Implementation Plan for AECOM Recommendations Q3 2019

Prepared in accordance with Ordinance 18628

November 2019

King County

Department of Natural Resources and Parks
Wastewater Treatment Division

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Attachment:
Attachment A – AECOM Recommended Responses

Executive Summary

Fifty-six of the West Point Independent Assessment Report's proposed 98 recommendations (prepared by AECOM) have been completed and 22 are in progress. The remaining 20 recommendations will not be implemented because they are either addressed through the implementation of other recommendations or not feasible.

Progress on implementing the AECOM recommendations in the third quarter of 2019 (Q3) includes submitting a letter to the Washington Department of Ecology (Ecology) to request its formal approval of the raw sewage pump replacement project's objectives and schedule, and preparing a report for submittal to Ecology for the passive bypass weir project. The Wastewater Treatment Division (WTD) of the Department of Natural Resources and Parks will submit a request for the passive bypass weir project to Ecology early in quarter four of 2019 (Q4).

In summer 2019, the King County Auditor's Office submitted its report on the WTD's response to the AECOM recommendations to the King County Council. WTD concurs with the findings in the Auditor's report[1] and is committed to implementing the AECOM recommendations and the related recommendations from the Auditor's oversight report on WTD's response to the initial AECOM report.

Background

On February 9, 2017, a severe flood occurred at the West Point Treatment Plant (West Point). The flooding inundated electrical and mechanical equipment resulting in emergency bypasses of sewage through the emergency outfall and discharge of partially treated sewage through the offshore outfall.

At the direction of the King County Council, the West Point Independent Assessment Report, dated July 18, 2017, was prepared by AECOM following the flood event. The report proposed 98 recommendations to minimize the likelihood of future flooding and performance issues at the plant. Ordinance 18628 requires an Implementation Plan for the AECOM Recommendations that specifically addresses each of the 98 recommendations.

On November 15, 2017, the Washington State Department of Ecology (Ecology) issued an Amended Administrative Order #15480, which required WTD to complete six corrective actions related to the flooding event. In addition, Ordinance 18628 requires an Implementation Plan that addresses each of these required corrective actions. As of February 2019, all six corrective actions were completed.

[1] https://www.kingcounty.gov/~/media/depts/auditor/new-web-docs/2019/west-point-cpo-2019/west-point-2019.ashx?la=en

Implementation Plan for AECOM Recommendations
Ordinance 18628

The primary themes of AECOM's recommendations fall into four categories:

1. Implementation of a Life Safety Management system.

2. Development, implementation and continuous improvement of more comprehensive emergency/wet weather training.

3. Assessment of strategies to address plant constraints and improve redundancy.

4. Evaluation and prioritization of potential capital improvement projects to increase redundancy and minimize the risk of flooding.

Table 1 breaks down the recommended strategies and summarizes their current accomplishment status. The full list of 98 recommendations can be found in Attachment A.

Table 1 – Recommended Strategies by Category

Category	Total # of Recommendations	Adopted		Not Incorporated*
		In Progress	Completed	
Plant Hydraulics	6	5	1	0
Influent Control Structure	8	1	6	1
Preliminary Treatment	2	0	1	1
Raw Sewage Pump Station	8	3	4	1
Preaeration and Sedimentation Tanks	7	2	1	4
Flow Diversion Structure	3	0	3	0
Effluent Pump Station	11	2	5	4
Electrical	9	1	6	2
Instrumentation and Control	12	5	2	5
Staffing	2	1	1	0
Operators	13	1	11*	1
Training	5	0	5	0
Equipment and System Testing	9	1	7	1
Maintenance Procedures	3	0	3	0
Totals	**98**	**22**	**56**	**20**

Attachment A includes an explanation for each recommendation that was not incorporated.

*In the Q2 2019 report, this table showed 12 completed and zero in progress in this category. This was an accounting oversight and these numbers reflect current circumstances.

Changes in Q3 2019 Report

Progress in Q3 includes WTD's submission of a letter to Ecology requesting its formal approval of the raw sewage pump replacement project's objectives and schedule. Also during Q3, WTD prepared a report for submittal to Ecology for a passive bypass weir project. The request for the passive bypass weir project will be submitted to Ecology early in Q4.

Appropriation for West Point's Life Safety Improvement program was approved via a recent supplemental budget request and will be chartered later this year. This program will evaluate the remaining life safety recommendations and will implement the life safety improvements identified in Attachment A.

King County Auditor's Report

In summer 2019, the King County Auditor's Office submitted its report on WTD's response to the AECOM recommendations. The Auditor's Office provided the four recommendations listed below.

1. The Wastewater Treatment Division should gain conceptual approval from the state Department of Ecology no later than January 2020 for its passive weir and raw sewage pump capital investments to alleviate the risk of future flooding events at West Point.

WTD's Response – WTD is working with Ecology and is on track to receive conceptual approval of the passive weir and raw sewage pump projects by January 2020. Once WTD receives conceptual approval for the projects, it will continue working with Ecology during the design phase. In August 2019, WTD applied for a Hazard Mitigation Assistance Grant through the Federal Emergency Management Agency for the passive weir project. The estimated cost for the passive weir project is $6.9M and WTD anticipates completion of this project by 2023. The project to replace the raw sewage pumps at West Point is also funded in WTD's six-year capital improvement program and is currently estimated at $177M.

2. The Wastewater Treatment Division should adopt formal mechanisms to track its life safety management activities, until the planned enterprise asset management system (EAMS) is fully implemented.

WTD's Response – Life safety management is a culture of safety and accountability through systematic evaluation of plant function, performance, and safety. The Enterprise Asset Management System (EAMS) will integrate both life safety management activities, such as hazard and risk assessments, with WTD's other planned and current maintenance workload/asset management activities. A capital project is underway to implement EAMS with completion anticipated by March 31, 2023. Implementation of this system requires working with King County Information Technology, which is looking to launch this effort as an enterprise-wide system. There is a high level of complexity involved in integrating WTD's asset management data from

the past 50 years for $6 billion in assets into a new system.

Until EAMS is fully implemented, WTD is temporarily tracking life safety management activities through an electronic routing and approval system for asset management work using a SharePoint site accessible to employees and management. This protocol utilizes an electronic submission form, alerting plant management when committee review is needed. The SharePoint system provides for consolidation and centralization of asset management requests and responses until EAMS can be integrated into work order planning and scheduling of routine asset management.

3. As part of its comprehensive planning process, the Wastewater Treatment Division should reevaluate its combined sewer overflow program to determine whether there are opportunities to manage or reduce flows to the West Point Treatment Plant within the broader collection system and to document the results of its evaluation.

WTD's Response – WTD continuously seeks to improve operations to manage flows to West Point, particularly higher flows that occur during severe storm events and can result in combined sewer overflows. An example of planned improvements is "in-line" storage where, if there is capacity, wastewater flows are stored in WTD's sewer lines during a heavy storm event and released once West Point has capacity to treat those flows. Additionally, the joint Ship Canal Water Quality Project with the City of Seattle, that is currently under construction and expected to be operational in 2026, will help with reducing higher flows going to West Point during wet weather.

WTD is also in the midst of its comprehensive planning process, and as part of that work will reevaluate the current combined sewer overflow program.

4. The Wastewater Treatment Division should develop, document, and implement a training plan that provides information on frequency of recurring training and includes provisions to continuously update trainings to reflect new systems and related procedures as they are implemented.

WTD's Response – By the end of 2020, WTD will have developed a training plan that clarifies and explains training requirements for different types of operations staff, as well as providing a schedule for trainings. WTD has plans in place for safety training at all of its facilities, and will be making this information into a single, accessible location for employees working in operations at the County's wastewater treatment facilities. For example, WTD has Emergency Operations Training prior to each wet weather season for employees to review, discuss, and practice for significant rain events. This is one of the trainings that will be documented in the training plan.

As described above, WTD is committed to implementing AECOM's recommendations consistent with the Auditor's recommendations in its oversight report.

July 19 Event at West Point

Early in the morning of Friday, July 19, a Seattle City Light power voltage sag disrupted West Point operations. WTD's employees followed the protocols put in place based on AECOM's recommendations, which resulted in the bypass event that prevented flooding West Point. While power was restored within moments, the high volume of water in the system required an emergency bypass system to engage for 27 minutes.

Prior to the Seattle City Light power disruption, the plant was treating flow at a rate of 300 million gallons per day (mgd) due to a substantial rainstorm. The power bump occurred at 1:07 a.m., the bypass started at 1:38 a.m., and concluded at 2:05 a.m. About 2.1 million gallons of mostly stormwater, mixed with wastewater, entered Puget Sound through the plant's emergency outfall pipe.

While the power disruption, which lasted for ¾ of a second, caused a discharge, steps taken by WTD following the 2017 discharge event helped to significantly lessen the impact of the July 2019 discharge event. High-level floats worked to automatically close both the Primary Effluent gates and the Influent Control Structure gates to protect the plant from flooding. By 2:05 a.m., the Emergency Bypass gate was fully closed, ending the bypass event and the plant resumed normal operations. Following this event, King County and Seattle City Light have engaged a consultant to further study each agency's systems to improve power quality, power reliability, and equipment resiliency in order to withstand short duration power issues.

Conclusion and Next Steps

WTD is committed to implementing AECOM's recommendations and the recommendations in the related Auditor's oversight report. Timelines for completion of each recommendation are identified in Attachment A. Progress towards completion of projects will take longer as smaller, easy to implement projects are completed and resources are directed toward planning and implementing longer-term capital projects. The remaining recommendations are either part of an ongoing improvement effort, part of West Point's Life Safety Management Program, or are long-term capital projects.

The following descriptions apply to the status assigned to the recommendations:

Status	Description
Complete	The recommendations have been implemented in full and there is no further action required.
In Progress	Implementation of the recommendations has begun but, due to complexity, resource availability, and/or budget constraints, the work is not yet completed.
Ongoing	Implementation of the recommendations has been completed and they are now systematically and/or programmatically subject to periodic review, updating, and/or continuous improvement.
Under Evaluation	Evaluation has begun to determine the feasibility of recommendations and their resource, prioritization, budgetary and scheduling constraints.
Implementing Alternative	Recommendations that were replaced with more effective, alternative solutions that meet the intent of the original recommendations.
Not Incorporated	After evaluation and consideration, the recommendations will not be implemented because they do not mitigate operation risks.

#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
1	Table 10 Plant Hydraulics	Evaluate ways to improve control strategies and flow management within the collection system.	Help delay peak flows to West Point.	Under evaluation	2020 Initial Evaluation	WTD regularly considers collection system (pipeline) storage and control strategies when determining how to best manage flows. Storage is typically considered as an option when addressing collection system capacity constraints and is one of the control strategies to be evaluated in the Combined Sewer Overflow (CSO) planning work.
2	Table 10 Plant Hydraulics	Evaluate the collection system to identify new areas for storage.	For example, the Old Fort Lawton Tunnel.	Under evaluation	2020 Initial Evaluation	WTD regularly considers collection system (pipeline) storage and control strategies when determining how to best manage flows. Storage is typically considered as an option when addressing collection system capacity constraints and is one of the control strategies to be evaluated in the CSO planning work.
3	Table 10 Plant Hydraulics	Add primary treatment technologies to the collection system.	Relieve West Point during high flows.	Under evaluation	2020 Initial Evaluation	Adding treatment to the collection system has been and will continue to be considered as part of WTD's future long-term planning efforts. For example, the Georgetown Wet Weather Station that is currently under construction will add primary treatment technology to the collection system. Where appropriate, projects with primary treatment technologies, will be submitted and considered as part of WTD's Six-Year Capital Improvement Plan.

= ‘Under evaluation’ = Almost done - ‘in progress’ = Done - includes ‘complete’, ‘not incorporated’, ‘implementing alternative’ ‘ongoing’

#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
4	Table 10 Plant Hydraulics	Consider implementing passive overflows at key locations.	Passive overflows that do not rely on equipment and controls provide the most failsafe mechanism to protect the plant and workforce.	Under evaluation	2019/2020 Discussion of Options with Regulators	Current state and federal regulations, as well as WTD's 2013 Combined Sewer Overflow federal consent decree with the Washington Department of Ecology and EPA, require WTD to control its overflows to a required standard. During discussions with our regulators in 2019/2020 on West Point's National Pollution Discharge Elimination System permit, WTD will explore options with regulators.
5	Table 10 Plant Hydraulics	Request that West Point Treatment Plant (West Point) be regulated as a combined sewer overflow outfall.	Currently able to discharge to outfalls at other locations. This would require coordination with Department of Ecology.	Under evaluation	Evaluating as part of WTD system-wide planning	Current state and federal regulations, as well as WTD's 2013 CSO federal consent decree with the Washington Department of Ecology and EPA, require WTD to control its overflows to a required standard. During discussions with our regulators in 2019/2020 on West Point's National Pollution Discharge Elimination System permit, WTD will explore with options with regulators.
6	Table 10 Plant Hydraulics	Evaluate maximizing flow through the overflow weir by allowing head to build in the Influent Control Structure.	There is some freeboard above the weir, but flow is limited because of the elevation of the high-high level alarm, triggering the Emergency Bypass gate to open. Increasing the water level in the Influent Control Structure can negatively influence downstream (bar screens) and upstream (Ballard weir) systems.	Complete	Capital project started in 2019	WTD completed a project that evaluated the viability and options to construct a passive weir. A project began implementation as part of WTD's Six-Year Capital Improvement Plan. This project will need Ecology approval prior to implementation.
7	Table 11 Influent Control Structure	Evaluate adding a passive bypass weir.	Possibility of using the 84-inch Old Fort Lawton Tunnel to back flow to the Marine Outfall Gate at the Flow Diversion Structure. Utilize upstream storage, if any.	Complete	Capital project started in 2019	WTD completed a project that evaluated the viability and options to construct a passive weir. A project began implementation as part of WTD's Six-Year Capital Improvement Plan. This project will need Ecology approval prior to implementation.
8	Table 11 Influent Control Structure	Avoid overriding controls of the Emergency Bypass gate to keep the gate manually closed.	None.	Complete	Implemented and ongoing	Standard operating procedures have been revised to ensure controls on the Emergency Bypass gate are not overridden except during maintenance.
9	Table 11 Influent Control Structure	Add automated Emergency Bypass gate control at the Influent Control Structure.	Consider adding a second solenoid alarm for redundancy and switching from hardwired interlock controls to control from the Ovation system.	Complete	Implemented	Equipment has been installed to allow for an emergency open of both the Emergency bypass and Emergency Marine Outflow gates.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
10	Table 11 Influent Control Structure	Add ability to remotely operate Emergency Bypass gate from Main Control.	Provides rapid response without putting operators in harm's way	Complete	Implemented	Operations staff now have the ability to open the Emergency Bypass gate remotely from the main control room.
11	Table 11 Influent Control Structure	Add ability to control influent gates from Main Control.	Clogged bar screens could cause water to back up in the Influent Control Structure and trigger the Emergency Bypass gate to open but would not close the influent gates.	Complete	Implemented	Operations staff now have the ability to control influent gates from Main Control.
12	Table 11 Influent Control Structure	Add control system programming that closes influent gates automatically when the Emergency Bypass gate is opened.	Clogged bar screens could cause water to back up in the Influent Control Structure and trigger the Emergency Bypass gate to open but would not close the influent gates.	In progress	Implementation 2019	As part of the implementation of West Point's life safety system the influent gates will automatically close as the Emergency Bypass gate opens.
13	Table 11 Influent Control Structure	Install flow meters on influent lines.		Not incorporated	N/A	WTD considered whether a flow meter would provide additional information to reduce operational risk and determined it would not reduce risk or improve overall plant control. West Point has a small footprint and relies on lift stations to pump wastewater through the treatment process. This means that West Point relies on level not flow for overall plant control.
14	Table 11 Influent Control Structure	Add real-time collection system controls.	Incorporate historical collection system and watershed data into control strategies.	Complete	Ongoing	WTD considered this recommendation and confirmed that our offsite control system already incorporates real-time control of the collection system. As new collection system facilities come online, WTD will update our real-time control strategies.
15	Table 12 Preliminary Treatment	Continuously rake bar screen area during wet-weather events.	This is opposed to using a differential-level trigger. WTD has made this change.	Complete	Implemented and ongoing	West Point has updated its bar screen standard operating procedures to incorporate this recommendation.
16	Table 12 Preliminary Treatment	Raise the channel height at the bar screen area.	Provides surge protection and increased head in the Influent Control Structure for flow over the passive bypass weir.	Implementing alternative	Capital project started in 2019	WTD completed a project that evaluated the viability and options to construct a passive weir. The evaluation determined an upstream passive weir (see #6 & #7 above) would best prevent flooding without the need to raise the channel height.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
17	Table 13 Raw Sewage Pump Station	Evaluate options to provide 440 mgd firm pumping capacity at raw sewage pumps.	Options and study items could include: 1. Adding a new pump. 2. Replacing existing pumps with new/larger capacity pumps. 3. Increasing the speed of the existing pumps. 4. Changing impellers to provide more flow. This may require a larger engine and modifications to the right-angle gearbox. 5. Controlling and limiting collection system flow to the plant at 330 mgd. 6. Considering providing more on-site and/or off-site CSO storage volume.	Complete	Capital project started in 2019	WTD evaluated all recommendations related to the raw sewage pumps as one single evaluation, including options to increase the capacity of the raw sewage pumps. Changes to the collection system will be evaluated as part of the CSO planning work. A Raw Sewage Pump Improvement project began implementation as part of WTD's Six-Year Capital Improvement Plan.
18	Table 13 Raw Sewage Pump Station	Develop a detailed plan to operate at 330 mgd in preparation for losing a pump.	Not enough firm capacity at raw sewage pumps.	Complete	Implemented and ongoing	West Point Operations is implementing this recommendation as part of a larger Operator training improvement effort. That larger effort includes creating new, and modifying existing, training modules and standard operating procedures.
19	Table 13 Raw Sewage Pump Station	Install flow meters on influent lines.	Provides instantaneous influent flow for faster reaction times during high-flow events (compared to calculating influent flows from the effluent discharge).	Not incorporated	N/A	WTD considered whether a flow meter would provide additional information to reduce operational risk and determined it would not reduce risk or improve overall plant control. West Point has a small footprint and relies on lift stations to pump wastewater through the treatment process. This means that West Point relies on level not flow for overall plant control.
20	Table 13 Raw Sewage Pump Station	Evaluate incorporating automatic controls through a supervisory control and data acquisition (SCADA) system.	Automatically stop pumps based on critical plant high-high water level set points to help prevent flooding.	In progress	Implementation 2019	As part of the implementation of West Point's life safety system the control system will be modified to reduce plant flow when levels are higher than normally allowed.
21	Table 13 Raw Sewage Pump Station	Provide additional staff training on operating raw sewage pumps.	During peak-flow events and various failure events, more training is needed.	Complete	Implemented and ongoing	West Point Operations is implementing this recommendation as part of a larger Operator training improvement effort. That larger effort includes creating new, and modifying existing, training modules and standard operating procedures as well as implementing an Operator Training Simulator. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
022	Table 13 Raw Sewage Pump Station	Update safety procedures on operating the raw sewage pumps during peak-flow conditions.	Not enough firm capacity at raw sewage pumps.	Complete	Implemented and ongoing	See the response to #21 above.
23	Table 13 Raw Sewage Pump Station	Replace raw sewage pump engines with electric motors. Evaluate current condition of raw sewage pumps and determine expected life span. Provide backup systems to increase redundancy. Evaluate current condition and determine expected life span of the raw sewage pump station [piping system].	Electric motors are more reliable and less expensive to maintain (high initial cost). Plan/budget for equipment maintenance, updates, and replacements. Redundancy reduces opportunity for failure. Estimate pressure capacity, and incorporate corrosion inspections and durability to withstand earthquakes.	In progress	Capital project started in 2019	WTD evaluated all recommendations related to the raw sewage pumps as one single evaluation, including options to increase the capacity and/or add redundancy to the raw sewage pumps. A Raw Sewage Pump Improvement project began implementation as part of WTD's Six-Year Capital Improvement Plan. In addition, WTD's current asset management practices regularly assess, track and report the condition and the end-of-life date for all West Point equipment including the raw sewage pumps.
24	Table 13 Raw Sewage Pump Station	Modify control strategy to include secondary instruments.	Redundancy reduces opportunities for failure. Automatically stop pumps based on critical plant high-high water level set points to help prevent flooding.	In progress	Implementation 2019	As part of the implementation of West Point's life safety system, the control strategy will be modified to include secondary instruments.
25	Table 14 Preaeration and Sedimentation Tanks	Replace level switches with modern tethered switches that do not require a stilling well and are less likely to fail.	WTD has already done this.	Complete	Implemented	Tethered switches were installed during the restoration work at West Point immediately following the February 9 flooding event. These floats have demonstrated greater reliability in industrial settings and can be tested without possibility of damage.
26	Table 14 Preaeration and Sedimentation Tanks	Modify control strategy to include secondary instruments.	Redundancy reduces opportunities for failure.	In progress	Implementation 2019	As part of the implementation of West Point's life safety system, the control strategy will be modified to include secondary instruments.
27	Table 14 Preaeration and Sedimentation Tanks	Incorporate automatic controls through a supervisory control and data acquisition (SCADA) system.	Multilayered control system is not limited to a single interlock control.	In progress	Implementation 2019	As part of the implementation of West Point's life safety system, automatic controls will be incorporated.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
28	Table 14 Preaeration and Sedimentation Tanks	Evaluate feasibility of a passive bypass.	Effluent can be diverted to the Emergency Bypass Outfall within the Flow Diversion Structure.	Implementing alternative	Capital project started in 2019	This recommendation would provide roughly 30 million gallons of diversion, which would not provide significant relief. Diversion opportunities are being considered at head works as part of the passive weir project and through the development of West Point's life safety system.
29	Table 14 Preaeration and Sedimentation Tanks	Evaluate feasibility of connecting east and west primary effluent channels.	If one gate fails, near-full utilization of both primary sedimentation basins can continue.	Not incorporated	N/A	Connecting the primary effluent channels would allow primary effluent to flow over one or both gates. The failure of a gate would still result in a capacity reduction and loss of redundancy regardless of which gate failed. Alternatively, construction of a common channel is considered impractical given the existing plant design and site limitations.
30	Table 14 Preaeration and Sedimentation Tanks	Evaluate feasibility of a passive bypass.	Primary Effluent can be diverted to the Emergency Bypass Outfall and 3x3 vent within the Flow Diversion Structure.	Implementing alternative	Capital project started in 2019	This recommendation would provide roughly 30 million gallons of diversion, which would not provide significant relief. Diversion opportunities are being considered at head works as part of the passive weir project and through the development of West Point's life safety system.
31	Table 14 Preaeration and Sedimentation Tanks	Reevaluate control strategy.	The control strategy can be based primarily on influent flow measurement, not a series of cascading system levels.	Not incorporated	N/A	WTD considered whether a flow meter would provide additional information to reduce operational risk and determined it would not reduce risk or improve overall plant control. West Point has a small footprint and relies on lift stations to pump wastewater through the treatment process. This means that West Point relies on level not flow for overall plant control.
32	Table 15 Flow Diversion Structure	Evaluate feasibility of a passive bypass.	Options include creating a bypass from the Old Fort Lawton Tunnel or directing primary effluent to the Emergency Bypass Outfall pipe.	Complete	Capital project started in 2019	WTD completed a project that evaluated the viability and options to construct a passive weir. A project began implementation as part of WTD's Six-Year Capital Improvement Plan.
33	Table 15 Flow Diversion Structure	Add automated Emergency Marine Outfall gate control at Flow Diversion Structure.	Previous practice was to manually override controls at low flow (<250 MGD). The Emergency Bypass gate is now always valved in.	Complete	Implemented and ongoing	Standard operating procedures have been revised to ensure controls on the Emergency Bypass (aka CSO Flow Diversion Gate) and the Emergency Marine Outfall. These gates cannot be overridden except during maintenance.

= ‘Under evaluation’

= Almost done - ‘in progress’

= Done - includes ‘complete’, ‘not incorporated’, ‘implementing alternative’ ‘ongoing’

#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
34	Table 15 Flow Diversion Structure	Add ability to remotely operate Emergency Marine Outfall gate at the Flow Diversion Structure from Main Control.	Provides rapid response without putting operators in harm's way.	Complete	Complete	As part of the implementation of West Point's life safety system a manual push button was installed in Main Control to allow remote, emergency opening of the Emergency Bypass and Emergency Marine Outfall gates.
35	Table 16 Effluent Pump Station	Provide a spare hydraulic unit that can operate with any pump control valve.	Redundancy reduces opportunity for failure.	Complete	Implemented	One spare hydraulic power unit was added to one series of effluent pump station pumps. A capital project installed a hydraulic power unit on the other series. This recommendation also addresses corrective action #1 required by Department of Ecology's Administrative Order.
36	Table 16 Effluent Pump Station	Provide redundant electrical power supply to all hydraulic power units.	Redundancy reduces opportunity for failure.	Complete	Implemented	Automatic transfer switches, to provide redundant power, were installed in mid-2017. This recommendation also addresses corrective action #1 required by Department of Ecology's Administrative Order.
37	Table 16 Effluent Pump Station	Add pressure relief valves at pump discharge lines.	Prevents pump from operating at zero flow/shut-off head conditions if control valve is closed while pump is operating. Discharge flow from pressure relief valves to gravity or pump discharge pipeline.	Implemented alternative	Complete	This recommendation is not being implemented because it does not address the root cause of the Effluent Pump Station failure nor improve reliability. As an alternative, West Point installed additional hydraulic power units to each Effluent Pump Station pump series.
38	Table 16 Effluent Pump Station	Provide portable ladder platform and hand wheel to manually operate the butterfly control valve.		Implemented alternative	Complete	This recommendation is not being implemented because a hand wheel would take 30-60 minutes to adjust the valves that need to be opened and closed in seconds for successful operation. As an alternative, a secondary hydraulic power unit on a separate electrical power source was installed to address the root cause of failure that resulted in this recommendation.
39	Table 16 Effluent Pump Station	Routinely examine data from vibration monitors to determine trends to help forecast pump maintenance and repairs.	None.	In progress	Substantial Completion 1st Qtr. 2020	WTD procured a vibration monitoring vendor, purchased a mobile vibration monitoring system, trained maintenance staff on how to use the system, and implemented a vibration monitoring program. An existing capital project is replacing vibration monitors and variable

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						frequency drives for all Effluent Pump Station pumps.
40	Table 16 Effluent Pump Station	Update vibration monitors.	None.	In progress	Substantial Completion 1st Qtr. 2020	An existing capital project is replacing vibration monitors and variable frequency drives for all Effluent Pump Station pumps.
41	Table 16 Effluent Pump Station	Evaluate the current condition of the Effluent Pumping System and determine its expected life span.	Plan/budget for spare parts and equipment maintenance, updates, and replacements.	Complete	Implemented and ongoing	WTD's current asset management practices accomplish this function by assessing, tracking and reporting condition and the end-of-life date for all West Point effluent pumping system equipment.
42	Table 16 Effluent Pump Station	Provide backup systems to increase redundancy.	Redundancy reduces opportunity for failure.	Complete	Implemented and ongoing	Redundancy is being added to critical Effluent Pump Station systems. Staff regularly evaluate current maintenance best practices and will adjust as needed to reduce the risk of equipment and system failures.
43	Table 16 Effluent Pump Station	Provide good maintenance, closely monitor systems, and stock critical spare parts.		Complete	Implemented and ongoing	WTD's current asset management practices require maintenance tracking and system monitoring. WTD's asset management and maintenance best practices accurately predict the critical parts, which WTD keeps in stock for the effluent pump station.
44	Table 16 Effluent Pump Station	Use a differential pressure sensor across the pump to estimate flow rate.	An algorithm would be developed that considers pump head/flow curve, pump speed, and pump differential pressure reading. The algorithm can be calibrated using information from the existing effluent flow meter.	Not incorporated	N/A	WTD considered whether developing and calibrating an algorithm would reduce risk or improve overall plant control. We determined this would not provide any additional information beyond what we already receive from the effluent flow meter and would not reduce operational risks.
45	Table 16 Effluent Pump Station	Provide controls that allow the Effluent Pump Station to operate at constant speed.	As a backup, provide controls that allow the pump to operate at constant speed while using the control valve to throttle discharge flow and maintain the wet-well water level set points. This would require adding single-speed starters.	Not incorporated	N/A	This recommendation is not being implemented as it is intended to allow the pumps to operate if the variable frequency drives fail, but does not address the root cause of the failure or improve reliability. West Point has existing equipment redundancy to maintain treatment at full capacity in the event of a variable frequency drive failure.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
46	Table 17 Electrical	Incorporate automatic transfer of switchgear main and tie breakers upon power loss.	Provides rapid response for substations that require faster response time than what personnel can provide.	Not incorporated	N/A	This recommendation is not being implemented because the plant's current, comprehensive procedure is required for safety reasons regardless of whether an automatic transfer system was in place. In addition, implementing this recommendation would be complicated, requiring additional structures at a site where space is limited.
47	Table 17 Electrical	Staff at least two electricians during high-flow events.	Two electricians are required for life-safety reasons.	Complete	Implemented and ongoing	WTD now requires instrumentation technicians, electricians, and mechanics on standby during weekday evenings and weekends to ensure sufficient coverage during high-flow events.
48	Table 17 Electrical	Provide additional permanently connected hydraulic power unit on the B side.	Include provisions for either unit to power all discharge valves.	Complete	Implemented	One spare hydraulic power unit was added to one series of Effluent Pump Station pumps. A capital project installed a hydraulic power unit on the other series. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
49	Table 17 Electrical	Power Effluent Pump Station discharge valve controls from individual variable-frequency drives.	This is rather than powering from the hydraulic power units.	Implemented alternative	Complete	As an alternative to this recommendation, WTD improved reliability at the Effluent Pump Station by installing permanent hydraulic power units for each of the two sets of pumps, valves and variable frequency drives.
50	Table 17 Electrical	Analyze single points of failure for all components.	For example, a breaker that would feed control power to all Effluent Pump Station pump controllers or both primary and backup Ovation system controllers.	Complete	Implemented	During a recent interview, AECOM clarified this recommendation relates to the Ovation control system. AECOM considers this item fully addressed.
51	Table 17 Electrical	Add surge suppressors.	Medium-voltage transient surge suppressors on both sides of the main 15 kV switchgear.	In progress	Capital project started in 2019	Lighting arrestors have been installed on both sides of the main 15 kV switchgear. A future capital project will replace the motor control centers (MCCs) which includes surge suppressors.
52	Table 17 Electrical	Install power line monitors with transient waveform capture feature on each substation’s main breaker.	A maintenance tool to help analyze power system health and forensic analysis of failures.	Complete	Capital project started in 2019	A project was submitted and approved as part of WTD's Six-Year Capital Improvement Plan.
53	Table 17 Electrical	Conduct the remainder of testing related to the main switchgear 722-MSG01 circuit breaker ground fault 52-3 trip.	As soon as a plant shutdown is feasible.	Complete	Implemented	WTD completed the testing and changed the ground trip settings based on new, more accurate, modeling information.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
54	Table 17 Electrical	Update standard operating procedure for Effluent Pump Station restart after ground fault.	Locally reset Effluent Pump Station vibration panels, variable-frequency drives, and pump local control panels upon a fault.	Complete	Implemented	West Point staff updated the standard operating procedures for the Effluent Pump Station.
55	Table 19 Instrumentation and Control	Add an “Interlock Active” indication light to the local control panels.	Alert the operators when the interlock is engaged (help with troubleshooting).	In progress	Implementation 2019	As part of the implementation of West Point’s life safety system, an “interlock active” indication light will be added to local control panels.
56	Table 19 Instrumentation and Control	Add a supervisory control and data acquisition (SCADA) system bypass switch to bypass the interlock.	This should be available only to the supervisors.	Not incorporated	N/A	The existing interlock is in place for safety reasons and it is unsafe to bypass at any time during regular plant operations. The risk and consequence of another potential flooding event is being reduced by implementing other recommendations.
57	Table 19 Instrumentation and Control	Prevent interlock from being activated during high-plant-flow scenarios.	High-flow events pose a life-safety risk.	Not incorporated	N/A	See the response to #56 above.
58	Table 19 Instrumentation and Control	Remove the requirement to use both the High and high-high switches to activate the interlock.	Only the high-high switch would be required.	In progress	Evaluate in 2019/2020 Implementation TBD	As part of the implementation of West Point’s life safety system staff will evaluate the use of high and high-high level conditions for control and adjust as needed to improve life safety.
59	Table 19 Instrumentation and Control	Add an Ovation-level high-high signal to the hardwired interlock.	The Ovation signal should be set to activate before the float switches.	In progress	Evaluate in 2019/2020 Implementation TBD	See the response to #58 above.
60	Table 19 Instrumentation and Control	Add remote start/stop pump controls to the Main Control room through the Ovation system.	Provides rapid response without putting operators in harm’s way.	Implementing alternative	Complete	The existing engines cannot be restarted remotely. Remote start will be considered as part of a future raw sewage pump replacement project. Remote stop capability has been implemented (see response to #61 below).
61	Table 19 Instrumentation and Control	Add a hard-wired emergency stop push button not controlled through Ovation.	Provides rapid response without putting operators in harm’s way.	Complete	Complete	A manual push button has been installed in Main Control to allow remote, emergency stop of all four raw sewage pumps.
62	Table 19 Instrumentation and Control	Add remote start/stop pump controls to the Main Control room through the Ovation system.	Operations must send operators to the raw-sewage wet-well area to locally open/close the gates, taking time and potentially placing operators in harm’s way.	Implementing alternative	Complete	See the response to #60 above.
63	Table 19 Instrumentation and Control	Remove the requirement to use both the High and high-high switches to activate the interlock.	Only the high-high switch would be required.	In progress	Evaluate in 2019/2020 Implementation TBD	This item is included in the West Point Life Safety Capital Improvement project

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						submitted as part of WTD's Six-Year Capital Improvement Plan.
64	Table 19 Instrumentation and Control	Add an Ovation-level high-high signal to the hardwired interlock.	The Ovation signal should be set to activate before the float switches.	In progress	Evaluate in 2019/2020 Implementation TBD	See the response to #58 above.
65	Table 19 Instrumentation and Control	Add remote open/close gate controls to the Main Control room through the Ovation system.	Make these controls highly visible to respond in emergencies.	Implementing alternative	Complete	As part of the implementation of West Point's life safety system a manual push button has been installed in Main Control to allow remote, emergency opening of the Emergency Bypass and Emergency Marine Outfall gates. Gates will not be allowed to close remotely. Operations staff is required to physically inspect equipment before gates are closed and equipment is restarted.
66	Table 19 Instrumentation and Control	Conduct an alarm management review workshop to properly prioritize alarms and remove or condition alarms.	The system is not optimized to prioritize alarms	Complete	Implemented and ongoing	An alarm management review workshop was held and an alarm management improvement process has been implemented Plant staff have reduced the number of nuisance alarms and will continue to review priorities and improve alarm procedures as part of ongoing operations and maintenance. This recommendation, in addition to #78 and #94, also address corrective action #2 required by Department of Ecology's Administrative Order.
67	Table 21 Staffing	Develop incentive programs to retain staff at West Point.	It is difficult to retain employees at West Point.	Ongoing	Ongoing	Attempts to negotiate incentive pay for new employees at West Point through the 925 bargaining process was unsuccessful in Fall 2017. WTD provided more detail on our ongoing staff retention efforts as part of this West Point Quarterly Report due to Council on February 15, 2018.
68	Table 21 Staffing	Extend aspects of the Operator-in-Training program to existing staff.	Currently the Operator-in-Training Program is only for new hires with no previous wastewater treatment plant experience.	Complete	Implemented and ongoing	WTD-reviewed and updated its standard operating procedures. Operations staff now have 1-on-1 training and more formal communications between crews. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.

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#	AECOM Table #	AECOM Recommendations	AECOM Comments	Status	Timeline	WTD Response
69	Table 22 Operators	Create an Emergency Bypass standard operating procedure.	If a standardized process is in place, the operators could operate the plant as it is designed.	Complete	Implemented and ongoing	WTD implemented standard operating procedures on use of the Emergency Bypass gate. These procedures will continue to be improved as part of a larger Operator training improvement effort. Also, see response to #21.
70	Table 22 Operators	Change the “no bypass” philosophy.	This is important to protect life safety and equipment and to reduce the amount of time the plant is in bypass mode.	Complete	Implemented and ongoing	WTD management has clearly communicated that the Emergency Bypass gate is a tool to be used as required. Operations has instituted new guidelines regarding the appropriate use of the Emergency Bypass gate. Operators are also being trained using desktop exercises and scenario-based discussions to train on emergency response procedures. In the near future, these exercises will be part of the new simulator training referred to in recommendation #92.
71	Table 22 Operators		Important to keep the environmental protection mission of the organization.	Complete	Implemented and ongoing	See response to #70 above.
72	Table 22 Operators	Add an Emergency Bypass override button at the Main Control room.	Currently this is embedded in the control strategy.	Complete	Implemented	Equipment has been installed in Main Control to allow remote, emergency opening of the Emergency Bypass and Emergency Marine Outfall gates.
73	Table 22 Operators	Provide hands-on Emergency Response Plan training.	None.	Complete	Implemented and ongoing	Emergency Response training sessions have been increased from one per year to two. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
74	Table 22 Operators	Run the hydraulic simulation model so operators know narrow time margins and potential consequences.	None.	Complete	Implemented and ongoing	A computer model (simulator) has been developed and deployed. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
75	Table 22 Operators	Implement a Life Safety Management system.	An aspect of this type of process is that it focuses on the process rather than the individual worker to avoid scapegoating and to effectively reduce risk.	Complete	Implemented and ongoing	A Life Safety Coordinator has been hired and an initial Life Safety Evaluation was completed. That evaluation, which will be continuously refined, provides a framework of recommendations that the West Point employees will implement and maintain.

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76	Table 22 Operators	Add an automated call program to contact on-call personnel.	None.	Implemented alternative	Implemented and ongoing	As an alternative, WTD implemented a two-way communication protocol that is required to confirm contact between personnel. A secondary operator is responsible for making calls while the lead operator manages control of the plant.
77	Table 22 Operators	Increase the number of staff on duty in Main Control during wet-weather events.	None.	Complete	Implemented and ongoing	When weather predictions indicate heavy rainfall, the minimum amount of emergency/wet weather staffing has been increased to comply with new high flow protocols and procedures.
78	Table 22 Operators	Conduct an alarm management review workshop to properly prioritize alarms and remove or condition alarms.	The system is not optimized to prioritize alarms.	Complete	Implemented and ongoing	An alarm management review workshop was held and an alarm management improvement process has been implemented. Plant staff have reduced the number of nuisance alarms and will continue to review priorities and improve alarm procedures as part of ongoing operations and maintenance. This recommendation, in addition to #66 and #94, also address corrective action #2 required by Department of Ecology's Administrative Order.
79	Table 22 Operators	Add a visual beacon/strobe-type alarm in the control room.	To warn the operators in the control room that flooding was imminent unless action is taken.	In progress	Evaluate in 2019/2020 Implementation TBD	As part of the implementation of West Point's life safety system staff will determine how best to implement visible and audible alarms in Main Control and Area Control Centers (ACC) 1, 2 and 3. These alarms will notify operators when there is a high liquid level in the galleries and/or a wet well.
80	Table 22 Operators	Provide Emergency Communications training.	Should be part of Emergency Response Plan training.	Complete	Implemented and ongoing	Operations staff have been trained and Emergency Communications training has been incorporated into the West Point Emergency Response Plan. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
81	Table 22 Operators	Practice standard operating procedures for Effluent Pump Station restart.	This was listed as a step to be checked on the standard operating procedure for Effluent Pump Station restart. Recent issues with EPS pumps have been related to vibration, and based on this previous experience, the operators did not expect power to the valves to be an issue.	Complete	Implemented and ongoing	WTD updated its standard operating procedures and Operations staff have been trained using those updated materials.

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82	Table 25 Training	Create a designated emergency evacuation path.	Train often on designated emergency evacuation path.	Complete	Implemented and ongoing	A designated emergency evacuation path exists and this has been reinforced and emphasized in the Emergency Response Plan.
83	Table 25 Training	Develop standard operating procedure for tunnel entry.	Develop a standard operating procedure for tunnel entry, particularly to avoid entering at high flows.	Complete	Implemented and ongoing	Immediately following the flood event, WTD implemented standard operating procedures to limit, and closely monitor, tunnel entry by employees during periods of high flows. As part of a continuous improvement effort, West Point employees are evaluating how best to update existing communication protocols and where to install visual alarm indicators within the tunnels. This work is being done as part of the life safety management system implementation.
84	Table 25 Training	Review operator training program.	Need to assess the appropriateness and amount of training provided.	Complete	Implemented and ongoing	West Point implemented weekly training with a technical trainer and updated training materials. In addition, Operation staff conduct daily training and lessons learned sessions within and between crews. This recommendation also addresses corrective action #5 required by Department of Ecology's Administrative Order.
85	Table 25 Training	Increase number of operators on duty.	Operators need time on nonemergency shifts to gain on-the-job training across the plant.	Complete	Implemented and ongoing	Operations vacancies have been filled. WTD has also expanded its existing training program to improve the number and quality of candidates for future vacancies. This was done by hiring 15 additional operator-in-training and term-limited temporary (TLT) staff who will be trained and competitive for hire into career service positions. Additionally, West Point has updated standard operating procedures and increased the type and frequency of operator training. West Point employees continue to evaluate how to improve all training, especially emergency response, and will implement training improvements as they are developed.

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86	Table 25 Training	Provide hands-on Emergency Response Plan training.		Complete	Implemented and ongoing	Emergency Response training sessions have been increased from one per year to two. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
87	Table 26 Equipment and Systems Testing	Add waterproof lighting in the basement.		Implemented alternative	Complete	As an alternative to this recommendation, WTD implemented revised standard operating procedures that limit and monitor tunnel entry during periods of high flow.
88	Table 26 Equipment and Systems Testing	Have two permanent skids hooked up at all times.	Have online but connected.	Complete	Implemented	One spare hydraulic power unit was added to one series of Effluent Pump Station pumps. A capital project replaced the temporary installation for the one on the other series of pumps. This recommendation also addresses corrective action #1 required by Department of Ecology's Administrative Order.
89	Table 26 Equipment and Systems Testing	Secure walkway covers.	Fixed.	Complete	Implemented	Walkway covers have been bolted down.
90	Table 26 Equipment and Systems Testing	Revise standard operating procedure for annual plant hydraulic safety.	It was done this way because of multiple tank leaks experienced when water levels are above normal. This has been fixed.	Complete	Implemented and ongoing	A review and update of standard operating procedures has been completed and float testing is scheduled for twice a year.
91	Table 26 Equipment and Systems Testing	Implement a Life Safety Management system.	A Life Safety Management system should be developed and implemented to reduce risks and improve safety for the staff at the plant, protect the equipment, and reduce the duration of bypass events.	Complete	Implemented and ongoing	A Life Safety Coordinator has been hired and an initial Life Safety Evaluation was completed. That evaluation, which will be continuously refined, provides a framework of recommendations that the West Point employees will implement and maintain. WTD and King County IT are working on a joint Enterprise Asset Management System (EAMS) that will integrate with LSM functions. Until the EAMS is in place, WTD implemented a LSM SharePoint site and chain of custody routing forms.

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92	Table 26 Equipment and Systems Testing	Develop a dynamic computer model to simulate plant hydraulic conditions.		Complete	Implemented and ongoing	A computer model (simulator) has been developed and deployed. This recommendation also addresses corrective action #4 required by Department of Ecology's Administrative Order.
93	Table 26 Equipment and Systems Testing	Implement routine testing of the Primary Effluent gate interlock indicator in Area Control Center 1.		Complete	Implemented and ongoing	West Point Maintenance employees will conduct an interlock test as part of their annual float testing procedure.
94	Table 26 Equipment and Systems Testing	Conduct an alarm management review workshop to properly prioritize alarms and remove or condition alarms.	Alarm criticality ratings should be reviewed. Only life-safety/hydraulic protection–related alarms should be classified as criticality level 1. These alarms should remain visible until cleared.	In progress	Evaluate in 2019/2020 Implementation TBD	WTD is developing an initial list of criticality level 1 alarms. This list will be revised as part of the development of West Point's life safety system. This recommendation in addition to #66 and #78 also address corrective action #2 required by Department of Ecology's Administrative Order.
95	Table 26 Equipment and Systems Testing	Revise standard operating procedure for Effluent Pump Station reset.	Need to specify the amount of time operators have during different flow conditions. Standard operating procedure specifies 2 attempts for restart.	Complete	Implemented and ongoing	WTD implemented a standard operating procedure for the Effluent Pump Station that specifies two restart attempts and updated training also emphasizes that procedure.
96	Table 27 Maintenance Procedures	Implement a Life Safety Management approach to all maintenance not included in Process Safety Management.	Implement a Life Safety Management approach to all maintenance not included in Process Safety Management.	Complete	Implemented and ongoing	A Life Safety Coordinator has been hired and an initial Life Safety Evaluation was completed. That evaluation, which will be continuously refined, provides a framework of recommendations that the West Point employees will implement and maintain.
97	Table 27 Maintenance Procedures		Maintenance may negatively affect component performance if the execution is incorrect, insufficient, delayed, or excessive.	Complete	Implemented and ongoing	A Life Safety Coordinator has been hired and an initial Life Safety Evaluation was completed. That evaluation, which will be continuously refined, provides a framework of recommendations that the West Point employees will implement and maintain.
98	Table 27 Maintenance Procedures		Organized communication is a component of a Life Safety Management system.	Complete	Implemented and ongoing	A Life Safety Coordinator has been hired and an initial Life Safety Evaluation was completed. That evaluation, which will be continuously refined, provides a framework of recommendations that the West Point employees will implement and maintain.

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