

# Clean Water 2020 Program

## **MAINTENANCE MANAGEMENT SYSTEM**

May 2015



We Are Columbia

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# Summary and Intent

## Introduction and Objectives

The City of Columbia (City) has designed this Maintenance Management System (MMS) to ensure that preventive and corrective maintenance is conducted at the Wastewater Treatment Plant (WWTP) and that WWTP equipment integral to proper operation and maintenance, treatment units, and tanks is maintained with the goal of achieving compliance with the NPDES Permit.

This MMS has been prepared in accordance with the requirements of Paragraph 11 of the Consent Decree entered by order dated May 21, 2014 in *The United States of America and State of South Carolina by and through the Department of Health and Environmental Control (SCDHEC) vs. the City of Columbia*, Civil Action No. 3:13-2429-TWL, DOJ Case Number 90-5-1-1-00954. The MMS addresses the specific requirements of the Consent Decree (CD) as outlined in **Table 1**, and was developed based on the specific needs of the City’s WWTP.

**Table 1 - Consent Decree Compliance Requirements for MMS**

CD Section	CD Requirement	MMS Section
11. a. (i)	Identification of equipment integral to proper operation and maintenance, treatment units, and tanks used in the treatment of wastewater liquids and bio-solids (hereafter referred to as “Equipment”).	Section 2.1 Equipment Identification
11. a. (ii)	Standard procedures to conduct periodic preventive maintenance of the Equipment (hereafter referred to as Standard Maintenance Procedures).	Section 2.2.1 Preventive Maintenance of Equipment
11. a. (iii)	Standard Maintenance Procedures, which includes the frequencies of preventative maintenance, necessary to ensure that Equipment is properly maintained.	Section 2.2.2 Frequencies of Preventive Maintenance
11. a. (iv)	Adequate training and education for maintenance personnel to perform the Standard Maintenance Procedures.	Section 2.2.3 SMP Training and Education
11. a. (v)	Procedures for recognition of indicators that corrective maintenance on Equipment is necessary.	Section 2.2.4 Corrective Maintenance Indicators
11. a. (vi)	Procedures for the generation of work orders associated with preventive and corrective maintenance of the Equipment.	Section 2.2.5 Generation of Work Orders
11. a. (vii)	Procedures for the generation of purchase orders associated with preventive and corrective maintenance of the Equipment.	Section 3.3 Inventory Management and Purchase Order Generation
11. a. (viii) (A-C).	An Inventory Management System that requires Columbia to maintain (A) lists of critical equipment and critical spare parts for the operation of the WWTP; (B) an inventory of critical spare parts stored at the WWTP and a list of the remaining critical spare parts not stored at the WWTP may be obtained to enable the repair or replacement of Equipment in a minimum amount of time and to ensure proper operation of the WWTP; and (C) written procedures for maintaining and updating the information in the Inventory Management System.	Section 3.2 List and Location of Critical Equipment and Critical Spare Parts. Section 3.3 Inventory Management and Purchase Order Generation

CD Section	CD Requirement	MMS Section
11. a. (ix) (A-B)	An accessible system for tracking preventive and corrective maintenance activities and histories at the WWTP including the generation of summary reports each month that identify: (A) Equipment failures occurring in the previous month; and (B) the end-of-month status of preventive and corrective maintenance work orders issued or outstanding in the previous month for Equipment.	Section 4.1 Tracking of Maintenance Activities and Histories Section 4.2 Summary Reports
11. a. (x)	Procedures to ensure that failures of Equipment and/or loss of power supply during abnormal and emergency conditions are corrected in a timely fashion so as to limit downtime of the facility or component.	Section 2.2.6 Abnormal and Emergency Condition Procedures
11. a. (xi)	The updated WWTP Operations Program shall include an implementation schedule specifying dates and actions.	Section 5 MMS Implementation Schedule

## Acronyms & Abbreviations

**CD** – Consent Decree

**City** – City of Columbia

**EPA** – United States Environmental Protection Agency

**HR** – Human Resources

**MMS** – Maintenance Management System

**NPDES** – National Pollutant Discharge Elimination System

**PM** – Preventive Maintenance

**PMTAP** – Plant Maintenance Technologist Apprenticeship Program

**SCADA** – Supervisory Control and Data Acquisition

**SCDHEC** – South Carolina Department of Health and Environmental Control

**SCE&G** – South Carolina Electric & Gas

**SMP** – Standard Maintenance Procedure

**T1DAF** – Train 1 Dissolved Air Flotation

**WWTP** – Wastewater Treatment Plant

## Section 1 MMS Overview

The MMS is a component of the following requirement of the CD:

- **Paragraph 11** "*Wastewater Treatment Plant Programs*. Columbia shall develop and implement the specific Wastewater Treatment Plant Programs set forth below and ensure that each Program has a written, defined purpose; a written defined goal; is documented in writing with specific detail as required herein; is implemented by trained personnel; has established performance measures; and has written procedures for periodic review."

### 1.1 MMS Goal and Objectives

The objectives of the Maintenance Management System are to ensure that preventive and corrective maintenance is conducted at the WWTP and that WWTP equipment integral to proper operation and maintenance, treatment units, and tanks is maintained with the goal of achieving compliance with the NPDES Permit.

For purposes of the MMS, certain WWTP equipment is defined as follows:

"Equipment" is defined in Section 11.a.(i) of the CD as equipment integral to proper operation and maintenance, treatment units, and tanks used in the treatment of wastewater liquids and bio-solids.

"Critical Equipment" as used in Section 11.a.(viii) of the CD shall mean equipment which, when failure occurs, will impede the WWTP's ability to comply with the NPDES permit.

"Critical Spare Parts" as used in Section 11.a.(viii) of the CD shall mean spare parts which, when failure occurs, will impede the WWTP's ability to comply with the NPDES permit.

### 1.2 Description of the Wastewater Treatment Plant (WWTP)

The WWTP, located at 1200 Simmon Tree Lane, is an advanced secondary treatment plant with two liquid trains providing preliminary, primary, and secondary treatment optimized to provide nitrogen removal. The solids handling process consists of thickening and dewatering. Final effluent is disinfected and dechlorinated prior to discharge.

## Section 2 Maintenance Management System

The Maintenance Management System Section of the MMS addresses the following specific requirements of the Consent Decree.

- Subparagraph 11.a.(i) “Identification of equipment integral to proper operation and maintenance, treatment units, and tanks used in the treatment of wastewater liquids and bio-solids (hereafter referred to as “Equipment”).”
- Subparagraph 11.a.(ii) “Standard procedures to conduct periodic preventive maintenance of the Equipment (hereafter referred to as Standard Maintenance Procedures).”
- Subparagraph 11.a.(iii) “Standard Maintenance Procedures, which includes the frequencies of preventative maintenance, necessary to ensure that Equipment is properly maintained.”
- Subparagraph 11.a.(iv) “Adequate training and education for maintenance personnel to perform the Standard Maintenance Procedures.”
- Subparagraph 11.a.(v) “Procedures for recognition of indicators that corrective maintenance on Equipment is necessary.”
- Subparagraph 11.a.(vi) “Procedures for the generation of work orders associated with preventive and corrective maintenance of the Equipment.”
- Subparagraph 11.a.(x) “Procedures to ensure that failures of Equipment and/or loss of power supply during abnormal and emergency conditions are corrected in a timely fashion so as to limit downtime of the facility or component.”

### 2.1 Equipment Identification

Identification of Equipment as defined above has been performed by WWTP maintenance staff. The Equipment identified is currently being maintained in the Asset Condition Assessment Report. As described within this document, an inventory of the Equipment identified will eventually reside in a computerized maintenance management system. Implementation schedule for this activity is found in **Section 5.1**.

### 2.2 Standard Maintenance Procedures and Work Order Management

#### 2.2.1 Preventive Maintenance of Equipment

Standard maintenance procedures (SMPs) are the instructions intended to provide guidance to staff in performing maintenance work on the Equipment as scheduled. The SMPs in use at the WWTP are instructions provided from the manufacturers’ manuals for a specific component for maintenance of the Equipment according to the frequency recommended by the manufacturer. These provide the technical basis for any recommended maintenance of system components.

### 2.2.1 Frequencies of Preventive Maintenance

Manufacturers' maintenance manuals are currently being collected for all existing Equipment. They also include specific recommended information for preventive maintenance frequencies. Preventive maintenance activities are defined by asset and frequency (e.g., monthly, annually, etc.). Cityworks® automatically generates the PM work order based upon this schedule. This process, which was piloted last year, is being expanded for all WWTP equipment.

### 2.2.3 SMP Training and Education

Currently the WWTP utilizes an on-the-job training and mentoring approach for maintenance personnel to perform the SMPs. A Plant Maintenance Technologist Apprenticeship Program (PMTAP) is being developed and is currently under review within the City's Human Resources (HR) Department. The Association of Boards of Certification Need-To-Know criteria (comprehension, application, analysis) were used to develop the PMTAP. Detailed information will be provided in the CD required WWTP Training Plan due to EPA.

### 2.2.4 Corrective Maintenance Indicators

Recognition of indicators that corrective maintenance on the Equipment is necessary is defined in the manufacturers' manuals and provided in the training for both operations and maintenance staff. These indicators may include high temperature, vibration, erratic operation, leakage, unusual wear and tear, the unit's capacity, and any anomalies when the unit is disassembled. Cityworks® is then utilized to generate corrective maintenance work orders for all WWTP process areas.

### 2.2.5 Generation of Work Orders

The WWTP currently uses a manual maintenance management system to track maintenance activities. The City purchased and has installed Cityworks®. Cityworks® is a computerized maintenance management system that supports work order generation and is being fully implemented for all process areas at the WWTP to include preventive and corrective maintenance activities. A pilot program for Train 1 Dissolved Air Flotation (T1DAF) was completed in 2014. The schedule for identifying the remaining assets and their related information to be entered into Cityworks® is presented in **Table 4** in **Section 5**.

**Preventive Maintenance Work Order Generation (Figure 1)** and **Corrective Maintenance Work Order Generation (Figure 2)** display the business process utilized by staff to generate and complete both preventive and corrective maintenance work orders.



Figure 1 – Preventive Maintenance Work Order Generation

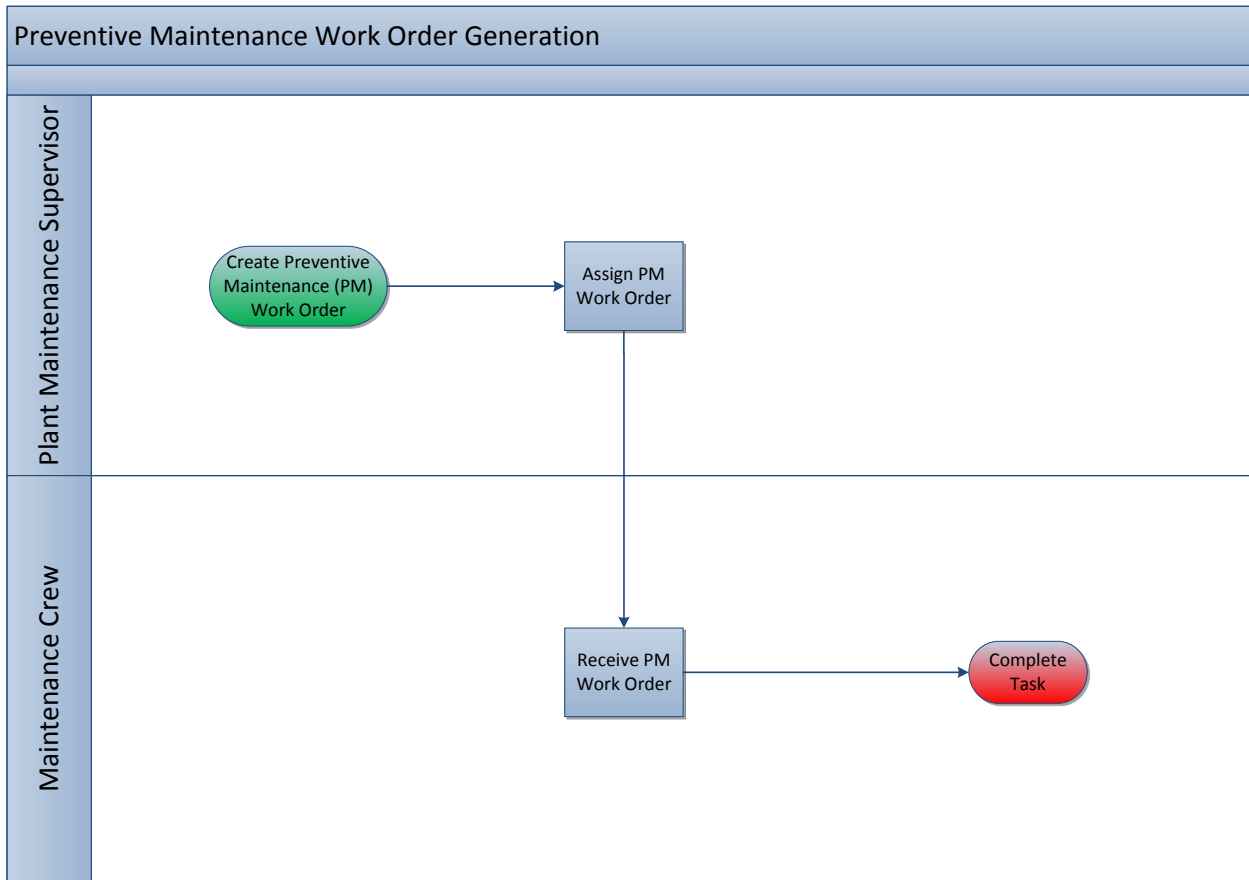
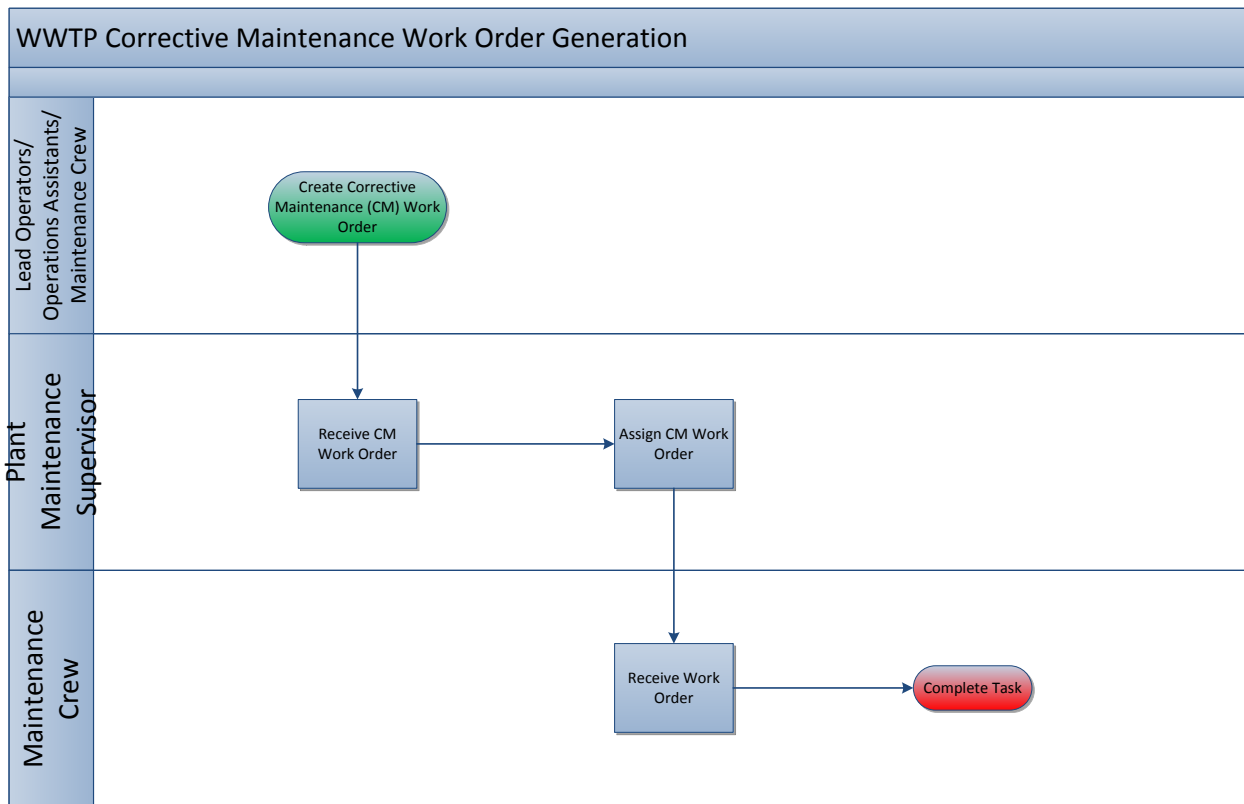


Figure 2 – Corrective Maintenance Work Order Generation



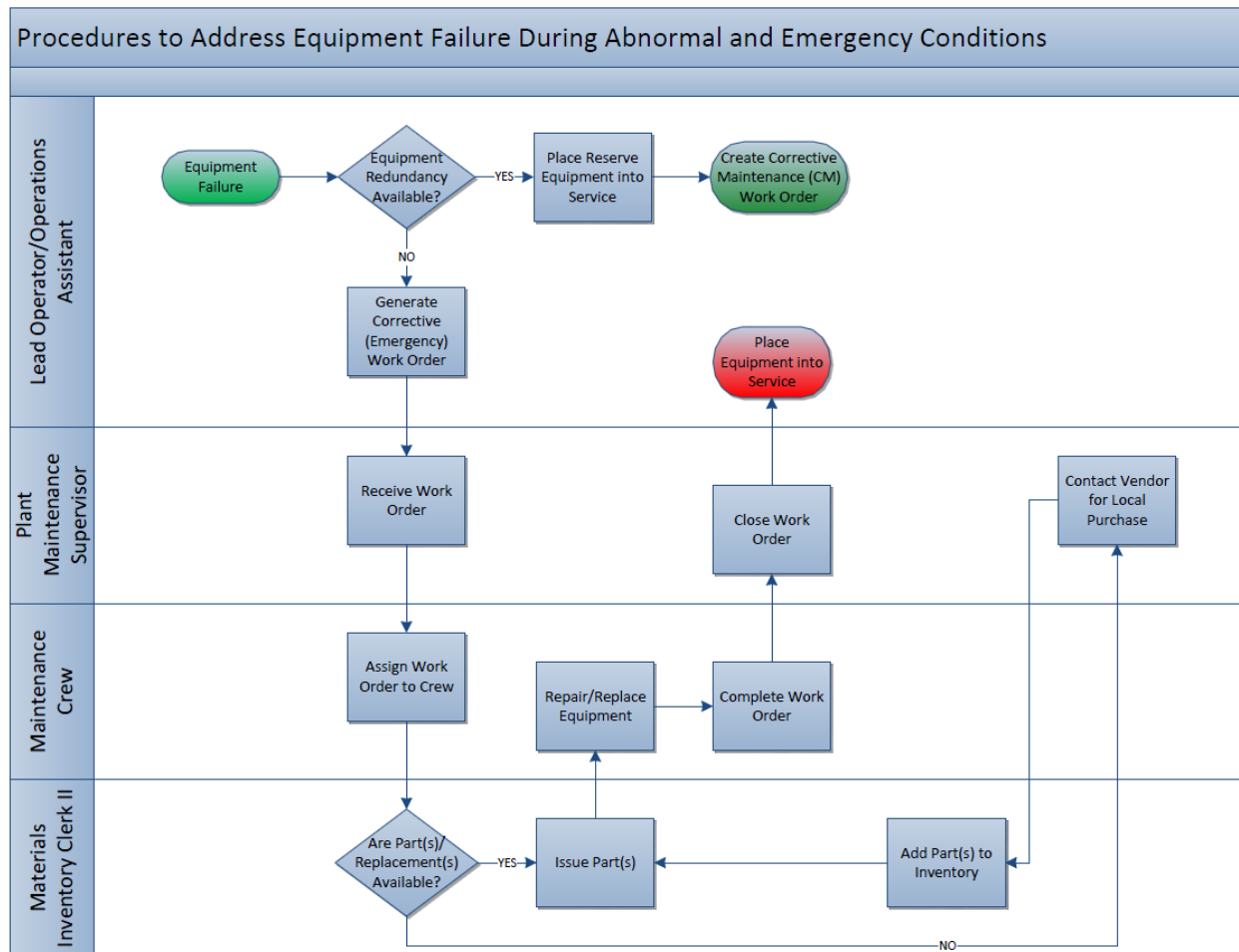
### 2.2.6 Abnormal and Emergency Condition Procedures

The procedures in place to respond to equipment failures and/or loss of power supply during abnormal and emergency conditions are the same as those to respond to emergencies that may occur during normal operating conditions. Process area equipment redundancy is provided to allow for alternate operation under different flow and weather conditions.

One critical area of concern for which a defined action has been implemented is the loss of the main electrical circuit feed to the WWTP. Should this occur, the City shall immediately contact South Carolina Electric and Gas (SCE&G) at 866-975-7316. Depending on the nature of the outage, SCE&G personnel may have already been notified by its remote SCADA system. For both events, SCE&G will dispatch the appropriate operations personnel to the WWTP. Once onsite, SCE&G will coordinate with WWTP personnel to determine the cause of the outage, verify that this cause has been cleared and/or isolated, and ensure all personnel are safely clear from the circuits. At that point, SCE&G will work with its System Control and Distribution Dispatch centers to determine the appropriate steps needed to restore service. If necessary SCE&G will de-energize the main circuit feed and energize the back-up feed to the WWTP.

**Procedures to Address Equipment Failure During Abnormal and Emergency Conditions (Figure 3)** displays the business process followed by WWTP staff during abnormal and emergency conditions.

Figure 3 – Procedures to Address Equipment Failure during Abnormal and Emergency Conditions



## Section 3 Inventory Management System

The Inventory Management System within the MMS addresses the following specific requirements of the Consent Decree.

- **Subparagraph 11.a.(viii)** “An Inventory Management System that requires Columbia to maintain”
  - A. “lists of critical equipment and critical spare parts for the operation of the WWTP;”
  - B. “an inventory of critical spare parts stored at the WWTP and a list of the remaining critical spare parts not stored at the WWTP may be obtained to enable the repair or replacement of Equipment in a minimum amount of time and to ensure proper operation of the WWTP; and
  - C. written procedures for maintaining and updating the information in the Inventory Management System.”
- **Subparagraph 11.a.(vii)** “Procedures for the generation of purchase orders associated with preventive and corrective maintenance of the Equipment.”

### 3.1 Identification of Critical Equipment and Critical Spare Parts

The following definition is in use for determining if equipment or spare parts are critical to WWTP system operation: “Critical equipment and parts are those which, when failure occurs, will impede the WWTP’s ability to comply with the NPDES permit.”

### 3.2 List and Location of Critical Equipment and Critical Spare Parts

Critical Equipment and Critical Spare Parts stored at the WWTP are shown in **Table 2**. Critical Equipment and Critical Spare Parts not stored at the WWTP are shown in **Table 3**.

**Table 2 - Critical Equipment and Critical Spare Parts Stored at the WWTP**

Process Area	Critical Equipment	Critical Spare Parts Quantity (complete units or parts)
Train 1 Dissolved Air Flotation	None due to redundancy.	
Influent Pump Station	Raw Inclined Screw Pumps	Belts
		Lower Bearing Grease
		Gearbox Oil
Equalization Basin	None	
Preliminary Treatment Facility	Influent Sampler	Influent Sampler
Train 1 Return Activated Sludge	None due to redundancy.	
Train 2 Return Activated Sludge	None due to redundancy.	
Chlorination	Water Champs	Water Champs

Process Area	Critical Equipment	Critical Spare Parts Quantity (complete units or parts)
		Seals & O-Rings for Liquid V-Notch Feeder
Dechlorination	Water Champs	Water Champs
	Effluent Sampler	Effluent Sampler
Dewatering	Sludge Feed Pump	Rotor & Stator; Gear Joint Shell Kit; Ball/Ring Gear; Connecting Rods
	Conveyors	Grease; Hangar Bearing Parts including flanges, lip seals, seal holders, O-rings
	Centrifuge	Drive Belts
Digesters 1 & 2	Recirculation Pump	Recirculation Pump
	Digested Sludge Transfer Pump	Rotor & Stator; Gear Joint Shell Kit; Ball/Ring Gear; Connecting Rods
Train 2 Aeration Basins	None due to redundancy	
Train 2 Primary Clarifiers	None due to redundancy	
Train 1 Secondary Clarifiers	None due to redundancy	
Train 1 Aeration Basin	Mixer	Gearbox
Train 1 Primary Basin	Transfer Pumps	Rotor & Stator
Train 2 Secondary Clarifiers	None due to redundancy	
Train 2 Dissolved Air Flotation	None due to redundancy	
Valves & Piping	None due to redundancy	

Table 3 - Critical Equipment and Critical Spare Parts Not Stored at the WWTP

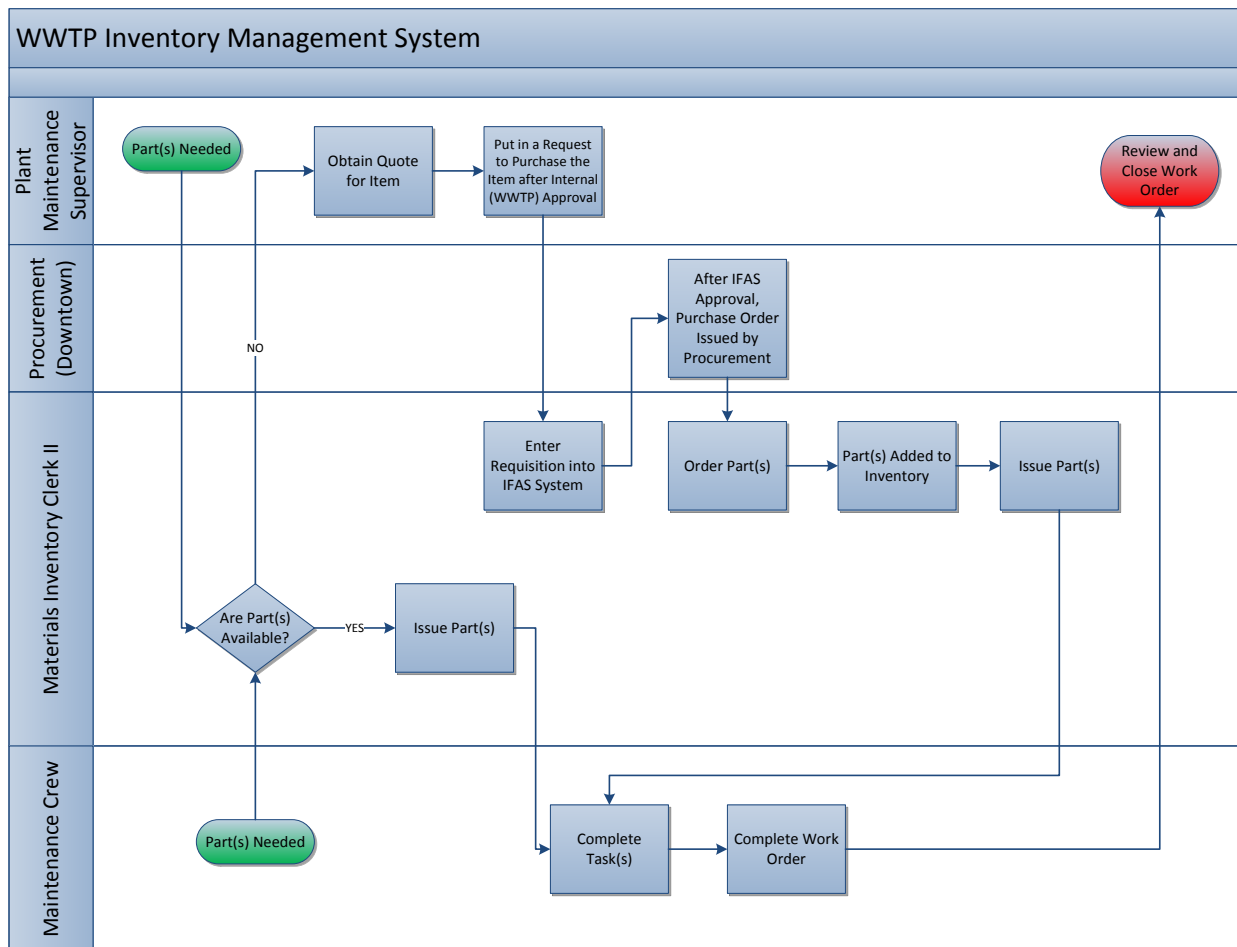
Process Area	Critical Equipment	Critical Spare Parts Quantity (complete units or parts)
Dewatering	Polymer System	All parts

### 3.3 Inventory Management System and Purchase Order Generation

Written procedures have been developed to govern the inventory maintained at the WWTP including the generation of purchase orders. The City is currently migrating from a manual system for inventory management to Cityworks® Storeroom for parts management. Implementation of inventory management within Cityworks® Storeroom is identified in **Section 5.3**.

**WWTP Inventory Management System (Figure 4)** displays the business process utilized by staff to manage inventory.

Figure 4 – WWTP Inventory Management System



## Section 4 Data Management and Analysis

The Data Management and Analysis Section of the MMS addresses the following specific requirements of the Consent Decree.

- **Subparagraph 11.a.(ix)** “An accessible system for tracking preventive and corrective maintenance activities and histories at the WWTP including the generation of summary reports each month that identify:
  - A. Equipment failures occurring in the previous month
  - B. The end-of-month status of preventive and corrective maintenance work orders issued or outstanding in the previous month for the Equipment.”

### 4.1 Tracking of Maintenance Activities and Histories

Reports that provide an accessible means for tracking preventive and corrective maintenance activities and associated histories on the Equipment will be available from the Cityworks® system.

### 4.2 Summary Reports

The development of the summary reports providing equipment failure and work order status are presented in **Table 5** in **Section 5**. These will be generated monthly by the Cityworks® system once Cityworks® is fully functionally. These reports can also be generated on demand.

## Section 5 MMS Implementation Schedule

The Implementation Schedule Section of the MMS addresses the following specific requirements of the Consent Decree and will be included in the updated WWTP Operations Program.

- **Subparagraph 11.a.(ix)** “The updated WWTP Operations Program shall include an implementation schedule specifying dates and actions.”

### 5.1 Asset Data Collection and Migration into Cityworks®

The following table presents the schedule for Cityworks® implementation.

**Table 4 - Asset Data Collection and Migration into Cityworks®**

Action Item	Completion Date	Item Description
Data Collection and Maintenance Schedules	December 31, 2015	Collect WWTP Asset Data and Create Maintenance Schedules for Equipment in the Following Process Areas: Influent Pump Station & Equalization Basin, Preliminary Treatment Facilities, Train 1 & 2 Return Activated Sludge, Chlorination, Dechlorination, Dewatering, Flow Meters, Samplers, Train 1 & 2 Aeration Basins, Train 1 & 2 Secondary Clarifiers, Train 1 & 2 Primary Clarifiers, Train 2 Dissolved Air Flotation.
Migration of Data and Maintenance Schedules into Cityworks®	December 31, 2017	Import WWTP Asset Data and Maintenance Schedules into Cityworks® for Equipment in the Following Process Areas: Influent Pump Station & Equalization Basin, Preliminary Treatment Facilities, Train 1 & 2 Return Activated Sludge, Chlorination, Dechlorination, Dewatering, Flow Meters, Samplers, Train 1 & 2 Aeration Basins, Train 1 & 2 Secondary Clarifiers, Train 1 & 2 Primary Clarifiers, Train 2 Dissolved Air Flotation.
Cityworks® Testing & Implementation	March 31, 2018	Complete Cityworks® Testing and Implementation

### 5.2 Summary Reports Generation Schedule

The following table presents the schedule for development of reports that provide an accessible means for tracking preventive and corrective maintenance histories on the Equipment that will be generated through Cityworks®.



**Table 5 - Summary Reports Generation Schedule**

Completion Date	(Action) Reports Generated by Cityworks®	Report Description
July 1, 2018	Equipment Failures For Prior Month	Equipment failures occurring in the previous month for the equipment as entered into the Cityworks® based on the implementation schedule in <b>Table 4</b> above
July 1, 2018	Outstanding Work Orders for Prior Month (>5 days)	End-of-month status of preventive and corrective maintenance work orders issued or outstanding in the previous month for the equipment as entered into Cityworks® based on the implementation schedule in <b>Table 4</b> above

### 5.3 Inventory Management within Cityworks® Storeroom Schedule

By March 31, 2018, the WWTP will transition from a manual inventory management system to Cityworks® Storeroom.