5 Stormwater Condition Assessment Program

Effective utility management requires an approach to handling assets and making decisions to plan, inspect, and care for aging infrastructure based on the goal of maximizing life-cycle performance while managing life-cycle cost. Condition assessment is a foundational component to life-cycle asset management because it provides the basis for making infrastructure-related decisions based on risk.

The City's condition assessment program covers the stormwater system through a combination of inspection and preventive maintenance (PM) schedules by asset class. The program relies on asset information residing in several City information systems.

The City of Bellingham Public Works Department Asset Management Policy states:

> Assets are the people, infrastructure, facilities, tools, institutional knowledge and business relationships that our Department has. Asset Management is the systematic and coordinated activities and practices that are used to manage these assets.
>
> The Department's Asset Management approach will treat all assets as interrelated components and provide sustainable, high quality service to our customers; optimize asset value, while minimizing lifecycle costs; and manage risks to the delivery of established service levels.

5.1 Asset Inventory

The City's stormwater asset inventory resides in its GIS, which also contains other City utility infrastructure, including wastewater conveyance, water distribution, and roadway assets.

The following attribute information is recorded for conveyance assets:

- Material type
- Installation date
- Size
- Lining type (if applicable)
- Main versus lateral designation, where laterals are any pipeline less than 8 inches in diameter (lateral asset attribute information is less detailed/complete than main line asset attribute information) (conveyance only)
- Componentry [non-conveyance, such as catch basins and control structures only]

The asset inventory is nearly complete in GIS (with about 6 percent missing pipe size and only 9 percent lacing pipe material); however, at this time, expected useful life or other attribute information that may be used to predict age-based condition is not yet included in the database. To advance its utility management efforts, the City is a developing an Asset Management working group that will focus on life-cycle management for the Public Works Department. The initial intent of this group is to identify and analyze additional attribute information to help the Stormwater Maintenance group prioritize inspection and maintenance activities.

The City also maintains a computerized maintenance management system (CMMS) to track work orders and maintenance-related activities. The City is transitioning to Cityworks™ for this purpose; it historically used Infor (Hansen). The configuration between GIS and Cityworks™ is still to be established; however, it is anticipated that GIS will remain the database of record for the asset inventory, and will "push" information to Cityworks™. Once implemented, some information may also move from Cityworks™ to GIS to facilitate regular uploading of data to the storage database.

The City also maintains closed-circuit television (CCTV) inspection footage in a GraniteNet database, which includes video inspection footage for the last 5 to 6 years (since approximately 2013 when the Public Works Department began video inspections of stormwater conveyance infrastructure).

5.2   Condition Assessment Strategy

The City uses defined PM programs for each major asset class to assess and monitor the condition of the stormwater system. Additionally, some condition assessment is performed in response to customer inquiries and complaints.

5.2.1   Preventive Maintenance Programs

The City has the following PM programs in place, by asset class:

- **Conveyance CCTV inspection**: Conveyance assets are video-inspected once every 5 to 7 years. The entire system is divided into geographic sections, and inspections are run from end to end (once a section is completed, the next section is started, until all are completed, and then the process is started again). Lines are cleaned as needed to allow crews to complete video inspections. The City's video inspection program has been in place since 2005 and 2013 for stormwater. With the implementation of Cityworks™, geographic scheduling of work may change for conveyance assets as well as catch basins and other assets; the optimal schedule breakdown is still being assessed.

- **Catch basin inspection and cleaning**: The City visits all catch basin structures once every 2 years, or within an alternative schedule compliant with its Phase II Permit requirements. An inspection of each catch basin is conducted to determine if cleaning is required: crews measure the depth from the invert to the outlet of the catch basin to calculate how much sediment has developed. If cleaning is required, a work order is written, and cleaning is performed separately by a crew in a vactor truck. As with conveyance assets, the entire system is divided into geographic sections, and inspections are run from end to end.

- **Detention facilities, vaults, and fat pipes**: All assets are visited one time per year. Any maintenance needs identified at the time of inspection are performed immediately; no work order is written.

- **Bioretention facilities and other green stormwater infrastructure**: All assets are visited two times per year for cleaning. At the time of the visit, any material that needs to be replaced is replaced; no work order is written.

- **Control structures**: All assets are visited one time per year for servicing and cleaning (as needed). Any maintenance needs identified at the time of inspection are performed immediately; no work order is written.

- **Trash racks and other debris collection devices**: Assets are visited monthly on average, depending on the season (during periods of high flows and debris buildup, such as fall and leaf season, assets are visited more frequently; in summer, less frequently). Areas prone to flooding are targeted for more frequent inspection and cleaning, and have their own asset-level PMs. No work order is written. Targeted areas are identified primarily through customer service requests (CSRs).

- **Pollution control devices and oil/water separators**: All assets are visited one time per year. Any maintenance needs identified at the time of inspection are performed immediately; no work order is written.

- **Permeable pavement**: All assets are inspected and cleaned one to two times per year, depending on availability of resources. Any maintenance needs identified at the time of inspection are performed immediately; no work order is written.

- **Infiltration trenches**: All assets are visited one time per year and maintenance is performed immediately as necessary; no work order is written.

- **Media filters**: All assets are inspected and cleaned one to two times per year, depending on availability of resources. No work order is written for any required cleaning.

- **Ditches**: There is no established PM program; inspection and maintenance is performed as needed (if a crew working in the area identifies a problem, or a customer complaint is received); no work order is written.

5.2.2   Customer-Driven Condition Assessment

Customer-driven (or reactive) condition assessment occurs in response to problems identified by users of the system using CSR as described above. CSRs are received by the City, which investigates the source of each complaint. In some cases, the investigations require video inspections.

CSRs are tracked by location and, where possible, by address. In some instances, a CSR may be linked to a work order written in response. If enough CSRs are received against a given asset, a specific PM program may be developed for the asset. For example, trash racks and other debris-capturing devices may have a specific PM program for cleaning if enough CSRs related to localized flooding have been received.

5.3   Condition-Based Maintenance and Renewal

O&M staff make maintenance and renewal decisions based on findings from asset inspections. For most non-conveyance asset classes, maintenance decisions are made by inspection crews on site, and work is performed immediately or shortly thereafter. This decision process is described in each asset PM, in Section 5.2.1. Currently, if work is performed on site, a maintenance work order is not written. If the required maintenance cannot be performed at

the time of inspection, a work order is written to a specific asset and scheduled by the group supervisor.

Once Cityworks™ is implemented, staff will write work orders for all needed work that is identified, and supervisors will schedule work based on work order priority. In all cases, major failures that require capital resources are elevated to the Pavement and Utility Rating Committee (PURC) for review.

5.3.1   Conveyance Renewal Decision Making

Inspection of conveyance assets is performed by the Video Inspection Group, which identifies failures or defects through CCTV inspection. Separately, maintenance and renewal needs are identified following the inspection by supervisors reviewing CCTV footage. Maintenance and renewal that can be performed in-house with existing resources is then planned over the course of a year via work orders.

Inspection Rating System

When conveyance assets are CCTV-inspected, their condition is scored using a defect rating system included in the inspection database software (GraniteNet). Defects include both structural defects (such as voids in a pipe or cracks in pipe material) and O&M defects (such as root intrusion or debris buildup). After a geographic section has been completely inspected, a report of all defects by asset is run and reviewed. The Video Inspection Program supervisor then reviews the defects identified and creates work orders for necessary repairs and/or maintenance.

Emergency Repairs

The exception to this is if a serious defect is observed during the video inspection; in this case a repair work order is written immediately. The work order and associated video is reviewed by either the Stormwater Maintenance Group supervisor or the Video Inspection Program supervisor (or their seniors). At this time there is no standard operating procedure (SOP) or guideline for the types, number, or severity of defects that warrant an emergency work order; however, staff are generally knowledgeable in which types of defects need to be elevated to this status.

Inspection Training

Currently two maintenance staff are trained to perform CCTV inspections using the coding system, with an additional staff currently being trained. The City's goal is to train all maintenance staff to be able to perform these inspections. All training is done by the Video Inspection Program supervisor to ensure that a consistent approach is used.

5.3.2   Short-term Renewal

Short-term renewal consists of those types of repairs that can be addressed by the City's maintenance staff without additional resources or funding. In-house maintenance crews can perform most repairs to conveyance assets, including pipe sections up to 100 feet in length, spot repairs, etc. There are no documented thresholds to identify which renewal activities

require additional support, as it typically is determined by an individual project's scope. Work that typically requires outside resources includes those types of renewal projects that require longer than 5 days to complete, require the support of specialty subcontractors, and/or those that require engineering design. These projects are elevated to the PURC for long-term renewal.

Emergency work orders identified during inspections are addressed immediately by in-house crews, unless in-house crews are not able to perform the work. While a large backlog of work orders exists, there is no backlog of emergency repair work orders. Generally cities experience large backlogs of work orders for a variety of reasons, including system growth, competing priorities between funding for aging infrastructure and capacity/regulatory demands, new technologies without well-understood maintenance needs or useful life, and staff retirements and vacancies. Currently, there is no process or standard for prioritizing work orders in the backlog. However, experienced operators can typically assess work orders to determine which should be done first based on risk and need. The City performs re-inspections as necessary, both to check on the progression of certain types of defects and to confirm the type of repair needed.

5.3.3   Long-term Renewal

Long-term renewal refers to rehabilitation and replacement projects that can be performed in-house. Often, these projects may require significant capital investment, outside of annual operating budgets. These typically large projects may have other drivers in addition to deteriorating infrastructure; for instance, a capacity upgrade may be required on a pipe segment requiring replacement.

The City's PURC prioritizes all infrastructure projects using a point system that takes into account the risk and criticality of delaying or not doing a project.

An A and B condition rating is established and is based on field assessments; however, at this time, the field assessment scores are not tied directly to CCTV inspection scores. The City intends to tie field assessment scores to CCTV inspection results for conveyance assets in the future.

5.4   Recommendations for the Condition Assessment Program

Based on interviews with City maintenance staff, a series of recommendations has been developed that may enhance the City's current condition assessment program, which are shown in Table 5-1. These are for the City's consideration, and should be reviewed in further detail as necessary. Additionally, some of these recommendations may already be under consideration or in process at the City.

Table 5-1. Condition assessment program recommendations

Recommendation	Description
Asset inventory	
Additional asset attributes	For each asset class, review existing attribute information and identify additional information that may be included, with the purpose of supporting a risk-based condition assessment and renewal program. For example, develop an expected life for each asset based on type, material, etc. The expected life can be used to create a "percent consumed" measure as a preliminary risk of failure measure.
Condition assessment strategy	
Risk-based framework	Develop a risk-based framework to prioritize condition assessment strategies by asset class (while keeping strategies in accordance with Phase II Permit requirements). The framework may also be used to prioritize repair work orders in the backlog and expanded to include projects reviewed and prioritized by the PURC (the PURC uses some risk factors for assessing projects; these may be expanded). A risk-based framework should take into account both likelihood-of-failure factors and consequence-of-failure (criticality) factors. A formal framework will also help convert staff institutional knowledge into a replicable approach. As Cityworks™ is implemented (or once a risk framework is developed), consider using geographic scheduling that takes into account asset risk when developing asset inspection schedules. The City is doing this in limited ways, for example scheduling more frequent inspections of trash racks in areas prone to flooding; this type of scheduling may be expanded over time using formal risk factors.
Condition score	Develop a simple condition scoring system for non-conveyance assets that can be quickly assigned during routine asset inspections. The condition score should take into account structural defects, as well as other failure types, which would be defined for each asset class. For conveyance assets, develop a "quick score" that accounts for size, type, and number of defects from the GraniteNet condition scoring system.
Customer service request and repair activity tracking	Tie any follow-up work order(s) to a CSR; assign both to one asset. By doing this, it will be easier to perform trend analyses on assets, and to identify problem areas or "hot spots" that should be on an aggressive PM schedule.
Training	Ensure that training is provided to staff performing inspections and maintenance on infrastructure, particularly infrastructure involving new stormwater management technology. Also ensure that for all new infrastructure accepted by the City, O&M manuals, as-builts, and other relevant information are provided prior to acceptance.
Condition assessment and renewal program resourcing	Develop an approach for estimating resource needs (capital and O&M budget, staffing, vehicles, and equipment) to support the current condition assessment and renewal program. This may include quantifying system growth and corresponding maintenance needs, a projection of need to reduce the current backlog over a certain period, and/or a one-time projection of system condition and corresponding renewal needs. It may also leverage the Risk-Based Framework to help determine the size and scope of condition assessment that should be occurring (outside of Phase II Permit requirements).

Recommendation	Description
Condition-based maintenance and renewal	
Inspection training	To supplement the existing training, and as new staff begin performing video inspections, develop a quality control (QC) program for reviewing scores given to pipes in the field. This may be done by a dedicated reviewer, or when videos are reviewed to determine follow-up actions. The intent of the QC program would be for training purposes only, to ensure that scores are consistently being applied by all inspectors.
Renewal decision-logic	Develop formal guidelines for the type, severity, number, and size of defects that trigger an emergency repair work order, and to ensure that all inspectors are trained in the guideline. Also develop formal guidelines for the types of renewal technologies preferred for different defect types, numbers, and severity. For instance, a point repair may be preferable for a pipe with only one defect, but replacement or lining may be preferable for a pipe with multiple defects throughout. Guidelines will help formalize staff institutional knowledge and create a replicable approach. They will also create additional prioritization criteria for the existing work order backlog. Finally, the City may wish to bundle together several individual projects into larger programmatic repair packages, which may be identified and budgeted as capital projects.

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