SUPPLEMENTAL INFORMATION #1

For Planning Commission Agenda of:
July 28, 2022

[ ] Consent Agenda Item
[ ] Continued Hearing Item No. G-1
[x] Public Hearing Item
[ ] Department Report
[ ] Old Business

Project Title: **Nordic Aquafarms California, LLC,** Coastal Development Permit and Special Permit
Record Number: PLN-2020-16698
Assessor Parcel Numbers: 401-112-021
Samoa Area

Attached for the Planning Commission's record and review is the following supplementary information:

1. Additional Technical Memorandum on Humboldt Bay Water Intakes prepared by SHN

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**

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Bay as it relates to the proposed Humboldt Bay Master Baywater Intake System, including an evaluation of volumes withdrawn by the system relative to the volumes of water exchanged due to natural tidal processes.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.

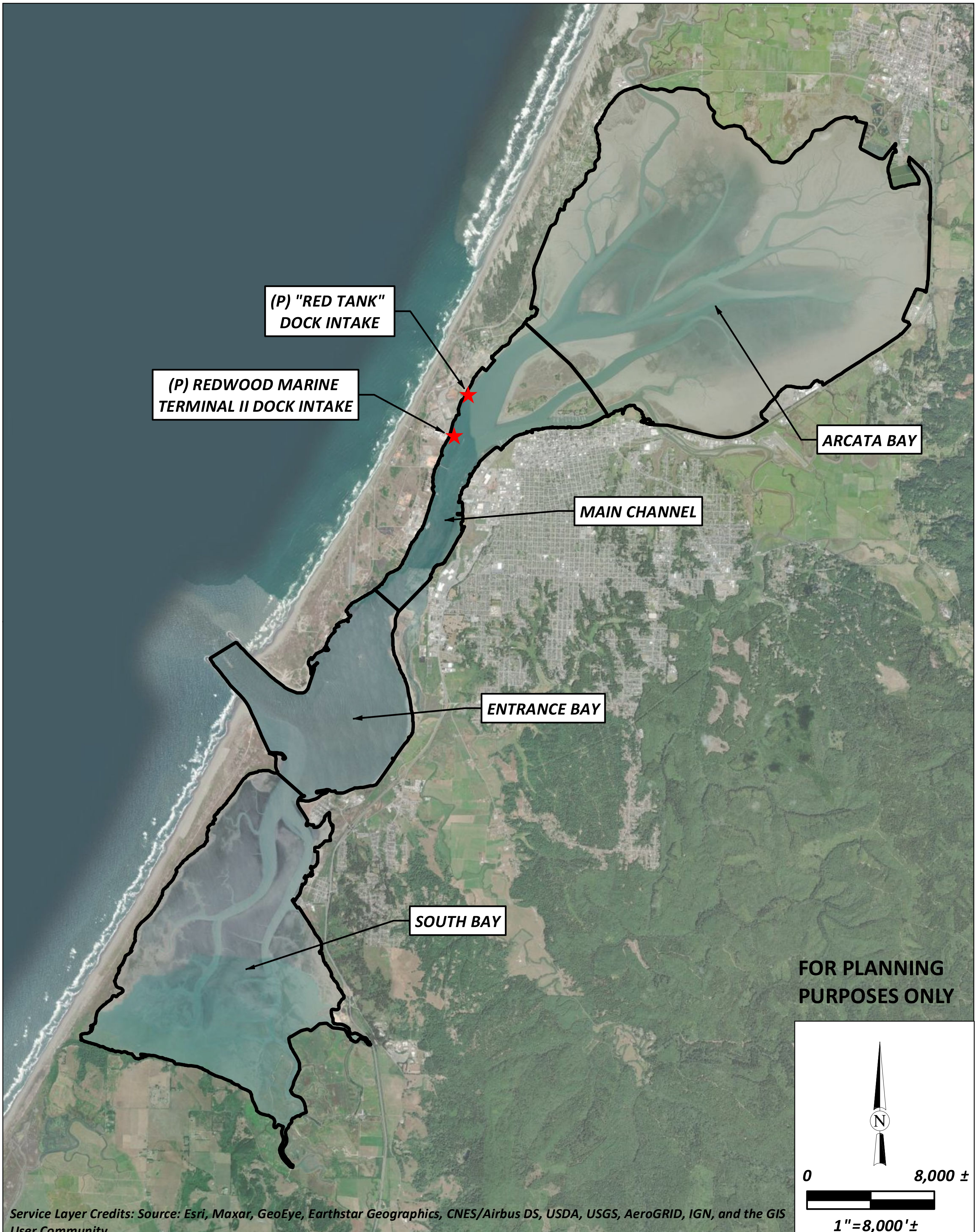
Part 1: Tidal Dynamics Relative to Proposed Intake System

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 the 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.

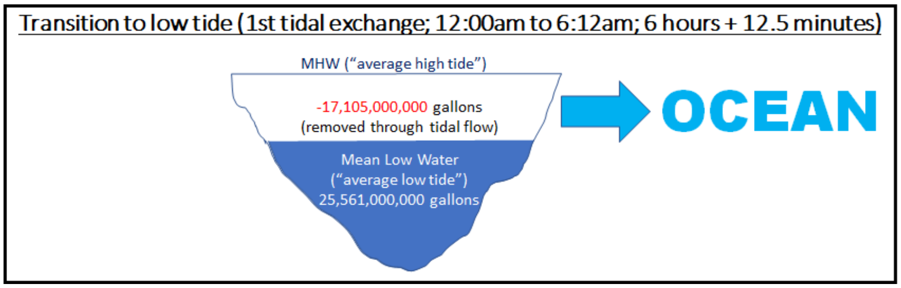


Path: \\Eureka\Projects\2016\016240-Engr-HBHRCD\005-Intake-Screen\GIS\PROJ_MXD\BayIntake_BayCompartments.mxd User Name: cswanson DATE: 7/11/22, 1:39PM

SHN	HBHRCD Humboldt Bay Intake Screens Samoa, California	Humboldt Bay Compartments SHN 016240.005
	July 2022	BayIntake_BayCompartments
		Figure 1

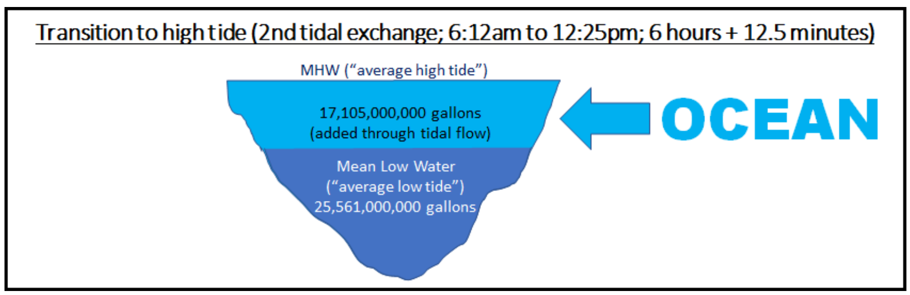
General Tidal Dynamics in a 24-hour Period

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:



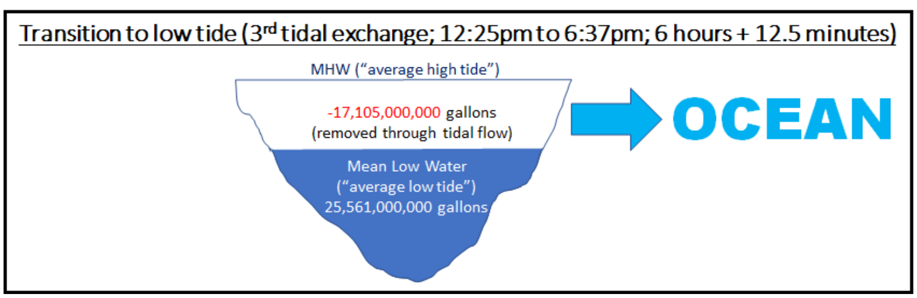
Transition to low tide (1st tidal exchange; 12:00am to 6:12am; 6 hours + 12.5 minutes)

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.



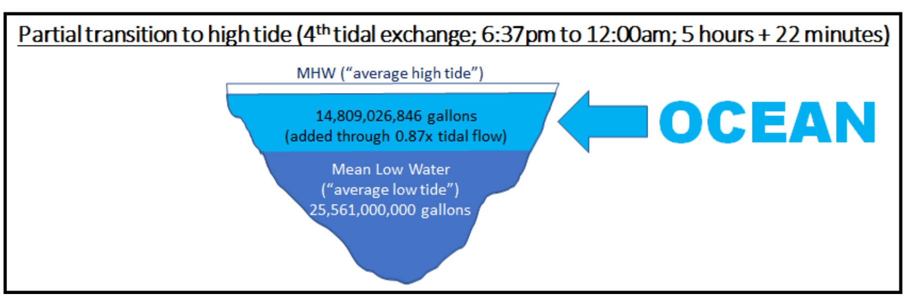
Transition to high tide (2nd tidal exchange; 6:12am to 12:25pm; 6 hours + 12.5 minutes)

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.



Transition to low tide (3rd tidal exchange; 12:25pm to 6:37pm; 6 hours + 12.5 minutes)

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).



Partial transition to high tide (4th tidal exchange; 6:37pm to 12:00am; 5 hours + 22 minutes)

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).

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**
Total Source Water Volume (MSL+(1.93*[Tidal Prism]))	**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 1/5525th 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 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.[1]

***Table 3**. Intake flow rates for the three phases of operation and daily percentages of the source water (SW).*

	A				B			C	D	E			
	ACTIVITIES OCCURING DURING INCOMING TIDES (in millions of gallons)				ACTIVITIES OCCURING DURING OUTGOING TIDES (in millions of gallons)			TOTAL GALLONS OF WATER WITHDRAWN (A.2 + B.2) (millions)	BASELINE GALLONS OF WATER IN HBAY (MLW) (millions)	SOURCE WATER DURING TIDAL EVENT (A.4 + D) (millions)	WATER WITHDRAWN RELATIVE TO SOURCE WATER		
TIDAL EVENT	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
TOTAL (24-HOURS)	**31,914**	**(5.734)**	**5.734**	**31,920**	**(34,210)**	**(6.146)**	**(34,204)**	**(11.880)**	**25,561**	**57,481**	**0.000207**	**0.0207%**	**4,838**

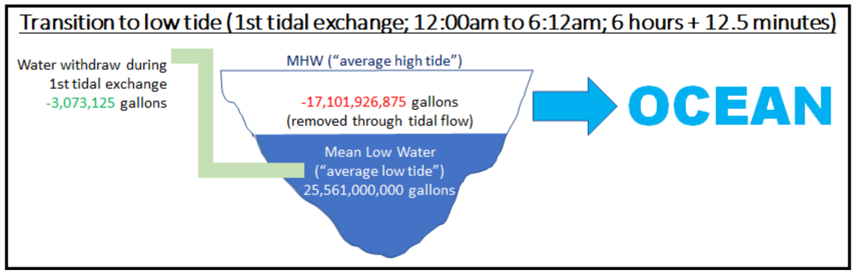
COLOR KEY	
Blue #s = Gallons of water entering the bay from the ocean	Red #s = Gallons of water leaving the bay and going into the ocean
Green #s = Gallons of water leaving the bay and going into the intake syst	(#s in parathenses) = Reduction of the amount of water in the bay

[1] 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 1/4,838th) instead of the 0.0181% (or 1/5,532nd) shown under Table 2 (which shows an average daily tidal cycle).

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 1/8,318th. In an average 24-hour period, the intake system withdraws 0.000207 or 1/4,838th of the total source water volume.

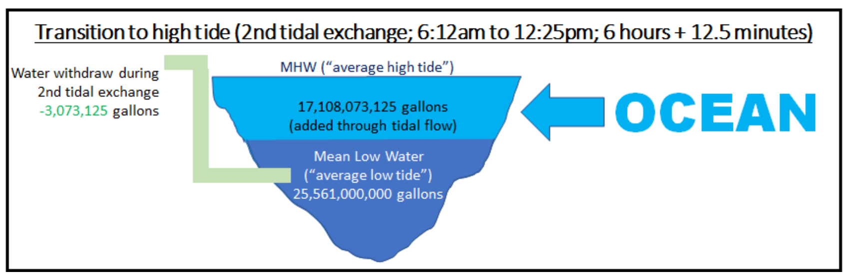
The following provides a generalized step-by-step description of the intake system relative to daily tidal dynamics by visualizing an idealized 24-hour period:

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 1/8,318th of the source water.



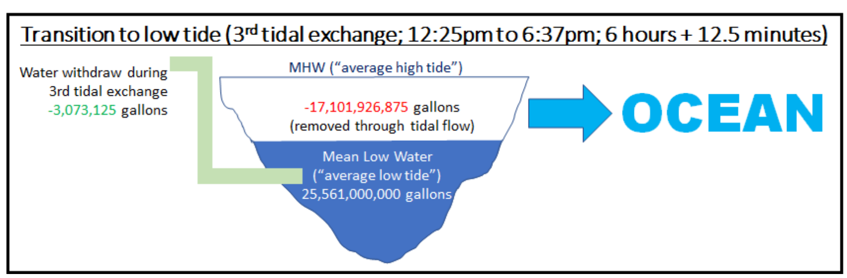
Transition to low tide (1st tidal exchange; 12:00am to 6:12am; 6 hours + 12.5 minutes)

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 1/13,885th of the source water.

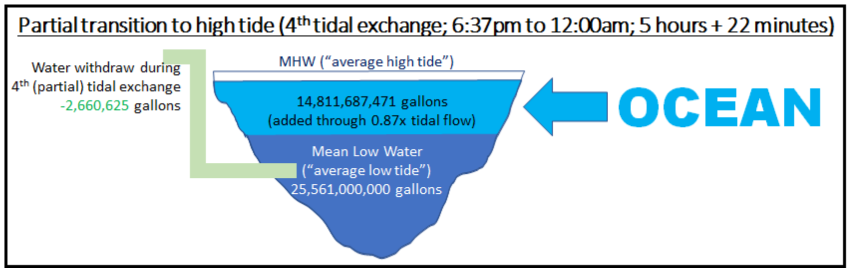


Transition to high tide (2nd tidal exchange; 6:12am to 12:25pm; 6 hours + 12.5 minutes)

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 1/8,318th of the source water.



Transition to low tide (3rd tidal exchange; 12:25pm to 6:37pm; 6 hours + 12.5 minutes)



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/ 15,174th 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 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 1/13,885th 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 1/8,318th 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.

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Sydeman, W. J., S. Dedman, M. Garcı´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.

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 ($ft^3 \times 10^6$ [$gal \times 10^6$])			
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