# Concept Paper for the Ocean Storage and Transport of Fresh Water by the use of Water Bundles

(Patent pending)

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Houston, Texas

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713  834 7905

**Concept Paper for the Ocean Transport of Fresh Water**

Around the world billions of people struggle on a daily basis to find the most basic of commodities, water. It is said that 60 per cent of the planet's population lacks access to potable water of acceptable quality or in adequate quantity. The majority of the world's megacities and most of the world's population live within a hundred miles of a salt water coast line and these already stressed cities will need to provide for an additional 2 billion inhabitants by 2050.

The American Southwest also faces water challenges. While not the life threatening situations of the African Sahel, they are real and actions are being taken, not all of them popular. As of this first writing (2013), the Southern Nevada Water Authority was being sued to stop it from building a multibillion-dollar pipeline to the Northeastern area of the State to tap underground aquifers in the area. Over 40,000 pages of public comment were submitted as part of the permitting process and the pro and con have been well documented. The matter now lies before a state judge while Lake Mead is at record lows not seen since it was filled in the 30's.

The City of San Diego, low on the list for Water Rights to the Colorado River's oversubscribed and drought shrunken flow, has signed a contract for a Billion-dollar Reverse Osmosis plant in Carlsbad, Ca. Financed through a take or pay contract that will produce 7% of the City's needs, the 50 million gallon a day plant will see evaporative losses of about 3 million gallons a day from the production of the electric power needed to run the plant. The plant was completed in late 2015 and then it started raining.

The Bureau of Reclamation is the big, but by no means only player when it comes to water in the West. It is both aware and active in dealing with the ongoing and worsening situation. To that end, it periodically funds studies on various aspects. One study, *Colorado River Basin Water Supply and Demand Study,* (copies attached) is a comprehensive but historical document. As such it only serves to catalog existing knowledge and never attempts to correct assessed flaws or make improvements to the examined technology.

We think there is an opportunity and a need to re-examine the previously studied options for ocean transport; specifically, water bags, use of tankers and the towing of icebergs. We found four main reports associated with the Colorado River Basin or the proposed pipeline that included cursory examination of ocean transport. The later reports rested on the earliest ones and like them quickly dropped these methods of augmentation based only on the actual and limited history of the three methods.

We don’t disagree with those assessments but wonder why no consideration was given to possible improvements or innovations that might have made the basic concept, (import via ocean vessel with rights swaps) viable from an economic, technical and environmental perspective. A short critique of the methods as they now stand is given below.

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**Key issues with each**.

*Converted Oil Tankers*

In our reexamination we too could not find a way to justify the use of tankers. While we do think they could be cleaned and lined to meet water quality issues the costs of the conversion and subsequent operations eliminated them in our judgment as well. As proposed, the tankers for the Colorado River Basin would have been at the end of their useful service lives. How well the owners would have maintained them in the final leg of their service lives was a cause for concern.

However, studying tanker operations in crude oil service offers some insights into large volume, deep draft vessel techniques. The Colorado report dealt with single hulled US tankers forced into retirement as a part of the Exxon Valdez spill. Elsewhere five Ultra Large Crude Carriers have been built in the last 40 years. Too big to get into traditional ports and terminals, special offshore moorings and pipelines were needed to support these ships. Later in their service lives they were permanently moored and served as storage vessels. The methods used to handle these vessels have applications for ocean transport of fresh water.

The proposed use of converted tankers for water transport to Southern California had operational constraints because of the high operating cost of the converted tankers which meant loading and unloading had to occur quickly to minimize these costs. The source water had to be available in great volume or the tanker would have literally sucked the stream dry.  People realized this and opposition formed on this and other issues. Conversely, the unloading operation needed sufficient terminal capacity to handle the water upon arrival and move it to the treatment and distribution system.  The lesson to be learned for water transport from the tankers is to separate the storage function of the vessel from the propulsion and labor elements. i.e. load as water becomes available, and unload as needed.

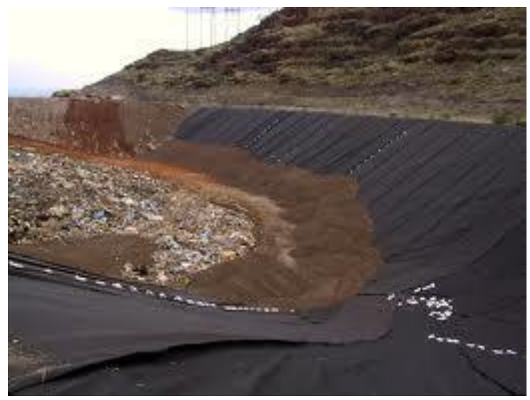
**Two of the largest ships ever built. Up to 81’ draft and too big to transit the English Channel.  A 69m beam and 450m in length**.

### Iceberg Towing

Not a very complicated idea but one that has a huge challenge.  Like the small child with an ice cream cone on a hot day, the challenge is to consume it before it melts. The towing is actually the easy part and is a matter applying the necessary towing power and paying for it.

To solve the melting problem, wrapping the berg was proposed but no one has been able to figure out how to wrap an iceberg at sea and in very cold water.  Recently, Cape Town, South Africa saw their reservoirs empty and a local Salvage Operator was proposing using tankers not to carry water but to tow icebergs after some how wrapping them in the frigid waters off Antarctica.  The situation and his proposal got serious consideration and World-Wide press.  Then it started raining.

The kernel of wisdom in the approach was the use of a wrapping material to keep the fresh melt water separate from the salt water of the ocean.  An impervious liner large enough can be made but there is no way to maneuver it around an iceberg as large as a football stadium, nine tenths of it underwater. But the liner and the technology to make it exist.



**Landfills being fitted with impervious vinyl liners.  Liners come in various materials and are delivered on large rolls which are then welded together. (Yes plastics can be welded)**

**Water Bags**

We actually liked the water bag approach until we looked at the gap in scale between moveable volume and volumes needed.  That and the potential for tears and the difficulty to repair while loaded.  The biggest problem seems to be in getting water bags up to and beyond tanker or iceberg volumes and then being able to tow them. The only way to justify the handling costs that would be associated with bags is to get volumes up to a level far beyond anything achieved to date. We think the water bag concept can be modified to get above tanker and iceberg volumes. The use of ocean going tugs was cost prohibitive for the bags (labor and fuel) for the volumes involved and tearing was a result of the material being put under a tension load during tow.

A more detailed assessment of the three approaches can be found in the various reports. We now turn to possible innovations and improvements that could make Ocean Transport and Storage a viable option.

In general, the movement of a bulk material is governed by the need to move the largest volume with the lowest cost. Grains, coal and aggregates are examples of such bulk material. Chemicals, food stuffs and other products, while having bulk like characteristics, have more specialized handling requirements which may be more important than lowest cost and are handled in smaller volumes.

Water with its low cost to volume ratio is in a class by itself and has to be handled in the greatest volume of all. When this rule is applied to Ocean Transport, in a non pipeline mode, only volumes not previously contemplated can meet the economically justifiable criteria. For example, at the start of 2016, crude oil prices were around 30 dollars a barrel (about 70 cents per gallon) while the cost of the produced water from the Carlsbad reverse osmosis plant was about **.6** cents per gallon nearly a 100 to 1 cost differential.

For Ocean Transport to be viable from a cost perspective an individual volume has to compete with the cost of water from Reverse Osmosis. That volume of water needs to be large enough to absorb incurred expenses and in our view becomes viable as volumes approach 1Billion gallons or about 3000 acre/ft.

**Can it be done? And how?**

The above mentioned Ultra Large Supertankers and others like them could carry as much as 4 million barrels of oil. Converted to gallons, 168 million. For a water vessel to be economically justifiable it would need to have a carrying capacity of an unprecedented scale, roughly five to six times that of these huge tankers.

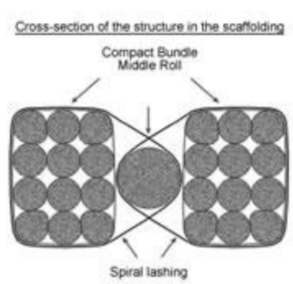
You cannot build such a vessel out of steel. What is needed is a method to create a **structure** capable of being wrapped with a water bag like material to produce an impervious barrier. The outside liner or skin of the vessel would have to be extremely tough to resist tears and routine abuse.

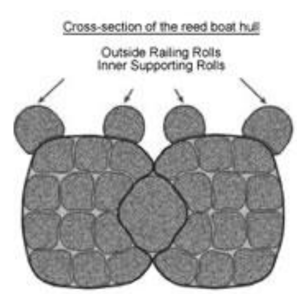
**Marine ship fenders which are extremely tough**.

But to get to the 3000 acre foot target the skin would have to be supported by a structure onto which the skin could be applied and a foam layer included beneath it.

One way this can be done by assembling individual buoyant tubes into bundles of seven, securing them and then assembling seven bundles into an even larger bundle. Why seven? Place seven equivalent coins together and the geometry becomes apparent.

Some years ago, Norwegian Thor Heyerdahl built and sailed the Ra II, a bundled reed boat on several ocean voyages. The reeds acted like the tube structure we are proposing, each contributing a small amount of structure and buoyancy in order to create a large volume supported by the sea itself, but like the iceberg largely underwater.

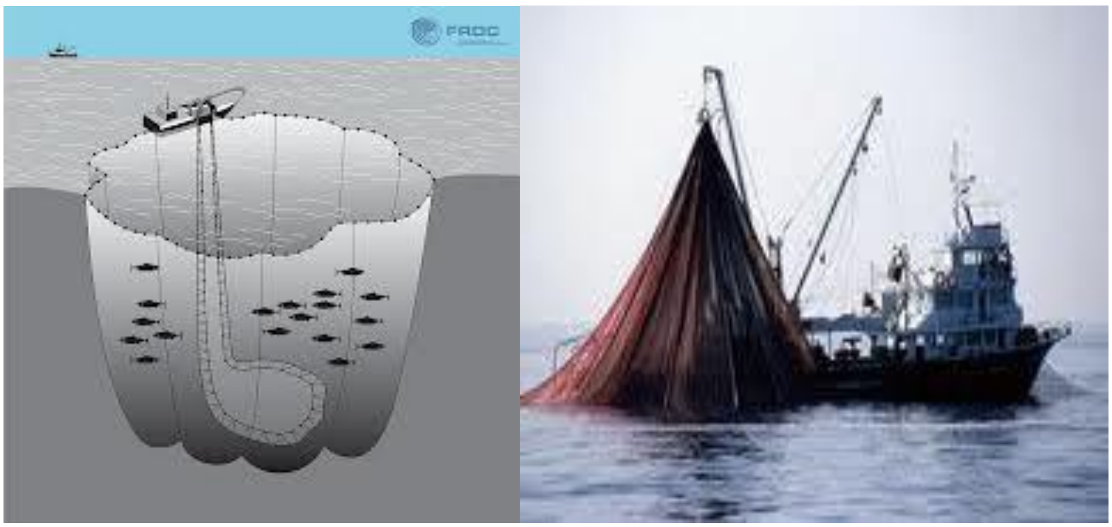






**The RA II and cross section of the reed bundles.**

The bundles of bundles in turn are wrapped with a net fabricated in situ over the exterior (membrane) to take the strain of the tow. With the buoyant tubes supporting the liner (membrane) and fresh water less dense than salt water, the entire vessel floats, but barely, above the surface.

Bundling offers both a resistance to compression and tensional forces which will be encountered at sea.  We have found and are exploring several other geometries that may offer cost and construction options.



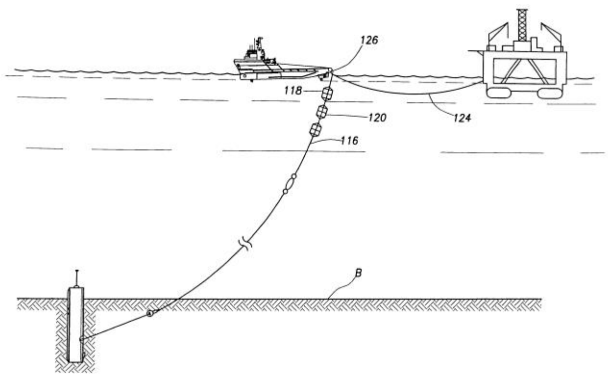
**A commercial fishing purse seine net, indicating a sense of scale**.

**Operations**

As our focus is a rethinking of ocean transport, part of that thinking has to be on the motive power needed to move and control such a large mass.  The reports site high energy consumption and lease rates for tugs and rightly so.  While water bags and ice-berg towing relied on ocean going tugs and tankers were self contained as to power, we would suggest an alternative method, stationary tow.

What might be a better approach is to tow the vessel by use of a capstan on an anchored, floating platform.  A series of such platforms along a predetermined and semi permanent route would provide the means to control and move the vessel. Ocean going ships have such capstans mounted on their decks to provide maneuverability during docking operation and require relatively low power to move the ship.  The Panama Canal uses a semi stationary capstan mounted on a small rail locomotive to move ships through the locks. It is just a very efficient means to move floating vessels when one end of the tether is stationary to the land or sea bed.

For a route measured in hundreds or even thousands of miles many such platforms would be needed and some in deep water.  We again turn to the offshore oil industry for inspiration.  Oil drilling platforms can be anchored in waters of 10,000 feet with what are known as suction anchors and which actually work better as depth increases.  From such an anchor a concrete barge platform could be tethered with sufficient deck space for the capstan and flaking the towline.




**Configurations of suction anchors**

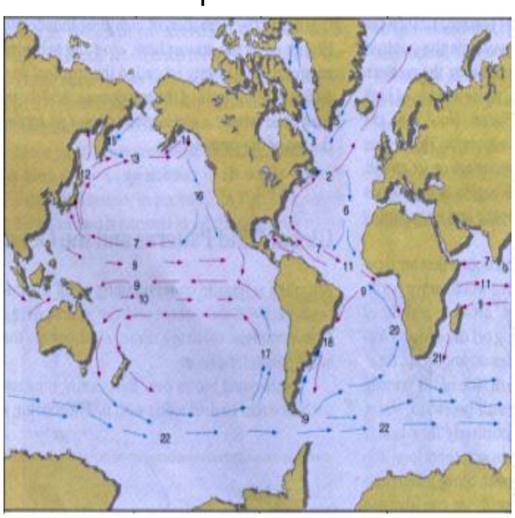
A Mobile Reservoir

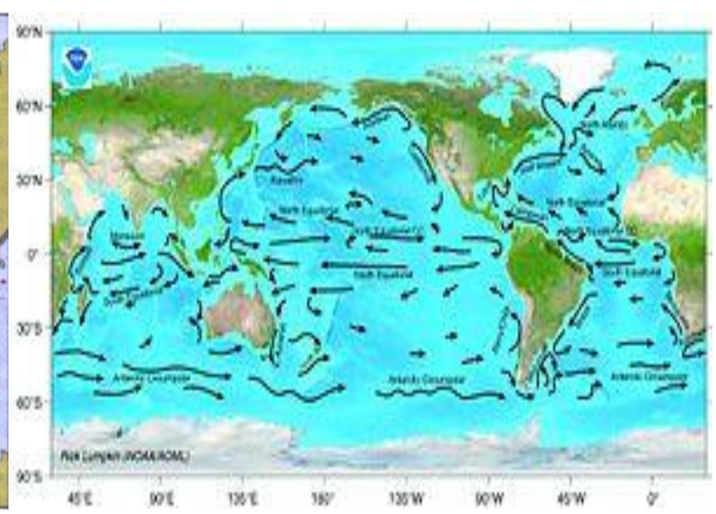
Previously mentioned was opposition to water withdraw from streams.  Fearing impacts on salmon runs people were loudly opposed. Sitka Alaska was a notable exception as they had a glacier fed lake as a supply source. To address this issue we feel that mooring a tube bundle offshore and connecting it to shore with an appropriately sized pipeline (routine in oil production) and allowing the local water authority to fill on an "as available" basis would address this issue.  Of course this means multiple tube bundles and mooring points.  However, in this manner floating reservoirs are created along the length of the supply chain.  Multiple tube bundles could be moored together offshore Southern California and be available on an as needed basis. For the currently proposed Nevada pipeline project, the annual water take is to be 84,000 acre feet.  At 3000 acre feet per bundle, 28 bundles would yield the equivalent volume and act as an on demand storage facility.

Labor to handle this process is largely available in the form of the West Coast fishing industry.  Already accustomed to the equipment that would be used and working in the marine environment, the system could be set up on a zone basis. Typical medium size fishing boats have on board power to operate the capstan and labor to handle the load line as well as experience in handing very large nets or long lines used in ocean fishing.

Large fishing boat and small capstan

Aiding the stationary tow process is a favorable pattern of wind and current that moves south along the west coast. The back haul, after refilling with salt water, takes advantage of the westerly wind pattern and a tow pattern to the north.  Dependence on winds and currents may seem antiquated in today’s world but prior to steam, was how ocean trade operated.





Wind patterns and ocean currents

## Buoys

Previously mentioned were suction anchors and their use to hold either a mooring or a platform buoy. The mooring buoy is used for loading and unloading while the platform buoy is used for the transit portion of the system. Pictured below are the LOOP (Louisiana Offshore Oil Port) buoy and a tanker offloading to it. A pipeline carries the oil to onshore storage tanks.


A similar process would be used for water transfers in sufficiently deep water. In the case of Las Vegas, water rights swaps would have to be negotiated with Southern California or even Mexico.

## Summary

The above document is a conceptualization of how innovation and modification of existing technology could come together to partly solve a growing worldwide problem. There remains considerable work to be done just in looking at the feasibility of such an effort. However, the Nevada water shortage situation is not unique and the cost estimate for the pipeline project is staggering.

We have tried to offer insight into addressing some of the environment impacts of the ocean transport method and also address opposition to stream takings through job creation in the depressed fishing industry and by putting control of the volume shipped in local hands. We feel that the energy and carbon emission numbers will be found to be low and that the fabrication of the bundle could use considerable recycled plastics.

We would like to see the Bureau of Reclamation, Southern Nevada Water Authority or the States of Colorado River Compact work with us to reexamine Ocean Transport. By lowering energy consumption while increasing volume the economics change enough so that this method deserves a second look.

Robert Pulliam

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Part II, Texas

A state water plan was recently the subject of an article by the Dallas Morning news. The reporter gave an account of an ongoing conflict between interests in the Dallas area and Northeast Texas landowners over the submerging of nearly 100 square miles of rural land to create a 3.4 Billion dollar, 472,000 acre/foot yield reservoir to serve far away but fast growing Dallas. Needless to say, the matter has found its way to court.

East of San Antonio, a $400,000,000 proposal is moving along to make available 75,000 acre feet per year. All told, some 53 billion dollars worth of projects are in motion. Will it be enough, can we afford it?

As of the summer of 2014 the drought conditions have eased in East Texas but worsened in North Central Texas and California.  The situation had gotten bad enough in Wichita Falls, Texas so that the Texas Commission on Environmental Quality approved a six month trial of direct reuse of discharged waste water, a first in the state for a city this size.  Not far from Wichita Falls, Fort Worth residents pay $10 per 1000g or about a penny a gallon or over $3000 per acrefoot.

The  Dallas-Fort Worth water region, known as Region C, covers part or all of 16 counties. Its latest regional plan, contained in the state water plan, has some proposed short- and long-term water strategies.

**Marvin Nichols Reservoir**, providing up to 472,300 acre-feet per year of water. Capital cost: $3.4 billion. (Opposed by Region D water group in northeast Texas.)

**Lake Tawakoni pipeline project,** providing up to 77,994 acre-feet per year of water. Capital cost: $496 million.

**Toledo Bend Reservoir supply**, providing up to 400,229 acre-feet per year of water. Capital cost: $2.4 billion. (Some cost-sharing with another region.)

**Reallocation of flood pool of Wright Patman Lake**, providing 112,100 acre-feet per year of water. Capital cost: $897 million.

SOURCE: Texas Water Development Board

While the first part of this paper dealt primarily with use of the Bundles as transport for Western States, Texas, or parts of it actually get a lot of rain.  The issue here is more of a storage matter.  Of the ten most critical cities for water supply in the US, three, Houston, San Antonio and Fort Worth are in Texas.

These projects and others in the water plan can be added together to produce a capital cost per acre/foot supply capacity in the range of $7000 per acre/foot.

The averaged number for these four projects can be used to quantify the bundle storage value by multiplying the value and the volume (3000 acf/bundle X 7000 dollars/acf = $21,000,000.

While the bundle does not yield secondary, but legitimate benefits such as recreation and land appreciation it does not suffer the evaporative water losses either. The 21 million dollar value is a place to examine what might be a justifiable cost for construction of the water bundle.

Preliminary estimates for total amount of buoyant plastic needed to build the bundle were developed to see if the unit could be built and where it would fall in terms of allowable costs per acre foot. We think it is worth taking a more detailed look. The key will be designing a tube or a structure with enough compressive resistance while minimizing the amount of material used. For inspiration, the following real-world bridges can offer some guidance in design.

Calgary’s pedestrian Peace Bridge

European light rail bridge.

For the Water Bundle to be cost effective a similar minimal material approach would be needed.  Texas, with both the basic plastic industry and a wealth of offshore fabrication companies may be in a unique position to develop this approach.

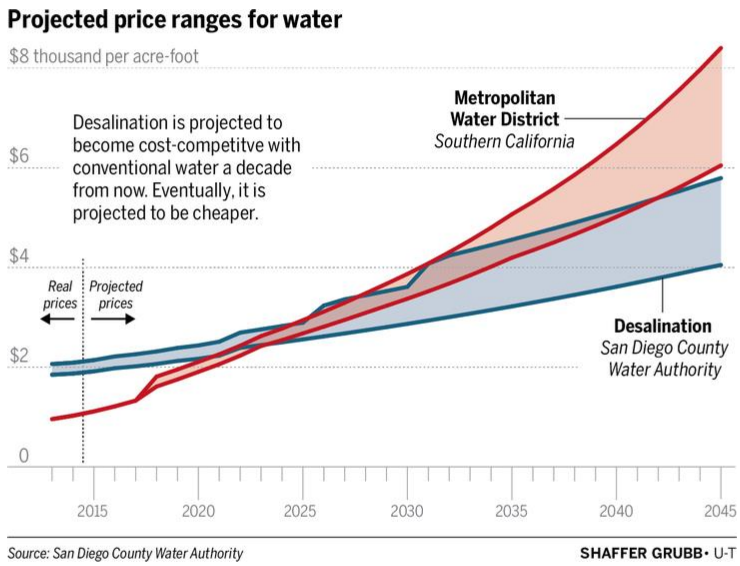
Tubular Rail Inc. is a small closely held US corporation developing several patented and pending innovations in Water supply/transport.and passenger and freight transportation The subject of this grant request concerns the use of Water Bundles for Ocean Transport and Storage of fresh water in economical quantities.  In the past those concerned with water supply and storage have focused on reservoir construction using dams, aquafer explotation and new technology such as reverse osmosis or vaccum distillation.  While these methods have been effective in the past, a changing world means that the old methods may not work as well in the future of are no longer as cost effective.

This is not a new observation and others have worked todevelop Ocean Transport as a viable alternative.

In the San Diego area, the Carlsbad Reverse Osmosis plant will generate 50 million gallons a day of fresh water for an investment of nearly a billion dollars. The plant represents an absolute dollar amount that is required to obtain fresh water at any cost in that its source of feed water, the Pacific Ocean is unlimited.  The daily bill to the city is over 300,000 dollars whether they use the water or not.  The contact provided the financial mechanism to fund the construction with its multi decade payment guarantee where the delivered water fetches a price of nearly a penny/gal.

This ***take or pay*** type of contract has also enabled the Vista Ridge pipeline project for San Antonio to move forward.

This document, like the weather that yields the rain is ongoing and changeable. It is not meant as a business plan but rather a starting point for a conversation on finding ways to solve real world problems realizing that the free market can usually provide the best answer once it becomes aware.




Water won't be getting any cheaper in the future.

July 2021

Are we in a 1200-year drought? There are a lot of people who think we are as Lake Mead drops to levels not seen since it was filled. The Nevada Pipeline Project mentioned earlier was finally abandoned in the Spring of 2021 while Southern Nevada has reduced average water consumption by a remarkable 47 percent yet they may still see a reduced allocation of the Colorado's water. The Metropolitan Water Authority of Los Angeles is moving aggressively to develop a 4-billion-dollar waste water recycling effort offering Nevada a rights swap for shared funding of the project.

The Huntington Beach Reverse Osmosis plant, while still on the drawing board, has gained support from the California Governor. Both the recycling effort and the RO plant would send water to aquafers for storage and resale to the Water Authority's municipal customers.  In the case of the RO plant the injected water will cost about 2800 dollars per acre foot and then resold for 500 dollars per acre foot.  Eyebrows are being raised.

# Tubular Rail Inc.

Water Bundles for Cost Effective Ocean Transport and Storage of Fresh Water

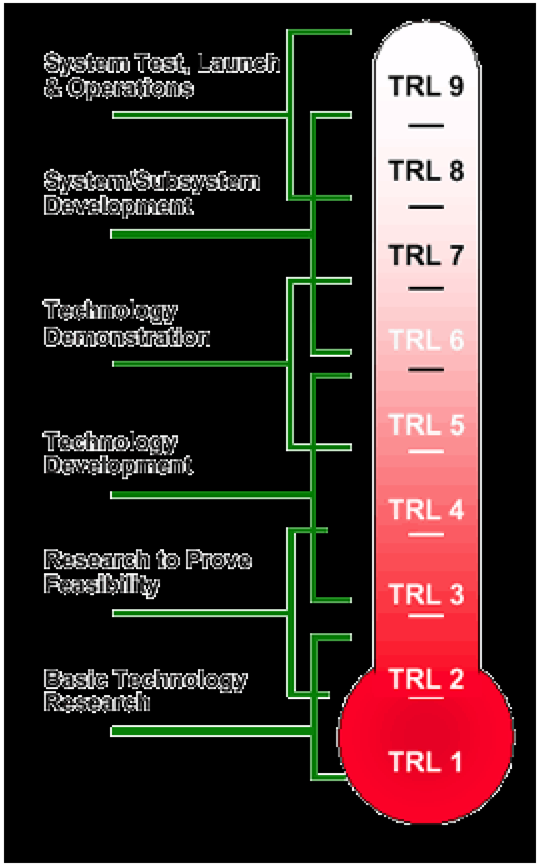
# Rethinking Ocean Transport and Storage of Fresh Water

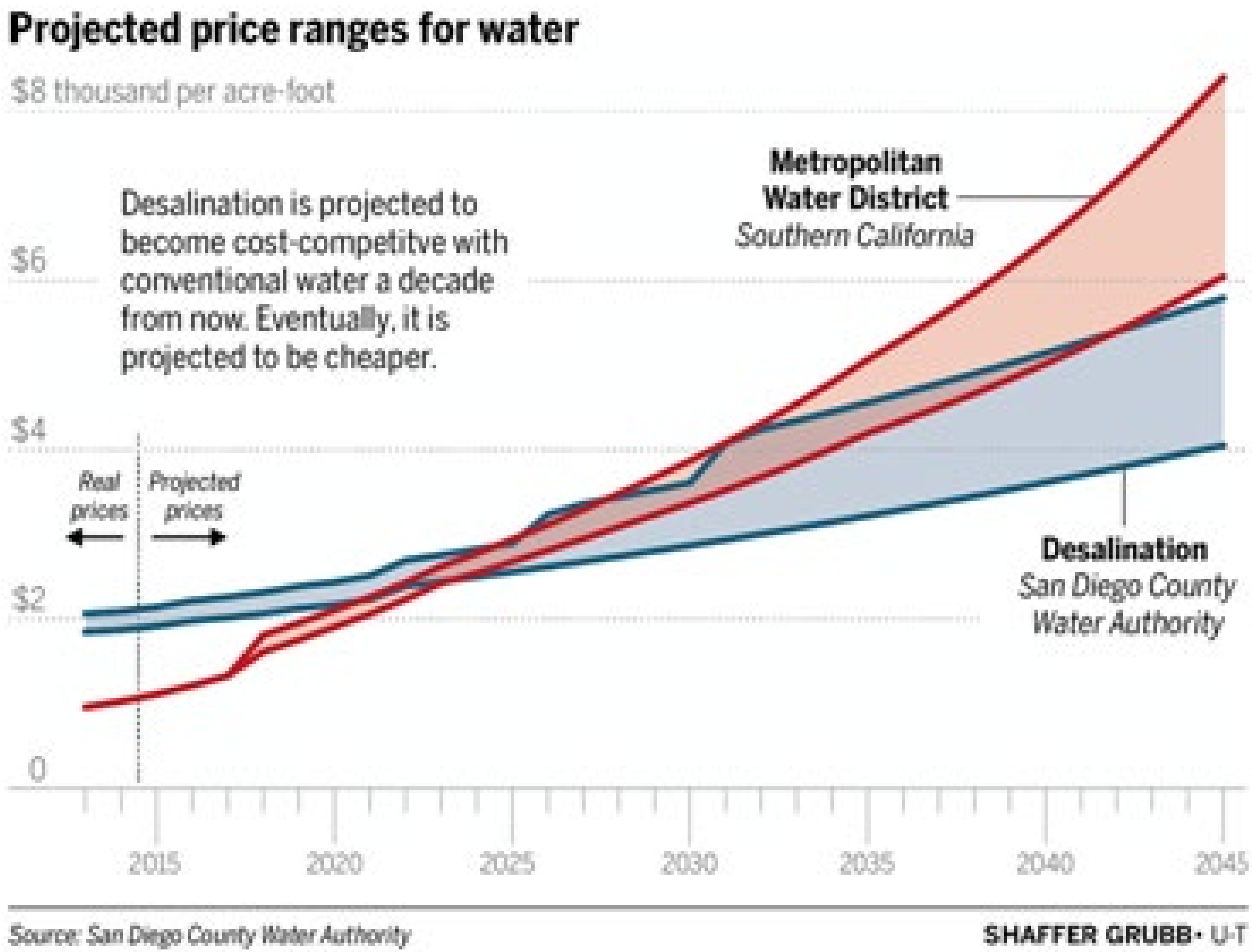
Solving the unit cost, energy cost and Reservoir challenges

Source, transport, storage

# Technology Readiness Levels (TRLV)

- **John Parker writes in National Defense**
- The Defense Department has adopted a classification system that segregates technology into nine levels with increasing maturity — measured by evidence of testing or prior use — corresponding to an increase in "technology readiness levels." While reducing reliance on immature technologies may lower the risk of cost and schedule problems, it also ensures that nothing revolutionary, innovative or even new can make it into the system.

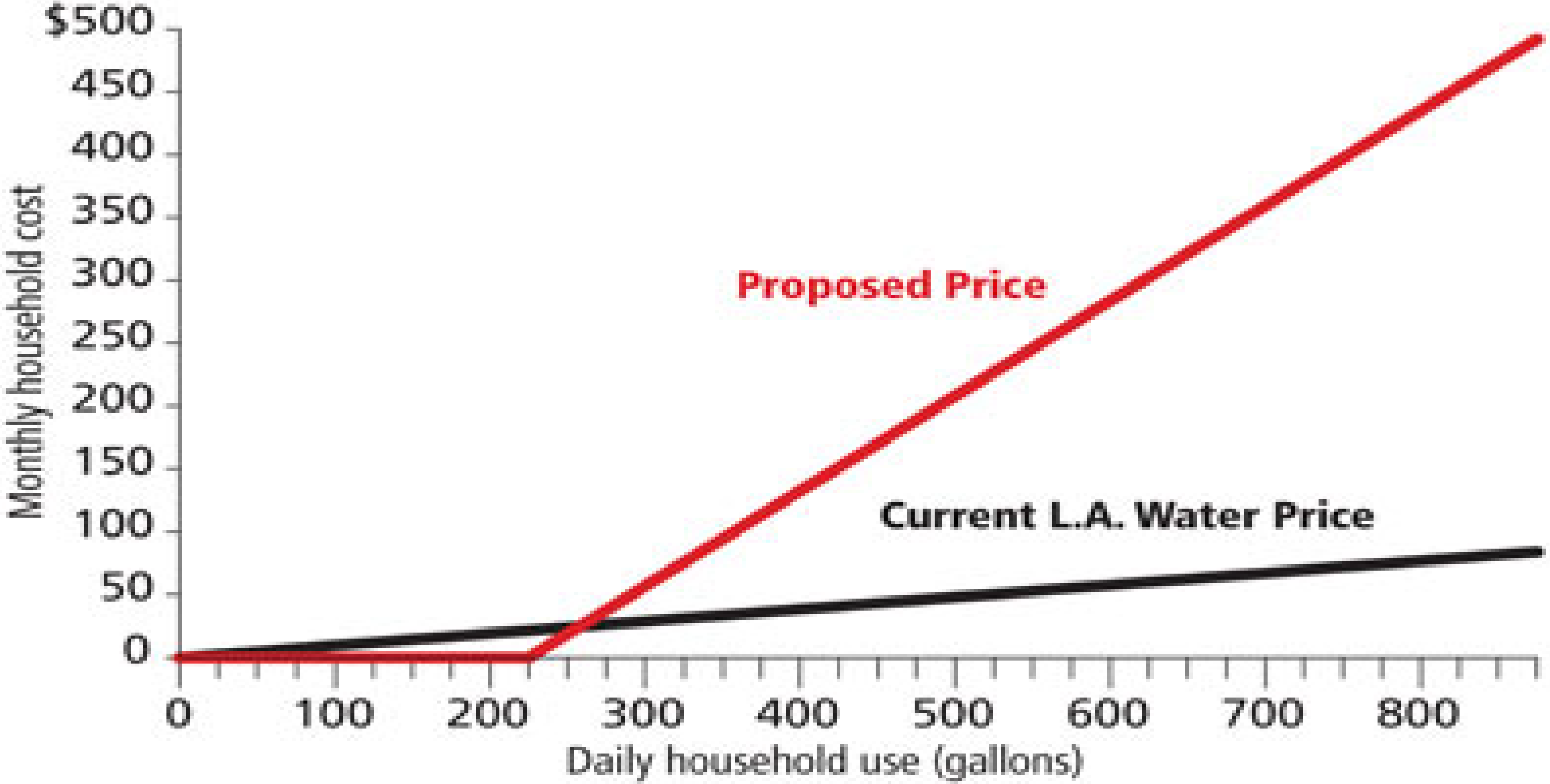




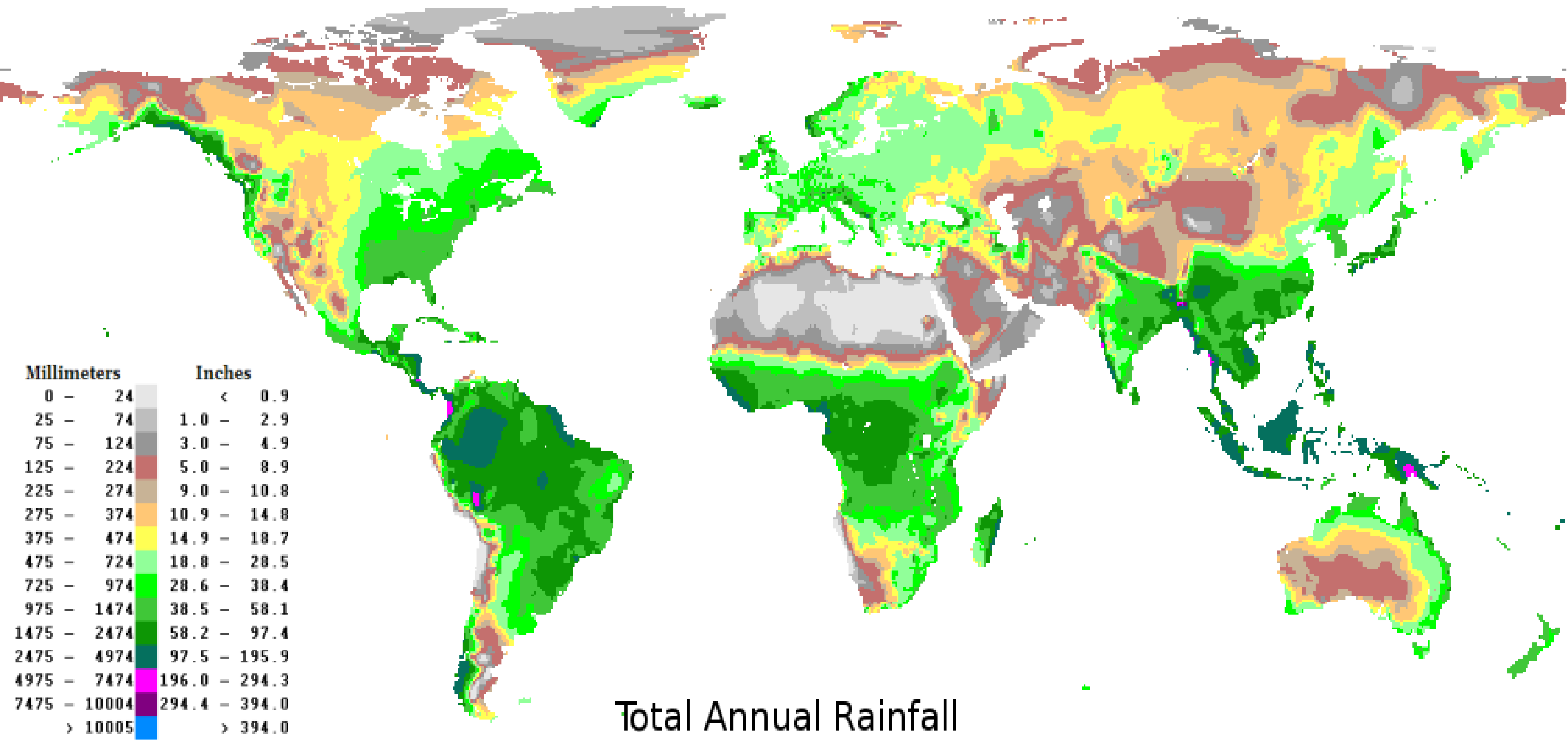
Projected price ranges for water
$8 thousand per acre-foot
$6
$4
$2
0
Desalination is projected to become cost-competitve with conventional water a decade from now. Eventually, it is projected to be cheaper.
Metropolitan Water District
Southern California
Real prices
Projected prices
Desalination
San Diego County Water Authority
2015
2020
2025
2030
2035
2040
2045
Source: San Diego County Water Authority
SHAFFER GRUBB • U-T

# The Price of H2O

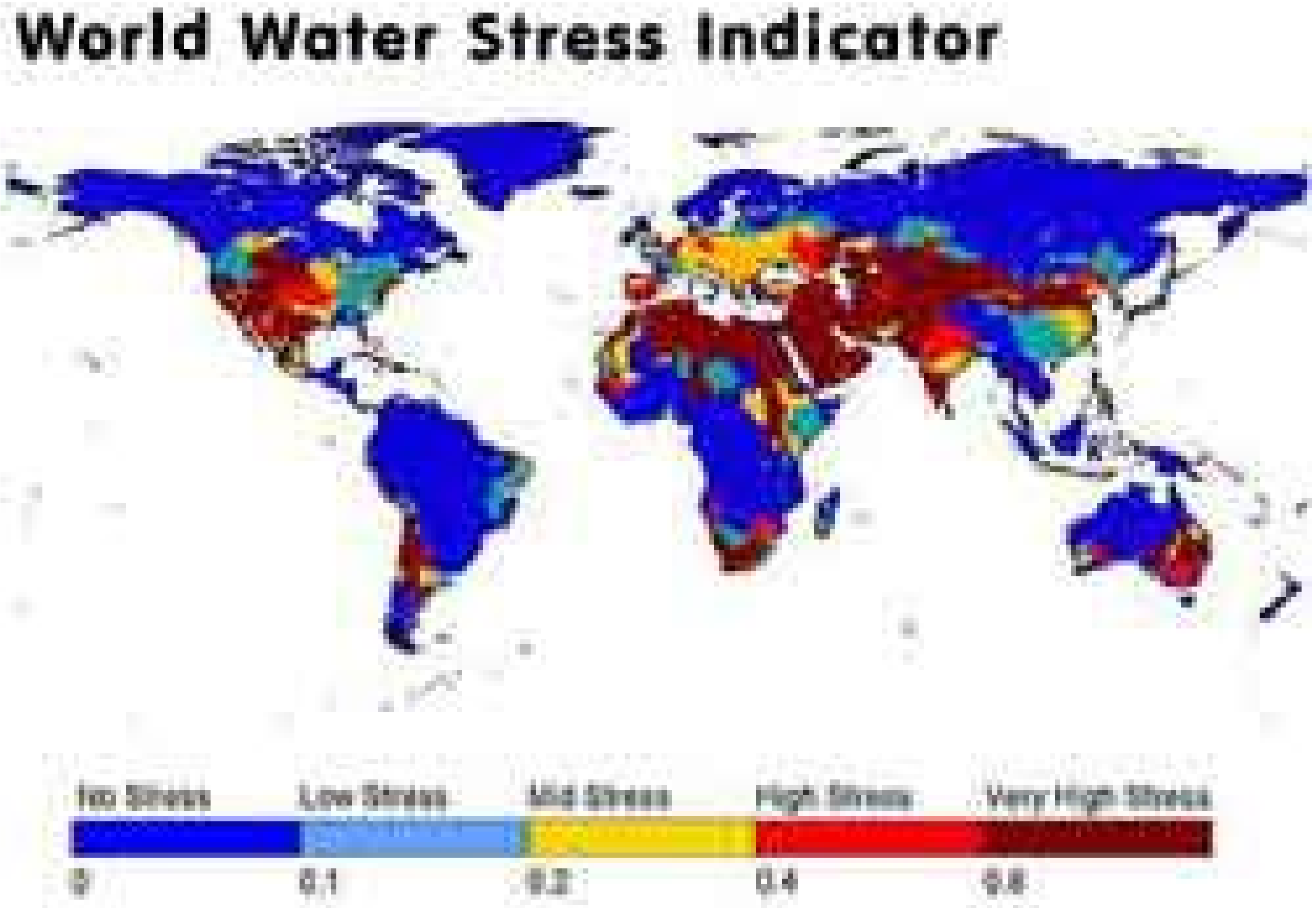
Current prices merely cover costs. Instead prices should be aimed at reducing demand.




*Source: Los Angeles Department of Water and Power.*


Millimeters
Inches
0 – 24
< 0.9
25 – 74
1.0 – 2.9
75 – 124
3.0 – 4.9
125 – 224
5.0 – 8.9
225 – 274
9.0 – 10.8
275 – 374
10.9 – 14.8
375 – 474
14.9 – 18.7
475 – 724
18.8 – 28.5
725 – 974
28.6 – 38.4
975 – 1474
38.5 – 58.1
1475 – 2474
58.2 – 97.4
2475 – 4974
97.5 – 195.9
4975 – 7474
196.0 – 294.3
7475 – 10004
294.4 – 394.0
> 10005
> 394.0
Total Annual Rainfall

# Not just a Colorado River Basin Problem



# 4.0 Imports to Southern California

This group of options is focused on importing high-quality water from other regions using ocean routes to Southern California coastal areas. Potential sources of water include the Columbia River, rivers in Alaska, or icebergs. Delivery mechanisms include sub-ocean pipelines for Columbia River supplies, tanker ships for Alaskan river supplies, or tug boats for icebergs. All of the options in this group require extensive transport or conveyance of water from the source regions to Southern California and require relatively complex facilities and operations to integrate the supply within the current water supply system in Southern California.

Four representative options were developed from this group of options to reflect the differences in potential location of imported water, modes of transport and conveyance, and associated impacts. The representative options are:

- Columbia River Imports
- Icebergs
- Tankers
- Water Bags

Overall the reports found major issues with imports. Permitting and interstate negotiation on the land based options, Environmental on the Ocean related concepts based on impacts as proposed.

Conservation measures were best on cost and implementation difficulty but did not represent NEW water and would have to be enforced.

**LEVEL 9’S BUT NOT VIABLE**

# Regional Recycled Water Program

In partnership with the Sanitation Districts of Los Angeles County and the Metropolitan Water District, The Regional Recycled Water Program will introduce purified and treated wastewater that will replenish groundwater basins across Los Angeles and Orange Counties that aims to potentially accommodate direct potable reuse demands in the near future.[17] The program includes 60 miles of new pipelines to convey the treated water across four regional groundwater basins, an industrial facility, and two MWD treatment plants.

The program calls for a water treatment facility that would be the one of the largest in the nation, producing 150 million gallons per day or 168 thousand acre-feet per year of purified water.[18] However, before the full-scale facility is developed, a 0.5 million gallon per day demonstration facility, The Advanced Purification Center, in Carson will take its place and vigorously test, treat, and operate to ensure the highest quality standards of wastewater treatment are met prior to the development of the new facility.[18] The construction and application of a membrane bioreactors in the demonstration facility cost nearly $17 million dollars and the total cost of building the full-scale program will be $3.4 billion, resulting in an annual operation cost of $129 million, and water cost of **$1,830 per acre-foot.**[18] The full scale treatment facility would serve 500,000 homes daily and deliver a purified source of water to the four regional groundwater basins: Central, West Coast, Main San Gabriel, and Orange County.[16]

# Poseidon Water
# Jul 09, 2021, 14:49 ET

HUNTINGTON BEACH, Calif., July 9, 2021 /PRNewswire/ -- Poseidon Water today announced the company has submitted a Coastal Development Permit (CDP) application to the California Coastal Commission for the construction of the proposed Huntington Beach Desalination Project ("Project"). The Project is in the final phase of its permitting process and Poseidon Water anticipates the Coastal Commission's consideration of the CDP before the end of the year.

"Poseidon Water has a lengthy 15-year history of working cooperatively with the Coastal Commission on the permitting of the proposed Huntington Beach Desalination Project," said Poseidon Water Vice President and Project Manager Scott Maloni. "As California continues to grapple with climate change-induced drought and wildfires we remain committed to building on the success of our Claude 'Bud' Lewis Carlsbad Desalination facility by delivering Southern California a second large-scale, environmentally responsible and cost-effective desalination facility in Orange County," he said.

The Project is preparing to obtain from the Coastal Commission the last major discretionary permit needed to build the long-awaited seawater desalination plant as federal and state government officials work on appropriating billions of dollars to water infrastructure projects designed to help communities weather the effects of climate change. Earlier this year the U.S. Environmental Protection Agency reaffirmed its 2019 selection of the Project to receive up to $644 million in credit assistance under the federal government's Water Infrastructure Finance and Innovation Act (WIFIA). The WIFIA program accelerates investment in the nation's water infrastructure by providing long-term, low-cost supplemental loans for regionally and nationally significant projects.

The benefits of the credit assistance provided by WIFIA to the Huntington Beach Project will result in a direct financial pass through to Orange County water ratepayers, which Poseidon estimates will reduce consumer water costs by $290 million over the life of the Project as compared to current financing options.

The Cost of Poseidon’s Water

Poseidon’s water will likely be 440% the current cost of groundwater in Orange County!

I know that is hard to believe, but here are the facts. The current Ground Water Price in Orange County is $700 for an Acre Foot of water. The current Poseidon Price in Carlsbad is $ 2830 for an Acre Foot of water.

But Wait, That’s Not All!    There is a 2-3% escalator clause built into the contract, each year!

*Randy Kokal*

# There are two costs
# Cost of the water and cost of the storage

Headworks

230 million / 400 acre/ft

½ million per acre foot

# Sites Reservoir

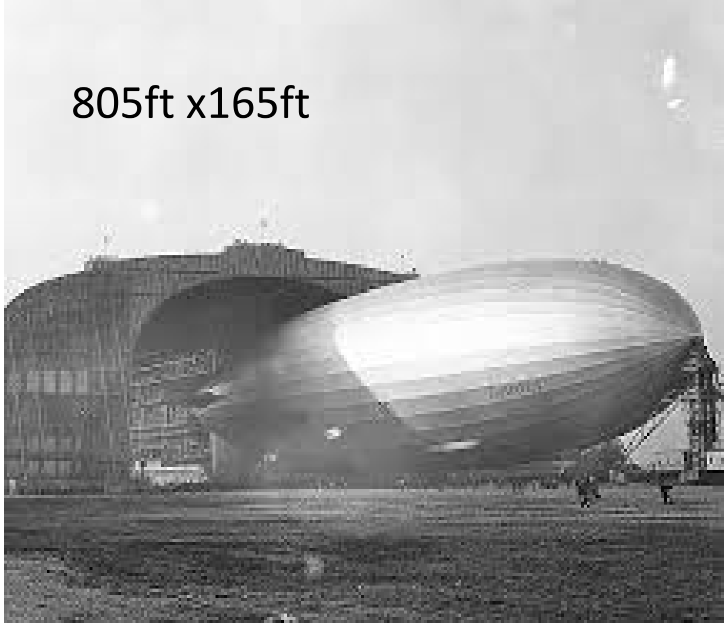
- After the cutback—
- 3 billion for 1.5 million ac/ft  = 2000 ac/ft
- 243,000 ac/ft annual yield
- Off line storage from the Sacramento River
- ? What will be charged for the water?
- Urban / Rural Divide – who gets the water and for how much?

# Part II

# Scale to 1 Billion Gallons
# (3000 acre/feet)

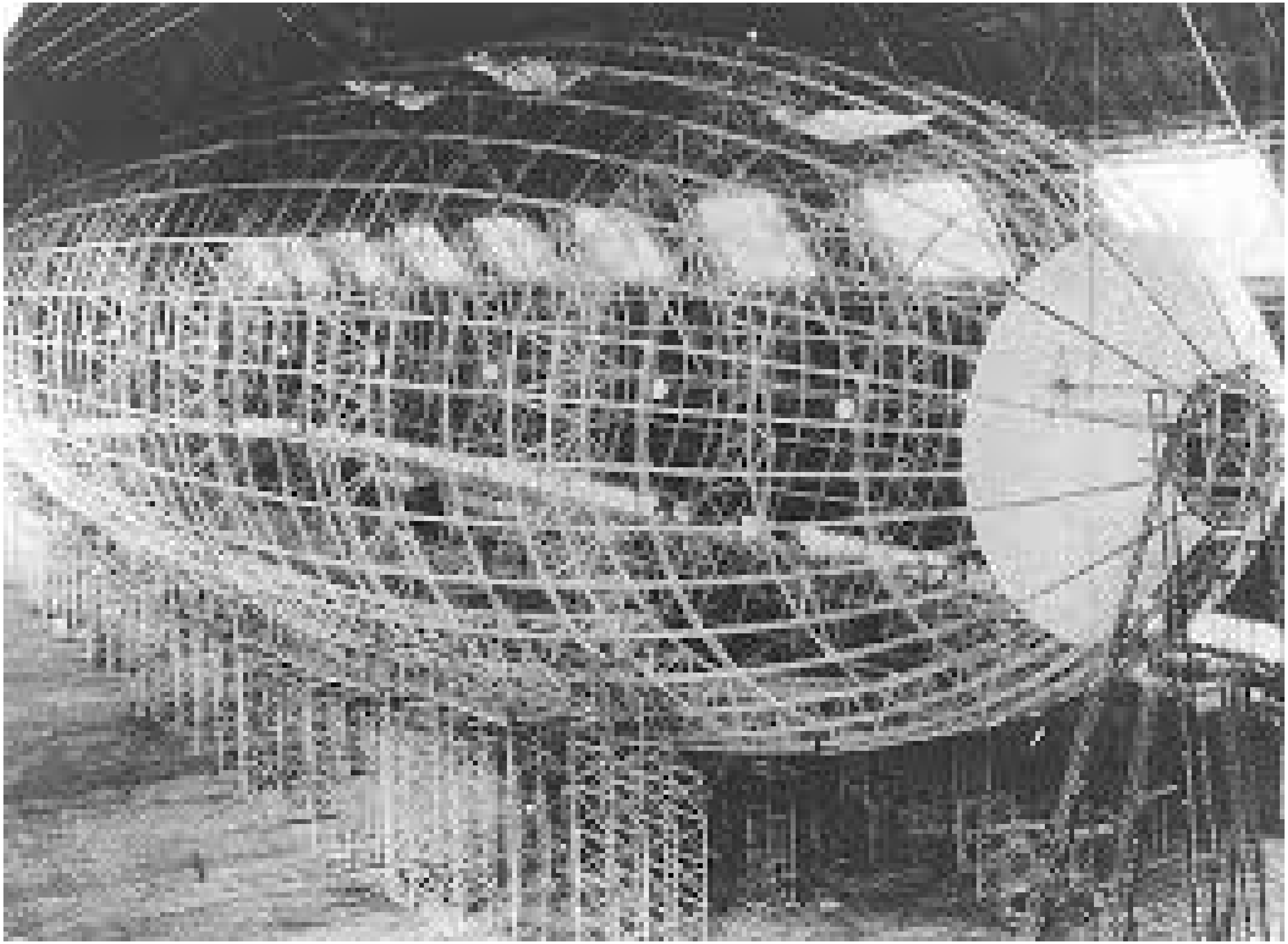
# A matter of scale

**ULCC 415m x 70m x 25m** **5 gal**



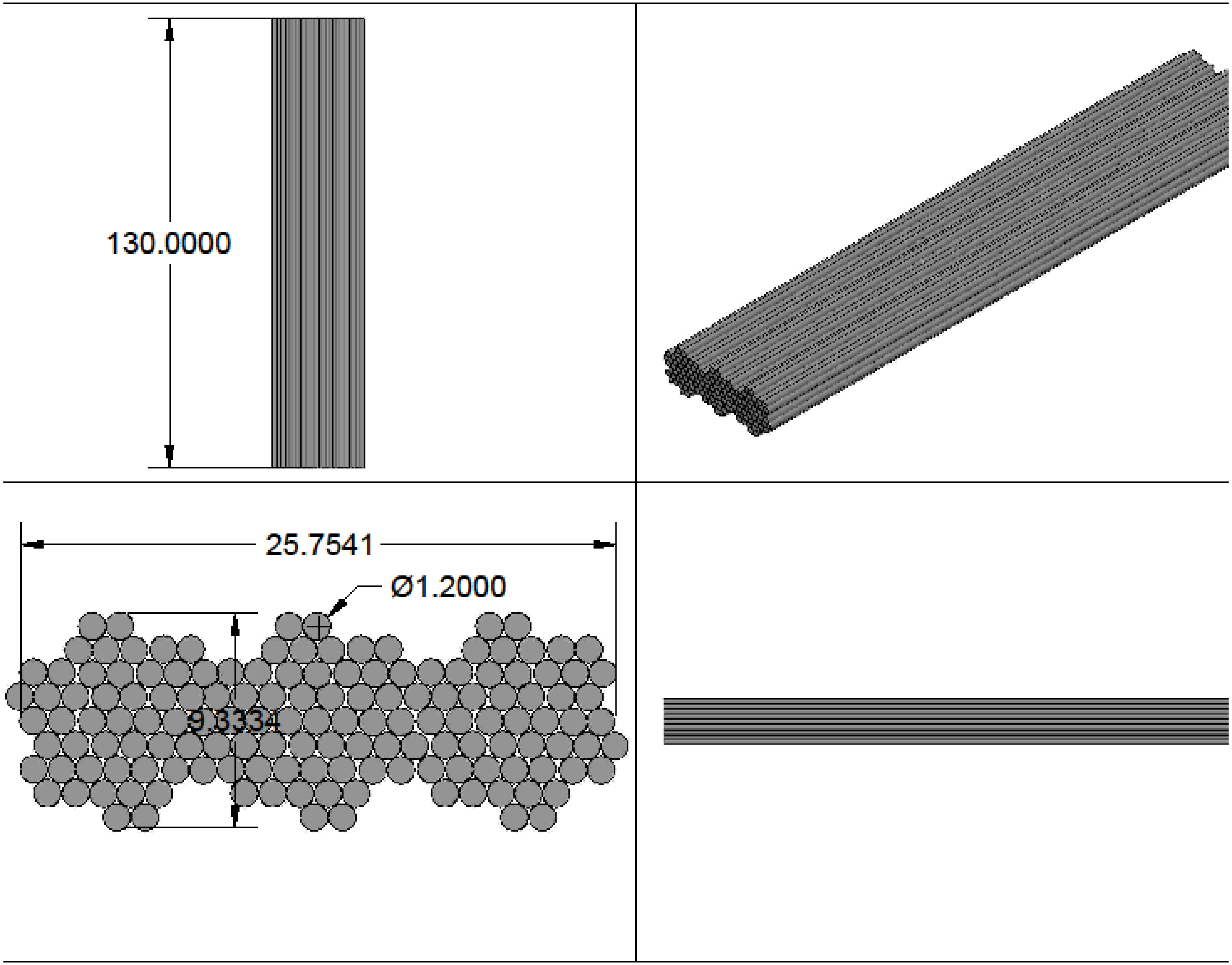
# Lightering operations

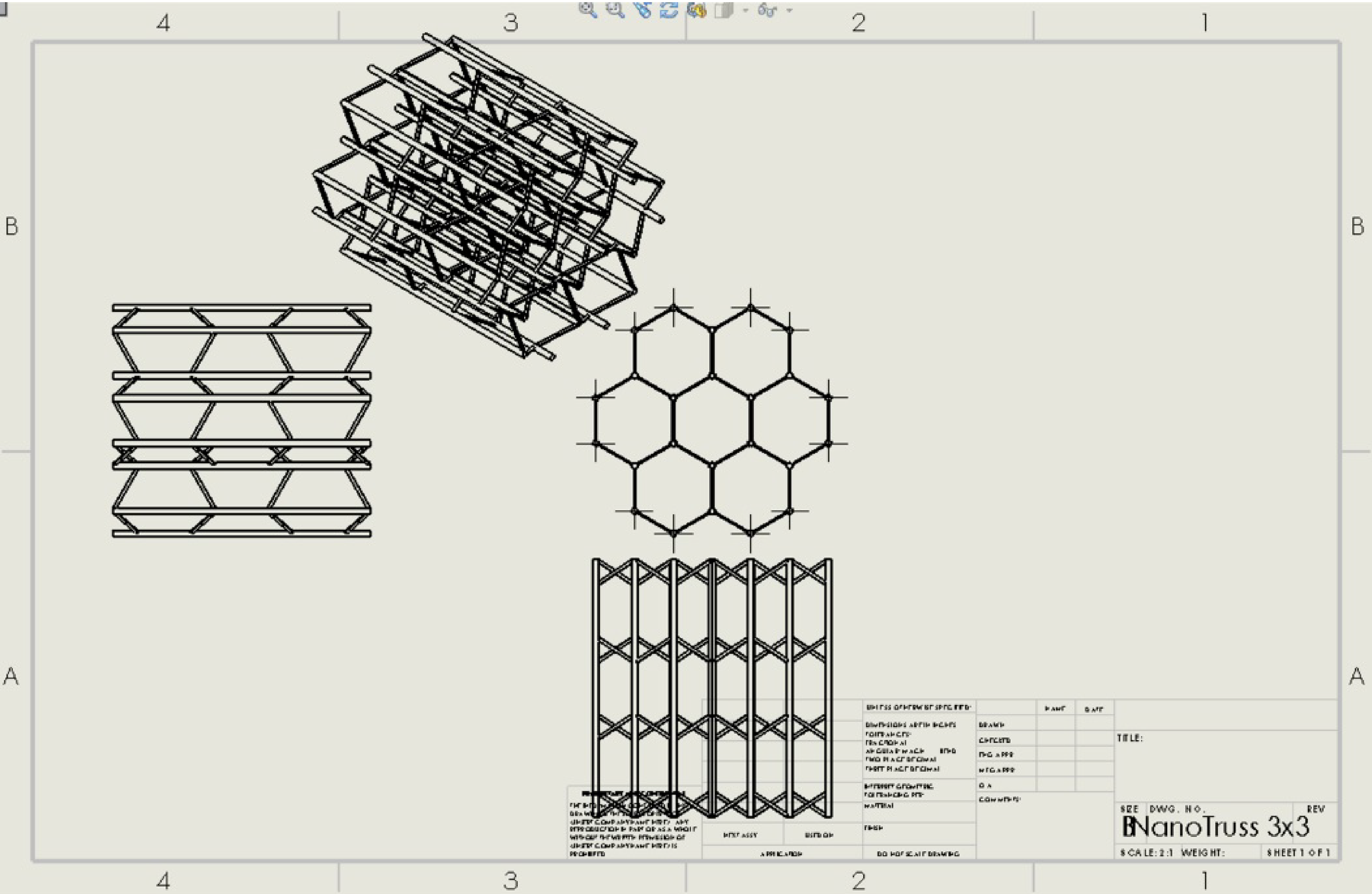
# Dirigible construction

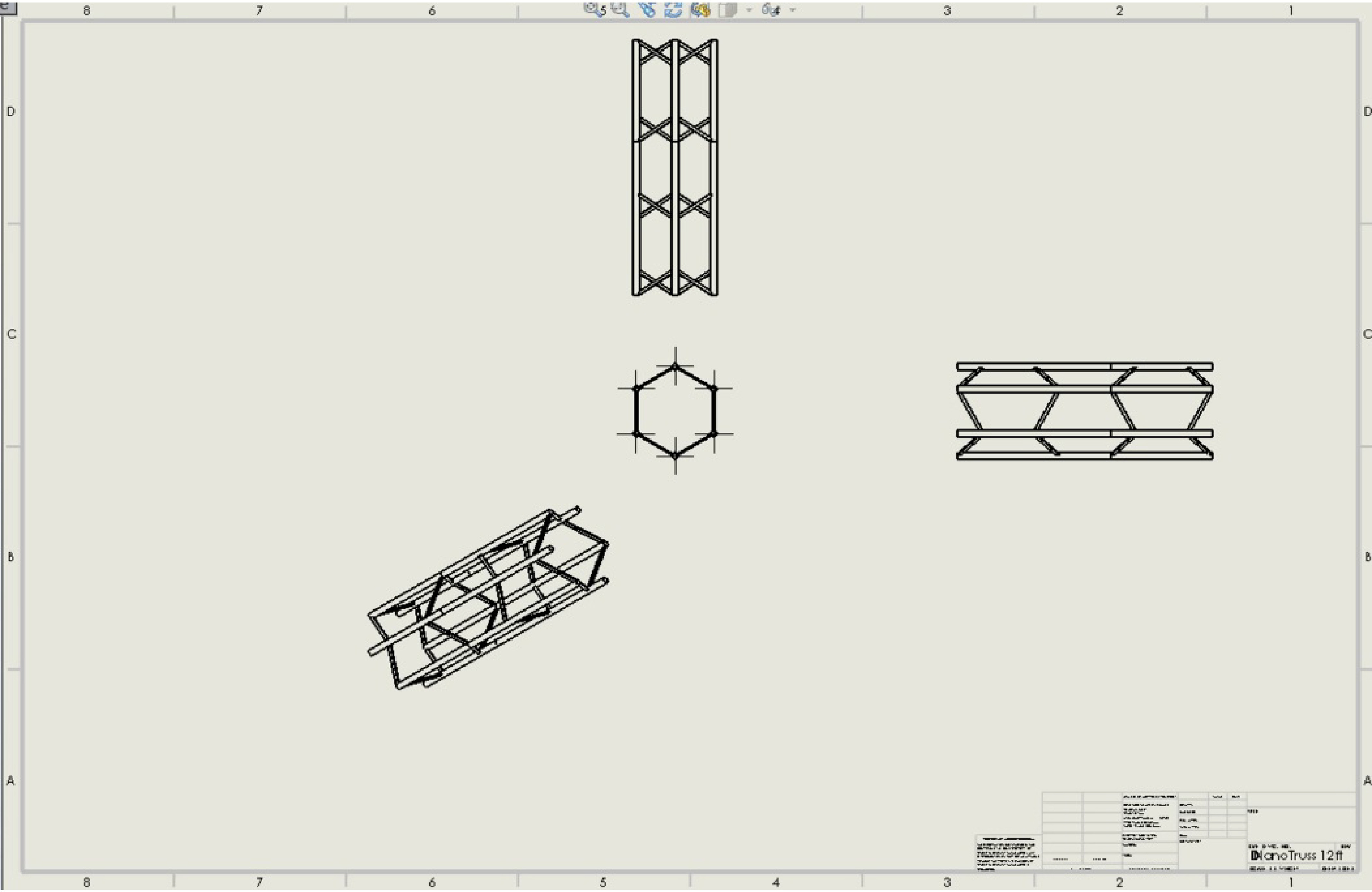


# Bundles

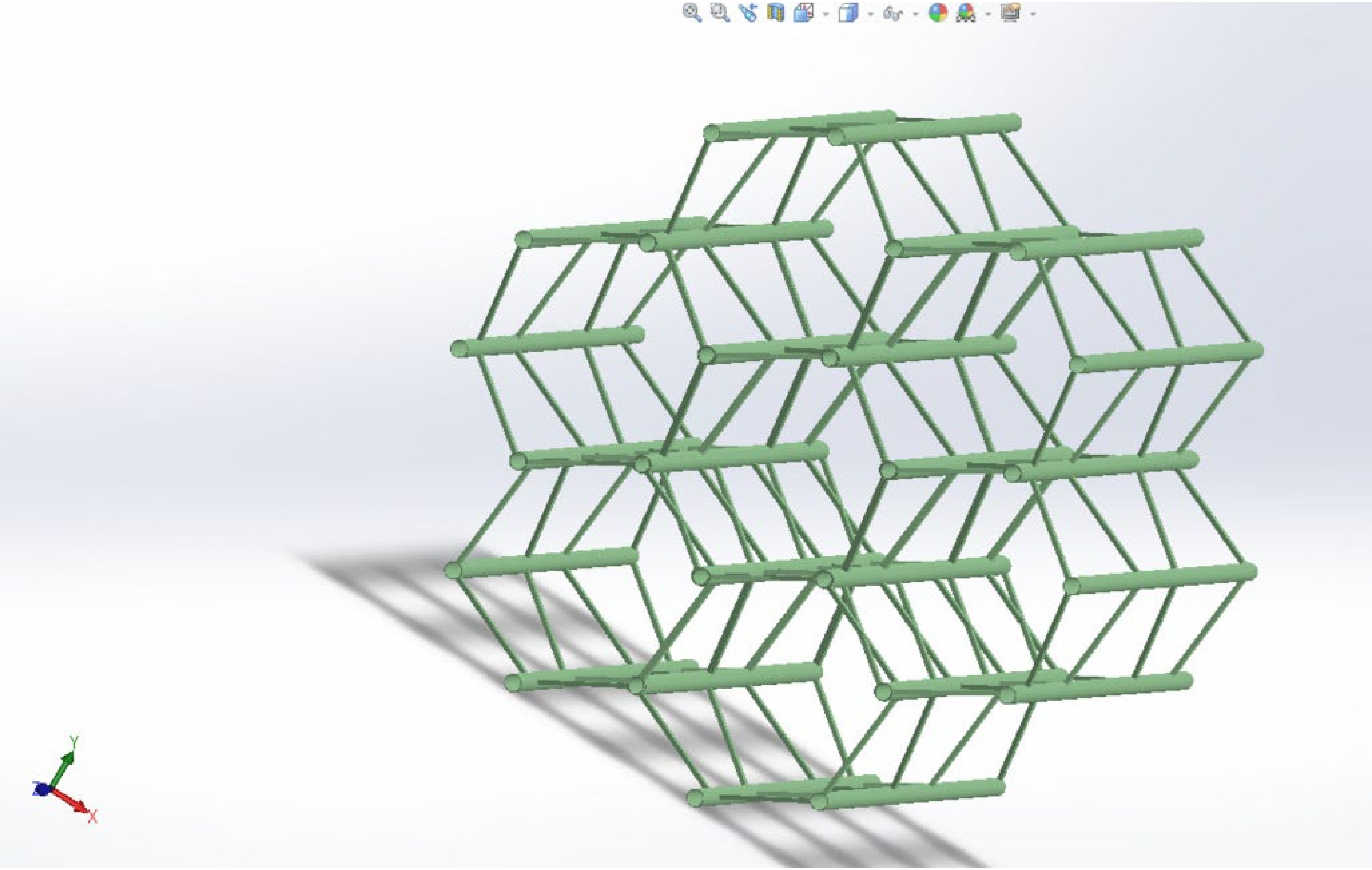

de Mona

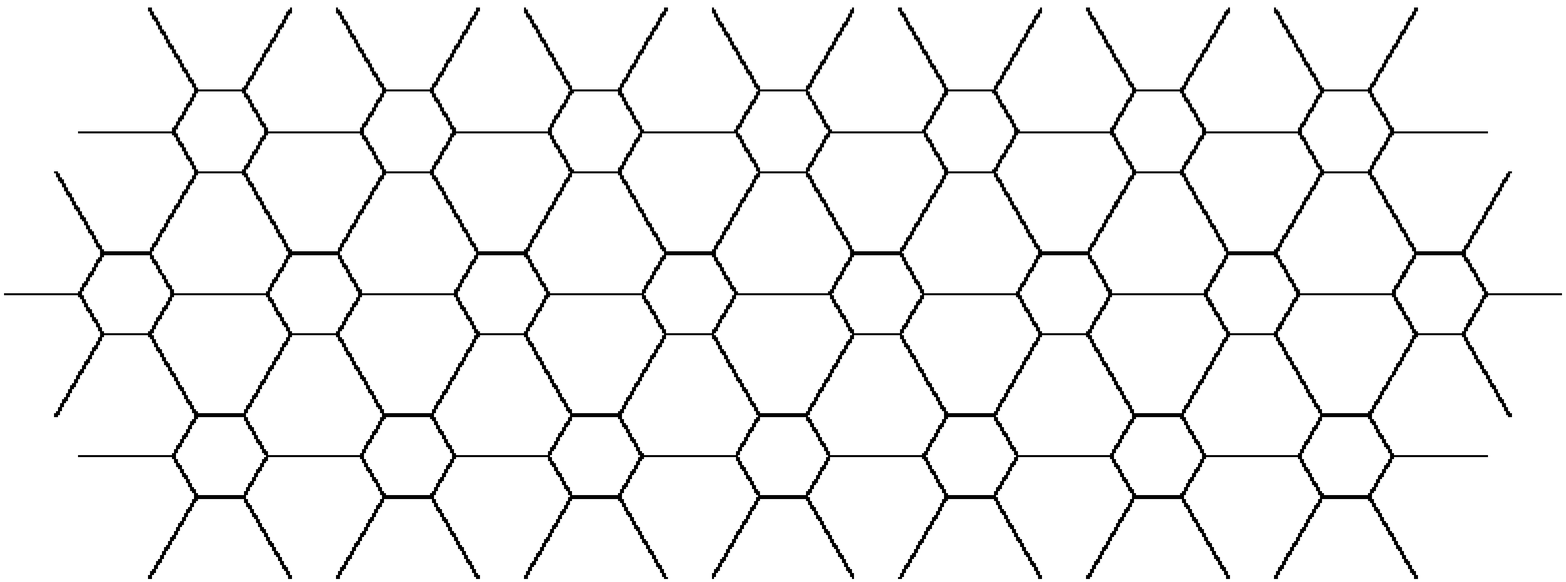

130.0000
25.7541
Ø1.2000
9.3334

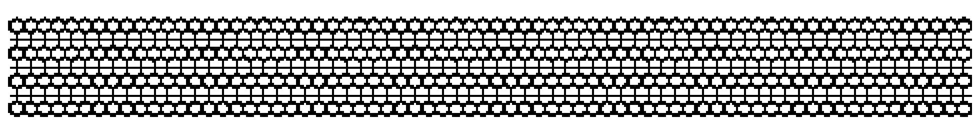

TITLE:
SIZE DWG. NO. REV
B NanoTruss 3x3
SCALE: 2:1 WEIGHT: SHEET 1 OF 1

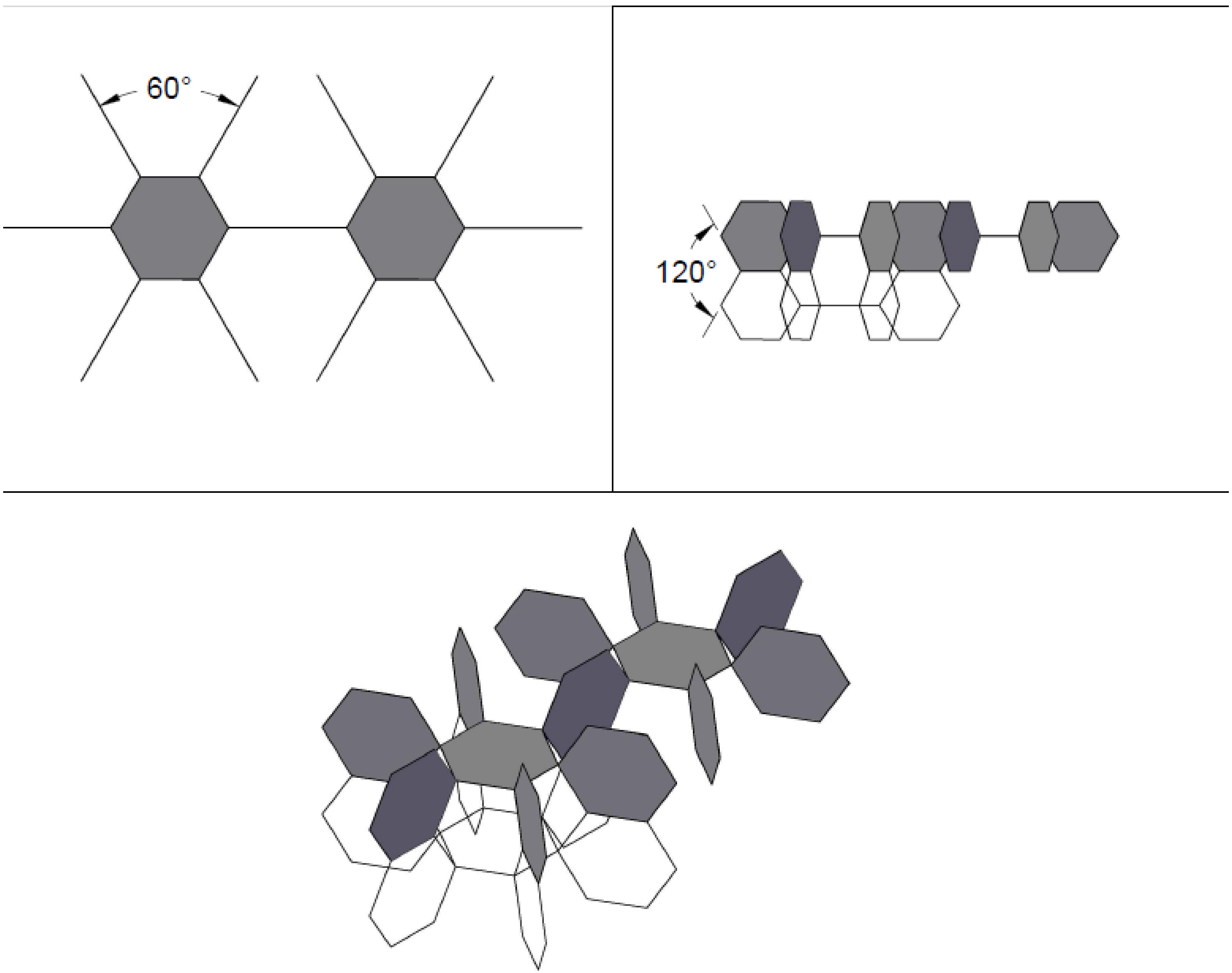


NanoTruss 12ft

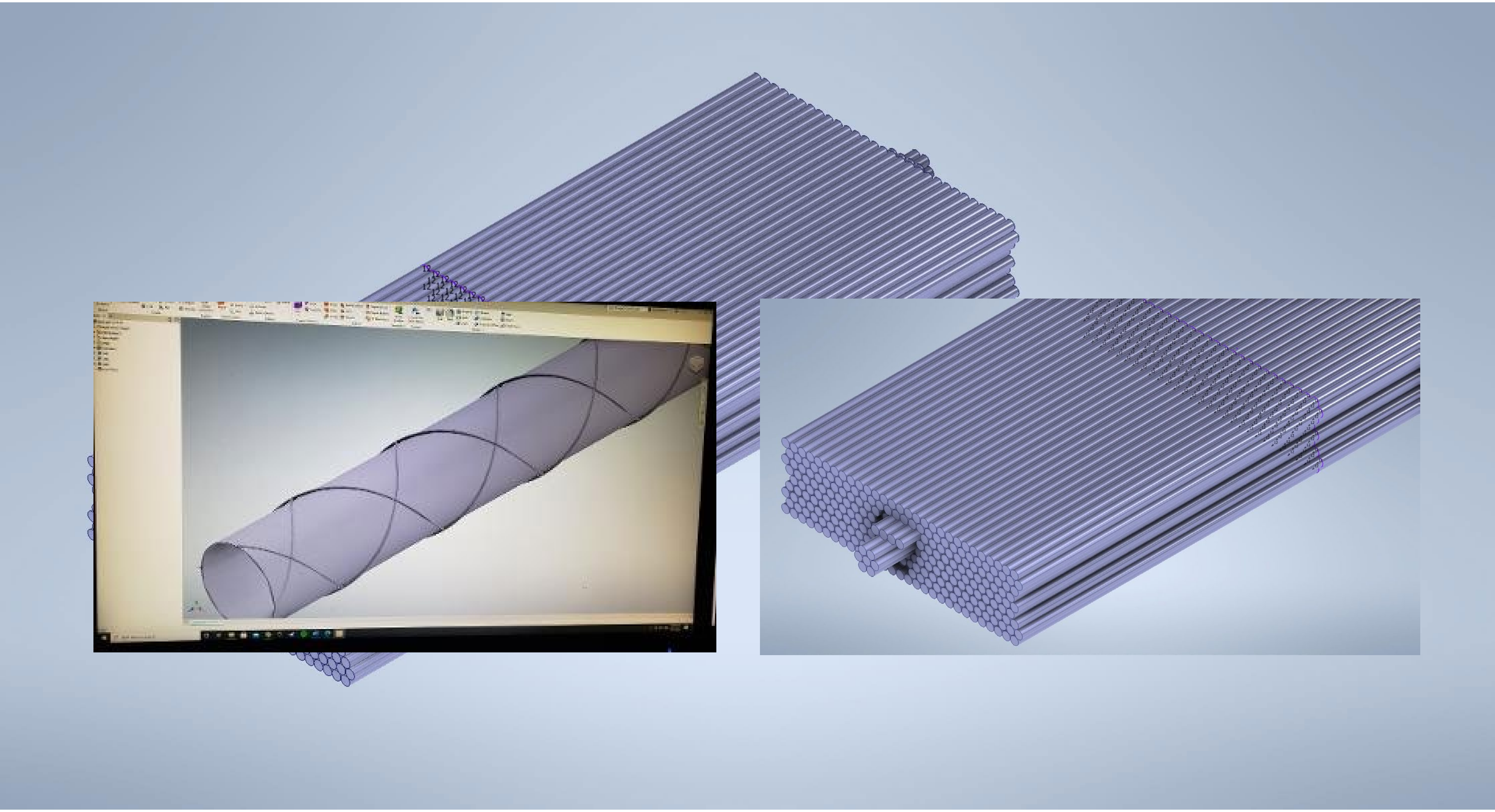

Y
X



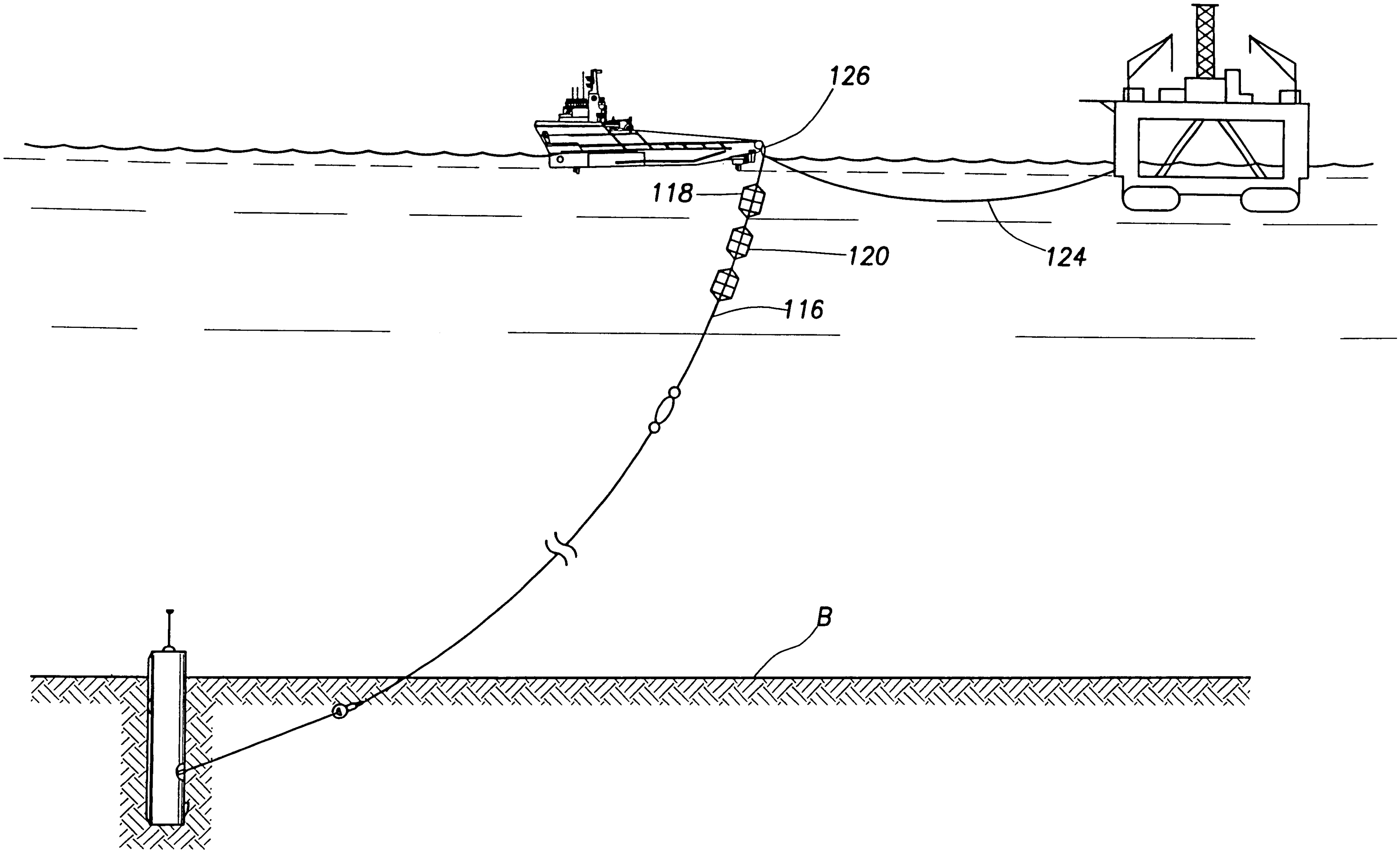



60°
120°

# Sketches



# Part Three
# Reduce Power and Labor Inputs


126
118
120
124
116
B

# Handling Operations

# Justified for North Sea Oil not Water


Troll A Platform
Q1 Tower
Petronas Towers
Gold Coast QLD
Kuala Lumpur KL
Australia
Malaysia
built
built
built
2005
1998
78
88
industrial
residential
office
472 m
322.5 m
275 m
452 m

# The Membrane, Skin or Hull

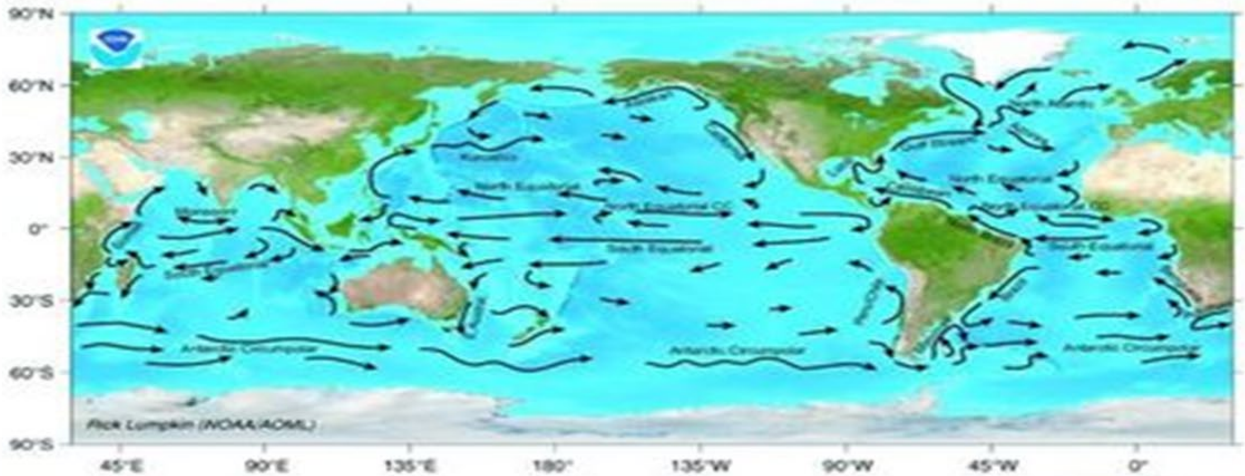

MFI
MFI

# Large ship marine bumpers


# Halocline Interface

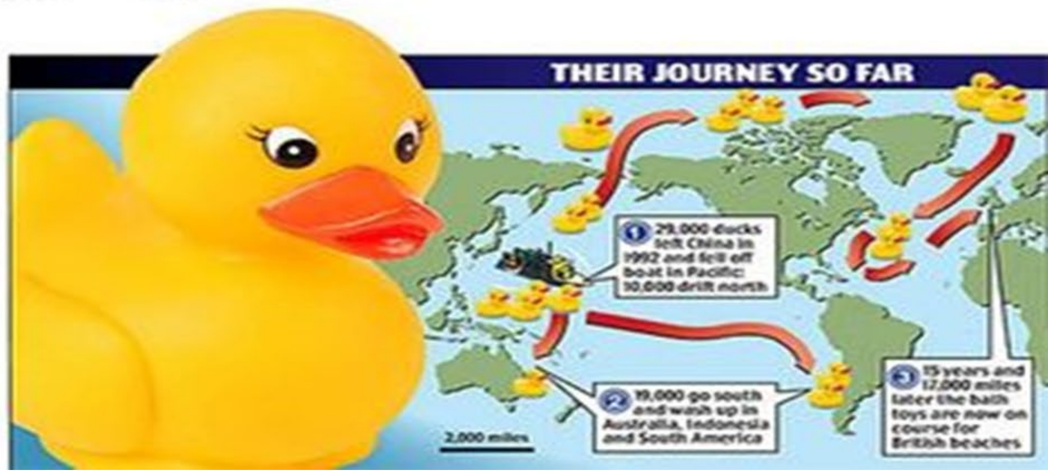
# Part IV
# Sources

# Surface Ocean Currents

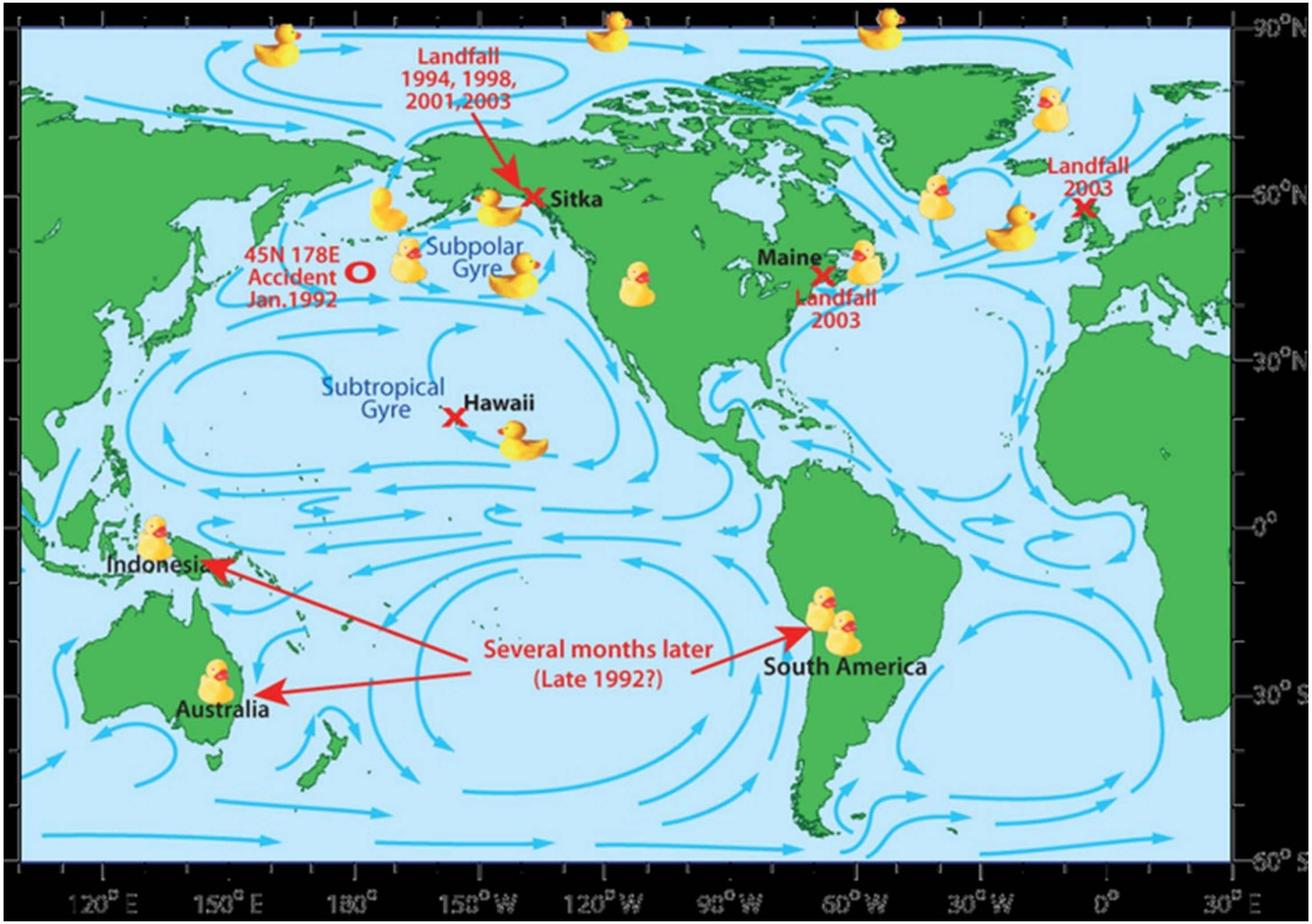



Common surface ocean currents show the flow of the sea

In 1993, thousands of rubber duckies washed up on Alaskan beaches. Oceanographers determined that a ship carrying the toys lost a container during a storm near Hawaii in 1992. The ducks were used to map ocean currents.



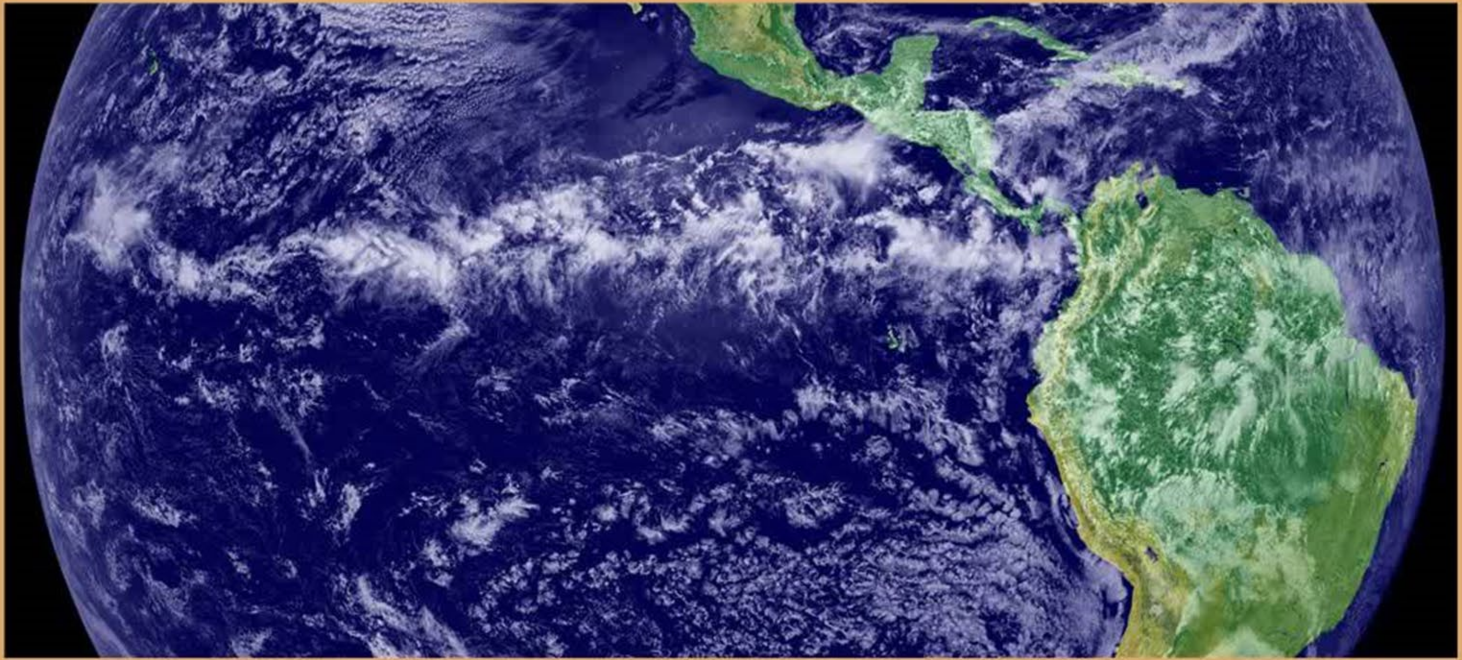

THEIR JOURNEY SO FAR
1 29,000 ducks left China in 1992 and fell off boat in Pacific: 10,000 drift north
2 19,000 go south and wash up in Australia, Indonesia and South America
3 15 years an 17,000 mile later the bath toys are now o course for British beache
2,000 miles



Landfall
1994, 1998,
2001,2003
Sitka
45N 178E
Accident
Jan.1992
Subpolar
Gyre
Maine
Landfall
2003
Landfall
2003
Subtropical
Gyre
Hawaii
Indonesia
Several months later
(Late 1992?)
South America
Australia
90° N
60° N
30° N
0°
30° S
60° S
120° E
150° E
180°
150° W
120° W
90° W
60° W
30° W
0°
30° E

# Intertropical Convergence Zone

# Intertropical Convergence Zone



https://en.wikipedia.org/wiki/File:IntertropicalConvergenceZone-EO.jpg

# Sources

- North from Rivers
- Southeast Coastal Alaska (Sika), Aleutians Oregon (Columbia River) and Canadian Rivers.
- Favorable Currents

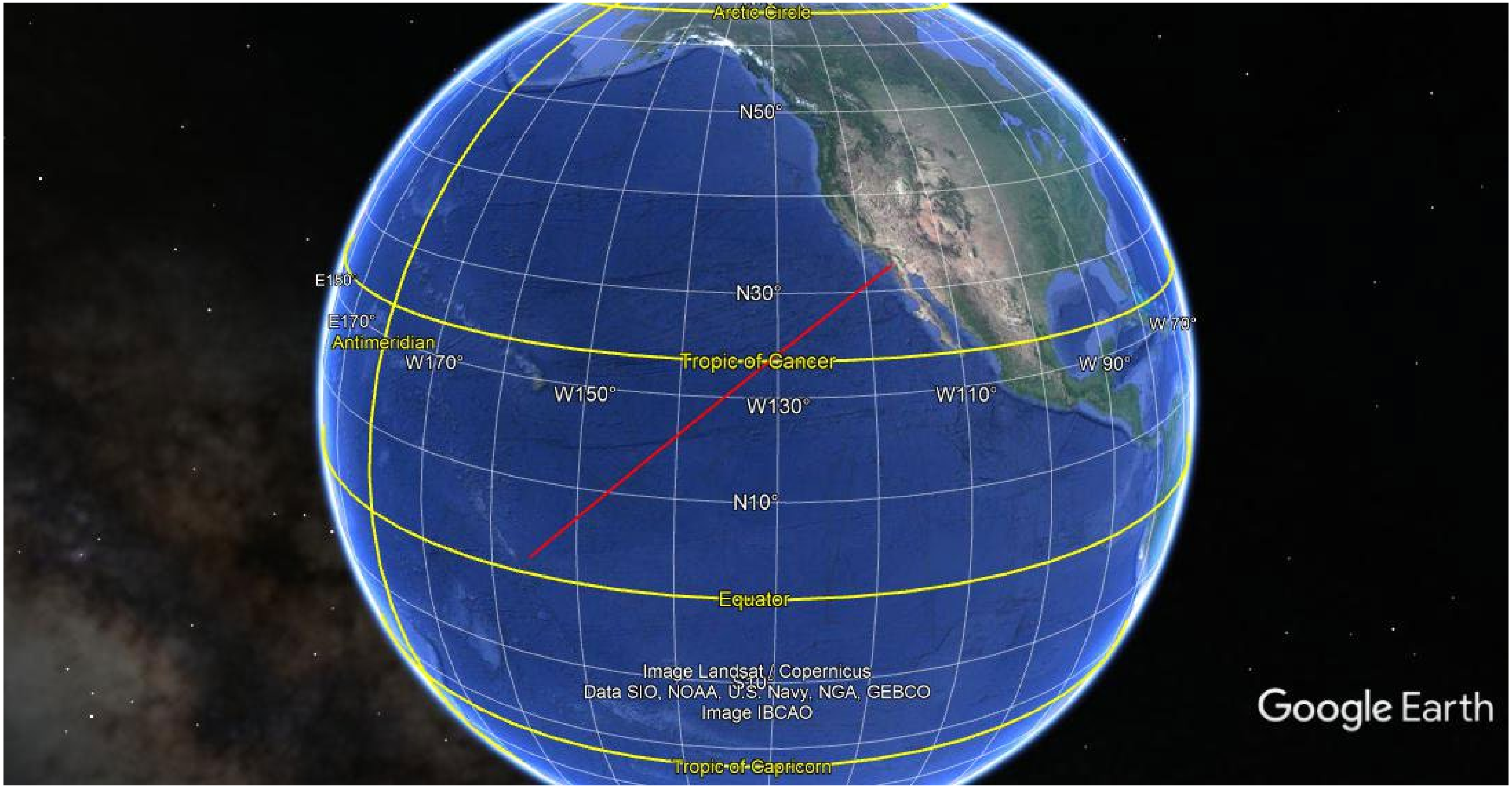
- South and Southwest
- Los Angeles is 2300 miles from the Equator
- Kiribati 3300 miles from LA
- Colorado River Headwaters are over 1500 miles from LA
- Ocean capture of ITCZ (itch)

# Kiribati

# Kiribati

- One of the World's poorest (annual income $2300)
- Min. wage $0.98
- Less than 700 square miles of land.
- Controls 1.4 million square miles of Ocean in the ITCZ (8 x's Ca.)
- WWII Battle of Tarawa
- Monthly rainfalls above 300 mm
- Rains nearly daily
- Most threatened by Sea Level Rise
- Easternmost Islands (Line Islands group} 900 miles due South of Hawaii

# LA to Fanning Island
# 3300 air miles



# Next Steps

- Partner with water authority
- MWD of So Cal, So Nevada Water Authority
- San Diego or even Coastal Mexico
- Utilize University Access for low cost but high quality design and costs study ($7500)
- Students are graded, not the project (removes bias)