

Groton, CT Pump Station Evaluation

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Asset Management II – Case Studies

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CH2M



Presentation Outline

- Project Background and Goals
- Condition Assessment
- Risk Assessment
- Remaining Useful Life
- Summary and Next Steps



Background and History of Pump Stations



- Constructed during the same time period; early 1970s
- Similar upgrades over the years

- Similar Layouts
 - Two wet wells
 - Multiple Pumps
 - Pump Speed Control based on level
 - Backup power generation with fuel storage
 - Remote monitoring

Project Goals

- Gain an understanding of the current condition of the Town's six major pump stations
- Gauge the effectiveness of the current maintenance program
- Prioritize upgrades based on condition and risk; assist in CIP planning

Condition Assessment

Condition Assessment

PREPARATION

- Develop Asset Registry
 - Review as-built plans
 - Review data from Groton's CMMS
 - Assign asset types (pump, motor, valve, MCC, etc)
- Develop Condition Assessment Criteria
 - Corrosion
 - Safety Features
 - Acceptable Vibration
 - Leaks

• Condition Grading System

Rating	Description of Condition
1 Very Good	No corrective maintenance required
2 Good	A few minor deficiencies and minimal corrective maintenance required
3 Fair	Several minor deficiencies noted and corrective maintenance required
4 Poor	Major deficiencies and significant corrective maintenance or rehab required
5 Very Poor	Asset may be unserviceable, needs replacement or rehabilitation

Condition Assessment

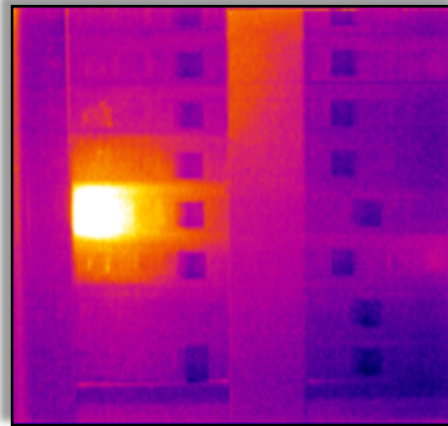
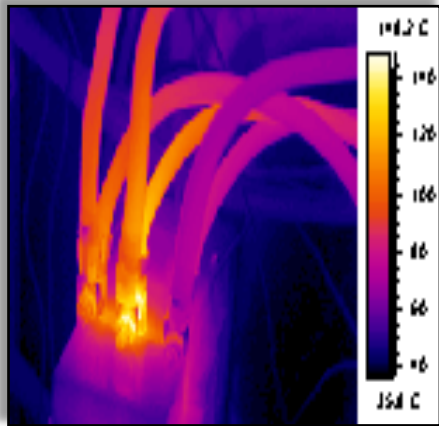
ASSET TYPE WEIGHTING

Asset Type	Asset Type Weight
MECHANICAL/HVAC	
Compressor-Air	1
Fan	1
Flume	1
Grinder	3
Heater	1
Pump-Centrifugal	5
Pump-Vertical Turbine	1
Valve-General	1
Valve-Check	1
Valve-Knife	1
Valve-Sluice	1

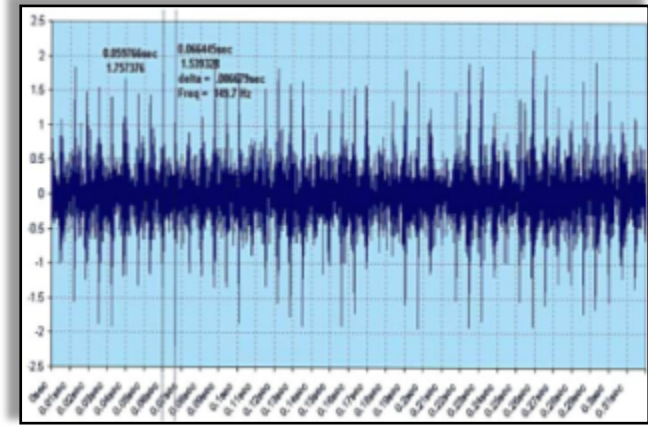
Asset Type	Asset Type Weight
ELECTRICAL/I&C	
Control Panel	3
Electrical Panel	3
Generator	3
MCC	5
Motor	5
Tank-Fuel	1
Transformer	1
VSD	5
BUILDING (STRUCTURAL)	
	5
SITE	
	1

Condition Assessment Methods

FIELD ASSESSMENT



Thermography



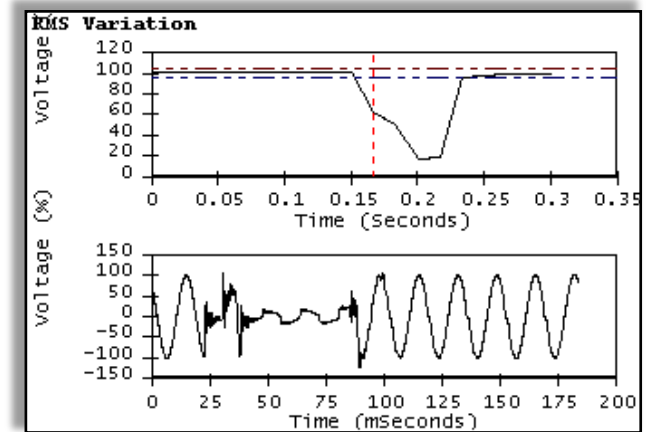
Vibration Analysis



Visual Inspection



Sonic



Power Quality Testing

Condition Assessment

ASSET CONDITION EVALUATION SYSTEM (ACES) TOOL



- Condition data gathered is entered into ACES
- Pre-populated with risk analysis
- Web-based



ID: GC_EL_16, Inspection Date: 4/2/2015

MCC, MCC CABINET

General Condition Questions Risk Questions Photos and Documents

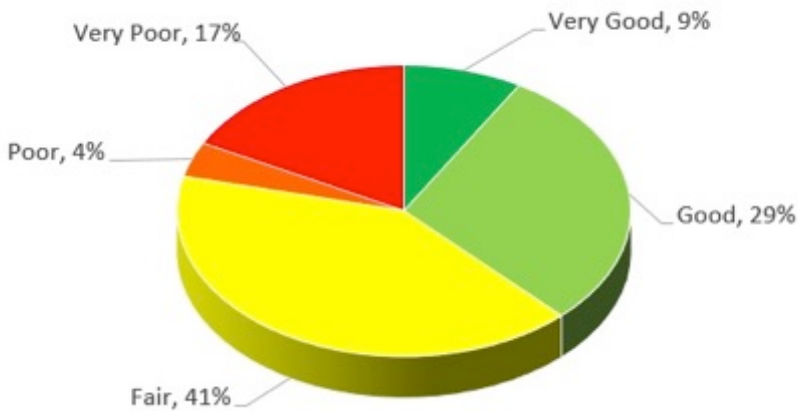
Save Changes Cancel

Question	Answer	NA	Flag	Comment
Absence of Burn Marks	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
Acceptable Noise	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
Acceptable Smell or Heat	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
All Components	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
All Safety Features Present	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>
Arc Flash Boundary Posted	<input type="radio"/> Yes <input type="radio"/> No	<input type="checkbox"/>	<input type="text"/>	<input type="text"/>

Condition Assessment

CONDITION ASSESSMENT SUMMARY

- Identify *specific* deficiencies in equipment assessed
- Develop condition summary
- Provide data for the prioritization process
- Produce multiple reporting options



Groton Asset Condition Assessment Report

Asset Description	Liquid Rheostat Drive (pump 1)	System	PUMP STATION
Asset Type	VSD	Location	Beebe Cove
Asset ID	BC_EL_11	Inspection Date	7/23/2014
Comments		Flag	

Question	Overriding?	Answer	NA	Flag	Answer Comment
Acceptable Wire Labeling		5 No			
All Components		1 Yes			
All Safety Features Present		1 Yes			
Ambient Environment		3 Moderate Environmental Impact			
Arc Flash Boundary Posted		5 No			
Corrosion - Metal		2 Minor Corrosion			
Display/Indicator Ok		5 No			
Drive Efficiency	Yes	3 86% - 90%			88%
Fan and Fan Motor		4 Maintenance Overdue			
Filter			X		
Good Housekeeping		1 Yes			
Infrared		2 Normal			
Installation/Accessibility		2 Installed properly, minor access obstructions			
Mounting		1 Securely mounted, well supported			
Obsolescence		5 Obsolete, Not Supported			Old load cell system no longer able to vary pump speed
Proper Drawings Accessible		5 No			Drawing at the plant

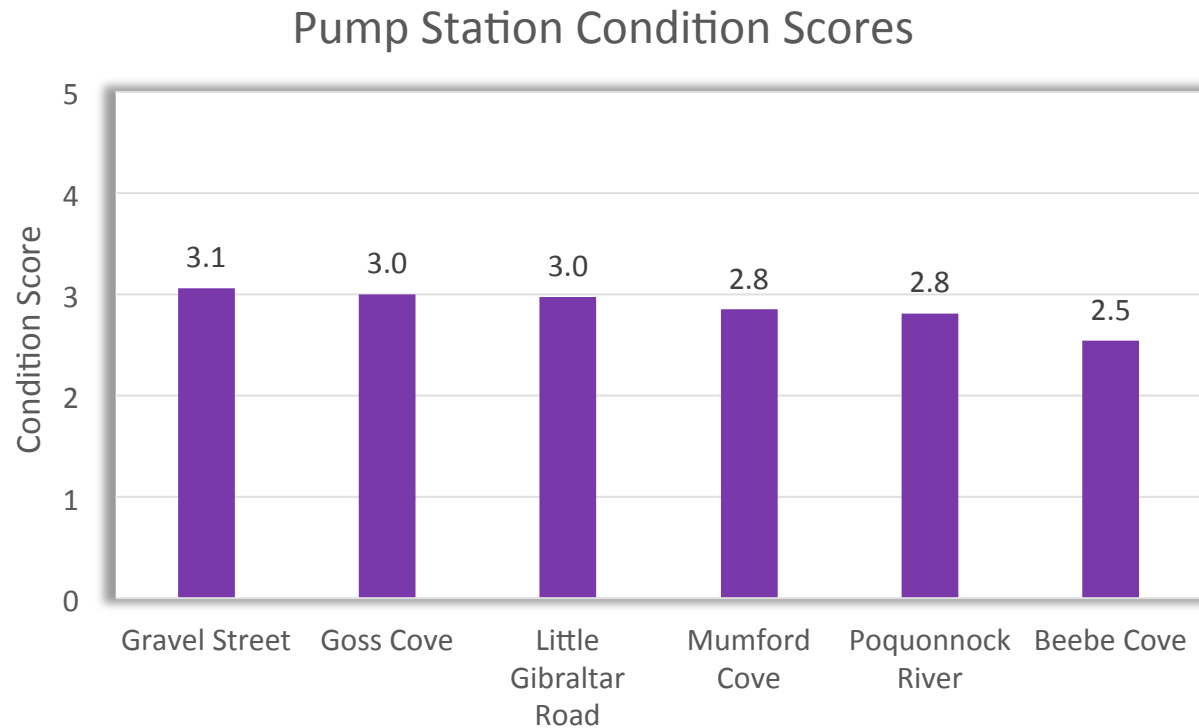
Condition Category Fair. Condition Grade 3. Major Wear Impacting Level Of Service.

Condition Score	3.00	Consequence Score	6.70
Risk Score	34.84	Likelihood Score	5.20

Photo	Photo Comment
	Old load cell system no longer able to vary pump speed correctly

Condition Rollup by Pump Station

CONDITION ASSESSMENT SUMMARY

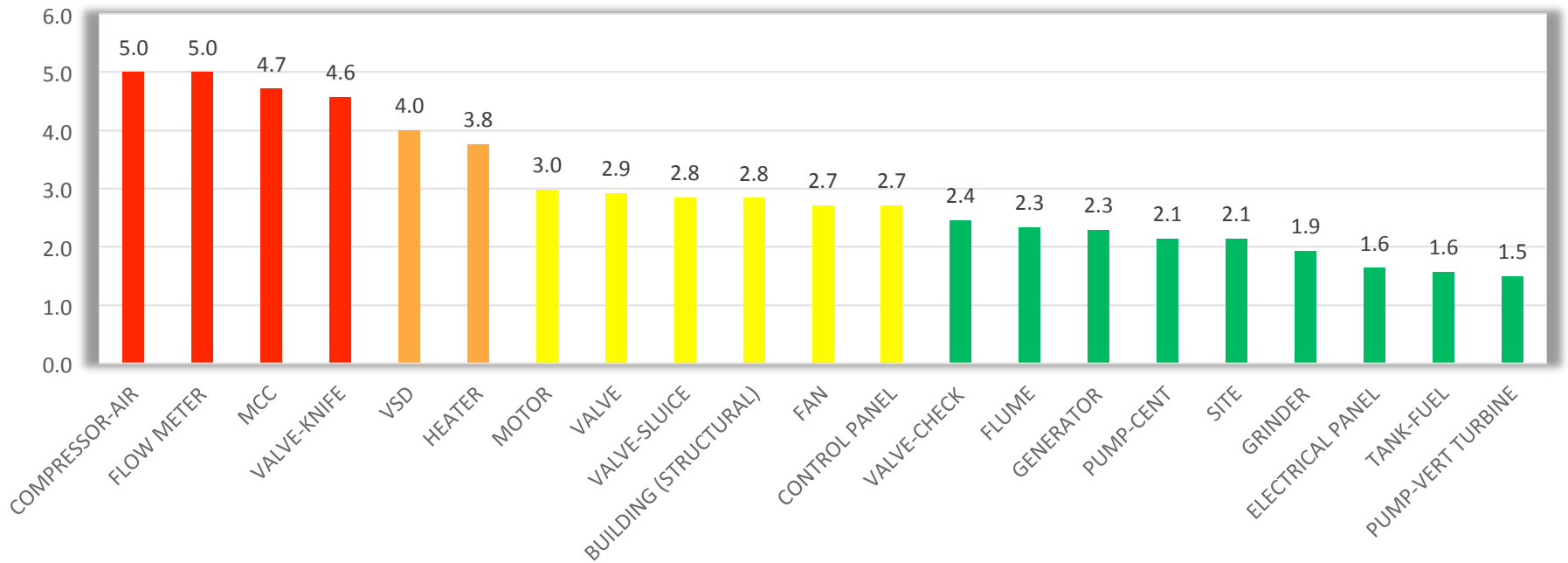


- Average of the condition score of each asset within that location taking into account the weight assigned to each asset type
- Not a lot of differentiation in overall condition of the pump stations due to historical similarities

Condition Rollup by Asset Type

CONDITION ASSESSMENT SUMMARY

Asset Type Condition Score



Sewage Pumps

FIELD CONDITION ASSESSMENT

- Each Pump Station has three or four sewage pumps with average score 2.1

Location	No. Pumps	Manufacturer	Model	Flow (gpm)	TDH (ft)	HP	Speed
Beebe Cove	4	Chicago	VPM	1800	45	25	1150
Goss Cove	3	Fairbanks Morse	5400	1800	96.5	75	1150
Gravel Street	3	Chicago	VPM	1000	65	25	1150
Little Gibraltar	3	Allis Chalmer	300 NSWV	1400	122	75	1150
Mumford Cove	2	Aurora	613 SF	2800	80	75	1090
Mumford Cove	2	Aurora	613 SF	2400	70	60	1090
Poquonnock River	4	Aurora	612 SF (two); 613 SF (two)	2600	33	40	1190



Gravel Street
Chicago



Goss Cove
Fairbanks Morse



Little Gibraltar
Allis Chalmer



Mumford Cove
Aurora

Energy Analysis

ENERGY CONSERVATION MEASURES

	Cost Saving Measures	Annual Energy Savings (kWh)	Annual Cost Savings (\$)
	ENERGY CONSERVATION MEASURES		
ECM 1A	Poquonnock Pump Station - Discontinue Use of Pumps 1 and 3	43,445	\$6,951
ECM1B	Poquonnock Pump Station - New Motors and VFDs on Pumps 1 and 3	43,445	\$6,951
ECM 1C	Poquonnock Pump Station- Optimize the Operation of Pumps 2 and 4		
ECM 2	Goss Cove Pump Station - Pump Replacement and VFDs	114,634	\$17,195
ECM 3	Mumford Cove Pump Station - New Motors and VFDs	33,825	\$4,736
ECM 4A	Beebe Cove Pump Station - Discontinue Use of Pumps 1 and 4	16,223	\$2,596
ECM 4B	Beebe Cove Pump Station - New Motors and VFDs on Pumps 1 and 4	16,223	\$2,596
ECM 5	Beebe Cove Pump Station Heating Controls	4,697	\$705
ECM 6A	Little Gibraltar Pump Station - Pump Rebuild	29,834	\$5,072
ECM 6B	Little Gibraltar Pump Station - New Motors and VFDs	41,094	\$6,986
ECM 7	Gravel Street Pump Station- New Motors and VFDs	2,809	\$421
	Potential Energy Program Cost and Savings¹	256,728	\$39,590

- Electrical testing of pumps:
 - Operating power (kW)
 - Flow rate
 - Suction and discharge pressure
- Electrical testing of motors:
 - Operating power (kW)
 - Amperage
 - Voltage
 - Power factor

21% savings in energy costs

Structural Assessment

FIELD CONDITION ASSESSMENT

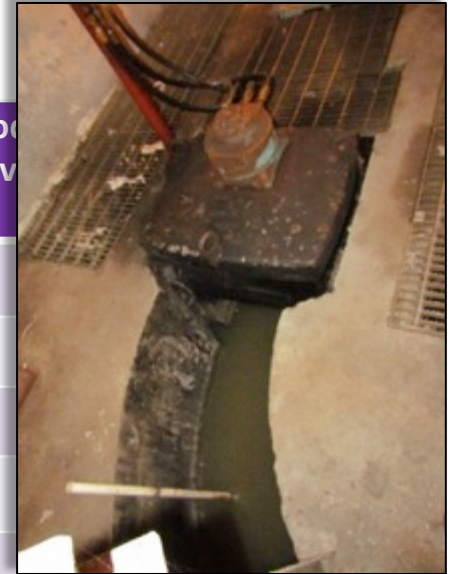
- Issues common to all pump stations
 - Failure of protective wall and ceiling coatings
 - Failure of metal coatings
 - Cement paste loss/exposed aggregate in wastewater channels
- Goss Cove: Condition score 4
 - Wet well rehabilitation is required to protect from further damage
- Little Gibraltar: Condition score 5
 - Salt water intrusion has compromised structural integrity of lower level walls
 - Suspect same condition on wet well side



Safety Assessment

FIELD ASSESSMENT

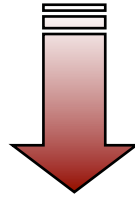
Deficiency Type	Beebe Cove	Goss Cove	Gravel Street	Little Gibraltar	Mumford Cove	Pocahontas River	
Chemical Storage	1	4	4	1	0	1	
Confined Space	0	2	0	0	0	0	
Electrical	9	6	5	8	9	9	
Fire Extinguishers	0	0	0	1	0	0	
Guarding	8	5	4	7	9	9	
Housekeeping	2	4	0	2	1	4	13
Labeling	3	2	4	4	1	6	20
LO/TO	0	0	0	1	1	0	2
Other	6	5	4	3	4	7	29
Railings	0	1	2	0	8	8	19
Walking Surfaces	15	11	8	8	14	13	69
TOTAL:	44	40	31	35	47	57	254



Risk Assessment

Risk Assessment Criteria

$$\text{Risk} = (\text{consequence} \times \text{likelihood})$$



How severe are the consequences of asset failure?

- Health and Safety implications 30%
- System Restoration 30%
- Regulatory compliance 20%
- Public confidence 15%
- Financial impact 5%



How likely is it for the asset to fail?

- **Condition 40%**
- Reliability 20%
- O&M Protocols 20%
- Performance 15%
- Redundancy 5%

Risk Matrix

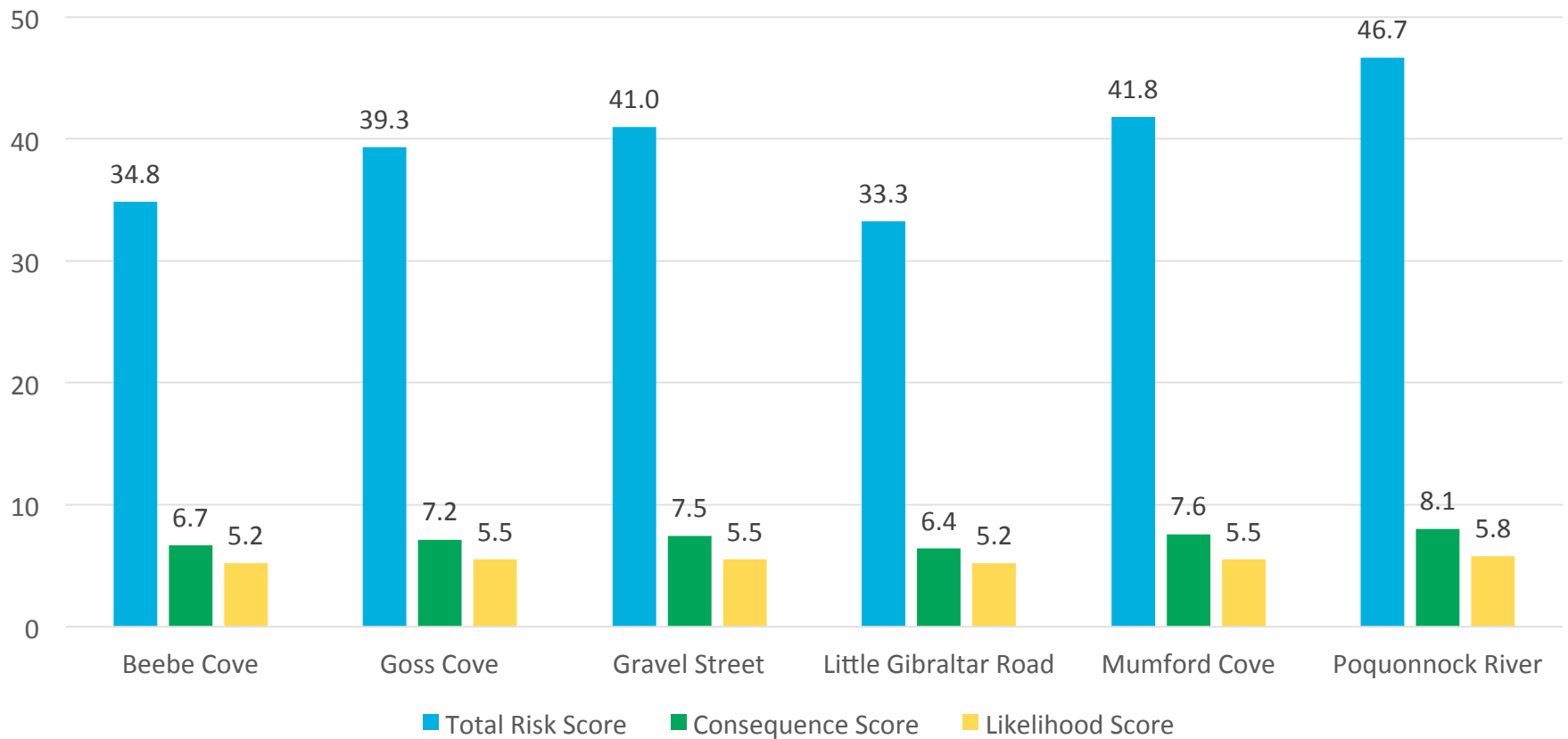
RISK ASSESMENT

Facility	CONSEQUENCES					LIKELIHOOD					TOTALS		
	Safety of Public and Employees	System Restoration	Regulatory Compliance	Expense	Public Confidence and Perception	Physical Condition	Performance	Reliability	O&M Protocols	Redundancy	Consequence Score	Likelihood Score	Total Risk Score
	30%	30%	20%	5%	15%	40%	15%	20%	20%	5%			
Beebe Cove	4	7	10	7	7	5	5	7	5	1	6.7	5.2	34.8
Goss Cove	4	10	7	10	7	5	3	10	5	1	7.2	5.5	39.3
Gravel Street	4	10	7	7	10	5	3	10	5	1	7.5	5.5	41.0
Little Gibraltar Rd	4	7	10	10	4	5	1	10	5	1	6.4	5.2	33.3
Mumford Cove	4	10	7	10	10	5	3	10	5	1	7.6	5.5	41.8
Poquonnock River	4	10	10	7	10	5	7	7	5	7	8.1	5.8	46.7

Overview of Risk Scoring

RISK ASSESMENT

CONSEQUENCE, LIKELIHOOD, AND TOTAL RISK SCORE
By Pump Station

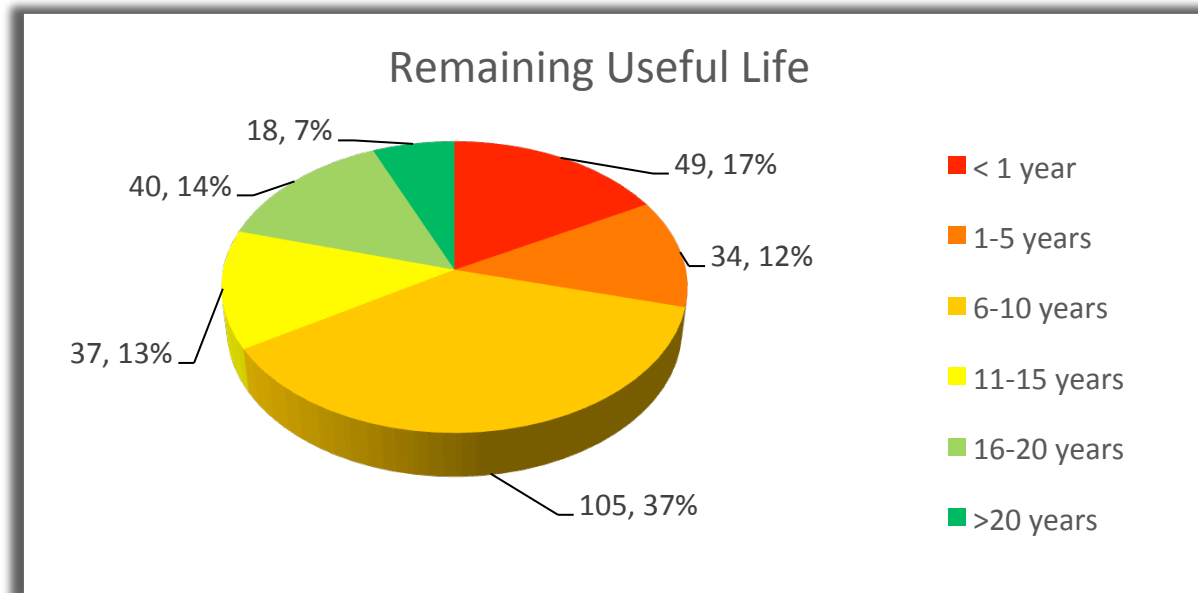


Remaining Useful Life

Remaining Useful Life

- Remaining useful life was calculated for each asset based on the assets condition score and the typical useful life of the asset type
- Based on the condition score, a percentage was applied to the typical useful life of the asset

Condition Grade	Percent of Remaining Useful Life
1 – Very Good	100%
2 – Good	80%
3 – Fair	50%
4 – Poor	25%
5 – Very Poor	0%



Remaining Useful Life Matrix

<10 YEARS

Pump Station	<1 Year	1-5 Years	6-10 Years
Beebe Cove	Safety, MCC, Isolation Gate Valve	Control System, Liquid Rheostat VSDs #1 and #4 and associated Pump Motors, Comminutor #2, HVAC	Comminutor #1, VFDs #2 and #3 and associated Pump Motors, Electrical Panels, Suction and Discharge Gate Valves, Sluice Gate
Goss Cove	Safety, MCC, Liquid Rheostat VSDs and Pump Motors, Isolation Gate Valve	Control System, HVAC	Sewage Pump #1 and #3, Comminutor #1 and #2, Electrical Panels, Suction and Discharge Gate Valves, Sluice Gate
Gravel Street	Safety, MCC, Liquid Rheostat VSDs and Pump Motors, Generator, Isolation Gate Valve	Control System, HVAC, Suction and Discharge Gate Valves	All Sewage Pumps, Comminutor #1 and #2, Electrical Panels, Discharge Gate Valves, Sluice Gate, Structural Improvements
Little Gibraltar	Safety, MCC, Liquid Rheostat VSDs and #2 and #3 and associated Pump Motors, Isolation Gate Valve	Control System, Liquid Rheostat VSD #1 and associated Pump Motor, Comminutor #1, HVAC	All Sewage Pumps, Comminutor #2, Electrical Panels, Sluice Gate, Structural Improvements
Mumford Cove	Safety, MCC, Liquid Rheostat VSD #1, #2 and #4 and associated Pump Motors	Control System, Liquid Rheostat VSD #3 and associated Pump Motor, HVAC, Isolation Gate Valve	All Sewage Pumps, Comminutor #1 and #2, Electrical Panels, Sluice Gate
Poquonnock River	Safety, Liquid Rheostat VSDs and associated Pump Motors, Flow Measurement, Isolation Gate Valve	Control System, HVAC	MCC, VFDs #2 and #4 and associated Pump Motors, Sewage Pump #1, Comminutor #1 and #2, Electrical Panels, Suction and Discharge Gate Valves, Sluice Gate

Remaining Useful Life Matrix

>10 YEARS

Pump Station	11-15 Years	16-20 Years	>20 Years
Beebe Cove	Check Valves	All Sewage Pumps, Seal Water Pumps	Flow Measurement, Generator, Structural Improvements
Goss Cove	Structural Improvements, Check valves	Sewage Pump #2, Seal Water and Plant Water Pumps, Fuel Tank	Flow Measurement, Generator
Gravel Street	Flow Measurement, Check Valves	Seal Water and Plant Water Pumps, Fuel Tank	
Little Gibraltar	Flow Measurement, Suction and Discharge Gate Valves, Check Valves	Seal Water and Plant Water Pumps, Fuel Tank	Generator
Mumford Cove	Flow Measurement, Suction and Discharge Gate Valves	Check Valves, Seal Water and Plant Water Pumps, Fuel Tank	Generator, Structural Improvements
Poquonnock River	Check Valves	Sewage Pump #2, #3 and #4, Seal Water and Plant Water Pumps	Generator, Structural Improvements

Summary

- All six pump stations are in similar (fair) condition
- MCC and VSD asset types are in very poor condition
- The Poquonnock River Pump Station has the highest risk score but is still moderate
- 17% of assets (49 total) have a remaining useful life of less than 1 year
- Two critical structural issues were identified
- Lack of standardization of equipment manufacturers

Next Steps

- Currently addressing safety issues
- Developing capital plans for other recommendations
- Continue with evaluation of remaining smaller pump stations.
- Intended as a baseline; to be updated as pump stations are upgraded and equipment is repaired/replaced.

Thank You

Co- Authors

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Jacob Peck, Management Consultant, CH2M



Backup Slides

Consequence of Failure Matrix

RISK ASSESMENT

Level of Service	Wt.	Negligible =1	Low = 4	Moderate =7	Severe = 10
Safety of Public and Employees	30%	No injuries or adverse health effects	No lost-time injuries or medical attention required	Lost-time injury or medical attention required	Loss of life or widespread outbreak of illness
System Restoration	30%	No system interruption	Minor impact	Major Impact	Catastrophic impact to meet demand
Regulatory Compliance	20%	No State permit violations	Possible technical violations	Probable enforcement action	Permit or license suspension or State control of system
Public Confidence and Perception	15%	No social or economic impact on community	Minor disruption. No adverse media coverage. Some complaints	Substantial but short term disruption. Adverse media coverage due to public impact	Long-term impact. Area-wide disruption. Regional media coverage
Expense	5%	Can be repaired within repair budget vis purchase order (< \$500)	NA	Can be repaired between \$500 to \$15,000 (requires obtaining 3 quotes)	Greater than \$15,000 (formal bid or emergency purchase)
TOTAL	100%				

Likelihood of Failure Matrix

RISK ASSESMENT

Likelihood Category	Wt.	Negligible =1	Unlikely = 3	Possible =5	Likely = 7	Very Likely = 10
Physical Condition	40%	Very good. Condition grade 1. New or nearly new. Only normal maintenance required.	Good. Condition grade 2. Minor wear.	Fair. Condition grade 3. Major wear impacting level of service.	Poor. Condition grade 4. Unable to meet level of service life. Failure imminent.	Very poor. Grade 5. Requires complete rehabilitation or replacement. Failed.
Reliability	20%	Majority of equipment is new or like new; easy to maintain equipment and obtain spare parts	Some equipment is old (newer versions available) but still able to maintain and obtain spare parts	NA	Difficult to obtain spare parts for some equipment due to age/obsolescence	Majority of equipment is either difficult to maintain or unable to obtain spare parts due to age/obsolescence
O&M Protocols	20%	Complete, up-to-date, written, easily accessible and is being used.	Complete, written, up-to-date, being used but not easily accessible	Partially developed	Written, but out-date and not used	No written protocols
Performance	15%	Sufficient capacity to meet assigned performance and peak flow requirements.	Under-utilized or oversized, causing O&M issues	Sufficient capacity, but does not meet functional requirements/over-utilized, or susceptible to operational issues	Able to meet assigned performance, but not peak demands	Unable to meet assigned performance
Redundancy	5%	Total redundancy under all operating conditions including peak capacity	Total redundancy under all current normal operating condition	Redundancy capable of keeping up without overflowing surge tank capacity	Redundancy capable of maintaining operation for up to 12 hours	No redundancy or insufficient redundancy to maintain normal flow for 12 hours
TOTAL	100%					