Mr. Mayor and The Board of Commissioners:

The final report of the Sewer Advisory Committee was placed on the agenda for last month's meeting and a substantial packet of materials, including the committee's final report, was provided for your review prior to the meeting. Unfortunately, I was unable to attend, so the report will be made at this month's meeting.

There is a good deal of information contained in the materials and the suggestions made in the committee's final report suggest the town make a substantial monetary commitment to address various threats to the continued viability of the sewer system.

Under the circumstances, it is understandable that you may have questions and concerns relative to the committee's final report. If so, I ask that each of you send me any questions prior to the next meeting, so that I will be better prepared to address them. I will not reply to any questions you may submit, but rather will wait until they are asked at the BOC, thereby, giving all interested residents an opportunity to be informed.

For you convenience, attached are copies of he documents that have previously been provided.

> The motion establishing the Sewer Advisory Committee, (SAC) contained the following pertinent authorizing language. "The scope of the Advisory Committee's functions shall be to (A) review and assess the vulnerability of the Town's sanitary sewer system, including the lift stations, to flooding from storm surge; (B) provide estimates with respect to the level of flooding to which the system is vulnerable; (C) report on the types of potential failures related to pumps, controls and electrical subsystems to which the sewer system is vulnerable and provide estimates with respect to the time and cost required to repair such failures and return the sewer system to operation in the event of a flood; (D) report on the availability and methods or options available to secure the availability of replacement parts in the event of failure; (E) review and report on protective measures and emergency systems in place in other oceanfront communities in North Carolina that rely upon similar sewer systems; and (F) review and present, with recommendations, engineering and systems alternatives for mitigating the vulnerability of the Town's sewer system and preparing

for the prompt recovery of that system in the event of a failure as a result of flooding."

Scope

A. Determine system vulnerability to flooding and storm surge
B. Flood levels that may impact the system
C. Types of potential failures and time and cost to repair
D. Availability of replacement parts
E. Review other similar systems in coastal NC communities
F. Present recommendations

A. The scope of the motion authorizing SAC limited the review to issues related to storm surge and flooding. The majority of the committee members present at the initial committee meeting recommended that the scope be expanded to include any and all foreseeable threats to the system. As examples, electrical outages, lightning strikes, auto accidents and employee error. At the March Board of Commissioners (BOC) meeting, SAC made its initial report and requested that its scope be expanded to identify and address any vulnerabilities threatening the sewer system. The BOC granted the request and asked that all vulnerabilities be prioritized. Attached is a spread sheet containing the identified vulnerabilities, in priority order. Electrical outage is number one, followed by storm surge, retention tank failure and various failures of pumps and electrical components. Electrical failure was determined to be the likeliest cause of a sewer failure because of the multiple means of causation, including those for which we have no means of prevention nor warning. As an example, there could be a lightning strike or auto accident, on or off the island that can disrupt electrical service causing a shutdown of the sewer system. Storm surge or flooding can result in the inundation of the pumps and electrical equipment that is based in the subterranean vaults at each sewer station. The failure of the retention tank at any pump station will result in a loss of service for days if not weeks. The retention tanks are currently

stored in the subterranean vaults at each pumping station. The roof of the vault is comprised of two feet thick concrete. The only access to the tanks is by means of a staircase. Therefore, in the case of tank failure, the concrete slab would have to be broken, so the failing tank can be replaced by a new tank. Each of the three named failures can result in a prolonged shutdown of the sewer system and a resulting evacuation of the island with catastrophic consequences to the residents and businesses that depend on Holden Beach for a livelihood. The remaining vulnerabilities, while troublesome, can be addressed quickly and do not pose catastrophic threats to the residents and economy of Holden Beach.

B. Tim Evans volunteered to research the severity and frequency of storms/hurricanes impact on Holden Beach. Tim contacted a number of agencies and reports, other than the 100 year flood map constructed by FEMA, they could not provide any definitive information, specific to Holden Beach. The committee did obtain two documents, one from NOAA, which provided information related to storms along the coast another relative to storm surge along the U.S. coastline. Although neither has the specificity SAC was hoping to find, they do offer insight relative to the number and severity of storms along the Carolina coast in general (see attached).

C. Public Works, provided an estimate of 700,000.00 for the replacement of the pumps and electrical components situated at the four pump houses. In addition, there is a lead time of up to three months in procuring replacement sewage pumps. There is a similar lead time should the electrical panels be destroyed. Component electrical parts, for the most part, can be repaired or replaced in hours.

D. Discussion disclosed that each pump station contains unique component parts. A pump in pump station #1 is most likely not interchangeable with a pump from another station. This applies to a significant portion of component parts. This makes the possibility of Holden Beach becoming a participant in a parts sharing program difficult. Entering into such an agreement, imposes legal

obligations on the participants. The town will have to explore the viability of such a program. It also became clear that should a storm, with enough force to cause major flooding and/or storm surge strike the Carolina coast, it is unlikely that neighboring communities would be amenable to loaning another community replacement sewer parts.

E. Research disclosed that all similar sewer systems, in the immediate area, protect the vulnerable pumps, electrical panels and component parts, from flooding and or storm surge, by storing them in structures above the Base Flood Elevation (BFE).

F. 1. The possible loss of electrical service can be addressed by the purchase of portable back up electrical generators for each sewer station. Holden Beach currently has two such generators available, to provide power in the case of an emergency, and would have to purchase two more, at a cost of approximately $30,000 each, to fully and adequately address the sewer systems electrical needs should an outage occur.

2. SAC suggests that the best way to protect the sewer system from flooding or storm surge is to raise the vulnerable pumps and component parts above BFE. Mr. Leo Green, an engineer and SAC member, using FEMA's preliminary flood zone maps, prepared drafts of structures for the housing of the vulnerable pump station equipment above (BFE) (attached). His analysis discovered that pump station 1 is barely above BFE, pump stations 2, 3 and 4 need to be raised between five –six feet to be above BFE. Although station one is above BFE, the vault containing the pumps and electrical equipment is actually below BFE since the vault is at least eight feet below ground. Therefore, it is advisable to raise all pump stations. Should the BOC agree with the recommendations of SAC and deem the raising of the pump stations advisable, since pump station #1 is least vulnerable, it is suggested that it be last station raised. Furthermore, since each proposed raised station has to be fully functional, requiring a presence of all component parts, in both the raised and current pump houses, before the existing pump station's work can be transferred to the new raised station, it is suggested that pump station #2 be the first station raised. Station #2 has all the parts necessary for rebuilding stations #3 and #4, while stations #3 and #4 do not have all the parts necessary to build a new pump house at #2 therefore, if station

#2 is done first, it will be more economical since, after the raised station at #2 is operational, we can remove and reuse the parts from the current station #2 to construct the new raised station at #3 or #4.

3. The retention tanks are currently housed in the subterranean vaults at each pumping station. The roof of the vault is comprised of two foot thick concrete. The only access to the tanks is by means of a staircase. Therefore, in the case of tank failure, the concrete slab would have to be broken, so the failing tank can be replaced. Mr. Green suggested that the slab be modified by cutting a hole large enough to remove and replace the tank and covering the hole with a stainless steel hatch cover (attached draft). An independent contractor reviewed the proposal to determine if the modified slab would withstand the weight and pressure exerted by the opening, raised structure and pumps and electrical components stored in the structure. His report indicates that the slabs will maintain their integrity if supporting beams are placed beneath them in the vault.

4. The remaining vulnerabilities address differing levels of component part failure, e.g., of one vacuum pump, two vacuum pumps, one waste pump or two waste pumps. These failures can be remedied by proper inventory and replacement and repair procedures. The Public Works Dept. has a current inventory of parts (attached) and is adept at the timely repair and replacing of failing pumps and electrical components.

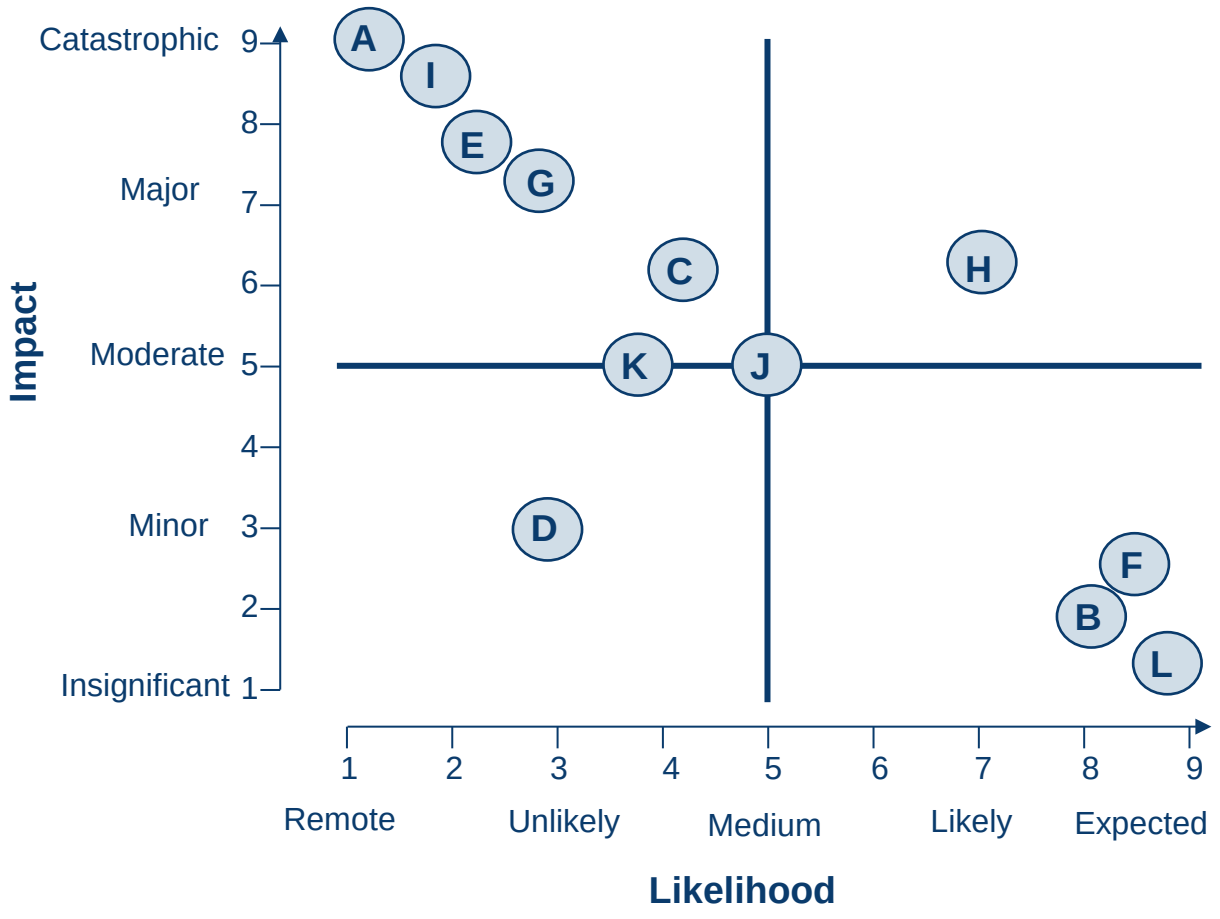
5. The costs for the suggested recommendations is approximately $2,200,000.

Storm surge imagery for the U.S. coast | Weather Underground

Description	Cause	Impact	Severity	Response / Mitigation	Costs	Inventory
Electrical panel failure	Power surge, lightning strike, operator error; flooding	Station down until panel can be replaced	Major to Catastrophic depending upon timeframe	1) Replace entire electrical panel (2 month timeframe) 2) Ensure proper fault/surge/lightning protection is in place 3) Procure spare panels 4) Arrange for expedited replacements (e.g., shared spares)	$45,150	0
External power failure	Brunswick Electric outage	System shut down until at least partial power restored (e.g., 1 or the 2 feeds to the island)	Moderate to Major depending upon the duration of the outage and the availabilty of backup generators	1) Sufficient number of backup generators on hand 2) Arrangements for emergency generators (e.g., shared spares)	$39,299.17	2
Wash-Over	Hurricane	Loss of pumps and electrical system	Major to Catastrophic	1) System down until all pumps and electrical is replaced and functional 2) Raised building to house vacuum pumps and electrical panels. 3) Sealed stations to withstand storm surge without flooding. 4) Remove redundant pumps and electrical components to have available after the storm 5) Purchase sufficient spares to have available after the storm 6) Arrange for expedited spares (e.g., shared spares)		

Description	Cause	Impact	Severity	Response / Mitigation	Costs	Inventory
Tank Failure	Sewage holding tank fails	System down until tank replaced (partial or total system?)	Major to Catastrophic	1) Perform sufficient tank maintenance to prolong expected 25-35 year life 2) Monitor tank condition to predict failure in advance 3) Prepare facility to allow for tank removal	$79,000	0
Double vacuum pump failure	Station overloaded; electrical problem that impacts both pumps	Station down until at least one pump can be brought back online	Moderate to Major	1) Replace both pumps with spares, send off to be rebuilt; must have two spares available	$50,000	2
Single vacuum pump failure	Age, electrical, physical failure	None as long as second pump is able to maintain the vacuum until replacement is made	Insignificant to Minor	1) Replace pump with spare, send off to be rebuilt 2) Monitor noise, vibration, output to predict pending failure	$25,000	2
Double sewage pump failure	Station overloaded; electrical problem that impacts both pumps; second pump fails while first pump is being fixed	Station down until at least one pump can be brought back online	Major to Catastrophic depending upon timeframes	1) Replace both pumps 2) Need at least one spare to mitigate 3 month leadtime 3) Monitor noise, vibration and output to predict pending failure	$64,000	3
Single sewage pump failure	Age, electrical, physical failure	None as long as second pump is able to maintain the volume until replacement is made (3 month timeframe)	Insignificant to Minor	1) Replace pump 2) Monitor noise, vibration and output to predict pending failure	$32,000	3
Electrical panel component failure	Age, electrical, physical failure	None as long as backup circuits continue to function	Insignificant to Minor	1) Replace failed component with spare; order new spare 2) Ensure proper fault/surge/lightning protection is in place 3) Ensure sufficient number of spare parts is available	$10,000	several
Operator Error	Operational mistakes that result in system problems	Equipment failure or system shutdown	Minor to Major	1) Training and documentation (e.g., operating manuals) 2) Capture and record "lessons-learned" from prior mistakes		

Description	Cause	Impact	Severity	Response / Mitigation	Costs	Inventory
Operator Attrition	Skilled employees leave	Decreased ability to operate the system and/or respond to problems	Minor to Major	1) Make sure sufficient personnel are trained and available 2) Provide retention incentives		
Candy Cane Failure	Broken off or leaks in flooding situation	Individual pit overloads, stops functioning	Insignificant to Minor	1) Improve ability to detect and quickly resolve problem 2) Increase inspections to identify problems	minor	several


Catastrophic
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Medium
Likely
Expected
Likelihood

DIXON ASSOCIATES
CONSULTING ENGINEERS, INC.

April 8, 2016

Mr. David W. Hewett, Manager
Holden Beach Town Hall
110 Rothschild Street
Holden Beach, NC 28462-5037

Re: ***Structural Study - Holden Beach Vacuum Station Modifications*** **1615**

Dear Mr. Hewett:

As requested, we have investigated and analyzed the floor framing for the existing vacuum pump stations based on the proposed modifications, per the drawings provided by Green Engineering. The modifications consist of fabrication of a new 10'x15' equipment access hatch and a new slab supported pump building for Vacuum Station #1 and fabrication of new 9'x12' equipment access hatches and elevated pump buildings for Vacuum Stations #2, 3 & 4.

These stations were originally constructed in approximately 2005. Dixon Associates served as the structural engineers for design of the pump stations. The original design called for 10 feet of saturated sand loading (1,300 psf) above the top slab for potential hurricane flooding/drift conditions. In conversations with Mr. E. Leo Green Jr., PE, Green Engineering, proposed new flood maps show the flood elevation at approximately 14.00 (reference NAD 88). Mr. Green's drawings and data show the top of slab elevations as: 15.42 for Station #1, 7.13 for Station #2, 7.45 for Station #3 and 6.30 for Station #4. Therefore, it appears that Station #1 will not be subject to flood loading, and the flood loading for Stations #2, 3 & 4 could be reduced from a 10 foot depth to a maximum depth of 7.70 feet.

We analyzed the floor slabs for the proposed modified loadings with the proposed new floor openings. Based on our analysis, we find that the modified slabs will be overstressed adjacent to the new floor openings. We analyzed the modified floor slabs with additional supports, two new interior columns located above the bottom slab step, approximately aligning with each end of the new floor opening. Based on our revised model/analysis, we find that the existing slabs, with the new floor openings, will be acceptable with these additional supports.

Therefore, we have determined that two new columns will be required in each pump station to safely support the existing roof/floor slab if the proposed new roof/floor hatches are provided. We have determined that HSS 9x9x1/2 steel columns will be acceptable for use as the additional supports.

In conversation with Mr. Green, he said that flood walls were not planned for the new hatch locations at Stations #2, #3 & #4. I would suggest that flood walls around the new hatch be provided to raise the new hatch door above the design flood level to minimize potential flooding into the pump station, and minimize weight from flood waters and drifting sand loads on top of the hatch door.

We appreciate the opportunity to have assisted you with this evaluation. Please let us know if we can be of any further assistance.

Respectfully submitted,
DIXON ASSOCIATES

William P. Dixon, PE
President/Project Engineer
North Carolina Registration Number 10958

CC: Mr. Leo Green Jr., PE

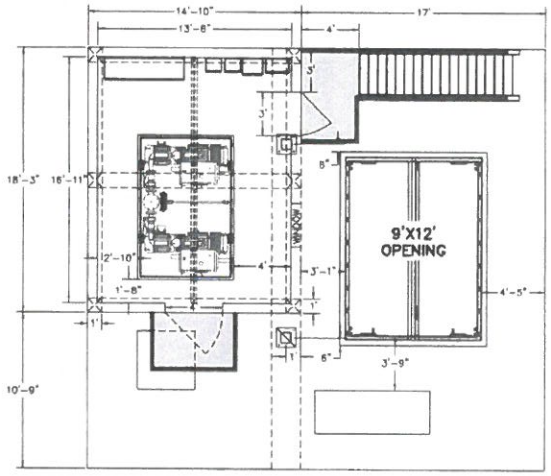
G:\Project\1600\1615 Holden Beach PS\1615 Holden Beach PS Structural Report

TOWN OF HOLDEN BEACH
PUMP STATION(S) VULNERABILITY
SCOPE OF WORK AND COST ESTIMATES
April 18, 2016

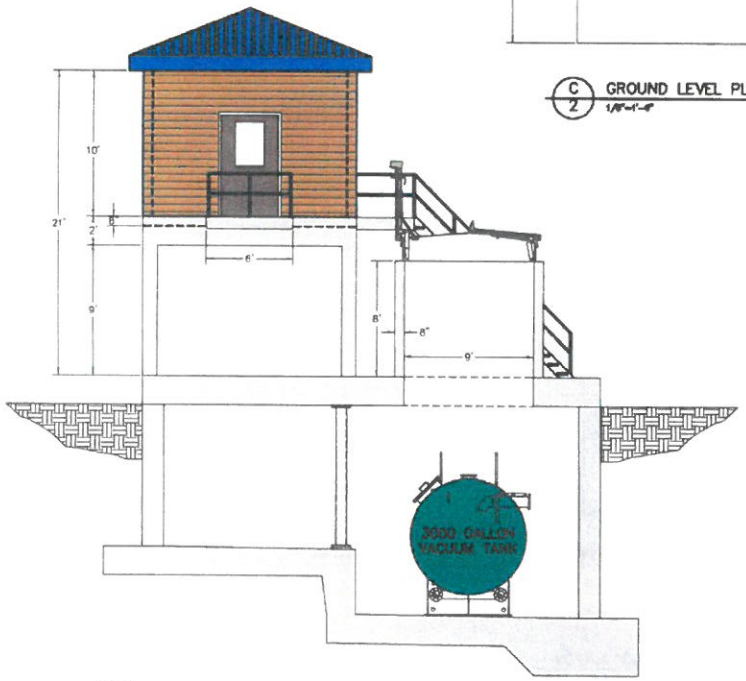
04/18/16

Item	Proposed Improvements / Sequence	VPS # 1	VPS # 2, 3, 4
1	Install steel column support for existing 24-inch roof slab on existing Vacuum Pump Stations.	$ 15,000.00	$ 15,000.00
2	Construct poured in place concrete columns and support platform for new vacuum system and controls.	----	$ 45,500.00
3	Sawcut existing top slab access opening and install aluminum hatch cover. (8' Flood Perimeter Wall on #2,3,4 only)	$ 68,000.00	$ 56,000.00
4	Erect precast concrete building walls and site build roof system with galvalume metal finish. Install required HVAC system. Install trolley rail system.	$ 77,500.00	$ 65,000.00
5	Install new vacuum pump skid system including vacuum pumps, controls, SCADA, piping, fittings and connections.	$ 185,000.00	$ 125,000.00
6	Electrical installation including feeders, transformer, main panel, generator with auto transfer switch, misc. switches, conduit, cable, panel and labor.	$ 185,000.00	$ 126,000.00
	Total Construction Cost	**$ 530,500.00**	**$ 432,500.00**
	Contingency (+/- 10%)	$ 53,000.00	$ 44,000.00
	Technical: Electrical	$ 20,000.00	$ 15,000.00
	Structural	$ 15,000.00	$ 15,000.00
	Procurement/Facilitation	$ 25,000.00	$ 25,000.00
	Total Development Cost	**$ 643,500.00**	**$ 531,500.00**

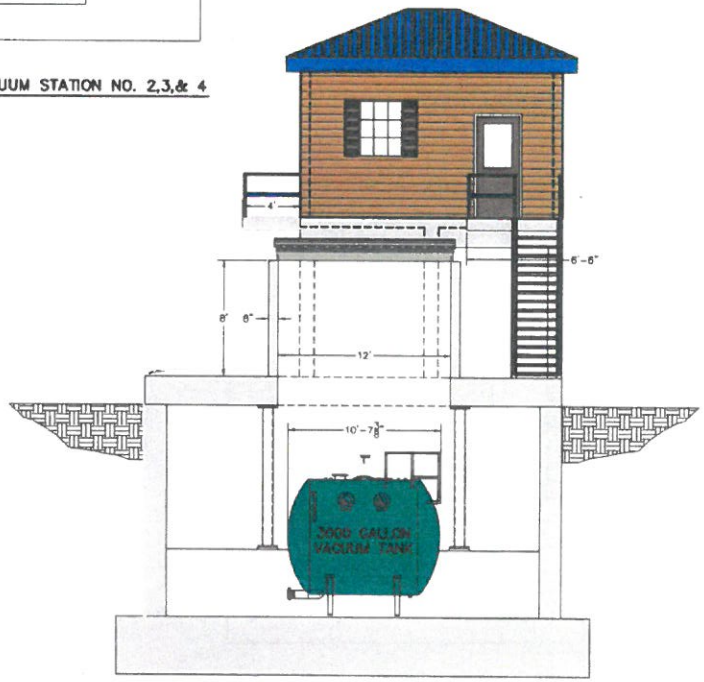
LOCATION	TOP SLAB	100' YR FLOOD
STATION #2	7.13	14.00
STATION #3	7.45	14.00
STATION #4	6.30	14.00



C/2 GROUND LEVEL PLAN – VACUUM STATION NO. 2,3,& 4
1/8"=1'-0"



A/2 SIDE ELEVATION – VACUUM STATION NO. 2,3,& 4
1/8"=1'-0"



B/2 ELEVATION – VACUUM STATION NO. 2,3,& 4
1/8"=1'-0"

PLAN REVIEW ONLY

Green Engineering

WATER
WASTEWATER
SURVEYING
PLANNING
PROJECT MANAGEMENT
NC FIRM LICENSE: P-0115

303 N. GOLDSBORO ST.
P.O. BOX 609
WILSON, NC 27893
TEL 252.237.5365
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office@greeneng.com

HOLDEN BEACH

VACUUM SEWER SYSTEM STATION # 2, 3, and 4

TOWN OF HOLDEN
NORTH CAROLINA

DATE FEBRUARY 2016

REVISION	DATE	BY

SCALE AS SHOWN

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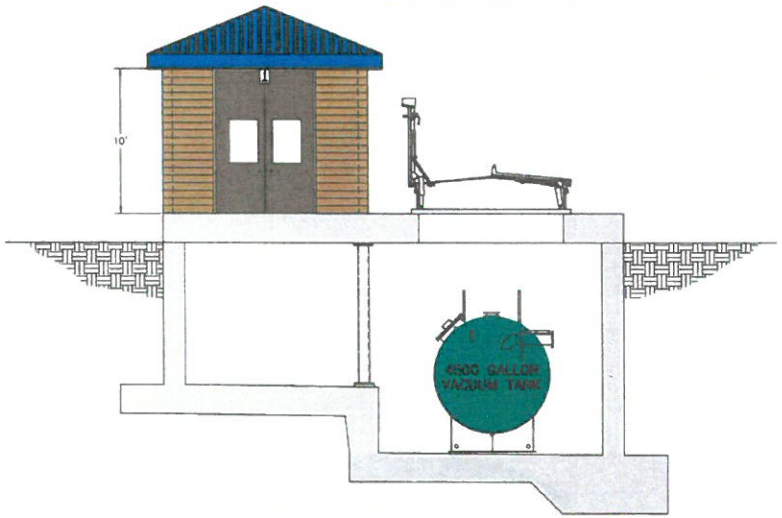
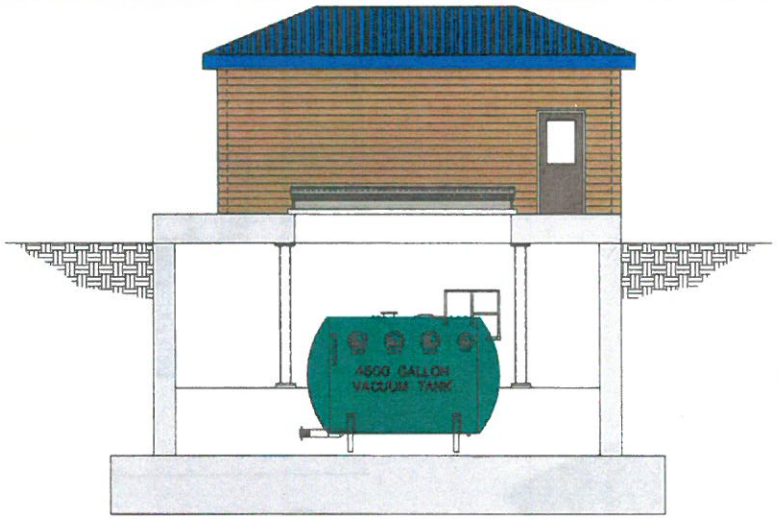
DRAWN BY: ABB
REVISED: ?

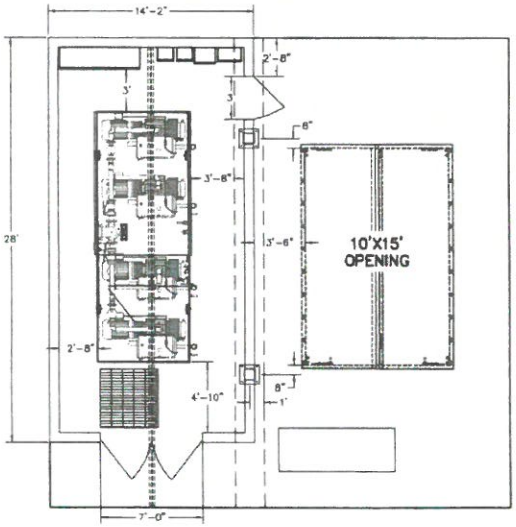
SHEET: 2 of 4 #-##



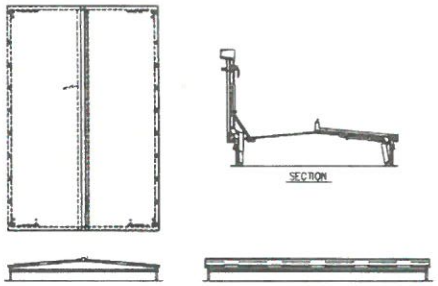
A/1 FRONT ELEVATION – VACUUM STATION NO. 1
1/8"=1'-0"



B/1 SIDE ELEVATION – VACUUM STATION NO. 1
1/8"=1'-0"



C/1 UPPER LEVEL PLAN – VACUUM STATION NO. 1
1/8"=1'-0"



D/1 TANK HATCH – VACUUM STATION NO. 1
3/16"=1'-0"

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HOLDEN BEACH

VACUUM SEWER SYSTEM STATION #1

TOWN OF HOLDEN
NORTH CAROLINA

DATE FEBRUARY 2016

REVISION	DATE	BY

SCALE AS SHOWN
DRAWING NO: 16-017 VS
F.B. #
DRAWN BY: ABB
REVISED:?

SHEET: 1 of 4 #-##