City and Borough of Juneau
Cruise Ship Wastewater Evaluation

February, 2001

Carson Dorn, Inc.

CITY AND BOROUGH OF JUNEAU
CRUISE SHIP WASTEWATER EVALUATION

Carson Dorn, Inc.

712 west 12th Street
Juneau, Alaska 99801

(907) 586-4447

February, 2001

Cruise Ship Wastewater Evaluation

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Introduction

The purpose of this study is to evaluate the feasibility of using Juneau's wastewater collection and treatment system for collecting and treating wastewater from the cruise ship industry. The evaluation considers both the hydraulic and organic capacity of the system and makes recommendations for capital improvements.

Projected Cruise Ship Wastewater Loadings

Flows. The average potential discharge from each vessel while in port in Juneau is estimated to be about 232,000 gallons. The cruise ship industry would like to discharge these wastes in about 8 hours. This results in a flow rate of about 480 gallons per minute from one vessel. Since there are three berths available for docking cruise ships, the flows at any one time could be as high as 1,440 gallons per minute. In addition on some days a second vessel will use one of the berths after the first vessel has departed. This means the total volume of wastewater could be as high as 928,000 gallons per day (232,000 gallons/vessel x 4 vessels/day)

Biological Oxygen Demand (BOD) Loading. The total pounds of BOD (organic loading) from gray water and treated black water from each cruise ship is estimated to be 843 lbs BOD. Total pounds per day discharged to Juneau's treatment system on a day where four vessels use the dock along the waterfront could be as high as 3,372 lbs. BOD.

Total Suspended Solids (TSS) Loading. The total pounds of TSS (solids loading) from gray water and treated black water from each cruise ship is estimated to be 1,105 lbs TSS. Total pounds per day discharged to Juneau's treatment system on a day where four vessels use the dock along the waterfront could be as high as 4,420 lbs. BOD.

Collection System Evaluation

The existing Juneau sewage collection system that could be used to collect wastewater from the cruise ships consists of a collection and pumping system located on Thane Road and South Franklin Street that would serve the Princess Cruise Line Dock and another collection and pumping system located on Marine Way and Egan Drive that would serve the Alaska Steamship Dock.

The gravity sewers on Thane Road and South Franklin Street are only able to handle flows up to 340 gpm and consequently are too small to handle the projected flows of 480 gpm from a cruise ship docked at the Princess Cruise Line Dock. The pumping system on South Franklin Street has two pumps, each with a capacity of 200 gpm. Consequently the South Franklin Street Pump Station does not have sufficient capacity to handle wastewater from a single cruise ship.

The gravity sewers on Marine Way and Egan Drive are only able to handle flows up to 886 gpm and consequently are too small to handle the projected flows of 960 gpm from two cruise ships docked at the Alaska Steamship Dock. However, the pumping system serving the area appears to have sufficient capacity to handle flows from two vessels.

EXECUTIVE SUMMARY

Juneau Douglas Wastewater Treatment Plant Evaluation

Hydraulic Capacity. The Juneau Douglas Wastewater Treatment Plant has a maximum hydraulic capacity of 7.23 million gallons per day (MGD). This corresponds to a flow rate of about 5,020 gpm. During the cruise ship season peak flows occurring on about 5% of the days are such that accepting additional flows from the cruise ships would cause the plant to exceed its hydraulic capacity. Discussion with cruise ship industry representatives indicate that since using CBJ's treatment system is only a short term solution, they believe they can make other arrangements for handling wastewater the 5% of the time the Juneau Douglas plant is unable to hydraulically handle the wastewater flows from the cruise ships.

BOD Loadings. Currently the Juneau Douglas plant exceeds it average day BOD design loadings about 45% of the time. The plant is not able to consistently handle the expected BOD loading from the cruise ships.

TSS Loadings. Increased loading of TSS from the cruise ships does not appear to be a problem. Current solids handling facilities at the plant (belt filter press and incinerator) appear to have sufficient capacity to handle the projected additional load from the cruise ships.

Recommended Improvements

Pump Stations. Since the existing CBJ gravity wastewater collection system does not have sufficient capacity to transport cruise ship wastewater to CBJ's existing pump stations, it is recommended two new pump stations be constructed to pump cruise ship wastewater directly into the 20" forcemain that transports wastewater to the Juneau Douglas plant for treatment. Estimated total project cost (including construction, design, inspection, CBJ administration and contingency) of each pump station is estimated to be $300,00. Total cost for the two pump stations is therefore $600,000.

Juneau Douglas Treatment Plant. In order to handle the projected BOD loadings a primary clarifier has been recommend to remove some BOD before it enters the plant. Also, additional aeration capacity is required to handle the BOD removed by the primary clarifier. Estimated total project costs for a primary clarifier and additional aeration is $2.31 million.

Consideration should also be given to constructing an additional aeration basin and secondary clarifier to supplement the two existing aeration basins and secondary clarifiers. This would increase the overall treatment capacity of the plant by 50%. The additional facilities are important to achieve the reliability necessary to ensure permit conditions can consistently be met. Total estimated project cost for a new aeration basin and secondary clarifier is about $3.4 million.

INTRODUCTION

Discharge of wastewater from cruise ships in Southeast Alaska is becoming a greater concern to Alaskans and regulatory agencies as the number of cruise ship visits increase each year. In the past decade, the size and number of cruise ships frequenting Alaska's coastal waters has increased dramatically. It is reported that approximately 237,000 cruise ship passengers visited Alaska in 1990 and 632,000 cruise ship passengers were expected during the 2000 season.

There have been reports of high concentrations of fecal coliform bacteria in wastewater discharges from cruise ships and the concentration of biological oxygen demand (BOD) and total suspended solids (TSS) in the effluent exceed what would be expected from most municipal secondary treatment plants.

The cruise ship industry is aware of these problems and is pursuing new technologies that will address the issues of fecal coliform, BOD and TSS in their wastewater discharges. It is expected that testing of the new technologies and modification of the vessels will take several years to implement. In the interim it has been suggested that one possible measure to reduce wastewater discharges to the waters of Southeast Alaska is to use the Juneau Douglas Wastewater Treatment Plant for treatment and subsequent discharge of wastewater from the cruise ships.

The purpose of this study is to evaluate the feasibility of using Juneau's wastewater collection and treatment system for handling wastewater from the cruise ship industry. The evaluation will consider both the hydraulic and organic capacity of the system and will make recommendations for capital improvements if necessary.

PROJECTED CRUISE SHIP WASTEWATER LOADINGS

Wastewater discharges from cruise ships include the following:

- **Blackwater**, (Wastewater from toilets, urinals and medical facility water)
- **Graywater**, (Typically characterized as drainage from dishwashers, showers, laundry, baths, galleys, and wash basins)
- **Bilgewater**, (The bilge is the area where water that seeps into the ship from various operational sources collects. The bilge beneath all engine and machinery will also collect oil that leaks from machinery fittings and engine maintenance. This oily water is known as bilge water.)
- **Ballast Water**, (Any water taken on board to control or maintain trim, draught, stability, or stresses of the vessel)
- **Food Waste**, (Consists of all food and food liquids. This waste is pulped, compressed, dehydrated and eventually incinerated or discharged over 12 miles offshore).

Wastewater loadings to be considered for the purposes of this report have been limited to blackwater and graywater only. These two waste streams are similar to the domestic wastewater currently being treated at the Juneau Douglas Wastewater Treatment plant. The Juneau Douglas plant was not designed to handle bilgewater, ballast water or concentrated food waste and consequently these waste streams should not be accepted at the Juneau Douglas plant. Additional liquid wastes generated from industrial sources on-board the cruise ships, such as photo processing, dry-cleaning, and print shops should also be prevented from being discharged to Juneau's wastewater collection and treatment system.

Cruise Line Agencies of Alaska was contacted to determine the cruise line industry's need for wastewater treatment and the quantity and quality of the wastewater they would like to discharge in Juneau. The concept of using Juneau's wastewater collection and treatment system for treating wastewater from the cruise ships is relatively new and consequently most of the cruise lines had not given very much thought to how they could incorporate Juneau's treatment facilities into their operation and had no estimates of their needs. In fact, only one cruise line provided estimates of the volume of wastewater they would like to discharge during each visit and had data showing the concentration of BOD and total suspended solids in the discharge. The local Cruise Line

Agencies of Alaska representative believes that the wastewater treatment needs from that cruise line (Princess Cruises) would serve as a representative sample for the cruise lines in general. Table 1 (included at the end of this section) shows the projected average loadings from each vessel per visit. Loadings have been shown for up to four vessels in a given day.

There are currently three berths along Juneau's waterfront for cruise ships to dock. As a result there will never be more than three vessels discharging to Juneau's wastewater treatment system at any one time. However, one day a week the arrival and departure schedules are such that two vessels would use one of the berths in a single day. Consequently most days there will be a maximum of three vessels that might unload wastewater and one day a week there could be four vessels.

Flows

The average discharge from each vessel while in port in Juneau is estimated to be about 232,000 gallons (see Table 1). The cruise ship industry said they would like to be able to discharge this wastewater in about 8 hours. This results in wastewater flows of about 480 gallons per minute (gpm) from one vessel. Table 1 shows the projected flows from more than one vessel. Since there are only three berths available for docking cruise ships the flows at any one time would never be greater than would occur for three vessels.

Biological Oxygen Demand (BOD) Loading

BOD is an indication of the amount of organic matter in a water sample that may be degraded by microbial action in a given time period. BOD loading from the cruise ships is an important criterion because wastewater treatment plants are typically designed based on the total pounds of BOD that is in the influent.

The total pounds of BOD from the gray water and treated black water from each cruise ship is estimated to be 843 lbs (see Table 1). The total pounds of BOD from cruise ships that would need to be treated at the Juneau Douglas treatment plant could be as high as 3,372 pounds per day on a day where four vessels dock along the waterfront.

Total Suspend Solids (TSS)

TSS is a measure of the amount of solid material in wastewater. The total pounds of TSS from the gray water and treated black water from each cruise ship is estimated to be 1,105 lbs (see Table 1). The total pounds of TSS that would need to be handled at the Juneau Douglas treatment plant could be as high as 4,420 pounds per day in a day where four vessels would be docking.

TABLE 1
CRUISE SHIP LOADINGS

Wastewater	Volume (Metric Tons)	Volume (Gallons)	Avg BOD (mg/l)	Total lbs BOD	Avg TSS (mg/l)	Total lbs TSS (mg/l)
Treated Black Water	180	47,482	130	51	660	261
Galley Gray	300	79,137	720	475	885	584
Domestic Gray	300	79,137	450	297	380	251
Laundry Gray	100	26,379	90	20	39	9
TOTALS						
One Vessel		**232,134**		**843**		**1,105**
Two Vessels		**464,268**		**1,686**		**2,210**
Three Vessels		**696,402**		**2,529**		**3,315**
Four Vessels		**928,536**		**3,372**		**4,420**

COLLECTION SYSTEM EVALUATION

The existing Juneau sewage collection system that would be used to collect wastewater from the cruise ships needs to be considered in two parts. The first is the collection and pumping system located on Thane Road and South Franklin Street in front of the Princess Cruise Ship Dock (Figure 1). The second is the collection and pumping system located on Marine Way and Egan Drive in front of the Alaska Steamship Dock (Figure 2).

The hydraulic capacities of the gravity sewer pipes in the collection system were reviewed to determine if they have sufficient capacity to handle wastewater from the cruise ships. The capacity of the sewers was determined using the Manning formula for calculating flow in gravity sewers. Invert elevations and the distances between manholes were collected from as-built drawings and were used to determine the pipe slope. Table 2 is a summary of the hydraulic capacity of the sewer system from the Princess Cruise Dock to the South Franklin Street Pump Station and from Marine Park to the Outer Drive Pump Station. Figure 1 shows the collection system and its capacity from the Princess Cruise Dock to the South Franklin Street Pump Station. Figure 2 shows the collection system and its capacity from Marine Park to the Outer Drive Pump Station.

The projected wastewater discharge rate from a single cruise ship was previously estimated to be 480 gallons per minute. This exceeds the capacity of the gravity sewers on South Franklin Street and Thane Road. Consequently the gravity sewers in this area are too small to accept wastewater from the cruise ships.

The South Franklin Street Pump Station currently has two pumps each with a capacity of 200 gallons per minute. Even with both pumps running it would not be able to handle the projected flows of 480 gallons per minute from a single cruise ship.

Two cruise ships could potentially use the collection system piping between Marine Park and the Outer Drive Pump Station at the same time. The projected wastewater discharge rate from two cruise ships was estimated to be 960 gallons per minute. This exceeds the capacity of the 12”

gravity sewer along Marine Way. Again the gravity sewers are too small to accept wastewater from the cruise ships.

The Outer Drive Pump Station has three pumps, a constant speed pump with a capacity of 2,100 gpm and two variable speed pumps one with a capacity of 2,700 gpm and the other with a capacity of 2,100 gpm. It appears the Outer Drive Pump Station has sufficient capacity to handle the projected flows from two cruise ships unloading wastewater simultaneously, provided the system is not being subjected to unusually high domestic wastewater flows.

U.S.S. 982
P MILL SITE

U.S.M.S. 982B
F MILL SITE

U.S.M.S. 982B
T MILL SITE

FORMER JUNEAU COR

U.S.M.S. 982B
A MILL SITE

U.S.M.S. 982B
G MILL SITE

U.S.M.S. 982B
L MILL SITE

20" FM

SOUTH FRANKLIN STREET

8"

SOUTH FRANKLIN STREET
PUMP STATION
2 PUMPS @ 200 GPM EACH

8" (340 GPM)

8" (360 GPM)

20" FM

THANE ROAD

PRINCESS CRUISE SHIP DOCK

A.T.S. 3

FR.I6

FR.I7

NORTH

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CITY/BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

CITY AND BOROUGH OF JUNEAU

SEWER SYSTEM
CRUISE SHIP WASTEWATER EVALUATION

STATE OF ALASKA 49TH
REGISTERED PROFESSIONAL ENGINEER

Carson Dorn Inc.
712 WEST 12TH STREET
JUNEAU, ALASKA 99801
(907) 586-4447

MAXIMUM FLOW IN THANE ROAD GRAVITY SEWERS

DRAWING 1

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CITY/BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

CITY AND BOROUGH OF JUNEAU

SEWER SYSTEM
CRUISE SHIP WASTEWATER EVALUATION

STATE OF ALASKA 49TH
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712 WEST 12TH STREET
JUNEAU, ALASKA 99801
(907) 586-4447

MAXIMUM FLOW IN MARINE WAY GRAVITY SEWERS

DRAWING 2

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TABLE 2

HYDRAULIC CAPACITY OF EXISTING SEWERS FROM PRINCESS CRUISE DOCK TO THE SOUTH FRANKLIN P.S.

Pipe Inlet Manhole Number	Pipe Outlet Manhole Number	Pipe Invert Elevation In	Pipe Invert Elevation Out	Total Elevation Difference	Pipe Length	Pipe Slope	Pipe Size	Projected Flows With The Pipe Flowing Full (gpm)
P18	P16	19.46'	18.16'	1.30'	291	0.0045	8"	361
P16	L15	18.16'	16.84'	1.32'	334	0.0040	8"	339

HYDRAULIC CAPACITY OF EXISTING SEWERS FROM MARINE PARK TO THE OUTER DRIVE P.S.

Pipe Inlet Manhole Number	Pipe Outlet Manhole Number	Pipe Invert Elevation In	Pipe Invert Elevation Out	Total Elevation Difference	Pipe Length	Pipe Slope	Pipe Size	Projected Flows With The Pipe Flowing Full (gpm)
B7	W21	21.02'	20.00'	1.02'	224	0.0046	8"	364
W21	V20	20.00'	19.93'	0.07'	147	0.0005	12"	347
V20	S18	19.93'	18.95'	0.98'	350	0.0028	12"	842
S18	Q16	18.95'	16.90'	2.05'	310	0.0066	15"	2346
Q16	Q15	16.90'	15.75'	1.15'	100	0.0115	15"	3093
Q15	R15	15.75'	14.97'	0.78'	80	0.0097	15"	2848
R15	D13	14.97'	13.90'	1.07'	345	0.0031	12"	886
D13	N10	13.90'	13.45'	0.45'	300	0.0015	15"	1117
N10	N8.1	13.45'	13.15'	0.30'	200	0.0015	18"	1817
N8.1	N5	13.15'	12.58'	0.57'	358	0.0016	18"	1872
N5	N4.1	12.58'	12.42'	0.16'	97	0.0016	18"	1905
N4.1	N3	12.42'	8.48'	3.94'	18	0.2189	18"	21947

JUNEAU DOUGLAS WASTEWATER TREATMENT PLANT EVALUATION

The original design criteria for flows and BOD loadings at the Juneau Douglas Wastewater Treatment Plant are as follows:

Avg. Flow	2.76 MGD
Peak Flow	7.23 MGD
Total (Avg. Day) BOD lbs/day	3,290 lbs/day
Total (Max. Day) BOD lbs/day	5,980 lbs/day

Flows

The Juneau Douglas Treatment Plant has a maximum hydraulic capacity of 7.23 MGD. This corresponds to a flow rate of about 5,020 gpm. Flow at the treatment plant typically varies over the course of a day with low flows occurring late at night and peaks flows in the morning and again in the evening. The review of daily flow charts indicate that when the flow over an entire day is in excess of about 3.0 MGD that the peak flows on those days approaches about 6.0 MGD. Consequently on days when it appears flows may be on the order of about 3.0 MGD it may not be possible to accept additional flows from the cruise ships because the plant could exceed its hydraulic capacity.

Table 3 contains the daily flow records at the Juneau Douglas plant during the past two cruise ship seasons. The days with flows in excess of 3.0 MGD have been highlighted. In 1999 flows on 6.5% of the days (10 days out of 153 days) exceeded 3.0 MGD and in 2000 3.9% (6 days out of 153 days) exceeded 3.0 MGD.

It was previously projected that the wastewater flow rate from a single cruise ship would be about 480 gpm. This is equivalent to a rate of 0.69 MGD. Consequently with three ships docked and each unloading wastewater at a rate of 480 gpm (0.69 MGD) the equivalent flow rate at the plant from cruise ships would be 2.07 MGD. From a flow standpoint it appears that under most circumstances the Juneau Douglas treatment plant will be able to handle the additional flow from the cruise ships under most circumstances. There will however be times that the plant cannot

accept additional flow from the cruise ships due to hydraulic limitations and the cruise ships will need to make alternate plans for those occasions.

BOD Loadings

The average day design load at the Juneau Douglas treatment plant for BOD is 3,290 lbs/day. Table 4 contains the influent BOD loadings at the Juneau Douglas plant for the past two summer cruise ship seasons. A review of the BOD loadings indicates that nearly 45% of the current BOD loadings exceeded the average day design load for BOD. It appears that the plant is nearing its organic loading capacity.

Projected BOD loading from the cruise ships is about 843 lbs/vessel. The combined BOD loading from four vessels would add 3,372 lbs of BOD to the loading at the Juneau Douglas plant. This by itself exceeds the average day design value for BOD. Adding additional BOD from the cruise ships to the Juneau Douglas plant will result in the plant being organically overloaded on occasion and will most likely result in unsatisfactory effluent quality.

TSS Loadings

Increased levels of TSS do not constitute a treatment problem, it just represents the amount of sludge solids that will need to be dewatered and incinerated by CBJ. Currently the belt filter press used for treating solids at the Juneau Douglas treatment plant only operates about 2 times per week. The incinerator is operated two shifts per day for 4 days each week and one shift per day for the remaining 3 days each week. Additional shifts can be added as required.

TABLE 3
JUNEAU DOUGLAS WASTEWATER TREATMENT PLANT FLOWS

Avg Day Design Flow 2.76 MGD
Peak Day Design Flow 7.23 MGD

	May-99	Jun-99	Jul-99	Aug-99	Sep-99	May-00	Jun-00	Jul-00	Aug-00	Sep-00
1	2.480	1.935	1.389	1.162	1.310	1.593	1.370	1.120	1.228	1.155
2	2.164	2.283	1.251	1.229	2.055	1.477	1.319	1.511	1.319	1.002
3	1.848	2.045	1.111	1.155	1.583	1.570	1.304	1.314	1.231	2.415
4	1.884	1.864	1.063	1.154	1.364	1.577	1.311	1.187	1.013	**4.743**
5	1.943	1.685	1.224	1.062	1.240	1.499	1.256	1.103	0.985	1.846
6	1.865	1.615	1.121	1.112	1.733	1.377	1.617	1.050	1.030	2.922
7	1.635	1.458	1.127	1.329	1.853	1.291	1.203	0.953	0.939	1.637
8	1.508	1.431	1.247	1.842	1.932	1.193	1.090	0.920	2.013	2.239
9	1.575	1.417	1.335	1.674	2.555	1.061	0.968	0.957	1.078	1.445
10	1.567	1.535	1.722	1.501	1.873	1.027	0.920	0.881	0.995	2.906
11	1.711	1.525	1.806	1.396	1.755	0.943	1.043	0.986	0.931	2.104
12	1.635	1.647	1.510	1.480	1.562	0.872	1.011	0.930	0.947	1.672
13	1.652	1.804	1.413	**3.532**	1.470	1.048	1.206	0.933	1.026	2.591
14	1.663	1.740	1.296	1.565	1.513	1.240	1.177	0.920	2.472	1.989
15	1.690	1.774	1.223	1.496	1.755	1.122	1.313	1.110	1.609	**3.118**
16	1.866	2.382	1.114	1.828	1.648	1.249	1.811	1.090	1.289	**4.669**
17	1.831	1.434	1.079	1.406	**4.423**	1.667	1.420	1.190	1.191	2.383
18	1.956	1.549	1.280	1.245	**4.866**	1.595	1.363	1.569	1.078	1.566
19	2.056	1.441	1.619	1.365	2.831	1.749	1.642	1.956	2.138	1.480
20	1.813	1.285	1.331	1.168	**3.003**	1.237	1.737	1.300	2.013	1.156
21	1.851	1.243	1.604	1.574	2.860	1.765	1.820	1.414	**3.320**	1.058
22	1.644	1.188	1.270	1.783	**4.390**	2.367	1.312	2.080	2.135	1.132
23	**3.047**	1.156	1.171	2.000	**3.555**	2.136	1.050	**5.135**	1.484	1.014
24	1.945	1.000	1.236	2.076	2.370	1.350	0.925	**3.380**	1.345	1.056
25	2.495	1.122	1.677	2.276	1.931	1.172	0.923	1.701	1.297	1.087
26	2.356	1.094	2.181	1.665	1.605	1.048	1.032	1.462	1.202	1.198
27	**3.521**	1.502	2.280	2.193	1.547	0.998	1.061	1.453	1.763	1.408
28	**3.053**	1.344	1.887	2.336	1.617	1.357	1.873	1.658	1.462	1.600
29	2.727	1.483	1.490	1.712	1.415	1.398	1.506	1.421	1.475	1.484
30	**3.487**	1.544	1.285	1.799	1.653	1.177	1.393	1.620	1.449	1.334
31	2.350		1.161	1.384		1.302		1.886	1.230	

TABLE 4

JUNEAU DOUGLAS WASTEWATER TREATMENT PLANT INFLUENT BOD

BOD Avg Day Design 3290 lbs/day
BOD Max Day Design 5980 lbs/day

	May-99	Jun-99	Jul-99	Aug-99	Sep-99	May-00	Jun-00	Jul-00	Aug-00	Sep-00
1					3256					
2		3008							2420	
3						3038				
4										
5	**4570**							2024		
6										1706
7			**4465**				1605			
8					1772					
9		**3439**								
10						**3717**				
11				2631						
12	**4663**									
13										
14			2616							
15					**3967**					
16		**3337**								
17						3156				
18				**4496**						
19	**4535**									
20										
21			**3839**							
22					2087					
23		**4242**								
24						1779				
25				3094						
26	**3832**									
27										
28			1637							
29					1511					
30										
31						**3757**				

RECOMMENDED IMPROVEMENTS

Pump Stations

Since the existing gravity sewer system does not have sufficient capacity to handle the projected wastewater flows from the cruise ships, it is recommended that two new pump stations be constructed to pump cruise ship wastewater directly into the 20" forcemain that transports wastewater to the Juneau Douglas plant for treatment. One would be located at the Princess Cruise Ship dock and the other would be located to serve the two berths at the Alaska Steamship Dock. These pump stations would include the necessary piping to connect to the forcemain, pumps, a flow meter, electrical and control system. Total project costs including design, inspection, CBJ administration and contingency are estimated to be $300,000 for each pump station. Total project costs for the two stations is therefore $600,000

Juneau Douglas Treatment Plant

Currently the Juneau Douglas Treatment Plant consists of a grit removal system, two aeration basins and two secondary clarifiers followed by disinfection by ultraviolet light. Figure 3 shows the current layout of the plant. It appears that the Juneau Douglas Treatment Plant is close to reaching its treatment capacity for BOD. As discussed earlier in this report, nearly 45% of the current measured BOD loadings to the plant exceeded the average day design for the plant of 3,290 lbs. BOD/day. On average over the past two summers the BOD loading to the plant has been 3,111 lbs BOD/day. If it is assumed each cruise ship will add 843 lbs BOD/day the BOD loading on the plant will be as follows:

TABLE 5

PROJECTED BOD LOADINGS AT JUNEAU DOUGLAS TREATMENT PLANT

Number of Ships Discharging Wastewater	Total lbs. BOD from Cruise Ships	Avg. BOD Loading at JD Plant	Projected BOD Loading at JD Plant
One Ship	843 lbs. BOD	3,111 lbs. BOD	3,954 lbs. BOD
Two Ships	1,686 lbs. BOD	3,111 lbs. BOD	4,797 lbs. BOD
Three Ships	2,529 lbs. BOD	3,111 lbs. BOD	5,640 lbs. BOD
Four Ships	3,372 lbs. BOD	3,111 lbs. BOD	6,483 lbs. BOD

There are three possibilities for increasing the capacity of the plant to handle the additional BOD loading. One is to increase the amount of microorganisms in the aeration basins to maintain a constant food/microorganism ratio with increased BOD loading. The second is to add a primary clarifier to remove influent BOD before the secondary treatment process. The third is to increase the capacity of the plant by adding another aeration basin and secondary clarifier.

Currently the plant is designed to treat an average of 3,290 lbs/day of BOD. This is based on a food to microorganism ratio of 0.15. The amount of microorganisms in the plant is determined by the concentration of solids in the mixed liquor in the aeration basins. Currently the concentration of solids in the mixed liquor is kept at about 2,000 mg/l. Increasing the concentration of solids in the mixed liquor to 2,500 mg/l should increase the capacity of the treatment plant by about 25% resulting in a design capacity of 4,112 lbs BOD/day. To accomplish this, additional aeration capacity needs to be added to each of the aeration basins and additional aeration should be added to the sludge digester to handle the increased amount of solids that will be generated. Even with this increase in treatment capacity, the plant will only be able to reliably handle the additional BOD loading from one ship.

In association with increasing the mixed liquor concentration in the plant, a primary clarifier should be considered to remove BOD before it enters the plant for treatment. A primary clarifier with a surface loading rate of about 800 gal/day/sf will typically result in about 30% removal of influent BOD. This reduces the BOD loadings on the aeration basins to 2,767 lbs BOD with one ship, 3,357 lbs BOD with two ships, 3,948 lbs BOD with three ships and 4,538 lbs BOD with four ships. Under this scenario, the plant can handle BOD loadings from three ships and can nearly handle the BOD loading from four ships in a day. Since four ships discharging wastewater is only expected to happen once a week, the combination of increasing the microorganism concentration in the aeration basins and a primary clarifier will be able to handle the organic loading from the cruise ships. Figure 4 shows a possible schematic layout for a new clarifier and blowers for the aeration basins and the sludge digester. The estimated construction cost for the improvements shown on Figure 4 is $1.54 million. Including 50% of construction costs for design, inspection, CBJ administration and contingency results in a total estimated project cost of $2.31 million.

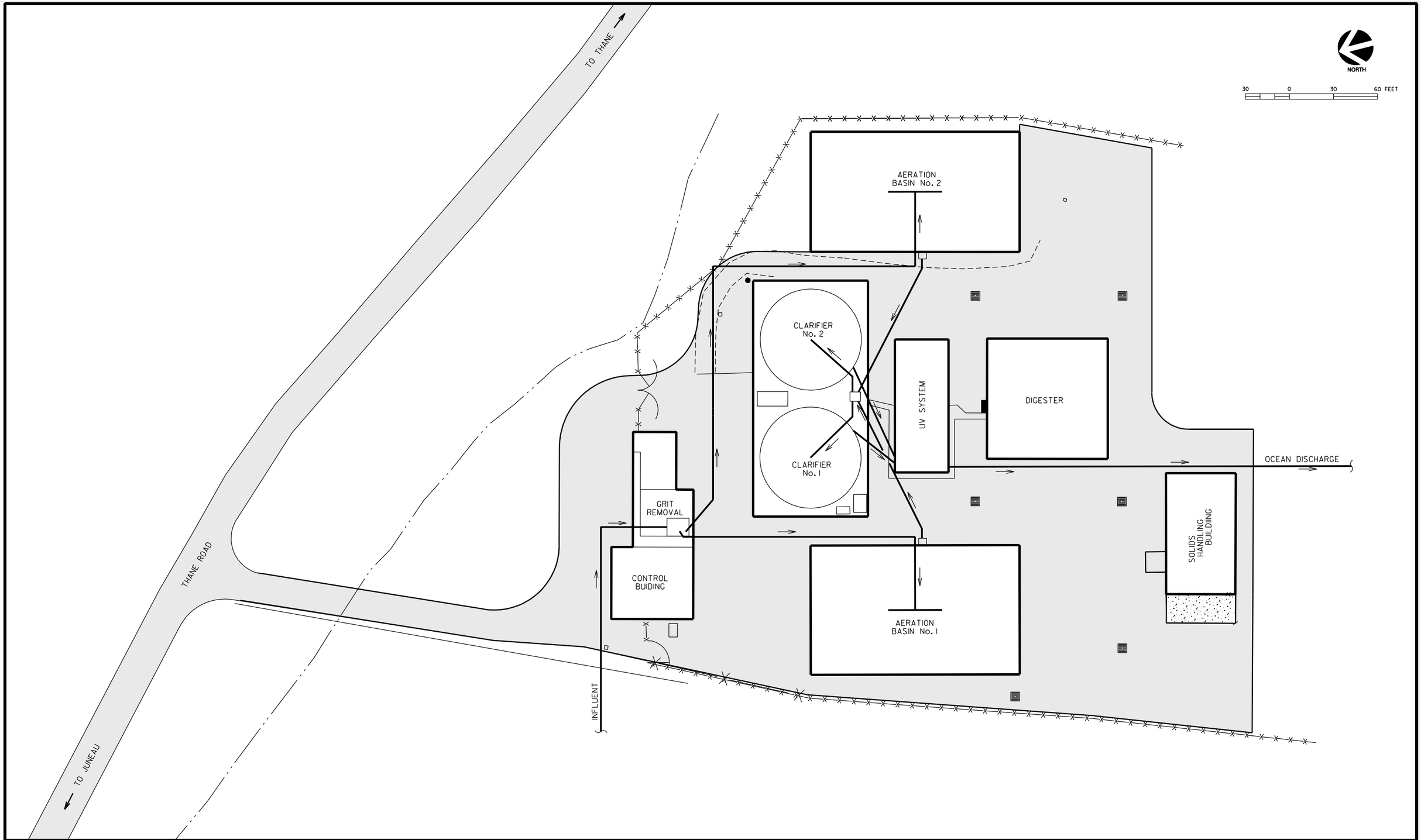
The overall treatment capacity of the plant can be increased by 50% if an additional aeration basin and secondary clarifier is added. If the plant treatment capacity were increased to 4,112 lbs BOD per day by increasing the mixed liquor concentration, an additional aeration basin and clarifier would further increase the plant capacity to 6,168 lbs BOD per day. This is greater than the 4,538 lbs BOD per day loading on the plant expected after construction of a primary clarifier. It is not good practice to operate a wastewater treatment plant right at its capacity. Any small mechanical problem or interference with the treatment process can quickly result in permit violations. Adding an additional aeration basin and secondary clarifier to the primary clarifier will provide the reserve treatment capacity necessary to ensure effluent limits in the permit can be consistently met. Figure 5 shows a schematic layout of the primary clarifier with an additional aeration basin and clarifier. The estimated construction cost for an additional aeration basin and secondary clarifier is $2.2 million. Including 50% of construction costs for design, inspection, CBJ administration and contingency results in a total estimated project cost for a new aeration basin and secondary clarifier of about $3.4 million. Table 6 contains a summary of the cost estimate for the primary clarifier and for a new aeration basin and secondary clarifier.

In summary, the following improvements are required to handle wastewater from the cruise ships:

Two new wastewater pump stations @$300,000 each	$600,000
Primary clarifier with additional blowers for aeration basins and digester	$2,250,000

The following is desirable for achieving long-term reliability of the wastewater treatment process at the Juneau Douglas Treatment Plant:

New aeration basin and secondary clarifier	$3,400,000



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CITY/BOROUGH OF JUNEAU
ALASKA'S CAPITAL CITY

CITY AND BOROUGH OF JUNEAU

SEWER SYSTEM CRUISE SHIP WASTEWATER EVALUATION

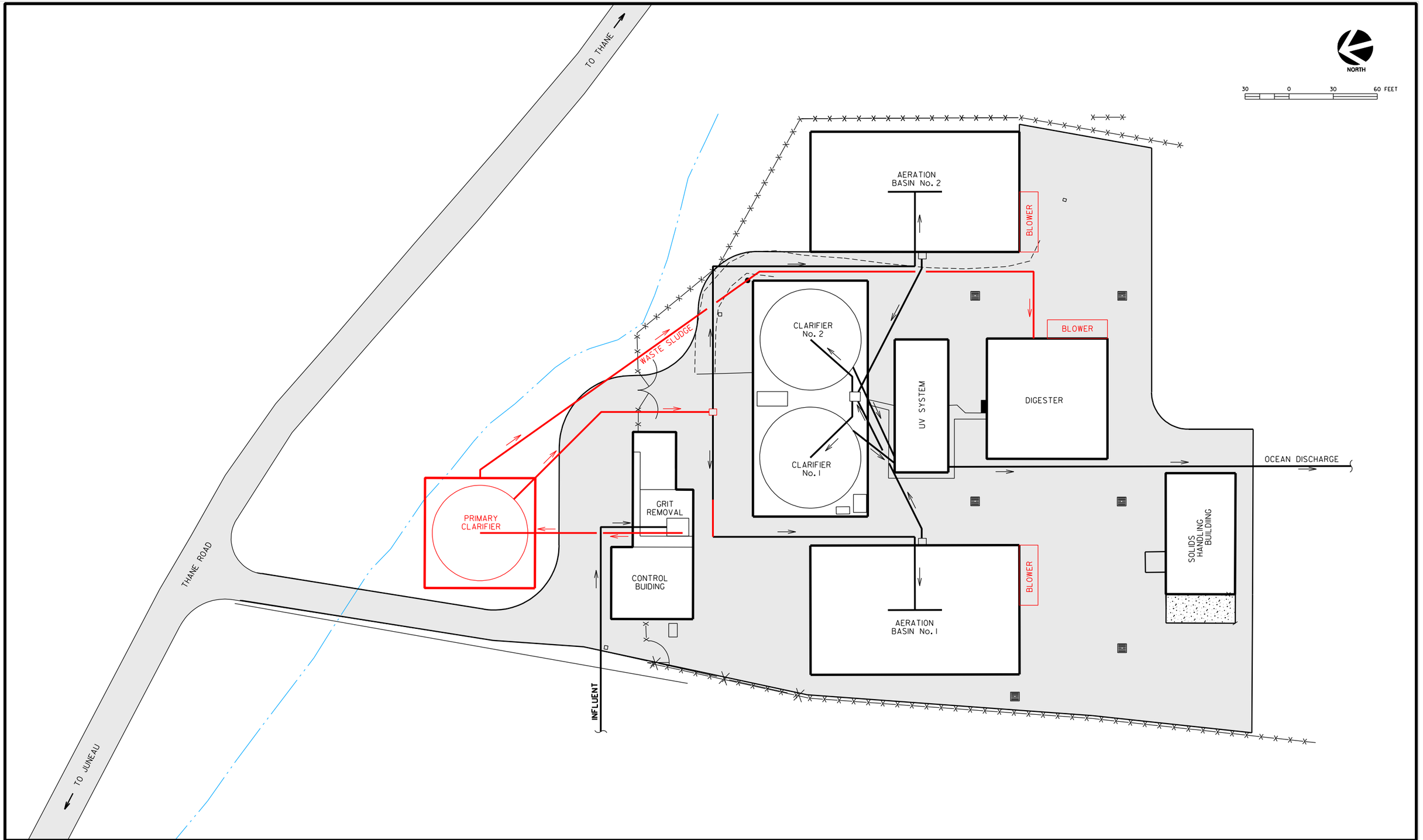
STATE OF ALASKA 49TH
JAMES L. DORN CE 5323
REGISTERED PROFESSIONAL ENGINEER

Carson Dorn Inc.
712 WEST 12TH STREET
JUNEAU, ALASKA 99801
(907) 586-4447

EXISTING JUNEAU – DOUGLAS WASTEWATER TREATMENT PLANT

DRAWING 3

SHEET No. of



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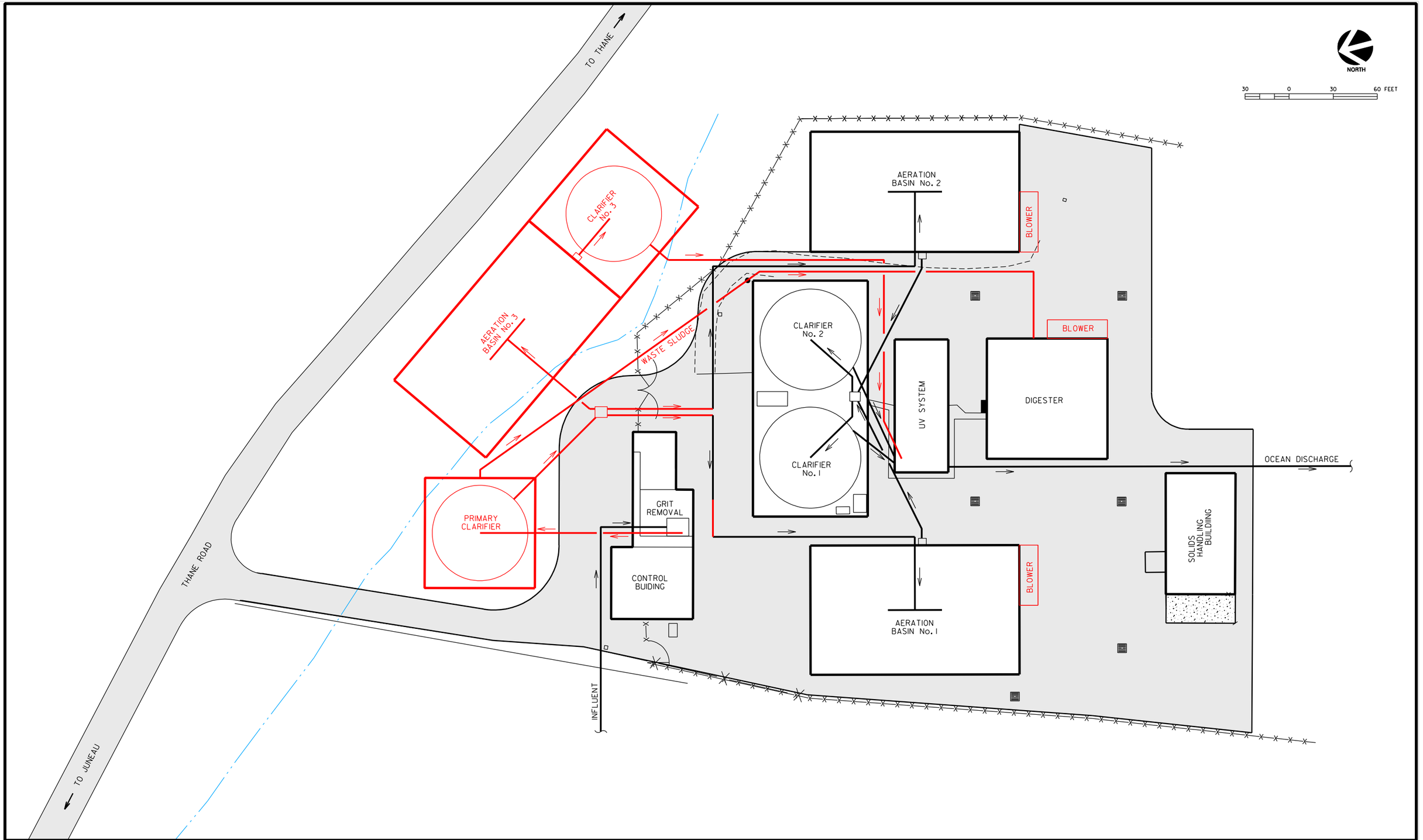
SEWER SYSTEM
CRUISE SHIP WASTEWATER
EVALUATION

Carson Dorn Inc.
712 WEST 12TH STREET
JUNEAU, ALASKA 99801
(907) 586-4447

EXISTING
JUNEAU – DOUGLAS
WASTEWATER TREATMENT PLANT
WITH PRIMARY CLARIFIER

DRAWING 4

SHEET No. of



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CITY AND BOROUGH OF JUNEAU

SEWER SYSTEM
CRUISE SHIP WASTEWATER EVALUATION

Carson Dorn Inc.
712 WEST 12TH STREET
JUNEAU, ALASKA 99801
(907) 586-4447

EXISTING JDWTP
w/ PRIMARY CLARIFIER
& ADDITIONAL TREATMENT CAPACITY

DRAWING 5

SHEET No. of

TABLE 6
ESTIMATED CONSTRUCTION COST
J-D WWTP IMPROVEMENTS

J-D Treatment Plant Clarifier and Blowers

Site Prepartion	$100,000	each	1	$100,000
Clarifier	$350,000	each	1	$350,000
Building	$280,000	each	1	$280,000
Sludge Return Pump	$20,000	each	1	$20,000
Electrical and Controls	$40,000	each	1	$40,000
Site Piping	$150,000	each	1	$150,000
Blowers and Diffusers	$200,000	each	3	$600,000

CONSTRUCTION COST SUBTOTAL	**$1,540,000**
Design, Inspection, CBJ Administration, Contingency (50%)	**$770,000**
TOTAL ESTIMATED CONSTRUCTION COST	**$2,310,000**

J-D Treatment Plant Aeration Basin and Secondary Clarifier

Site Preparation	$150,000	each	1	$150,000
Aeration Basin	$380,000	each	1	$380,000
Secondary Clarifier	$350,000	each	1	$350,000
Building	$920,000	each	1	$920,000
Blower and Diffusers	$200,000	each	1	$200,000
Sludge Return Pump	$20,000	each	1	$20,000
Site Piping	$100,000	each	1	$100,000
Electrical	$80,000	each	1	$80,000

CONSTRUCTION COST SUBTOTAL	**$2,200,000**
Design, Inspection, CBJ Administration, Contingency (50%)	**$1,100,000**
TOTAL ESTIMATED CONSTRUCTION COST	**$3,300,000**