

Big Lake Feasibility Study

Prepared By: Claire Cropper, Miles Allen, Peyton Briggs, and Kieran Braun

Introduction

From:
Big Lake North Inoculative Site
Big Lake Water Treatment
Big Lake, AK

I. Project Purpose and Background

II. Literature Review

ADEC Studies
EPA Digester Study
Watershed Study

III. Engineering Analysis

We need a system that treats bigge water! But how?
- Is biological treatment feasible?
- We have a Treatment Option

Treatment Option 1: Gravity Oil Water Separation
Treatment Option 2: Combined Separation
Treatment Option 3: Aeration

And the winner is... Gravity Oil Water Separation!!

Our Next Steps: Building a Big Water for Further Treatment

VII. Conclusion

Where We've Been
I. Project Background and Purpose
II. Literature Review
III. Engineering Analysis
IV. Design
V. Community Impact
VI. Recommendations

Where We're Going

VI. Recommendations

- 1) Need further research before implementing a Big Water system
- 2) Support Good Shepherd's water treatment efforts
- 3) Move oil/water area further from the dock

V. Community Impact

Problems
- We need a system that treats bigge water for our community

Impacts
- All of the Bigge Water

IV. Design

Our Two Designs:
1) Design Alternative A
2) Design Alternative B

Design A
Design B

Bilge Water Treatment Volumes

1) Aeration Bigge Water
2) Gravity Oil Water
3) Detention Basin

Thank You



Supervised By: Professor's Name
Civil Engineering Program
University of Alaska, Anchorage

Big Lake Feasibility Study

Prepared By: Claire Cropper, Miles Allen, Peyton Briggs, and Kieran Braun

Introduction

Facility:
Big Lake North Recreation Site
Bilge Water Treatment
Big Lake, AK

Client:
U.S. Army Corps of Engineers
2225 G Street
Anchorage, Alaska 99503
907.261.5000
www.usace.army.mil

I. Project Purpose and Background



II. Literature Review

ADOC Studies

ETA Bilge Water Study

Wharves Study

III. Engineering Analysis

We need a system that treats bilge water! But how?

1) Oil Treatment or 2) Biological Treatment? GoodMe!

We Have 3 Treatment Options

Treatment Option 1: Gravity Oil Water Separators The Separator Separates Oil and Water from Bilge Water. It is a simple and effective method for treating bilge water. It is a simple and effective method for treating bilge water. It is a simple and effective method for treating bilge water.	Treatment Option 2: Centrifugal Separators Centrifugal separators use centrifugal force to separate oil from water. They are more expensive than gravity separators but can handle higher volumes of bilge water. They are more expensive than gravity separators but can handle higher volumes of bilge water.	Treatment Option 3: Absorption Absorption involves using a chemical absorbent to capture oil from bilge water. This method is effective but can be expensive and may require additional treatment for the absorbent. This method is effective but can be expensive and may require additional treatment for the absorbent.
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And the winner is Gravity Oil Water Separation!!

Our Plans for Collecting Bilge Water from Further



VI. Recommendations

- 1) Need further research before implementing a bilge water system
- 2) Support Coast Interceptor's lower maintenance efforts
- 3) Move intercepting area further from the dock



V. Community Impact

Problem: We need a program to remove the public oil catchment system.

Goal: To remove the public oil catchment system.

Method: To remove the public oil catchment system.

Timeline: To remove the public oil catchment system.

IV. Design

Our Two Designs:
1) Design Alternative A
2) Design Alternative B

Design A



Design B



Bilge Water Treatment Volumes

Design A: 1000 Gallons per Day

Design B: 1000 Gallons per Day

Design C: 1000 Gallons per Day

Design D: 1000 Gallons per Day

Thank You



Introduction

Focus:
Big Lake North Recreation Site
Bilge Water Treatment
Big Lake, AK



Outline

- I. Project Background and Purpose
- II. Literature Review
- III. Engineering Analysis
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- VI. Recommendations
- VII. Conclusion

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Focus:
Big Lake North Recreation Site
Bilge Water Treatment
Big Lake, AK



Outline

- I. Project Background and Purpose
- II. Literature Review



Prepared For:

Mr. Rys Miranda

State of Alaska Department of Natural
Resources Division of Parks and Outdoor
Recreation
Design and Construction Section

Prepared By:

University of Alaska Anchorage
Seawolf Engineering

Claire Cropper, PM
Miles Allen, Peyton Briggs, and
Kieran Braun

Outline

- I. Project Background and Purpose
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I. Project Purpose and Background

Location

Big Lake, AK
- 10 minutes off the Parks Highway
- 30 minutes West of Wasilla, AK



Existing Facility



Managed by Alaska Department of Natural Resources
Division of Parks and Outdoor Recreation
Dual-Launch Ramp is main access point
470-1,100 boats per summer
By far the most used inland boat launch in AK



Background

- Alaska Department of Energy Conservation has listed Big Lake as an "impaired waterbody"
- High levels of Total Aromatic Hydrocarbons (TAHs)
- During high traffic weekends, the quality standard water was exceeded by 400%
- Concerning because of its negative effects on wildlife



Purpose

Determine the feasibility of constructing an on-site bilge water treatment system at Big Lake North SRS

The Alaska Department of Natural Resources' general design criteria:

- 1) Reduce pollutants in bilge water entering lake to acceptable levels
- 2) System with low maintenance/operational cost
- 3) Maximum waste load and local requirements
- 4) User friendly for boaters



Location

Big Lake, AK

- 10 minutes off the Parks Highway
- 30 minutes West of Wasilla, AK



Existing Facility



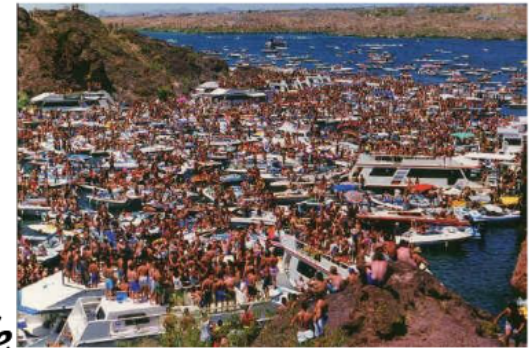
- Managed by Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation
- Dual-Launch Ramp is main access point
- 470-1,100 boats per summer
- By far the most used inland boat launch in AK



Background:



- ***Alaska Department of Energy Conservation has listed Big Lake as an "impaired waterbody"***
- ***High levels of Total Aromatic Hydrocarbons (TAHs)***
- ***During high traffic weekends, the quality standard value was exceeded by 400%***
- ***Concerning because oil has negative effects on wildlife***





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The Alaska Department of Natural Resources' general design criteria:

- 1) Reduce pollutants in bilge water entering lake to acceptable levels
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II. Literature Review

ADEC Studies

Studies on hydrocarbon levels in Big Lake in 2004, 2006, and 2014

Method	Findings
<ul style="list-style-type: none">Measured TAHs levels around various depths and locationsMeasured levels of TAHs using a volatile organic carbon compound designed by the USGS	 <ul style="list-style-type: none">Direct correlation between the number of boats on Big Lake and hydrocarbon levelsHydrocarbon levels are not rising each yearLet this be bad!... for the lake.

EPA Bilgewater Study

A survey of current bilge water treatment technologies available for ocean-faring ships

Why This is Helpful:

- 1) Explained how bilge water is generally treated
- 2) Explained composition of bilge water

Wisconsin Study

Aimed to determine effects of motorized watercraft on aquatic ecosystems

Findings

- Most significant impact boats have on wildlife in lakes is turbulence
- Most hydrocarbons were injected directly into lake by two-stroke (onboard) motors
- Observed no negative short-term effects of increased hydrocarbon level
- Suggested that agencies be cautious of long-term effects

ADEC Studies

Studies on hydrocarbon levels in Big Lake in
2004, 2006, and 2014

Table

Method:

- Measured TAHs levels around various depths and locations
- Measured levels of TAHs using a volatile organic carbon compound designed by the USGS



Findings:

- Direct correlation between the number of boats on Big Lake and hydrocarbon levels
- Hydrocarbon levels are not rising each year
- Jet skis are bad!for the lake...



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III. Engineering Analysis

We need a system that treats bilge water! But how?

- Collection is crucial
- Is biological treatment feasible?

We Have 3 Treatment Options

Treatment Option 1: Gravity Oil Water Separation

Use dissimilar densities of oil and water to separate oil particles from clean water

- Gravity as the only driving force
- Benefits:
 - Efficient
 - Simple
 - Low maintenance
 - Works regardless of inflow concentrations or contents

Stokes' Law

$$v_s = \frac{g D^2 (\rho_p - \rho_f)}{18 \mu}$$

v_s : settling velocity of the drop (m/s)
 g : gravitational constant (9.81 m/s²)
 D : the droplet diameter (m)
 ρ_p : the density of the light liquid phase (kg/m³)
 ρ_f : the density of the heavy liquid phase (kg/m³)
 μ : the dynamic viscosity (kg/m·s)

Main forces behind particle separation are:
 - Gravity
 - Buoyancy

Diffusion is not a problem because of particle collision and aggregation of particles.

Addition of particles does not result in a significant increase in viscosity.

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Treatment Option 2: Centrifugal Separation

- Force: Centripetal Acceleration
- Benefit
 - Faster than gravity separation
- Drawbacks:
 - Many moving parts
 - Higher costs
- Not concerned about the time it takes for particles to separate

Treatment Option 3: Absorption

- Absorb oil through a material medium
- Drawback:
 - Need to frequently remove and replace oily fabric

And the winner is.....
Gravity Oil Water Separation!!

Our Plans for Collecting Bilge Water for Further Treatment:



- Concrete Slab Will Serve as:
- New Boat Launch Ramp
 - Drainage Mechanism for our Collection Basin



III. Engineering Analysis

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$$v_d = \frac{g D_d^2 (\rho_h - \rho_l)}{18 \eta_c}$$

where

- v_d rising velocity of the droplet (m/s)
- g gravitational constant (9.81 m/s²)
- D_d the droplet diameter (m)
- ρ_l the density of the light liquid phase (kg/m³)
- ρ_h the density of the heavy liquid phase (kg/m³)

Main forces behind particle separation:

- Gravity
- Size

Difference in density produces movement of particle in direction (or opposite direction) of gravity.

Problem: Oil particle droplets get so small that this velocity becomes insignificant.

Solution: Use a coalescing agent to bind the small particles to bigger ones.

Stokes' Law

$$v_d = \frac{g D_d^2 (\rho_h - \rho_l)}{18 \eta_c}$$

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Treatment Option 3:

Absorption

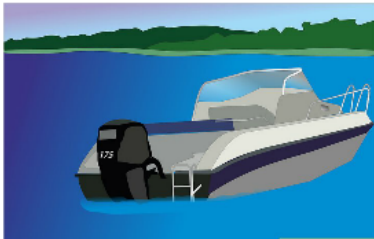
- Absorb oil through a material medium
- Drawback:
 - Need to frequently remove and replace oily fabric



And the winner is.....
Gravity Oil Water
Separation!!

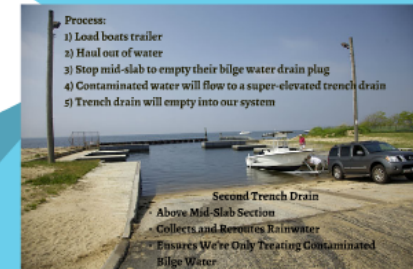
Gravity Oil Water Separation!!

Our Plans for Collecting Bilge Water for Further Treatment:



Concrete Slab Will Serve as:

- New Boat Launch Ramp
- Drainage Mechanism for our Collection Basin





Process:

- 1) Load boats trailer**
- 2) Haul out of water**
- 3) Stop mid-slab to empty their bilge water drain plug**
- 4) Contaminated water will flow to a super-elevated trench drain**
- 5) Trench drain will empty into our system**

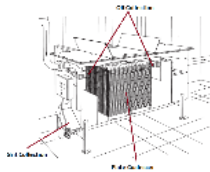
Second Trench Drain

- Above Mid-Slab Section**
- Collects and Reroutes Rainwater**
- Ensures We're Only Treating Contaminated Bilge Water**

IV. Design

- Our Two Designs:
- 1) Design Alternative A
 - 2) Design Alternative B

Design A



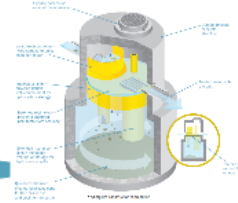
- Additional Components:**
- Coalescing Agent (calcium-carbonate based plate)
 - Auger for filtration of larger material
 - Pump station
 - GAG Unit
 - Additional Waste Oil Tank (500 gal)
 - Pump Station Activated by Sensors in Collection Basin



- Benefits:**
- Less mechanical complexity
 - Low maintenance

- Drawbacks:**
- System sits above-ground, thus, it's an eyesore
 - Requires extra energy to operate

Design B



- Specifications:**
- Centrifugal Separation
 - Separate Coalescing Agent
 - Underground Installation
 - Pumps aren't Needed
 - Minimal Footprint
 - Large Catchment Basin
 - No Additional Tank Needed

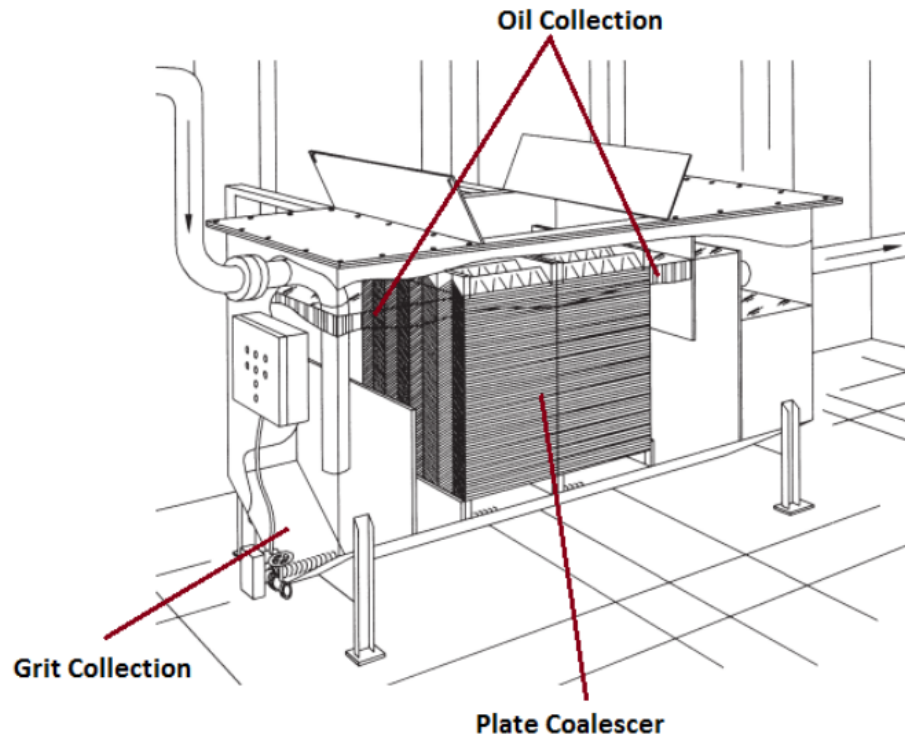


- Design B Testing Results:**
- Separates 99.3% of oil contaminants
 - Inflow Rate: 144 gal/min
- Still, we need an OGS Polishing System

We have 2 comparable systems.
What do we need to know now??

Cost!!

Design A



Additional Components:

- Coalescing Agent (calcium-carbonate based plate)
- Auger for filtration of larger material
- Pump station
- GAC Unit
- Additional Waste Oil Tank (300 gal)
- Pump Station Activated by Sensors in Collection Basin

Location



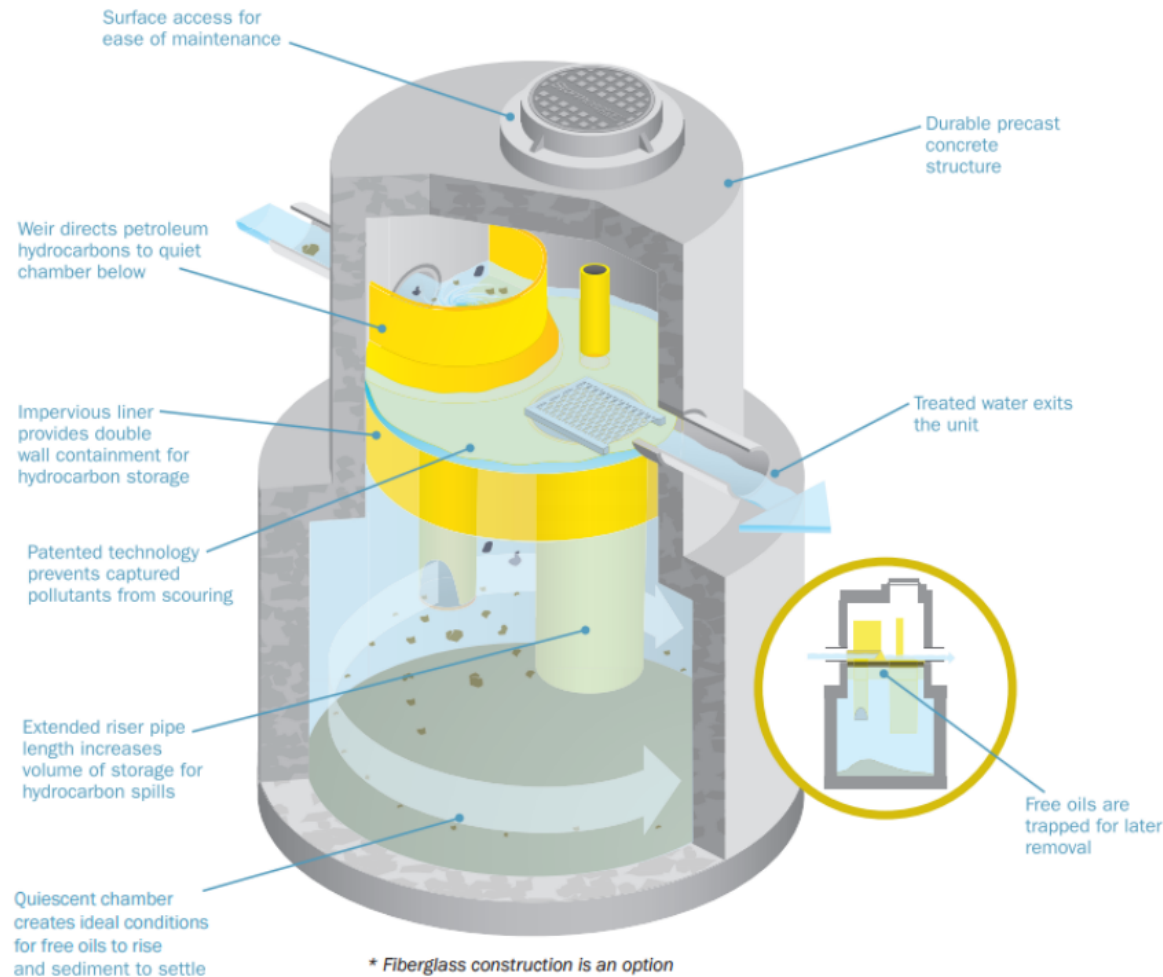
Benefits:

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Design B



Specifications:

- Centrifugal Separation
- Separate Coalescing Agent
- Underground Installation
- Pumps aren't Needed
- Minimal Footprint
- Large Catchment Basin
- No Additional Tank Needed

Location



Design B Testing Results:

- Separates 97.8% of oil contaminants
 - Inflow Rate: 142 gal/ min

Still, we need an OGS
Polishing System

We have 2 comparable
systems.

What do we need to know
now??

Cost!!

Bilge Water Treatment Volumes

Purpose: Determine Hydrocarbon Demands on Our System to Determine Proper System Size

Steps:

- 1) Assess bilge water components
- 2) Determine how much water our system collects
 - a. Assess where water comes from
 - b. Calculate 3 variables affecting water volume

1) Assessing Bilge Water Components

- a. Water (majority)
- b. Engine oil deposit

2) Determine How Much Water Our System Collects

a. Two Possible Sources of Water

1. Leak
 - Possible Sources
 - Fuel
 - Water
 - Oil
2. Die
 - 200 gallons per hour
 - 1000 gallons per hour
 - 2000 gallons per hour
 - 3000 gallons per hour
 - 4000 gallons per hour
 - 5000 gallons per hour
 - 6000 gallons per hour
 - 7000 gallons per hour
 - 8000 gallons per hour
 - 9000 gallons per hour
 - 10000 gallons per hour

b. Calculate 3 Variables Affecting Water Volume



3) Results

- a. Bilge Water Volume
 - Low flow
 - Low traffic
 - 1000 gallons per hour
 - 2000 gallons per hour
 - 3000 gallons per hour
 - 4000 gallons per hour
 - 5000 gallons per hour
 - 6000 gallons per hour
 - 7000 gallons per hour
 - 8000 gallons per hour
 - 9000 gallons per hour
 - 10000 gallons per hour
- b. Hydrocarbon Volume
 - 1. Assess the water composition
 - 2. Assess the hydrocarbon content
 - 3. Final Hydrocarbon Results: 10000 gal per hour

Bilge Water Treatment Volumes

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1) ASSESSING Bilge Water

Components

- a. Water (majority)
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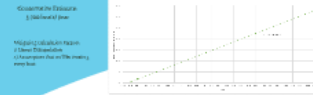
2) Determine How Much Water Our System Collects

a. Two Possible Sources of Water

- i. Lake
 - Possible Sources
 - Splashes
 - Leaks
 - Unlikely
- ii. Sky
 - Only other option
 - Easy to determine with 3 variables
 - 1) Amount of boats using our system
 - 2) Approximate rainwater collection area of typical boat
 - 3) Average rainfall

b. Calculate 3 Variables Affecting Water Volume

i. Amount of boats using our system



ii. Approximate rainwater collection of typical boat

Typical boat: 10ft x 16ft
Collection Area Estimate: 30ft²

iii. Average Rainfall

10ft. width
Per 1000 Department of Commerce Weather Bureau
May - August

3) Results

a. Bilge Water Volume

- i. Lower bound
 - Low traffic
 - 30% awning allowance
 - 70,000 gal/ summer
- ii. Upper bound
 - High traffic
 - 0% awning allowance
 - 105,000 gal/ summer

b. Hydrocarbon Volume

- i. Assume bilge water composition: about 0.1% hydrocarbons
- ii. Final Hydrocarbon Results: 70-105 gal/ summer

a. Two Possible Sources of Water

i. Lake

- Possible Sources
 - Splash
 - Leak
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- Only other option
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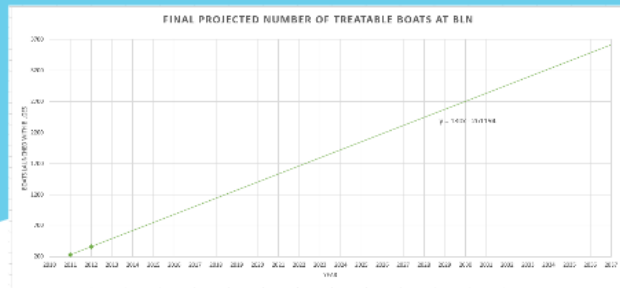
ur System Collects

b. Calculate 3 Variables Affecting Water Volume

i. Amount of boats using our system

Conservative Estimate:
3,700 boats/ year

Mitigating Calculation Factors:
1) Linear Extrapolation
2) Assumption that we'll be treating every boat



ii. Approximate rainwater collection of typical boat

Typical boat: 12ft x 8ft
Collection Area Estimate: 70ft²

iii. Average Rainfall

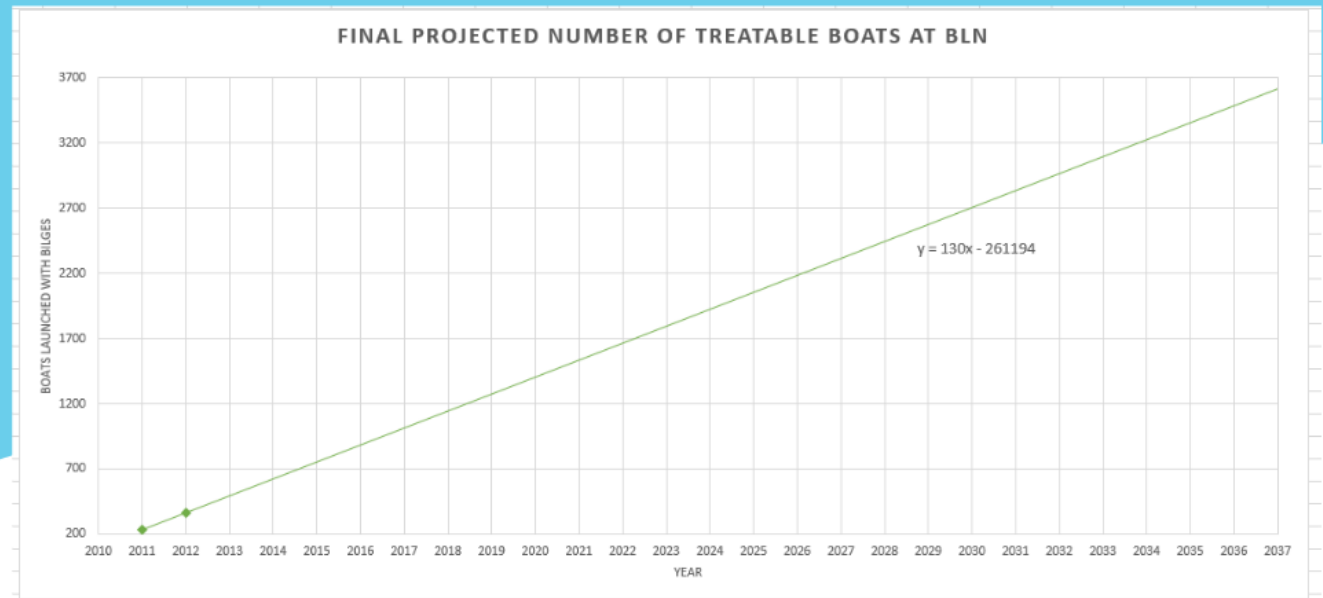
3 in/ month
Per U.S. Department of Commerce Weather Bureau
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b. Calculate 3 Variables Affecting

i. Amount of boats using our system

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b. Hydrocarbon Volume

- i. Assume bilge water composition:
about 0.1% hydrocarbons
- ii. Final Hydrocarbon Results: 70-105
gal/ summer

V. Community Impact

Problem:

We need a program to convince the public to use our system!

Current Solution:

Cook Inletkeeper's "Keep Big Lake Clean"

Methods:

- 1) Educate Boaters
- 2) Work with local businesses to develop a clean boating discount card program
- 3) Hand clean boating kits out to local boaters
- 4) Conduct surveys to measure boater awareness

Graph

Our Solution:



"Fish Will Judge,
Dump the Sludge"

V. Community Impact

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We need a program to convince the public to use our system!

Current Solution:

Cook Inletkeeper's "Keep Big Lake Clean"

Graph

Methods:

→ Educate Residents

use our system!

Current Solution:

Graph

Cook Inletkeeper's "Keep Big Lake Clean"

Methods:

- 1) Educate Boaters
- 2) Work with local businesses to develop a clean boating discount card program
- 3) Hand clean boating kits out to local boaters
- 4) Conduct surveys to measure boater awareness

Our Solution:

"Fish will be...

Our Solution:



"Fish Will Judge,
Dump the Sludge"

VI. Recommendations

- 1) Need further research before implementing a bilge water system
- 2) Support Cook Inletkeeper's boater awareness efforts
- 3) Move swimming area further from the dock



2) Support Cook Inletkeeper's boat
awareness efforts

3) Move swimming area further from the dock



VII. Conclusion

Where We've Been:

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Where We're Going

VII. Conclusion

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v. Community Impact
VI. Recommendations



Where We're Going



Thank You

Peyton Briggs



Claire Cropper



Miles Allen



Kieran Braun



Supervised By: Professor's Name

Civil Engineering Program
University of Alaska, Anchorage