BIG LAKE NORTH STATE RECREATION SITE
BILGE WATER TREATMENT
BIG LAKE, ALASKA

FEASIBILITY STUDY

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EXECUTIVE SUMMARY

The Big Lake North State Recreation Site is a popular boating recreation destination in Big Lake, Alaska. The amount of recreational watercraft activity has been linked to hydrocarbon levels that exceed the Alaska Department of Environmental Conservation (ADEC) standard of 10ppb. This project looked into the impacts of bilge water discharged directly into the lake and consisted of a reviewing literature on hydrocarbons and bilge water treatment and determining which system would be most effective in helping reduce hydrocarbon levels at Big Lake. After the research was completed it was determined that the maximum amount of hydrocarbons that can be removed with current bilge water technologies is about 104 gallons annually. This number drops to 14 gallons if local residents do not use the system for their boats. There are two types of bilge water treatment systems recommended. The initial cost for this system is $84,000 - $142,000, and the yearly maintenance costs are estimated to be $1,000 - $2,000. Further research is recommended before building either of these systems.

1. INTRODUCTION

1.1 PROJECT LOCATION

The Big Lake North State Recreation Site (SRS) is a popular boating recreation destination in Big Lake, Alaska, 10 minutes off of the Parks Highway and 30 minutes north of Wasilla, Alaska.

Figure 1.1 Project Location (Google Earth, 2017)

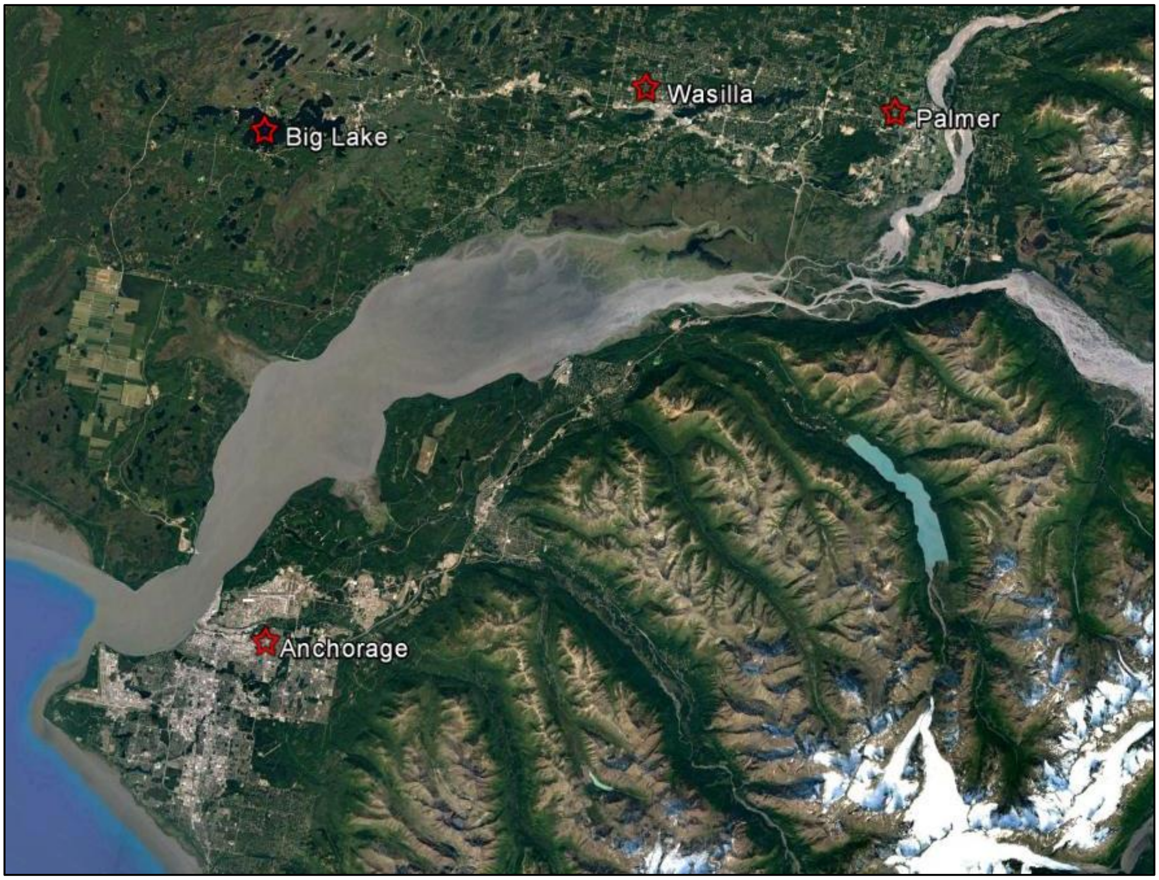


Figure 1.2 Big Lake Location (Google Earth, 2017)

Figure 1.3 Big Lake North State Recreation Site Location (Google Earth, 2017)

The Big Lake North SRS is shown in Figure 1.3 The existing facility is managed by the Alaska Department of Natural Resources, Division of Parks and Outdoor Recreation (DNR-DPOR) and consists of a dual-launch boat ramp, which is the main access point into Big Lake. Given the recreation site's close proximity to Southcentral Alaska's major population centers, it attracts heavy use during the summer months with boat traffic ranging from 470 - 1,100 boats per summer in recent years. Recreational opportunities at the site include boating, waterskiing, jet skiing, swimming, and fishing. This site is by far the most used inland boat launch in the state.

1.2 PROJECT BACKGROUND

This feasibility study concerns the design and construction of an onsite bilge water treatment system, otherwise known as a reception facility, at the Big Lake North SRS. This is a suggested course of action due to the fact that Big Lake has been listed as an "impaired waterbody" by the Alaska Department of Environmental Conservation (ADEC) for several years running due to high levels of Total Aromatic Hydrocarbons (TAHs). This classification means that this waterbody does not meet the water quality standards set in the Clean Water Act, and that the ADEC must show improvement in their management of Big Lake. The Water Quality Standards criterion value of this pollutant is 10ppb. In ADEC's 2014 study it was found that during high traffic weekends this value was exceeded by up to 400% near the Big Lake North boat launch. High TAH levels are a concern because oil has been shown to have various negative impacts on aquatic life, including reproduction impairment and fin erosion.

1.3 PROJECT PURPOSE

The purpose of this project is to determine the feasibility of constructing an onsite bilge water treatment system at Big Lake North SRS. The general design criteria provided by the Department of Natural Resources, Division of Parks and Outdoor Recreation (DNR-DPOR) are:

1. Reduce pollutants in bilge water to acceptable levels
2. System with low maintenance/operational cost
3. Minimum waste haul-out requirements
4. User friendly for boaters

Given those design criteria, a review of existing studies will be performed, system alternatives will be presented, and a recommended system identified and discussed. A cost analysis will be performed for the selected system. Finally, a community impact assessment will be done to determine how to best present this facility to the public.

2. LITERATURE REVIEW

Upon starting research for this project, it became clear that little information concerning bilge water treatment in marinas is readily available. The documents that proved most useful in research were the several ADEC studies done on the hydrocarbon levels in Big Lake, an Environmental Protection Agency (EPA) document on Oily Bilgewater Separators in ocean-faring ships, and a study done on similar issues in Wisconsin.

2.1 ADEC STUDIES

The ADEC commissioned studies on the hydrocarbon levels in Big Lake in 2004, 2006, and 2014. The 2004 and 2006 studies were performed by OASIS Environmental, and the 2014 study was performed by the Aquatic Restoration and Research Institute (ARRI). These studies tested the hydrocarbon levels at various depths and locations in Big Lake, and the Big Lake North site is referred to as BL 10, circled for emphasis in Figure 2.1 below.

Figure 2.1 ADEC Big Lake Hydrocarbon sampling locations (OASIS Environmental, 2004)

The hydrocarbon testing measured levels of TAHs using a volatile organic carbon sampled designed by the U.S. Geological Survey (USGS). The results of these studies is shown in Table 2.1 below.

Table 2.1 - Summary of Historic Sample Data at Big Lake North SRS

Year	Day Sampled	Weekend/Weekday	TAH concentration (ppb[1])
2004	5/15	Weekend	9.94
	5/29	Memorial Day Weekend	**12.11**
	6/12	Weekend	**11.15**
2006	5/12	Weekend	<<10
	5/28	Memorial Day Weekend	**23.17**
	7/3	July 4th Weekend	**62.24**
	7/23	Weekend	**40.83**
	8/20	Weekend	<<10
	9/4	Weekday	**11.0**
2014	6/7	Weekend	5.6
	6/8	Weekend	**43.7**
	6/9	Weekday	**40.1**
	6/10	Weekday	**11.0**
	6/29	Weekend	9.6
	7/4	July 4th Weekend	6.7
	7/5	July 4th Weekend	6.6
	7/6	July 4th Weekend	**12.7**
	7/7	Weekday	7.3

(OASIS Environmental, 2004); (OASIS Environmental, 2006); and (Davis, J. et al., 2014)

In Table 2.1, weekends consisted of Fridays through Sundays and weekdays consisted of non-weekend days. Values above the allowable ADEC limit of 10ppb are shown in bold for emphasis. The data for 2006 only included numbers for concentrations over the limit, so values for low concentration sites could not be approximated. The concentrations for 2004 are the surface concentrations at the site, and the 2006 and 2014 concentrations are at a depth of .5ft. The spike in 2006 numbers may be due to the fact that these days were all above 50 degrees Fahrenheit with 0 in. of precipitation. Memorial Day Weekend was not surveyed in 2014 because Big Lake was still covered in ice. The first weekend in June is the first weekend boating was available on the lake that year.

The 2004 study also measured hydrocarbon levels in the designated swimming area next to the dock, shown in Figure 2.2 below. The hydrocarbon levels at this location were 47.04ppb.

[1] Data was given in μg/L, converted to ppb for the purposes of this report. 1 μg/L = 1 ppb

Figure 2.2 Swimming Area Near Dock (Davis et al., 2014)

The 2004 study also showed that hydrocarbons only appeared to mix in the first 5ft. of the water column, so hydrocarbon sedimentation is generally not a concern. The 2014 study was much more extensive than the other two, measuring the number of boats using transect surveys, aerial photography, and stop action photography. They found a direct correlation between the number of boats on Big Lake and the hydrocarbon levels. Furthermore, they found that roughly 30% of the watercraft observed were 2-stroke motors or Personal Water Craft (PWC), otherwise known as jet skis. The type of engine in these watercraft discharges a significant amount of oil and gasoline through its exhaust pipe. This is important because a bilge water treatment system would not be able to address the hydrocarbons discharged into the lake in this manner.

In summary, these studies found that peak boating traffic correlated with very high hydrocarbon levels near popular boating locations, especially docks such as Big Lake North SRS. They determined that these levels are not rising each year, and that the hydrocarbons are staying relatively close to the surface of the water. The 2014 study found that 30% of the watercraft on Big Lake are 2-stroke motors or jet skis, which discharge hydrocarbons that cannot be treated with a bilge water collection system.

2.2 EPA BILGEWATER STUDY

The EPA study was done as a survey of the current bilge water treatment technologies available for ocean-faring ships. The EPA aimed to determine whether decreasing the allowable discharge concentration into the ocean from 15ppm to 5ppm is feasible. This study was useful for our research because it defined a specific test fluid, and the practical problems of installing different types of bilge water treatment systems. The systems outlined in this study were built for flows far beyond a marine bilge water treatment system, but the section comparing the pros and cons of treatment types was invaluable.

The test fluid used in this study, Test Fluid “C”, is a standard fluid used by the EPA. It contains a mixture of fresh water, marine residual fuel, marine distillate fuel, surfactant (a compound that lowers surface tension), and iron oxides. This is not the exact mixture of bilge water that a marine system would treat, since smaller boats use regular, not marine, gasoline, but it shows the importance of particles and other fluid pollutants in designing a treatment system. The expected composition of bilge water at Big Lake will include grit, oil, gasoline, and other marine fluid pollutants.

The treatment technologies reviewed by the EPA were gravity oil water separators (OWS), centrifugal separators, and polishing treatments. The polishing treatments reviewed were absorption and adsorption, biological treatment, coagulation and flocculation, flotation, and membrane technologies. These were all considered in the Engineering Analysis section of the report, with important pros and cons pertaining to the Big Lake North Site.

2.3 WISCONSIN STUDY

This study was done by Timothy Asplund of the Wisconsin Department of Natural Resources. Research was done in conjunction with the University of Wisconsin to determine the effects of motorized watercraft on aquatic ecosystems. This study found that the most significant impact boats have on wildlife and fish in lakes is turbulence, which can be mitigated through no-wake zones. Asplund found that most hydrocarbons were injected directly into the lake by two-stroke or outboard motors, and that no observed negative short-term effects of increased hydrocarbon levels have been observed. He did suggest that agencies be cautious about long-term effects, since no studies have yet been done on what they may be. This is in direct opposition to statements from the ADEC and EPA, and will need to be evaluated to determine whether Asplund’s conclusions are applicable to Big Lake.

3. ENGINEERING ANALYSIS

This section is a review of the data collected and analyzed on the Big Lake North State Recreation Site and the assumptions behind the numbers used in the final calculations.

3.1 ENVIRONMENTAL CONSIDERATIONS

The studies reviewed above had differing opinions on the effects of bilge water. Its components, benzene, toluene, ethyl benzene, and xylene, are the main contributors to the high TAH levels observed by the ADEC. These compounds are known carcinogens, but their concentrations vary significantly in bilge water samples, and it is difficult to know at which concentration harmful side effects will occur. Generally, it has been observed that motor oil has a significantly more harmful effect on aquatic life than gasoline. It is possible that the Wisconsin study determined that bilge water is not harmful based on the assumption that most hydrocarbons in bilge water are from gasoline. Oil has been associated with reduced growth of fish, enlarged livers, fin erosion, and reproduction impairment.

The current limit on TAHs set by the ADEC is 10ppb, which is regularly exceeded during peak boating hours, especially during the Fourth of July and Memorial Day. Any bilge water treatment system implemented will need to reduce this concentration by purifying the water and collecting hydrocarbons for disposal. The purified water returning to the lake must have a hydrocarbon concentration below 10ppb (Eldred, 2017).

Another environmental concern is the location of two nearby wells, one on site and one on a neighboring property. If the system is placed closer than 200 ft. away from these two wells, a special permit will need to be issued. There is also a required distance of 100 ft. from the shore that may require a permit if the system is closer. Considering the expense of additional safety measures, such as a double walled collection tank or a specialty geotextile liner would be beneficial.

Finally, the construction of a lakeside bilge water system will include environmental considerations, especially with drainage. These concerns are addressed in the Design section of this report.

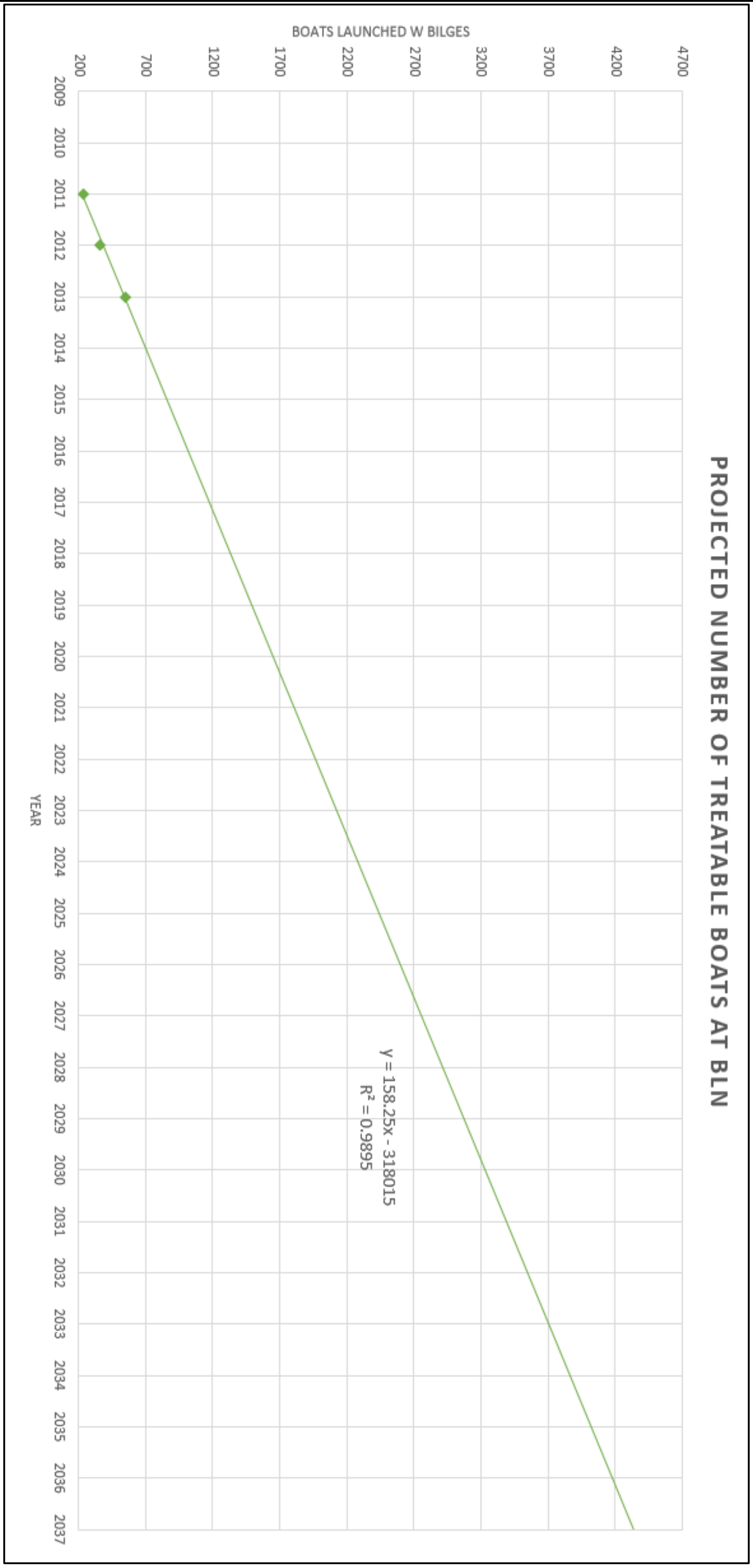
3.2 GEOLOGICAL DATA

Information on the soil types near Big Lake North were available in the 1983/84 USGS survey. This survey found that the general soil type is sandy silt and stony soils, which is fairly ideal. The soil near the lake shore will be avoided to minimize environmental impact and seepage from the water table, but otherwise there are no serious geotechnical considerations in the location of a treatment facility.

Big Lake itself is a freshwater lake, recharged by runoff in a 17,600-hectare watershed basin. Meadow Creek also recharges the lake, connecting near the North Shore. The lake has roughly 17 miles of shoreline and has 22 islands, some with permanent residences. The maximum depth of Big Lake is roughly 88 feet (Woods, 1983/84).

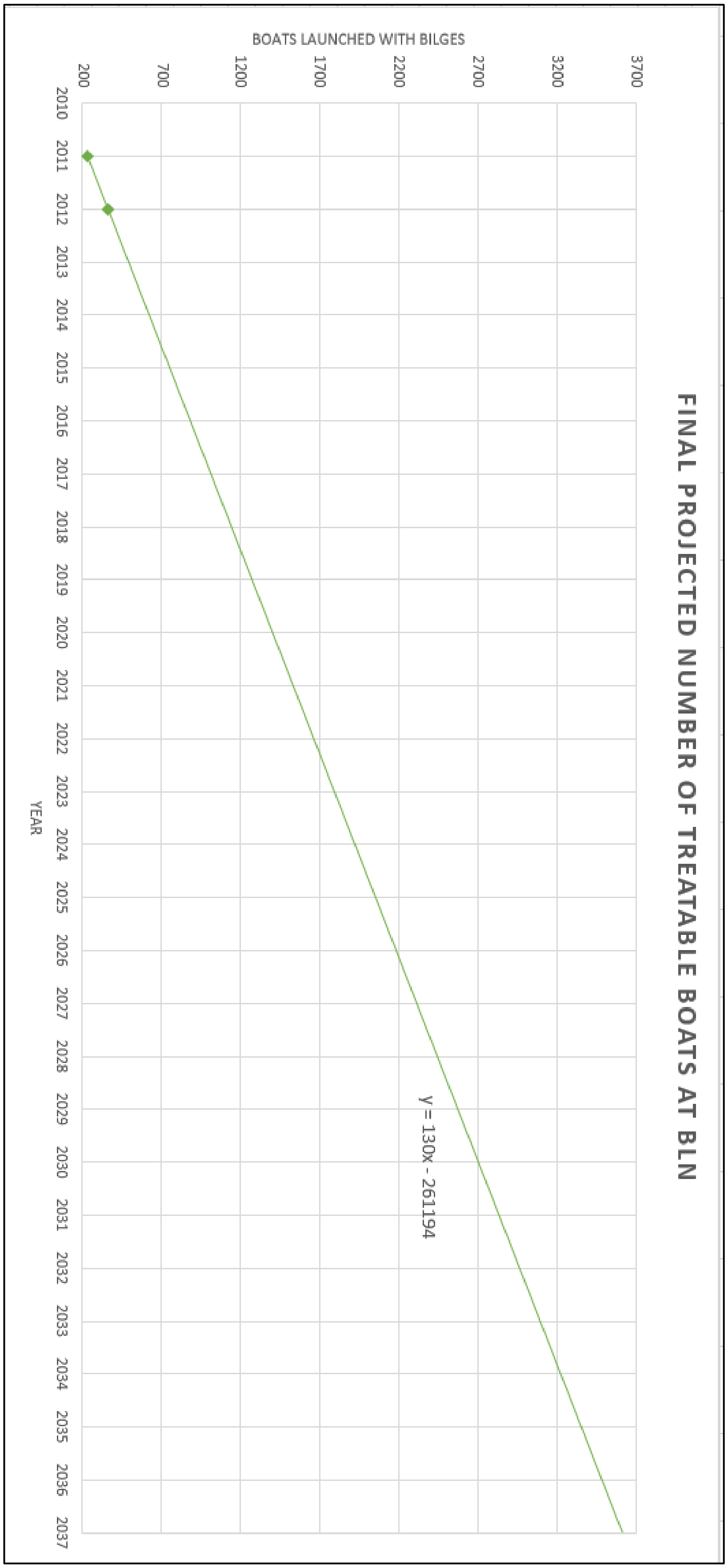
3.3 BOAT USE AND PEAK WATER PROJECTIONS

DNR-DPOR provided data on the number of boats using the launch at Big Lake North for 2011, 2012, and 2013. This data was projected 20 years, to 2037. The number of treatable boats in the ADEC study was 70%, but this did not account for outboard motors. After speaking with local boat dealerships with more experience in the area, it was found that a value of 50% was more accurate. When the data was graphed, the numbers were surprisingly linear. It is likely that the data follows the general logarithmic S-curve trend of most population data, but we have no way of determining when the linear region of that curve will end, so a linear projection was used as a conservative estimate. This is shown in Graph 3.1.



Graph 3.1 Initial Projected Number of Treatable Boats

From Graph 3.1, if a linear approximation is used, the design number of boats using the boat launch is 4,300. This number is extremely high, and is effected by the boom in the number of boats in 2013. This year had a record summer, which is believed to have skewed the approximation since it only includes three years. If 2013 data is considered an outlier, Graph 3.2 shows the projected number of boats.



Graph 3.2 Final Projected Number of Treatable Boats

From this graph, it is estimated that the final design number of boats using the launch is 3,616 per year. It is also necessary to calculate the peak amount of water the system would need to treat. The grate system used to collect bilge water after the pumps are opened will not be closed during rainfall events, so the peak flow will be determined by how much rainwater enters during a storm event. This rainwater won't need to be treated, but it would still be detrimental to the system if it overflowed during rainfall events. This maximum flow was calculated for an intake grate size of 20 square feet and using the peak 24-hour rainfall data from the U.S. Department of Commerce Weather Bureau's paper. Figure 3.1 below shows the peak 24 hour rainfalls given for the State of Alaska.

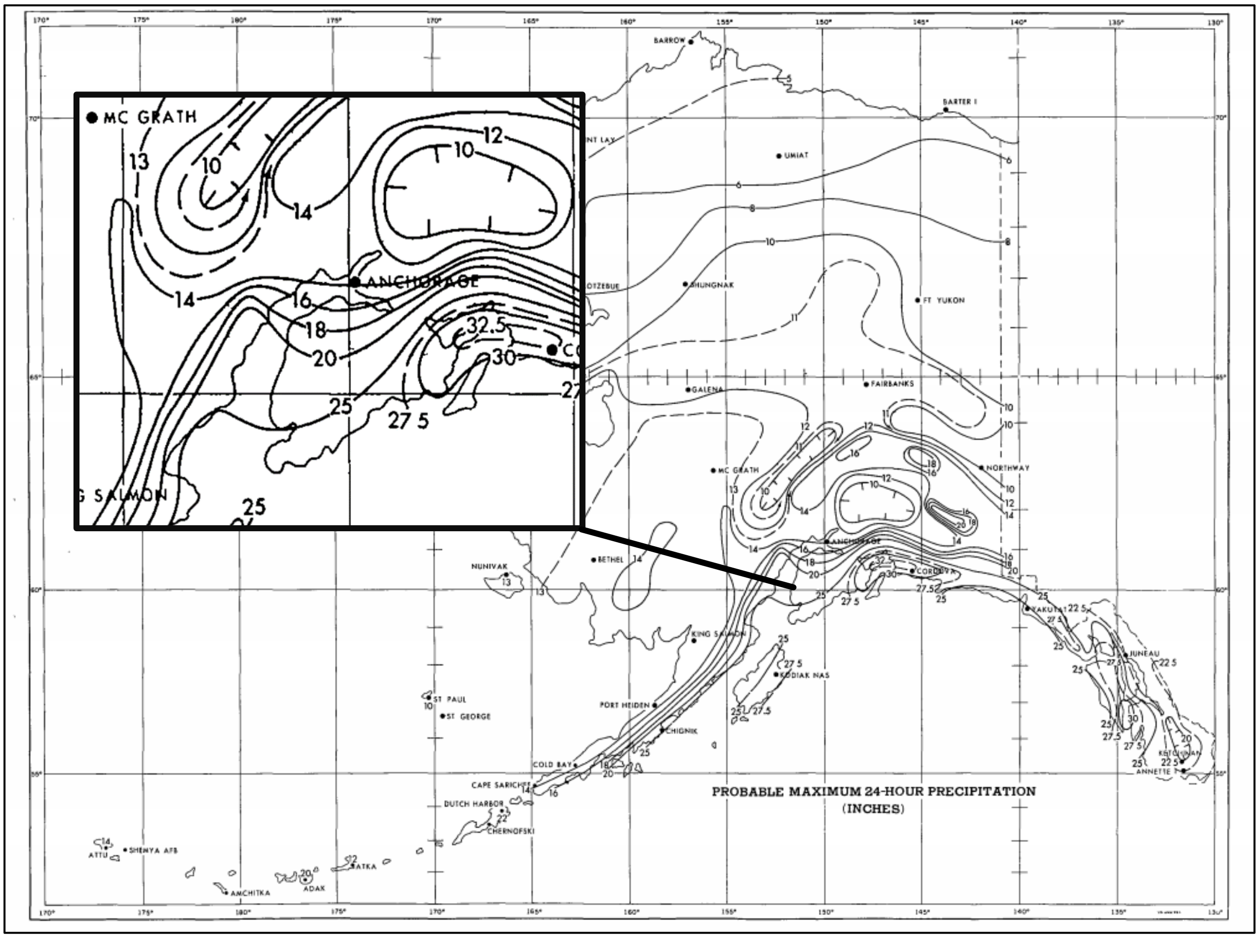


Figure 3.1 Peak 24 Hour Rainfall (Miller, 1963)

This paper gave a peak rainfall of 14 in/ 24 hours. With these numbers, the peak flow through the bilge water treatment system will be 0.97 ft^3/hr. The design system chosen must be adequate for this maximum flow.

3.4 BILGE WATER PROJECTION

If the total number of boats launched is 3,616, then the total amount of hydrocarbons collected through bilge water treatment can be calculated. This number is necessary to know the size of the hydrocarbon storage container that will be pumped annually. Other necessary variables are the average summer rainfall, average boat size, and average boat hours. From contact with a Big Lake boat dealership, the average boat size was determined to be 12 ft. by 8 ft., shown in Figure 3.2 below. This boat size gives a square footage of 69 ft^2/boat.

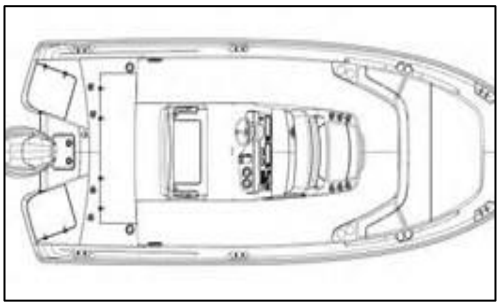


Figure 3.2 Average Boat Type (Boston Whaler, 2017)

In these calculations, it was assumed that these boats were 30% covered, that is, 30% of the boat's area did not collect rainfall in the bilge, and that the average summer boat hours are 48 per boat. We also chose to include 100% of the bilge water accumulated in lakeside properties in the North Bay (designated in Figure 2.1). Using the Mat Su Borough Parcel Viewer, there are roughly 400 properties with houses in this area, and there is a possibility to collect their bilge as well; plans are discussed in the Community Impact section of this paper.

In these calculations it was assumed that the average summer rainfall to be 7.5 in, an average of the values found on Weather Underground's Weather Forecast Archives for Big Lake, AK. With these numbers the estimated maximum amount of bilge water treated will be 104,000 gallons per summer. From personal conversation with John Cooney, a chemist at the National Response Corporation, the amount of hydrocarbons collected from bilge water is roughly 0.1% (Cooney, 2017). The hydrocarbon collection tank for the recommended system will need to hold 104 gallons. If the surrounded properties' boats are not considered this number drops to 14 gallons.

3.5 SYSTEM TYPES

There are several types of bilge water treatment systems, but not all are feasible for the Big Lake North Site. The major categories of systems given in the EPA Bilgewater Document are: gravity oil water separators (OWS), centrifugal separators, and polishing treatments. The polishing treatments reviewed were absorption and adsorption, biological treatment, coagulation and flocculation, and membrane technologies. Each of these treatments will be summarized below.

3.5.1 Gravity Oil Water Separators

Gravity Oil Water Separators make use of the difference in density of oil and water to separate the two liquids. Simply put, oily water moves slowly through a tank, and the oil floats to the surface where it is collected and disposed of. The cleaned water then leaves the tank through a valve that is located under the surface of the water. Any particles or grit in the water will settle to the bottom and will be removed after accumulating.

The main drawback to this process is that it is not effective when oil is emulsified. Emulsified oil is oil droplets with a diameter less than 20 µm across. When droplets are this small, there is no effective buoyancy force, and gravity is not sufficient to separate the oil from the water. There are several mechanisms that can be implemented in a gravity separator to increase its ability to separate these drops. Many OWSs have a coalescing material that attracts these small oil droplets. As more oil collects on the coalescing material, they join together and eventually are large enough to separate through buoyant force.

Some specific benefits of this system are that it is fairly simple, has a low initial cost, and is low maintenance. This system is able to remove hydrocarbons from water regardless of incoming concentration and contents, an attribute that is necessary to treat bilge water. The exact content and concentration of bilge water varies widely. These separators typically reduce oil concentrations to 20-100 ppm, which is not low enough to meet the ADEC standard of 10 µg/L. A polishing treatment would be necessary after using gravity separation.

3.5.2 Centrifugal Separators

Like gravity oil water separators, centrifugal separators use the difference in density of oil and water. Centrifugal separators are able to separate oil and water by effectively increasing the force of gravity using centrifugal force. This method is faster than gravity separators and more effective, but comes at a cost. It is more expensive to operate, install and maintain. It requires power and has moving parts. For the purposes of this project, the use of a centrifugal separator will not be considered.

3.5.3 Absorption and Adsorption

Absorption and adsorption are processes where a substance gets incorporated into the structure of a substance of another phase (i.e. solid, liquid, or gas). This process can be used to separate oil and water very effectively. Essentially, oily water flows through a medium that pulls the hydrocarbons out of the water and incorporates the hydrocarbons into that medium.

A common and effective adsorption unit uses granular activated carbon (GAC). A GAC unit is effective for treating oily water that is already fairly clean. If too much oil is present in the water, the GAC will become quickly saturated and the unit will no longer be effective. For this reason, GAC units are used as a polishing treatment; they treat water that has already been treated by a gravity or centrifugal separator. GAC units do not require power to operate as long as there is a hydraulic head at its inlet. They also are very low maintenance. The only regular maintenance they require is the replacement of the GAC. The frequency of this depends on the oil content of the incoming oil. Normally, the weight of oil a GAC unit can adsorb while staying effective is 10-20% of the weight of the GAC.

3.5.4 Biological Treatment

In biological treatment, microorganisms convert hydrocarbons to carbon dioxide and cell components. This treatment method is especially effective in removing emulsified oil, but there are many complications. The microorganisms are very sensitive to temperature, type of hydrocarbon, and concentration of hydrocarbon. A technician or a sophisticated computer is required to avoid harming the microorganisms. This method is not practical for use in this project.

3.5.5 Coagulation and Flocculation

Coagulation and flocculation involves the addition of new chemicals that attract emulsified oil droplets. The emulsified oil droplets collect on these chemicals until they form a particle that is large enough to be removed via a gravity or centrifugal separator, similarly to the used in gravity separators. This method is especially effective for emulsified oil. It does require very specific amounts of added chemicals, and accurate testing of the oily water to be carried out by a skilled technician. This method is also not practical for use in this project.

3.5.6 Membrane Technologies

Membrane filtration implements a membrane that is essentially a microscopic sieve. This sieve lets only water through and stops larger molecules. The major advantage of this system is that the concentration of the outflow will be the same regardless of the inflow concentration. Bilge water inherently varies in concentration and composition making membrane filtration appealing. It does however require a significant amount of maintenance making it less desirable.

4. DESIGN

After considering these systems, it was determined that a total amount of roughly 104 gallons of hydrocarbons can be removed from Big Lake using current bilge water treatment technologies. If the residents with private boat launches do not use the system, this number drops to 14 gallons. It is left to DNR-DPOR to determine whether these numbers are sufficient to cause need for a bilge water treatment system.

The ideal system for the Big Lake North SRS was narrowed down to two designs, Design A and Design B. These two alternatives are briefly outlined below; more details and specifications about these systems is available in Appendices A and B.

4.1 DESIGN A

Design A is an OWS similar to the ATAGOWS-50 sold by Anchorage Tank. Other necessary parts for this option include a 300-gallon tank, granular activated carbon (GAC) unit, a lift station, and a hose and valve assembly. The collection process will require the addition of a trench drain located across the boat launch, with a steel grate covering. There would be a small catchment basin at the end of the ditch. Finally, a dockside water pump would be required for boats not exiting the water at the boat launch. The lift station pumps water to the OWS. From then on, the system is gravity fed. After this, the water runs through a GAC unit for polishing. Then it flows into the discharge trench drain before being discharged into the lake.

4.1.1 Oil Water Separator

The maximum flow rate for this system is 50 GPM, which is well over the required maximum rate. The OWS is a gravity separator that uses calcium carbonate-filled oleophilic propylene M-Pak plates to coalesce small oil droplets. This helps the system to be more effective. A side view of the OWS is shown in Figure 4.1.

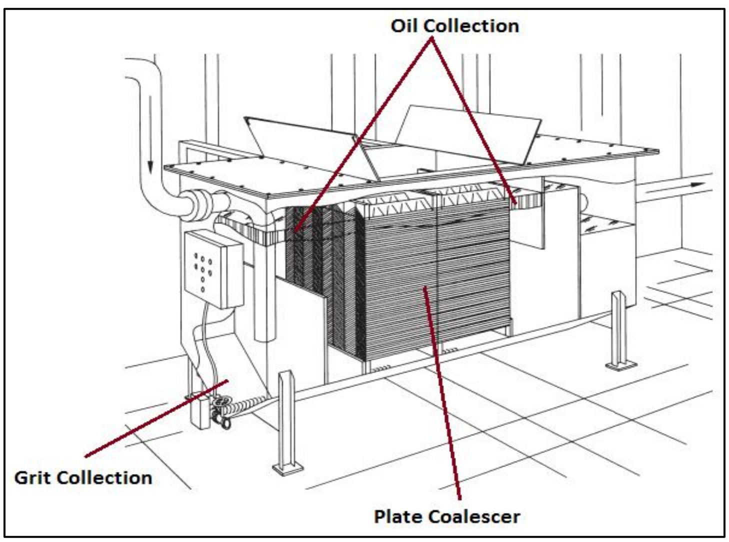


Figure 4.1 Design A Layout (Anchorage Tank, 2017)

In the figure, the inflow is on the left side near the top and the outflow is located near the bottom on the right. The unit itself is 9 feet long, 3 feet wide and 7 feet tall. It is easy to clean and empty. The plates can be cleaned without being fully removed. There is also a small auger that allows for removal of grit from the grit collection basin. Within the OWS there an oil capacity of 83 gallons. Since there is expected to be more waste oil this, oil will need to be stored in an additional tank. Lastly, the OWS has a built in level sensor to alert the user when oil levels are high.

4.1.2 Waste Oil Tank

The OWS does not have sufficient space to hold all the waste water, so an additional waste oil tank is required. An appropriate tank would be a 300 Gallon Carbon Steel IBC Tank similar to the one produced by The Cary Company. A tank this size would have enough space to comfortably hold the required waste oil. This tank is durable so it would have a long life span. It also has a large hatch, which would allow for easy access for a vacuum truck when it needs to be emptied. The dimensions of this tank is 3.5 feet wide, 4 feet long and 3.4 feet tall.

4.1.3 GAC Unit.

The water that exits the OWS is much cleaner than the water that enters it but it is not clean enough to discharge into the lake. For this reason, a polishing treatment is recommended. The most desirable polishing treatment used granular activated carbon (GAC) to filter the water. The recommended GAC unit is the Econo LS (or similar). This GAC unit has a maximum flow capacity of 15 GPM. This flow capacity is higher than our maximum flow so it will be sufficient. The GAC unit is the size of a 55-gallon drum. Based on the capacity of the GAC unit and our expected flow through it, the granular activated carbon will need to be replaced once every one to two years.

4.2.4 Collection Systems

A dockside pump would be located at the dock near the boat launch sot that bilge water can be collected from boats that are not leaving the water. Something similar to a S26 Dockside Slim-Line pro would be recommended. This is a 1 HP, 10 GPM pump build for this exact purpose. It would be used, by the boat owner, to pump bilge water to the trench drain where the bilge water would join with the rest of the system. This addition would allow people who leave their boat in the water all summer to use the system.

In addition to dockside pump, a concrete slab with two trench drains will be installed that will catch bilge water drained onto the boat ramp. The lower trench drain will catch bilge water and route it to the catchment basin. The purpose of the upper trench is to reroute rain water away from the system. Otherwise, the system may overload during rain events. A diagram of the concrete slab is shown in Figure 4.2.

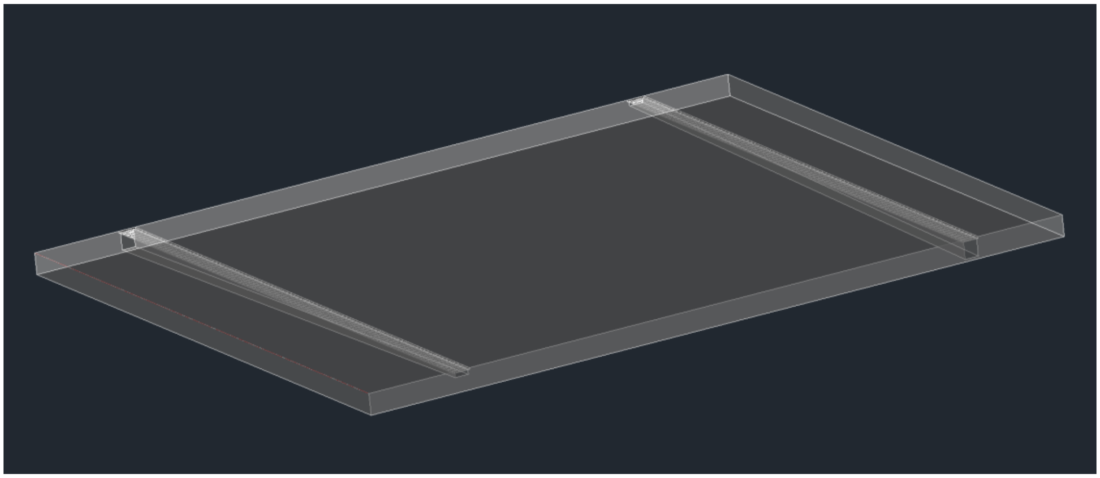


Figure 4.2 Collection Slab for Design B

4.1.5 Lift Station and Hose and Valve Assembly

One of the drawbacks of this system is that it is not 100% gravity fed. The benefit of this is a lower construction cost. It will require a pump station as well as wiring sensors. As the catchment basin at the end of the trench fills, a sensor will engage the lift station, which will pump water into the OWS. This is the only lift station that will be required for the system. The project site is within the electrical grid so finding a power source will not require an elaborate solution. There will also be a fair amount of hoses and valves throughout this system. Anchorage Tank makes lift stations, and hose and valve assemblies. Since these parts are for use with other Anchorage Tank products, they will be compatible and assembly will be easier.

4.2 DESIGN B

Design B is a gravity controlled oil and grit separator (OGS) with a supplementary coalescing structure, also gravity controlled. The benefits of using these gravity-controlled systems are that there aren't any electricity costs and that they are installed underground, minimizing the system's footprint. Similar to the OWS system mentioned previously, the collection process for this system will require the installation of a trench drain with a steel grate covering across the boat ramp. This trench drain will collect bilge water as it flows down the ramp before it reaches the lake. The benefit of using a trench drain installed on the ramp is that boat owners will not have to change their routine when they remove their boat from the water.

4.2.1 Oil and Grit Separator

Several potential OGS units were analyzed for use in this design option, and the Stormceptor EOS-300 provided the highest rate of hydrocarbon removal. The Stormceptor oil and grit separators utilize centrifugal force and non-turbulent flow to separate oil and grit which has become suspended in inflowing water. The EOS models are specifically designed to handle more oil and hydrocarbons than a regular oil and grit separators, the EOS in the product name stands for extend oil storage. The Stormceptor EOS-300, which is the smallest of the EOS line, has the ability to store over 140 gallons of separated hydrocarbons which is much greater than the anticipated number of hydrocarbons and oil to be collected annually. If the amount of boat traffic increases and more storage is needed, this system is expandable, and an additional runoff tank can be added to hold more hydrocarbons. A graphic showing this structure can be found in Figure 4.3.

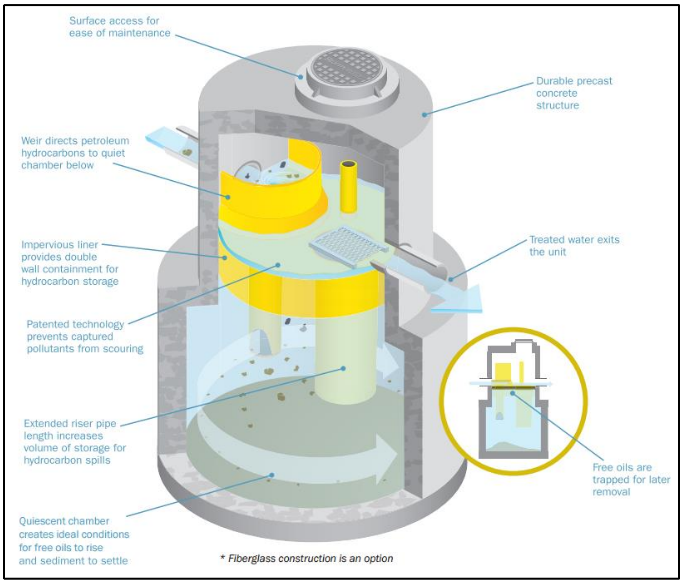


Figure 4.3 Design B Layout (Imbrium, 2017)

When tested by Coventry University, the Stormceptor product line removed 97.8% of the suspended oil from water flowing at 142 gallons per minute. This quantity of water is well over the projected flowrate of bilge water and rain water which will be flowing in, therefore this product is more than adequate for the primary treatment of bilge water.

4.2.2 Polishing System

Similar to Design A, water that leaves the OGS is much cleaner than when it enters, however it still requires an additional polishing treatment. For this system, the desired supplemental treatment can be performed by coalescing system similar to Contech's VortClarex. The VortClarex system utilizes corrugated plates which provide a surface for oil droplets to coalesce, allowing the system to remove oil droplets down to 60 microns. Figure 4.4 shows how this system works.

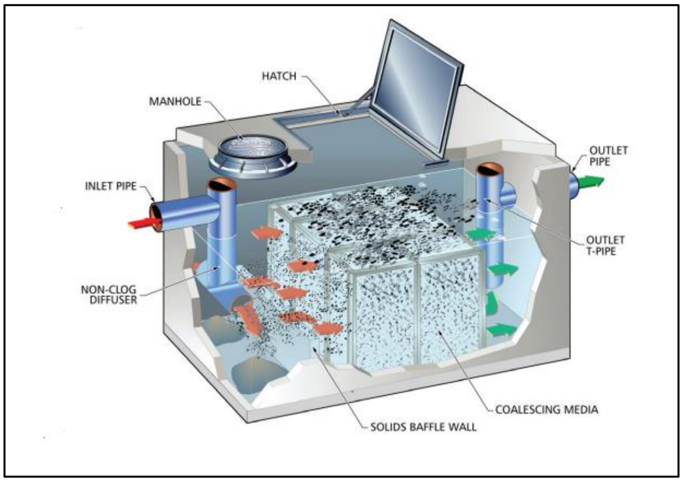


Figure 4.4 Design B Polishing Treatment (Contech, 2017)

For this system to provide maximum separation the horizontal flow through the coalescor needs to be below 4 ft/min, laminar, and with a Reynolds's number less than 500. This goal is easily achieved because exceeding a velocity of 4ft/min would occur at a flowrate of 426 gallons per minute, much greater than the maximum flow rate anticipated.

4.2.3 Collection System

In order to collect the drainage from the boats being removed from Big Lake via the boat ramp, a custom built concrete slab with have to be installed in the boat ramp. This concrete slab is similar to the collection system referenced in the previous design however the trench drains will flow the opposite directions, see Figure 4.4. This will allow Design B to be installed underground on the opposite side of the ramp as Design A. In addition to the concrete slab Design B will also use the dockside vacuum pump which is outlined in 4.2.4.

4.3 LOCATION

The ideal location for this system is as close to the dock as possible, with an outlet flow on the East side of the dock, away from the swimming pool. This is recommended not because the outlet flow is polluted, but to minimize public resistance to the system. Design A will be placed as shown in Figure 4.5 below.

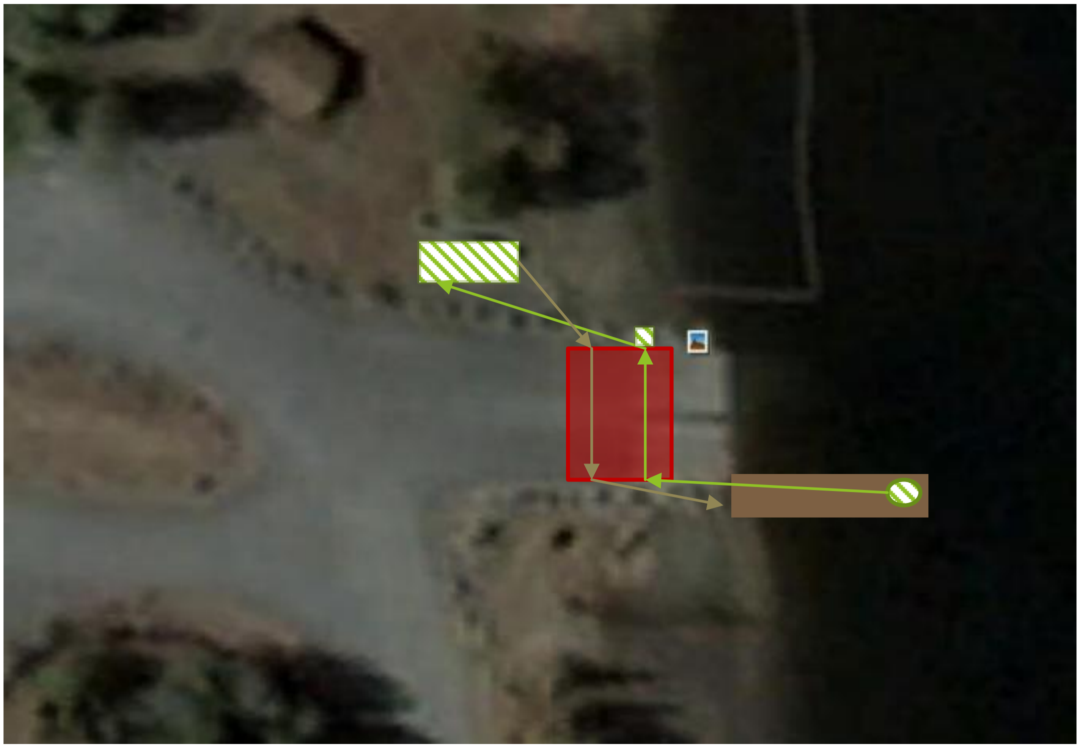


Figure 4.5 Design A Location

Design B will be placed as shown in Figure 4.6 below.

Figure 4.6 Design B Location

Both of these locations are more than the required 200 ft. from the nearest well, but are within the 100 ft. clearance from Big Lake, so some permitting will be required.

4.4 COST ESTIMATE

The cost estimate for the recommended system is broken down in Appendix C. This estimate includes material cost, delivery cost, installation cost, maintenance costs, and the expected design life. It is assumed that NRC will be contracted for disposal of the condensed hydrocarbons, as they are the only known entity in the state that is qualified to do so. Final costs are summarized for both Design A and Design B.

4.5 CONSTRUCTION CONSIDERATIONS

Construction considerations include phasing, pollution, and cost. In order to minimize the effect on boaters using the boat launch, the installation of the system should occur in the late Fall when ramp usage decreases. Fall installation is preferable to the Spring because ground conditions will be more conducive to construction. Many boaters begin using the lake as soon as the ice goes out. Since this is a small project, starting construction in the Fall won't cause issues because the project will be completed quickly. Pollution is another important construction factor; water runoff from the site can pollute Big Lake with suspended solids and chemicals as well as create a large amount of noise pollution. These are all considerations for the construction of a treatment system at this site.

4.6 MAINTENANCE CONSIDERATIONS

Both designs are generally low maintenance, per the general design criteria. Check-ups and disposal will be required only annually. Design A also requires the filter for the GAC unit to be changed every two years, and monitored annually. If the amount of boat traffic increases significantly, this level of service may increase to annually. Design A also requires that the system be drained before freezing to prevent damage to pumps, pipes, and other mechanisms.

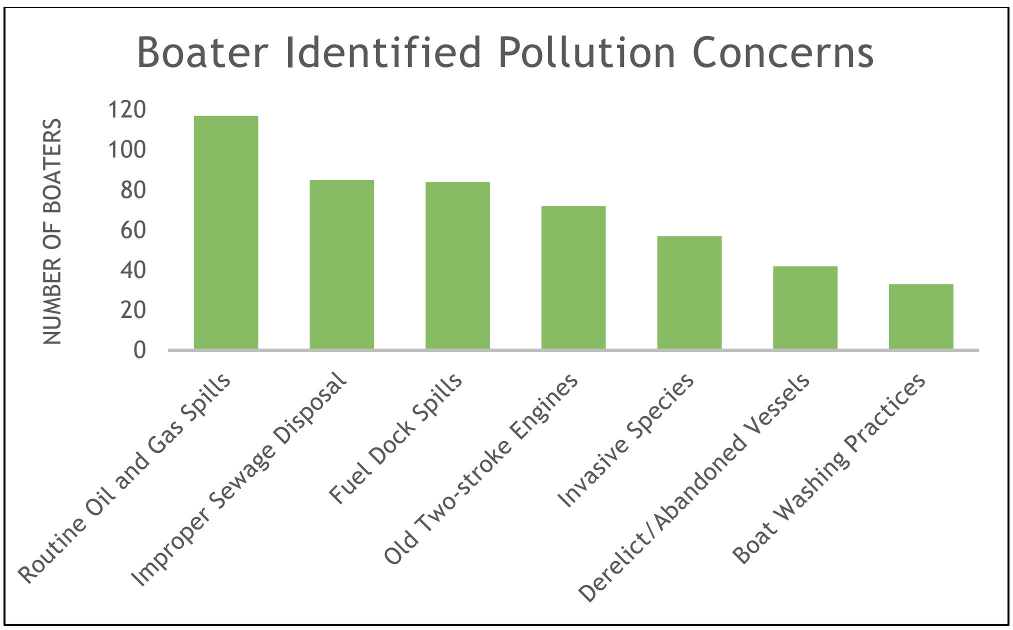
4.7 ENVIRONMENTAL CONSIDERATIONS

The outgoing flow from both of these systems meets the ADEC standard of 10ppb. Neither system uses harmful chemicals, and both are located above the ground water table. If only Big Lake North SRS users use the system, only 14 gallons of hydrocarbons will be removed, as opposed to 104 gallons if residents are involved.

5. COMMUNITY IMPACT

For this system to be successful, the public will have to be convinced to use it, especially those living on the lake shore, who will likely be harder to convince. The vacuum pumps and system were designed to make the system as convenient as possible for these users, but a program to further convince them is still needed. New Jersey has implemented a slogan for Lake Hopatcong, “Pump It! Don’t Dump It!”, and we propose a similar solution, “Fish Will Judge, Dump the Sludge.” This slogan, along with some sort of aquatic mascot, will help to further the perceived importance of bilge water for boaters.

After initial research was done, it was found that a campaign called “Keep Big Lake Clean” already exists in the Big Lake area. This campaign is led by Cook Inletkeeper, a community-based nonprofit, and is an initiative to reduce pollutants in Big Lake by reaching out to local communities, private businesses, DNR-DPOR, and boaters to identify solutions. Cook Inletkeeper’s efforts were focused on educating boaters and working with local businesses to develop a clean boating discount card program. Clean boating kits were handed out to local boaters, and surveys were done to measure boater awareness. In 2016, they found that most boaters were aware of the hydrocarbon pollution in Big Lake, and they surveyed the boaters’ identified pollution concerns. This is shown in Graph 5.1 below.



Graph 5.1 Boater Identified Pollution Concerns in 2016

From the graph it is obvious that boaters are aware of the pollution issues concerning spills, so it should be possible to convince them to dispose of these bilge spills in a specific location, provided that it is sufficiently convenient.

Another consideration is the response of the Wave Runners renters at Big Lake North. The official policy of refueling at one of the Big Lake Marinas, and not on the lake shore, was argued and ignored in 2012. The wait time was cited as one of the main reasons for this issue. While the recommended system is not at all related to jet skis, the wait time is minimized in our recommended system to allow for ease of use. This is especially important for the roughly 400 properties in the North Bay of Big Lake. The system will be inherently less convenient for residents' use, so it is recommended that further outreach through Cook Inletkeeper be pursued to persuade these residents.

It is also recommended that signage be placed at the main boat launch and disposal station, as well as at various locations around the lake. Signs should be whimsical, consisting of an aquatic mascot, and the slogan "Fish Will Judge, Dump the Sludge."

6. RECOMMENDATIONS

After reviewing the available data, it is recommended that further research be done before implementing a bilge water treatment system. Very little information is known on the expected projection of boats that will use the Big Lake SRS in the future; three years is insufficient data. It is also recommended that DNR-DPOR considers moving the swimming area farther from the dock, perhaps near the sandy area they maintain east of the dock. This will help to minimize risk due to spills, which are more difficult to mitigate.

The research on bilge water and hydrocarbon contamination seems to indicate that the main culprits are two-stroke and older engines. A feasibility study is recommended to determine whether a buyback program to replace these engines would be more cost effective than installing a bilge water treatment system. Further support for the current efforts of Cook Inletkeeper is also recommended, as it appears that boater awareness is central to solving this environmental issue.

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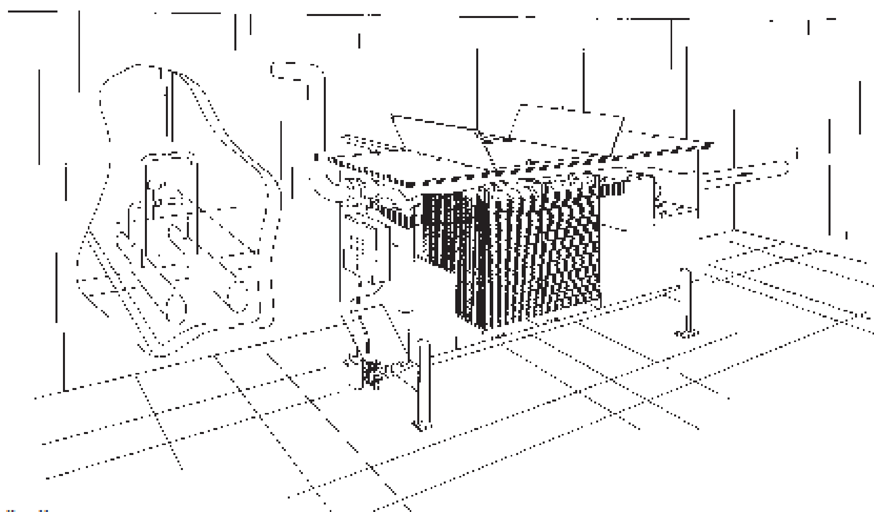
APPENDIX A

The specifications for Design A are included in this Appendix.

Submittal Data Sheet

Aboveground Oil Water Separators



Applications:

- Vehicle Maintenance Shops
- Truck Stops
- Gasoline Service Stations
- Military Installations

Features:

- Aboveground Oil Water Separators can be fabricated in a variety of shapes and sizes to accommodate your requirements.
- M-Pak Plate Packs: packaged with stainless steel & plastic hardware. Media is calcium carbonate-filled oleophilic propylene.
- Plate Packs may be cleaned in place - no need to remove them from the unit.
- Hinged and gasketed covers allow easy access to separator interior for maintenance and inspection.
- Variety of level sensors and control panels.
- Units can be supported by legs or skid-mounted.
- Optional solids collection trough v-bottom with a motortized auger screw to remove solids from the separator.
- Collected oil may be stored internally or in a separate storage tank.

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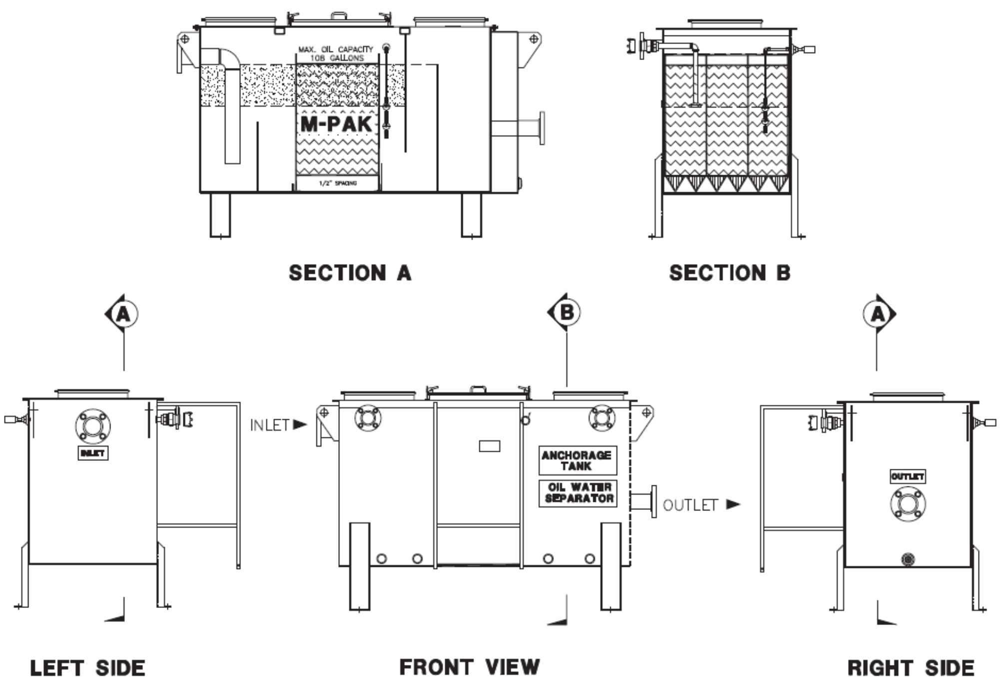
Submittal Data Sheet



ANCHORAGE TANK MODEL NUMBER	FLOW RATE (GPM)	OIL HOLDING CAPACITY	TANK LENGTH	TANK WIDTH	TANK HEIGHT	INLET/ OUTLET DIAM.	PLATE PACK SPACING	PLATE PACK FRONTAL AREA (SQ.FT.)
ATAGOWS-50	50	83	9'	3'	7'	4"	1/2"	12.00
ATAGOWS-100	100	83	9'	3'	7'	4"	1/4"	12.00
ATAGOWS-150	150	105	11'	3'	7'	6"	1/2"	12.00
ATAGOWS-200	200	105	11'	3'	8'	6"	1/4"	15.00

The parameters listed above are for general reference only. Site-specific conditions, such as influent composition and water temperature, may significantly alter the information in this table.

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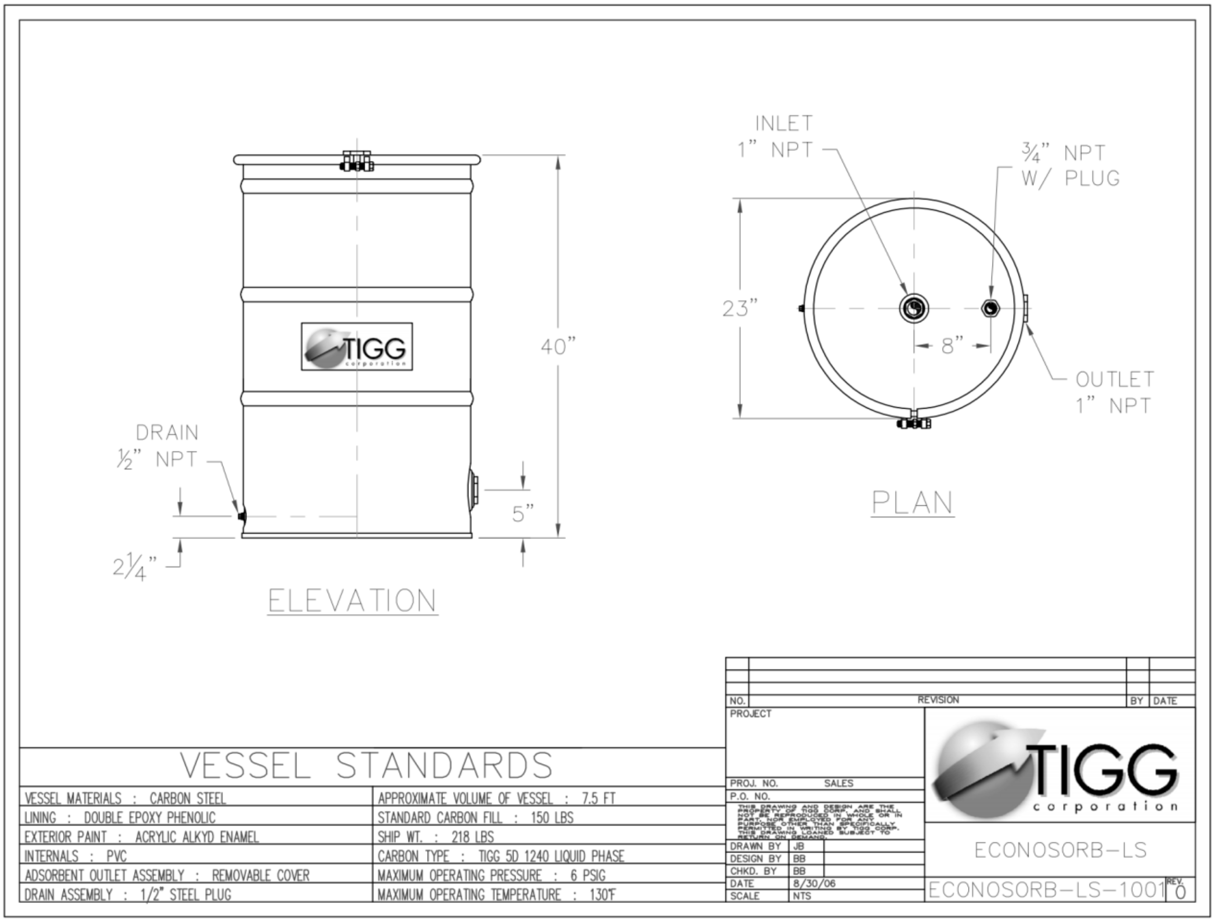
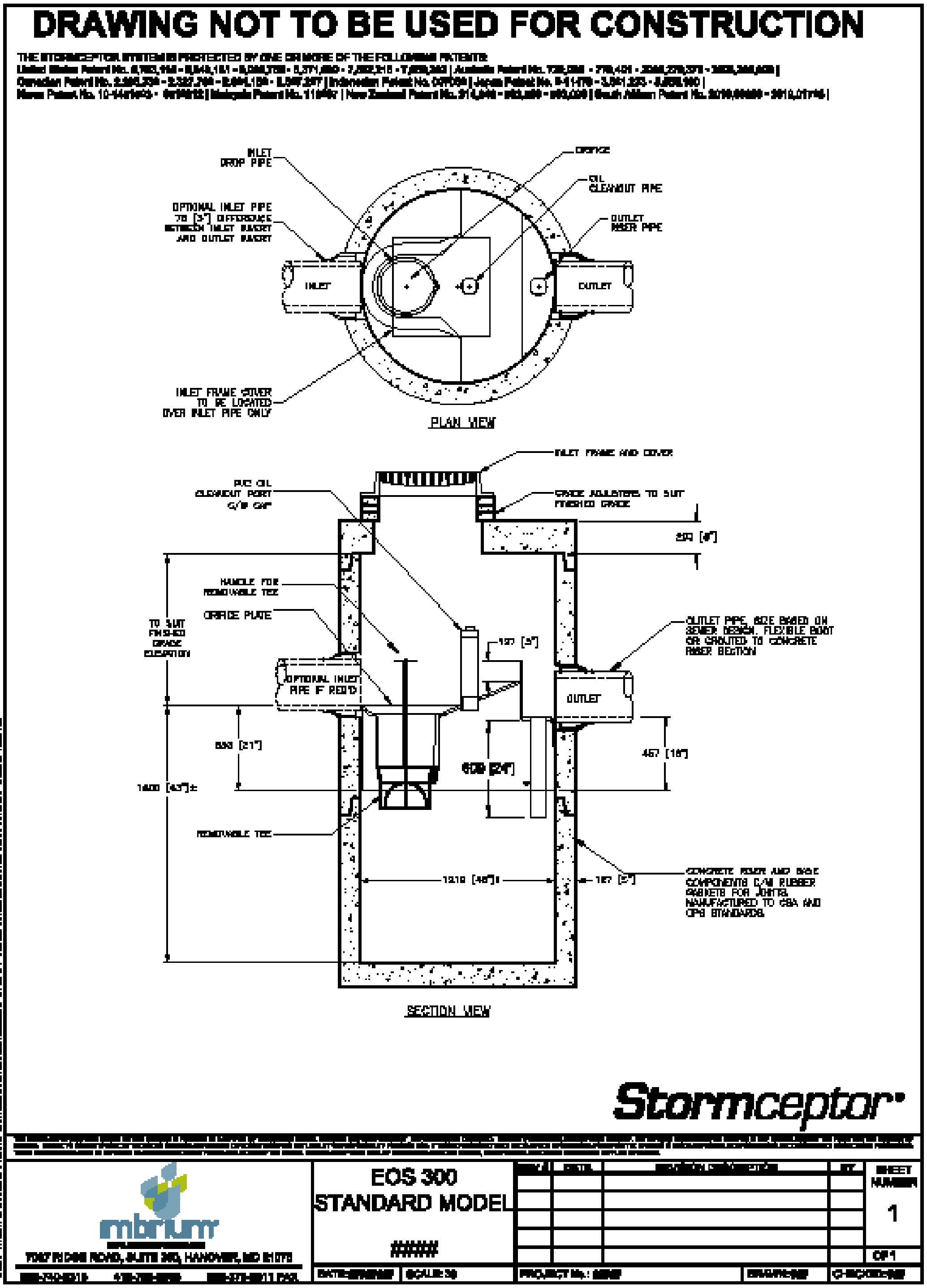
OWS Specifications pg. 2



GAC-Unit Specifications

APPENDIX B

The specifications for Design B are included in this Appendix.



OGS Specifications

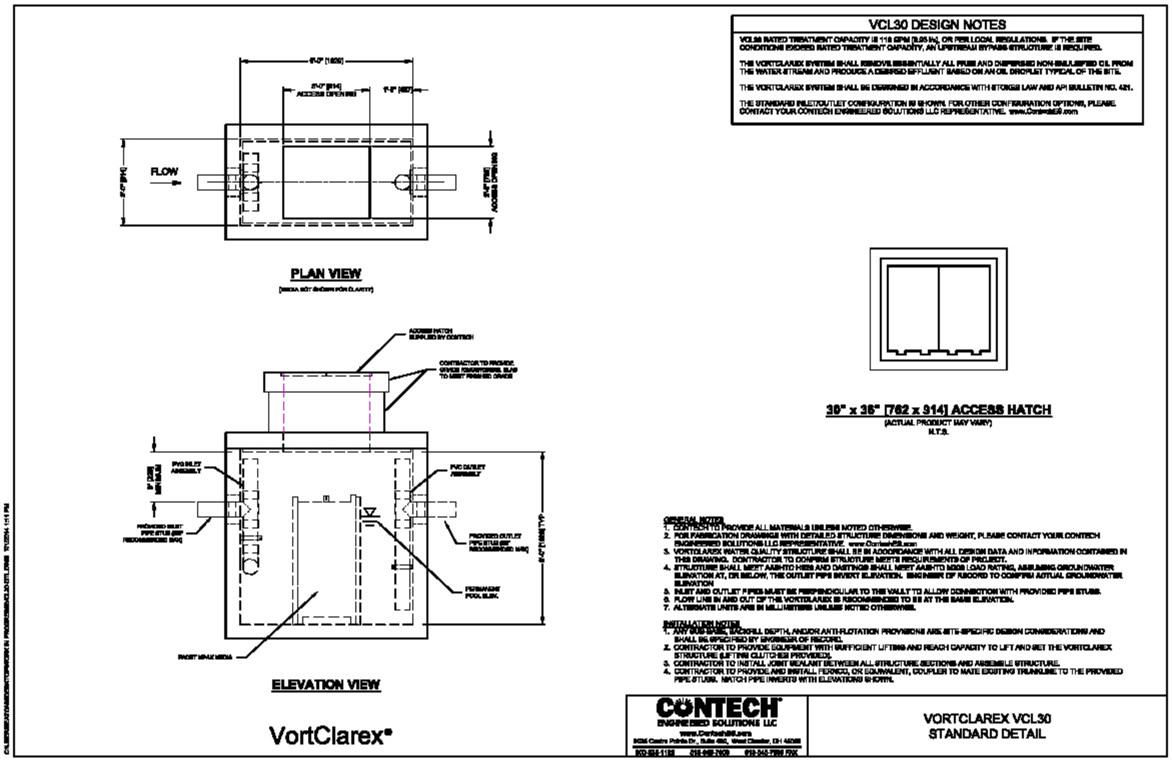


Plate Specifications

APPENDIX C

The cost estimates for both Design A and Design B are included in this Appendix.

Itemized Costs of installation for Design A

Item	Pay Unit	QTY	Unit Price	Total Price
Removal of asphalt	SY	133	$ 17.00	$2,261.00
Clearing and Grubbing	SY	18	$ 10.00	$180.00
Borrow	CY	50	$ 10.00	$500.00
Concrete Apron	SY	133	$ 300.00	$40,000.00
Grate	SF	30	$ 30.00	$900.00
18" CPEP	LF	150	$ 63.00	$9,450.00
OWS	EA	1	$ 13,000.00	$13,000.00
300 Gallon Tank	EA	1	$ 1,500.00	$1,500.00
Hose and Valve Assembly	EA	1	$ 500.00	$500.00
Lift Station	EA	1	$ 500.00	$500.00
Float Switch Assembly	EA	2	$ 400.00	$800.00
GAC unit	EA	1	$ 3,000.00	$3,000.00
Dockside Pump	EA	1	$ 600.00	$600.00
Mobilization	LS	1	$ 10,000.00	$10,000.00
Seeding	SY	28	$ 50.00	$1,400.00
			Total	**$82,330.00**

Maintenance costs for Design A

Item	Frequency per year	Unit Price	Total Price per year
Vacuum truck removal	1	$ 825.00	$825.00
GAC unit replacement	0.5	$ 3,000.00	$1,500.00
		Total	$2,325.00

Itemized Costs of installation for Design B

Item	Pay Unit	QTY	Unit Price	Total Price
Removal of asphalt	SY	133.3	$ 17.00	$2,270.00
Clearing and Grubbing	SY	18	$ 12.78	$230.00
Borrow	CY	138.9	$ 10.00	$1,390.00
Concrete Apron	SY	133.3	$ 300.00	$40,000.00
Grate	SF	30	$ 30.00	$900.00
18" CPEP	LF	150	$ 63.00	$9,450.00
Oil Grit Separator	EA	1	$ 70,000.00	$70,000.00
VortClarex	EA	1		
Mobilization	LS	1	$ 20,000.00	$20,000.00
Seeding	SY	27.78	$ 50.00	$1,390.00
			Total	**$145,630.00**

Maintenance costs for Design B

Item	Frequency per year	Unit Price	Total Price per year
Vacuum truck removal	1	$ 825.00	$825.00
		Total	$825.00