DESIGN BRIEF

BOILER ROOM - SANITARY SUMP PIT REFURBISHMENT

Canadian Centre for Inland Waters

867 Lakeshore Road, Burlington

Environment and
Climate Change Canada

ARC Project: 17-167-020

8th January 2018

ARC ENGINEERING INC.
solutions | excellence

1100 South Service Rd., Suite #417
Stoney Creek, ON L8E 0C5
Tel: (905) 643-8530 Fax: (905) 643-8510

Website: www.arcengineering.ca Email: contact@arcengineering.ca

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1 EXECUTIVE SUMMARY

ARC Engineering has been engaged to provide multidiscipline engineering services for the refurbishment of the sanitary sump pits (2) located in the existing boiler room at the Canadian Centre for Inland Waters (CCIW), 867 Lakeshore Road, Burlington, ON.

As part of the design brief, ARC have been asked to provide high-level comments on the possibility of increasing the capacity of the existing sump pits and the existing sump pumps considering the increased loads coming from the Aquatic Life Research Facility.

1.1 Structural Conclusions & Recommendations

1) The service tunnel floor is believed to be approximately 8.5' below the groundwater table and the bottom of the existing sump pits to be approximately 14' below the groundwater table. Excavation in these conditions would require significant dewatering provisions and is believed to be high risk with respect to additional unforeseen outcomes in questionable soil conditions. We do not recommend attempting to expand the existing sump pits.

2) The existing sump pits are heavily corroded. This is understood to be due to boiler blowdown temperatures, chemical treatment carryover and almost 50 years of operation. We recommend that the refurbishment of the existing sump pits be limited to the following surface preparation and treatment:

   a. The sumps will be removed from service, including both inflow and discharge, for a minimum of 3 days each to allow for cleaning, surface preparation, application of restoration compounds, and adequate curing before being placed back into service.

   b. Temporary discharge by way of pumped suction lines through watertight plugs in the inlets will probably be required.

   c. The existing steel cover plates and frames will be removed and replaced with new galvanized steel.

3) Given the extent of the current groundwater infiltration in the service tunnel and sump pit area we would recommend limiting the refurbishment to the pit surfaces alone and defer additional floor / wall treatment until exterior civil works can be undertaken to rectify the observed infiltration.

1.2 Mechanical Conclusions & Recommendations

1) Sump Pumps

   The capacity of the existing 8" section of the sanitary piping system (receiving pipe capacity) is calculated to be 226.8 usgpm. This portion of the sanitary piping system was originally designed to accept flows from the sanitary sump pit (primarily floor drains), the bilge sump pit, and all the drains from the ground floor, second floor, and penthouse floors of Part "B" research and development laboratories.

   Currently, a single sump pump with a measured discharge of 144 usgpm utilizes 63.5% of this capacity without any reported receiving system issues.

Additionally, during peak flows it is possible that the overflow (bilge) pump runs in parallel with one of the sump pumps. This scenario was not observed but it is anticipated that this scenario would max out the capacity of the receiving 8" sanitary drain line.

We recommend replacing the existing sump pumps, like for like, since they have generally performed well and have not overloaded the receiving system. In addition, we recommend replacing the existing float system to improve system operational reliability. (Note: Once both pumps are operational, a test should also be conducted to determine the parallel pump flow rate in order to determine any potential overload risk.)

2) Aquatic Life Research Facility Flows

None of the flows projected from the Aquatic Life Research Facility were envisioned in the original sanitary sump pumping arrangement and the system would not be able to keep up with the maximum continuous flows envisioned. (Note: these are just the continuous flows from the data provided.)

Aquatic Life Research Facility - Continuous Flows - Maximum					
		Unit Flowrate			Combined
System	Qty.	Description	L/min	USGPM	USGPM
8 Rack Units	8	Flow Through	90	23.8	190.2
8 Recirculation Units	8		170	44.9	359.3
					549.5

That said, the operation of a reduced number of units should be possible. See example below. These scenarios would have to be carefully monitored against sump pump run times.

Aquatic Life Research Facility - Continuous Flows - Reduced Operations					
		Unit Flowrate			Combined
System	Qty.	Description	L/min	USGPM	USGPM
8 Rack Units	2	Flow Through	90	23.8	47.6
8 Recirculation Units	2		170	44.9	89.8
					137.4

Additionally, periodic flows may also be managed but only with carful monitoring of the sump conditions.

Aquatic Life Research Facility - Periodic Flows					
				Unit	Combined
System	Qty.	Description	L/min	USGPM	USGPM
3 Rack Units	1	Water Bath - Static Renewal Option	90	23.8	23.8
3 Environmental Chambers	1	Mostly Static Renewal	50	13.2	13.2
5 Carbon Tanks (Declorination)	1	10 min backwash - 2x / week	230	60.8	60.8
					97.7

In order to maximize utilization of the Aquatic Life Research Facility we recommend a separate effluent management system be designed (new project) that can intercept the facilities wastewater discharge ahead of the connection to the boiler room floor drains.

2 BACKGROUND

ARC Engineering has been engaged to provide multidiscipline engineering services for the refurbishment of the sanitary sump pits (Qty.2) located in the existing boiler room at the Canadian Centre for Inland Waters (CCIW), 867 Lakeshore Road, Burlington, ON.

As part of the design brief, ARC have been asked to provide high-level comments on the possibility of increasing the capacity of the existing sump pits and the existing sump pumps considering the increased loads coming from the Aquatic Life Research Facility.

3 BUILDING / SITE OVERVIEW & COMMENTS

The CCIW complex consists of six inter-connected buildings, most built in the late 1960's and early 1970's, with a total of almost 50,000 square meters of floor space.

CCIW is located on approximately 40 acres of filled / reclaimed land reaching into Hamilton Harbour adjacent to the Burlington Skyway bridge.

Given the location of the buildings on filled / reclaimed land, groundwater levels are of interest for any subgrade alterations.

ARC have been provided copies of two geotechnical reports for reference:

- Coffey Geotechnics – Hydraulics Laboratory Investigation, October 4, 2010.
- Terraprobe – Sanitary Sewer Upgrade Investigation, September 14, 2015

The 2010 Coffey report discovered groundwater at levels ranging from 2.6m (8.5') to 3.4m (11') below the existing ground surface.

The 2015 Terraprobe report discovered groundwater in the boreholes at depths of about 2m below the existing ground surface. The water level measured in the monitoring well was at a depth of 1.8m (5.9') or at elevation 75.3m on August 25, 2015.

The two reports were completed five years apart and on almost opposite sides of the property. Additionally, the Great Lakes, their connecting waterways, and their watersheds, comprise one of the largest lake systems in the world with monthly, seasonal, and annual average surface water elevations of the lakes fluctuating in response to a variety of factors.

According to the National Oceanic and Atmospheric Administration in Ann Arbor, MI, Lake Ontario reached a level of 75.43m in August of 2017, a rise of 67 cm (26.4") over August of 2012.

For the purposes of this assessment we can assume that groundwater is present at levels ranging from 1.67m (5.5') to 3.4m (11') below the existing ground surface.

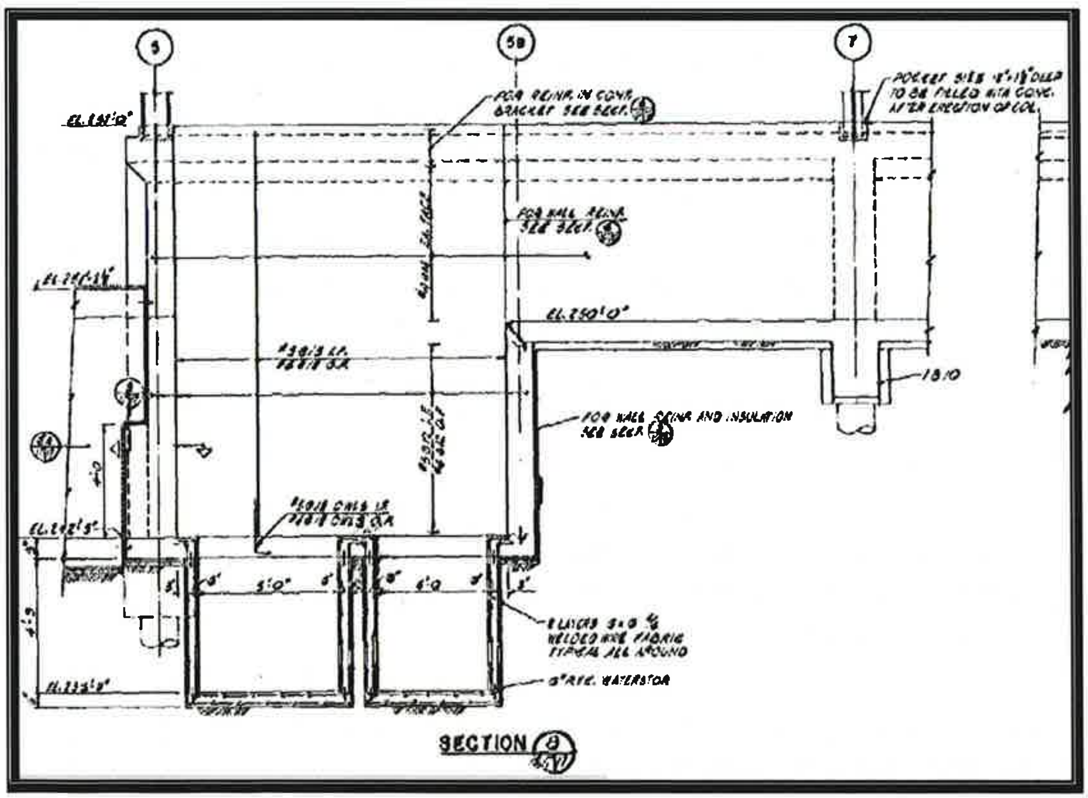
4 STRUCTURAL REVIEW

In order to assess the potential for expanding the existing sump pits ARC Engineering and Shoalts Engineering reviewed the original 1969 drawings available from Reid, Crowther & Partners ltd.

These drawings indicate that the original structure appears to have been built with concrete piles, numerous waterproofing membranes, and numerous water stops due to the nature of the soil conditions.

The following elevations were obtained from Reid, Crowther & Partners Ltd., Job No. R88121, Drawing S17 of 22, Service Tunnel and Ground Floor Sections & Details, June 1969:

- Boiler Room – Finished Floor (FF) 257'-0"
- Exterior Grade 256'-6"
- Boiler Room – Lower Mezzanine (FF) 250'-0"
- Boiler Room – Service Tunnel (FF) 242'-5"
- Bottom of Sump Pit 236'-11"



4.1 Structural Comments & Observations

Based on the information available on the Reid, Crowther & Partners drawings, the bottom of the existing sump pits is approximately 19.5' below grade and therefore between 14' and 8.5' below groundwater levels.

The finished floor of the service tunnel is approximately 14' below grade and therefore between 8.5' and 3' below groundwater levels.

Given evidence of infiltration at the wall penetration for the 4" ductile iron drain pipe, which is 6' above the floor of the service tunnel, we can assume that the groundwater is closer to the higher values in this range.

Additionally, groundwater is running steadily between the service tunnel wall and the service tunnel floor. Assuming 1 psi per 2.31' of water head, groundwater pressure could be in the order of 3.7 psi at this wall / floor joint.

The existing sump pits are heavily corroded as evidenced in the photos below.

4.2 Structural Conclusions & Recommendations

4) The service tunnel floor is believed to be approximately 8.5’ below the groundwater table and the bottom of the existing sump pits to be approximately 14’ below the groundwater table. Excavation in these conditions would require significant dewatering provisions and is believed to be high risk with respect to additional unforeseen outcomes in questionable soil conditions. We do not recommend attempting to expand the existing sump pits.

5) The existing sump pits are heavily corroded. This is understood to be due to boiler blowdown temperatures, chemical treatment carryover and almost 50 years of operation. We recommend that the refurbishment of the existing sump pits be limited to the following surface preparation and treatment:

   a. The sumps will be removed from service, including both inflow and discharge, for a minimum of 3 days each to allow for cleaning, surface preparation, application of restoration compounds, and adequate curing before being placed back into service.

   b. Temporary discharge by way of pumped suction lines through watertight plugs in the inlets will probably be required.

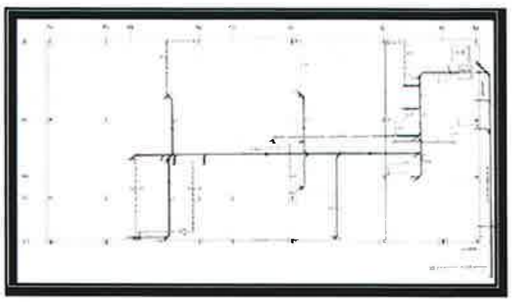
   c. The existing steel cover plates and frames will be removed and replaced with new galvanized steel.

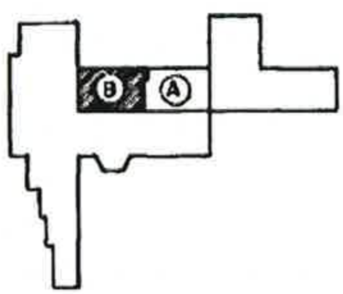
6) Given the extent of the current groundwater infiltration in the service tunnel and sump pit area we would recommend limiting the refurbishment to the pit surfaces alone and defer additional floor / wall treatment until exterior civil works can be undertaken to rectify the observed infiltration.

5 MECHANICAL REVIEW

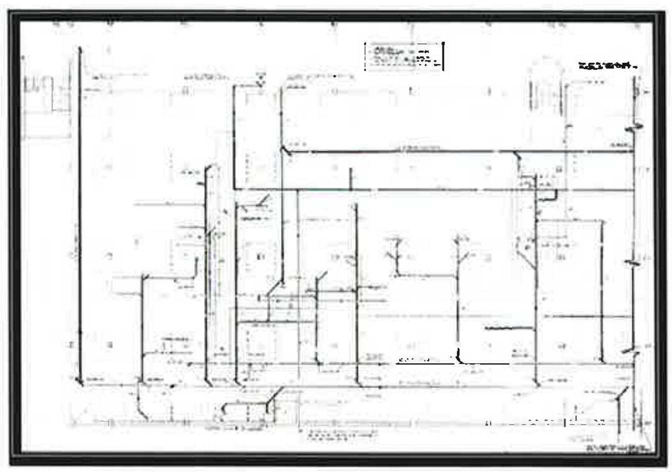
In order to assess the potential for increasing the capacity of the existing sump pumps ARC reviewed the original 1969 drawings available from Reid, Crowther & Partners ltd. to determine downstream conditions.

According to Reid, Crowther & Partners Ltd., Job No. R-88121, Drawing P17 of 19, Boiler Room – Foundation Plan – Plumbing & Drainage, June 1969, the sewage ejector (sanitary sump pump) 4" diameter discharge pipe penetrates the wall to the exterior of the building and connects to an 8" sanitary drain that is continued on Drawing P11 of 19, Research & Development - Part "B" – Foundation Plan – Plumbing & Drainage.





Key Plan



This 8" sanitary drain services the ground floor, second floor, and penthouse floors of Part "B" research and development laboratories.

Aquatic Life Research Facility - Water Usage Data - Projected				
		Unit Flowrate		**Combine**
System	**Qty. Description**	**L/min**	**USGPM**	**USGPM**
Rack Units	3 Water Bath - Static Renewal Option	90	23.8	71.3
Rack Units	8 Flow Through	90	23.8	190.2
Recirculation Units	8	170	44.9	359.3
Environmental Chambers	3 Mostly Static Renewal	50	13.2	39.6
5 Carbon Tanks (Declorination)	2 10 min backwash - 2x / week	230	60.8	121.5
				782.0

5.1 Mechanical Comments and Observations

Receiving Pipe Capacity – 226.8 gal/min

According to Ontario Building Code Table 7.4.10.8 the maximum permitted hydraulic load drained to an 8" horizontal sanitary drainage pipe with a slope of 1% is 1600 fixture units.

Fixture units can be converted to gal/min using table 7.4.10.5 to establish a probable drainage rate of 226.8 gal/min.

See reference tables below.

Table 7.4.10.8.
Maximum Permitted Hydraulic Load Drained to a Horizontal Sanitary Drainage Pipe
Forming Part of Sentences 7.4.10.6.(2) and 7.4.10.8.(1)

Item	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Drain *Size*, Nominal in.	Maximum Hydraulic Load, *fixture units*					
		Slope[1]					
		1 in 400	1 in 200	1 in 133	1 in 100	1 in 50	1 in 25
1.	3	—	—	—	—	27	36
2.	4	—	—	—	180	240	300
3.	5	—	—	380	390	480	670
4.	6	—	—	600	700	840	1300
5.	8	—	1400	1500	1600	2250	3370
6.	10	—	2500	2700	3000	4500	6500
7.	12	2240	3900	4500	5400	8300	13000
8.	15	4800	7000	9300	10400	16300	22500

Notes to Table 7.4.10.8.:

(1) Slope is the ratio of rise to run in whatever measurement units are chosen.

Sentence 7.4.10.5 (2) of the Ontario Building Code 2012 states: "Where the hydraulic load is to be expressed in gal/min, *fixture units* shall be converted in accordance with Table 7.4.10.5.

Table 7.4.10.5.
Maximum Probable Drainage Rate, gal/min
Forming Part of Sentence 7.4.10.5.(2)

Item	Column 1	Column 2	Column 3	Column 4
	Fixture Units in Service	*Fixture Units*	*Fixture Units*	*Fixture Units*
		Col. 1	Col. 1 × 10	Col. 1 × 100
1.	100	53	174	900
2.	90	51	164	835
3.	80	49	153	750
4.	70	47	140	680
5.	60	44	128	600
6.	50	41	115	520
7.	40	38	102	435
8.	30	33	88	350
9.	20	27	72	262
10.	10	21	53	174

Pump Capacity – 144 GPM @ 31FT Head

Pump Information: Goulds; Model WS1537BHF; 4" Dia. Impeller; 1.5Hp / 575 / 3 / 60; 3.9 Max. Amps; 2" NPT Discharge; Capacity up to 220 GPM; TDH up to 81 FT; and Shipping Weight of 92lbs. (All pumps are the same.)

In order to determine the capacity of the existing pumps field measurements were made as follows:

Pump 1: Not working at time of inspection

Pump 2:
Run time: 1min 54s
Initial Elevation= 5'-0"
Finial Elevation= 7'-1"

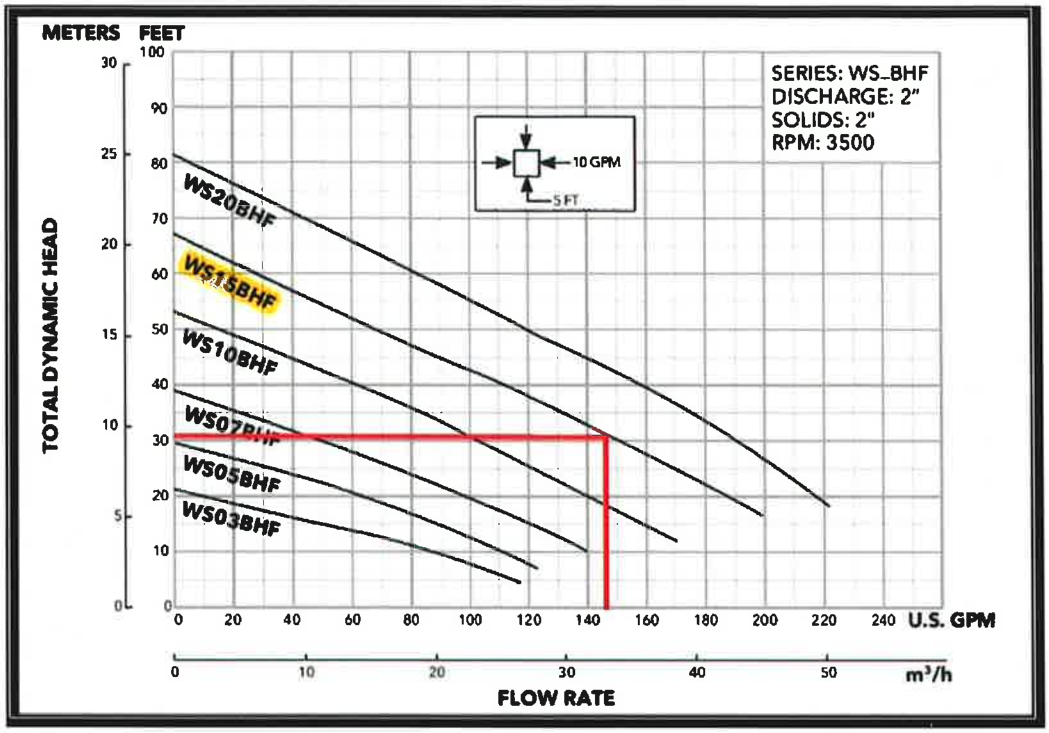
Pit Fill Time:
Elapsed Time: 5min 6s
Initial Elevation= 6'-6"
Finial Elevation= 7'-0"

Flow rate calculations:	
Drain Down Flow Rate Calculation	**Fill Flow Rate Calculation**
$V_{dd} = A_{sump\ pit}\, x\, [E_f - E_i] x \frac{7.48\ gal}{1 ft^3}$ $= 16ft^2 x [7.08ft - 5.0ft] x \frac{7.48\ gal}{1ft^3}$ $= 249.3\ gal$ $f_{dd} = \frac{V_{dd}}{t_{dd}} = \frac{249.3\ gal}{1 \min 54 sec} = 132\ GPM$ Where: V_{dd} is drained down volume E_f is finial elevation E_i is initial elevation f_{dd} is drain down flow rate t_{dd} is elapsed drain down time	$V_f = A_{sump\ pit}\, x\, [E_f - E_i] x \frac{7.48\ gal}{1 ft^3}$ $= 16ft^2 x [7.0ft - 6.5ft] x \frac{7.48\ gal}{1ft^3}$ $= 60\ gal$ $f_f = \frac{V_f}{t_f} = \frac{60\ gal}{5 \min 6 sec} = 12\ GPM$ Where: V_f is fill volume E_f is finial elevation E_i is initial elevation f_f is fill flow rate t_f is elapsed fill time

$$f_{P2} = f_{dd} + f_f = 132\ GPM + 12\ GPM = 144\ GPM$$

On this basis, a single pump running utilizes 63.5% of the available 8" sanitary drain capacity for the entire area defined as Research & Development - Part "B" on the Reid, Crowther & Partners Ltd. drawings.

Total dynamic head is estimated from manufacturers pump curves to be 31 FT at 144 USGPM. See following pump curve.

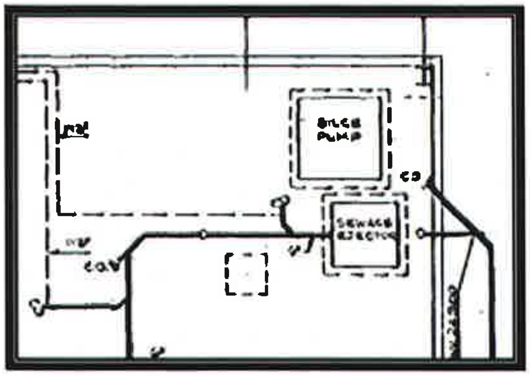


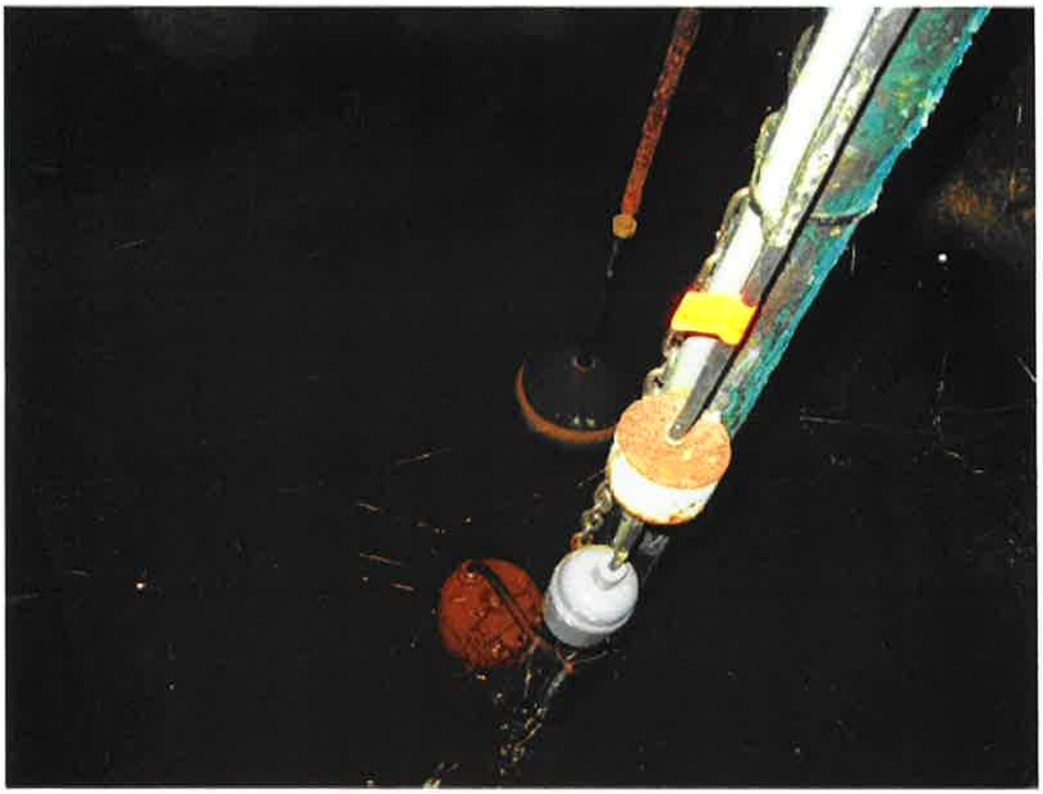
Pump Condition

As noted above, pump #1 was not functioning during our field survey. Additionally, issues have been conveyed with respect to float reliability and pumps not alternating service correctly.

Corrosion, as evidenced in the photo below, is believed to be a major contributor to these issues.

It should also be noted that the overflow pump that services the original bilge sump is stand alone and operates off a directly connected float switch.





5.2 Mechanical Conclusions & Recommendations

1) Sump Pumps

The capacity of the existing 8" section of the sanitary piping system (receiving pipe capacity) is calculated to be 226.8 usgpm. This portion of the sanitary piping system was originally designed to accept flows from the sanitary sump pit (primarily floor drains), the bilge sump pit, and all the drains from the ground floor, second floor, and penthouse floors of Part "B" research and development laboratories.

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Additionally, during peak flows it is possible that the overflow (bilge) pump runs in parallel with one of the sump pumps. This scenario was not observed but it is anticipated that this scenario would max out the capacity of the receiving 8" sanitary drain line.

We recommend replacing the existing sump pumps, like for like, since they have generally performed well and have not overloaded the receiving system. In addition, we recommend replacing the existing float system to improve system operational reliability. (Note: Once both pumps are operational, a test should also be conducted to determine the parallel pump flow rate in order to determine any potential overload risk.)

2) Aquatic Life Research Facility Flows

None of the flows projected from the Aquatic Life Research Facility were envisioned in the original sanitary sump pumping arrangement and the system would not be able to keep up with the maximum continuous flows envisioned. (Note: these are just the continuous flows from the data provided.)

Aquatic Life Research Facility - Continuous Flows - Maximum					
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That said, the operation of a reduced number of units should be possible. See example below. These scenarios would have to be carefully monitored against sump pump run times.

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