirements described in this procedure.



# STANDARD OPERATING PROCEDURE FOR ZOOPLANKTON COLLECTION

## 1.0 SCOPE AND APPLICATION

These Standard Operating Procedures (SOP) describe the field sampling and fixation/preservation of marine zooplankton samples collected from locations off California.

## 2.0 SUMMARY OF METHODS

Zooplankton collection is generally accomplished using a small-meshed net to filter planktonic organisms from seawater. As water passes through the net planktonic organisms are filtered from the water and concentrated in a receptacle (codend) at the end of the net. Once a target volume of seawater has been filtered the net is lifted from the water, washed down, and the codend removed. The contents of the codend are then emptied into sample jars and preserved for later processing in a laboratory. Sampling success involves the selection of suitable gear that is selected based on the objectives of the investigation. Gear considerations include net frame type, net mesh size, time of collection, water depth of the study area and depth strata to be sampled, and sampling strategy.

### 2.1 Towed Net Sampling

A common method of zooplankton collection is by towing a plankton net through the water column from a boat. Plankton nets used are of various sizes and types. In addition to the mesh size, the frame type, net length, mouth area of the net, towing speed, time of collection, and type of tow (surface, oblique, etc.) will determine the quality and quantity of zooplankton collected.

The bongo frame used for zooplankton sampling is a double net frame which two plankton nets are mounted in a side by side configuration. Calibrated flowmeters in the net frame opening are used to record the volume of ocean water filtered by each net. Once the desired volume of seawater has been filtered the nets are lifted from the water and thoroughly rinsed down from the outside so that any planktonic organisms adhering to the net are pushed into the codend. The contents from each codend may be preserved as separate replicates or combined into a single sample. Debris or extraneous material is removed from the codend and the zooplankton sample is transferred into clean, dry sample containers. Prior to the next tow the nets are sprayed to prevent contamination of samples with collections from the previous tows. Washing the nets will also prevent clogging, especially when there is a bloom or if a finer mesh is used for obtaining the samples. Samples are preserved in 10% buffered formalin or 95% ethanol in the field and delivered to the Tenera Plankton Lab for processing.

### 2.2 Pump Sampling

Pump gear can be used on board a vessel or pump sampling can be carried out from a pier or shore station. In this method, an inlet pipe is lowered into the source water and the outlet pipe is positioned in the mouth of a net of suitable mesh size. The net is submerged in a tank of seawater to prevent damage to the planktonic organisms that are filtered through the net. A flowmeter on the inlet pipe records the water volume filtered. This method is used for quantitative estimation and to study the small scale distribution of plankton.

After lifting the nets from the tank, they are thoroughly washed so that any planktonic material adhering to the plankton net is pushed down into the codend. Debris or extraneous material is removed from the codend and the zooplankton sample is transferred into clean, dry sample containers. Prior to the next tow the nets are sprayed to prevent contamination of samples with collections from the previous tows. Washing the nets will also prevent clogging, especially when there is a bloom or if a finer mesh is used for obtaining the samples. Samples are preserved in 10% buffered formalin or 95% ethanol in the field and delivered to the Tenera Plankton Lab for processing.

### **3.0 SAFETY AND WASTE HANDLING**

Refer to the *Tenera Injury and Illness Prevention Plan (IIPP)* (January 2018, or as amended), SOPs, SDS, and individual procedural operations manuals for specific details on applicable 1) personal health and safety issues; 2) chemical and waste handling procedures; and 3) accident prevention. Never compromise your personal safety or that of a field partner to collect a sample. Always wear appropriate safety gear.

It is each Project Manager's responsibility to determine an approximate amount of project waste, trash and scrap materials that will be generated, prior to the initiation of work. This determination will allow the Project Manager to provide adequate waste containers for removal and disposal.

It is the responsibility of the user of these procedures to comply with all applicable safety and waste handling rules. Additionally, all relevant chemical disposal and waste regulations are to be followed. All containers storing reagents and wastes used in sample collection must be properly identified through appropriate labeling and hazard definition.

Every chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. Please refer to the IIPP and applicable SDS for more detailed descriptions of the potential risks associated with any chemicals used in these procedures.

All employees handling chemicals, and/or their wastes products, are subject to training prior to use of specific products and at least annually thereafter. Training will consist of proper selection, sizing, and use of PPEs, including safety glasses and chemical resistant gloves and aprons. Training will also include the care and maintenance of PPEs so that PPEs are store and maintained in a sanitary and clean condition. Any defective PPEs should be given to the Laboratory Director for proper disposal and subsequent replacement. All training will be documented using Tenera's standard format (see IIPP, Appendix B).

### **4.0 EQUIPMENT AND SUPPLY LIST**

(see Appendix A)

## 5.0 CHEMICALS

- 70% denatured alcohol (*Use 95% denatured alcohol*). To make 1 L of 70% denatured alcohol, dilute 740 ml of 95% alcohol with 260 ml of distilled water.
- 95% non-denatured ethanol (*Use 190 proof reagent stock*).
- 10% Formalin (3.7% formaldehyde) Prepare 8 L of 10% buffered formalin solution by mixing 1 part 37% formaldehyde (800 ml) with 9 parts clean sea water (7200 ml) in a calibrated carboy. Add borax for additional buffering capacity (160 grams). Take note if a buffer other than seawater is used.

## 6.0 CHAIN OF CUSTODY

The primary objective of the chain of custody procedure is to create a written record that can be used to trace the possession of the sample(s). The chain of custody form (Tenera COC form; Attachment A) is filled out at sample collection and follows the sample through every person involved in the chain of possession until it reaches the laboratory. All samples, whether received in person or via commercial carrier, must be accompanied by a chain of custody form. Sample custody procedures are important to ensure the integrity of the samples whether for legal or other purposes.

### 6.1 Chain of Custody Procedures

- a. The chain of custody form should be completed by the sampler using a waterproof pen at the time of sample collection and the form should be packaged with the samples for transport to the laboratory.
- b. Samples may be delivered to the laboratory by Tenera field crews or arrive by US Mail, Federal Express, or other commercial carriers. When samples arrive at the Lab, the completed chain of custody form must be signed by Tenera personnel. If there is an address slip on the package for the shipment (e.g., a Fed- Ex slip) that log is saved and marked with the Project Identification and Survey Number.
- c. Every time the sample changes possession, the person relinquishing the sample and the person receiving it must complete the chain of custody form to include the date, time, their printed name, and signature. Minimally, there must be two signatures on the chain of custody.
- d. The Lab representative receiving the samples must review the chain of custody data to ensure all samples are accounted for. Any discrepancies on the form must be documented.
- e. A copy of the signed chain of custody form shall be returned to the party of origin. The completed, signed, chain of custody forms shall be filed and stored in the Chain of Custody binder in the laboratory (A2 Lab).

## 7.0 SAMPLE FIXATION

The necessity of proper fixation and preservation of zooplankton needs no emphasis. After sampling, the fixation of samples should occur as early as possible (at least within five minutes) after the collection to avoid damage to animal tissue by bacterial action and autolysis.

The most common fixing reagent is 10% formalin (3.7% formaldehyde). Analytical grade formalin should be used for fixation as the commercial formalin is often contaminated with iron compounds which produce a precipitate of iron hydroxide that may render zooplankton identification difficult. The concentrated formalin (37% formaldehyde) should be diluted with filtered seawater (preferably with water from the sampling area) to avoid undesirable osmotic effects. The dilution is in the ratio of 1 part 37% formalin and 9 parts seawater. The pH of the fixative should be around 8.0. Commonly used buffers are borax (sodium tetraborate), baking soda (calcium bicarbonate), or a phosphate buffer can be used for long-term storage. The buffers are added in an amount of approximately 200 grams to one liter of concentrated formalin (37%). Dilutions of formalin shall be prepared in a well-ventilated area outside while using safety goggles, gloves, and protective clothing.

### 7.1 Formalin Mixing Procedures

- Splash goggles and chemical proof gloves must be worn when handling formalin
- Pour 800 ml of 37% formalin into a 10 liter formalin carboy
- Fill carboy to the 8 liter mark with filtered seawater (7200 ml seawater)
- Add Borax buffer (approximately 160 grams) to form a super saturated solution
- Stir thoroughly until most of the Borax is dissolved

For samples involving DNA and/or otolith analysis, 95% non-denatured ethyl alcohol is used. Immediately after collection, drain the samples of excess seawater and wash the sample into a glass jar using 95% non-denatured ethyl alcohol. Add additional 95% ethyl alcohol to fill the jar; there must be three to four times more ethanol than plankton volume.

## 8.0 FORMALIN

Formaldehyde is a colorless, strong-smelling highly reactive gas that is composed of hydrogen, carbon, and oxygen. Formalin is usually used in a liquid solution with water or methanol. The occupational health hazards of formalin are primarily due to its toxic effects after inhalation, after direct contact with the skin or eyes in liquid or vapor form, and after ingestion. When present in the air at levels above 0.1 ppm (parts per million) it can cause watery eyes, burning sensations in the eyes, nose, and throat, nausea, coughing, chest tightness, wheezing, skin rashes, and allergic reactions. Ingestion of as little as 30 ml of a 37% solution of formalin can result in death. Long term exposure to formaldehyde has been shown to be associated with an increased risk of cancer.

### 8.1 Employee's Responsibilities

- a. Read this SOP and refer to the *Tenera Injury and Illness Prevention Plan (IIPP)* (January 2018, or as amended). Discuss any questions with the Field Supervisor or Lab Director.

- b. Read the Formaldehyde Safety Data Sheet (SDS) before beginning field collection procedures. The SDS is available in the plankton laboratory, A2 Lab, and the Lab director's office.
- c. Participate in the Formaldehyde Awareness Training (IIPP Section C-4).
- d. Report immediately to the Field Supervisor any symptoms or reactions that might be related to formalin exposure.
- e. Properly use PPE.
- f. Immediately flush with water any skin area that comes into contact with formalin.

## 8.2 Personal Protective Equipment

- Safety splash goggles/glasses
- Chemical resistant gloves
- Portable eyewash kit
- Formalin spill clean-up kit
- Formalin monitoring badges (project dependent)

## 8.3 Monitoring

- a. Representative monitoring for airborne formalin shall be conducted at the inception of a new procedure involving handling of formalin or at the resumption of an established procedure after a long period of time has elapsed.
- b. The exposure of each employee involved in sample processing will be determined, using appropriate short-term exposure or long-term exposure monitoring badges.
- c. Complete records of the results of airborne formalin monitoring will be kept for 20 years.

## 8.4 Clean Up

- a. If a formalin spill occurs on the vessel, encircle the spill at its perimeter by pouring on FSC-1 solidifier located in the Formaldehyde Spill Kit. Once the spill is covered completely, wait until the residue is a semi-solid mass (15 minutes or more).
- b. Transfer the absorbed material using the pick-up scoop and scraper to the appropriate sized bag.
- c. Rinse the area thoroughly with copious amounts of water. Scrub the area with a mild detergent and water.
- d. If formaldehyde or formalin has contaminated your clothing, change into clean clothing immediately.
- e. Do not take contaminated work clothes home. An authorized individual should launder contaminated work clothes.
- f. If personal exposure to formaldehyde or formalin occurs, wash all body areas IMMEDIATELY and THOROUGHLY with copious amounts of water.



- g. Notify lab director and project manager of any spills that occur immediately after.

## 8.5 Hazardous Waste Disposal

Any absorbent materials used to clean up a spill should be placed into a heavy-duty plastic garbage bag, sealed, labeled, and disposed of according to local ordinances.

## 8.6 Transport of Samples from a Vessel to the Laboratory

Formalin should always be carried in containers that are approved for this purpose. The containers should be of a material that is impervious to the formalin solution or vapor. All containers must be checked prior to transport. If there is any apparent leakage of liquid or vapor from the container, or there appears to be a potential for leakage, then the container is not suitable for the transport of formaldehyde solution. Ideally, concentrated formalin should be carried as 10 liter aliquots with no more than 25 liters being carried in a single container. At sea 37% formaldehyde solution is stored on deck in a properly labeled chemical storage container (carboy). Plankton samples containing 10% formalin are stored on deck in labeled cartons or crates.

Formaldehyde solution must not be transported to or from a vessel in a situation where fumes generated from a spillage can come into contact with the driver or passengers. All quantities of 37% and 10% formaldehyde must be carried in an approved chemical container and securely stored in a vehicle that separates the occupants of the vehicle from the formaldehyde. Containers of formaldehyde solution must be clearly labeled with Formalin Biohazard Labels. An approved formaldehyde spill kit and formaldehyde SDS must always be carried when transporting all concentrations of formaldehyde solution in case of accidental spillage. Spillages of formaldehyde in enclosed vehicles should, when possible, be irrigated with water. If this is not possible, the formaldehyde must be allowed to evaporate, and all fumes should be dispersed before the vehicle is used again.

## 9.0 FIELD SAMPLING PREPARATION

- a. Coordinate with the Lab Director ahead of time to ensure there are enough jars, labels, and preservative for the sample collection effort.
- b. Prepare all sample jars and transport containers.
- c. Prepare internal and external sample jar labels: use either waterproof paper and pencil or pre-printed labels on waterproof paper. Pre-labeling will include the project code, survey number, date of collection (unless conducting a 24-hour survey), sampling station, and preservative type (if using only one type of preservative). Following successful collection of the sample, the cycle number, sample number, and time of collection are added in permanent marker or pencil.
- d. Affix the appropriate chemical hazard label (i.e., formalin, alcohol) to the sample jar lid.
- e. Checkout the required number of Field Data Sheets (Attachment C) from the Data Coordinator. Standard uniform field datasheets will be maintained. Field data sheets will include the following information for each sampling event:
  - Sample sequence number

- Collection date
  - Sampling personnel
  - Sampling event start and end times
  - Status of plant makeup water pump operation
  - Cycle of start, end, and total time
  - Cycle start and end flowmeter readings
  - Total cubic meters (m<sup>3</sup>) sampled in cycle
  - Total cubic meters (m<sup>3</sup>) collected in sampling event
  - Number of jars of sample collected per cycle and total jars per sampling event
  - Pump serial number ID (if applicable)
  - Flowmeter serial number ID
- f. Inspect the frame, nets, and codends for any damage. If damaged, repairs must be made before sampling begins. Ensure the flowmeters are within the necessary calibration period and they are operational.
- g. Check all equipment and supplies against the Equipment and Supply List (Appendix A) and ensure that all equipment is in good operating condition. Make repairs if necessary.
- h. A calibration log will be created for each instrument. The logs shall include at least the following information: name of instrument, serial number and/or identification number of instrument, date of calibration, and calibration results. These logs will be provided to the Project Manager and maintained in a master calibration file as part of the QA/QC.
- i. All field staff should be briefed by the Field Supervisor on the sampling goals and objectives prior to arriving at the site.

## 10.0 COMMUNICATION REQUIREMENTS

Contact plant/site personnel or appropriate person(s) prior to sampling according to the project-specific Study Plan.

The state requires that at least one of the individuals conducting the field sampling have a Scientific Collecting Permit. Notify the local California Department of Fish and Game office of the sampling event and location of the activity prior to collecting. Notification must be made during normal business hours at least 24 hours prior to collecting and can be made using the Notification of Intent to Collect for Scientific Purposes form (Attachment B). Also, CDFG requires that the list of species collected during the sampling be submitted at the end of the study.

Cell phones will be carried by personnel in the field. All vessels will have VHF radios on board capable of contacting the United States Coast Guard and the local Harbor Master in the event of an emergency.

## 11.0 TOWED NET SAMPLE COLLECTION

The Study Plan will contain a detailed description of the project-specific sampling procedures based on the Study Plan's rationale and protocols. The Study Plan's appendices will also contain additional information on SOPs, equipment operation and maintenance, and quality assurance programs for the field collecting efforts. The following are general procedures for towed net sampling:

- a. Samples will be collected during specific sampling cycles according to the schedule detailed in the project-specific Study Plan. A sampling team consists of, at minimum, a boat captain and one investigating biologist.
- b. Attach the two plankton nets to the bongo frame. Assure that the plankton nets are the correct length and mesh size for the particular study. Mount a flowmeter to the mouth of each net.
- c. Attach the winch line to the bongo net frame and ensure that a codend is attached to each net. The winch line is marked at regular intervals so that the sampling personnel know how much line has been deployed.
- d. Navigate to the first sampling station. Locate the station using the latitude/longitude coordinates.
- e. Determine the water depth with the fathometer or other depth measuring device. Record the water depth on the field data sheet.
- f. Record each flowmeter's serial number and number of spins from the unit's totalizer on the field data sheet. Make sure that the propeller does not spin until the bongo frame and nets are in the water.
- g. Start the hydraulic pump and capstan, attach a weight (15 to 20lb salmon ball) securely to the center of the bongo frame and lower the nets until the frame is at the water's surface and the nets are underwater.
- h. Record the start time (Pacific Standard Time) on the field data sheet.
- i. Using the measured marks on the winch line lower the nets from the surface and let out line so that the net assembly sinks, mouth first, to the desired depth (within 1 meter from the bottom). Shift the vessel motor into forward gear and proceed forward slowly (1 to 2 knots) for a specified period of time (usually four to six minutes). When the nets have been towed for the desired length of time activate the winch and raise the nets. The tow time may need to be adjusted so that each net on the frame has filtered the appropriate amount of water (usually at least 40 m<sup>3</sup> of water). When the frame reaches the surface check the number of spins on each flowmeter counter to verify that the target volume has been collected (number of spins should be about 4,000 for 40 m<sup>3</sup>). If the target volume has not been achieved with one tow, subsequent tows will be performed at the station until the target volume has been collected.
- j. Raise the nets from the water and stabilize the flowmeters to prevent spinning. If flowmeter readings indicate that the target volume has been filtered through each net, record the end number of spins from each flowmeter on the field data sheet. Record the end time (Pacific Standard Time) and total time of the collection on the field data sheet. Subtract the initial number of spins from the end number and record the total on the

field data sheet. If the integrity of either or both flowmeter readings is questionable (e.g., seaweed wrapped around the propellers), discard both samples by detaching the codends and rinsing the nets of collected material and then reattach the codends. Record the reason(s) for voiding the tow on the data sheet. Repeat the sample collection at that station.

- k. Use the winch to raise the net assembly to a height where the weight can be removed. Securely stow the weight then raise the nets to their maximum height for rinsing. Verify that the nets have not picked up any sediment from the bottom. If there is any sediment in the nets or codends, discard both samples by detaching the codends and rinsing the nets of collected material. Reattach the codends and repeat the sample collection at that station. If the nets become clogged with material during the hauls, they must be rinsed prior to the total volume being filtered. Rinse the material in the nets into the codends. Attach a closing device above the codend of each net to ensure the collected material will not be lost during the subsequent hauls. Continue the net hauls until the correct volume has been filtered.
- l. Rinse the sample, using the washdown sprayer, into the codend of each net beginning at the top of the net. Since the wash water is not filtered and may contain plankton, rinse the net from the outside ensuring that unfiltered water does not contaminate the sample. Inspect the net to ensure that it has been thoroughly rinsed.
- m. Place pre-printed labels (containing the information specified in Section 9. c. above) into the corresponding pre-labeled sample jar. Add preservative (10% formalin or 95% ethanol); allow a ratio of at least two to three times the volume of preservative to volume of the plankton sample. Use additional jars if necessary.
- n. Detach the codend from net #1 and rinse the sample from the codend into a funnel with the appropriate mesh size using a wash bottle containing filtered seawater. Transfer the sample from the funnel into a pre-labeled sample jar using a wash bottle containing filtered seawater (for Ethanol fixation use 95% non-denatured Ethanol). Add an adequate amount of formalin to the sample jar (or 95% non-denatured Ethanol) for proper fixation. Rinse and inspect the codend of net #1 before reattaching to the net. Follow the same procedure for net #2. Sample preservation should be completed soon after collection. Depending on the specific project, samples from each net may be combined and placed in a labeled jar. Add additional preservative from the onboard carboy if necessary.
- o. Ensure that all sample jars contain a corresponding inner label and jar-top label and that the Chain of Custody form is filled out correctly and completely. Pack the sample jars for transport in accordance with safety and/or Department of Transportation standards. Deliver the samples to the Tenera Plankton Laboratory at the completion of the sampling effort.
- p. The following is an explanation of the coding for the field datasheet and jar labels:
  - Each survey number on the data sheet consists of a series of letters followed by 2 or 3 numbers (e.g., DCPPEA##). The first letters refer to the name of the project (e.g., “Diablo Canyon Power Plant”) and the “EA” refers to “Entrainment Abundance”. The numbers refer to the survey number with the first survey being 01. The survey number increases by one for each subsequent sampling event.

- The station designation (numbers and/or letters) is project specific and is detailed in the project's Study Plan.
- Sample labeling also includes a cycle designation. Each 24-hour sampling period is divided into four six-hour cycles or a "day" and "night" cycle, depending on the specific project. The first sampled time block of each 24-hour sampling period is Cycle 1.
- The date of sampling will correspond to the actual start date of each sample.

## 12.0 PUMP SAMPLE COLLECTION

The Study Plan will contain a detailed description of the project-specific sampling procedures based on the Study Plan's rationale and protocols. The Study Plan's appendices will also contain additional information on SOPs, equipment operation and maintenance, and quality assurance programs for the field collecting efforts. The following are general procedures for pump sampling:

- a. Samples will be collected during specific sampling cycles, usually day and night, according to the schedule detailed in the project-specific Study Plan.
- b. Place pre-printed labels (containing the information specified in Section 9. c. above) into the corresponding pre-labeled sample jar. Add preservative (10% formalin or 95% ethanol); allow a ratio of at least two to three times the volume of preservative to volume of the plankton sample. Use additional jars if necessary.
- c. Rig sampling pipe assemblies and flowmeters to the flange/bib fittings installed on the water supply systems from the wedge wire screen intakes (specific to the Study Plan).
- d. Attach net frames to each of the plankton nets. Assure that the plankton nets are the correct length and mesh size for the particular study. Ensure that a codend is attached to each net.
- e. Set up the sampling station by filling the tank(s), suspending the plankton nets so approximately three fourths of their length is submerged in the tank, and positioning the discharge pipe from the sampling pipe assemblies over the net mouth.
- f. At the desired time, turn off the water flow into the tank and zero the totalizer on the flowmeter. Start the flow of water from the sampling pipe assemblies and record the start time and totalizer values on the data sheet. Collect the sample for the appropriate period of time. To lessen the impact of abrasion and predation, water flow should be stopped after about 15 minutes and the net removed. A clean net is put in the tank and the water is started again. The net that was used for the collection is then rinsed and the material in the codend is put into a labeled sample jar.
- g. When the flow meter totalizer indicates that the target volume has been filtered, turn off the water, remove the net from the tank, and record on the data sheet the stop time and the total number of gallons filtered during the sample collection period.
- h. Rinse the sample down into the codend beginning at the top of the net. Since the wash water is not filtered and may contain plankton, rinse the net from the outside to ensure



that unfiltered water does not contaminate the sample. Inspect the net to ensure that it has been thoroughly rinsed.

- i. Detach the codend from the net and rinse the sample from the codend into a funnel with the appropriate mesh size using a wash bottle containing filtered seawater. Transfer the sample from the funnel into a pre-labeled sample jar using a wash bottle containing filtered seawater (for Ethanol fixation use 95% non-denatured Ethanol). Add an adequate amount of formalin (or 95% non-denatured Ethanol) for proper fixation. Rinse and inspect the codend of the net to make certain that all the collected material is rinsed from the codend before it is reused. Follow the same procedure for the nets at the other sampling stations. Add additional preservative from the carboy at the station if necessary.
- j. Ensure that all sample jars contain a corresponding inner label and jar-top label and that the Chain of Custody form is filled out correctly and completely. Pack the sample jars for transport in accordance with safety and/or Department of Transportation standards. Deliver the samples to the Tenera Plankton Laboratory at the completion of the sampling effort.

### **13.0 SAMPLE VOIDING IN THE FIELD**

- a. Samples should be voided if any of the following occurs: 1) possible flowmeter obstruction due to kelp or other debris on the propeller; 2) obviously malfunctioning or damaged flowmeters; 3) damaged (torn) nets found after a sample is collected; 4) gear failure which prevents completion of any tows/hauls; 5) an incident or situation which may prevent reliable data collection (i.e. net dragged along the seabed); 6) an incident or situation which may jeopardize the safety of sampling personnel.
- b. If a hole or tear is found in the net mesh, mark the damaged area and either repair or replace the net. Discard both samples and repeat the sample collection after the net has been repaired or replaced. Record the circumstance on the field data sheet.
- c. The number of flowmeter spins from the paired bongo nets needs to be checked in the field to confirm that the measured volumes were similar. If there appears to be a discrepancy, discard the sample and repeat the sample collection after the flow meters have been recalibrated or replaced.

### **14.0 RECORDS**

All data sheets will be reviewed and signed off by a Field Supervisor or their designate and submitted to the Data Coordinator for logging, computer entry, and storage. Original data sheets will be stored in fireproof locations. If desired, copies of all completed data sheets will be transferred to client staff at least quarterly.

## 15.0 FIELD SAMPLING QUALITY ASSURANCE /QUALITY CONTROL

The appropriate Quality Assurance/Quality Control methods will be selected for each project on the basis of circumstances, objectives, and requirements. The provisions of this SOP will be adapted to these project specific requirements in the project QA plan. Current Field Sampling QA/QC consists of the following:

### 15.1 Plankton Net Flowmeter Calibration

- a. Disconnect the flow meter from the net. Record the serial number of the flow meter on the Zooplankton Net Flowmeter Calibration Log (Attachment D). Connect the flow meter to a rod. Measure and mark a distance of at least 6 to 9 m (20 to 30 ft) on the dock and record the distance on the Calibration Log.
- b. Record the initial number of spins from the readout on the flowmeter totalizer on the Calibration Log. Lower the flowmeter into the water slowly so that the propeller does not spin. Walk along the dock towing the flowmeter at a speed of between 30 to 46 cm (1 to 1.5 ft) per second for the marked distance, checking to make sure that the propeller is spinning. When the flowmeter has been towed over the measured distance, carefully raise it out of the water. Record the end number of spins from the flowmeter totalizer on the Calibration Log.
- c. Repeat this procedure at least 10 times for each flow meter. Subtract the initial reading from the end reading and record the total number of spins per trial on the Calibration Log. The total spins for each of the ten trials are summed and divided by the number of trials. The resulting mean is the calculated calibration value for the measured tow length. Record all information on the Zooplankton Net Flowmeter Calibration Log and enter into the computer database.
- d. Calibrate each flow meter at least once every three months. If the average of these readings differs by more than 10% from the original calibration readings, and the differences cannot be explained by sampling conditions (e.g., rough seas or boat is drifting), then the meter needs to be serviced and re-calibrated by taking 10 additional readings.

### 15.2 Sample Collecting Process

- a. Sample labels must be properly completed, including project code, survey number, sample number, date and time of collection, sampling station, cycle number, and preservative type and placed into the sample container. The outside of the container must be labeled with the same information and the appropriate Hazardous Materials Warning label.
- b. Chain of custody forms must be completed during sampling and include the same information as the sample container labels.
- c. After each sample collection, all nets, codends, buckets, etc. that have come into contact with the sample should be thoroughly rinsed, examined, and picked free of organisms or debris. Any additional organisms found should be placed into the sample container.

### 15.3 Chain of Custody

Chain of custody procedures will follow those outlined in Section 6.0. They will be initiated when the first sample is collected and will be followed until all samples are relinquished to the plankton laboratory. Chain of custody forms will provide an unbroken trail of accountability that ensures the physical security of samples, data, and records. At the end of each sampling event all sample containers are checked against the chain of custody form(s). It is important to verify the survey and station identification numbers, sample number, collection date, collection time, and preservation as part of the QA/QC procedures.

## 16.0 SOP REVISIONS

In order to ensure that TENERA, client staff, and contractor(s), are using the current document, control copies of this manual are maintained. These control copies are maintained in binders in the Plankton Lab and are labeled as control copies. Electronic copies are also maintained.

Revisions to the SOPs in this document are made as follows:

- 1) Obtain a copy of the current SOP from a control copy of the manual,
- 2) Obtain the electronic copy from the Quality Assurance Manager,
- 3) Revise the electronic copy of the SOP in Word using redline and strikethrough (this will provide a record of the revisions) and prepare a clean copy of the revised SOP,
- 4) Update the revision number on the cover page and in the footer,
- 5) Provide the two versions of the revised SOP (redline/strikethrough version and the clean edited version) to the appropriate scientist(s) for review and approval.

Upon approval, the final revised SOP is given to the Quality Assurance Manager for inclusion in the control hard-copy and electronic copy of the manual. All procedure revisions (summary of changes) are to be recorded in this section with the revision date and number, changes noted by page and section, and name of reviser.

### History of SOP Revisions

Revision Date	Revision Number	Page/Section	Summary of Changes	Reviser
1/2018	2.0	Entire doc.	Reviewed and revised. All attachments were previously missing.	TKL

**APPENDIX A**

**TITLE: EQUIPMENT AND SUPPLY LIST**

<b>GENERAL EQUIPMENT</b>	<b>QUANTITY</b>
Bongo net frame with micron mesh nets	2
Codends	4
Calibrated flowmeters	4
Metal or wooden rod for calibration	1
Winch line	2
Winch for net deployment and retrieval	1
Boat hook	2
Wash-down pump	1
Filter with attached micron mesh	2
Extra gas (for pump)	3 gal.
Salmon weights (10 to 20 lb)	2
Fathometer or other water depth measuring device	1
GPS for nearshore sampling	1
Field watch	2
Flashlight (for night sampling)	2
<b>SUPPLIES</b>	
Sample containers: size and type are project specific (include extras)	Project specific
Inner jar labels (include extras)	Project specific
Field datasheets (on Rite-in-Rain paper)	Project specific
Wash/squeeze bottles	5
Small funnel	2
Preservative (10% Formalin or 95% Ethanol)	Project specific
5-gallon carboy with spigot	2
Formalin stirring stick, 37% Formalin, borax	Project specific
Container to provide secondary containment during sample transfer	2
Hazardous materials labels	1 box
Hazardous waste container	1
Liquinox soap	1 bottle

Sample container rack	2 racks
Indelible ink pens (extra fine and regular sharpies)	1 box
Pencils	1 box
Scissors	1 pair
Ziploc bags	1 box
Garbage bags	1 box
Cable ties	1 box
Rubber bands	1 bag
Duct tape	1 roll
Field notebook	1
Tool box (including diagonal cutters, “dikes”)	1
Extra nets	2

**SAFETY EQUIPMENT**

Life-vests (Coast Guard approved)	1 for each person aboard
Throwable floating device (Coast Guard approved)	1 for boat 16+ ft.
Visual Distress Signals (Coast Guard approved)	3 daytime & 3 nighttime signals (boats 16+ ft)
Sound signaling device	1
Fire extinguisher	1
VHF radio	1
Cell Phone	1
Navigation lights	Vary by vessel/Project specific
Safety goggles/glasses	3
Eye-wash bottle	1
Formalin spill clean-up kit	1
Formaldehyde monitoring badges – TWA	Project specific
First aid kit	1
Disposable nitrile gloves	1 box
Leather work gloves	Project specific
Rain gear and rubber boots	Optional
Safety Data Sheets (SDS)	Project specific

**REGULATORY**

- Scientific Collection Permits
- California Boating Card or Captain’s License for boat operators



# ATTACHMENTS



ATTACHMENT B

TITLE: Notification of Intent to Collect for Scientific Purposes Form

[Print](#) [Clear](#)



California Natural Resources Agency  
DEPARTMENT OF FISH AND WILDLIFE

**NOTIFICATION OF INTENT TO COLLECT FOR SCIENTIFIC PURPOSES**

**Regional Office: Please forward this notification to the appropriate biological and law enforcement staff covering the locations below.**

Instructions: **It is mandatory to complete all items.** Type or print clearly in ink. You must notify the Department of Fish and Wildlife regional office by noon one (1) business day prior to scientific collecting activity authorized, and no more than two weeks in advance of your activity. Collectors: Use the map on the back of this form to determine the regional office whose boundaries surround the area where you will be collecting and the appropriate fax number. If you are unable to fax this form, you must telephone the office directly during business hours and provide this information.

# OF PAGES (including this form)		TODAY'S DATE		PERMANENT ID NUMBER SC-	
TO: Department of Fish and Wildlife regional office Select a Department of Fish and Wildlife Office			FAX NUMBER OR EMAIL Select a CDFW Fax Number		
FROM: PERMITTEE'S FIRST NAME		LAST NAME		DAY TELEPHONE	
INSTITUTION/ENTITY'S NAME				E-MAIL ADDRESS	
1 <sup>st</sup> DATE COLLECTING	2 <sup>nd</sup> DATE COLLECTING	3 <sup>rd</sup> DATE COLLECTING	4 <sup>th</sup> DATE COLLECTING	5 <sup>th</sup> DATE COLLECTING	
TIME COLLECTING	TIME COLLECTING	TIME COLLECTING	TIME COLLECTING	TIME COLLECTING	
SPECIFIC LOCATION	SPECIFIC LOCATION	SPECIFIC LOCATION	SPECIFIC LOCATION	SPECIFIC LOCATION	
COUNTY	COUNTY	COUNTY	COUNTY	COUNTY	
NUMBER IN PARTY	NUMBER IN PARTY	NUMBER IN PARTY	NUMBER IN PARTY	NUMBER IN PARTY	
YEAR/MAKE OF VEHICLE	YEAR/MAKE OF VEHICLE	YEAR/MAKE OF VEHICLE	YEAR/MAKE OF VEHICLE	YEAR/MAKE OF VEHICLE	
COLOR/LICENSE PLATE #	COLOR/LICENSE PLATE #	COLOR/LICENSE PLATE #	COLOR/LICENSE PLATE #	COLOR/LICENSE PLATE #	
DESCRIPTION OF BOAT	DESCRIPTION OF BOAT	DESCRIPTION OF BOAT	DESCRIPTION OF BOAT	DESCRIPTION OF BOAT	
BOAT CF #	BOAT CF #	BOAT CF #	BOAT CF #	BOAT CF #	
GEAR TYPE TO BE USED	GEAR TYPE TO BE USED	GEAR TYPE TO BE USED	GEAR TYPE TO BE USED	GEAR TYPE TO BE USED	
SPECIES TO BE COLLECTED	SPECIES TO BE COLLECTED	SPECIES TO BE COLLECTED	SPECIES TO BE COLLECTED	SPECIES TO BE COLLECTED	

FG1379f (Rev. 11/2015)



ATTACHMENT D

TITLE: Zooplankton Net Flowmeter Calibration Log

**FLOWMETER CALIBRATION DATA SHEET**

Date: \_\_\_\_\_ Time: \_\_\_\_\_  
 Dist.: \_\_\_\_\_ Speed: \_\_\_\_\_

Flowmeter #	Flowmeter #	Flowmeter #			
Run	# of spins	Run	# of spins	Run	# of spins
1		1		1	
2		2		2	
3		3		3	
4		4		4	
5		5		5	
6		6		6	
7		7		7	
8		8		8	
9		9		9	
10		10		10	

Flowmeter #	Flowmeter #	Flowmeter #			
Run	# of spins	Run	# of spins	Run	# of spins
1		1		1	
2		2		2	
3		3		3	
4		4		4	
5		5		5	
6		6		6	
7		7		7	
8		8		8	
9		9		9	
10		10		10	

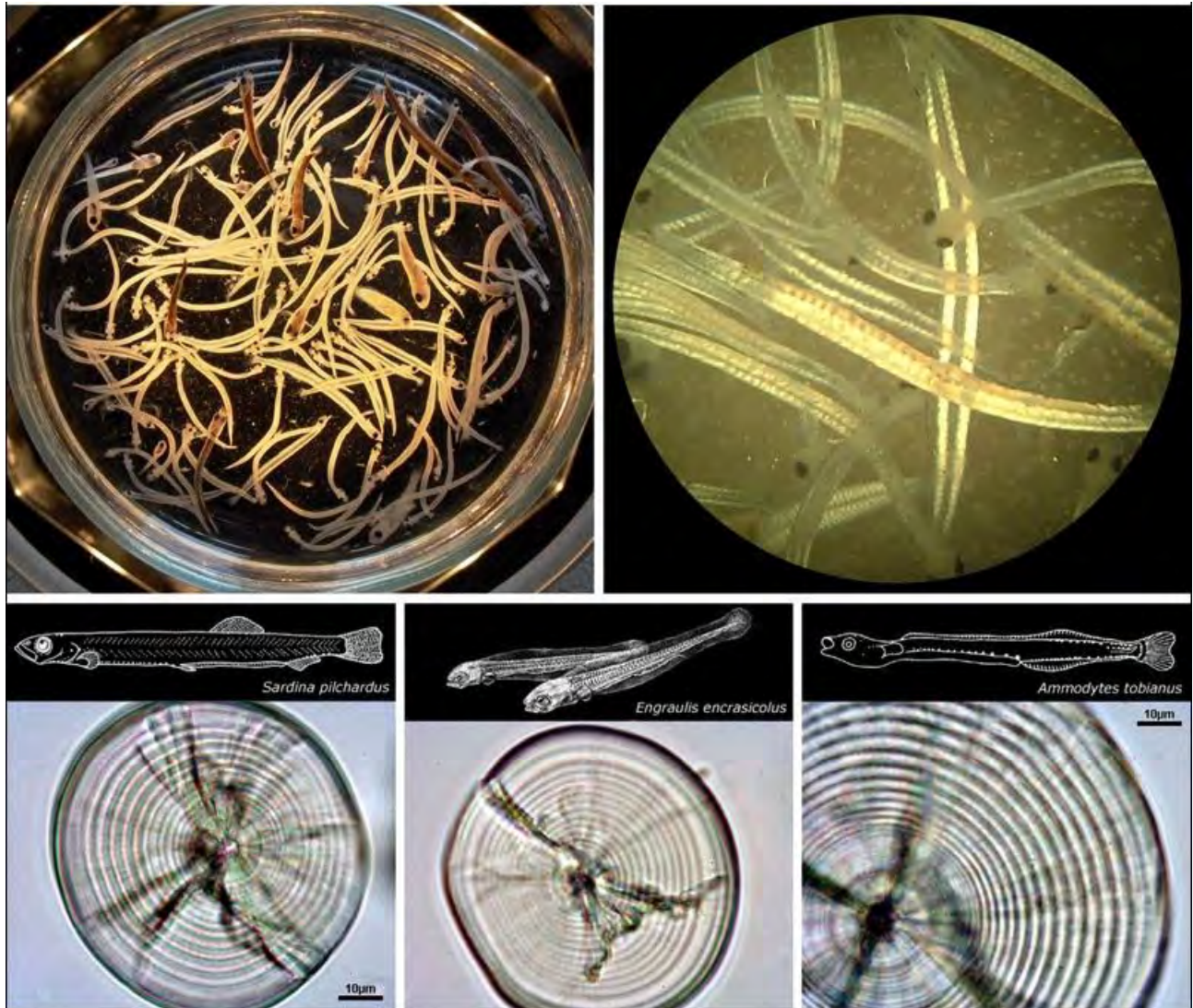
Calibrated By: \_\_\_\_\_



## Appendix B Sample Processing Procedures



# Standard Operating Procedures For Zooplankton Laboratory



**TENERA** Environmental

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San Luis Obispo, CA 93401

Revised  
January 2018

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## INTRODUCTION

Zooplankton encompass an array of macro and microscopic animals and includes haloplankton, meroplankton, and ichthyoplankton. Zooplankton species play a vital role in the marine food chain. The herbivorous zooplankton feed on phytoplankton and in turn constitute an important food item to animals in higher trophic levels, including fish. The occurrence and abundance of ichthyoplankton (fish eggs and fish larvae) facilitate the location of probable spawning and nursery ground of fishes. Zooplankton are ubiquitous. The most characteristic feature is their variability over space and time in any aquatic ecosystem. The success of zooplankton estimation and productivity largely depends upon the use of correct methodology which involves collection of samples, fixation, sorting, identification, length analysis, and preservation. The detailed procedures on all lab aspects are given in this manual.

## RESPONSIBILITIES

- The Laboratory Director is responsible for ensuring that plankton sample processing is being conducted in accordance with these written procedures. The Lab Director is responsible for ensuring that all samples are properly logged into the laboratory, tracked, and processed (transferred, split, sorted, identified, measured) on schedule; data are properly recorded; and samples are properly handled after analysis (stored, discarded, etc.). The Laboratory Director is responsible for training of pertinent employees in the proper handling, storage and waste disposal of chemicals used in the laboratory. This includes training of new employee and annual refresher training.
- The Laboratory Director and Project Manager are responsible for designing and implementing the Quality Control Program that monitors accuracy in accordance with written procedures.
- Scientists and Research Assistants are responsible for processing samples in accordance with written procedures.
- Before work begins all laboratory employees, prior to the use, handling, storage, or transportation of hazardous materials must review and follow TENERA's IIPP, SDS, SOPs, and all laboratory rules and procedures. Yearly and as needed reviews are also required.

# STANDARD OPERATING PROCEDURE FOR ZOOPLANKTON LABORATORY

## 1.0 SCOPE AND APPLICATION

These standard operating procedures describe the methods used in the laboratory processing of marine zooplankton samples collected from locations off California and Hawaii. The methods are appropriate for all sample types of collection (bongo nets used in surface, oblique, and depth-specified tows as well as pump sampling). Laboratory analysis of zooplankton samples provide data to be used in calculating percent concentrations and percent relative abundances of individual taxon.

## 2.0 SUMMARY OF METHOD

This procedure includes chain of custody and sample log-in guidelines and explains how to 1) prepare samples for processing, 2) separate target organisms from collected samples, 3) prepare, record, and maintain specimens for taxonomic identification and storage, 4) obtain larval fish length measurements, 5) extract and read otoliths, and 6) perform the required Quality Assurance/Quality Control procedures.

## 3.0 SAFETY AND WASTE HANDLING

Refer to the *Tenera Injury and Illness Prevention Plan (IIPP)* (January 2018, or as amended) and individual procedural operations manuals for specific details on applicable 1) personal health and safety issues; 2) chemical and waste handling procedures 3) spill response; and 4) accident prevention.

It is each Project Manager's responsibility to determine an approximate amount of project waste, trash and scrap materials that will be generated, prior to the initiation of work. This determination will allow the Project Manager to provide adequate wastes containers for removal and disposal.

It is the responsibility of the user of these procedures to comply with all applicable safety and waste handling rules. Additionally, all relevant chemical disposal and waste regulations are to be followed. All containers storing reagents and wastes used in the laboratory must be properly identified through appropriate labeling and hazard definition.

Every chemical should be regarded as a potential health hazard and exposure to these compounds should be as low as reasonably achievable. Please refer to the IIPP for more detailed descriptions of the potential risks associated with any chemicals used in these procedures.

All lab employees handling chemical and/or their wastes products are subject to training prior to use of said products and at least annually thereafter. Training will consist of proper selection sizing and use of PPEs including safety glasses and chemical resistant gloves and aprons. Training will also include the care and maintenance of PPEs so that PPEs are store and maintained in a sanitary and clean condition. Any defective PPEs should be given to the

Laboratory Director for proper disposal and subsequent replacement. All training will be documented using Tenera's standard format (see IIPP, Appendix B). All formalin use in the lab must be conducted inside the formalin fume hood.

## 4.0 EQUIPMENT LISTS

The following Tenera owned equipment and PPEs will be available for staff use:

- Safety glasses
- Chemical resistant gloves
- Chemical resistant aprons
- Eye wash stations
- Spill response supplies
- Microscope and light sources
- Forceps and other sorting supplies
- Formalin fume hood
- Hazardous waste containers with proper labeling

Prior to use of any personal PPE it must be checked by the Laboratory Director.

## 5.0 CHEMICALS

- 70-95% denatured alcohol (*Use 95% denatured alcohol*). To make 1 L of 70% denatured alcohol, dilute 740 ml of 95% alcohol with 260 ml of distilled water.
- 95% non-denatured ethanol (*Use 190 proof reagent stock*).
- 10% Formalin (3.7% formaldehyde) *Prepare 8 L of 10% buffered formalin solution by mixing 1 part 37% formaldehyde (800 ml) with 9 parts clean sea water (7200 ml) in a calibrated carboy. Add borax for additional buffering capacity (160 grams). Take note if a buffer other than seawater is used.*

## 6.0 CHAIN OF CUSTODY

The primary objective of the chain of custody procedure is to create a written record that can be used to trace the possession of the sample. The chain of custody form (Tenera COC form; Attachment 6.0 A) is filled out at sample collection and follows the sample through every person involved in the chain of possession until it reaches the laboratory. All samples, whether received in person or via commercial carrier, must be accompanied by a chain of custody form. Sample custody procedures are important to ensure the integrity of the samples whether for legal or other purposes.

### 6.1 Chain of Custody Procedures

- a. The chain of custody form should be completed by the sampler at the time of sample collection and the form should be packaged with the samples for transport to the laboratory.

- b. Samples may be delivered to the laboratory by Tenera field crews or arrive by US Mail, Federal Express, or other commercial carriers. When samples arrive at the Lab, the completed chain of custody form must be signed by Tenera laboratory personnel. If there is an address slip on the package for the shipment (e.g., a Fed- Ex slip) that log is saved and marked with the Project Identification and Survey Number.
- c. Every time the sample changes possession, the person relinquishing the sample and the person receiving it must complete the chain of custody form to include the date, time, their printed name, and signature. Minimally, there must be two signatures on the change of custody.
- d. The Lab representative receiving the samples must review the chain of custody data to ensure all samples are accounted for. Document any discrepancies on the form.
- e. A copy of the signed chain of custody form shall be returned to the party of origin. File and store completed, signed, and returned chain of custody forms in the Chain of Custody binder in the laboratory (A2 Lab).

## **7.0 SAMPLE LOG-IN AT LABORATORY**

All samples are logged via a COC upon delivery to the laboratory personnel and an electronic tracking spreadsheet is created under LAB\_SORT ID TRACKING. Samples are logged into the laboratory to verify sample arrival and sample condition. The integrity of the samples is checked (correct preservation used, lids and jars intact, fixation times fall within the requirements, and so on) and missing or damaged samples must be reported to the Laboratory Director immediately. During log in, samples are assigned a laboratory storage location (within the A2 Storage Area).

### **7.1 Sample Log-In Procedures**

- a. Place samples preserved in ethanol on the Prep Table against the north wall of the A2 Storage Area. Place samples preserved in formalin on the Transfer Shelf under the fume hood.
- b. Confirm receipt of the samples by completing the Sample Log-In Sheet.
- c. Check sample fluid levels and, if needed, add additional preservative or fixative. Check the integrity of the sample jars and lids. Document any discrepancies or problems.
- d. Verify the field data sheets (Project Manager) and enter data into the Access database (Senior Data Analyst).
- e. Create the electronic LAB\_SORT ID TRACKING spreadsheet for the samples/survey.
- f. Update the SAMPLE\_PLANKTON ARCHIVING RECORD database to include new samples.
- g. Generate pre-printed labels for individual sample jars and sample boxes, including hard copy tracking sheets and ID logs for all samples (Senior Data Analyst). Label samples by placing the pre-printed labels on the jar lid; label sample boxes with pre-printed labels. Label data must include the survey number, collection date, collection time, station, cycle, sample number, and if appropriate, split code.

- h. Place 95% ethanol identification stickers on the appropriate ID data sheets. Place tracking sheets and ID data sheets into the appropriate Lab and Project binders. Place correct alcohol label (70% or 95%) on the side of the sample jar.
- i. Place samples in appropriate labeled and color-coded project boxes. Place sample boxes in the A2 Storage Area designated for the project.

## 8.0 SAMPLE TRANSFERRING

Plankton samples that are originally fixed in formalin must be transferred to 70% alcohol before laboratory processing. **Allow 72 hours as the minimum fixation period.** If ethanol is used to initially preserve samples (e.g., for otolith or DNA analysis) the samples should be transferred into fresh ethanol within **24 hours** because water in the tissues of gelatinous plankton or fish flesh quickly dilutes the preservative.

The chemical formaldehyde (CH<sub>2</sub>O) plays an indispensable role in fixing the proteins in a fresh specimen in order to prepare it for wet preservation. Until recently, various solutions of formaldehyde have also been used as a preservative for long-term storage of specimens. The most common preservative used is formalin, a 37% solution of formaldehyde mixed in water to form 10% formalin (i.e., 9 parts seawater and 1 part formaldehyde). However, it is now recognized that formalin, because of its acidity, makes a very poor long-term preservative for many specimens, resulting in the decalcification of bones, distortion of tissues, and acidic decomposition of specimens. Today, the recommended long-term preservative for maintaining a variety of vertebrate and invertebrate specimens is a 70%-75% solution of ethanol.

Only qualified personnel who have the approval of the Lab Director may transfer samples. Personnel who work with formaldehyde must have signed documentation that he/she understands the hazards and has been trained in how to work with formaldehyde safely. Transferring must be conducted in a fume hood or in a well-ventilated area to lessen the exposure to formaldehyde fumes. Proper Personal Protection Equipment (PPE) should be worn while preparing and handling samples for transfer.

### 8.1 Sample Transferring Procedure (Formalin to Alcohol)

- a. After a sample has been collected in the field, the appropriate information as to the identity of the sample shall be written on the sample lid. Verify that the sample information is correct by comparing the data on the sample jar lid to the pre-printed sample labels and the Chain of Custody form.
- b. Samples should be processed one at a time. Place a mesh funnel with the appropriate mesh size into a Ball<sup>®</sup> jar. The mesh size must not be larger than that used during sample collection. Place the Ball<sup>®</sup> jar and mesh funnel in a Pyrex<sup>®</sup> tray so the sample can be retrieved if a spill occurs.
- c. **Working under the fume hood**, transfer the sample from the collection jar into the mesh funnel. While transferring, care should be taken so that no part of the sample is lost. Using a wash bottle containing fresh water, thoroughly rinse the zooplankton to flush the formalin from the sample. Thoroughly rinse the sample jar and lid into the mesh funnel to remove any residual organisms adhering to the walls of the sample collection jar.



- d. Using a wash bottle containing 70% alcohol, rinse the sample into the appropriately labeled container. Use only new or clean containers. Ensure that the container has both an inner label and a lid top label and that the information matches and is correct. Carefully decant 70% alcohol into the container; allow a ratio of at least two to three times the volume of alcohol to volume of the plankton sample. Label the jar with a “70% alcohol” label.
- e. The waste formalin and rinse water shall be discarded into the appropriate labeled hazardous waste containers.
- f. After transferring, all field sample collection jars are to be thoroughly cleaned and allowed to air dry.
- g. Fill in the required information on the LAB SORT\_ID TRACKING excel datasheet and the Transfer Log on the computer.

## 8.2 Sample Transferring Procedure (Ethanol to Ethanol)

- a. After a sample has been collected in the field, the appropriate information as to the identity of the sample shall be written on the sample lid. Verify that the sample information is correct by comparing the data on the sample jar lid to the pre-printed sample labels and Chain of Custody form.
- b. Samples should be processed one at a time. Place a mesh funnel with the appropriate mesh size into a Ball<sup>®</sup> jar. The mesh size must not be larger than that used during sample collection. Place the Ball<sup>®</sup> jar and mesh funnel in a Pyrex<sup>®</sup> tray so the sample can be retrieved if a spill occurs.
- c. Transfer the sample from the collection jar into the mesh funnel. While transferring, care should be taken so that no part of the sample is lost. Using a wash bottle containing 95% non-denatured ethanol, thoroughly rinse the sample jar and lid into the mesh funnel to remove any residual organisms adhering to the walls of the sample collection jar.
- d. Using a wash bottle containing 95% non-denatured ethanol, rinse the sample into the appropriately labeled container. Use only new or clean containers. Ensure that the container has both an inner label and a lid top label and that the information matches and is correct. Carefully decant 95% non-denatured ethanol into the container; allow a ratio of at least two times the volume of ethanol to volume of the plankton sample. Label the jar with a blue “95% ethanol” label.
- e. The original ethanol preservative should be placed into an approved safety container labeled “To Be Recycled” for recycling through the Alcohol Recycling System (ARS) or to be disposed if the alcohol content is below 65% with a Hazardous Waste label (Figure 16.4.1, Hazardous Waste Container Label).
- f. After transferring, all field sample collection jars are to be thoroughly cleaned and allowed to air dry.
- g. Fill in the required information on the LAB SORT\_ID TRACKING datasheet and the Transfer Log on the computer.

## 9.0 SAMPLE SPLITTING

When samples are particularly dense, a Folsom Plankton Splitter may be used to divide samples into smaller, more manageable subsamples. Aliquot portions of approximately  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ , etc. of the original sample are obtained and the process is continued until the sample is small enough for sorting. Plankton concentrations of split samples are calculated based upon the number of splits and the volume of water filtered. Multiplying the organism count in the  $m^{\text{th}}$  fraction by  $2^m$  gives an estimate of the number in the original sample.

Formalin-fixed samples that have not yet been transferred into ethanol should not be split. Since the plankton splitter is not alcohol-resistant, ethanol samples must be transferred into and split in water using the following procedure.



**Folsom Plankton Splitter**

### 9.1 Sample Splitting Procedure

- a. Set up the Folsom Plankton Splitter in the designated lab area (Prep Table). Level the splitter using the adjustable legs until the air bubble is centered within the circle. Make sure the drum and trays are clean. Wash with mild soap and water, rinse with distilled water before drying.
- b. Because the field volume may not fully represent how much material is in the sample, each sample jar should be individually inspected to determine how many splits, if any, may be necessary. The number of splits determines how many jars will be needed:

Number of Splits	No Split	Split in half ( $\frac{1}{2}$ )	Split in fourths ( $\frac{1}{4}$ )	Split in eighths ( $\frac{1}{8}$ )	Split in sixteenths ( $\frac{1}{16}$ )	Split in thirty-seconds ( $\frac{1}{32}$ )
Number of Jars	1	2	3	4	5	6

Prepare the needed number of sample jars, re-print the appropriate pre-printed jar lid labels, and re-label each new jar, initially leaving the “split code” designation blank. (See Section 9.2 Labeling and Recordkeeping for Split Samples.)

- c. Place a mesh-sieve funnel into a regular funnel over the alcohol bottle used for plankton splitting. Place the alcohol bottle into a Pyrex<sup>®</sup> tray so the sample can be retrieved if a spill occurs. Pour the sample and ethanol into the mesh funnel. The funnel will contain the material to be split while the ethanol will drain into the alcohol bottle.
- d. Using specimen forceps, place the sample material back into its original sample jar. Rinse any remaining sample from the funnel into the jar using a wash bottle containing water. Make sure the entire sample is returned to the original sample jar. Fill the jar with water until the sample is completely covered.

- e. Carefully pour the sample into the drum of the plankton splitter. Use a wash bottle filled with water to rinse any remaining sample from the jar into the rotating drum and to get any sample off the sides of drum and the drum axel. Carefully, but thoroughly, mix the sample with a glass stirring rod.
- f. Place the trays, labeled “A” and “B”, underneath the drum. Place one hand over the drum opening and rotate the drum 120° to divide the stirred sample with the separating blade. Continue rotating the drum 120° approximately six (6) times or until the sample looks evenly distributed between the two compartments of the drum. Water may be added as needed. Once the sample is evenly distributed, rotate the drum carefully so the sample and water pour into the trays. Use a water wash bottle to flush any residual sample from the drum into the trays.
- g. For samples involving just one split (i.e., split in half) pour the contents of Tray A into a mesh-sieve funnel that is placed over a Ball<sup>®</sup> jar; the sample will remain in the funnel, while the water will drain into the empty jar. The water in the jar may be disposed of down the drain.
- h. Transfer the sample material from the funnel into a newly labeled jar. Using a wash bottle containing the appropriate ethanol (i.e., the same type as the original sample) rinse any remaining sample into the jar. Ensure that the container has both an inner label and a lid top label and that the information matches and is correct (see labeling below). Carefully decant the ethanol from the original sample (i.e., from the plankton splitting alcohol bottle) into the sample jar; allow a ratio of two to three times the volume of ethanol to volume of the plankton sample. Repeat the process for Tray B. Additional ethanol may be added to the sample jar if needed.
- i. When additional sub-sampling is needed, the contents of one tray are placed into a new sample jar while the other tray is returned to the drum for further splitting. Use the random 1 & 2 number chart (1=A, 2=B) that was selected for the first split (Tray A or Tray B) and further subdivide the selected portion to keep. Pour the contents of the selected tray into the drum and completely rinse out the tray using a water wash bottle. Replace the clean trays under the drum and repeat step 9.1.g. above. Continue the process until the sample is small enough for sorting.
- j. The jars should be of sufficient size so that when filled the volume of ethanol is at least three times greater than the volume of the sample (i.e., the sample volume should be no more than 25% of the volume of the storage jar).
- k. Use mild soap and fresh water to clean the plankton splitting drum. Do not use chemicals such as acetone or ketone for cleaning. Final rinse should be with distilled water before drying.

## 9.2 Labeling and Recordkeeping for Split Samples

Sample labels and tracking/ID sheets must reflect when a sample has been divided into sub-samples. Split code information is essential to making zooplankton density calculations from the samples.

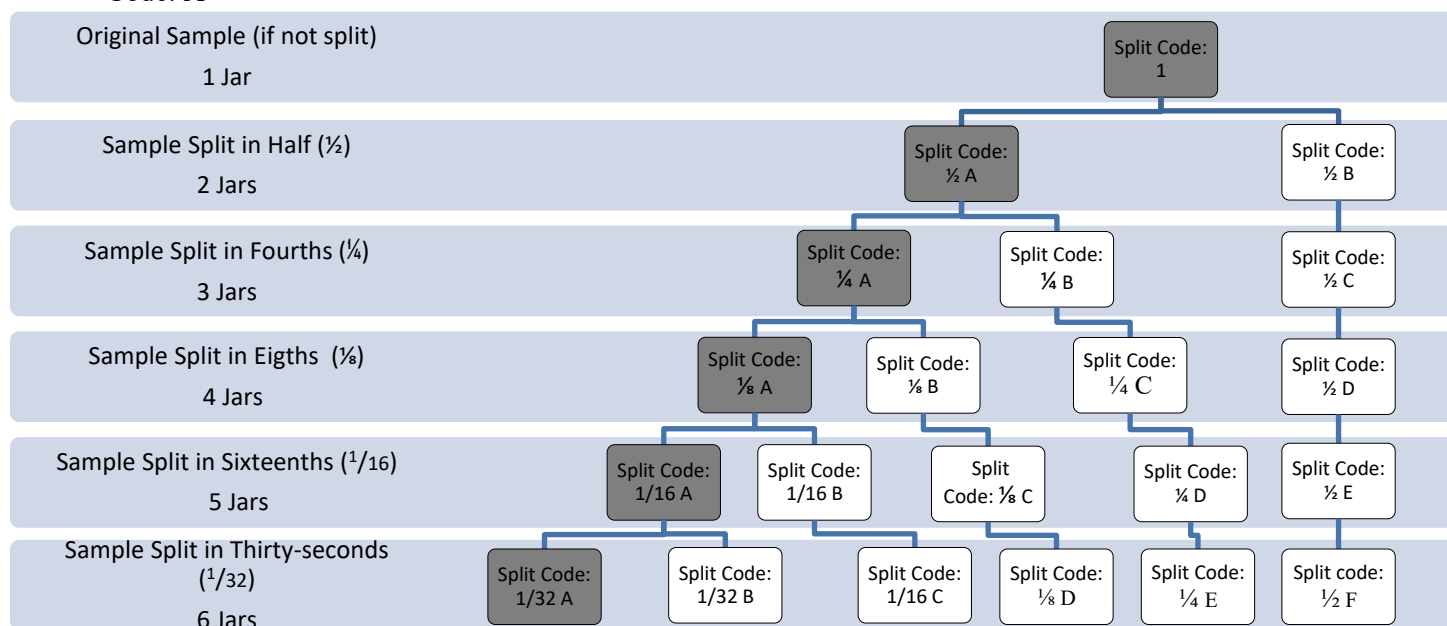
The split codes are in the form of a fraction ( $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ , etc.) and the letters A or B. The fraction indicates what proportion of the original sample is contained in the sample jar. The A and B correspond to the individual plankton splitting trays. For example, the split code  $\frac{1}{2}A$

indicates that the original sample has been split into two sub-samples and the jar contains the plankton material from Tray A and is  $\frac{1}{2}$  the original sample.

Likewise a sample containing the split code  $\frac{1}{32}$  on the sample label indicates the jar contains one thirty-second of the sample. However, the entire sample has not been split into thirty-two sub-samples. Only one sub-sample or tray (designated A or B) from each split is chosen (by random number) for subsequent splitting. Therefore a sample split into thirty-seconds will have six jars: one labeled  $\frac{1}{2}$  F), one  $\frac{1}{4}$  (E), one  $\frac{1}{8}$  (D), one  $\frac{1}{16}$  (C), one  $\frac{1}{32}$  A and one  $\frac{1}{32}$  B. See Figure 1 for clarification.

**Figure 9.2.1. Split Code Designations for Samples Divided into Subsamples.**

Note that only one tray or “subsample” (shown in gray) is selected for subsequent splitting. The other tray/subsample (shown in white) is not split but remains intact. Example shown for keeping Split Code: A



### 9.2.1 Labeling and Recordkeeping for Sample Split In Half ( $\frac{1}{2}$ )

- a. Sample labels should be made from waterproof paper and be placed inside and on the outside of each jar. Use a heavy weight cotton fiber paper (Rite in the Rain) and a No. 2 pencil or Pigma Micron pen if labeling by hand.
- b. After the sample has been split in half, fill in the split code on the new jar lid labels (pre-printed) with  $\frac{1}{2}$ A for the split from tray ‘A’ and  $\frac{1}{2}$ B for the split from tray ‘B’. The  $\frac{1}{2}$  indicates that the jar contains  $\frac{1}{2}$  of the sample, and the A or B corresponds to the tray.
- c. Use a random number chart (1=A, 2=B) to select the sample “split” (subsample) to be sorted. A ‘1’ on the random number chart means that  $\frac{1}{2}$ A will be sorted and  $\frac{1}{2}$ B will be stored. A ‘2’ on the random number chart means that  $\frac{1}{2}$ B will be sorted and  $\frac{1}{2}$ A will be stored.

- d. Take the inside label from the original sample jar, write in the proper split code, and put the label into the sub-sample (or “split”) that was selected to be sorted. Copy the original sample information onto a new inside label (on waterproof paper) for the sample not to be sorted. Place the sample to be sorted in the box that is designated “To be Sorted” and place the sample that was not chosen into the box designated “Not to be Sorted”. Proper labeling for sample (split in half with subsample “1” selected for sorting):

DCPPEA 05	9/15/08
E1A1    Cycle 1	10:08
Sample #3	Split: $\frac{1}{2}$ A

- e. On the hardcopy tracking sheets in the appropriate Project binder, enter “2” under the column title ‘# of subsamples’. In the ‘Split Code’ column enter either  $\frac{1}{2}$ A or  $\frac{1}{2}$ B, depending on which subsample was selected for sorting.
- f. Enter the number of subsamples and split code data onto the LAB SORT\_ID TRACKING computer tracking sheets:

Survey Number	Sample #	Station	Cycle	# of Sub- Samples	Split Code
DCPPEA05	03	E1A1	1	2	$\frac{1}{2}$ A

- g. Fill out the Split Log (density, field and sort volumes, number of jars, etc.) located in the Project’s folder in the LAB SORT\_ID TRACKING database. Record initials, date, and time data under the Split Information on the LAB SORT\_ID TRACKING computer tracking sheet for the Project.
- h. Record the appropriate Split Multiplier data (i.e., number of subsamples) for the sorted sample on the corresponding Lab ID Data Sheet.

#### 9.2.2 Labeling for Sample Requiring More than One Split ( $\frac{1}{4}$ , $\frac{1}{8}$ , $\frac{1}{16}$ , or $\frac{1}{32}$ )

- a. Sample labels should be made from waterproof paper and be placed inside and on the outside of each jar. Use a heavy weight cotton fiber paper (Rite in the Rain) and a No. 2 pencil or Pigma Micron pen if labeling by hand.
- b. After the second split (split into fourths [ $\frac{1}{4}$ ]) there are three subsamples: one  $\frac{1}{2}$  subsample and two  $\frac{1}{4}$  subsamples. If the sample is not to be divided into any additional splits, put both  $\frac{1}{4}$  splits into jars, copy the original sample information onto waterproof paper for the inside labels, attach the new pre-printed lid labels, and write  $\frac{1}{4}$ A and  $\frac{1}{4}$ B for the split code on both inside and lid top labels.
- c. Use the random number chart to pick which  $\frac{1}{4}$  sample will be sorted. Place the sample to be sorted in the box that is designated “To be Sorted” and place the other two samples ( $\frac{1}{2}$  and  $\frac{1}{4}$  subsamples) into the box designated “Not to be Sorted”.



- d. On the hardcopy tracking sheets in the appropriate Project binder, enter “4” under the column title ‘# of subsamples’. In the ‘Split Code’ column enter either ¼A or ¼B, depending on which subsample was selected for sorting.
- e. Enter the number of subsamples and appropriate split code data onto the LAB SORT\_ID TRACKING computer tracking sheets:

Survey Number	Sample #	Station	Cycle	# of Sub-Samples	Split Code
DCPPEA05	03	E1A1	1	4	¼ A

- f. Record the appropriate Split Multiplier data (i.e., number of sub-samples) for the sorted sample on the corresponding Lab ID Data Sheet.
- g. If additional splits are necessary, repeat the procedure, indicating the proper number of sub- samples and the split code on the jar labels (inside and top). Enter the information on the hardcopy tracking sheets, on the LAB SORT\_ID TRACKING computer tracking sheets, and the corresponding Lab ID Data sheets.

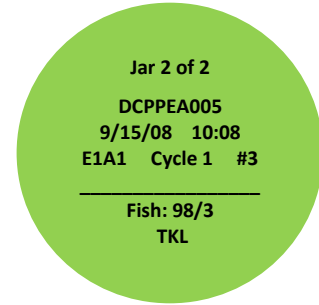
## 10.0 SAMPLE SORTING PROCEDURES

### 10.1 Sample Sorting Procedure for 70% Alcohol Samples

- a. Upon arrival check the bulletin board and white board for messages, updates, meetings, etc.
- b. Ensure that the necessary equipment for sample processing is available (Attachment 10.1-A).
- c. Consult the Plankton Lab sorting schedule posted in the laboratory to determine sorting priorities. A list of target organisms to pull for each Project is posted in the lab.
- d. Obtain the sample to be sorted from the Sample Storage Area and check it out by initialing under the “sorted by” column on the Laboratory Sample Tracking Sheet (Attachment 10.1-B) and the LAB SORT\_ID TRACKING electronic spreadsheet. Transcribe all information from the sample label into the Sorter’s Log Book (Attachment 10.1-C) and into the Sorter’s Notebook (each sorter has separate log sheets and a notebook for this purpose).
- e. Rinse two mesh-sieve funnels (one labeled “S” [sorted] and the other labeled “U” [unsorted]) with fresh water prior to use. The mesh size should be no larger than that used to collect samples. The mesh size is written on the sieve funnel.
- f. At the sample preparation station near the Lab sink, place the ‘unsorted’ mesh funnel into the mouth of a clean Ball® jar. Place the Ball® jar and mesh funnel into a Pyrex® tray so the sample can be retrieved if a spill occurs. Pour the sample and alcohol into the mesh funnel. The funnel will contain the material to be sorted while the alcohol will drain into the Ball® jar.

- g. Using 70% alcohol in a wash bottle, rinse any remaining sample from the sample jar, the jar lid, and inner sample label (hold the label with forceps) into the mesh funnel containing the unsorted sample.
- h. Place the 'unsorted' mesh funnel containing the sample material over the funnel situated in the container labeled "Alcohol Water Waste". Using fresh water in a wash bottle, carefully rinse the entire sample with fresh water.
- i. Place the 'unsorted' mesh funnel containing the sample and the empty 'sorted' funnel into individual glass bowls and place both bowls in a Pyrex<sup>®</sup> tray. Place enough water into the bowl to cover the sample. Continue adding water as needed. Do not let the unsorted or sorted sample desiccate during processing.
- j. Pour the 70% alcohol that was filtered through the mesh funnel back into the original sample jar. Keep the original alcohol-filled sample jar with the sample.
- k. Place the "sorting tray" (a petri dish marked with a sorting grid) on the base of the dissecting microscope. Adjust the magnification so that the field of view is slightly larger than the width of an individual marked grid on the sorting tray.
- l. Arrange the light source to provide satisfactory illumination.
- m. Using specimen forceps carefully transfer a small amount of the sample from the 'unsorted' funnel to the sorting tray. Using a wash bottle, slowly add enough water to cover the sample. Carefully distribute the sample evenly in the sorting tray using insect handling forceps.
- n. Look thoroughly through the entire sorting tray using the grid for orientation. Remove the target organisms (fish, crab, etc.) with insect handling forceps and place into a glass dish ("fish dish") containing water. Count and record the type of organism removed from the sample and keep a running tally of each organism in the Sorter's Notebook.
- o. Carefully re-distribute the sample in the sorting tray and inspect a second time. If target organisms are found on the second pass, repeat a third time. Continue this process until a scan does not produce any additional target organisms.
- p. Once the tray is sorted, pour the sorted sample into the 'sorted' funnel and rinse the sorting tray with a small amount of water. Take a second aliquot from the 'unsorted' funnel as described above. Repeat the above steps until the entire sample has been sorted.
- q. When sorting is completed, fish and eggs should be re-counted (to verify the count recorded in the Sorter's Notebook) and transferred from the fish dish into ½ dram shell vials containing clean 70% alcohol. Use separate vials and snap caps for fish and eggs. Wet one end of a small piece of cotton with alcohol and place the cotton into the top end of the vial to keep the organisms inside. Place the shell vial into a snap cap vial and add enough 70% alcohol to completely cover the shell vials. For fish samples, label the snap cap lid with a green colored dot label. For egg samples, label the snap cap lid with a white colored dot label, for megalops label with yellow, and for squid/lobster label with red dot sticker. Prepare waterproof inner labels for the snap cap vial containing the shell vial. Both the inner label and snap cap label should contain the following information:  
Snap-Cap Outer Label Example:

- Jar # (if more than one jar)
  - Survey serial number
  - Date and time the sample was collected
  - Station, cycle, and sample number
  - Number of organisms in vial (ex. #fish/#fragments)
  - Sorter's initials
  - 70% alcohol label on side of vial
- r. Recount and transfer invertebrates from the fish dish into a 2 dram screw-top vial and fill with alcohol. Prepare a white rectangular outside label and a waterproof inner label for the screw-top vial containing the same information as shown in step q above. Place the white label on the side of the vial and the appropriate small color coded dot containing the survey and sample number on the screw-top lid. Refer to the invertebrate color code chart posted in the Lab.
- s. Record the total number of sorted organisms and the total time required to process the sample in the Sorter's Notebook. In addition, input the following information into the LAB\_SORT\_ID TRACKING spreadsheet:
- Sample start date
  - Sample completion date
  - Sort time
  - Number of organisms (fish, eggs, invertebrates)
  - Number of fish fragments
- t. Return the sorted sample back into the original sample jar containing 70% alcohol. Rinse any remaining sample from the funnel into the jar using a wash bottle containing 70% alcohol. If needed, use recycled 70% alcohol to fill the sample jar to at least  $\frac{3}{4}$  full to allow for any evaporation. Ensure the correct inner waterproof label is in the sample jar.
- u. Using fresh water, thoroughly clean the mesh sorting funnels, sorting tray, bowls, Pyrex<sup>®</sup> dish, fish dishes, and forceps.
- v. If a sample must be stored before completion, put the sorted portion of the sample back into the original sample jar. Rinse any remaining material from the funnel into the jar using a wash bottle containing 70% alcohol. Make sure that the sample is adequately covered with 70% alcohol. Put the unsorted sample into a second jar. Rinse any sample from the 'unsorted' funnel into the jar using a wash bottle containing 70% alcohol. Using a dot label, label the jar lid with the sample identification information, sorter's initials, and the word "unsorted". Make an additional inner label with the sample identification information and marked 'unsorted'. Place the label inside the jar with the 'unsorted' sample. Ensure that the 'unsorted' sample is adequately covered with alcohol. The sorted and unsorted portion of the sample should be stored together in a



container until sorting can continue. Record the number of organisms found and the time spent in the Sorter's Notebook.

- w. Once the sample is completed, place a green colored dot label on the sample jar top with the survey number, sample number, sorter's initial, and date sorting was finished. Return the jar, in the proper order, to the box from which it was originally removed. The vials containing organisms should be stored in the appropriate labeled box in the lab.
- x. Fill out the required information in the LAB SORT\_ID TRACKING datasheet and Sorter's QC log on the computer. Transcribe the information recorded in the Sorter's Notebook to the Laboratory Sample Tracking Sheet and to the Sorter's Log.

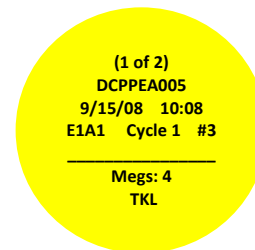
## 10.2 Sample Sorting Procedures for 95% Ethanol (non-denatured) Samples

- a. Rinse two mesh-sieve funnels (one labeled 'sorted' and the other labeled 'unsorted') with fresh water prior to use. The mesh size should be no larger than that used to collect samples. The mesh size is written on the sieve funnel.
- b. At the sample preparation station near the Lab sink, place the 'unsorted' mesh funnel into the mouth of a clean Ball<sup>®</sup> jar. Place the Ball<sup>®</sup> jar and mesh funnel into a Pyrex<sup>®</sup> tray so the sample can be retrieved if a spill occurs. Pour the sample and ethanol into the mesh funnel. The funnel will contain the material to be sorted, while the ethanol will drain into the jar.
- c. Using a 95% ethanol wash bottle, rinse any remaining sample from the sample jar, the jar lid, and inner sample label (holding the label with specimen forceps) into the mesh funnel containing the unsorted sample.
- d. Place a funnel into the mouth of an empty ethanol wash bottle and pour the ethanol from the Ball<sup>®</sup> jar through the funnel into the empty bottle. Check that the ethanol wash bottle is labeled "95% non-denatured ethanol". This ethanol will be used in the sorting process instead of water. If needed, add more ethanol to the wash bottle from the stock 95% non-denatured ethanol container.
- e. Place the 'unsorted' mesh funnel into a glass bowl in a dish and cover the sample with 95% ethanol. Do not let the sample desiccate during processing. Ethanol evaporates quickly; continually check the condition of the sample, adding ethanol as needed.
- f. Using specimen forceps transfer a small amount of sample from the 'unsorted' mesh funnel into the sorting tray. Add enough 95% ethanol to cover the sample. Carefully distribute the sample evenly in the sorting tray using insect handling tweezers.
- g. Place the sorting tray on the base of the dissecting microscope. Adjust the magnification so that the field of view is slightly larger than the width of an individual marked grid on the sorting tray.
- h. Arrange the light source to provide adequate illumination.
- i. Carefully inspect the entire sorting tray using the grid for orientation. Remove the target organisms (fish, crab, squid, etc.) with insect handling tweezers. Place fish into a small fish dish containing 95% ethanol. Invertebrates found in 95% ethanol samples shall be placed in an invertebrate vial with 70% ethanol. Count and record the type of

organism removed from the sample and keep a running tally of each organism in the Sorter's Notebook.

- j. Carefully re-distribute the sample in the sorting tray and inspect the sample a second time. If target organisms are found on the second pass, repeat a third time. Continue this process until a scan does not produce any additional target organisms.
- k. Once the tray is sorted, pour the sorted sample into the 'sorted' mesh funnel and rinse the sorting tray into the mesh funnel with a small amount of 95% ethanol. Take a second aliquot from the 'unsorted' funnel as described above. Repeat the above steps until the entire sample has been sorted.
- l. Approximately every hour recount the fish and place them into a shell vial containing 95% ethanol. Place a small piece of cotton into the top of the shell vial and place the shell vial into a snap cap container filled with 95% ethanol. Keep the snap cap container closed.
- m. If there is not enough ethanol in the ethanol wash bottle to sort the entire sample, place the 'sorted' sample into the original sample jar. Use either the sorter's ethanol wash bottle or the clean 95% ethanol wash bottle to rinse the sample from the mesh funnel into the sample jar. Cover the sample with enough ethanol to prevent desiccation. At the sink, use a funnel to refill the sorter's ethanol wash bottle with the ethanol from the 'sorted' glass bowl or refill from the stock 95% non-denatured ethanol container.
- n. If a sample will take more than approximately two hours to sort, keep the unsorted sample in a jar with ethanol instead of the mesh funnel. This will prevent desiccation. To get the last bit of sample out of the jar it may be necessary to put the sample into the mesh funnel.
- o. When the sample is complete make sure all fish and invertebrates are counted.
- p. Add enough 95% ethanol to completely cover the shell vials and label each snap cap lid with a yellow dot to denote the snap cap vial contains 95% ethanol. Prepare a waterproof inner label for the snap cap vial containing the shell vial. Both the inner label and snap cap label should contain
  - Jar Number (if more than one jar)
  - Survey serial number
  - Date and time the sample was collected
  - Station, cycle, and sample number
  - Number of organisms in shell vial
  - Sorter's initials

Example: Yellow snap cap Megalop lid label
- q. Place a yellow '95% ethanol' sticker on the side of the snap cap container.
- r. When the sample is completed, place a green dot on the sample jar lid labeled with the survey number, sample number, sorter's initial, and date sorting was finished. Also include a yellow sticker to indicate inverts were sorted for:





- s. Return the jar, in the proper numerical order, to the box from which it was originally removed. The snap cap vials containing fish and eggs and the invertebrate vials should be stored in the appropriate location in the lab.
- t. Fill out the required information in the Laboratory Tracking Sheets binder, the Sorter's Logbook binder, and on the LAB SORT\_ID TRACKING datasheet and Sorter's QC log on the computer.
  - Sample start date
  - Sample completion date
  - Sort time
  - Number of organisms (fish, eggs, invertebrates)
  - Number of fish fragments

### 10.3 Sample Sorting Procedures for Sub-Sampling Fish Eggs

- a. In samples to be processed for fish eggs, if the sorter thinks there will be more than 500 eggs in a sample then the sample should be "subsampled" for eggs. In some instances, all samples may be subsampled for eggs. When subsampling, the sample should be processed first for fish larvae and selected invertebrate larvae, ignoring any eggs. When ready to subsample put the sorted sample back in the original sample jar and fill the jar with 70% alcohol up to the lip of the jar. Jar size varies, but will typically be 500 ml (if sizes varies there will be a posting in the lab). A 'sub sample' should be 10 percent of the sample volume.
- b. After thoroughly mixing the sample, take the subsample as quickly as possible to avoid biasing the subsample as organisms begin to sink. For a 500 ml sample use a Hensen-Stempel pipette with a 10-ml plunger and take 5 aliquots (totaling 50 ml). There should be no air bubbles inside the Hensen-Stempel pipette. If there are, replace the subsample into the jar, completely dry the pipette, and begin again. When the subsample is bubble-free, dry the outside of the pipette and dispense the subsample into the mesh funnel. Mix the sample again and repeat the procedure to obtain 10 percent of the sample volume. Rinse the pipette into the mesh with water, washing the ethanol out of the sample through the mesh.
- c. Once the aliquot is processed for fish eggs return it to the original sample jar with the rest of the sorted sample. Record in the Sorter's Notebook that the sample was subsampled and record the total volume of the sample and the volume of the subsample. Additionally, fill in the subsample information on the laboratory tracking sheets and on the computer tracking sheets. Place a white dot sticker labeled with the survey number, sample number, sorters initials, subsample date, and the abbreviation "SS" on top of the sample jar.

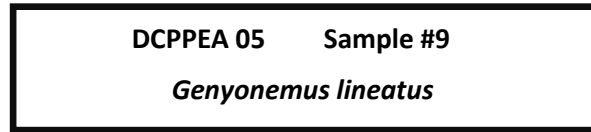
## 11.0 IDENTIFICATION OF LARVAL FISHES AND MACROINVERTEBRATES

### 11.1 Target Organism Identification Procedures

- a. Ensure that the proper equipment necessary for processing is available (Attachment 11.1-A Taxonomic Equipment List).
- b. Consult the Plankton Lab schedule posted in the laboratory to determine ID priorities.
- c. Obtain the sample to be identified from the ID Station and check it out by initialing under the “identified by” on the LAB SORT\_ID TRACKING electronic spreadsheet. Ensure that the correct sample is signed out (Attachment 11.1 – B Chain of Custody – In Lab Use). Transcribe all information from the sample label into the Taxonomist’s Log (Attachment 11.1-C Taxonomist’s Fish ID Log) and into the identifier’s individual Notebook (each taxonomist has separate log sheets and a notebook for this purpose).
- d. The fish and target invertebrates from each sample are to be kept in separate containers. Keep fish and eggs in shell vials and target invertebrates in screw-top or cotton-packed vials.
- e. Carefully empty the container of target organisms to be identified into a small watch glass. Place the dish on the microscope stage and adjust the lighting to provide adequate illumination.
- f. Unless otherwise specified, identify each target organism to the lowest taxonomic classification possible.
- g. A fish is considered to be “whole” when 1) the head and 50% or more of the body is present or 2) a headless fish with at least 80% of the body present. Fish are considered to be “fragments” when less than 50% of the body is present (with or without a head). Place mutilated larvae (partial organisms that are unable to be identified) and fragments in a separate vial labeled “Unidentified fragments”. Place whole larvae that are unidentified in a separate vial labeled “Unidentified larvae”. Uncertain identifications should be checked with other TENERA identifiers and the reference collection. The conservative guidance for IDs is not to push rare organisms beyond a verifiable identity.
- h. Record initial identifications and counts in the individual identifier’s Notebook, which should also include notes and comments on the organisms in each sample.
- i. Record the species identification, including life stage(s), and total number of each taxon on the Taxonomic Identification Data Sheet (Attachment 11.1-B); sign and date the sheet. In addition, record the total number of organisms in the sample, the ID time, date, and identifier’s initials on the electronic LAB SORT\_ID TRACKING database for the project and in the identifier’s personal QC log. If more than one day is needed to complete the identification, the date the sample identification was completed is to be recorded on the tracking sheets.
- j. All individuals of each identified taxon of fish larvae from a sample should be put into a shell vial containing either clean 70% alcohol or 95% non-denatured ethanol, as appropriate. A yellow “95% ethanol” sticker on the snap cap container indicates the specimens are stored in 95% non-denatured alcohol. Each vial should contain an inside

label with the taxon, survey number, and sample number. Use a heavy weight cotton fiber paper [e.g. Rite in the Rain] and a No. 2 pencil or Pigma Micron pen to make the label. To avoid specimen damage, the label shall be placed in the vial before the specimens. If this is not practical, care must be taken that larvae are not trapped between the label and vial, either on the walls or floor of the vial. Cotton should be pushed into the upper end of the vial to keep the label and organisms enclosed.

- k. Inside label with the taxon name, survey number, and sample number.



- l. If greater than 100 fish of any stage of larval development are present in a sample, then each stage shall be grouped and placed in individual labeled shell vials (unless fish are small and can easily fit more without destroying integrity of larval fish). The exception is fish within the family Engraulidae; each developmental stage, regardless of the total number in a sample, shall be grouped and placed in individual labeled shell vials.
- m. Place all vials containing larval fish from an individual sample into a Whirl-pak bag containing enough 70% alcohol, or 95% non-denatured ethanol, as appropriate, to cover the vials. Place the Whirl-pak into a Ball® jar that contains both an inside label and a label attached to the outside of the lid denoting the survey number, sample number, date and time collected, and identifier's initials. Tighten the jar lid to prevent evaporation of the preservative. Samples with many different fish taxa may require more than one jar, vial, or Whirl-pak bag.
- n. All individuals of each identified taxon of macroinvertebrate larvae from a sample should be put into a 2 dram screw-top vial containing 70% alcohol. Each vial should contain an inside label with the taxon name, survey number, and sample number. Use a heavy weight cotton fiber paper [Rite in the Rain] and a No. 2 pencil or Pigma Micron pen to make the label. To avoid specimen damage, the label shall be placed in the vial before the specimens. If this is not practical, care must be taken that larvae are not trapped between the label and vial, either on the walls or floor of the vial. Cap the vial tightly with a screw-top lid.
- o. Fill out the required information in the Identification Tracking Sheets binder, the Taxonomist's Logbook binder, on the LAB SORT\_ID TRACKING datasheet, and the identifier's ID QC log on the computer.
- p. At the end of work, all in-progress identification sheets shall be placed in the fire proof box located in the Lab. The datasheets are to be placed into the individual identifier's folder under the appropriate Project file.
- q. The Ball® jar containing fish larvae shall be placed into the appropriately labeled box containing identified samples. Macroinvertebrate vials shall be placed in labeled racks.
- r. If needed, archive representative identified specimens in the reference/voucher collection.
- s. Place any liquids containing ethanol into the appropriate waste container.

## 11.2 Identification of Sort QC Organisms

- Identification procedures used to identify those organisms resulting from a Sort QC are the same as the identification procedures described above (Section 11.1 Target Organism Identification).
- Once identified, record the species identification and the total number of each taxon on the Sort QC Laboratory Identification Data Sheet (color-coded to indicate a Sort QC). Sign and date the datasheet and file it behind the original Lab ID Data Sheet in the appropriate Project Binder.
- Transcribe all taxonomic Sort QC data onto the original Lab ID Data Sheet and update taxa counts.
- Remove the orange QC sticker from the snap cap containing the QC organism(s) and place the sticker onto the original Lab ID Data Sheet and sign and date the datasheet.
- Place the vials containing fish larva from the SORT QC sample into a Whirl-pak bag containing enough 70% ethanol, or 95% non-denatured ethanol, as appropriate, to cover the vials. Place the Whirl-pak into a Ball® jar that contains both an inside label and a label attached to the outside of the lid denoting survey number, sample number, date and time collected, identifier's initials and the words "SORT QC".
- Place macroinvertebrates from the SORT QC sample back into the screw-top vial and fill with 70% alcohol. Place both an inside label and a label attached to the outside of the vial denoting survey number, sample number, date and time collected, identifier's initials and the words "SORT QC". Place the vials on the invertebrate shelf in the Lab.

## 12.0 LABORATORY QUALITY ASSURANCE /QUALITY CONTROL

### 12.1 Quality Assurance

The appropriate Quality Assurance methods will be selected for each project on the basis of circumstances, objectives, and requirements. The provisions of this SOP will be adapted to project specific requirements in the project QA plan. Current Laboratory QA consists of the following:

- All samples are to be logged into the Laboratory and sample information (through the entire process) will be recorded on the LAB SORT\_ID TRACKING datasheet and **SAMPLE ARCHIVING PLANKTON RECORD** to track the progress of each sample within the Project/Survey. Tracking of each sample will be updated as each step is completed (i.e., transferring, splitting, sub-sampling, sorting, taxonomy, measuring, QC checks, storage, maintenance, and disposal).
- The target control limit for sorting efficiency is 90%. Precautionary measures are taken when sorting efficiency falls below 95%. Corrective action is taken when sorting efficiency falls below 90%.
- After laboratory processing is complete for a given sample, all mesh-sieves, forceps, bowls, trays, etc. that have come into contact with the sample are to be carefully

examined, thoroughly rinsed, and picked free of organisms or debris; organisms found will be added to the sample residue.

- All procedures outlined in this SOP will be followed. Any deviations known ahead of time must be approved by the Project Manager and/or Lab Director. Any deviations made during the project must be recorded and also approved by the Project Manager and/or Lab Director as soon as practicable.
- Procedures are established to evaluate the quality of the taxonomy. At least 10% of the samples are identified again by a second taxonomist. The taxonomy passes the QC check if a prescribed percentage (PTD of 10%) of the identifications is in agreement between the original taxonomist and the second taxonomist.
- Voucher Collection/Identifications: A voucher collection of all samples is to be maintained. These samples should be properly labeled, preserved, and stored in the laboratory for future reference. A taxonomist not responsible for the original identifications will check samples corresponding to the identifications on the Voucher Collection ID sheets. Labels with specific taxa names are added to the vials of specimens by the taxonomist. Individual specimens may be extracted from the sample to be included in a reference collection or to be verified by a second taxonomist. Identifications are initialed by the identifying taxonomist. The word “validated” and the first initial and last name of the person validating the identification should be added to Voucher Collection ID sheets. Specimens sent out for taxonomy validations should be recorded in the “Taxonomy Validation Notebook” showing the label information and the date sent out. Upon return of the specimens, the date received and the finding should also be recorded in the notebook along with the name of the person who performed the validation.
- A library of basic taxonomic literature is essential in aiding identification of specimens and will be maintained (and updated as needed) in the taxonomic laboratory. Taxonomists will participate in periodic training of specific taxonomic groups to ensure accurate identifications.

## 12.2 Quality Control

### 12.2.1 Quality Control Program for Laboratory Sample Sorting

The basic processing of zooplankton samples involves the time-consuming removal of organisms from large amounts of debris. Inevitably, processing errors occur during this sorting phase regardless of the diligence of the technician and those errors must be estimated. Therefore, the first QA/QC component of sample processing is the requirement to assess the sorting efficiency (i.e., the proportion of total organisms extracted from the sample upon sorting). High sorting efficiencies will ensure that endpoint calculations are reasonably reliable and without bias between samples.

The recommendation for assessing sorting efficiency is that at least 10 percent of all samples are to be resorted and any organisms found on the second sort be enumerated. The criterion for an acceptable sort is that > 90 percent of the total number of organisms are recovered during the initial sort. Sorted samples (and unsorted samples/subsamples) are retained until taxonomy and sorting efficiency (QC) are confirmed and the data are reviewed.



All laboratory personnel receive basic instruction and evaluation in the sample processing procedure by experienced laboratory staff. Experienced technicians are used to remove target organisms from the sample. A Quality Control (QC) technician must be present when samples are processed by an inexperienced individual (i.e., sorter in training).

#### 12.2.2 Sorting Efficiency Requirements

- a. A QC technician or trainer will check all sorted trays from the first ten samples processed by a sorter in training to ensure that each sample meets the >90 percent sorting efficiency. Qualification as an experienced technician may only occur when a sorter achieves >90 percent sorting efficiency for ten consecutive samples, however additional samples may be checked until the trainer decides that training is complete.
- b. After the sorter has passed 10 consecutive samples with an efficiency rate of at least 90 percent, the program is switched to a '1 sample in 10' QC program for that sorter. Using a random number chart, one of the next ten samples is selected for a QC check.
- c. A QC technician re-sorts the selected sample, retrieving and counting any organisms found. If the sorter maintains the 90% efficiency sorting rate for this sample, then the sorter continues in the '1 sample in 10' QC mode. If a sample does not meet the 90% efficiency rate the sorter's subsequent samples will be resorted until 10 consecutive samples meet the criterion.
- d. A sorter is allowed to miss one target organism when the original sort count is 1 through 19. For original sorter counts above 20 organisms a sorter must maintain a sorting efficiency of 90% based on the total combined count of individuals found by both the original sorter and the QC re-sorter. The sorting efficiencies obtained on each sample are calculated as below and recorded on the SORTER's QC LOG datasheet.

#### Determination of Sorting Efficiency

$$\text{Sorting efficiency (\%)} = [\text{Total organism} - \text{QC organisms}] \div \text{Total organisms} \times 100$$

Where:

Total organisms = total number of organisms found in the sample plus the QC organisms

QC organisms = total number of organisms found in the QC check

Example:

- 18 organisms are found in the QC re-sort
- 193 organisms were recovered in the original sort process

$$\text{Total organisms} = 211$$

$$\text{QC organisms} = 18$$

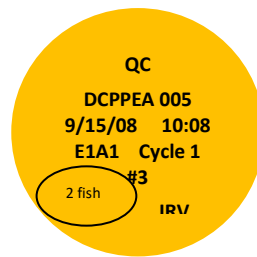
$$\% \text{ Sorting Efficiency} = [211 - 18] \div 211 \times 100 = 91.5\%$$

- e. After all organisms sorted from the original sample have been counted, the total number of organisms found in the sample and the total number found in the QC check are entered on the Sorter's Log Tracking Sheet, Laboratory Sample Tracking Sheet, and LAB SORT\_ID TRACKING datasheet.

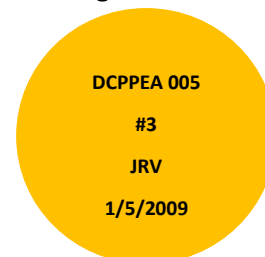
### 12.2.3 Sorting Procedure for QC Resort

- a. Sorting procedures used during the QC resort are the same as the sorting procedures described above (Section 10.0 Sample Sorting Procedures). Any fish and selected invertebrate larvae that were missed by the sorter are removed during the QC resort.
- b. For the QC process, a larval fish is defined as having a head plus at least 50% of the body. Any parts without a head and/or less than 50% of the body will be considered a fragment and will not be counted against the original sorter as a missed fish (even if subsequently identified by a taxonomist). However, it is important for each sorter to remove all fish and fragments from each sample and correctly record them as # fish/# fragments in the Sorter's Notebook and on the tracking sheets.
- c. Any fish larvae generated from the QC are put into shell vials topped with cotton and then into snap cap vials. Both the inner waterproof label and snap cap should be labeled as described in the sorting procedures (section 10.0); however use an orange dot label for the snap cap lid with "QC" added to the label. Any invertebrates generated from the QC are put into screw-top vials with a QC label placed on the side of the vial.
- d. An orange dot label should also be placed on the top of the jar of the sample that was resorted and labeled with the QC technicians' initials, survey number, sample number, and date the QC resort was completed.

Orange QC label for snap cap lid



Orange QC label for sample jar lid



- e. Store the QC snap cap vials and screw-top vials on the shelf with other fish/inverts "to be IDed".
- f. Fill out the required QC information on the LAB SORT\_ID TRACKING datasheet, laboratory tracking sheets, and in the Sorter's Notebook.

### 12.2.4 Taxonomic Quality Control

Tenera maintains a reference compilation with a voucher collection containing over 300 specimens. The identification of most of these specimens has been verified by outside professional taxonomists. All new taxonomists are required to identify each of these specimens. The identification of any new taxon for our laboratory is currently verified by outside taxonomists and compared to known distribution records.

A taxonomic reference list of fish species is established for each project to assist in achieving consistently correct identifications. Ichthyoplankton from sorted samples are identified to the lowest taxonomic level possible (or practical). Macroinvertebrate taxa are usually identified to genus.

Since agreements are, in part, contingent on the targeted level of identification (i.e., species, genus, family, or higher) the list will identify the lowest level of identifiable taxon for each representative specimen. For example, if genus is the target, and one taxonomist provides a name

for a specimen at the species level, whereas the other leaves the name at genus level, it would be scored as an agreement. However, if one identification is at the genus level and the re-identification is at family, it would not be counted as an agreement (one identification met the target, the other did not). If disagreements affect a large number of specimens in samples throughout the entire data set, then those samples can be isolated and evaluated further for corrective re- identifications.

For projects involving new geographic areas/locations (and for new taxonomists) the first ten samples of fish identified by a taxonomist will be completely re-identified by a designated QC taxonomist. At least 50 individual fish larvae from at least five taxa must be present in these first ten samples; if not, additional samples will be re-identified until this criterion is met. Taxonomic identifications are subject to a 10 percent re-check by another in-house taxonomist (i.e., one out of ten consecutive samples is selected to be re-identified by a second senior taxonomist).

Taxonomic precision is calculated as Percent Taxonomic Disagreement and will serve to quantify the rates of error (percent disagreement) in assignment of nomenclature to individual specimens in the sample. The error rate will be quantified as the proportion of individual specimens in the sample identified differently (percent taxonomic disagreement [PTD]) by the two taxonomists calculated as:

$$PTD = [1 - \frac{com_{pos}}{N}] \times 100$$

where:  $com_{pos}$  is the number of agreements and N is the total number of organisms in the larger of the two counts. A PTD goal of less than or equal to 10% is targeted. Taxonomists are required to maintain a maximum 10% PTD accuracy level in these first ten samples. The lower the PTD value, the greater the overall taxonomic precision indicating relative consistency in sample treatment. If the PTD goal of 10% is attained, then the taxonomist will continue to have one of ten samples checked by a QA/QC taxonomist.

taxonomist interaction is used to determine problem areas, identify consistent disagreements, and define corrective actions. Questionable specimens are immediately shared with all other taxonomists and compared to voucher specimens. If consensus cannot be reached among Tenera taxonomists, the specimen is shown to an outside expert.

Taxonomists are required to maintain a maximum 10% PTD accuracy level in these first ten samples. After the taxonomist has identified ten consecutive samples with a 10% PTD or less, the taxonomist will have one of their next ten samples checked by a QC taxonomist. If the taxonomist maintains, then they will continue to have one of ten samples checked by a QA/QC taxonomist. If they fall below this level, then the next ten consecutive samples they have identified will be checked for accuracy. Samples will be re-identified until ten consecutive samples meet the 95% criterion. Identifications will be verified with taxonomic voucher collections maintained by Tenera.

#### 12.2.5 Verification of Taxonomic Identification

- a. After the taxonomist has identified ten samples, one of the ten samples is selected under the direction of the Lab Director from the taxonomist's ID QC LOG for verification by a second (QC) taxonomist (Consult Lab Schedule).
- b. Identifying labels are removed from each shell vial of the QC sample. The labels and the original Fish Identification Data Sheet are retained by the Lab Director. Fish are

kept in individual shell vials as originally grouped and identified by the first taxonomist.

- c. The second (QC) taxonomist re-identifies the sample and records the species identification, including life stage(s), and total number of individuals identified for each taxon on the QC Fish Identification Data Sheet (color-coded to represent an ID QC); the sheet is signed and dated.
- d. The original sample identification data is compared with the data obtained from the QC check and the PTD calculated on the Percent Taxonomic Disagreement Form (Attachment I). If there is a disagreement with an identification (not to include life stages) the original taxonomist is consulted until a consensus is reached, utilizing additional experts as warranted.
- e. All taxonomic discrepancies and comments associated with the QC check are recorded on the original Fish Identification Data Sheet.
- f. The cumulative taxonomic proficiency data for each taxonomist is calculate and retained.

### **13.0 PRESERVATION AND MAINTENANCE OF LARVAL FISH**

The majority of fish larvae are stored in 70% alcohol; however those designated for DNA or otolith analysis are stored in 95% non-denatured ethanol. When possible, concentrations should be measured with an alcohol hydrometer. "Treated water" (either de-ionized or distilled) is used to dilute the ethanol in order to reduce the risk of acidity caused by chloride and fluoride ions present in most urban water supplies. The ethanol is allowed to "settle" before use and is decanted using a carboy tap to keep particles, fuzz, and other debris away from specimens.

Ethanol is used as a preservative rather than formalin because of problems in maintaining pH in formalin solutions. Unbuffered formalin becomes acidic which destroys bone. Many buffers (including the widely-used borate buffer) damage larvae or allow the pH to rise too high, thereby bleaching larvae. Calcium carbonate can crystallize out on larvae, in effect "fossilizing" them. In addition, formalin presents health problems to those who work on the samples. Formalin is therefore best avoided as a storage solution for larvae. Alcohol, however, evaporates quickly so special measures must be taken to avoid this problem (see below).

Some larvae will be fixed initially in alcohol instead of formalin (e.g., for DNA and/or otolith studies). If so, this should be noted, as some investigations (such as clearing and staining) are not possible on ethanol-fixed material. Conversely, other investigations are not possible on formalin-fixed specimens (e.g., DNA, otolith). If fixed in formalin, the buffer should also be recorded (if different than seawater), as this, too, can affect what studies are possible with the material.

- Fish larvae are stored in ½ dram (1.8 ml) glass shell vials capped with cotton tops. Labels for larvae are placed in the vials. Vials from each sample are stored together in Whirl-paks which are filled with 70% alcohol or 95% ethanol. Whirl-paks are subsequently placed in pint glass Ball® jars. A yellow "95% ethanol" sticker indicates the specimens are stored in 95% non-denatured alcohol. Storing vials in Whirl-paks containing ethanol accomplishes two things: inhibits or eliminates evaporation from vials, and checking of alcohol levels involves inspecting only one "container" rather than many individual vials.

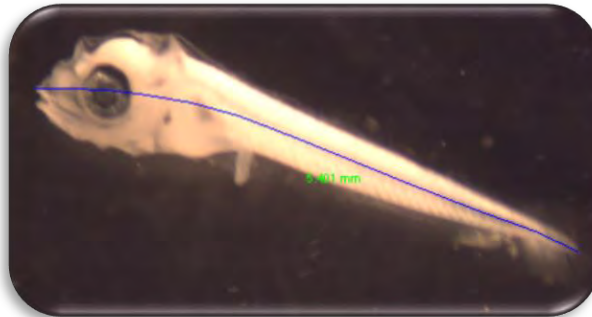
- Larval fish must be kept in the dark. Archived larvae should be stored in covered boxes. Those in the work/lab area should be stored in cabinets or behind black curtains hanging in front of the shelves; this prevents the fading of specimens caused by exposure to light. This point cannot be overstressed. Larval pigment is particularly susceptible to fading under exposure to light - even artificial light. Do not leave specimens out on a bench or desk exposed to direct sunlight. Faded specimens are usually unidentifiable.
- Vials, Whirl-paks, and jars should be securely sealed, the lids applied firmly.
- Checking and topping off the larval fish samples with alcohol should ideally take place at least **once a year**. For 70% alcohol samples where the alcohol level is found to be low (i.e., well below the neck) top-off with 80% alcohol. Eighty percent is used instead of 70% because the alcohol/water mix does not form a true azeotrope (mixture) and some separation occurs. The alcohol concentration at the top of the jar is higher than that at the bottom, and thus more alcohol than water evaporates with the result that the alcohol concentration drops below 70%. If over one third of the alcohol has evaporated, dispose of the old alcohol, refill the vial and/or Whirl-pak with clean 70% alcohol and replace the defective cotton, Whirl-pak, or lid.
- After completing the alcohol level check and topping off any samples, fill out the electronic SAMPLE\_ARCHIVING PLANKTON RECORD datasheet, place a sticker on the sample jar indicating the date and initials of the person responsible, and fill out the card attached to the survey storage carton, if appropriate.

## 14.0 LARVAL FISH MEASURING

Length measurements are taken on a representative sample of the target larval fish taxa. Approximately 100 fish from each taxon are measured using a video capture system and ImagePro© image analysis software. The fish from each taxon will be selected from entrainment stations based on the percentage frequency of occurrence of a taxon in each survey. For example, if 20 percent of the California halibut larvae for the entire study were collected during the June survey then 20 fish will be measured from that survey. Larval fish lengths are measured to the nearest 0.1 mm using an ocular micrometer.

- a. Turn on the computer, camera, and light source at the measuring station.
- b. Consult the Plankton Lab schedule posted near the measuring station to determine measuring priorities and retrieve the binder containing the appropriate data sheets.
- c. Obtain the sample containing the fish to be measured from the Fish Sample Collection and place it in an easily accessible area close to the measuring station.
- d. Enter the starting date and initial under “measured by” on the LAB SORT\_ID TRACKING electronic spreadsheet.
- e. Open the appropriate software on the computer (See ImagePro© Procedure 14.1.) by clicking with the mouse on the ImagePro© icon. Open the Larval Fish Measuring macro in ImagePro©, and follow the macro’s directions.
- f. Select the jar or vial of fish to be measured and compare the data on the jar label with the inner label and the data sheet for the sample. Consult an identification biologist if any discrepancies are found.

- g. Enter the data queried for by the macro including the last five digits of the serial number, the measurer's initials, the data sheet sequence number and the species code.
- h. Open the sample jar and remove the vials for the target taxa to be measured. Place the vials in a rack designed to allow the vials to maintain an upright posture so as to reduce the risk of a spill.
- i. Select the first vial to be measured. Remove the cotton and the label with forceps. Compare the label with the data sheet for confirmation.
- j. Empty the vial into a shallow petri dish. Remove any fish that have adhered to the vial, cotton, the label, or any tools used in the transferring process and place the fish in the dish. Add the appropriate alcohol to the dish if necessary to prevent desiccation. A yellow "95% ethanol" sticker on the snap cap container indicates the specimens are stored in 95% non-denatured alcohol.
- k. Place the petri dish on the stage of the microscope. With fine-tipped forceps carefully arrange the fish on the computer screen so that they can be measured. Adjust the zoom, focus, and lighting for the best possible image. If this is the first group of larval fish being measured, or if the magnification has been changed, it is necessary to re-calibrate the micrometer. Place the micrometer on the stage of the microscope and re-calibrate by drawing a line from one of the micrometers millimeter marks to another, noting the distance between the two marks, and entering that value when queried. Replace the dish containing the larval fish to be measured.
- l. Measure larval fish by drawing a line from the pre-maxillary to the end of the notochord, being careful to follow the contours of the fish.




- m. If the fish is too damaged to find either the pre-maxillary or to estimate the path taken by the notochord, do not measure the fish, but proceed to the next larval fish. If the line does not adequately approximate the larval fish's length it must be re-measured.
- n. Note the program's display of the fish measurement and check that it seems reasonable. If it does not seem reasonable, it may be necessary to re-calibrate and re-measure. If the problem persists, contact a larval identification biologist. Make note of any problems in measuring, record in log, and post near the measuring station.
- o. The macro will store the measurement in at least two separate data files along with the necessary sample information.
- p. Repeat the above steps for all fish in the sample that need to be measured.
- q. When all selected larval fish have been measured, put the fish back into their original labeled, ethanol filled vial.

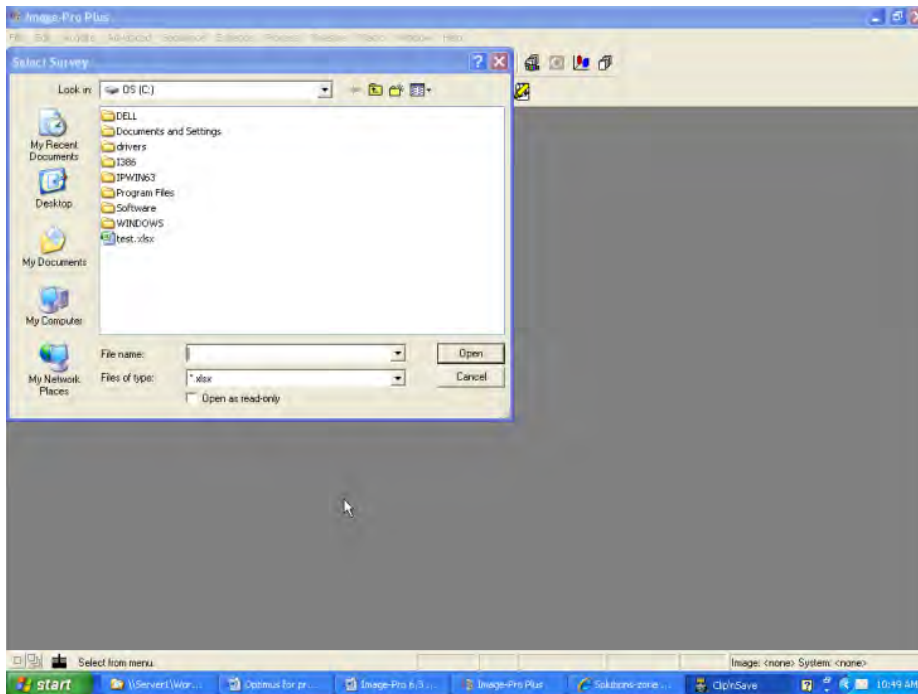


- r. If the larval fish from this vial have been segregated into two or more groups for ease of handling, place another group into the dish, being careful to submerge them in ethanol, and measure as above.
- s. At the end of work, all in-progress identification sheets shall be placed in the fire proof box located in the Lab. The datasheets are to be placed into the individual measurer's folder under the appropriate Project file.

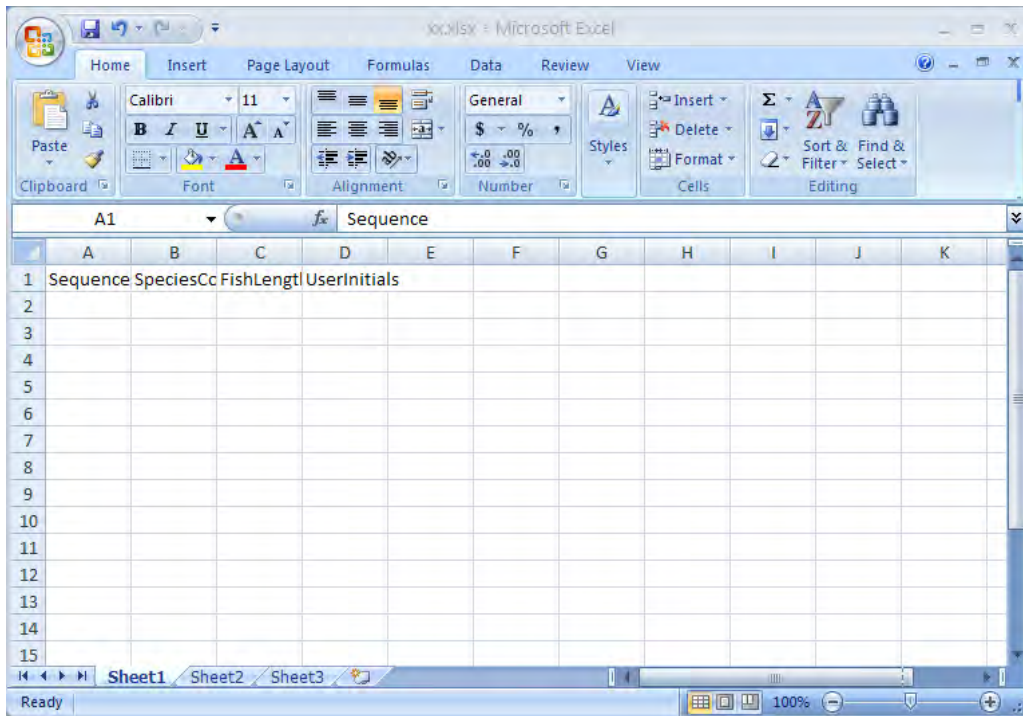
  - When all selected fish in a survey has been measured, fill in the required information on the LAB SORT\_ID TRACKING datasheet.
  - The Ball<sup>®</sup> jar containing fish larvae shall be placed back into the appropriately labeled box containing identified samples within the Larval Fish Collection.

#### 14.1 ImagePro© 6.3 Procedures for Measuring Larval Fish Length

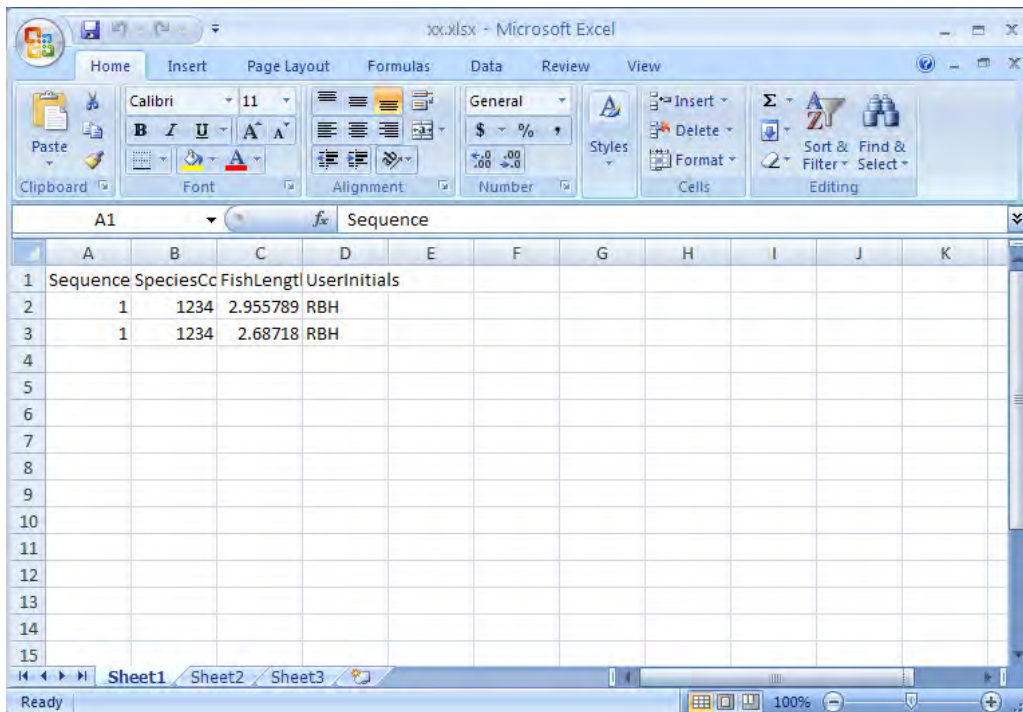
- a. Open ImagePro© by double-clicking its  icon.
- b. Turn on the camera.
- c. Select the **Macro>MeasureFishLengthOnly** menu option to start the macro.
  - The macro starts by trying to open a previous survey file or starting a new one.



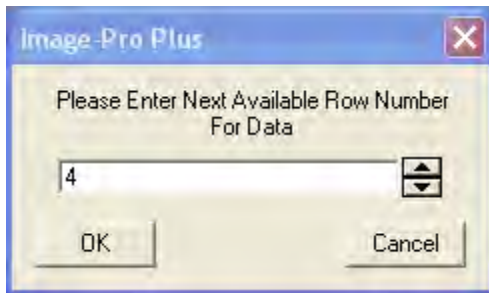
- If the file does not exist then enter a new file name in the appropriate folder. Excel will open a new spreadsheet with column headers in the first row.



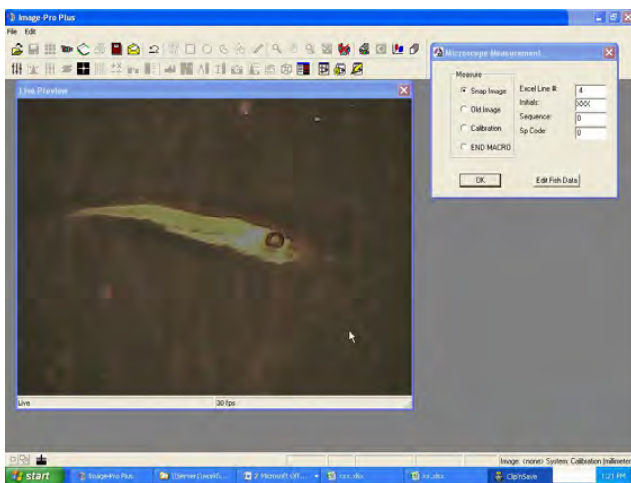
- If the file does exist then select it from the list. Excel will open it with previously entered data.



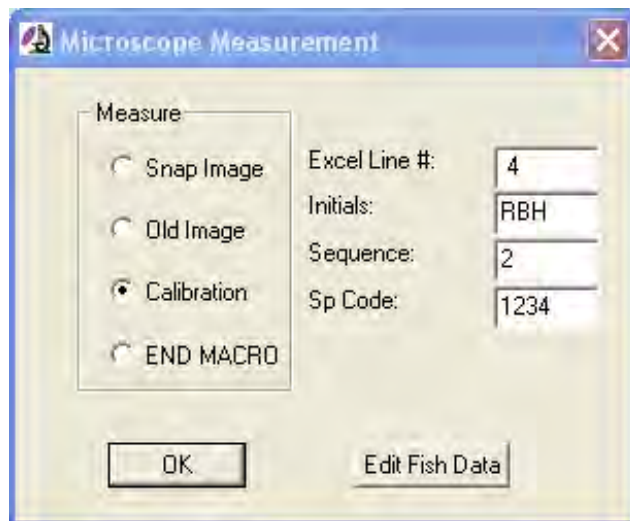
- d. In this case, clicking on the rightmost ImagePro© task in the Windows taskbar should open the **Please Enter Next Available Row Number For Data** prompt. Enter this value and then press the **OK** button to continue.



The **Live Preview** window and **Microscope Measurement** dialogue will open.



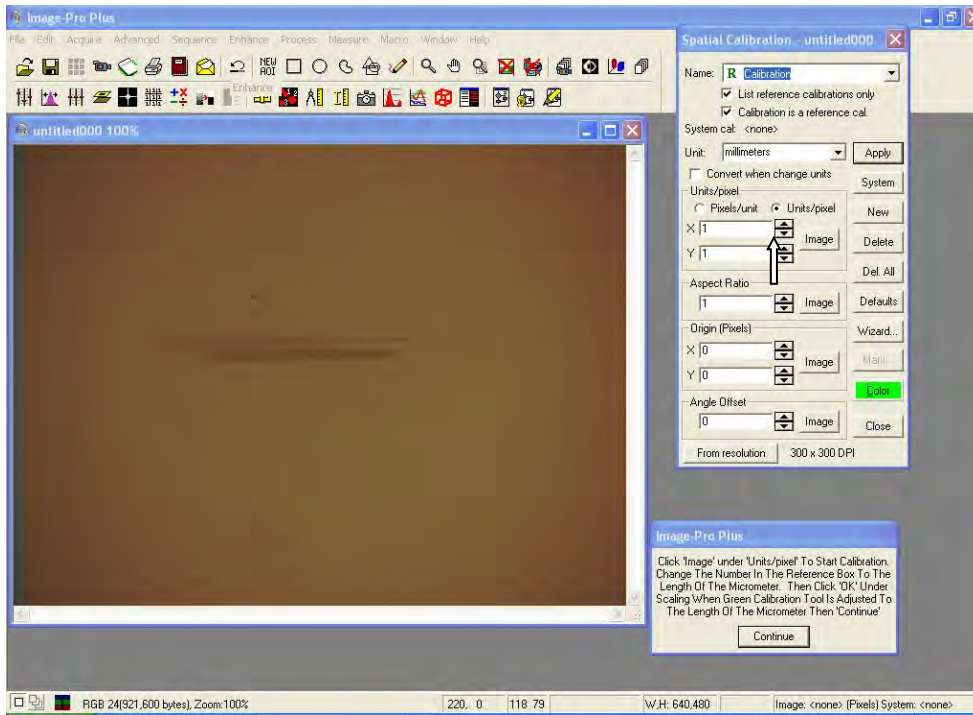
- e. Select the **Calibration** option and press **OK**.



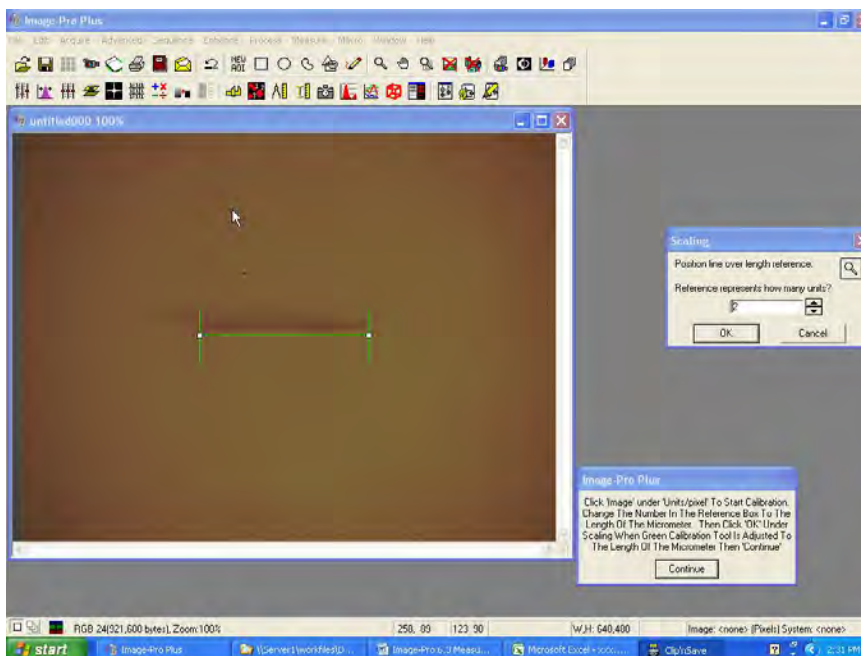
- f. Place a fish under the microscope and adjust the magnification so the whole fish fits in the field of view. It is important not to adjust the magnification from this point on until the measurer wishes to recalibrate. Replace the fish with the micrometer under the

microscope and adjust the focus. Only the focus and position of the micrometer may be adjusted at this time. Press **OK** to start calibration.

- g. Calibrate the measurements to the magnification. Click the **Image** button in the **Units/pixel** box to start this process.

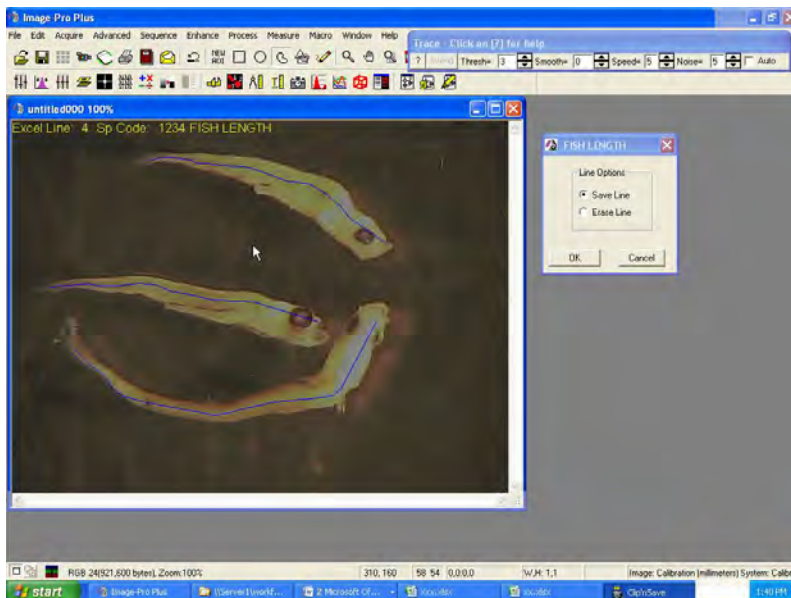


- h. Position the green calibration tool over the length of the micrometer. Change how many units the green reference line represents to “2” in the Scaling box. Press the OK button and then the Continue button to go on.





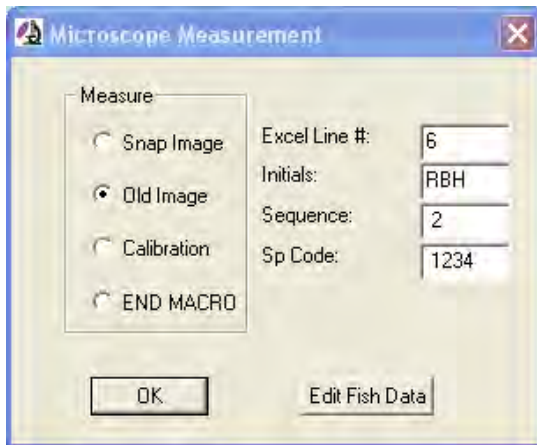
- i. Enter measurer's initials, the sequence number (data sheet number), and species (Sp) code in the appropriate text boxes.
- j. Place fish of the same species from the same sequence under the microscope and click **OK** to start measuring.
- k. Measure by left-clicking at points along the length of the fish to make poly-line segments and then right-clicking after the last segment has been made. If the measurement made is not satisfactory select the **Erase Line** option and click **OK** to erase it. Once measuring is completed select the **Save Line** option and click **OK** to write the measurements to the Excel file.



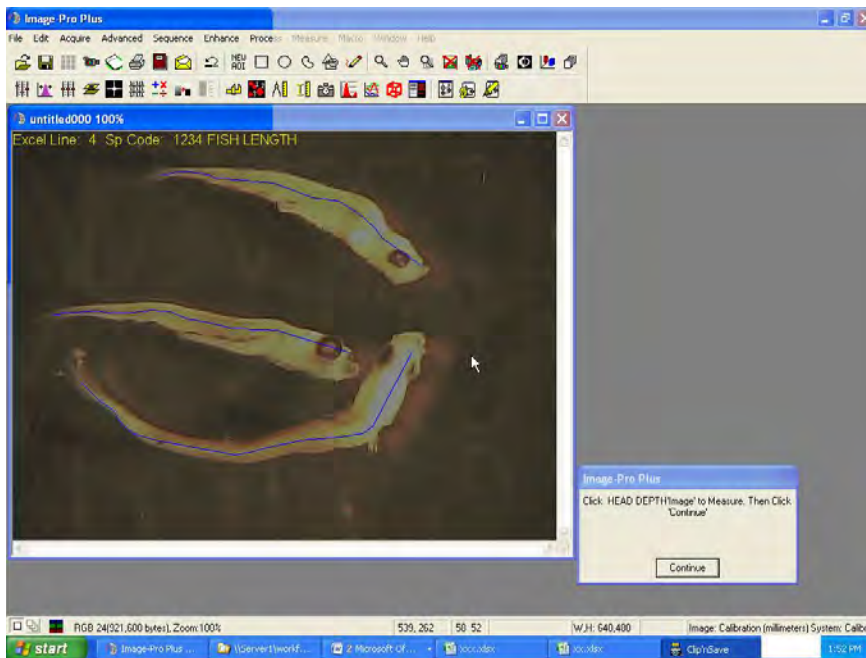
- i. Continue measuring while changing the information in the text boxes as applicable (i.e., new sequence or different species code are needed) and calibrating when the magnification needs to be changed.

#### 14.1.1 Method to Correct Measurement Error

- a. If an error has been made with a measurement it is possible to re-measure from a previously captured image. Make sure the text boxes are filled in with the proper information of the measurement to be changed, especially taking care to have the proper Excel line number entered in the Excel **Line #** text box. Select the **Old Image** option and press **OK** to continue.



b. Select the image to be re-measured and click Continue.




c. Follow steps m. through o. as normal to re-measure fish.

#### 14.1.2 Method to Correct Data Entry Error


- a. If the wrong fish information has been entered for a particular fish, these data may be changed by clicking the **Edit Fish Data** button.
- b. Enter the correct information in all the pertinent text boxes, especially taking care to have the proper range of Excel line numbers entered in the **Line Range** text boxes.

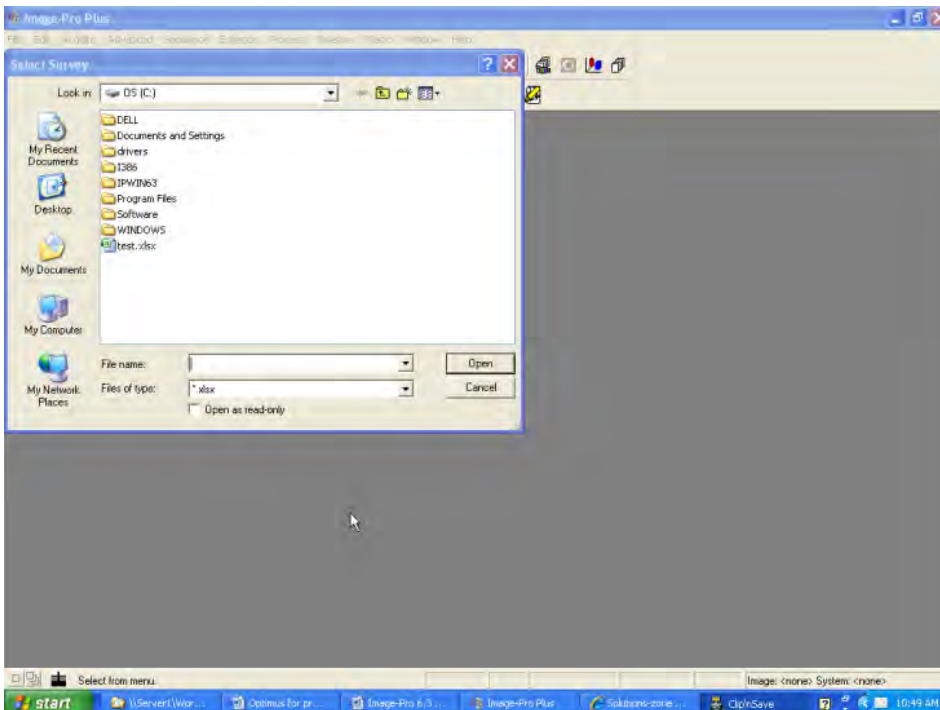




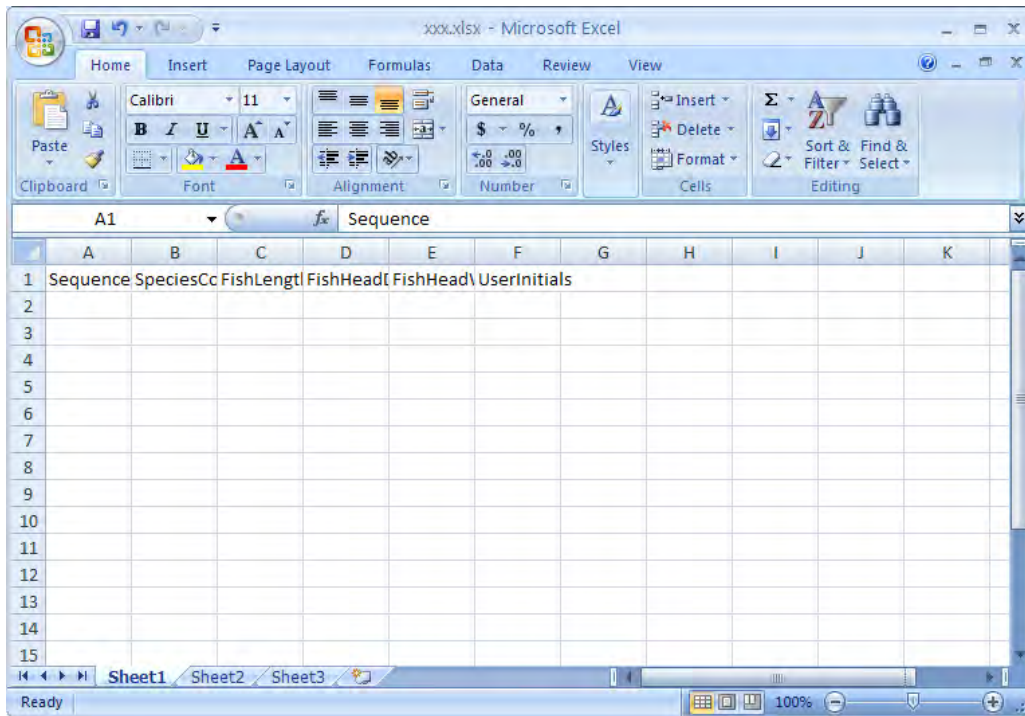
- c. When finished, select **END MACRO** and click on **OK**.
- d. Be sure to save in Excel often by selecting the Excel spreadsheet and clicking the save button in the upper left corner. 

## 14.2 ImagePro© 6.3 Procedures for Measuring Larval Fish Length and Head Capsule

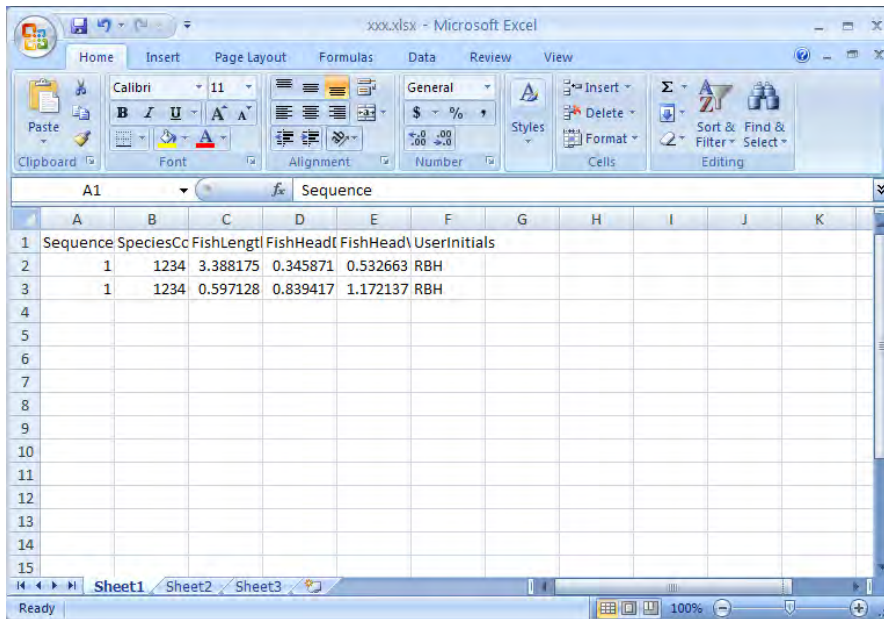
- a. Open ImagePro© by double-clicking its  icon.
- b. Turn on the camera.
  - Select the **Macro>MeasureFishLengthWidthDepth** menu option to start the macro.
  - The macro starts by trying to open a previous survey file or starting a new one.



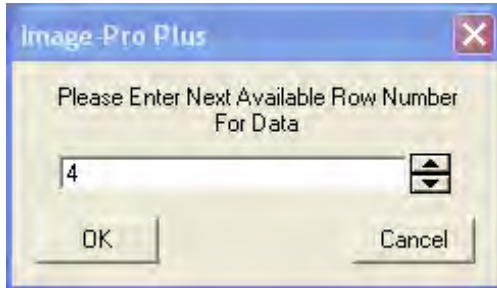
- c. If the file does not exist then enter a new file name in the appropriate folder. Excel will open a new spreadsheet with column headers in the first row.



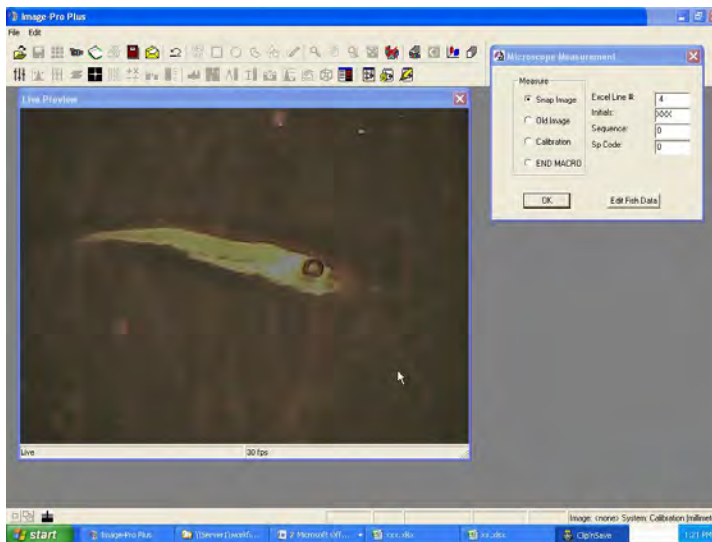
- d. If the file does exist then select it from the list. Excel will open it with previously entered data.



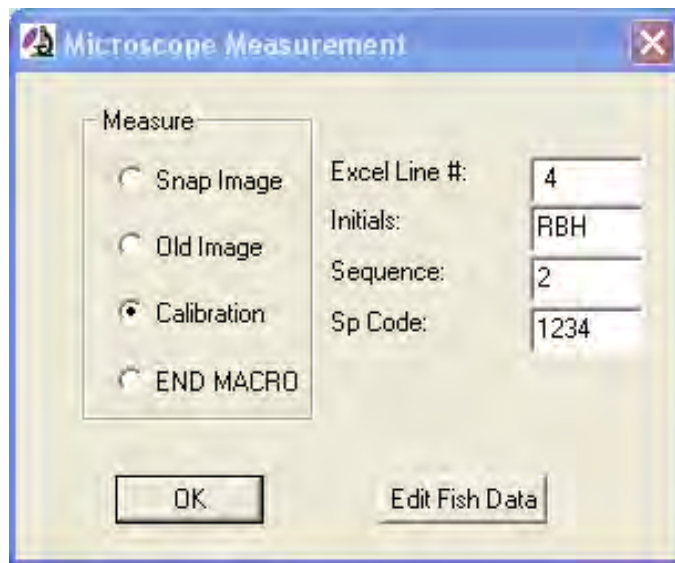
- e. In this case, clicking on the rightmost ImagePro© task in the Windows taskbar should open the Please Enter Next Available Row Number For Data prompt. Enter this value and then press the OK button to continue.



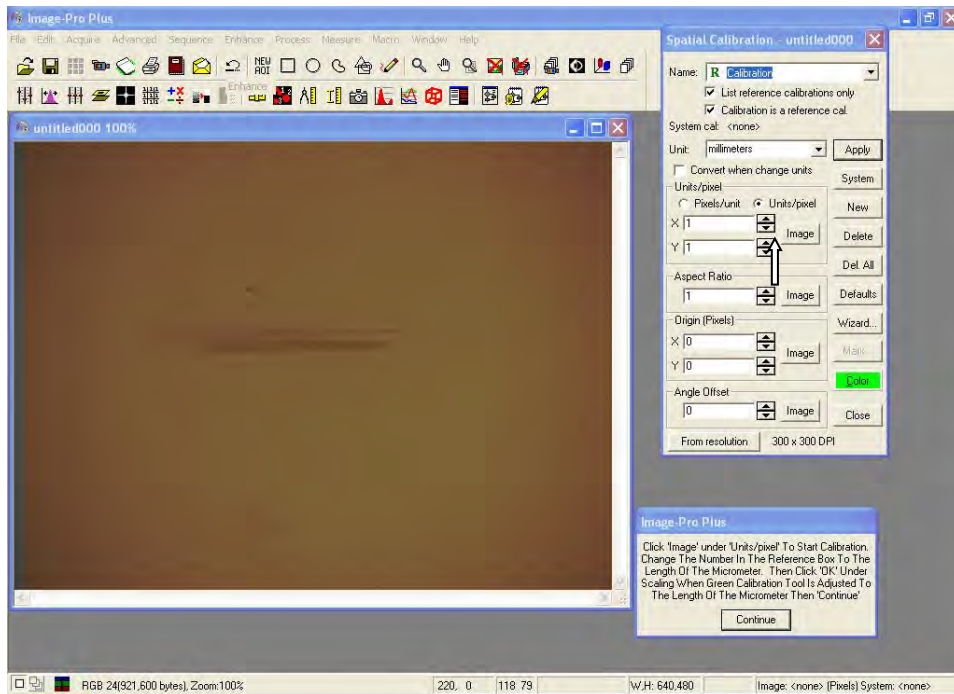
- f. The **Live Preview** window and **Microscope Measurement** dialogue will open.



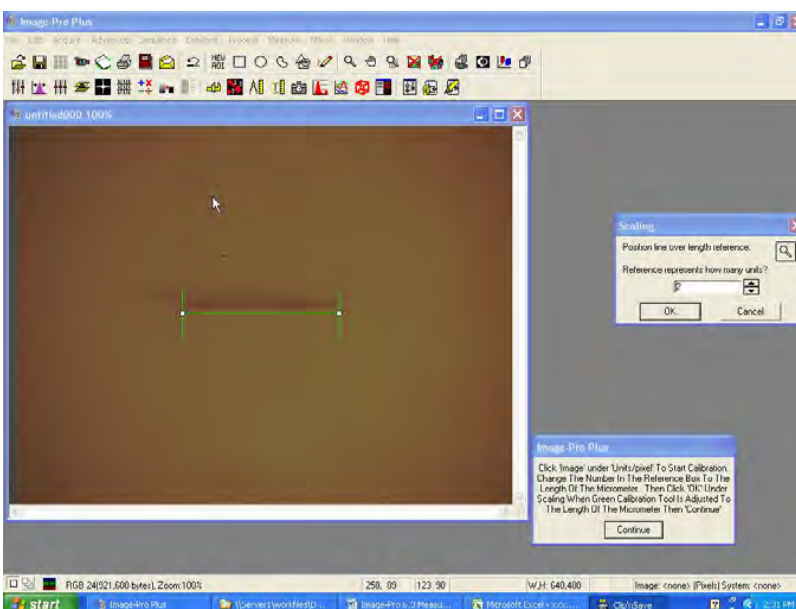
- g. Select the **Calibration** option and press **OK**.



- h. Place a fish under the microscope and adjust the magnification so the whole fish fits in the field of view. It is important not to adjust the magnification from this point on until the measurer wishes to recalibrate. Replace the fish with the micrometer under the microscope and adjust the focus. Only the focus and position of the micrometer may be adjusted at this time. Press **OK** to start calibration.
- i. Calibrate the measurements to the magnification. Click the **Image** button in the **Units/pixel** box to start this process.

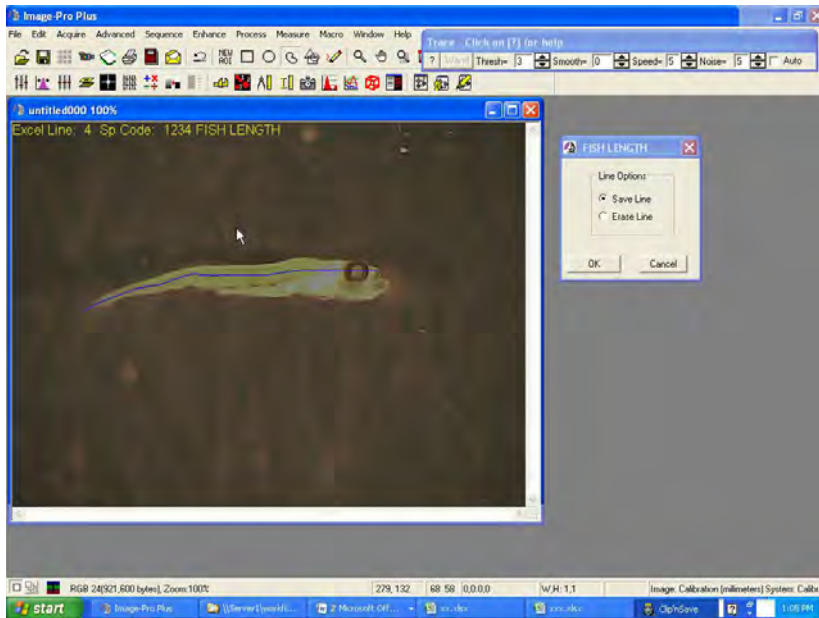


- j. Position the green calibration tool over the length of the micrometer. Change how many units the green reference line represents to “2” in the **Scaling** box. Press the **OK** button and then the **Continue** button to go on.





- k. Enter measurer's initials, the sequence number (data sheet number), and species (Sp) code in the appropriate text boxes.
- l. Replace fish under microscope and select an option (**Length, Head Depth, Head Width**) under **Measurement** then click **OK** to start measuring.
- m. Measure by left-clicking at points along the length of the fish to make poly-line segments and then right-clicking after the last segment has been made. If the measurement made is not satisfactory select the **Erase Line** option and click **OK** to erase it and start again. Once measuring is completed select the **Save Line** option and click **OK** to write the measurements to the Excel file.

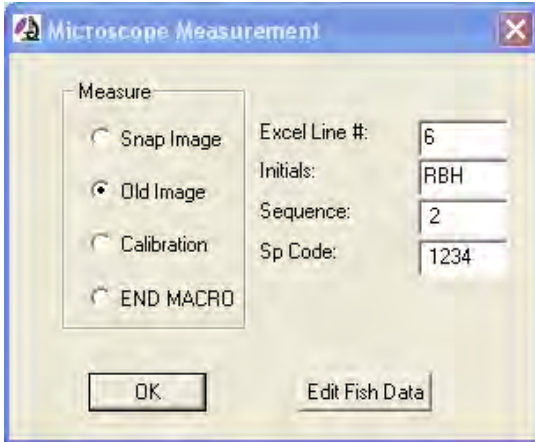


- p. Repeat steps l. and m. until a measurement has been written for all three **Measurement** options while making sure to adjust the angle of the fish when the **Live Preview** window is open to acquire the proper view of the dimension to be measured. If a previously captured image can be used for multiple measurements select the **Old Image** option in the **Source** box. The macro will automatically advance to the next Excel line when all three measurements have been made. However, if the measurer is unable to make a measurement due to unsuitability of the fish (e.g., unable to measure head depth due to the mouth being open) the measurer may advance to the next line in Excel manually by entering it in the **Excel Line #** text box in the **Microscope Measurement** dialogue.
- q. Continue measuring while changing the information in the text boxes as applicable (i.e., new sequence or different species code are needed) and calibrating when the magnification needs to be changed.

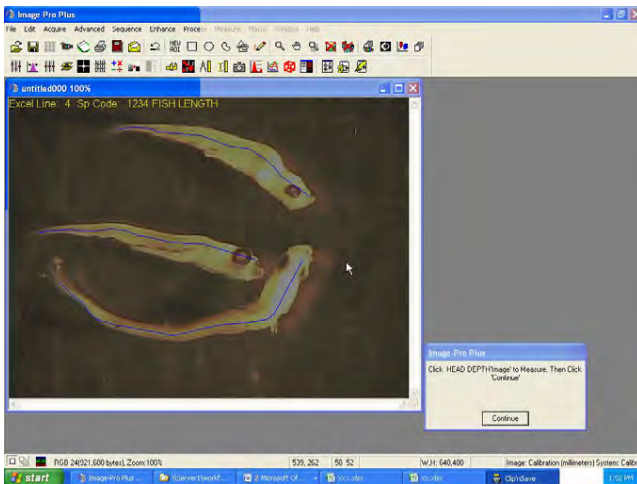
#### 14.2.1 Method to Correct Measurement Error

- a. If an error has been made with a measurement it is possible to re-measure from a previously captured image. Make sure the text boxes are filled in with the proper information of the measurement to be changed, especially taking care to have the

proper Excel line number entered in the Excel **Line #** text box. Select the **Old Image** option and press **OK** to continue.



b. Select the image to be re-measured and click Continue.

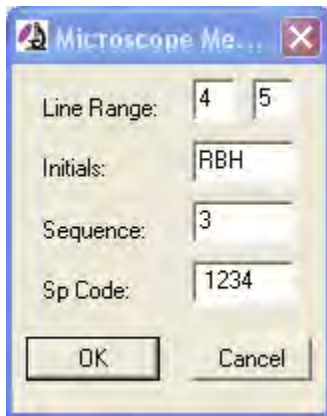



c. Follow steps m. through o. as normal to re-measure fish.

#### 14.2.2 Method to Data Entry Error

- a. If the wrong fish information has been entered for a particular fish, these data may be changed by clicking the **Edit Fish Data** button.
- b. Enter the correct information in all the pertinent text boxes, especially taking care to have the proper range of Excel line numbers entered in the **Line Range** text boxes.





- c. When finished, select **END MACRO** and click on **OK**.
- d. Be sure to save in Excel often by selecting the Excel spreadsheet and clicking the save button in the upper left corner. 

## 15.0 OTOLITH EXTRACTION AND READING PROCEDURES

### 15.1 Otolith Extraction and Reading

- a. Remove otoliths from larvae that were preserved in 95% non-denatured ethanol only. Preservation in formaldehyde, which is slightly acidic, can possibly dissolve the otolith which can decrease the overall size of the otolith. All larvae for analysis will be removed from the samples and placed in individually labeled vials.
- b. Three microscopes are used during this procedure. A Wild dissecting microscope (referred to as Scope #1) is equipped with a camera port which is used for photographing the larvae. Another Wild dissecting microscope (referred to as Scope #2) with bottom lighting is equipped with two pieces of polarizing film to aid in finding the otoliths in the larvae. This scope is used for the otolith extraction. The Olympus compound microscope is used for photographing the otolith after extraction.
- c. Via USB connection, plug the Infinity 2 microscope camera into the dissecting scope camera port and turn on the computer. Open the Infinity Analyze program. A new window will open automatically to preview the field of the microscope.
- d. Put a small dish with a little 95% ethanol under Scope #1. Place the larvae from which you want to remove the otoliths into the dish and then into the scope's field of view. At this point calibration is not necessary, so simply click the capture button on the monitor (the button with the picture of a camera on it) once the fish is in focus, has proper lighting, and is magnified large enough to see properly.
- e. Save the image according to the larvae's taxonomic family. The first letter of the family name is used followed by the number assigned to the individual fish (e.g. Pomacentridae number 45 would be saved as "P45"). The vial the fish came from should have a label with this name on it.

- f. Remove the camera from the dissecting microscope and attach it the Olympus compound microscope. Whenever either scope that is used for photographs is not in use replace, the dust cap on the camera tube.
- g. Label a clean microscope slide with the same name that was used to save the initial image of the fish (e.g . “P45”). Remove the fish from the dish and place it on the slide with a few drops of 95% ethanol to ensure it does not dry up.
- h. Place the microscope slide under the Scope #2. Adjust the light source so that all light is directed off of the mirror underneath the microscope. This scope has a piece of polarizing film on the mirror and another within the microscope head. This causes the light to be cross polarized and otoliths to appear as a bright spot when viewed under through microscope. Adjust the lighting and the angle of the mirror while looking in the microscope until you can view the otoliths clearly.
- i. Otoliths are found at the anterior portion of the head and appear as a small, circular, opaque disc. Using very thin, needle like probes begin to extract the otoliths. Gently peel back the operculum of the fish and scrape any tissue away that is surrounding the otoliths.
- j. There are three pairs of otoliths called the lapilli, asterisci and the sagittae. Attempt to extract all otoliths that can be found. The largest, easiest to find, and most important are the sagittae. Without these a comparative measurements of the otoliths cannot be taken. Often only one or two of the pairs are found. Be sure to add 95% ethanol as needed to ensure that the fish does not go dry. Get the otoliths as clean as possible.
- k. Place the remains of the fish back into the vial it came from, entirely filling the vial with 95% ethanol, and save for possible DNA testing.
- l. Dab any excess ethanol away without touching the otolith and let the slide dry. It is important to know where the otoliths are on the slide and not to touch the otoliths when they are dry, as they are easy to lose.
- m. Place a small drop of immersion oil on top of the otoliths once they are dry and move the slide to the compound microscope.
- n. Open a new window for video preview in the infinity analyze program.
- o. Find the magnification power that allows the sagittal otoliths to be seen at their largest while still fitting the entire otolith into the field of view of the camera.
- p. Calibration for the camera has been preset. In the upper left corner of the program there is a drop down box that has choices for the various magnifications of the camera. Choose the magnification that you are using, adjust the camera focus and lighting and take a picture (if taking pictures on 100x magnification use the 10x calibrations setting and adjust any later measurements by moving the decimal place). This scope cannot be calibrated for 100x measurements.
- q. The naming of the otolith photo goes as follows- the name of the fish, a hyphen, the number of the otolith (based on the order which they are viewed), and a letter telling if it is one of many possible photos taken of the same otoliths. For example the first otolith picture taken from fish P45 would be saved under the name “P45-1A”, and if a second photo were taken of the same otolith under a different focus it would be titled

“P45-1B”. When the next otolith from the same fish is photographed its first photo will be titled “P45-2A”, and so on.

- r. Now there should be a captured image on the screen. Go to the Measure tab at the top of the program and chose the “point to point” command. The mouse will now appear as a small crosshair. Click once to begin a measurement and once to end. Take a few diameter measurements making sure you get the largest and smallest diameter lengths on the otolith. Record the largest and smallest measurement on the datasheet for that individual larvae.
- s. Once measurements have been taken, repeat the process taking more photographs of the otolith under different magnifications and focuses (it is not important to have the entire otolith in these photos). Get as many photos as is necessary to be comfortable that the number of growth increment on the otolith can be determined. These photos will be the only record of the otoliths so more pictures is always better than fewer. It will probably be necessary to increase magnification, if there are no 100x pictures taken yet, as well as capture images under many focus positions, making sure that all areas of the otolith on the saved images are readable.
- t. Repeat the above steps for all otoliths found in the extraction process. Only one of the sagittal otoliths needs to have its diameter measured.
- u. When finished capturing images remove the slide and place it aside. It is best not to clean the slide until a final determination has been made on the number of growth increment of the larvae.
- v. Print all photographs taken of the otolith on a color printer. The images are easier to read when printed on a color printer.
- w. Using both the printed images and those saved on the computer to determine the number of increments found on each otolith. Using a permanent marker put a dot on each of the observed increments on the printed images, and label each picture with its larval identification number and the number of increment observed. Take more pictures of the otolith at this point if necessary.
- x. Photographs taken with different magnifications and focuses may lead to an opposing final conclusion about the number of rings present. Make a final decision based on the clearest photos available. If none are clear enough state in the data sheet that the otoliths were unreadable.
- y. Record the number of rings as well as the maximum and minimum diameter lengths of the otolith on the given data sheet.
- z. When confident you won't need any more pictures wash the slide with soap and water and use a tiny bit of ethanol to get the permanent marker label off the slide.
- aa. Close the infinity analyze program making sure all photos are properly saved and shut down the computer. All hard copies of the photographs are to be placed in the proper section of a binder labeled “Otolith Pictures”.

NOTE: These procedures are written for the extraction of otoliths from one fish at a time. When working with many fish at once it may be helpful to photograph all fish first, then pull otoliths a

few at a time and take the photographs a few at a time. This will help save time by not moving the camera twice for every fish that is being analyzed.

## 16.0 WASTE RECYCLING AND DISPOSAL

### 16.1 How to Decide to Dispose or Recycle Used Alcohol

All samples collected, including plankton and sediment samples, are fixed in formalin and later transferred to alcohol (except for samples stored for DNA purposes, which are fixed and stored in Non-Denatured Ethanol). All used formalin must be disposed and used alcohol can be recycled or disposed of after sample is no longer in need (depends on project and amount of storage time designated in contract; see project manager for length of contract before disposing of samples). Formalin is accumulated after transferring and alcohol is accumulated after sample disposal (plankton/sediment strained using mesh sieve and jars should be cleaned and reused if possible). To determine if alcohol should be disposed or recycled please read through the following bullet points:

- Formalin and alcohol waste must be placed in separate labeled containers and should not be combined in a single container.
- All formalin waste must be disposed (first transferred under the fume hood into a larger container), at Cold Canyon Landfill, following hazardous waste disposal protocols.
- Alcohol that is 70% or higher may be recycled (see ARS section). Alcohol with a lower percentage may be recycled if there is a substantially higher percentage alcohol that can also be recycled for an average of 70% (i.e. 60% alcohol may be mixed with 80% alcohol).
- All alcohol that is of a low percentage or unable to reuse must be disposed of following hazardous waste disposal protocols.
- Store hazardous waste in closed containers with proper labeling on the shelving below and to the left of the fume hood in the lab garage. See section 16.3 for proper labeling.

### 16.2 Alcohol Recycling System

Alcohol (denatured or non-denatured) can be recycled to make 70% alcohol for future sample preservation. Tenera has two Alcohol Recycling Systems (ARS), one to be used with denatured alcohol and the other for non-denatured alcohol. Each ARS is labeled and the appropriate ethanol should be recycled accordingly. If the ARS has not been used in several months it will need to be primed before using again.

#### 16.2.1 Priming the Alcohol Recycling System Procedures

- a. Make sure the handle in the pour spout is turned to the off position at the bottom of the ARS. Pour 1.5 – 2 gallons of 70% or higher alcohol through the opening at the

top of the cartridge. Do not overfill. The alcohol will work its way through the filters via gravity and into the bottom chamber of the ARS. It will take approximately 40-60 minutes to run through the cartridge. Empty the alcohol that has collected in the bottom into a large graduated cylinder and test the alcohol content using a hydrometer (see section 16.2.3 Proper Use of the Hydrometer). This alcohol will generally be too low of a percentage to keep and should therefore be disposed of into a properly labeled hazardous waste container.

- b. Repeat step #1 by running another 1.5-2 gallons of 70% or higher alcohol through the ARS. Using the hydrometer test the alcohol content. If the alcohol content is high enough, then save the alcohol in a labeled container (i.e. “Recycled 70% Denatured Alcohol”) and you are finished priming the ARS. If the alcohol content is still too low to be saved then dispose and repeat the process again until a desired alcohol percentage is reached. Once the ARS is primed it can be used for recycling alcohol and will not need to be primed again unless it has been unused for several months.

#### 16.2.2 Alcohol Recycling Procedures

- a. Use old samples (check with manager before recycling) and pour through a filter funnel into a large graduated cylinder (plankton samples generally have a higher alcohol content than benthic samples). Open the garage door and use a fan for good ventilation. Press sample with tweezers or something similar to remove all excess alcohol. Throw remaining sample waste and inner label into designated sample trash.
- b. Use a hydrometer to measure the used alcohol and decide whether to recycle or dispose. If the alcohol is less than 60-65% dispose of it using the following procedures in section 16.3. If alcohol is above 60-65% then pour into the top of the ARS container, making sure the down spout at the bottom of the container is in the off position. Do not overfill (it holds approximately 3.8 liters at a time).
- c. After the alcohol has ran through the ARS and into the bottom catchment (approximately 40-60 minutes) place the down spout into a large graduated cylinder and open the valve. Fill up the cylinder and place the hydrometer in the alcohol to test the percentage. Place the recycled alcohol into a carboy and add either higher percent recycled alcohol or lower percent recycled alcohol to achieve a 70% alcohol solution.
- d. To achieve the correct concentration use the following formula:

$$Y = \frac{(z-a)x}{(b-z)}$$

z= desired concentration (70%)

a= measured concentration (percent) of filtered alcohol  
x= height of fluid in container (mL)  
b= concentration (percent) of alcohol you are going to add (ex. 80%)  
y= amount of ethanol to add (mL)

- e. Update the chemical inventory data sheet in the Chemical Inventory folder under Lab Sort\_ID Tracking. Under the Recycled Alcohol tab insert the date and amount of alcohol added.

### 16.2.3 Proper use of the Hydrometer

The hydrometer is a device that allows the specific gravity or concentration of alcohol (water in alcohol) to be determined quickly and easily. The hydrometer is used to check the concentration of alcohol before and after using the ARS and when making new (clean) alcohol for fish/eggs/invert preservation.

- Make sure the hydrometer is clean before using. Liquids such as mineral oils and strong alcohols readily adhere to the stem. Weak aqueous solutions of sugar, salts, acids, and alcohol require scrupulous cleaning of the hydrometer stem. Thoroughly wash the hydrometer before/after using and dry with a clean lint-free cloth.
- If the alcohol to be tested is not at room temperature allow it to reach room temperature before testing. Stir the liquid to ensure it is of uniform temperature.
- The alcohol to be tested should not have any air bubbles for an accurate reading.
- Carefully insert the hydrometer into the alcohol, holding it at the top of the stem and release it when it is approximately at its position of equilibrium. Make sure the hydrometer is floating in the alcohol and not resting on the bottom of the container.
- Do not grip the stem, but allow it to rest slightly between finger and thumb. Excess liquid on the stem above the surface can affect the reading
- Note the approximate reading then push the hydrometer into the liquid a fraction of an inch beyond its equilibrium position. Don't overdo this because excess liquid above reading will give inaccurate reading. The hydrometer should rise steadily and after a few oscillations settle down to its position of equilibrium.
- If during these oscillations the meniscus is crinkled or dragged out of shape by motion of the hydrometer, this indicates that either the hydrometer or the surface of the liquid is not clean. Carefully clean the hydrometer stem. If the meniscus remains unchanged as the hydrometer rises and falls, then the hydrometer and liquid surface are clean, and a reading can be taken.



- The correct scale reading is that corresponding to the plane of intersection of the horizontal liquid (alcohol) surface and the stem. This is not the point where the surface of the liquid actually touches the hydrometer stem. Take the reading by viewing the scale through the liquid, and adjusting your line of sight until it is in the plane of the horizontal liquid surface. Do not take a reading if the hydrometer is touching the side of the container.

### 16.3 Disposal of old samples

Disposal of old samples must be done under the fume hood for formalin samples. Disposal of alcohol samples can be done on the counter. Open the garage door and turn on a fan for ventilation. Pour sample through filter funnel over waste container to catch waste alcohol/formalin. Press sample with spoon or something similar to remove all excess moisture and throw sample into designated sample trash. If formalin place in formalin waste container. If alcohol use hydrometer to measure the percent of alcohol content. Label container with the percent of alcohol.

In Lab sort/sample archive and disposal enter data for sample. Example below.

Billing Number	Survey Number	Sample #	Station	Cycle	Date of Disposal	Initials	# Jars
06180601	1	01	KB	1	5/5/2011	CWO	1
06180601	1	02	KA	1	5/5/2011	CWO	1

In project folder in Lab sort HECO for example change color to indicate it has been recycled.

Billing Number	Survey Number	Sample #	Station	Cycle
06180601	HECOEA01	01	KB	1
06180601	HECOEA01	02	KA	1
06180601	HECOEA01	03	W1	1
06180601	HECOEA01	09	KB	3
06180601	HECOEA01	10	KA	3
06180601	HECOEA01	11	W1	3
06180601	HECOEA01	12	H1	3
06180601	HECOEA01	15	W1	4
06180601	HECOEA01	16	H1	4

Tenera- A2
Storage-Clarion Ct.
Recycled
Tenera- UA2

### 16.4 Alcohol and Formalin Hazardous Waste Disposal at Cold Canyon Landfill

All alcohol and formalin waste can be properly disposed of at Cold Canyon Landfill, 2268 Carpenter Canyon Rd. (off Broad St.) San Luis Obispo, CA. Waste must be in a sealed and

properly labeled container. Carry spill kit (formalin/alcohol) and appropriate MSDS/SDS when transporting hazardous materials.

- Fill out and submit Conditionally Exempt Small Quantity Generator (CESQG) Waste Inventory and Certification Form online for Business with Hazardous Waste at SLO county IWMA website. Form with directions found at <http://www.iwma.com/business/hazardous-waste/>
- Wait for approval for permission to dump hazardous materials at landfill, given date and time to drop-off hazardous material will be on received copy of approval.
- All containers are disposable (will not be returned) and must contain proper Hazmat Labels, see Figure 16.4.1. Labels found at: Workfiles>Databases>Lab Sort\_ID Tracking>Lab Labels>Hazardous Waste Labels. Tape onto containers with clear packing tape; ignore EPA Waste No. and Manifest Document No.
  - Proper DOT Shipping Name/ Contents
  - Generator Info (Company name and address)
  - EPA ID Number (CAL000353031)
  - Accumulation Start Date
- No more than **26 gallons (98.42 L) total** hazardous chemicals (formaldehyde + Ethanol Waste) can be accumulated or disposed of within one month.
- Hazardous chemical waste may only be stored for 180 days (~6 months) from “accumulation start date”.
- Keep copy of approved CESQG Form and write down date and amt./type disposed on log in Hazardous Materials Waste folder, kept in file cabinet next to upstairs printers (see Figure 16.4.2)
- Electronically log date and amt./type hazardous material disposed on Waste Disposal Log, found at: Workfiles>Databases>Lab Sort\_ID Tracking>Chemical Inventory>Waste Disposal Tracking

Figure 16.4.1. Hazardous Waste Container Label

**HAZARDOUS  
WASTE**

**FEDERAL LAW PROHIBITS IMPROPER DISPOSAL  
IF FOUND, CONTACT THE NEAREST POLICE, OR  
PUBLIC SAFETY AUTHORITY, OR THE  
U.S. ENVIRONMENTAL PROTECTION AGENCY**

PROPER D.O.T.  
SHIPPING NAME \_\_\_\_\_ UN OR NA# \_\_\_\_\_

GENERATOR INFORMATION:  
NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

EPA ID NO \_\_\_\_\_ EPA WASTE NO. \_\_\_\_\_  
ACCUMULATION START DATE \_\_\_\_\_ MANIFEST DOCUMENT NO. \_\_\_\_\_

**HANDLE WITH CARE!  
CONTAINS HAZARDOUS OR TOXIC WASTES**





# ATTACHMENTS





## ATTACHMENT 10.1-A

### TITLE: SORTER'S EQUIPMENT LIST

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1. Dissecting microscope with light source and calibrated ocular micrometer
2. Sorting tray or petri dish
3. Squeeze bottle containing 100% ethanol (denatured)
4. Glass shell vials
5. Holder for shell vials
6. Jar containing target organisms to be identified
7. Cotton
8. Forceps
9. Waterproof labels
10. Dot labels
11. Data sheets
12. Identifier's log sheet
13. Taxonomic references





**ATTACHMENT 11.1-A**

**TITLE: TAXONOMIC EQUIPMENT LIST**

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14. Dissecting microscope with light source and calibrated ocular micrometer
15. Sorting tray or petri dish
16. Squeeze bottle containing 100% ethanol (denatured)
17. Glass shell vials
18. Holder for shell vials
19. Jar containing target organisms to be identified
20. Cotton
21. Forceps
22. Waterproof labels
23. Dot labels
24. Data sheets
25. Identifier's log sheet
26. Taxonomic references







## Appendix C Scientific Collecting Permit





State of California – Department of Fish and Wildlife

**SCIENTIFIC COLLECTING PERMIT, SPECIFIC USE – Permit**

DFW 1379S (NEW 09/01/17)

**Specific Use Permit Details:**

Specific Use Permit ID: **S-190090002-21305-001**

Reference Title: **Humboldt Bay Intake Entrainment Study**

**Principal Investigator (PI):**

Principal Investigator	PI Status	Approval Status	Conditions
SC-183620002: Gery R Cox	Active	Approved	

**Authorized Individuals (AI):**

Authorized Individual	Role	Approval Status	Conditions
SC-211320006: Hilanea K Wilkinson	Scientist	Approved	
SC-211310005: Brianna M Phillips	Scientist	Approved	
SC-183610007: Andrew C Harmer	Scientist	Approved	

**Approved Targeted Wildlife:**

**Inland Fisheries Wildlife:**

\*\*\*\*\*

**Marine Wildlife:**

Permitholder Initials: \_\_\_\_\_

Approved County	Approved Geographic Location	Approved Targeted Wildlife	Life Stage	Approved Quantity of Targeted Wildlife (Across all Locations)	Term of Take	Approved Method	Approved Procedure	Activity / Disposition	Approval Status	Conditions
Humboldt	Humboldt Bay	Unspecified Fish (Osteichthyes)	Larvae	Unlimited	Annually	Net, Plankton	Humanely Euthanize	Capture; Sacrifice	Approved with Conditions	See Marine Conditions 8-11
Humboldt	Humboldt Bay	Unspecified Fish (Osteichthyes)	Egg	Unlimited	Annually	Net, Plankton	Humanely Euthanize	Capture; Sacrifice	Approved with Conditions	See Marine Conditions 8-11

**Terrestrial Wildlife:**

\*\*\*\*\*

**Approved Non-Targeted Wildlife (Incidental by-catch)**

**Inland Fisheries Wildlife:**

\*\*\*\*\*

**Marine Wildlife:**

Approved Non-Targeted Wildlife	Approved Quantity of Non-Targeted Wildlife	Approval Status	Conditions
Zooplankton Plankton (Zooplankton)	Unlimited	Approved	
Unspecified Fish (Osteichthyes)	Unlimited	Approved with Conditions	See Marine Conditions 11

**Terrestrial Wildlife:**

\*\*\*\*\*

**Measures Minimizing Harm of Wildlife:**

Adult fishes incidentally captured will be released unharmed.

**Method Details:**

Permitholder Initials: \_\_\_\_\_

Taxonomic Group	Approved Methods	Details	Approval Status	Conditions
Marine	Net, Plankton	The sampling at each sampling location will involve towing a bongo frame that has two 0.71 m (2.3 ft) diameter openings. Each opening is equipped with a 335 µm mesh plankton net, codend (collection bucket) and calibrated flowmeter. The frame and nets will be lowered from the surface to a depth within approximately one meter (3.3 ft) from the seabed and towed back to the surface at a speed of between one and two knots. The nets will be lowered and raised until the target volumes for the samples is collected. The plankton nets will be towed until a target volume ranging from 80 to 100 m <sup>3</sup> (21,134–26,417 gal) seawater per net has been filtered. This target volume will be determined in the field by flowmeters attached to the nets. Prior to and after each tow, the flowmeter counter values will be recorded on sequenced waterproof datasheets to allow for calculation of the volume of water filtered by each net. At the completion of each tow, the frame and nets will be retrieved from the water and the collected material will be rinsed into the codends attached to the end of the nets. The contents of each net will be transferred into a single labeled jar and preserved in a 5–10% buffered formalin-seawater solution. Each survey will be conducted during one daytime cycle and one nighttime cycle to characterize potential diel variation.	Approved	

**Procedure Details:**

Taxonomic Group	Approved Procedures	Details	Approval Status	Conditions
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**Sacrifice of Wildlife Details:**

Taxonomic Group	Approved Wildlife to be Sacrificed	Approved Quantity	Approval Status	Conditions
Marine		Unlimited	Approved with Conditions	See Marine Condition 9

**Details:**

Since the number of larval fishes present in the water is unknown until after sample collection we cannot guess the number of fishes to be collected until after sample processing in the lab.

**Salvage of Wildlife Details:**

\*\*\*\*\*

**Details:**

\*\*\*\*\*

**Captivity of Wildlife Details:**

\*\*\*\*\*

Permitholder Initials: \_\_\_\_\_

**Details:**

\*\*\*\*\*

**Relocation of Wildlife Details:**

\*\*\*\*\*

**Details:**

\*\*\*\*\*

**Geographic Location Details:**

Taxonomic Group	Approved County	Approved Locations	Details	Approval Status	Conditions
Marine	Humboldt	Humboldt Bay	The two proposed intakes will be located at the Redwood Marine Terminal II Dock (RMT II) and the Red Tank Dock (RTD) which are located on the eastern shore of the Samoa Peninsula approximately 3.8 mi (6 km) from the entrance to the bay. The Samoa Peninsula is west of the City of Eureka in Humboldt County, California and east of the Pacific Ocean. The two intakes are located at the north end of the Main Channel where it starts to bifurcate around Tuluwat Island before opening into Arcata Bay. The distance between the two intake locations on the peninsula is approximately 0.5 mi (0.8 km). Sourcewater samples will be collected from other sites around the bay.	Approved	

**Disposition Locations:**

Name	Address	City	State	Zip Code	Details	Approval Status	Conditions
Tenera Environmental	141 Suburban Rd., Suite A2	San Luis Obispo	CA	93401		Approved	

**Additional Permit Conditions:**

All Standard Conditions for Scientific Collecting Permits: **SCP Standard Conditions**

Condition Title	Condition
Marine Condition 1. Notification of Field Work or Activity.	When collecting marine species anywhere in the state Student Permitholders, and Principal Investigators, or any Authorized Individual on an Entity or Individual permit shall notify the Department Law Enforcement offices and Department regional contacts at least 36 hours, but not more than 14 calendar days, prior to conducting permitted activity(ies) in the field, unless otherwise specified in the conditions of the permit, all fields on this form are required. Please complete the form found in Section 1a. (Notification of Field Work or Activities) in this permit within the SCP Portal at <a href="http://scpapp.wildlife.ca.gov">scpapp.wildlife.ca.gov</a>
Marine	Pursuant to Title 14 California Code of Regulations (CCR) subsection 650(p), this Mandatory Wildlife Report (MWR) is required to be filled out completely and submitted for any wildlife taken or possessed via a SCP issued by the Department. This report is due within 30 days following the expiration of this permit or when the applicant submits a renewal application, whichever comes first. Subsection 650(p) states: "Failure to submit required information or reports shall result in revocation of an existing permit and may result in denial of subsequent applications by that

Permitholder Initials: \_\_\_\_\_





State of California – Department of Fish and Wildlife

**SCIENTIFIC COLLECTING PERMIT, SPECIFIC USE – Permit**

DFW 1379S (NEW 09/01/17)

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**Permit**

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Specific Use Permit ID: **S-190090002-21305-001**

Reference Title: **Humboldt Bay Intake Entrainment Study**

Effective Date: **12/16/2021**

Expiration Date: **12/15/2024**

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**Permitholder**

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EID-190090002: Tenera Environmental

spengilley@tenera.com

141 Suburban Suite A2,

San Luis Obispo, California 93401

Preferred Phone Number: 805-541-0310

Alternate Phone Number: 805-550-6842

Permitholder Affiliation: Tenera Environmental

---

By signing this permit, the Permitholder agrees to the following:

*"I certify that I have read, understand, and agree to abide by the applicable provisions of the Fish and Game Code, and Title 14, Section 650, CCR, and will abide by all the conditions and attachments of the issued permit. I understand I am legally responsible for ensuring all persons working under this permit will be adequately supervised, and comply with the requirements noted above. I further understand that if I fail to provide required reports, my permit may be suspended or revoked pursuant to Title 14, Section 650, CCR, and the Fish and Game Code."*

Permitholder Signature: \_\_\_\_\_

Date: \_\_\_\_\_





## STANDARD CONDITIONS FOR ALL SCIENTIFIC COLLECTING PERMITS

Pursuant to California Fish and Game Code (FGC) Sections 1002, 1002.5 and 1003, and Title 14 California Code of Regulations (CCR), Section 650, the Permitholder is authorized to take and/or possess wildlife according to the authorizations, conditions and restrictions listed on the Scientific Collecting Permit (SCP or permit) issued by the California Department of Fish and Wildlife (Department). These Standard Conditions apply to all General and Specific Use level permits for all Permitholders, Authorized Individuals<sup>1</sup>, and any unnamed Field Assistants conducting activities under a SCP. The Department may revoke, suspend, or unilaterally amend or modify, or deny a permit for failure to comply with the authorizations, conditions or restrictions of the permit, or for other reasons listed in Title 14 CCR, subsection 650(s).

- A. **Possession of Identification.** Authorized Individuals named or covered on the List of Authorized Individuals shall carry in their possession a valid, government-issued photo identification card at all times when conducting any activity authorized by an SCP pursuant to Title 14 CCR, subsection 650(a)(2).
- B. **Permit Documents.** All Authorized Individuals shall carry in their possession a copy of the SCP, and all other required permit documents, pursuant to Title 14 CCR, subsection 650(a)(3).
- C. **Take and Possession Limits/ Allowances.** Permitholders shall always ensure strict compliance with limits and allowances granted by the permit. The limits described in the permit apply to the entire permit and are shared cumulative across the Permitholder and all Authorized Individuals.
- D. **Department Lands.** Prior to entering the following types of Department lands, or other managed areas, to conduct any permitted activities, the Permitholder shall first receive written authorization from the Regional Manager or their designee for the particular area, unless otherwise specifically conditioned in your SCP: Wildlife Area, Ecological Reserve (Title 14, Section 630 CCR, subsection 550(a)(4), and subsection 550(f)), Marine Managed Areas, and Marine Protected Areas (MPAs) (Title 14, CCR Section 632, and Public Resources Code 36602) (i.e., State Marine Reserve, State Marine Conservation Area, State Marine Park, State Marine Recreational Management Area), State Reserve, Marine Life Refuge (FGC Section 10500), Fish Refuge, Rockfish Conservation Area, or Cowcod Conservation Area (Title 14, Section 27.20 through 29.85, CCR).
- E. **Landowner Permission.** The Permitholder is responsible for obtaining permission from the owners and managers of all properties, whether public or private, prior to entering to conduct the activities authorized by the permit. It is the responsibility of the Permitholder to know the boundaries and managing authority of designated protected areas (e.g., State Parks, National Wildlife Refuges, National Parks, National Marine Sanctuaries, etc.).
- F. **Notification of Field Work or Activity.** The Student Permitholder, and the PI, or any Authorized Individual on an Entity and Individual permit, shall notify the Department at least 36 hours, but not more than 14 calendar days<sup>7</sup> prior to conducting permitted take and/or possession activity(ies) in the field, unless otherwise specified in the conditions of the permit. Additional requirements pursuant to Title 14 CCR, subsection 650(o) apply. The Permitholder shall complete all fields on the Notification of Field Work or Activity form (DFW 1379b) and electronically send the form to Law Enforcement Division contacts, Regional office(s), Regional Biologists, or other contacts, as specified in the permit conditions.
- G. **Reporting Requirements.** Permitholders shall carry the Mandatory Wildlife Report (MWR) form DFW 1379a, or required information fields, in a paper or electronic format while conducting activities pursuant to the permit, and shall record the information during, or upon completion of, each collecting event. Permitholders are required to submit the MWR form within 30 days following the expiration of the permit, or sooner if submitting an application to renew an SCP, whichever comes first, or as required by the Authorizations or conditions in the permit. The MWR is mandatory even if no wildlife was taken or possessed see form DFW 1379a instructions for specifics on how to complete the form).
- H. **California Endangered Species Act and Fully Protected Species.** No person shall intentionally take or possess any State-Threatened and or Endangered, or State-designated Candidate wildlife under the California Endangered Species Act, or any Fully Protected species, without a valid Memorandum of Understanding (MOU), permit, or other written authorization from the Department pursuant to Fish and Game Code Section 2050 *et seq.*, Title 14 CCR, subsections 670.7 and/or 786.9. If any Threatened, Endangered, Rare, or Candidate, or Fully Protected species are

<sup>1</sup>"Authorized Individual" means the Permitholder, the Principal Investigator, or any other person approved by the Department to independently conduct any permitted activity(ies) authorized by the permit, and who is named or covered on the permit's List of Authorized Individuals (LAI) (Title 14, CCR subsection 650(b)(2)).

Permitholder Initials: \_\_\_\_\_

Condition Title	Condition
Condition 2. Mandatory Wildlife Report.	Permitholder or may result in denial of future approval as an a Permitholder or Authorized Individual on other permits, pursuant to subsection 1002(m) of the Fish and Game Code." Please review the specific conditions of your permit to determine if you have any other reporting requirements (e.g., a written report or data), consistent with Title 14 CCR subsection 650(p)(A-F). When completing Form 1379a to report collections for this permit, please review all instructions and identify the species to the lowest taxonomic level and be specific as to what species and numbers were placed in captivity, sacrificed, caught and released, etc. Also, please separate what was caught in an MPA and what was caught outside of an MPA. Collection reports should be uploaded to the SCP Portal.
Marine Condition 3. Principal Investigator or Authorized Individuals must be present during the activities.	If you are the Principal Investigator, Permit Holder (Student Only), or are listed on this permit as an Authorized Individual and if you have any person(s) assisting with a scientific collecting project or activity, you are required to be present and overseeing the activities as described and must be in possession of a copy of your permit.
Marine Condition 4. Collecting in MPAs and other MMAs NOT AUTHORIZED.	NO COLLECTIONS may be made in any MARINE PROTECTED AREAS (MPA) or Marine Managed Area (MMA) without additional prior written permission from both the Department of Fish and Wildlife and the Reserve Manager. Protected areas include the following: California Rockfish Conservation Area, State Marine Reserve, State Marine Conservation Area, State Marine Park, State Reserve, Marine Life Refuge, Fish Refuge, Wildlife Area, State Game Refuge or Ecological Reserve.
Marine Condition 5. Responsibility to obtain other permits such as other federal or state permits.	Other Permits: This permit does not relieve the permittee of the responsibility to obtain any other permits, or comply with any other Federal, State or local laws or regulations. It is the responsibility of the permittee to know the boundaries and managing authority of State Parks, National Marine Sanctuaries, National Parks, or other specially designated protected areas. Department of Parks and Recreation: <a href="http://www.parks.ca.gov/">http://www.parks.ca.gov/</a> National Marine Sanctuaries: <a href="http://sanctuaries.noaa.gov">http://sanctuaries.noaa.gov</a> National Parks Service: <a href="http://www.nps.gov/">http://www.nps.gov/</a>
Marine Condition 6. Amendment required when making changes to SCP.	You are required to complete and submit an Amendment Request to the online SCP Application Portal when requesting a change to an existing Scientific Collecting Permit or if your affiliation changes. The online SCP application portal is found at: <a href="https://www.wildlife.ca.gov/Licensing/Scientific-Collecting">https://www.wildlife.ca.gov/Licensing/Scientific-Collecting</a> <b>YOU MAY NOT BEGIN ANY NEW COLLECTION ACTIVITY OTHER THAN WHAT IS APPROVED IN THIS PERMIT UNTIL YOU HAVE RECEIVED AN APPROVED, VALIDATED AMENDMENT.</b>
Marine Condition 7. Identification Banner Required.	All vessel-based research being conducted in marine waters shall prominently display the word "RESEARCH" on the vessel by means of flag, banner, sign, or some other method. The font should be a minimum of 14" and legible printed in a color that contrasts from the printed paper.
Marine Condition 8. Memorandum of Understanding Required.	Before you can begin this project, a CDFW issued memorandum of understanding (MOU) for listed species must be in hand. No sampling can occur under this permit without a MOU in place.
Marine Condition 9. Sample Preservation.	All samples collected during the months of January, February, March and April must be preserved in 95% Ethanol for genetic preservation of larvae Longfin Smelt. During all other sampling months, samples can be preserved in a formalin solution.
Marine Condition 10. Reporting Requirements.	All samples shall be processed and reported to the Department within four weeks of collection, prior to the next sampling event. The Permittee shall report the number of Longfin Smelt larvae caught, date, size, time of day, and location for each individual caught. The report shall also contain specific information about all other species observed.
Marine Condition 11. Capture of Listed Species.	The Permittee shall notify the Department within 24 hours if any adult or juvenile Longfin Smelt or Coho Salmon are caught during sampling.

Permitholder Initials: \_\_\_\_\_





taken inadvertently or incidentally (e.g., by-catch) as a result of activities authorized by an SCP, then any such wildlife shall be immediately released alive and unharmed at the site of capture without further handling, unless otherwise authorized by the Department. You shall follow additional Department notification and reporting requirements for any incidental capture, injuries and mortalities of these species, as outlined in your SCP conditions, and you may be required to temporarily cease field activities and obtain a MOU.

- I. **California Natural Diversity Database (CNDDDB).** Data collected during SCP activities for species on the Special Animals and the Special Plants, Bryophytes and Lichens lists (<https://www.wildlife.ca.gov/Data/CNDDDB/Plants-and-Animals>) should be submitted directly to the CNDDDB. Data may include field observations of wildlife listed as Threatened, Endangered, or Candidate under the California Endangered Species Act, Fully Protected species, California Species of Special Concern, or other special animals and plants. Please see the CNDDDB webpage for information on appropriate submission methods (<https://www.wildlife.ca.gov/Data/CNDDDB>). The preferred method of data submission for individual observations is the CNDDDB Online Field Survey Form. The CNDDDB accepts data in a range of other formats- see submission guidelines for alternatives and guidance for larger digital datasets.
- J. **Fishing, Hunting, and Falconry.** Sport or commercial fishing, hunting, falconry, trapping, and/or take activities authorized by another Department permit shall not occur on the same trips or time periods as scientific activities, unless otherwise authorized by this SCP.
- K. **Commercial or Personal Use.** The commercial sales, trade, or barter of wildlife taken under a SCP is prohibited, pursuant to Title 14 CCR, subsection 650(a)(5). Personal or human consumption of wildlife taken under an SCP is prohibited, unless specifically allowed by conditions of the permit.
- L. **Other Laws and Permits.** The SCP does not relieve the Permitholder or any Authorized Individual of the responsibility to comply with any other federal, tribal, state, or local law or regulation. The SCP does not relieve the Permitholder or any Authorized Individual of the responsibility to obtain any other tribal, federal, tribal, state, or local permits that may be required. This SCP is invalid unless accompanied by any other required permits for the authorized activities.
- M. **Labeling of Vessels, Vehicles, and Capture Equipment.** All traps, nets, and other capture or research equipment shall be marked with a tag or label that legibly shows the Permitholder's Identification Number (SC-ID) and/or other permit ID, as well as the word "Research," or as otherwise outlined in permit conditions, before placing the equipment in the field. Labeling of vessels is mandatory for MPAs, and labeling of other vessels, vehicles, or aircraft may be required at the Department's discretion, as outlined in your permit conditions.
- N. **Transfer of Possession.** Persons or entities receiving accidentally killed or legally acquired dead wildlife and/or parts thereof possessed pursuant to Title 14 CCR, Section 650 may be named as recipients of those wildlife on the permit itself. A completed Chain of Custody form (DFW 1379c) documenting the transfer(s) of live or dead wildlife and/or parts thereof shall accompany wildlife at all times, including during transport. Live wildlife may only be possessed with a valid permit issued by the Department. Subsequent transfers of such dead wildlife and/or parts thereof to another recipient shall also be documented and accompanied by form DFW 1379c. Reporting of such transfers via DFW 1379c shall occur as specified in the original Permitholder's permit conditions as the donor, as required form DFW 1379c for reporting by a subsequent recipient acting as a donor, or as otherwise stated by Title 14 CCR, subsection 650(p).
- O. **Release of Wildlife.** Unless otherwise authorized by the Department, all captured wildlife shall be immediately released at or near the site of capture after the permitted activity. Any wildlife authorized to be removed from the wild shall not be returned to the wild without prior written permission from the Department.
- P. **Compliance Inspection.** At the discretion of the Department, a Department wildlife officer or other Department employee may accompany persons during any permitted activity(ies) authorized by this SCP. The Permitholder shall, at all reasonable hours, allow a Department representative to enter and inspect the designated storage facility(s) and premises where live, or dead wildlife, and/or parts thereof are stored, and shall allow such Department representative to inspect reports and/or records, and the wildlife in possession.

Permitholder Initials: \_\_\_\_\_





# Appendix D CDFW Memorandum of Understanding (MOU)





State of California – Natural Resources Agency  
DEPARTMENT OF FISH AND WILDLIFE  
Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[www.wildlife.ca.gov](http://www.wildlife.ca.gov)

*GAVIN NEWSOM, Governor*  
*CHARLTON H. BONHAM, Director*



January 3, 2022

Gery Cox  
Tenera Environmental  
141 Suburban Suite A2  
San Luis Obispo, CA 93401  
[gcox@tenera.com](mailto:gcox@tenera.com)

Dear Mr. Cox:

**SECTION 2081(A) TAKE PERMIT FOR THE HUMBOLDT BAY INTAKE  
ENTRAINMENT STUDY**

Enclosed you will find an electronic copy of the Section 2081(a) Memorandum of Understanding for the above referenced Project, which has been digitally signed by the Department. Please read the permit carefully, sign the acknowledgement, and return the original no later than 30 days from Department signature. You may return a hard copy of the permit via mail to:

Corianna Flannery  
619 2<sup>nd</sup> Street  
Eureka, CA 95501

Alternatively, you may return an electronic copy of the permit with digital signature to [Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov). Digital signatures shall comply with Government Code section 16.5.

You are advised to keep the original signature permit in a secure location and distribute copies to appropriate project staff responsible for ensuring compliance with the conditions of approval of the permit. Note that you are required to comply with certain conditions of approval prior to initiation of subject activities. Additionally, a copy of the permit must be maintained in the field and made available for inspection by CDFW staff when requested.

**The permit will not take effect until the MOU is signed by both parties.** If you wish to discuss these instructions or have questions regarding the permit, please contact Corianna Flannery, Environmental Scientist, at (707) 499-0354.

Sincerely,

A handwritten signature in black ink, appearing to read "Craig Shuman".

Craig Shuman D. Env  
Regional Manager  
Marine Region

Gery Cox  
Tenera Environmental  
January 3, 2022  
Page 2

ec: Becky Ota, Environmental Program Manager  
Department of Fish and Wildlife  
[Becky.Ota@wildlife.ca.gov](mailto:Becky.Ota@wildlife.ca.gov)

Eric Wilkins, Senior Environmental Scientist Supervisor  
Department of Fish and Wildlife  
[Eric.Wilkins@wildlife.ca.gov](mailto:Eric.Wilkins@wildlife.ca.gov)

Corianna Flannery, Environmental Scientist  
Department of Fish and Wildlife  
[Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov)



## DEPARTMENT OF FISH AND WILDLIFE

Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[www.wildlife.ca.gov](http://www.wildlife.ca.gov)



**Expiration Date: January 31, 2023**

## **MEMORANDUM OF UNDERSTANDING REGARDING TAKE OF LONGFIN SMELT AND COHO SALMON UNDER THE CALIFORNIA ENDANGERED SPECIES ACT**

This Memorandum of Understanding (MOU) pursuant to Fish and Game Code section 2081, subdivision (a) is made and entered into by and between Gery Cox, Hilanea Wilkinson, Brianna Phillips, and Andrew Harmer of Tenera Environmental and the California Department of Fish and Wildlife (CDFW). The purpose of this MOU is to lawfully authorize incidental take (as defined by Fish & Game Code, §86) of Longfin Smelt (*Spirinchus thaleichthys*) and Coho Salmon (*Oncorhynchus kisutch*), for scientific purposes pursuant to the California Endangered Species Act (CESA; Fish & Game Code, §2050 et. Seq.; Calif. Code Regs. tit. 14, §28.06).

The California Fish and Game Commission listed Longfin Smelt as threatened on April 9, 2010 and Coho Salmon as endangered (populations south of Punta Gorda) and threatened (populations north of Punta Gorda to the Oregon border) on March 30, 2005, pursuant to CESA. These species are the "Covered Species" for the purposes of this MOU. These listings include individuals located in waters where the Permittees will collect samples while sampling in waters of Humboldt Bay and nearby offshore waters.

CESA prohibits the take of any species of wildlife designated by the Commission as an endangered, threatened or candidate species. Fish and Game Code section 86 defines take as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." Fish and Game Code section 2081, subdivision (a) allows CDFW to authorize take and possession of endangered, threatened, and candidate species for scientific, educational or management purposes.

This MOU authorizes the Permittees to possess adult, juvenile, and larval Longfin Smelt and Coho Salmon for scientific purposes pursuant to Fish and Game Code, section 2081, subdivision (a). For purposes of this MOU, Gery Cox of Tenera Consulting is the Principal Permittee.

CDFW encourages research by qualified investigators that may enhance the conservation and management of candidate, threatened or endangered species. The Permittees must possess a valid CDFW-administered Scientific Collecting Permit. The Permittees propose to conduct sampling within Humboldt Bay to assess potential entrainment of listed species from two proposed water intakes. As Longfin Smelt and Coho Salmon may be taken during these activities, the Permittees have requested an MOU to possess these species during the sampling activities.

Gery Cox  
 Tenera Environmental  
 January 3, 2022  
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## Methods

CDFW agrees with the methods in the corresponding Scientific Collecting Permit. Samples will be collected at both intake locations to characterize entrainment and six source water stations located throughout the Bay. The sampling at each sampling location will involve towing a bongo frame that has two 0.71 m (2.3 ft) diameter openings. Each opening is equipped with a 335 µm mesh plankton net, cod end (collection bucket) and calibrated flowmeter. The frame and nets will be lowered from the surface to a depth within approximately one meter (3.3 ft) from the seabed and towed back to the surface at a speed of between one and two knots. The plankton nets will be towed until a target water volume ranging from 10,567-13,209 gallons of seawater per net has been filtered. This target volume will be determined in the field by flowmeters attached to the nets. At the completion of each tow, the frame and nets will be retrieved from the water and the collected material will be rinsed into the cod end attached to the end of the nets. The contents of each net will be transferred into a single labeled jar and preserved in either a 5–10% buffered formalin-seawater solution or 95% Ethanol. Each survey will be conducted during one daytime cycle and one nighttime cycle to characterize potential diel variation. There will be a total of 16 samples per survey (192 total samples for the project).

## Sampling Locations, Methods and Dates

Sampling Location	Sampling Gear	Sampling Schedule
Humboldt Bay	Ichthyoplankton Net Tows	Year Round (monthly)

## Authorized Take Level of Longfin Smelt (*Spirinchus thaleichthys*)

Requested Take Activity	Developmental Stage	Total Capture	Expected Direct Mortality	Unintentional Mortality
Ichthyoplankton Net Tows	Adult (>85 mm FL)	1	0	1
Ichthyoplankton Net Tows	Juvenile (>20- <84 mm FL)	20	20	0
Ichthyoplankton Net Tows	Larval (<20 mm FL)	100	100	0

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 Tenera Environmental  
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### Authorized Take Level of Coho Salmon (*Oncorhynchus kisutch*)

Requested Take Activity	Developmental Stage	Total Capture	Expected Direct Mortality	Unintentional Mortality
<i>Ichthyoplankton Net Tows</i>	Juvenile	1	0	1

The total capture and expected direct mortality are cumulative through the duration of the permit. If either the total catch or direct mortality are met or exceeded, the Permittee **must immediately suspend operation** and notify the MOU contact, identified below, as soon as possible but no later than one calendar day. After either total or direct mortality take level is exceeded, the applicant may resume operation only upon written approval of the Marine Region Regional Manager, or his designee.

### Specific Conditions

The following provisions shall apply in addition to Federal Endangered Species Act 4(d) Rule and CDFW's Scientific Collecting Permit requirements:

- 1) Authorized methods of take are limited to ichthyoplankton net tows as identified in the corresponding Scientific Collecting Permit.
- 2) Juvenile and adult Longfin Smelt and Coho Salmon shall be handled with extreme care and kept in cool aerated water to the maximum extent possible during sampling and processing procedures. Adequate circulation and replenishment of water in holding units are required. The transfer of both species shall be conducted using a sanctuary net that holds water during the transfer to prevent the added stress of an out-of-water transfer. When using gear that captures a mix of species, listed species shall be processed first and released as soon as possible to minimize the duration of handling stress.
- 3) No intentional lethal take of adult Longfin Smelt or Coho Salmon is authorized. A thorough effort should be made to identify all juvenile and adult true smelt (Osmerids) collected while in the field. Any unidentified juvenile or adult Osmerids that perish in the field shall be preserved for later identification. The Principal Investigator is responsible for ensuring that all preserved Osmerids are enumerated, identified to species, and measured. All identified juvenile and adult Longfin Smelt should be transferred to 95% Ethanol and labeled with all pertinent sample data (i.e., project, date, time, location, length, water temperature, etc.) and sent directly to the CDFW MOU contact listed below.
- 4) All samples collected during the months of January, February, March, and April must be preserved in 95% Ethanol for genetic preservation of larvae Longfin



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Smelt. During all other sampling months, samples can be preserved in a formalin solution.

- 5) All juvenile and adult fish that are incidentally captured during ichthyoplankton net tows shall be released underwater while the vessel is stationary. Releasing fish from a vessel underway shall only be conducted when trying to avoid predation on listed species by piscivorous birds and/or marine mammals.
- 6) Western River Lamprey, *Lampetra ayresi*, are considered a Species of Special Concern within the state of California. If Western River Lamprey are captured, the Permittee shall report the encounter to CDFW on each day individual fish are captured. The daily report shall include the approximate location of the capture, tidal stage, time of day, fish length, and sex if possible.

### **General Conditions**

- 1) Each Permittee, operating under the authority of this MOU, is responsible for the actions of non-permitted individuals assisting them while conducting sampling activities.
- 2) During fish handling/sampling using the Authorized Gear, at least one of the Permittees must be on site.
- 3) A copy of this permit will be in possession of the Permittees when the permitted activity is undertaken.
- 4) The provisions of this permit may be amended by CDFW with reasonable notice to the Permittees.
- 5) This permit may be revoked if there is failure to follow activities and conditions in this MOU.

### **Reporting**

- 1) On days in which adult or juvenile Covered Species or Species of Special Concern are collected, a daily report shall be submitted to the CDFW MOU contact information below outlining the species collected and any other relevant environmental conditions encountered at the time of collection.
- 2) All samples shall be processed and reported to the Department within four weeks of collection, prior to the next sampling event. The Permittee shall report the number of Longfin Smelt larvae caught, date, size, time of day, and location for each individual caught. The report shall also contain specific information about all other species observed including the number of unidentified Osmerids awaiting DNA analysis.

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- 3) The results of the unidentified Osmerid DNA analysis and final quality control checks shall be reported as soon as possible in order to maintain an accurate total of the number of covered species captured.
- 4) An annual summary report shall be submitted to CDFW. The report shall include a summary of all species captured and contain specific information on the number of Longfin Smelt and Coho Salmon caught during the research surveys and collections. The annual summary report shall contain the following specific information: type of Covered Species caught, number of Covered Species caught, date, size, time of day, and location for each individual covered species caught. The report shall also include a description of the general health of each Covered Species when released. These reports shall be due to the CDFW MOU contact listed below within 30 calendar days of the expiration date of this CESA MOU.

Failure to submit the information outlined above may be cause for immediate revocation of this MOU, preclude renewal of this MOU, or may impact the eligibility of responsible parties to renew or secure subsequent California Scientific Collecting Permits or CESA MOUs.

### **Responsible Parties**

All terms, conditions, and obligations of this MOU shall be binding upon each of the Permittees listed. Notwithstanding California Civil Code section 1431 or any other provision of law, each Permittee is jointly and severally liable for performance of all terms, conditions, and obligations of this MOU. Any failure by one or more Permittees to comply with any term, condition, or obligation set forth in this MOU shall be deemed a failure to comply by all Permittees.

### **MOU Contacts**

Principal Permittee:

Gery Cox  
Tenera Environmental  
141 Suburban Suite A2  
San Luis Obispo, CA 93401  
805-541-0310  
[gcox@tenera.com](mailto:gcox@tenera.com)

CDFW MOU Contact:

Corianna Flannery  
California Department of Fish and Wildlife, Marine Region  
619 2<sup>nd</sup> Street  
Eureka, CA 95501  
(707) 499-0354  
[Corianna.Flannery@wildlife.ca.gov](mailto:Corianna.Flannery@wildlife.ca.gov)

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Tenera Environmental  
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**Effective Date and Termination**

This MOU shall commence on the date of execution and, unless amended, will terminate on January 31, 2023.

If there are substantial changes in conditions, including changes in study methodology, changes in study location or changes in conditions that may affect other fish and wildlife resources, CDFW may, at its discretion, amend or terminate this MOU.

**Amendments**

Amendments to this MOU, including renewals, may be proposed by either party and shall become effective when both parties sign a written modification to this document.

**Disclaimer**

CDFW shall incur no fiscal obligation under this MOU.

THE PARTIES HAVE EXECUTED THIS MOU TO BE IN EFFECT AS OF THE DATE LAST WRITTEN BELOW.


**Department of Fish and Wildlife**

  
\_\_\_\_\_

Date: 1/3/2022

Craig Shuman, D. Env.  
Regional Manager, Marine Region  
1933 Cliff Drive, Suite 9  
Santa Barbara, CA 93109  
[Craig.Shuman@wildlife.ca.gov](mailto:Craig.Shuman@wildlife.ca.gov)

**Principal Permittee**

DocuSigned by:  
  
5775D602A9854DB  
\_\_\_\_\_

Date: 1/3/2022

Gery Cox  
Tenera Environmental  
141 Suburban Suite A2  
San Luis Obispo, CA 93401  
805-541-0310  
[gcox@tenera.com](mailto:gcox@tenera.com)

## **Attachment H**

**SHN and Tenera Environmental (7/18/22).  
Humboldt Bay Water Intakes and Tidal Dynamics.**



## Technical Memorandum

Reference: SHN 016240.005  
Date: July 18, 2022  
To: Rob Holmlund, Development Director, HBHRCD  
From: Chuck Swanson (SHN) and John Steinbeck (Tenera Environmental)  
Subject: **Humboldt Bay Water Intakes**

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The purpose of this memorandum is to clarify the tidal dynamics of Humboldt Bay as it relates to the proposed Humboldt Bay Master Baywater Intake System, including an evaluation of volumes withdrawn by the system relative to the volumes of water exchanged due to natural tidal processes. This evaluation provides context and perspective when considering potential impacts to bioproductivity resulting from the proposed intake system. This memorandum has been prepared through collaboration between John Steinbeck of Tenera Environmental, Chuck Swanson of SHN, and Rob Holmlund of the Humboldt Bay Harbor, Recreation, and Conservation District (HBHRCD). Part 1 was prepared by all three parties. Part 2 was prepared by John Steinbeck. Part 3 was prepared by Rob Holmlund.

### Part 1: Tidal Dynamics Relative to Proposed Intake System

#### Setting and Terminology

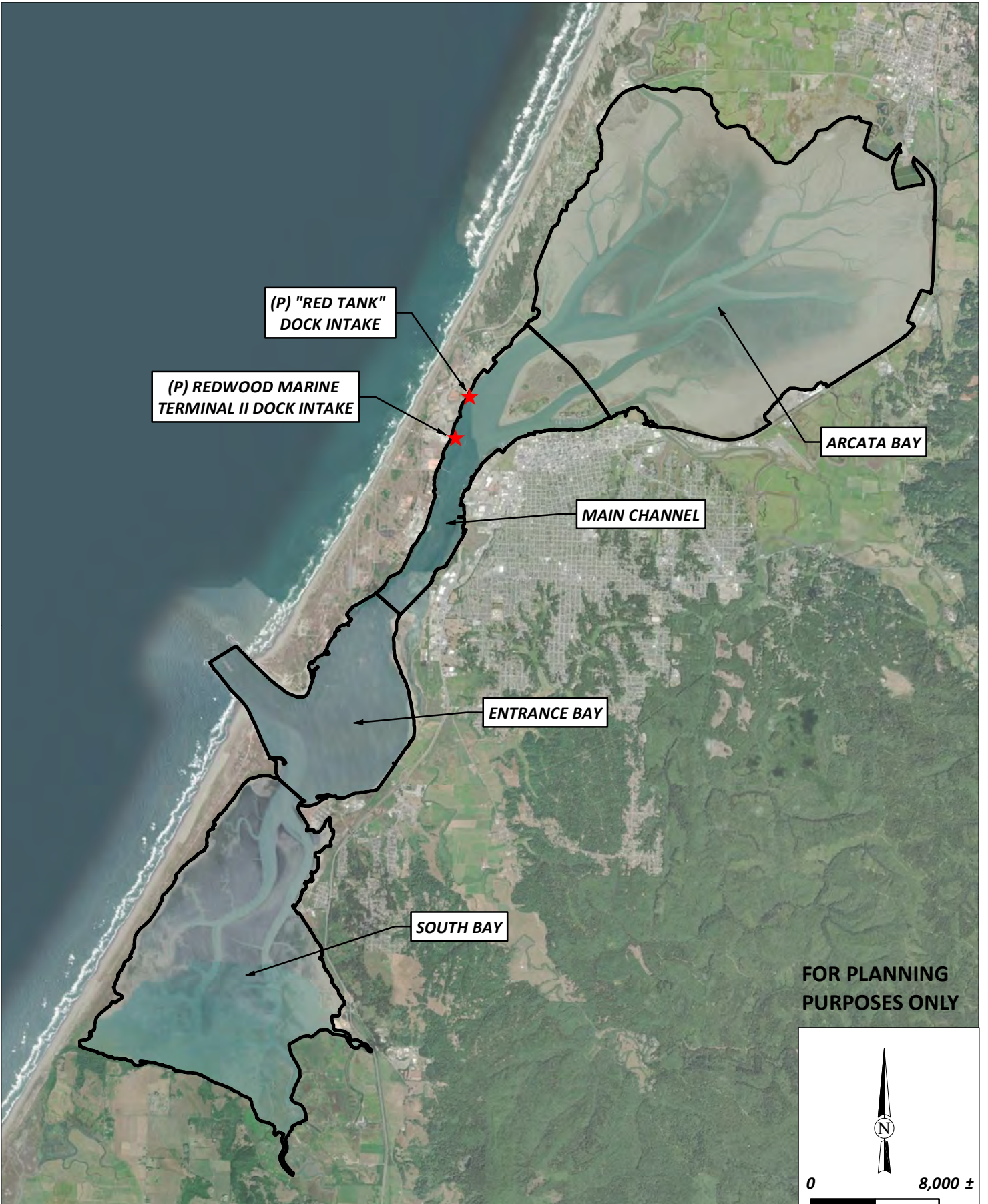
Evaluating the potential impacts of withdrawing water from Humboldt Bay (HBay) on productivity within HBay requires an understanding of the volume of water within HBay and the general tidal dynamics of the portions of HBay with direct tidal influence on the area of the proposed intakes. The intakes will be located along the Main Channel between the Entrance Channel and Arcata Bay (see Figure 1). For the purposes of this discussion, South Bay is excluded to focus on the volumes of water directly connected to the intakes on a daily basis. For a general overview of the volumes of water in all four sub-areas of HBay, see Attachment 1.

The following provides definitions of key terms that are needed to understand the volumes of water in HBay:

- **Mean Sea Level (MSL):** The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.
- **Mean Low Water (MLW):** The average of all low water heights observed over the National Tidal Datum Epoch.
- **Mean High Water (MHW):** The average of all high water heights observed over the National Tidal Datum Epoch.
- **Tidal Prism (TP):** The difference between Mean Low Water and Mean High Water. This can also be stated as the average total volume of water that enters or leaves HBay during each complete tidal cycle. A complete high-to-low tidal cycle is completed in 12 hours and 25 minutes. The two complete tidal cycles are completed in 24 hours and 50 minutes, which is referred to as the lunar day. As a result, there are 1.93 complete tidal cycles each day. This is because the Earth takes 24 hours to complete one rotation on its axis, while the time it takes for the Earth to reach the same position in relation to the Moon is on average 24 hours and 50 minutes, the time needed to complete two complete tidal cycles. Therefore, the average number of complete tidal cycles each 24 hour-day is 1.93.
- **Source Water (SW):** There are approximately 1.93 full tide cycles on an average day such that the average volume of water exchanged from the ocean is approximately 1.93 times the TP. The average volume of the source water subject to tidal forces for an embayment like HBay is typically defined as the volume at MLW + 1.93 times the TP. Since entrainment is continually occurring through the day and tidal cycle, the maximum source water potentially subject to entrainment each day is the volume at MSL + 1.93 times the TP. However, for the purposes of evaluating potential impacts to individual tidal cycle flows and volumes, the former definition using MLW is used herein.

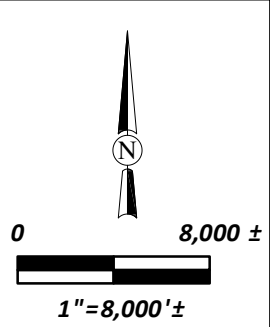


Path: \\Eureka\Projects\2016\016240-Engr-HBHRCD\005-Intake-Screen\GIS\PROJ\_MXD\BayIntake\_BayCompartments.mxd User Name: cswanson DATE: 7/11/22, 1:39PM



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FOR PLANNING PURPOSES ONLY



HBHRCD  
Humboldt Bay Intake Screens  
Samoa, California

Humboldt Bay Compartments  
SHN 016240.005

July 2022

BayIntake\_BayCompartments

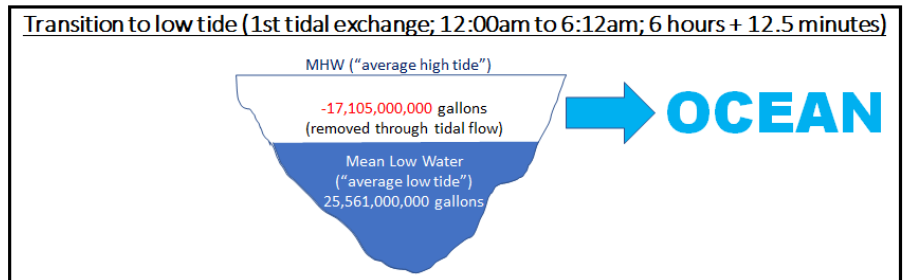
Figure 1



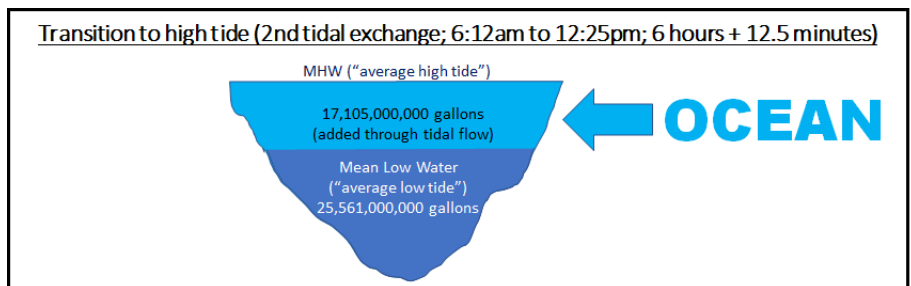
**General Tidal Dynamics in a 24-hour Period**

The following provides a generalized step-by-step description of the semi-diurnal tidal dynamics of HBay by visualizing an idealized 24-hour period assuming that the two high tides each day are equal to the levels at MHW, and the two low tides are equal to the levels at MLW:

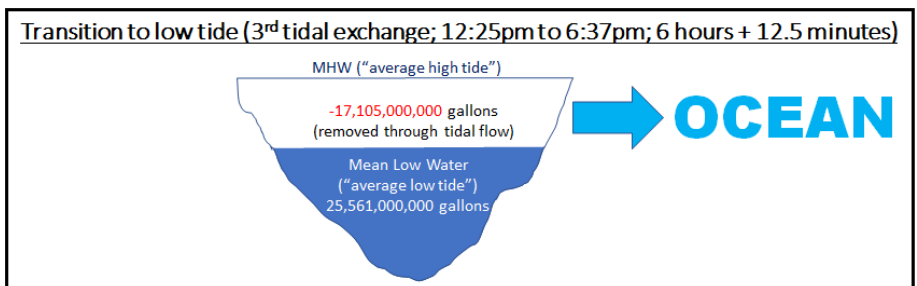
Assume that HBay is exactly at high tide (MHW) at the very beginning of a 24-hour period (12:00am). At that point, the bay contains nearly 43 billion gallons of water. Over the course of the following 6 hours and 12.5 minutes, over 17 billion gallons of water leave the bay out the entrance channel and into the ocean, such that the bay reaches low tide (MLW) at 6:12am. At that point, the bay contains over 25 billion gallons of water, or just under 60% of the amount of water it contained at high tide.



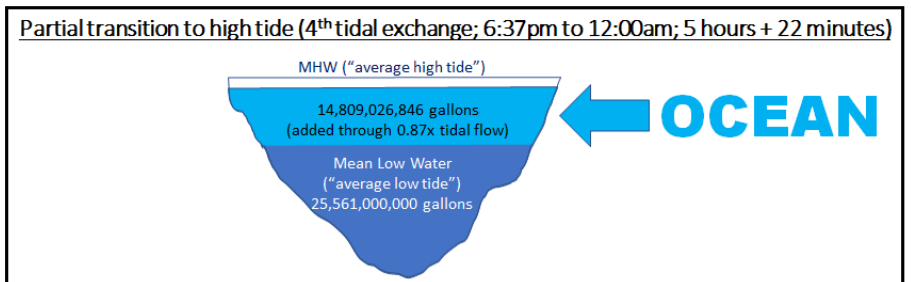
At 6:12am, the bay reaches low tide (MLW) and the process reverses. Over the course of the following 6 hours and 12.5 minutes, over 17 billion gallons enters the bay from the ocean. By 12:25pm, the bay reaches high tide (MHW) and once again contains nearly 43 billion gallons of water. At that point, the bay contains 167% of the water it contained at low tide.



At 12:25pm, the bay reaches high tide (MHW) and the process reverses again. Over the course of the following 6 hours and 12.5 minutes, over 17 billion gallons once again leaves the bay into the ocean. By 6:37pm, the bay has reached low tide (MLW).



At 6:37pm, the bay reaches low tide (MLW) and the process reverses one last time for the day. At this point, there are only 5 hours and 22 minutes remaining in the hypothetical 24-hour period, which is not enough time to complete another full tidal exchange.



Instead, only 87% of this low-tide-to-high-tide cycle is completed by 12:00am, meaning that over 14.8 billion gallons enters the bay from the ocean (instead of the 17 billion gallons that occurs in a full tidal cycle).

**Humboldt Bay Water Intakes**

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As shown in the scenario above, less than two complete tidal cycles occur each 24-hour period. In other words, on a long-term average, approximately 1.93 times the tidal prism is exchanged in a single day. Also, since each tidal cycle starts at one end of the tide (such as low tide) and ends at the other end of the tide (such as high tide), the average amount of water in HBay during an average tide cycle is approximately equivalent to Mean Sea Level (MSL). Thus, the total “source water” subject to entrainment in HBay is calculated as the Mean Sea Level (MSL) + 1.93 times the tidal prism. This is all summarized below in Table 1.

**Table 1. Volumes of Humboldt Bay (minus South Bay) at different tidal levels.**

Tidal Datum	Arcata Bay	Main Channel	Entrance Channel	Total
	Volume (million gallons)			
Mean Low Water (MLW)	5,733	8,483	11,346	25,561
Mean Sea Level (MSL)	10,179	9,489	12,984	32,652
Mean High Water (MHW)	17,684	10,570	14,413	42,667
Tidal Prism (TP) (MHW-MLW)	11,951	2,087	3,067	17,106
<b>Total Source Water Volume (MSL+(1.93*[Tidal Prism]))</b>	NA	NA	NA	65,665

**Volumes of Proposed Intake System Withdrawal Relative to MSL Source Water Volume**

The HBHRCD proposes to upgrade an existing bay water intake system as outlined in Table 1 below.

**Table 2. Intake flow rates for the three phases of operation and daily percentages of the source water (SW).**

Phases of Intake Operation	Gallons per Minute (GPM)	Maximum Daily Intake (million gallons)	Daily Percentage of Total SW (as defined above)
Phase I	694	0.99936	0.0015%
Phase II	1,250	1.8	0.0027%
Phase III	8,250	11.88	0.0181%

So, the relative volumes of source water to bay water intake system are:

65,665 million gallons (source water; Table 1)

11.88 million gallons (maximum daily intake; Table 2)

This means that the maximum volume of intake water is 0.0181% or 1/5525<sup>th</sup> of the total source water volume shown in Table 1 assuming a base volume in the bay at MSL.

**Step-by-Step Tide Cycle Discussion**

The description in the preceding section focuses on a more long-term average approach to evaluating tide volumes relative to intake volumes for the purpose of estimating the most conservative amount of source water that may be impacted by the intakes. This does not account for the step-by-step individual tide cycle

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dynamics throughout a 24-hour period. The following discussion walks through an idealized 24-hour period, including individual tide cycles relative to intake volumes during each individual tide cycle. Because this discussion focuses on a shorter time-period (24 hours), the base volume in HBay is understood to be the MLW volume as compared with the previous definition which uses the MSL volume. The reason for this is to consider more realistic potential hydraulic impacts resulting from the intakes which, to be more conservative, uses the lower base volume at MLW.

As the bay transitions from low tide to high tide, approximately 17,105 million gallons of water enter the bay over the course of 6.21 hours. However, in that same amount of time, the intake system withdraws 3.0492 million gallons of baywater, leaving an approximately 3.049 million gallon “gap” in the total tidal system. Due to the dynamics of tidal flow and gravity, the bay will not be 3 million gallons “emptier” than it otherwise would have been. Instead, an equivalent amount of “makeup water” from the ocean will flow into the bay to cover the loss. Thus, the amount of water entering the bay during the transition from low tide to high tide would be 17 billion gallons (TP) plus 3.049 million gallons (makeup water).

The scenario is the opposite on an outgoing tide. As the bay transitions from high tide to low tide, approximately 17,105 million gallons of water would normally leave the bay over the course of 6.21 hours. However, in that same amount of time, the intake system withdraws 3.0492 million gallons of baywater, which reduces the amount of water that would leave the bay by approximately 3 million gallons. Due to the dynamics of tidal flow and gravity, the bay will not be 3 million gallons “emptier” than it otherwise would have been. Instead, the amount of water leaving the bay (i.e. entering the ocean) will be slightly less than it otherwise would have been because a small amount of water is withdrawn via the intake. For the purposes of this analysis, this is called the “retention water.” Thus, the amount of water leaving the bay during the transition from high tide to low tide would be 17,105 million gallons (TP) minus 3.049 million gallons (retention water). Underlying both transitions (low tide to high tide and vice versa) is the baseline amount of water in the bay (MLW) of approximately 25,561 million gallons. This is all summarized in Table 3.<sup>1</sup>

**Table 3. Intake flow rates for the three phases of operation and daily percentages of the source water (SW).**

TIDAL EVENT	A ACTIVITIES OCCURRING DURING INCOMING TIDES (in millions of gallons)				B ACTIVITIES OCCURRING DURING OUTGOING TIDES (in millions of gallons)			C TOTAL GALLONS OF WATER WITHDRAWN (A.2 + B.2) (millions)	D BASELINE GALLONS OF WATER IN H BAY (MLW) (millions)	E SOURCE WATER DURING TIDAL EVENT (A.4 + D) (millions)	WATER WITHDRAWN RELATIVE TO SOURCE WATER		
	A.1: GALLONS OF WATER THAT WOULD NORMALLY FLOW FROM OCEAN TO BAY	A.2: BAYWATER SYSTEM WITHDRAW DURING INCOMING TIDE	A.3: MAKEUP WATER (WATER FLOWING FROM OCEAN TO BAY TO MAKE UP FOR WITHDRAWN WATER) (A.1 minus A.2)	A.4: ACTUAL GALLONS OF WATER THAT FLOWS FROM OCEAN TO BAY	B.1: GALLONS OF WATER THAT WOULD NORMALLY FLOW FROM BAY TO OCEAN	B.2: BAYWATER SYSTEM WITHDRAW DURING OUTGOING TIDE ("RETENTION")	B.3: ACTUAL GALLONS OF WATER THAT FLOWS FROM BAY TO OCEAN (B.1 minus B.2)				Fraction	Percent	Ratio (1 to #)
MHW to MLW (TP)	0	0.000	0.000	0	(17,105)	(3.073)	(17,102)	(3.073)	25,561	25,561	0.000120	0.0120%	8,318
MLW to MHW (TP)	17,105	(3.073)	3.073	17,108	0	0.000	0	(3.073)		42,669	0.000072	0.0072%	13,885
MHW to MLW (TP)	0	0.000	0.000	0	(17,105)	(3.073)	(17,102)	(3.073)		25,561	0.000120	0.0120%	8,318
MLW to MHW (0.87xTP)	14,809	(2.661)	2.661	14,812	0	0.000	0	(2.661)		40,373	0.000066	0.0066%	15,174
<b>TOTAL (24-HOURS)</b>	<b>31,914</b>	<b>(5.734)</b>	<b>5.734</b>	<b>31,920</b>	<b>(34,210)</b>	<b>(6.146)</b>	<b>(34,204)</b>	<b>(11.880)</b>	<b>25,561</b>	<b>57,481</b>	<b>0.000207</b>	<b>0.0207%</b>	<b>4,838</b>

COLOR KEY	
Blue #s = Gallons of water entering the bay from the ocean	Red #s = Gallons of water leaving the bay and going into the ocean
Green #s = Gallons of water leaving the bay and going into the intake system	(#s in parentheses) = Reduction of the amount of water in the bay

<sup>1</sup> The scenario shown in Table 3 is a conservative 24-hour cycle instead of an average 24-hour cycle, thus the total water withdrawn relative to source water is 0.0207% (or 1/4,838<sup>th</sup>) instead of the 0.0181% (or 1/5,532<sup>nd</sup>) shown under Table 2 (which shows an average daily tidal cycle).

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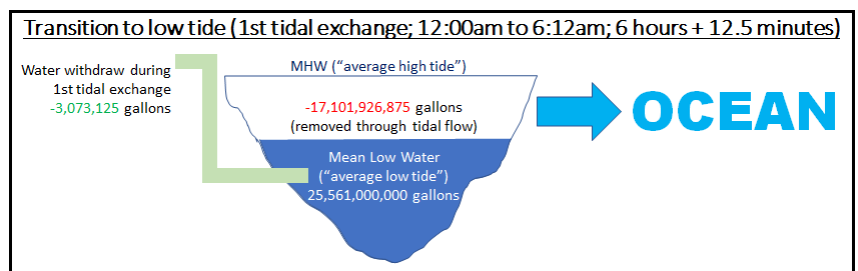
July 18, 2022

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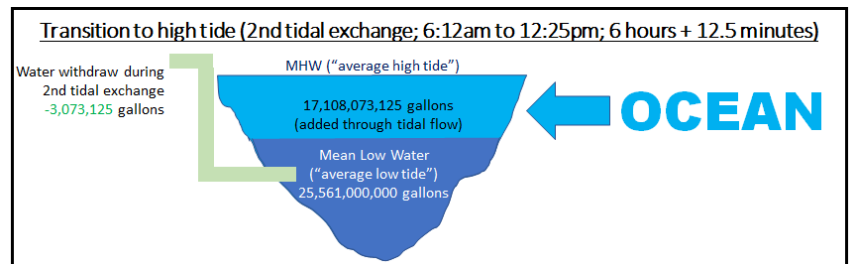
As Table 3 shows, during flood tides (MLW to MHW) for each average 24-hour period, the intake system withdraws 5.734 million gallons, all of which is made up by ocean water, meaning that the total water coming into the Bay is slightly higher than it would be without the intake system, thereby increasing the 31,914 million gallons of water that would enter the bay to 31,920 million gallons. Likewise, during the ebb tides (MHW to MLW) of an average 24-hour period, the intake system withdraws 6.146 million gallons, thereby reducing the 34,210 million gallons of water that would leave the bay to 34,204 million gallons. In any given tidal exchange, the amount of water withdrawn by the intake systems is no more than 0.000120 of the source water or 1/8,318<sup>th</sup>. In an average 24-hour period, the intake system withdraws 0.000207 or 1/4,838<sup>th</sup> of the total source water volume.

The following provides a generalized step-by-step description of the intake system relative to daily tidal dynamics by visualizing an idealized 24-hour period:

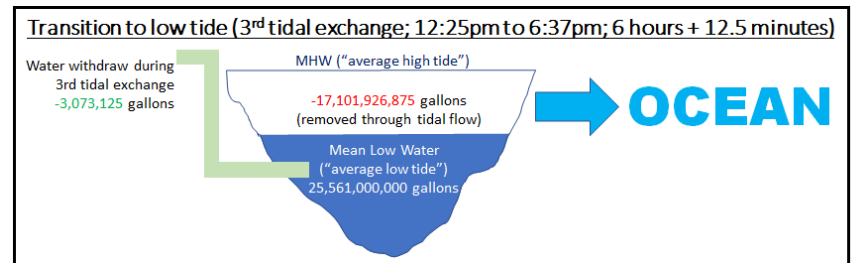
As before, assume that HBay is exactly at high tide (MHW) at the very beginning of a 24-hour period (12:00am). Over the course of the following 6.21 hours, water leaves the bay into the ocean. While this is normally about 17,105 million gallons, the intake system reduces the amount of water exiting the bay by 0.0175%, down to 17,102 million gallons. During this period, the intake system withdraws 0.000120 or 1/8,318<sup>th</sup> of the source water.



At 6:12am, the bay reaches low tide (MLW) and the process reverses. Over the course of the following 6.21 hours, water enters the bay from the ocean. While this is normally over 17,105 million gallons, the intake system increases the demand for water entering the bay by 0.0175% to 17,108 million gallons. During this period, the intake system withdraws 0.000072 or 1/13,885<sup>th</sup> of the source water.



At 12:25pm, the bay reaches high tide (MHW) and the process reverses again. Over the course of the following 6.21 hours, water leaves the bay into the ocean. While this is normally about 17,105 million gallons, the intake system reduces the amount of water exiting the bay by 0.0175%, down to 17,102 million gallons. During this period, the intake system withdraws 0.000120 or 1/8,318<sup>th</sup> of the source water.

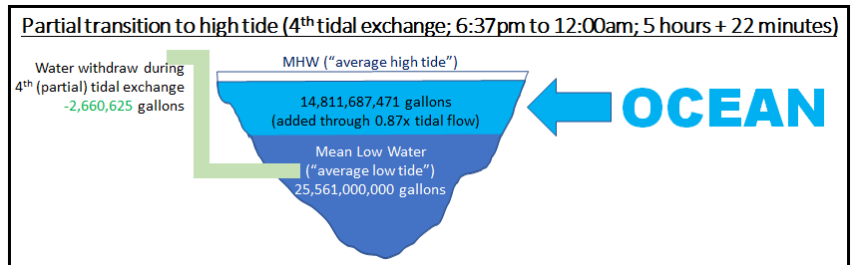


**Humboldt Bay Water Intakes**

July 18, 2022

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At 6:37pm, the bay reaches low tide (MLW) and the process reverses one last time for the day. At this point, there are only 5 hours and 22 minutes remaining in the hypothetical 24-hour period, which is not enough time to complete another full tidal exchange. Instead, only 87% of this low-tide-to-high-tide cycle is completed by



12:00am with the intakes withdrawing approximately 2.661 million gallons instead of 3.073 million gallons withdrawn during a full tide cycle. Without the intake system, over 14,809 million gallons would enter the bay from the ocean, but the intake system increases the demand for water entering the bay to 14,812 million gallons, an increase of 0.0203%. During this period, the intake system withdraws 0.000066 or 1/ 15,174<sup>th</sup> of the source water.

A side-by-side comparison of these tidal dynamics with and without the intake system is provided in Attachment 2.

Given the relatively miniscule ratio of intake water to source water, any potential hydraulic effects of water withdrawal by the proposed intakes will be relatively localized. As the intake system withdraws water from the Main Channel (see Figure 1 above), the water withdrawn by the intake system will be effectively replaced by water directly adjacent to the intakes, as the intakes will not withdraw enough water at a high enough rate to affect the bulk flow patterns within HBay. Considering that the water removed from HBay by the intakes will be directly replaced by the water immediately surrounding the intakes (regardless of tide cycle or water level) and considering the small volume of water withdrawn compared with the volumes and tidal prisms of HBay, the potential hydrodynamic impacts of the intakes on the flow patterns within HBay would be negligible. As outlined above, across the entire broad system of HBay, the water withdrawn will be replaced by makeup water from the ocean on flood tides and reduce outflow from the bay on ebb tides.

**Part 2: Impacts to Biological Productivity**

The daily losses to any larval populations in HBay subject to entrainment, even under maximum intake flow during Phase III and the most conservative source water estimate at MSL, would be expected to be less than 0.018%. Using the source water volume estimate for the entire population of organisms subject to entrainment, the maximum daily loss is estimated at 0.018% (Table 2).

It is hard to imagine how these conservative estimates of additional daily mortality to populations subject to entrainment could ever be considered biologically significant. This is especially true for a species like Northern Anchovy that is correctly identified as an important prey species for salmonids in the comment from NMFS staff. Northern Anchovy occur from British Columbia down to southern Baja California and can occur in bays and estuaries as well as in nearshore waters out to depths of over 1,700 feet (~520 meters). The females, which are described by Bakun (2001 cited in Sydeman et al. 2020) as “reproductive machines,” are extremely fecund and can produce up to 14,000 eggs per year. The females spawn multiple times per year, sometimes as often as every 6–8 days (MacCall 2009 cited in Sydeman et al. 2020). Mortality of up to 95% may occur during the larval stage, which can be highly variable since mortality has been shown to be affected by the abundance of prey and ocean conditions. The species has variable reproductive output that can result in large changes of up to two orders of magnitude in the adult population (Sydeman et al. 2020). For example, although the data on the



southern and central California Northern Anchovy stock in Sydeman et al. (2020) shows a decline in the population from 2005 through 2015, the most recent stock assessment by Kuriyama et al. (2022) shows an increase in each of the subsequent years through 2021. The extensive analysis of 65 years of data on the Northern Anchovy population in central and southern California by Sydeman et al. (2020) was unable to identify any definitive ocean conditions that explained the fluctuations in the population except for the strength of upwelling, which is thought to increase prey abundance for the species. These characteristics of Northern Anchovy all indicate that the small increase in larval mortality resulting from the operation of the intake would not result in any biologically significant effects on Northern Anchovy.

The wide geographic distribution of Northern Anchovy would indicate that a small incremental increase in mortality in Humboldt Bay would have no effect on a population that is highly mobile and occurs over such a large area. Also, the high reproductive capacity allows the population to rapidly increase when oceanographic and ecological conditions are favorable. This helps explain the fluctuations in the population. The potential association of population fluctuations with changes in upwelling and prey abundance indicate that strong density dependent factors may be operating on the population in the late larval stages and early juvenile stages. This would also reduce any effects of a small incremental increase in larval mortality at the early larval stages due to entrainment on the population.

It is also important to remember that the estimated entrainment losses are conservative and do not consider any of the design features of the cylindrical wedgewire screen intake that should result in reduced entrainment. A recent review on the effectiveness of cylindrical screening systems at reducing entrainment of fishes by Coutant (2020) presents several examples and reasons why the reductions by the systems exceed the expected levels based on screen size. Coutant (2020) discusses the design of cylindrical intake screen systems and the features that help reduce entrainment. These features include the cylindrical shape of the intakes, their alignment relative to existing tidal or river currents, and their low through-screen velocities. In a summary of lab studies on entrainment by cylindrical wedgewire screens, similar to the design proposed for the Humboldt Bay intakes, Coutant (2020) concludes that the contribution of screen-size opening and through-screen velocity was a minor factor in the reduction in entrainment. The major factor was the cylindrical design of the intake and its orientation parallel to ambient current that creates a bow wave and resulting flow dynamics that help move larvae and other objects away from the screen surface where they may be subject to entrainment. The increased turbulence probably decreased the likelihood that larvae would be oriented exactly parallel to the screen slots where they could be more easily entrained. Although not as large a factor as the cylindrical design of the screen, sweeping currents along the screen surface that far exceed through-screen velocities also made entrainment unlikely. Therefore, entrainment losses estimated based solely on the ratio of the intake volume to source water volume are likely to be highly conservative especially due to the placement of the intake screens in an area of HBay where they will be subject to strong sweeping velocities on ebb and flood tides.

Finally, as part of the Coastal Development Permit for the project, the results of the study currently being conducted will be used to provide estimates of the habitat restoration needed to replace the lost productivity due to the operation of the intakes. This process will result in compensation for any small levels of bioproductivity due to the intake system.

### **Part 3: Assumptions of Bioproductivity of Makeup and Retention Water**

An important factor to be considered is the population of plankton in HBay subject to entrainment by the proposed system. As detailed in other sources (see Reference section below), the proposed system is designed



to minimize “impingement” (trapping of aquatic animals against intake screens) and “entrainment” (the intake of aquatic species through the intake screens and into the system). The wedgewire intake screens use a slot opening of 1 millimeter (mm) and an approach velocity of 0.2 feet per second. These two design features significantly reduce the probability of impingement and entrainment, though some small species/individuals of plankton may still be entrained. For this study, we are interested in the population of plankton in HBay subject to entrainment as represented by the volume of source water in the bay relative to the intake volume. Note that the plankton in the source water that are subject to entrainment are also subject to tidal exchange. Thus, when the bay releases over 17 billion gallons of water to the ocean during the transition from MHW to MLW, the plankton in that 17 billion gallons is also leaving the bay. Likewise, when 17 billion gallons of water enter the bay from the ocean during the transition from MLW to MHW, the plankton in that 17 billion gallons is also entering the bay. Thus, the bioproductivity impacts of the intake system are also influenced by the tidal cycle that is occurring while the intake systems are operating.

As shown above, during a standard incoming tide the intake system withdraws 0.000072 or 1/13,885<sup>th</sup> of the source water during that tidal cycle. During such an incoming tide, the water withdrawn is “made up” by replacement water from the ocean (makeup water). It can be assumed that some plankton will be entrained into the intake system during this tidal cycle. However, it can also be assumed that the makeup water (which is water that otherwise would not have come into the bay during that tidal cycle) also contains plankton. The concentrations and composition of this makeup water is likely to be different from the intake water. Either way, at least some of the plankton lost due to entrainment will be compensated by the makeup water.

During a standard outgoing tide, the intake system withdraws 0.000120 or 1/8,318<sup>th</sup> of the source water during that tidal cycle. During such an outgoing tide, the water withdrawn causes a reduction of the amount of water that would have otherwise gone to the ocean (retention water). In other words, for every gallon withdraw, an equivalent amount of water is “retained” in the bay. It can be assumed that some plankton will be entrained into the intake system during this tidal cycle. However, it can also be assumed that the retention water (which is water that is being retained in the bay but that otherwise would have left the bay during that tidal cycle) contains some level of bioproductivity. Thus, some of the bioproductivity lost to the intake system is compensated for by the bioproductivity of the retention water.

## Literature Cited

- Bakun, A. 2001. “School-mix feedback”: a different way to think about low frequency variability in large mobile fish populations. *Progress in Oceanography*, 49: 485–511.
- Coutant, C. C. 2020. Why cylindrical screens in the Columbia River (USA) entrain few fish. *Journal of Ecohydraulics*. <https://doi.org/10.1080/24705357.2020.1837023>.
- MacCall, A. D. 2009. Mechanisms of low frequency fluctuations in sardine and anchovy populations. In *Climate Change and Small Pelagic Fish*, pp. 285–299. Ed. by D. M. Checkley, J. Alheit, Y. Oozeki, and C. Roy. Cambridge University Press, Cambridge.
- Sydeman, W. J., S. Dedman, M. Garcí a-Reyes, S. A. Thompson, J. A. Thayer, A. Bakun, and A. D. MacCall. 2020. Sixty-five years of northern anchovy population studies in the southern California Current: a review and suggestion for sensible management. *ICES Journal of Marine Science*. 77: 486–499.

**Humboldt Bay Water Intakes**

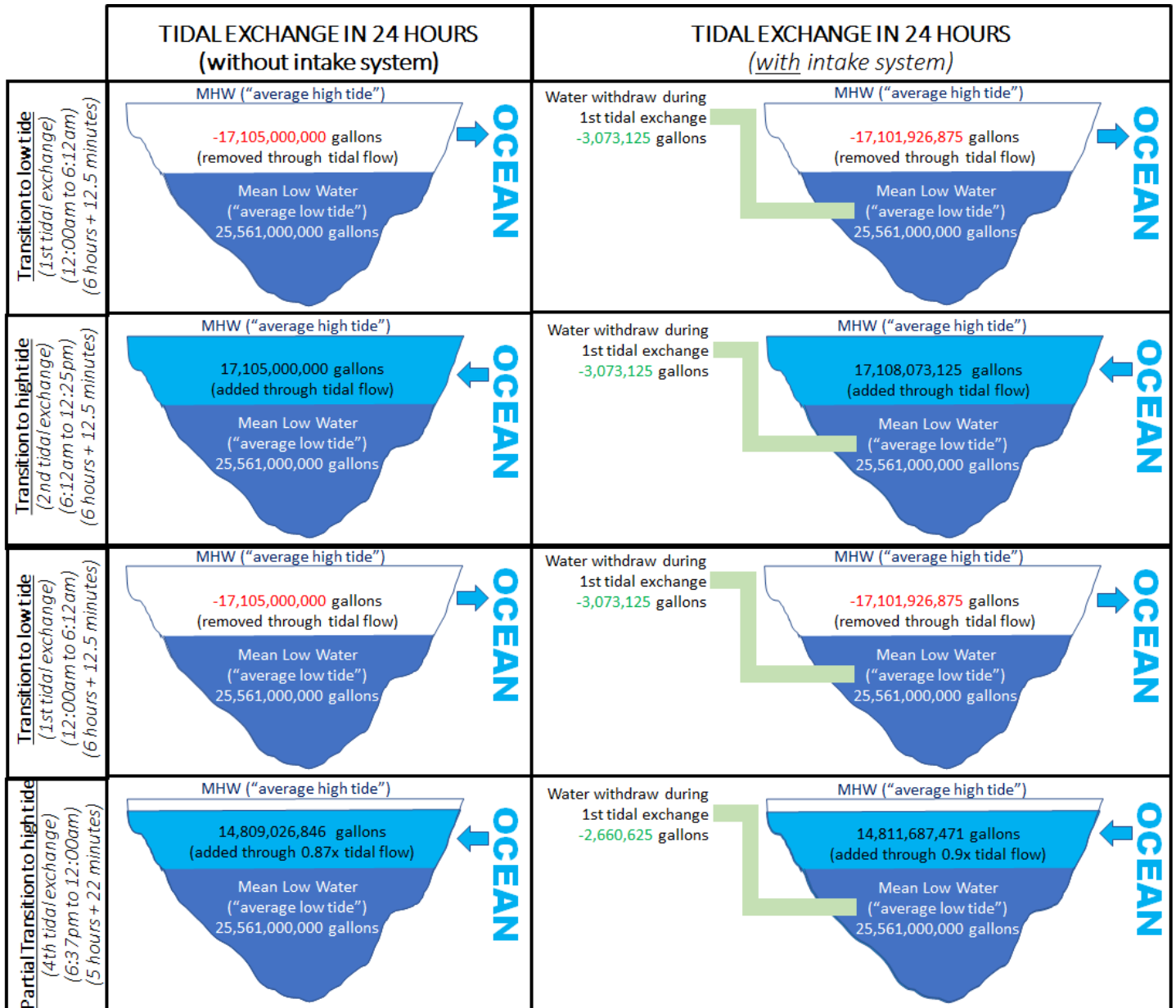
July 18, 2022

Page 10

**ATTACHMENT 1:** Humboldt Bay volumes at different tidal levels (mean lower low water [MLLW], mean low water [MLW], mean sea level [MSL], mean high water [MHW], mean higher high water [MHHW]) and source water (SW) volumes at mean sea level (MSL) and for the total SW volume population subject to entrainment.

Tidal Datum	Arcata Bay	Main Channel	Entrance Channel	Total
	Volume (ft <sup>3</sup> x 10 <sup>6</sup> [gal x 10 <sup>6</sup> ])			
MLLW	578 (4,322)	1,062 (7,946)	1,425 (10,662)	3,065 (22,930)
MLW	766 (5,733)	1,134 (8,483)	1,517 (11,346)	3,417 (25,561)
MSL	1,361 (10,179)	1,269 (9,489)	1,736 (12,984)	4,366 (32,652)
MHW	2,364 (17,684)	1,413 (10,570)	1,927 (14,413)	5,704 (42,667)
MHHW	2,600 (19,446)	1,456 (10,894)	1,991 (14,891)	6,047 (45,232)
Tidal Prism (MHW-MLW)	1,598 (11,951)	279 (2,087)	410 (3,067)	2,287 (17,105)
Total SW Volume (MSL + 1.93*[Tidal Prism])				8,778 (65,665)

**ATTACHMENT 2:** Side-by-Side Comparison of Tidal Dynamics With and Without Intake System during a 24-hour Period



## **Attachment I**

**GHD (1/17/22). Kramer Dock Habitat Restoration  
Memorandum.**

# DRAFT Memorandum

27 January 2022

<b>To</b>	Rob Holmlund (Humboldt Bay Harbor, Recreation and Conservation District)		
<b>From</b>	Brett Vivyan & Jeremy Svehla (GHD)		
<b>Reviewed By</b>	Misha Schwarz	<b>Tel</b>	707 267 2275
<b>Subject</b>	Suitability of Kramer Dock Site for Bay Water Intake Project Compensatory Off-site Restoration and Mitigation	<b>Project no.</b>	11225550

## Introduction

The Humboldt Bay Harbor, Recreation and Conservation District (HBHRCD) parcel APN 307-101-002 is located along the shoreline in Fields Landing, at the end of South Bay Depot Road (Exhibit 1). The property extends into the bay, north and south of South Bay Depot Road. The northern section includes a parking lot, boat ramp, structures and the southern section is largely undeveloped with a gravel trail along the shoreline. Rows of in-water pilings that historically supported the Kramer Dock (Figure 1) and a retaining wall span the shoreline of the parcel (Figure 2).



Figure 1. 1947 aerial photo showing former Kramer Dock and supporting piles (Humboldt Room 1947).





*Figure 2. Photo of representative shoreline erosion at project site. Photo source: Stillwater Sciences, 2016*

As a part of the eel grass mitigation planning process for the Fisherman's Channel Dredging Project in 2016, mitigation concepts were developed for the project shoreline that included measures to create eel grass habitat (Stillwater Sciences, 2016). The Fisherman's Channel Dredging Project did not move forward, as such the 2016 design concepts were not implemented. Since 2016, the HBHRCD has considered other multi-benefit approaches to habitat enhancement at the site.

The purpose of this memo is to present a habitat enhancement concept that builds on previous efforts and address feedback received from the California Coastal Commission. HBHRCD intends to implement eel grass and habitat enhancements along the shoreline of APN 307-101-002 to restore and improve natural processes and ecosystem functions that will provide habitat for essential fish habitat (EFH). Following implementation, HBHRCD intends to maintain ownership of the property and oversee follow-up monitoring and maintenance activities associated with the restoration.

## **Proposed Enhancements**

Eel grass and habitat enhancements may be achieved through the removal of creosote pilings and associated support structures used for the former Kramer dock. As shown in Exhibit 1, the total habitat restoration areas is 2.69 acres, and contains a total of 988 creosote treated pilings, and 151 cross beam supports, attached to the pilings. The pilings and cross beam supports were part the former Kramer dock have been identified along the shoreline (Exhibit 1).



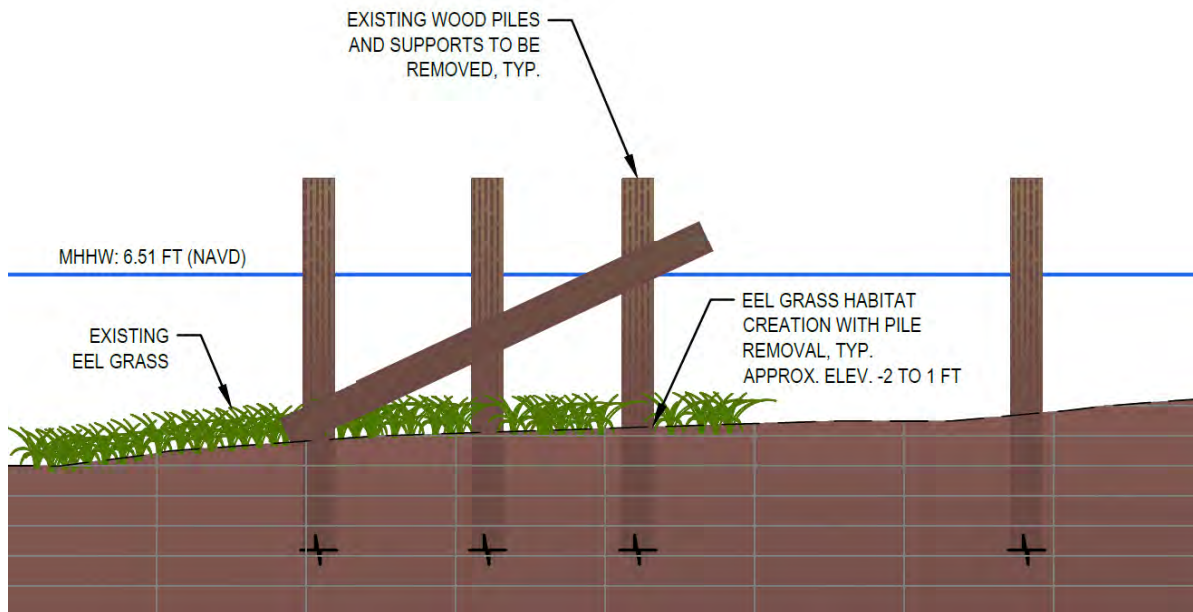


Figure 3 Typical pile removal section.

The general area containing pilings in which habitat restoration will occur is comprised of five sub-areas. Within the overall 2.69 habitat restoration area are two 150 ft wide sections that will be used as barge access. Barge access locations were selected based on a previously used location and access to South Depot Road. Existing eel grass exists among the some of the existing wood piles at elevations ranging from approximately -2 ft to 1 ft (NAVD 88).

Pilings would be removed using various methods including but not limited to a vibratory hammer, excavator, or cut-off at a minimum of 1 foot below bed elevation. Pilings located closer to shore would likely be removed from equipment operation on land during low tidal periods whereas piles further off-shore would likely require removal with equipment operating from a barge. Under current conditions, the pilings likely provide some wind wave energy dissipation along the shoreline and the existing eel grass beds have adapted to these conditions. Unarmoured portions of the adjacent shoreline show varying degrees of erosion likely caused by tide and wind waves. Piling removal may alter the nearshore hydraulic characteristics of shoreline erosion, but the project does not include removal of the old retaining wood wall which will continue to protect the shoreline.

## Conclusions and Next Steps

The concept presented in this memo provides creation of available space for eel grass habitat while enhancing a larger tidal habitat area with the removal of creosote piles and braces. The following next steps are recommended:

- Obtain Agency concurrence with this plan
- Develop Construction Documents for the removal of piles
- Develop Regulatory Approval Documents and Monitoring/Maintenance Plan

## References

1. Stillwater Sciences, 2016. Fields Landing Shoreline Stabilization – Preferred Approach and Alternatives Descriptions. Technical Memorandum. Arcata, CA
2. Humboldt State University Library, Humboldt Room Historic Photos



**Legend**

- Kramer Dock Piles
- General Area Containing Piling
- Compensatory Off-site Restoration Areas
- Compensatory Off-site Restoration Areas / Barge Landing Sites

Total Compensatory Off-site Restoration Areas = 2.69 acres

**Piling Removal Area 1:**

- 354 pilings
- 33 crossbeams
- .75 acres

**Piling Removal Area 2:**

- 67 pilings
- 8 crossbeams
- .21 acres
- This area to be used as a barge landing site after piling removal

**Piling Removal Area 3:**

- 143 pilings
- 15 crossbeams
- .42 acres

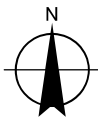
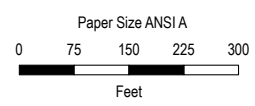
**Piling Removal Area 4:**

- 30 pilings
- 0 crossbeams
- .21 acres
- This area to be used as a barge landing site after piling removal

**Piling Removal Area 5:**

- 394 pilings
- 96 crossbeams
- 1.1 acres

Per Nordic DEIR Appendix N, four Piles will be removed from the "Compensatory Off-site Restoration Areas" to mitigate for the take associated with the entrainment of 295 LFS larvae, which represents less than the annual production of one female adult Longfin Smelt. In addition, if deemed necessary upon completion of an Entrainment Study, the District will utilize this same site to conduct "compensatory off-site restoration" as analyzed in the certified Final EIR for the Nordic project.



Baywater Intake CDP Application No. 1-21-0653

Project No. 11225550  
Revision No. 5  
Date Jan 2022

**Compensatory Off-site Restoration Areas at Kramer Dock**

**EXHIBIT 1**

## **Attachment J**

### **Humboldt Bay Harbor District (1/14/22). Pile Removal Methods and Best Management Practices.**



**COMMISSIONERS:**

- 1<sup>st</sup> Division  
Aaron Newman
- 2<sup>nd</sup> Division  
Greg Dale
- 3<sup>rd</sup> Division  
Stephen Kullmann
- 4<sup>th</sup> Division  
Richard Marks
- 5<sup>th</sup> Division  
Patrick Higgins

**Humboldt Bay  
Harbor, Recreation and Conservation  
District**  
(707) 443-0801  
P.O. Box 1030  
Eureka, California 95502-1030



**EXECUTIVE DIRECTOR:** Larry Oetker

# Methods and Best Management Practices for Pile Removal at Kramer Dock Site (10/21/22)

**Objectives**

The objectives of these Best Management Practices (BMPs) are to avoid impacts to eelgrass, to avoid the mobilization of contaminants, and to control turbidity and sediments re-entering the water column during the process of removing piles from the Kramer Dock site.

**Methods**

Pile removal will be conducted from shore and/or from a barge. A crane with a boom carrying a vibratory hammer and timber clamp will be used to remove the piles. Piles that break off above the bottom will be reattached to the vibratory hammer and removed. If a pile cannot be fully extracted, it will be cut off one foot below the mudline using a saw.

Removal with barge: The crane referenced above would be on a barge. The barge would be approximately 80' X 100' with a 4' draft and would be moved with a small tugboat. After being placed on the barge, the piles would be transferred to land and then transported to and disposed of at an appropriate upland location.

Removal from shore: The crane referenced above would operate from the shore immediately adjacent to the bay. The piles would be transported to and disposed of at an appropriate upland location.

**Best Management Practices**

The following best management practices (BMP) will be followed:

Best Management Practices	BMPs to Avoid Impacts to Eelgrass	BMPs to Minimize Sediment and Contaminant Mobilization
Harbor District staff or a designated representative will be present to ensure that these BMPs are adhered to.	X	X
Neither the barge nor the tug will anchor during the project. The barge may attach to existing piles to maintain its position.	X	X
During the barge method, piles will be removed at a tide of sufficient elevation to float the barge and tugboat adjacent to the piles being removed without scarring the mudflats or injuring eelgrass.	X	X
Grounding of the barge will not be permitted.	X	X
A floating containment boom will surround each pile being removed to collect any debris. To collect debris that floats below the surface but does not sink to the bottom, weighted plastic mesh (similar to orange construction fencing) will be attached to the boom and extended across the area surrounding the pile. If debris sinks to the bottom, then it will be removed by a diver.	X	X
All equipment will be checked before use to minimize risk of petroleum product releasing to the bay. A spill response kit, including oil absorbent pads will be on-site to collect any petroleum product that is accidentally released.	X	X

## Methods and Best Management Practices for Pile Removal at Kramer Dock

<b>Best Management Practices</b>	<b>BMPs to Avoid Impacts to Eelgrass</b>	<b>BMPs to Minimize Sediment and Contaminant Mobilization</b>
The crane and tug operators will be experienced with vibratory pile removal.	X	X
The crane operator will break the soil/pile bond prior to pulling to limit pile breakage and sediment adhesion.	X	X
All work should be confined to within the floating containment boom.		X
Piles will be removed slowly to limit sediment disturbance.	X	X
Piles will not be hosed off, scraped, or otherwise cleaned once they are removed from the sediment.	X	X
Piles will be placed in a containment area on the barge to capture sediment attached to the piles.	X	X
The containment area will be lined with plastic sheeting to not allow sediment or residual water to reenter the bay.	X	X
Sawdust or woody debris generated from pilings that are cut 1 foot below the mudline using a saw are to be retrieved and placed in the containment area	X	X
Holes left in the sediment by the pilings will not be filled. They are expected to naturally fill.	X	
Piles and debris will be removed from the barge carefully and moved to a designated site for disposal preparation. Prior to disposal, the piles and debris will be stored on a paved surface, covered with tarps, and surrounded by an erosion boom, straw waddle, or hay bale perimeter.	X	X
All removed piles or portions of piles will be disposed of at an authorized facility. No piles or portions of piles will be re-used in Humboldt Bay or along shoreline areas.	X	X
Land operations will avoid wetlands mapped at the site.		





## **Attachment K**

**GHD (4/5/22). Kramer Dock Pile Removal  
Quantities.**

# Technical Memorandum

April 5, 2022

<b>To</b>	Larry Oetker	<b>Tel</b>	707.267.2275
<b>Copy to</b>	Misha Schwarz, Rob Holmlund	<b>Email</b>	Brett.Vivyan@ghd.com
<b>From</b>	Brett Vivyan PE	<b>Ref. No.</b>	11205607
<b>Subject</b>	Pile and Cross Beam Removal Quantities		

This memorandum summarizes the field methods and estimated quantities of pile and cross beam removal of the remnant Kramer Dock, in support of the Humboldt Bay Master Baywater Intake Offsite Compensatory Restoration. At the request of California Department of Fish and Wildlife (CDFW), field measurements and desktop analyses were conducted to evaluate the weight, surface area and volume of and cross beam removal at the Kramer Dock site in Humboldt Bay (Fields Landing, California). A total of 988 creosote-treated pilings and 151 creosote-treated cross beam supports, attached to the pilings are proposed for removal.

On March 25, 2022 GHD staff visited the site to confirm creosote treatment and measure pile and cross beam dimensions. Piles were partially submerged at the time of observation and a combination of desktop assessments and field measurements were used to determine ground elevations. Pile dimensions are provided in Table 1 and cross beam dimensions are provided in Table 2. Typical pile and cross beam configuration is shown in Figure 1. The piles and cross beams exhibited a faint smell of petroleum product and are all assumed to have been treated with creosote, as was common for piers, docks and floats for more than a century<sup>1</sup>.

**Table 1** Typical pile dimensions.

Description	Cross Section	Average Ground Elevation at Pile <sup>2</sup>	Top of Pile Elevation	Length Above Ground	Length Below Ground <sup>3</sup>
Pile	12-inch Diameter	-1.8 feet (NAVD)	7.5 feet (NAVD)	9.3 feet	20 feet

<sup>1</sup> [www.dnr.wa.gov/publications/aqr\\_rest\\_creosote\\_factsheet\\_1019.pdf](http://www.dnr.wa.gov/publications/aqr_rest_creosote_factsheet_1019.pdf)

<sup>2</sup> Ground elevation at the piles was determined based on the water depth measurements and tidal water levels, as reported at Station 9418723 Fields Landing, Humboldt Bay, CA and 9418767 North Spit, CA and then cross referenced to available LiDAR elevation data. Predicted tidal water levels at Fields Landing were -0.25 ft (NAVD88). Measured tidal water levels at the North Spit were shown to be 0.197 ft higher than predicted at 12:00 pm PDT, resulting in a water level of 0.07 feet (NAVD) at the Kramer Dock site. Water depth at the closest pile was measured to be 1.16 feet (14 inches), resulting in an approximate ground elevation of approximately -1.1 feet (NAVD). Ground elevation, was also evaluated using the 2019 Humboldt Bay LiDAR data set. At the time of LiDAR data collection, the piles were submerged and hydroflattening (water surface elevation captured) occurred at a water level of -0.4 feet. The adjacent ground, approximately 5 feet from the piles was not affected by hydroflattening. The slope of the adjacent ground, over a length of 30 feet was used to extrapolate elevations, resulting in a ground elevation of -1.05 feet (NAVD) at the same measurement location. Using this same method, the two piles located at approximately 6-foot spacing further west, resulted in ground elevations of -1.8 feet and -2.6 feet. Resulting average ground elevation is -1.8 feet.

<sup>3</sup> Based on personal communication with Larry Oetker (Harbor District Executive Director) noting approximate length of piles below mud line during previous pile removal activities.

Table 2 Typical cross beam dimensions

Description	Cross Section	Length	Top Elevation	Bottom Elevation
Cross Beam	6-inch by 12-inch	12 feet	7.5 feet (NAVD)	0.5 feet (NAVD)

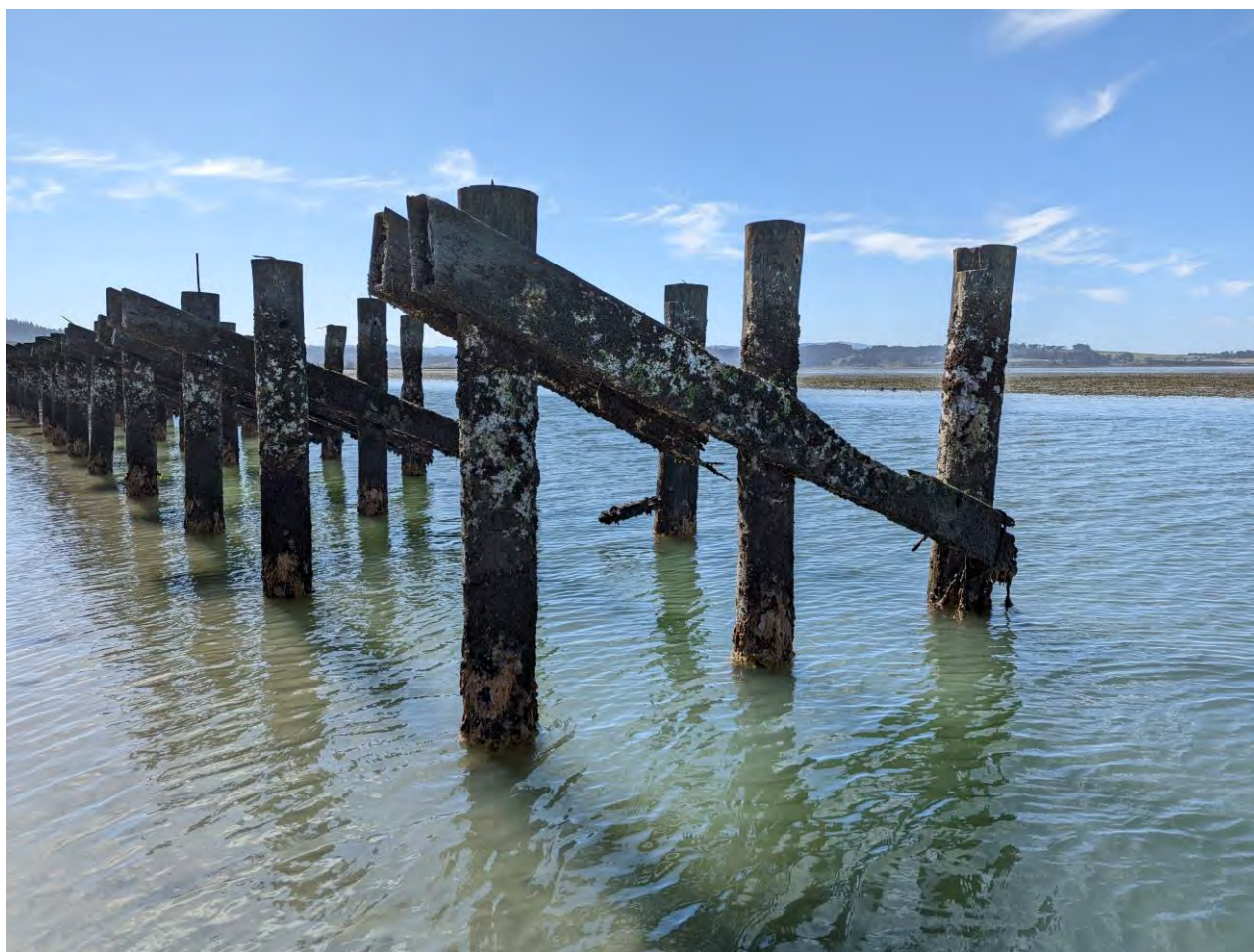


Figure 1 Typical piles and cross beams at mitigation site.

The resulting volume weight, and surface area of piles proposed for removal is summarized in Table 3. The proposed mitigation results in the removal and disposal of 1,139 creosote-treated piles and beams, totalling 23,650 ft<sup>3</sup>, 308 tons, and 96,530 ft<sup>2</sup> from Humboldt Bay.

Table 3. Resulting weight, surface area and volume calculations.

Description	Number Removed	Volume (ft <sup>3</sup> )	Weight <sup>4</sup> (tons)	Surface Area Exposed to Average Daily Water Column <sup>5</sup> (ft <sup>2</sup> )	Surface Area Above MHHW (ft <sup>2</sup> )	Surface Area Below Ground (ft <sup>2</sup> )
Piles	988	22,740	296	25,760	3,100	62,080
Cross Beams	151	910	12	4,900	690	NA
Totals	1,139	23,650	308	30,660	3,790	62,080

<sup>4</sup> Assumed Coast Redwood with density of 26 lbs/ft<sup>3</sup> (<https://www.wood-database.com/coast-redwood/>)

<sup>5</sup> Based on ground elevation of -1.8 feet (NAVD) and Mean Higher High Water (MHHW) of 6.51 feet (NAVD) at Station 9418767 North Spit, CA

## **Attachment L**

**County of Humboldt (9/29/22). CEQA Notice of Determination: Environmental Impact Report – Nordic Aquafarms California, LLC – Land-based Aquaculture Project & Coastal Development Permit & Special Permit.**



RECEIPT NUMBER: 12-2022-191
STATE CLEARINGHOUSE NUMBER (If applicable) 2021040532

SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY.

LEAD AGENCY HUMBOLDT CNTY PLANNING & BUILDING	LEAD AGENCY EMAIL CMCNAMARA@CO.HUMBOLDT.CA.US	DATE 09/29/2022
COUNTY/STATE AGENCY OF FILING HUMBOLDT		DOCUMENT NUMBER 12-2022-191

PROJECT TITLE  
 ENVIRONMENTAL IMPACT REPORT NORDIC AQUAFARMS CALIFORNIA LLC LAND BASED AQUACULTURE

PROJECT APPLICANT NAME NORDIC AQUAFARMS CALIFORNIA LLC	PROJECT APPLICANT EMAIL CMCNAMARA@CO.HUMBOLDT.CA.US	PHONE NUMBER (707) 268-3777
PROJECT APPLICANT ADDRESS PO BOX 11477	CITY EUREKA	STATE CA
		ZIP CODE 95502

PROJECT APPLICANT (Check appropriate box)

Local Public Agency   
  School District   
  Other Special District   
  State Agency   
  Private Entity

CHECK APPLICABLE FEES:

<input checked="" type="checkbox"/> Environmental Impact Report (EIR)	\$3,271.00	\$ _____
<input type="checkbox"/> Mitigated/Negative Declaration (MND)(ND)	\$2,354.75	\$ _____
<input type="checkbox"/> Certified Regulatory Program (CRP) document - payment due directly to CDFW	\$1,112.00	\$ _____
<input type="checkbox"/> Exempt from fee		
<input type="checkbox"/> Notice of Exemption (attach)		
<input type="checkbox"/> CDFW No Effect Determination (attach)		
<input type="checkbox"/> Fee previously paid (attach previously issued cash receipt copy)		
<hr/>		
<input type="checkbox"/> Water Right Application or Petition Fee (State Water Resources Control Board only)	\$850.00	\$ _____
<input checked="" type="checkbox"/> County documentary handling fee		\$ 50.00
<input type="checkbox"/> Other		\$ _____
PAYMENT METHOD:		
<input type="checkbox"/> Cash <input type="checkbox"/> Credit <input type="checkbox"/> Check <input checked="" type="checkbox"/> Other	TOTAL RECEIVED	\$ 50.00

SIGNATURE 	AGENCY OF FILING PRINTED NAME AND TITLE S Carns, Deputy County Clerk-Recorder
---------------	--

# NOTICE OF DETERMINATION

## FILED

To:  Office of Planning and Research  
1400 Tenth Street  
PO Box 3044  
Sacramento CA 95812-3044

County of Humboldt  
County Clerk  
825 Fifth Street  
Eureka CA 95501

County of Humboldt  
Kelly E. Sanders  
County Clerk  
**12-2022-191**  
**09/29/2022**  
sc

County of Humboldt  
Planning and Building Department  
3015 H Street  
Eureka CA 95501

Contact: Cade McNamara  
Telephone: 707 268-3777  
Email: cmcnamara@co.humboldt.ca.

Lead Agency (if different from above):  
Address:

Contact:  
Telephone:

**Applicant:** Nordic Aquafarms California, LLC

**APN:**

**Address:** PO Box 11477  
Eureka, CA 95502

401-112-021  
**Case No:** PLN-2020-16698

**Subject:** Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code.

**State Clearinghouse Number:** 2021040532

**Project Title:** Environmental Impact Report - Nordic Aquafarms California, LLC Land-based Aquaculture Project & Coastal Development Permit & Special Permit

**Project Location:** This project is located in Humboldt County, in the Samoa area, on both sides of Vance Avenue, approximately 2,000 feet north from the intersection of Vance Avenue and Bay Street, on the property known as 364 Vance Avenue.

**Project Description:** The applicant (Nordic Aquafarms California, LLC. (NAFC)) is requesting a Coastal Development Permit and Special Permit for the demolition and remediation of the Freshwater Tissue Samoa Pulp Mill facility and the construction of a land-based finfish recirculating aquaculture system (RAS) facility. This includes the development of five buildings totaling approximately 766,530 square feet and the installation of 4.8 megawatt (MW) solar panel array mounted on building rooftops, covering approximately 657,000 square feet. A Special Permit is required pursuant to Section 313-109.1.5.2 for an exception to the loading space requirements. The height of the tallest proposed building is 60 feet. The aquaculture facility would produce fresh head on gutted fish and fillets for delivery to regional markets. The species to be produced at the facility is intended to be Atlantic Salmon, pending approval from CDFW. The Project will include ancillary support features such as paved parking, fire access roads, security fencing, and stormwater management features. The Project would require approximately 2.5 million gallons per day (MGD) of freshwater and industrial water provided by the Humboldt Bay Municipal Water District, sourced from the Mad River. Existing on-site water service supplied by the Humboldt Bay Municipal Water District would be connected to the new buildings for potable use, fire sprinklers, and irrigation. The Project would require approximately 10 MGD of salt water, which will be provided by upgraded water intake infrastructure located adjacent to the NAFC Project Site, on Humboldt Bay. Treated wastewater would be discharged utilizing the existing Redwood Marine Terminal II ocean outfall pipe, which extends one and a half miles offshore. A total of 12.5 MGD would be released daily.

This is to advise that the,  Lead Agency or  Responsible Agency, Humboldt County Board of Supervisors has approved the above described project on September 28, 2022 and has made the following determinations regarding the above described project:

1. The project  will  will not have a significant effect on the environment.  
 An Environmental Impact Report was prepared for this project pursuant to the provisions of CEQA.
2.  A Negative Declaration was prepared for this project pursuant to the provisions of CEQA.  
 A Mitigated Negative Declaration was prepared for this project pursuant to the provisions of CEQA.
3. Mitigation measures  were  were not made a condition of the approval of the project.



## NOTICE OF DETERMINATION

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4. A mitigation reporting or monitoring plan  was  was not adopted for this project.
5. A statement of Overriding Considerations  was  was not adopted for this project.
6. Findings  were  were not made pursuant to the provisions of CEQA.

This is to certify that the final EIR with comments and responses and record of project approval, is available to the General Public at: Planning Division, 3015 H St, Eureka, CA 95501

Signature: x  Date: September 29, 2022

Title: Planner II Date received for filing at OPR: \_\_\_\_\_

**NOTICE OF DETERMINATION**

**To:**  Office of Planning and Research  
1400 Tenth Street  
PO Box 3044  
Sacramento CA 95812-3044

**From:** County of Humboldt  
Planning and Building Department  
3015 H Street  
Eureka CA 95501

County of Humboldt  
County Clerk  
825 Fifth Street  
Eureka CA 95501

**F I L E D**  
County of Humboldt  
Kelly E. Sanders  
County Clerk  
**12-2022-156**

Contact: Cade McNamara  
Telephone 707 268-3777  
Email: cmcnamara@co.humboldt.ca.us

Lead Agency (if different from above):  
Address:

08/05/2022  
tn

Contact:  
Telephone:

**Applicant:** Nordic Aquafarms California, LLC

**APN:**

**Address:** PO Box 11477  
Eureka, CA 95502

401-112-021  
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This is to advise that the,  Lead Agency or  Responsible Agency, Humboldt County Planning Commission has approved the above described project on August 4, 2022 and has made the following determinations regarding the above described project:


1. The project  will  will not have a significant effect on the environment.  
 An Environmental Impact Report was prepared for this project pursuant to the provisions of CEQA.
2.  A Negative Declaration was prepared for this project pursuant to the provisions of CEQA.  
 A Mitigated Negative Declaration was prepared for this project pursuant to the provisions of CEQA.
3. Mitigation measures  were  were not made a condition of the approval of the project.

**NOTICE OF DETERMINATION**

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- 4. A mitigation reporting or monitoring plan  was  was not adopted for this project.
- 5. A statement of Overriding Considerations  was  was not adopted for this project.
- 6. Findings  were  were not made pursuant to the provisions of CEQA.

This is to certify that the final EIR with comments and responses and record of project approval, is available to the General Public at: Planning Division, 3015 H St, Eureka, CA 95501

Signature:  Date: August 5, 2022  
CHAD D. MCNAMARA

Title: Planner II Date received for filing at OPR: \_\_\_\_\_



State of California - Department of Fish and Wildlife  
**2019 ENVIRONMENTAL FILING FEE CASH RECEIPT**  
 DFW 753.5a (REV. 12/01/18) Previously DFG 753.5a

RECEIPT NUMBER: 12-2022-156
STATE CLEARINGHOUSE NUMBER (If applicable)

SEE INSTRUCTIONS ON REVERSE. TYPE OR PRINT CLEARLY.

LEAD AGENCY HUMBOLDT CNTY PLANNING & BUILDING	LEAD AGENCY EMAIL CMCNAMARA@CO.HUMBOLDT.CA.US	DATE 08/05/2022
COUNTY/STATE AGENCY OF FILING HUMBOLDT	DOCUMENT NUMBER 12-2022-156	

PROJECT TITLE  
 NORDIC AQUAFARMS CALIFORNIA LLC LAND BASED AQUACULTURE PROJECT

PROJECT APPLICANT NAME NORDIC AQUAFARMS CALIFORNIA LLC	PROJECT APPLICANT EMAIL CMCNAMARA@CO.HUMBOLDT.CA.US	PHONE NUMBER (207) 505-5728
PROJECT APPLICANT ADDRESS PO BOX 1477	CITY EUREKA	STATE CA
		ZIP CODE 95502

PROJECT APPLICANT (Check appropriate box)

Local Public Agency   
  School District   
  Other Special District   
  State Agency   
  Private Entity

CHECK APPLICABLE FEES:

<input checked="" type="checkbox"/> Environmental Impact Report (EIR)	\$3,271.00	\$	\$3,539.25
<input type="checkbox"/> Mitigated/Negative Declaration (MND)(ND)	\$2,354.75	\$	
<input type="checkbox"/> Certified Regulatory Program (CRP) document - payment due directly to CDFW	\$1,112.00	\$	
<input type="checkbox"/> Exempt from fee			
<input type="checkbox"/> Notice of Exemption (attach)			
<input type="checkbox"/> CDFW No Effect Determination (attach)			
<input type="checkbox"/> Fee previously paid (attach previously issued cash receipt copy)			
<hr/>			
<input type="checkbox"/> Water Right Application or Petition Fee (State Water Resources Control Board only)	\$850.00	\$	
<input checked="" type="checkbox"/> County documentary handling fee		\$	\$50.00
<input type="checkbox"/> Other		\$	

PAYMENT METHOD:

Cash   
  Credit   
  Check   
  Other

TOTAL RECEIVED \$ 3,589.25

SIGNATURE <i>X T Nielsen</i>	AGENCY OF FILING PRINTED NAME AND TITLE T Nielsen, Deputy County Clerk-Recorder
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## **Attachment M**

**SHN (11/15/22). Mitigation and Monitoring Plan  
for the Humboldt Bay Master Water Intakes  
Project..**



Reference: 016240.005

November 15, 2022

Rob Holmlund, AICP  
Humboldt Bay Harbor, Recreation, and Conservation District  
601 Startare Drive  
Eureka, CA 95501

**Subject: Mitigation and Monitoring Plan for the Humboldt Bay Master Water Intakes Project**

Dear Rob Holmlund:

In accordance with Section 404 of the Clean Water Act, Subpart J, the California Regional Water Quality Control Board (RWQCB) requires submittal and approval of a mitigation plan that will avoid and minimize impacts to the Waters of the State. Plans shall include project objectives, site selection, site protection instrument (the legal arrangement or instrument that will be used to ensure the long-term protection of the compensatory mitigation project site), baseline site conditions, a mitigation work plan, a maintenance plan, a long-term management plan, an adaptive management plan, performance standards and success criteria, monitoring requirements, and financial assurances. This document has been organized in the same format as is required by the RWQCB.

## Introduction and Project Objectives

The Humboldt Bay Water Intakes Project is being implemented by the Humboldt Bay Harbor, Recreation, and Conservation District (see Appendix 1, Project Description). This project will modernize and operate two former bay-water intake systems in Humboldt Bay and will install new piping to deliver bay water to existing and future Harbor District tenants, as described in both the Certified Final Environmental Impact Report (FEIR) and Draft Environmental Impact Report (DEIR; FEIR; SCH 2021040532; County of Humboldt, 2022, DEIR; SCH 2021040532; County of Humboldt, 2021). The project includes pile removal, as conditioned by the project's regulatory approvals from the Harbor District, California Coastal Commission, North Coast Regional Water Quality Control Board, and U.S. Army Corps of Engineers. These conditions include the removal of 988 piles at the previous Kramer Dock along the Humboldt Bay shoreline near Fields Landing. Removal of these piles will create new benthic habitat that will mitigate for loss of biological productivity caused by fish species entrainment, as a result of the operation of the water intake systems as outlined in Section 2.4.7 (page 2-56) of the DEIR. The FEIR was certified by the Humboldt County Planning Commission on August 4, 2022. With a typical pile diameter of 12 inches (pile area 0.785 sf/pile), the removal of 988 piles would create a total of 776 sf (0.018 acres) of benthic habitat. In addition, Mitigation Bio-6a consists of creation or enhancement of habitat within tributaries of Humboldt Bay in areas of fresh and/or brackish water suitable for Longfin Smelt spawning, rearing, or nursery habitat, as described in the FIER (FEIR pgs. 4-8 and 4-9; SCH 2021040532; County of Humboldt, 2022).





## Potential Project Impacts to Waters of the State

### Summary

Table 1 described the actions proposed for the water intake upgrades, operations of the water intake structures, whether these actions may result in impacts, and how these impacts will be mitigated.

Table 1. Construction and Operation Actions, potential impacts, and mitigations.

Action	Impact	Direct/Indirect	Permanent/Temporary	Quantity	Mitigation
Remove sediment from Red Tank Dock intake structure	Reduction in water quality, turbidity	Direct	Temporary	6.3 cubic yards	Seal off openings to prevent turbidity release
Remove sediment from RMT II Dock intake structure	Reduction in water quality, turbidity	Direct	Temporary	5.2 cubic yards	Seal off openings to prevent turbidity release
Replace existing pump, piping, and electrical infrastructure	None	NA	NA	NA	None, out of water
Install new intake screens guide channels	None	NA	NA	NA	None, work from boat and divers bolt metal guide channels to existing structures
Install new intake screens air burst piping	None	NA	NA	NA	None, work from boat and divers to secure piping in place
Install new intake screens	None	NA	NA	NA	None, screens will be lowered into place from above



**Mitigation and Monitoring Plan**

November 15, 2022

Page 3

Action	Impact	Direct/Indirect	Permanent/Temporary	Quantity	Mitigation
Leak test intake structures	None	NA	NA	NA	None, structures will be drained to see if water enters to identify leaks
Seal existing structures	None	NA	NA	NA	None, in-water work will not disturb water quality. Inert non-toxic materials only.
bay water withdrawal	Reduction in biological productivity	Direct	Permanent	8,250 gpm, maximum	Pile removal
Air Burst Cleaning	None	NA	NA	NA	None, blowing air into the water will not harm any aquatic life or affect water quality
Routine Maintenance Screen Inspection and Cleaning	None	NA	NA	NA	None, screens will be lifted out of the water and cleaned. Organic material will be disposed of offsite.
Routine Maintenance Pump Inspections	None	NA	NA	NA	None, pumps will be lifted out of the water for inspection.



Action	Impact	Direct/Indirect	Permanent/Temporary	Quantity	Mitigation
Upland pipe trench construction	Stormwater runoff	Indirect	Temporary	NA	Construction SWPPP

**Short-term/temporary potential impacts (construction)**

The water intakes are existing and in-place, requiring limited modification, including new pumps, screening, and piping. In-water work (screening) in Humboldt Bay required to modernize and revitalize the water intakes would occur at lower tides to support access to the sea chests. The NCRWQCB must find the sea chests meet the criteria for California Water Code section 13142.5(b). The specific criteria are to employ, "best available site, design, technology and mitigation measures" feasible to minimize mortality of all forms of sea life, which includes avoidance of water quality impacts. In addition, the project will implement Best Management Practices as part of approved construction permits and as part of compliance with State Water Resources Control Board (Water Board) Order No. 2009-0009-DWQ, Waste Discharge Requirements for Discharges of Stormwater Runoff Associated with Construction and Land Disturbance Activities. Details of these requirements are documented within Mitigation Measure HWQ-2 in the DEIR section 3.9, pages 3.9-26 and 3.9-27 (DEIR; SCH 2021040532; County of Humboldt, 2021).

The new intake screen at Red Tank Dock will be placed approximately one foot off of the existing bay bottom, which will put the top of the screen near the lowest astronomical tide elevation. The manufacturer recommends a minimum of 12 inches of clear water be maintained above and below the top and bottom of the screen. The tidal water level will need to be monitored to ensure the intake pumps do not operate if the water level drops below 12 inches above the top of the screen. Leaving one foot between the bottom of the intake screen and the bay bottom will reduce the potential for pumps to draw sediment into the interior of the intake structure (SHN, 2021).

The proposed design of the RMT II intake structure puts the intake screen approximately three feet above the invert elevation of the existing intake structure. The bottom elevation of the bay outside of the intake structure is approximately six feet below the bottom of the intake structure, and may vary over time as sediment moves; however, there is sufficient depth between the invert of the existing structure and the mean lower low water (MLLW) elevation to provide three feet of clearance between the bottom of the new screen and the invert of the existing intake structure. This will provide room for sediment accumulation and prevent the new screen from drawing sediment from the bottom of the bay while maintaining complete submergence during all tides (SHN, 2021).

Installation of intake screen guide channels will be done from a boat by divers to bolt metal guide channels to existing structures. Screens will be lowered into place from above. Intake structures will then be drained to see if water enters to identify leaks prior to operation. Prior to new screen installation, use of specialized equipment or hand removal via divers may be required for removal of small quantities of sediment that have settled at the bottom of the existing water intakes. Removal of 6.3 cubic yards of sediment from the Red Tank Dock intake structure and 5.2 cubic yards of sediment from the RMT II intake structure has the potential to cause direct temporary impacts by increasing turbidity in the Bay waters. To avoid turbidity plumes, openings in the sea chests will be sealed off prior to sediment removal. The undisturbed water will be decanted from above until



the water is approximately 3-4 feet above the sediment layer to prevent disturbance of the sediment and creation of turbidity. Once the water has been drawn down, the pumps will be turned off and a vacuor truck or suction hose will be used to suck the sediment out. The sediment will be removed from the structure and hauled offsite for proper characterization and disposal. Dredging or expansion of the existing water intakes would not occur.

Therefore, due to the application of these best available site, design, and technology, California Water Code section 13142.5(b) criteria is met.

### **Long-term/permanent potential impacts (operation and maintenance)**

#### **Operation**

Bay water withdrawal has the potential to cause a direct permanent impact by intaking bay water at a maximum of 8,250 gpm. The water intakes are designed to avoid impingement of aquatic species and avoid entrainment of juvenile and adult aquatic species by meeting design criteria related to screen mesh, water approach velocity, and other parameters, and avoiding potential significant impacts to biological productivity. The slot size for the two screens is designed to be 1.00 mm with a minimum open area across the screen of 36%. The screens also have manifold systems inside the screen modules that equalizes pressure across the entire screen surface. These design features result in a low approach velocity of 0.2 feet per second (fps; 6 cm per sec), which exceeds NMFS criteria of screen slot size of no more than 1.75 mm (NMFS, 1997). It is expected that primarily non-special-status aquatic larvae have the potential to be entrained, in addition to the potential to entrain an estimated maximum of 200 Longfin Smelt larvae per year. SHN, Tenera Environmental, and the Harbor District prepared a technical memorandum for the Humboldt Bay Water Intakes. According to that technical memorandum, based on daily tidal dynamics and using the source water volume estimates, the daily losses to any larval populations in Humboldt Bay subject to entrainment would be expected to be less than 0.018%, even under maximum intake flow during Phase III of its operation and the most conservative source water volume estimate at Mean Sea Level (SHN, Tenera, Harbor District, 2022). As explained in the technical memorandum, entrainment losses estimated based solely on the ratio of the intake volume to source water volume are likely to be highly conservative, especially due to the design of the intake screens and their placement in an area of Humboldt Bay where they will be subject to strong sweeping velocities on ebb and flow tides. Loss of biological productivity will be mitigated by the pile removal included as part of the project proposal, completed prior to Phase III, as described in Section 11 of the Humboldt Bay Master Water Intakes Project Description Version 7 (see Appendix 1).

The need to offset the impact on biological productivity is based on Section 30231 of the California Coastal Act, California Ocean Plan requirements for desalination plant water intakes, and a Memorandum of Agreement among regulatory agencies during environmental review of applications for proposed seawater desalination facilities. Additionally, Section 3.14 of the Humboldt Bay Area Plan (consistent with Section 13142.5 (b) of the Ocean Plan) outlines requirements that the best available site, design, technology, and mitigation measures feasible shall be used to minimize the intake and mortality of all forms of marine life.

Nine hundred eighty-eight (988) creosote-treated pilings and 151 creosote-treated crossbeam supports, attached to the pilings, are proposed for removal at Kramer Dock as compensatory mitigation for biological productivity foregone as a result of the water intakes project. This is intended to create space for eelgrass (*Zostera marina*) habitat while enhancing a larger tidal habitat area, and in turn, supporting



## Mitigation and Monitoring Plan

November 15, 2022

Page 6

biological productivity. The removal of creosote piles and braces is proposed to offset a small reduction in the Humboldt Bay's biological productivity as a result of entrainment of non-special-status larval species. Following implementation, the Harbor District intends to maintain ownership of the property and oversee follow-up photo monitoring associated with the mitigation.

Mitigation Bio-6a consists of creation or enhancement of habitat within tributaries of Humboldt Bay in areas of fresh and/or brackish water suitable for Longfin Smelt spawning, rearing, or nursery habitat, as described in the FEIR (FEIR pgs. 2-52 to 2-54; SCH 2021040532; County of Humboldt, 2022). The total mitigation area will be calculated on a 1:1 basis. The equation to determine mitigation area will be  $([\text{larvae entrained}]/[1,000 \text{ larvae per female}]) * 43$  square feet. Based on current sampling and calculations, the mitigation area would be  $(24,000/1,000) * 43 = 1,032$  square feet of habitat replacement area (mitigation). This area of mitigation is feasible within Humboldt Bay, including within the Freshwater/Eureka Slough watershed. The impact assessment may be refined once the sampling is complete and final modeling is done (projected December 2022).

### Maintenance

Fish Screens shall be automatically cleaned with an automated air burst self-cleaning system as frequently as necessary to prevent accumulation of marine organic materials. Air will be blown outward through the screens, dislodging naturally accumulated organic material from the bay environment back into the bay environment. The cleaning system and protocol must be effective, reliable, and satisfactory to NMFS. Routine maintenance of screen inspection and cleaning will be done by lifting screens out of the water and cleaned. Materials removed will be disposed of offsite at an upland location. Routine maintenance of pump inspection will be done by lifting pumps out of the water. Therefore, maintenance of the water intake structures is not expected to cause impacts to bay water quality or biological resources.

### Potential Impacts to Beneficial Uses

An essential part of a water quality control plan is an assessment of the beneficial uses, which are to be designated and protected. Table 2 identifies beneficial uses for Hydrological Unit 110 (Eureka Plain, Humboldt Bay), as defined in the North Coast Basin Plan (NCRWQCB, 2018).

(See Next Page)







Within the overall 2.69-acre mitigation area, there are two, 150-foot-wide sections that will be used as barge access. Barge access locations were selected based on a previously-used location and access to South Depot Road.

The piles and cross beams exhibited a faint smell of petroleum product and are all assumed to have been treated with creosote, as was common for piers, docks, and floats for more than a century. Creosote is derived from coal tars and is made up of hundreds of thousands of chemical compounds with various forms of polynuclear aromatic hydrocarbons (PAHs), accounting for up to 90% of the creosote mixture. Even very low levels of leaching of PAHs from the weathered pilings in Humboldt Bay may still represent a risk to fishes and other marine organisms (Tenera, 2021). These toxins can accumulate in tissues of mollusks and other benthic invertebrates that do not metabolize as efficiently. An increase in concentration can result within organisms with higher fat content; this phenomenon is known as bioaccumulation. Reproduction may be inhibited, or death may occur. For some fish species, sediment contamination is linked to adverse impacts such as reproductive impairment, suppressed immune function, liver lesions, and fin abnormalities. In addition, embryonic development of the Pacific herring has been shown to be negatively affected by diffusible components of weathered creosote pilings (Washington State Department of Natural Resources, 2019).

Site selection for Phase II mitigation for LFS has not been finalized, awaiting final entrainment modeling by Tenera Environmental to be completed.

## Site Protection Instrument and Financial Assurance

Regulatory requirements of the California Coastal Commission, North Coast Regional Water Quality Control Board, California Department of Fish and Wildlife, and U.S. Army Corps of Engineers ensure the long-term protection of the compensatory restoration and mitigation project site.

The Harbor District is a public agency and subject to public agency regulations. Once permits are approved, the Harbor District will work within its overall budget to commit funds to the implementation of the project. The Harbor District will not begin the bidding process until project funds are committed. Then, the Harbor District will conduct a standard public-agency competitive construction bid process. Through that bid process, the Harbor District will be able to confirm the actual project costs and will reconcile those costs with committed Harbor District funds. As per all standard public agency contracting procedures, the Harbor District will require a bid bond, a performance bond, and 10% retention of all progress payments until project completion.

## Mitigation Work Plan

Pile removal will be conducted from shore and/or from a barge. A crane with a boom carrying a vibratory hammer and timber clamp will be used to remove the piles. Piles that break off above the bottom will be reattached to the vibratory hammer and removed. If a pile cannot be fully extracted, it will be cut off one foot below the mudline using a saw. Piles located closer to shore would likely be removed using equipment on land during low tidal periods, whereas piles further offshore would likely require removal with equipment operating from a barge. Under current conditions, the pilings likely provide some wave energy dissipation along the shoreline and the existing eelgrass beds have adapted



to these conditions. Unarmored portions of the adjacent shoreline show varying degrees of erosion, likely caused by tide and wind waves. Pile removal may alter the nearshore hydraulic characteristics of shoreline erosion, but the project does not include removal of the old retaining wood wall, which will continue to protect the shoreline (County of Humboldt, 2021).

Removal with barge: The crane referenced above would be on a barge. The barge would be approximately 80 feet X 100 feet with a 4-foot draft and would be moved with a small tugboat. After being placed on the barge, the piles would be transferred to land and then transported to and disposed of at an appropriate upland location.

Removal from shore: The crane referenced above would operate from the shore immediately adjacent to the bay. The piles would be transported to and disposed of at an appropriate upland location.

Schedule: The Harbor District will complete the approximate 1,032 square feet of habitat replacement area for LFS mitigation prior to Phase II of the project. Removal of all 988 pilings at Kramer dock will be complete prior to Phase III operation of the intake structures (Phase III is defined as cumulative water withdrawal by the intakes between 1,251 to 8,250 gpm; see Appendix 1, Section 11). This is anticipated to be within two years of permit approval.

## Maintenance Plan and Best Management Practices

The following best management practices (BMP) will be followed:

**PART 1** A Harbor District staff member or representative will be present to ensure that these BMPs are adhered to.

**PART 2** Neither the barge nor the tug will anchor during the project. The barge may attach to existing piles to maintain its position.

- a. Piles will be removed during a tide of sufficient elevation to float the barge and tugboat adjacent to the piles being removed without scarring the mudflats or injuring eelgrass.
- b. Grounding of the barge is not permitted.
- c. A floating containment boom shall be installed and maintained around each pile being removed to collect any debris, including debris floating below the surface but not sinking to the bottom, and weighted plastic mesh (similar to orange construction fencing) will be attached to the boom and extended across the area surrounding the pile. If debris sinks to the bottom, then it shall be removed by a diver.
- d. Any equipment used shall be without leaks of any coolant, hydraulic fluid, transmission fluid, or petroleum products. All equipment shall be checked before use in order to certify that there are no fluid leaks. A spill response kit, including oil absorbent pads, shall be onsite to collect any petroleum product accidentally released.
- e. Crane excavator and tug operators shall be experienced with vibratory pile removal.
- f. The crane or excavator operator shall break the soil/pile bond with the vibratory hammer prior to pulling in order to minimize pile breakage and sediment adhesion.



- g. Piles shall be removed slowly to limit sediment disturbance.
- h. Piles shall not be hosed off, scraped, or otherwise cleaned once they are removed from the sediment.
- i. Piles shall be placed in a containment area on the barge to capture sediment attached to the piles.
- j. The containment area shall include a structure around the perimeter, which precludes sediment or contaminated water from reentering the bay.
- k. Holes left in the sediment by the removed pilings will not be filled. They are expected to naturally fill.
- l. Piles and debris shall be removed from the barge and moved to a designated site for disposal preparation in such a manner as to prevent release of debris or contaminated material. Prior to disposal, the piles and debris will be stored on paved areas, in containers, or on impermeable material. Debris will be stored covered with tarps and surrounded by a soil erosion boom in order to prevent potential leaching or discharge of debris or contaminated material.
- m. All removed piles or portions of piles shall be disposed of at an authorized facility. Piles or portions of piles shall not be re-used in Humboldt Bay or along shoreline areas.
- n. Land operations shall not be conducted in wetlands in proximity to the staging site.

## Long-Term Management Plan

A long-term management plan is not proposed as part of this Plan. Pile removal is intended to allow for the natural re-colonization of aquatic organisms, including eelgrass, in the space created by the removal of the piles, compensating for the potential loss of biological productivity resulting from the water intake project. Eelgrass will be avoided using the measures described above to minimize impacts to eelgrass during pile removal. Therefore, the mitigation plan adequately compensates for all project impacts.

## Adaptive Management Plan

Working with tidal fluctuation, equipment will work from land when possible and from a floating barge when land access is not possible. Piles that break off above the bottom will be reattached to the vibratory hammer and removed. If a pile cannot be fully extracted, it will be cut off one foot below the mudline using a saw. If debris sinks to the bottom, then it shall be removed by a diver. Any eelgrass observed within the vicinity of a broken pile will be avoided during mud removal and cutting of the pile one foot below the soil surface. This includes avoiding trampling eelgrass during on the groundwork when access the broken piles and when conducting the actual removal. The contractor shall provide the location of all the broken and cut piles using a GPS unit.

## Performance Standards

In addition to the BMPs listed above, performance standards will be consistent with requirements of the California Coastal Commission, North Coast Regional Water Quality Control Board, and U.S. Army Corps



of Engineers. Implementation of compensatory mitigation would be consistent with the North Coast Regional Water Quality Control Board Basin Plan and would not conflict with the 303(d) listing for Humboldt Bay. Removal of creosote piles is supported by both the Basin Plan and 303(d) listing, as pollutant removal would occur (County of Humboldt, 2021). Benefits to the removal of old and derelict pilings reported by Tenera (2021) will include:

- reduced substrate for introduced species;
- reduced shading of the bottom of the water column;
- reduced toxic effects of creosote and other contaminants;
- reduced restrictions to flow and sediment movement;
- restoration, re-creation, or realignment of intertidal mudflats, sand flats, rock, and shellfish, eelgrass, and macroalgal beds;
- reduced navigational hazards; and
- improved aesthetics.

## Monitoring and Reporting Requirements

The Harbor District proposes to monitor the pile removal areas using photo documentation before and after pile removal efforts with a combination of drone and ground-based photo points at low tide approximately one week before pile removal, and again in the same photo point locations approximately one week after pile removal. A biological monitor will be on site as needed during pile removal efforts to document procedures and a final report will be prepared upon completion.

Success will be reported based on visual representation of the listed benefits above. Additionally, a minimum of 10 before and after photos from the same location shall be taken within the mitigation area. These photos will be used to document the success of the Mitigation, Monitoring, and Reporting Plan to be included in the final monitoring report for submittal to the RWQCB.

## Conclusion

Depressions around the base of piles are common and are most likely the result of increases in the speeds of ambient currents around the piles that pull away sediment. In an area where there are numerous piles closely spaced, such as the abandoned Kramer Dock, this effect would likely be expected to severely limit growth of submerged vegetation in the area with the piles in place. Therefore, the removal of a piling results in the restoration of a much larger area than just the area occupied by the piling (Tenera, 2021). Removal of the piles in the water will restore the habitat to support aquatic vegetation, such as eelgrass, and associated invertebrates and fishes and result in the removal of creosote-laden piles out of Humboldt Bay. Following pile removal, eelgrass currently occurring within the action area will be able to freely colonize the newly available habitat and will support increased biological productivity in this area of Humboldt Bay.



If you have any questions or comments, please call me at 707-822-5785 or email me at gobrien@shn-engr.com.

Sincerely,

**SHN**



Gretchen A. O'Brien  
Senior Wildlife Biologist

GAO:cet

## Appendix

### 1. Humboldt Bay Water Intakes Project Description Version 7

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## **Attachment N**

**H.T. Harvey Associates (12/92/22). Memorandum in response to concerns about effects of water intake operations by the Sea Chests on juvenile salmonid critical habitat.**



## Memorandum

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Project# 4444-01

December 9, 2022

**To: Rob Holmlund, Humboldt Bay Harbor District  
Misha Schwarz, GHD**

**From: Sharon Kramer and Sophie Bernstein**

**Subject: Memorandum in response to concerns about effects of water intake operations by the Sea Chests on juvenile salmonid critical habitat**

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### Executive Summary

The purpose of this memorandum is to synthesize the science on salmonid use of Humboldt Bay, or analogous habitats such as the marine portions of San Francisco Bay, to address the potential effects of seawater intake from Humboldt Bay through the Sea Chests on salmonids and food resources (i.e., prey). This memo describes salmonid use of habitats within Humboldt Bay, with a focus on their life stages, timing, duration of use, and diet. It also focuses on the location of the Sea Chests and characteristics of water at the intakes.

We considered the potential for an effect on food resources (i.e., prey) for salmonids by the intakes from the Sea Chests, which are fitted with 1 mm wire screens. Our analysis suggests that the amount of water removed by the Sea Chests relative to the volume and tidal exchange in the Main Channel, where the Sea Chests are located, is insignificant because it experiences a high level of tidal exchange, and connects to coastal waters through the Entrance Bay. In addition, tidal exchange would rapidly move large particles past the screens during flood and ebb tides, decreasing potential for entrainment.

Our findings also indicate that juvenile salmonids use the freshwater/brackish ecotones of Humboldt Bay as important rearing habitat in transition from freshwater to marine habitats, using the marine portions of Humboldt Bay primarily as a migration corridor. Once they undergo the physiological transition to survive in marine waters, they migrate relatively quickly through the bay to coastal waters. This migration occurs during coastal upwelling, when waters are highly productive and critical food resources for growth and survival are most abundant outside of the bay.

To maximize energetic gains, juvenile salmonids preferentially select and forage on the largest prey items available, and their most critical growth phase occurs in coastal waters outside of Humboldt Bay, where the most caloric food is available. With a 1 mm screen spacing, only the smallest particles (e.g., very early life stages of larval fish and zooplankton) that are unable to avoid or move away from the intakes would pass through the screen spacing: these very small organisms are a less valuable food resource compared to what is consumed in coastal waters, and any localized loss at the intakes should not impact the growth and survival of salmonids.

In addition, there is a low probability that juvenile salmonids occur in proximity of the Sea Chests. For example, outmigrating juvenile coho salmon in Humboldt Bay are known to use deeper channels during their



outmigration and are not necessarily attracted to anthropogenic structures (Pinnix et al. 2013). As such, exposure to the intakes would only be for a short duration.

NMFS's guidance indicates that "may affect, not likely to adversely affect" determinations need to be either 1) beneficial, 2) discountable, or 3) insignificant. Our analysis suggests that the intake of water at the Sea Chests is insignificant to the function of designated critical habitat of the listed salmonids in Humboldt Bay. Our analysis indicates that there would be no discernable impact to the conservation function, which for estuarine areas is to provide juvenile forage, including aquatic invertebrates and fishes supporting growth (70 FR 52488).

First, the hydrologic characteristics of Humboldt Bay is outlined as a means to contextualize the influence of the Sea Chests, followed by a summary of the movement, timing, and diet of three salmonids within Humboldt Bay. Our suggested determination of effects is included at the end of this document.

## **Hydrologic Characteristics in Humboldt Bay and Influence of the Sea Chest**

The hydrologic characteristics inside Humboldt Bay where the Sea Chests are located is an important factor to evaluate in determine the effects of seawater intakes on juvenile salmonid and their food resources. This characterization contextualizes the species-specific content on salmonids described in the next section.

The amount of water removed by the Sea Chests relative to the volume and tidal exchange in the Main Channel (where they are located) is insignificant compared to the tidal exchange in Humboldt Bay. Specifically, the Main Channel of Humboldt Bay connects Arcata Bay to the Entrance Bay, which opens to the ocean. The Main Channel has a large volume in part because it is dredged for ship navigation to industrial ports including the location of the Sea Chests, and is deeper than Arcata Bay. The tidal prism in the Main Channel between MHHW and MLLW is approximately 11.2 million m<sup>3</sup>: the volume of the Main Channel at MLLW contains over half of the maximum tidal prism from Arcata Bay (Swanson 2015). The tidal prism in the Main Channel also has enough volume at MHHW to contain more than twice the maximum tidal prism from Entrance Bay (Swanson 2015).

At mean sea level, the volume of water in the Main Channel is 35.92 million m<sup>3</sup> (Swanson 2015). Daily tides result in high levels of exchange: tides in Humboldt Bay typically exhibit diurnal inequality with a high-high, high-low, low-high, and low-low tide (Barnhart et al. 1992, Swanson 2015) resulting in a daily exchange of ~38.12 million m<sup>3</sup>. This information is important for putting the intake volume by the Sea Chests into context: the maximum intake volume is 12 MGD (45.425 m<sup>3</sup>/day), which is 0.12% of the daily tidal exchange volume in the Main Channel, and 0.127% of the total volume of water in the Main Channel. Therefore, the intakes remove only a very small fraction of water from the Main Channel, and the tidal exchange would rapidly move large particles past the screens during flood and ebb tides decreasing potential for entrainment.

Longitudinal profiles of temperature, salinity, and chlorophyll-a indicate that water quality at the intakes is similar to that of Entrance Bay (see longitudinal profiles from Swanson 2015, figures 39, 40 and 42 below) especially during incoming tides. Chlorophyll-a levels are highest during coastal upwelling periods which coincides with the outmigration timing of juvenile salmonids (see longitudinal profiles from Swanson 2015, figures 39, 40, 42 below). Since the characteristics of water in the Main Channel are similar to coastal waters, it is reasonable to assume that salmonids in the Main Channel are likely physiologically adapted to marine conditions, and are likely migrating to productive coastal habitat.

The hydrographic seasons influencing water characteristics (and determining productivity) in Humboldt Bay include the highly productive upwelling period from March to August, the oceanic period from August to November, and the Davidson Current period from November to March (Barnhart et al. 1992). The timing of outmigration of salmonids and transit through Humboldt Bay coincides with the upwelling period, when nutrient levels are highest in the region and productivity (e.g., food availability) is highest.

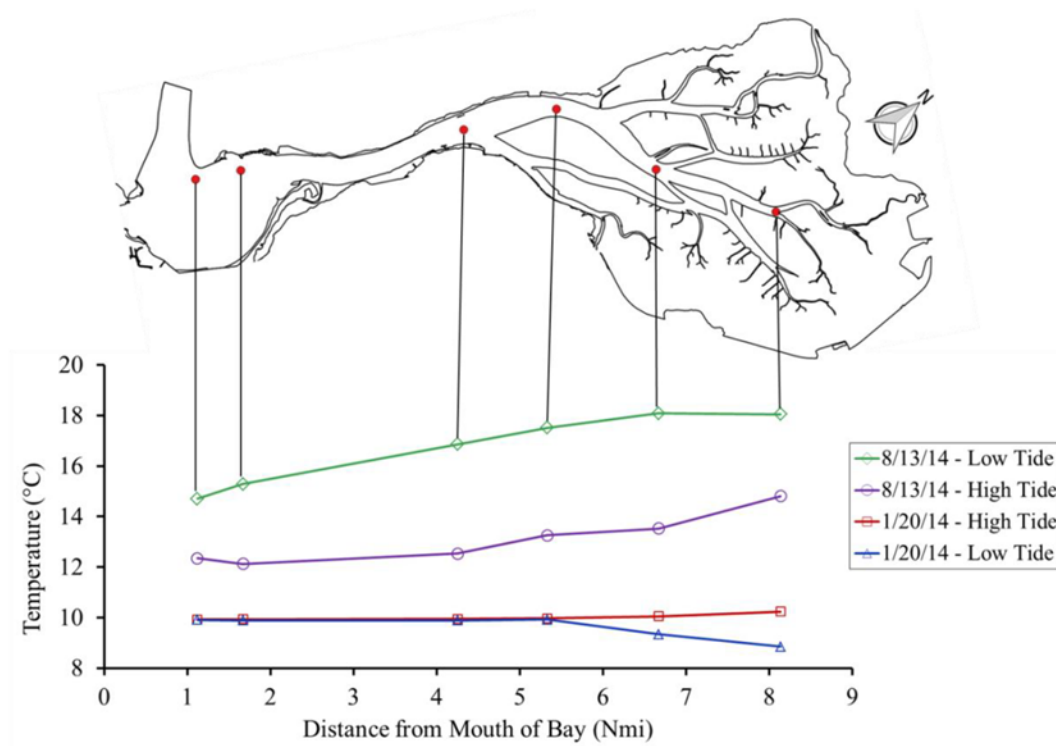


Figure 39 - Longitudinal and intertidal temperature gradients are greatest during the summer as water is heated over the shallow intertidal mud flats at low tide.

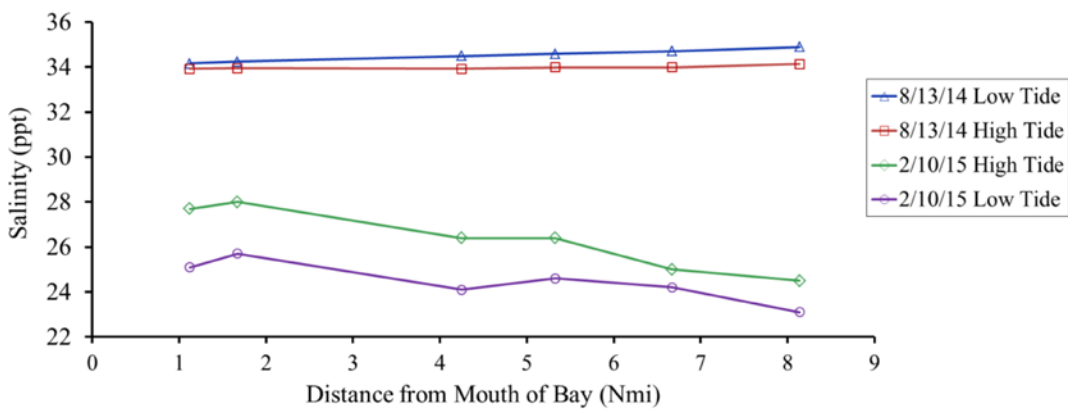


Figure 40 - Longitudinal and intertidal salinity gradients are greatest during the runoff season as freshwater runoff dilutes Arcata Bay.

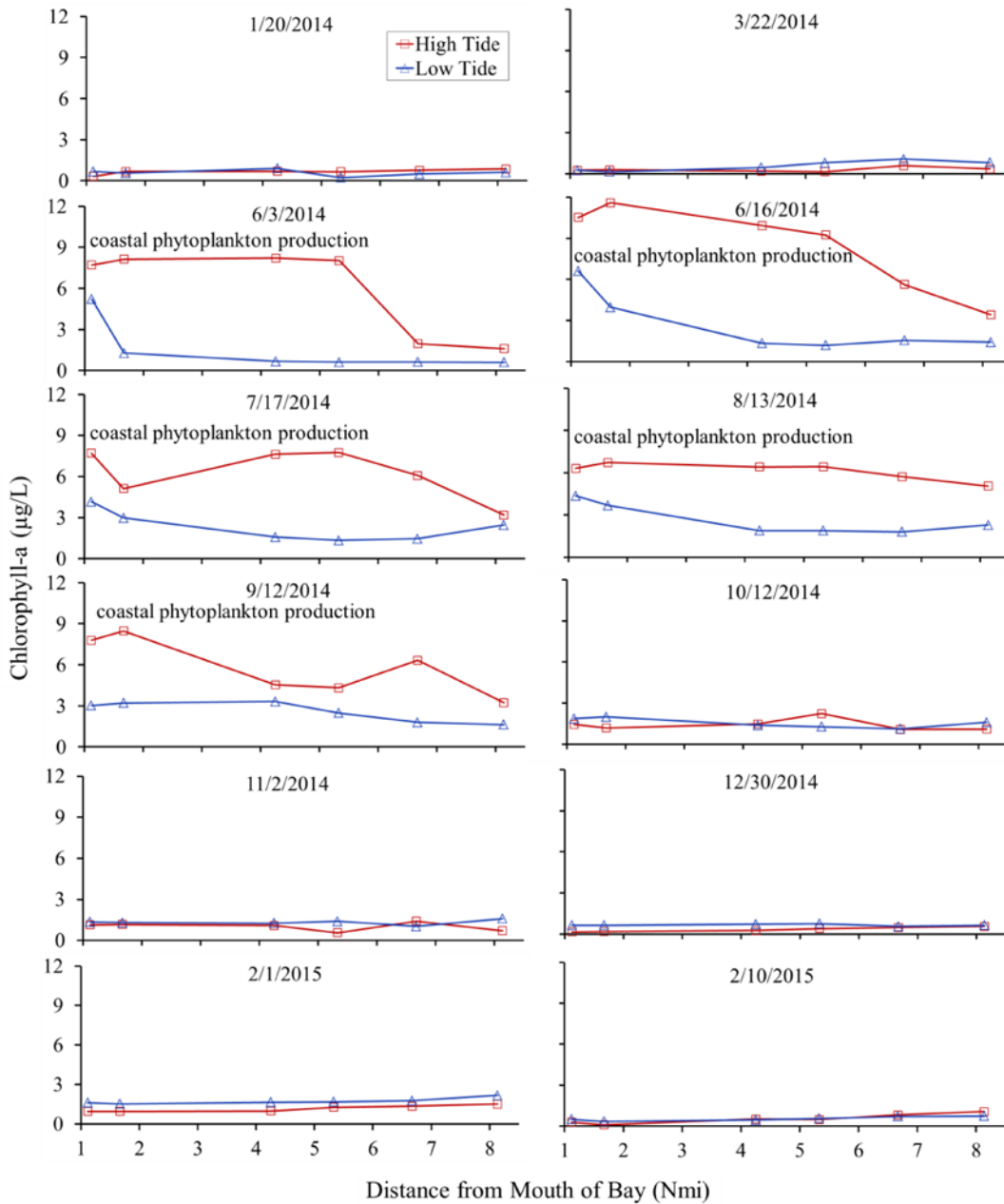


Figure 42 - High and low tide chlorophyll-a concentrations along a longitudinal transect from the Bay entrance to Arcata Bay.

### Salmonids of Humboldt Bay

Humboldt Bay supports three salmonid species that are listed as threatened under the federal ESA: coho salmon (*Oncorhynchus kisutch*) Southern Oregon-Northern Coastal California (SONCC) ESU, Northern California steelhead (*Oncorhynchus mykiss irideus*) DPS, and California coastal Chinook salmon (*Oncorhynchus tshawytscha*) ESU. Coho salmon SONCC ESU is also listed as threatened under CESA.

Salmonid life history is characterized by periods of adult upstream migration, spawning and egg development, fry and juvenile development, juvenile downstream migration, stream-estuary ecotone rearing, and oceanic foraging and growth to adulthood. This complex life history yields differential use of habitat over time. Salmonids can occur in Humboldt Bay as adults migrating from the ocean through Humboldt Bay to natal tributaries to spawn, and as smolts migrating from freshwater and brackish rearing habitat to sea to feed and grow. Each species has slightly different strategies described below.

#### *SONCC Coho Salmon*

Coho salmon (*Oncorhynchus kisutch*) are a widespread Pacific salmonid that occupy most river basins in Northern California. The SONCC ESU includes naturally spawned coho salmon originating between Cape Blanco, Oregon and Punta Gorda, CA, thus encompassing Humboldt Bay and its watersheds. The SONCC ESU is state and federally threatened. Humboldt Bay and its tributaries are considered critical habitat for this population (NMFS 1999).

Coho salmon typically exhibit a 3-year life history, split between freshwater and saltwater phases. There are two basic life history strategies for juvenile coho salmon in Humboldt Bay tributaries (Wallace and Allen 2007). The first strategy includes those that rear in the upper estuary (near salt marsh habitat) for the summer and migrate back upstream to over-winter, and the second strategy include those that rear in the lower estuary (e.g., intertidal habitat of Humboldt Bay) and then migrate to the ocean. Coho salmon residency in the tidal freshwater habitat of Freshwater Slough in Humboldt Bay was typically 25 days for yearling coho salmon (106-116 mm fork length (FL)), based on recaptured PIT tagged juveniles (Wallace et al. 2018). Coho salmon smolts (123-125 mm FL) spend less time in the lower (brackish) estuary, for an average of 10–12 days, then migrate to Humboldt Bay on their way to the ocean (Pinnix et al. 2013).

Extensive fish surveys conducted in most of the habitat types in Humboldt Bay from September 2000 through November 2001 used a variety of gear types, including minnow traps, pole seines (sampling shallow water mostly intertidal habitats near jetties, and in mud flats), beach seines (sampling intertidal and subtidal habitats from shore), and epibenthic otter and beam trawls (sampling deeper water/channels near the bottom) (Cole 2004). A total of 67 fish species from 25 families was collected in Humboldt Bay using all methods: the 10 most abundant species accounted for 94.75% of the total catch; the three most abundant made up over 55% (threespine stickleback, shiner surfperch, and topsmelt) (Cole 2004). Only 3 juvenile coho salmon, 1 juvenile steelhead, and 89 juvenile Chinook salmon were captured, contributing to <0.01% of the total number of individual fish captured (Cole 2004). Two juvenile coho salmon were captured in estuarine, subtidal, unconsolidated and sand bottom habitat measuring 93 and 99 mm total length (TL), and one juvenile coho salmon was captured in estuarine, intertidal, unconsolidated and sand habitat measuring 127 mm TL (Cole 2004). Notably, none were captured in eelgrass habitat (Cole 2004).

Juvenile coho salmon leaving freshwater and estuarine habitats occur in Humboldt Bay for 15-22 days prior to entering the Pacific Ocean (Pinnix et al. 2013). Based on acoustic telemetry of juvenile outmigrants within Humboldt Bay, juveniles primarily occurred in central, deep channels and channel margins of the bay, were rarely near pilings or docks, and were found near floating eelgrass mats in channels but not over shallower eelgrass beds (Pinnix et al. 2013). Coho salmon smolts are found in Humboldt Bay between April through July, but primarily move through the bay in May and June (Table 1) (Pinnix et al. 2013) to feed throughout the north Pacific. They reenter as adults between October and January to spawn in their natal tributaries. Therefore, juvenile coho salmon outmigrating to the sea are only present in Humboldt Bay for a short time period (Pinnix et al. 2013).

As juvenile coho salmon grow, their diets shift from consuming a mix of smaller invertebrates and smaller fishes to a diet comprised mostly of fish. Based on stomach content analysis (SCA), the smallest documented prey for juvenile coho salmon collected in coastal marine waters of the northern California Current are ~5 mm in length, and were juvenile rockfish and sculpins (Daly et al. 2009). The length of most of their food resources are larger than this, and as juvenile coho salmon grow their ingested prey length steadily increases

as well, shifting to sand lance, anchovies, and smelt (Daly et al. 2009). While the smallest of these prey items may be entrained by the intakes, such prey likely provide a relatively low contribution to the energetic intake required for rapid growth.

The most important period of growth and survival for juvenile coho salmon is marked by a shift to a more piscivorous diet dominated by larger fishes in coastal waters (Daly et al. 2009). Their feeding intensity peaks between 141-160 mm FL, at which point juvenile coho salmon shift towards eating larger forage fish such as northern anchovies, *Clupeidae spp.* and smelt (Daly et al. 2009). These fish provide the highest caloric quality food (Davis et al. 1998). The increase in piscivory by juveniles in coastal marine waters is also evident by the percent of fish in the diets of juvenile coho salmon increasing from 30.1% for small individuals between 100-120 mm FL to over 90% in individuals over 376 mm (Daly et al. 2009). Given the increases in piscivory and availability of larger fish in coastal waters, Humboldt Bay serves primarily as a migratory corridor as opposed to optimal feeding and foraging habitat. Thus, the potential for entrainment of smaller organisms by the intakes inside Humboldt Bay while juvenile coho salmon transit to the coast will not have a measurable impact on their overall survival.

Lastly, acoustically tracked juvenile coho salmon in Humboldt Bay are rarely detected near structure such as pilings or docks (Pinnix et al. 2013). In Humboldt Bay, juvenile coho salmon preferred deeper channels, suggesting that presence nearby the Sea Chests is unlikely. The juvenile coho salmon that may pass by the intakes are in transit to the coast, and any foraging that occurs along the way is incomparable to foraging and growth in coastal waters.

**Table 1. Southern Oregon/Northern California Coast Coho Salmon Life History Timing<sup>1</sup>**

	J	F	M	A	M	J	J	A	S	O	N	D
Adult migration into Humboldt Bay												
Upstream migration and spawning												
Juvenile freshwater rearing												
Downstream migration												
Humboldt Bay outmigrants												

<sup>1</sup> Peak timing indicated by dark grey.

*California Coastal Chinook Salmon*

The California Coastal ESU includes 15 independent populations of fall-run and six independent populations of spring-run Chinook salmon (NMFS 2011a). This ESU encompasses all Chinook salmon that naturally spawned from Redwood Creek in Humboldt County through the Russian River and has been listed as federally threatened since 1999, then recently updated in 2014 (NMFS 1999, 2014). Critical habitat was designated in 2005 and includes Humboldt County, and river reaches from Redwood Creek in Humboldt County to the Russian River in Sonoma County (NMFS 2005a).

California Coastal Chinook salmon are known to spawn and rear in the Eel and Mad rivers and in tributaries of Humboldt Bay such as Freshwater Creek, Elk River and Salmon Creek (Schlosser and Eicher 2012). Chinook salmon migrate through Humboldt Bay as adults returning to spawn in tributaries and as juveniles migrating to the Pacific Ocean. Adults migrate to freshwater tributaries to spawn in the fall and juveniles migrate through Humboldt Bay during their seaward migration in the spring and summer: unlike coho salmon and steelhead, juvenile Chinook salmon rear only a short time in freshwater habitats (they do not overwinter as juveniles in freshwater), and move into brackish and marine habitats. Based on studies in the freshwater/brackish ecotone in Freshwater Slough, PIT-tagged sub-yearling Chinook salmon were captured from April through June (Table 2) during which time their monthly mean FL increased from 44 mm in April



to 56-62 mm in May and to 72 mm in June (Wallace et al. 2018). Cole (2004) did extensive fish surveys in Humboldt Bay as noted above, and captured 89 juvenile Chinook salmon. Eighty-seven were captured in estuarine, subtidal, unconsolidated and sand bottom habitats with an average TL of 96 mm, ranging from 70 to 119 mm TL, and 2 were captured in regularly flooded intertidal mud habitat that measured 102 and 104 mm TL. Notably, none were captured in eelgrass habitat (Cole 2004).

Juvenile Chinook salmon migrate through Humboldt Bay on their way to the ocean; however, there is no specific information on residence time in Humboldt Bay as juvenile Chinook salmon are too small when they depart the freshwater/brackish ecotone to be implanted with acoustic tags. However, in analogous habitats in San Francisco Bay, juvenile Chinook salmon were captured by midwater trawl from RK 68 and through the bay to the Gulf of the Farallones from late April to mid-July and averaged 89 mm FL with a range from 68 to 113 mm (MacFarlane and Norton 2002). These juveniles spent approximately 40 days migrating along the 65 km length of the estuary or approximately 1.625 km/day (MacFarlane and Norton 2002). In comparison, the distance between Freshwater Slough and the entrance to Humboldt Bay is approximately 10 km, which would make residence time within Humboldt Bay on the order of 16 days, which is similar to acoustically tagged juvenile coho salmon.

During their outmigration from freshwater to marine habitats, juvenile Chinook salmon in San Francisco Bay shift their prey from invertebrates to fish larvae (MacFarlane and Norton 2002). More specifically, amphipod crustaceans and insects represented the highest index of relative importance in stomach contents of those juveniles captured directly downstream of riverine freshwater habitats. As the juvenile Chinook salmon entered the central portions of the bay, fish larvae and crustaceans had the highest index of importance in their diet. Once entering coastal waters, they feed on early life stages of euphausiids/krill, and decapods, and fish (MacFarlane and Norton 2002).

Similar to juvenile coho salmon, juvenile Chinook salmon are unlikely to experience significant impacts in their habitat or forage from the intakes of the Sea Chests. Even though the smallest prey consumed by Chinook salmon in coastal waters of the Northern California Current were *Clupeidae* spp. of ~3-5+ mm in forked length (Daly et al. 2009), which if inside Humboldt Bay and near the intakes, could be entrained, research suggests that juvenile Chinook salmon consume the highest caloric quality food available and are more dependent on coastal waters for food than embayment habitats. This is evident in that their most critical feeding and growth occurs outside of estuaries. An 11 year study on their energy dynamics in the San Francisco Bay versus the ocean found that energy gained in the estuary was 0.28 kJ/day compared to 3.2 kJ/day in coastal waters (MacFarlane 2010). MacFarlane and Norton (2002) also support the notion that coastal waters are primary sites for growth and energy gain, as body condition declined over time in San Francisco Bay, then improved (along with increases in feeding intensity) in marine coastal waters. As juvenile Chinook salmon grow, they obtain the highest caloric quality food from fish and gradually increase the proportional contribution of fishes in their diet (by weight) from 55% to 95% (Daly et al. 2009). The loss of smaller prey consumed while Chinook salmon transit through Humboldt Bay would be insignificant to their long-term fitness and survival in marine waters.

**Table 2. California Coastal Chinook Salmon Life History Timing<sup>1</sup>**

	J	F	M	A	M	J	J	A	S	O	N	D
Adult migration into Humboldt Bay												
Upstream migration and spawning												
Rearing and downstream smolt migration												
Humboldt Bay outmigrants												

<sup>1</sup> Peak timing indicated by dark grey.

*Northern California Steelhead Distinct Population*

The Northern California steelhead DPS includes the steelhead naturally spawned between Redwood Creek, Humboldt County and the Gualala River, Sonoma County. This DPS has been federally threatened since 2000 (NMFS 2020) and contains winter and summer populations. Critical habitat was designated in 2005 and consists of river reaches between Redwood Creek south to Point Arena on the Mendocino coast (NMFS 2005a). Humboldt Bay and its tributaries are included in its critical habitat (GHD 2021). Northern Californian steelhead are known to rear in tributaries of Humboldt Bay and migrate through the bay itself on their seaward migration as juveniles. After reaching the ocean in the spring, juvenile steelhead tend to move offshore quickly rather than use nearshore waters like other salmon. Adults also migrate through Humboldt Bay to reach their tributaries to spawn in winter and early spring.

The mean length of estuarine residence for juvenile steelhead PIT-tagged and recaptured in the freshwater/brackish ecotone habitat of Humboldt Bay was 37 days and size ranged from 82 to 192 mm FL, with captures primarily between April and August (Table 3) (Wallace et al. 2018). Notably, only 1 juvenile steelhead measuring 126 mm TL was captured by Cole (2004) in extensive fish surveys in estuarine subtidal unconsolidated and sand bottom habitat.

Juvenile steelhead collected inside the Columbia River estuary and those in marine waters outside of the brackish, estuarine water plume exhibit clear shifts in their feeding behavior and physiology. Those in marine waters offshore ate more, grew faster, and had improved body condition metrics (Daly et al. 2014), suggesting that their most important foraging and energetic gains are outside of estuaries and bays. Those in estuarine waters consumed far less food (primarily amphipods), and had decreased body condition and stomach fullness metrics (Daly et al. 2014). While amphipod crustaceans may be of a size class that is entrained by the intakes at the Sea Chests, it is unlikely to represent a significant loss of food resources because juvenile steelhead are more reliant on marine waters for energetic gains. Their reliance on marine waters for growth is evident by the fact that juvenile steelhead move quickly from coastal marine waters to water further offshore (Daly et al. 2014).

It has been found that once in marine waters off Washington, the dominant prey in terms of biomass for juvenile steelhead were fish, followed by euphausiids and *Cancer spp.* larvae (55.3%, 20.3%, 9.8%; Daly et al. 2014). Miller and Brodeur (2007) also found that juvenile steelhead in northern California and Oregon may be more reliant on euphausiids compared to their trophically similar counterparts, Chinook and coho salmon. While juvenile steelhead rely heavily on euphausiids, euphausiids are abundant along the coast but none were collected in the Main Channel (near the Sea Chests) during sampling efforts characterizing entrainable taxa present inside Humboldt Bay (J. Steinbeck, Pers. Comm., 2022).

**Table 3. Northern California Winter-Run Steelhead Life History Timing<sup>1</sup>**

	J	F	M	A	M	J	J	A	S	O	N	D
Adult migration into Humboldt Bay												
Upstream migration and spawning												
Downstream kelt migration												
Juvenile rearing												
Downstream smolt migration												
Humboldt Bay outmigrants												

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<sup>1</sup> Peak timing indicated by dark grey.

## Determination of Effects

Our analysis suggests that the intake of water at the Sea Chests is insignificant to the function of designated critical habitat of the listed salmonids in Humboldt Bay. Our analysis indicates that there would be no discernable impact to the conservation function, which for estuarine areas is to provide juvenile forage, including aquatic invertebrates and fishes supporting growth (70 FR 52488), for the following reasons:

1. The amount of water removed by the Sea Chest is insignificant relative to the volume and tidal exchange in the Main Channel. Tidal exchange would rapidly move large particles past the screens during flood and ebb tides decreasing potential for entrainment.
2. Juvenile salmonids use the freshwater/brackish ecotones of Humboldt Bay as important rearing habitat, then migrate relatively through quickly (a few days) to reach coastal marine waters. It is in these coastal marine waters where they experience extreme growth and energetic gains.
3. Juvenile salmonids migrate out of the bay during the upwelling period when productivity is at its maximum. Since they preferentially consume resources and larger prey (that peak during upwelling) outside of Humboldt Bay to maximize their energetic gain, entrainment of smaller prey inside the bay from the intakes is not likely to have a measurable impact on juvenile salmonid's growth and survival.
4. There is a low probability that juvenile salmonids occur in proximity of the Sea Chests. They move quickly through the bay, do not appear to be attracted to structures similar to that of the Sea Chests, and do not appear to use habitat where the Sea Chests are located (Pinnix et al. 2013, Cole 2004). Therefore, prey that could be entrained by the intakes unlikely to be a primary food source.

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