Operation Plan for Cleanup Action Plan Groundwater Pump and Treat System Cadet Manufacturing Company and Swan Manufacturing Company Sites

Prepared for
Port of Vancouver, USA

Port of Vancouver USA

March 2024

Parametrix

Operation Plan for Cleanup Action Plan Groundwater Pump and Treat System Cadet Manufacturing Company and Swan Manufacturing Company Sites

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Certification

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned whose seal is affixed below.

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3/29/2024

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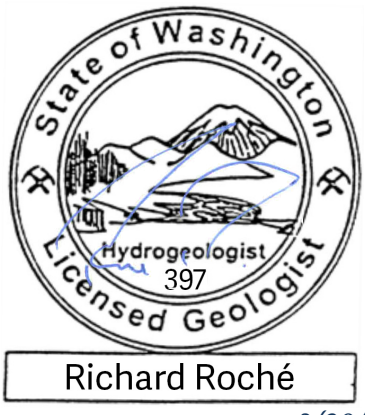

3/29/2024

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1. Introduction

This Operation Plan for temporary shutdown of the groundwater pump and treat system has been developed as a requirement for implementation of the Cleanup Action Plan (CAP) associated with the Cadet Manufacturing Company (Cadet) and former Swan Manufacturing Company (Swan) sites located in Vancouver, Washington. The Cadet and former Swan sites are part of a larger cleanup site referred to in the Washington State Department of Ecology (Ecology) database as the "Vancouver Port of NuStar Cadet Swan" site (the "Site"). Figure 1 shows the location of the Site. Figure 2 depicts the extent of the Site, as identified by Agreed Order (AO) DE 18152, and the areas associated with Swan, Cadet, NuStar, and Kinder Morgan facilities. Swan Figure 3 provides an overview of the pump and treat system layout and Figure 4 provides additional details of the treatment facility.

The CAP for the Swan and Cadet portions of the Site was issued by Ecology in September 2023 (Ecology 2023b). Agreed Order DE 21295, effective August 12, 2023 (Ecology 2023a), provides for implementation of the CAP which details the final remedy to address residual dissolved trichloroethylene (TCE), tetrachloroethylene (PCE), and associated compounds from the commingled plumes originating from the Swan and Cadet sites. The approved cleanup action consists of monitored natural attenuation (MNA) which uses natural processes to reduce contaminants of concern (COC) levels to acceptable concentrations. These processes include natural biodegradation, dispersion, dilution, sorption, volatilization, and chemical and biological stabilization, transformation, or destruction of hazardous substances.

The approved cleanup action was developed to support shutdown of the existing Port's groundwater pump and treat system to achieve remedial action objectives (RAOs). The pump and treat system, located at the Swan site, began operation in June 2009 to capture and treat the commingled dissolved VOC plumes sourced from the Swan and Cadet sites, and to reduce the concentrations of VOCs in groundwater at the Site. The Operation Plan is a primary aspect of the selected remedy and complies with the Model Toxics Control Act (MTCA) as defined in Washington Administrative Code (WAC) 173-340-400 and pursuant to requirements established in Agreed Order (AO) DE 21295 between Ecology and the Port. Additional Site information, including a description of the site and cleanup standards, is provided in the CAP (Ecology 2023b). Associated CAP documents include a Groundwater Compliance Monitoring Plan (Parametrix 2024a) and a Cleanup Action Contingency Plan (Parametrix 2024b).

This Operation Plan is intended to be used in conjunction with the Operation and Maintenance Manual, Groundwater Pump and Treat, Interim Action Swan/Commingled Plume (2019 O&M Manual; Parametrix 2019a) dated August 2019. The 2019 O&M Manual contains detailed descriptions of the equipment and general installation, operation, and maintenance procedures. For convenience, relevant procedures from the 2019 O&M Manual have been summarized in this Operation Plan.

2. Pump and Treat System Overview

This Operation Plan provides information related to placing the groundwater pump and treat (GWPT) system into temporary shutdown mode and restarting the system, if warranted based on criteria provided in the Cleanup Action Contingency Plan (Parametrix 2023b). This plan is intended to be used in conjunction with the 2019 O&M Manual.

This plan provides procedures for:

- Placing the pump and treat system into temporary shutdown.
- Maintenance during temporary shutdown to enable system restart (if warranted by criteria specified in the Contingency Plan).
- Re-starting the pump and treat system (if warranted by criteria specified in the Contingency Plan).

A plan for decommissioning of the pump and treat system will be developed in the future and submitted to Ecology for approval.

2.1 Groundwater Treatment System General Components

The system includes five main components, described below. Schematics of system components within the well house and the treatment system facility are provided in Figure 5. Additional drawings and figures are provided in the 2019 O&M Manual.

The treatment system consists of five main unit operations:

1. Groundwater extraction: Groundwater is pumped from extraction Well 1, located within the well house.
2. Pre-filters: The extracted groundwater is routed through the pre-filters to remove Total Suspended Solids (TSS). The pre-filters are located within the treatment facility.
3. Chemical feed: A chemical feed, located in the blower room within the treatment facility, amends the filtered groundwater with hydrogen peroxide (H_2O_2);
4. Air stripping: The groundwater is pumped into the air stripping towers, which remove VOCs from the groundwater. The air stripping towers are located within the treatment facility.
5. Storm drain connection: Treated groundwater is discharged to the City of Vancouver's storm sewer system under NPDES permit #WA0039942.
6. Programmable logic controllers (PLCs): Two PLCs allow the pump and treat system to operate in a fully automatic mode with little or no operator intervention.

2.1.1 Groundwater Extraction

Groundwater is extracted from the action area at groundwater extraction Well 1. The well is located within the well house (Figure 5). Well 1 is designed to produce a maximum groundwater extraction rate of approximately 3,900 gallons per minute (gpm). Photograph 1 and Photograph 2 show the well house and internal piping. A vertical turbine pump installed within Well 1 is used for groundwater extraction. Additional details regarding well construction and standard pump operation are provided

in the 2019 O&M Manual. Sections 3 and 4 describe the process for temporary shutdown and for potential re-start, respectively.

Photograph 1. Exterior view of well house.

Photograph 2. Pump and extraction piping.

2.1.2 Pre-Filters

Extracted groundwater (process water) is pumped through a pipeline from the well house to the treatment facility. Photograph 3 through Photograph 5 show treatment facility components. Within the treatment facility, process water flows through the pre-filters (Figure 5) to remove total suspended solids (TSS) from the groundwater.

The pre-filters may be backwashed for maintenance as needed. If backwash occurs, the solids and associated backwash water are sent to a backwash tank where the solids are settled for discharge to the sanitary sewer. The supernatant in the backwash tank is decanted off via a slurry/decant pump and reinjected into the water stream. The settled solids are then pumped via the slurry/decant pump from a sump within the backwash tank into the sanitary sewer.

If scaling or mineral deposition occurs within the air stripping towers (as described in the following subsection), the pre-filters can be used to reduce concentrations of iron and manganese in the process water. The pre-filters contain manganese dioxide, which can be chemically activated by the addition of chlorine to the process water.

Photograph 3. Treatment system pre-filters, blue vessels in left of photo.

Photograph 4. Backwash tank, blue tank on right.

Photograph 5. Slurry/decant pump.

2.1.3 Chemical Feed

The chemical feed system (Figure 5) provides H_2O_2 to the process water following TSS removal by the pre-filters. The H_2O_2 amendment inhibits biological growth in the air stripping towers.

The chemical feed system consists of a storage container of H_2O_2 that is placed in the southeast corner of the Blower Room within the treatment facility (Photograph 6). Chemical feed pumps are mounted above the H_2O_2 container, and the pump intake tubing is placed within the H_2O_2 container.

Photograph 6. H_2O_2 storage container and chemical feed pumps.

2.1.4 Air Stripping

Air stripping involves the mass transfer of VOCs from water to air. The air causes the volatile organics to partition (i.e., evaporate) from groundwater to the air by greatly increasing the surface area for contact between the two mediums. The air strippers (Figure 5) consist of tall, cylindrical towers filled with a packing material made of plastic. The groundwater is pumped from the well into the top of the towers and is sprayed over the packing material. The water cascades downward through the spaces between the packing material toward the bottom of the towers. At the same time, a fan at the bottom of the towers blows air upward in a direction that is countercurrent with water flow. As the air passes upward through the cascading water, it causes the VOCs in the groundwater to be transferred (stripped) into the air phase. The air containing VOCs is then discharged to the atmosphere through a stack in the top of the air stripping tower. Photograph 7 and Photograph 8 show the air strippers and blowers.

Photograph 7. Air stripper towers.

Photograph 8. Air blowers inside blower room.

2.1.5 Storm Drain Connection

The storm drain connection consists of a connection box (Photograph 9) located prior to the outfall to the Columbia River (Figure 3). The storm drain connection is set up with control sensors to monitor the water level inside and outside the connection box. This system is designed to prevent water from backing up into the treatment system and also discharging into the stormwater infiltration pond adjacent to the connection box. Also, the level sensors will shut down the system and notify the operator if the stormwater level in the infiltration pond rises to a preset level.

Photograph 9. Storm drain connection junction.

2.1.6 Programmable Logic Controller

Two PLCs are programed to operate the pump and treat in a fully automatic mode with little or no operator intervention. The main control system for the treatment plant consists of an Allen Bradley CompactLogix PLC and Wonderware interface, located in the control room. A second PLC and interface are located in the well house for control of the well pump and communication to the treatment plant. Communication between the two PLCs is via ethernet through fiber-optic cable. Alarm notification to Port operators, maintenance staff, and Port security is done by auto dialer from the main PLC in the treatment plant control room. Additional details regarding operation of the PLC system are provided in the 2019 O&M Manual.

2.2 Operation Permits

The GWPT system currently discharges treated process water to the storm drain connection under National Pollution Discharge Elimination System (NPDES) permit #WA0039942. The NPDES permit specifies required compliance measurements, frequency, and limits. Air emissions from the treatment system air strippers is regulated under Southwest Clean Air Agency (SCAA) air discharge permit ADP 12-3024 issued on June 14, 2012. Quarterly discharge monitoring reports are submitted to SCAA.

The Port will notify Ecology's NPDES permit manager prior to placing the system on temporary shutdown. Discharge monitoring reports (DMRs) will continue to be submitted to the NPDES permit manager during temporary shutdown. However, with the approval of Ecology's NPDES permit manager, effluent and air emission monitoring will be suspended during temporary shutdown. This information will be recorded on the DMRs, which will be submitted in compliance with the NPDES permit.

In the event of system re-start, Ecology's NPDES permit manager will be notified prior to re-starting the system. Effluent and air emission monitoring and reporting and will be re-initiated if the system is reactivated.

2.3 Health and Safety Program

Activities conducted under this Operation Plan will be performed in compliance with the pump and treat health and safety plan, as described in detail in the 2019 O&M Manual. Safety precautions addressed in the 2019 O&M Manual include chemical storage and handling, electrical equipment operation and maintenance, and mechanical equipment operation and maintenance. A copy of the emergency plans and procedures and a copy of the SWPPP, as described in the 2019 O&M Manual, will remain on site.

In addition to procedures provided in the 2019 O&M Manual, the following safety precautions will be implemented:

- During temporary shutdown of the system, chemicals associated with operation of the pump and treat system will be removed from the site to the maximum extent feasible to reduce risks associated with chemical storage and handling.
- Prior to pump and treat system re-start, operators, material handlers, and supervisors shall review the health and safety plan, as provided in the 2019 O&M Manual. These personnel shall also be provided with health and safety training. Training shall also include accidental release prevention and hazardous material management.

3. Pump and Treat System Temporary Shutdown and Long-Term Storage Procedures

The following steps detail the procedures for placing the GWPT system in temporary shutdown and for long-term storage of the pump and treat system equipment. While the system is in temporary shutdown, public utility services, including water and electricity, will remain active. A detailed summary of instrumentation and other equipment associated with each of the following system components is provided in the 2019 O&M Manual. A summary of these equipment is provided in Section 2.2 of this Operation Plan.

3.1 Initial Procedures for Temporary Shutdown

Prior to initiating temporary shutdown, cancel delivery of H_2O_2 and reduce the volume of H_2O_2 on site to the maximum extent feasible.

Manual deactivation of the pump and treat system includes the following:

1. Set both air stripper water flow controllers in manual position with a manual set point of 100%.
2. Close hydrogen peroxide injection hand valves and shut off chemical feed pumps.
3. Set the Well 1 flow control to manual, and slowly reduce the manual set point to 30%.
4. Turn the switch for Well 1 pump to off position.
5. Shut off the air stripper blowers.
6. Confirm slurry decant pump is off.

3.2 Well Pump

After initial shutdown, the pump will be removed from Well 1, cleaned, and stored in a manner to allow for reuse if system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b). Well 1 will be covered in a manner to mitigate potential fall hazards and potential contamination of the well. Initial procedures for cleaning and long-term storage procedures are described in detail below.

See Appendix A for the long-term storage recommendations from U.S. Motors for the well pump motor.

Storage Preparation Procedures

1. Remove pump and column pipe from Well 1.
2. Pressure-wash pump and column pipe.
3. Store the pump motor, discharge head, column pipe, and shaft in the well building or blower room.
    3.1. Sort and label the pump components for ease of inspection and maintenance.
    3.2. Inspect pump setting, never leave the shaft in the extreme raised or lowered lateral position.
    3.3. Place pump components (column pipe, bowl sections) at least 6 inches above the ground for good air circulation.
    3.4. Ensure the pump components are fully supported. Include at least four supports, evenly spaced, per piece of column pipe or shaft.
    3.5. Inspect the lube-oil and seal-flush piping. Either fill the piping with rust-preventative oil or recoat the piping periodically to prevent corrosion.
    3.6. Place desiccant bags into each component of the pump.
    3.7. Loosely seal the ends of each component (e.g. columns and bowls) to discourage pests.
    3.8. Consult Goulds with any questions about storing the pump.
4. Bolt a metal plate to the extraction well head.

Long-Term Storage Procedures

1. Maintain a temperature in the well house that is 60 degrees Fahrenheit (deg F) or greater to prevent condensation.
2. Rotate the pump shaft and bowl assembly counterclockwise at least 3 rotations per month, and rotate the motor shaft 15 rotations per month.
    2.1. Never leave the shaft in a previous position or in the extreme raised or lowered lateral position.
    2.2. Make sure the shaft rotates freely.

3.3 Pre-Filters

Long-term storage of the pre-filters consists of removing excess water from the pre-filter tanks and associated piping. The slurry/decant pump will remain off and will be serviced if backwash of the pre-filters is needed.

Procedures for these activities are detailed below.

Tanks

1. Drain the interior of the pre-filter and backwash tanks.
2. Leave tanks open until all visible moisture is removed and then close filter vessels.
3. Drain above grade piping.

Slurry/Decant Pump

1. Currently this pump is not used regularly. Confirm that liquids are not currently present within the pump. Continue current maintenance protocols.

3.4 Chemical Feed

Long-term storage of the chemical feed system consists of removal of the H_2O_2 tank and of storage and maintenance of the chemical feed pumps to allow for reuse if system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b).

Procedures for long-term storage of the chemical feed system are detailed below.

1. Remove remaining H_2O_2 and the H_2O_2 tank.
2. Flush the chemical feed pumps, intake tubing, and discharge tubing with water.
    2.1. Place a tank of potable water adjacent to the chemical feed pumps.
    2.2. Place intake tubing into the potable water tank.
    2.3. Turn on chemical feed pumps and allow potable water to flow through the chemical feed system until H_2O_2 has been displaced from the system; approximately 3 times system volume.
3. Disconnect intake tubing and discharge tubing from the chemical feed pumps and allow water to drain from the pumps and tubing.
4. Store chemical feed pumps in a dry, interior space.

3.5 Air Stripping

The air stripping system consists of the air stripping towers and air blowers. The following procedures describe storage and maintenance of these components to allow for reuse if system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b).

Procedures for long-term storage of the pumps, tower, and blower system are detailed below.

Air Stripping Towers

1. Continue blower operation until no more visible water is present within the tower.
2. Close exterior vents/cover stacks to the tower to keep the space dry.

Air Stripping Blowers

1. Disconnect electricity to the blowers.
2. Rotate blower blades manually once per month.

3.6 Electrical Equipment

Electrical equipment includes the PLC systems and various variable frequency drives (VFDs). The following procedures describe maintenance of electrical systems to allow for reuse if system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b).

Procedures for long-term storage of the PLCs and VFDs are detailed below.

3.6.1 Programmable Logic Controller

1. Leave energized CP-1102 and CP-3000 in-place so that heat from the transformer prevents condensation from forming.
2. Maintain building temperature within the control room and well house of 60 deg F or greater to prevent condensation.

3.6.2 Variable Frequency Drives

1. Turn off power to VFDs.
2. On a yearly basis, turn on power to the VFDs for a minimum of 4 hours. Then, turn off power to VFDs.

3.7 Miscellaneous Components

Other components of the pump and treat system include the HVAC system, exposed piping, instrumentation and meters, various control and butterfly valves, and plumbing features. The following procedures describe maintenance of these systems to allow for reuse if system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b).

- HVAC system:
  - → Maintain building temperature within the control room and well house of 60 deg F or greater to prevent condensation.
- Exposed Piping
  - → After pumps are turned off, allow fluids to drain from above grade piping by gravity methods.

- → Leave heat trace on or add heat trace and insulation for any above grade piping that cannot be fully drained.

- Instrumentation and Flow Meters
  - → Disconnect pH meter and other instrumentation. Re-purpose this equipment for alternative operations
  - → Gravity-drain flow meters and leave in place.
- Control Valves and Butterfly Valves
  - → For electric actuators, leave the power to the actuator on and the heaters will keep condensation from forming. Operate the valves through a full cycle monthly. Otherwise store the actuators indoors.
  - → Butterfly valves left outside should be empty so that if there is any water in the valve during freezing temperatures, ice doesn't damage the internals.
  - → If butterfly valves are removed from piping, coat valve flange with rust inhibitor and cover the valve to prevent UV light from damaging internals.
  - → Port should evaluate if non-motorized valves can be dewatered and left in place, or if they would prefer to remove them entirely. Dewatering of valves may include unbolting the piping and letting water drain out.
- Plumbing Fixtures (including water heater, emergency shower, eyewash and other plumbing fixtures)
  - → Turn off, disconnect, and gravity-drain the water heater.
  - → Operate emergency equipment (e.g. emergency shower and eyewash) following the Port's current preventative maintenance work orders.

3.8 Housekeeping

1. Check that openings in the buildings are sealed so that pests cannot get into the buildings.
2. Check exterior and interior of buildings for pests or animals and remove or clean monthly.

3.9 System Temporary Shutdown Summary Checklist

The table below summarizes the procedures described in Section 3 and can serve as a checklist for long-term storage and maintenance.

Table 1. Summary of Ongoing Maintenance Activities

Equipment Description	Status	Maintenance or Action Required	Interval
Well Pump	De-energized, removed from well, in storage	Rotate shaft	Monthly
Pre-Filter Tanks	Drained	No ongoing action	NA
Slurry/Decant Pump	Closed	Per current maintenance protocol	Per current schedule
Chemical Feed	Drained and chemicals removed	No ongoing action	NA
Air Stripping Towers	Closed	No ongoing action	NA
Air Stripping Blowers	De-energized	Rotate blades	Monthly
PLCs	Energized	Maintain building temperature	Ongoing
VFDs	De-energized	Energize VFD for 4 hours, but do not start the drives	Every 12 months
HVAC	In service	Perform preventive maintenance work orders	NA
Exposed Piping	Drained	No ongoing action	NA
Instrumentation/Flow Meters	Removed or drained	No ongoing action	NA
Control/Butterfly Valves	Removed from piping and placed in storage or energized in place	If energized in place, operate valve through full cycle	Monthly
Plumbing fixtures	Operational	Perform preventive maintenance work orders	NA
Housekeeping	N/A	Check for pests and remove	Monthly

4. Pump and Treat System Re-Start Procedure

This section summarizes procedures that will be used if pump and treat system re-start is triggered, as described in the Cleanup Action Contingency Plan (Parametrix 2023b). System re-start will generally follow procedures described in detail in Section 2.7.2 of the 2019 O&M Manual.

In addition, pump and treat system re-start will include the following:

1. Notify Ecology Site Cleanup Manager of scheduled re-start date.
2. NPDES Permit
    a. Notify Ecology's NPDES permit manager prior to system re-start.
3. Groundwater Extraction Well
    a. Remove metal plate that was installed for long term storage.
    b. Re-develop Well 1 using pressure washing, sonar jetting, or equivalent methods.

4. Well Pump
    a. Thoroughly inspect the pump components (i.e. motor, impeller, wear rings, column pipe bearings). Contact the pump manufacturer if any questions arise about the condition of the pump components.
    b. If components are damaged, coordinate with the pump manufacturer to replace components.
    c. Install the well pump into the well and reconnect wiring and piping.
5. Prefilters
    a. Assess condition of filter media. If potential clogging noted, disinfecting and/or backflush the pre-filters.
    b. If backflush is needed, assess condition of slurry/decant pump.
6. Chemical Feed
    a. Order H_2O_2 and place in Blower Room.
    b. Re-install chemical feed pumps and attach tubing.
7. Air Strippers
    a. Uncover any vents that have been blocked off.
    b. Remove debris as needed.
8. PLCs
    a. Update Wonderware software.
9. VFDs
    a. Energize and re-start VFDs.
10. Exposed Piping
    a. Install removed piping and valves.
    b. Purge any trapped air.
    c. Test piping connections.
    d. Perform a pressure test.
11. Instrumentation/Flow Meters
    a. Procure and install new pH meter and other removed instrumentation.
    b. Reinstall and recalibrate flow meters.
12. Control Valve/Butterfly Valves
    a. Reinstall valves as needed.

REVISION HISTORY

This document was originally issued as Revision 0. It has been revised as follows:

Date	Revision Details	Revision

5. References

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Figures

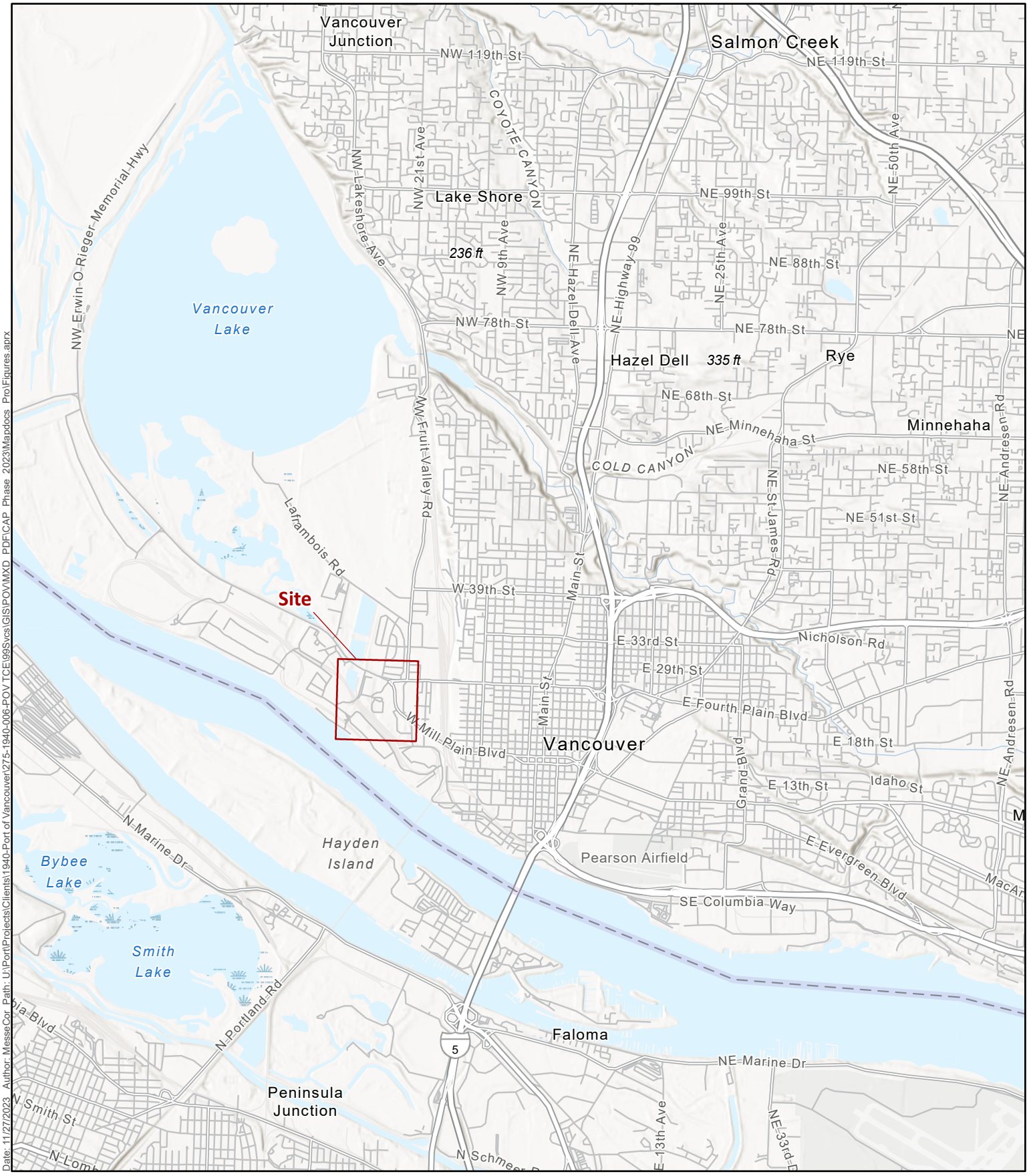

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Figure 1
Site Location Map

Operation Plan - Cleanup Action Plan
Groundwater Pump and Treat System
Swan and Cadet Sites
Port of Vancouver, WA

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Source: © Mapbox, © OpenStreetMap, Port of Vancouver

0 250 500 1,000 Feet

- Site - Historical Maximum Extent of HVOC Contamination
- Area of Site Included in Agreed Order 18152
- Cadet Facility
- Kinder Morgan Facility
- NuStar Facility
- Swan Site

Figure 2
Area of Site

Operation Plan - Cleanup Action Plan
Groundwater Pump and Treat System
Swan and Cadet Sites
Port of Vancouver, WA

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Source: © Mapbox, © OpenStreetMap, Port of Vancouver

- Pipeline From Well To Treatment Facility
- Treated Water Discharge Pipeline
- Existing Storm Drain
- Facilities

0 125 250 500 Feet

Figure 3
Groundwater Pump and Treat System

Operation Plan - Cleanup Action Plan
Groundwater Pump and Treat System
Swan and Cadet Sites
Port of Vancouver, WA

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Source: © Mapbox, © OpenStreetMap, Port of Vancouver

0 10 20 40 Feet

Figure 4
Treatment Facility

Operation Plan - Cleanup Action Plan
Groundwater Pump and Treat System
Swan and Cadet Sites
Port of Vancouver, WA

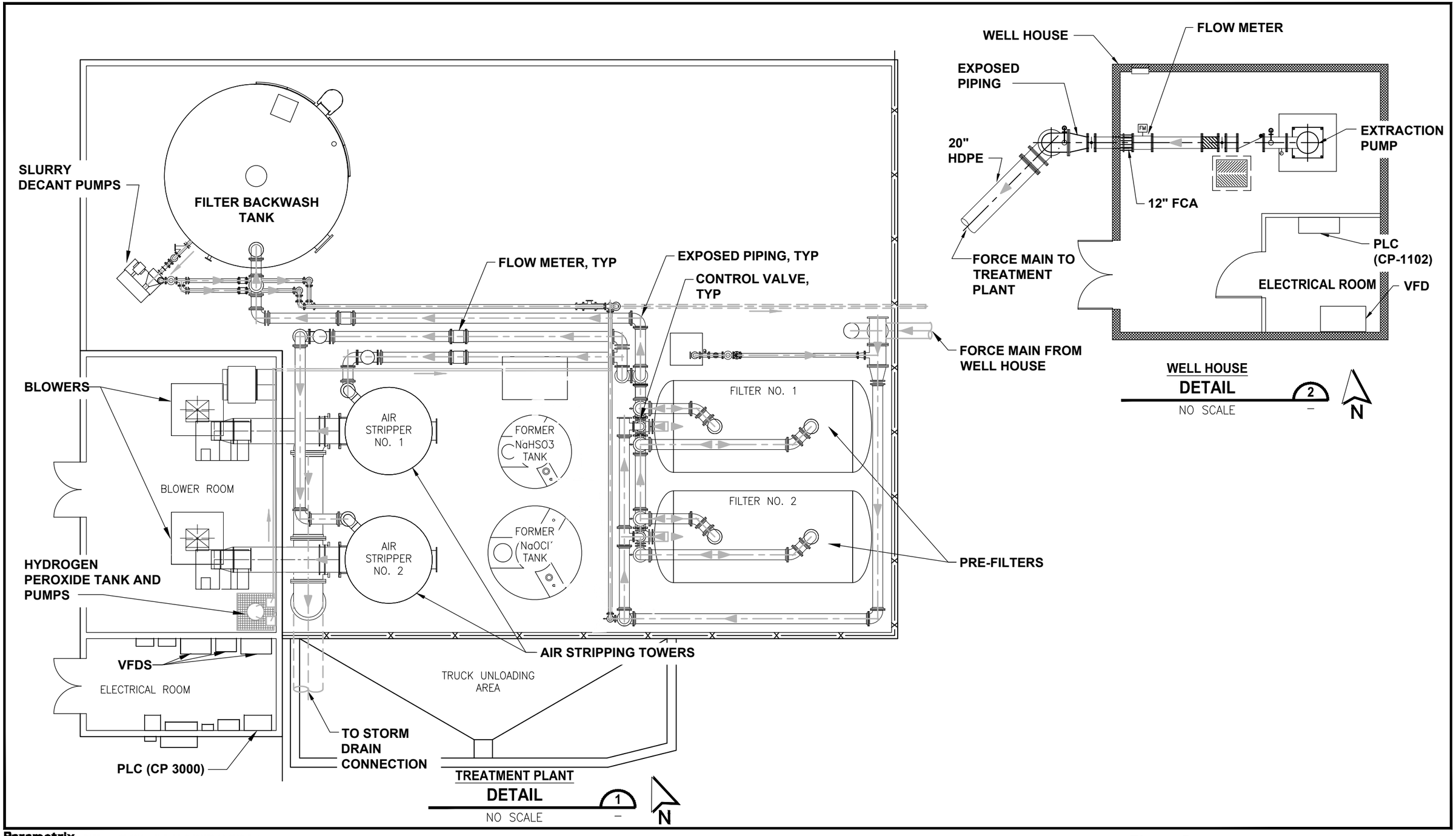

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Figure 5
Well House and Treatment Plant Schematic

OPERATION PLAN - CLEANUP ACTION PLAN
GROUNDWATER PUMP AND TREAT SYSTEM
SWAN AND CADET SITES
PORT OF VANCOUVER, WASHINGTON

Appendix A

Long-Term Storage Procedures from U.S. Motors

LONG TERM STORAGE FOR MOTORS WITH GREASE AND OIL LUBRICATED BEARINGS		

LONG TERM STORAGE -GREASE AND OIL LUBRICATED BEARINGS

NOTE: DO NOT WRAP OR COVER MOTOR WITH PLASTIC !

1. When To Put A Motor In Storage.

If a motor is not put into immediate service (one month or less), or if it is taken out of service for a prolonged period, special storage precautions should be taken to prevent environmental damage. The following schedule is recommended as a guide to determine storage needs.

A. Out of service or in storage less than one month -- no special precautions except that space heaters, if supplied, must be energized at any time the motor is not running.

B. Out of service or in storage for more than one month but less than six months -- store per items 2A, B, C, D, E, F2, and G, items 3A, B, and C, and item 4.

C. Out of service or in storage for six months or more - all recommendations.

2. Storage Preparation.

A. Where possible, motors should be stored indoors in a clean, dry area.

B. When indoor storage is not possible, the motors must be covered with a tarpaulin. This cover should extend to the ground; however, it should not tightly wrap the motor. This will allow the captive air space to breathe, minimizing formation of condensation. Care must also be taken to protect the motor from flooding or from harmful chemical vapors.

C. Whether indoors or out, the area of storage should be free from ambient vibration. Excessive vibration can cause bearing damage. A unit which must be stored in areas with high ambient vibration, such as from heavy construction equipment or other sources, must have the shaft locked to prevent any movement.

D. Precautions should be taken to prevent rodents, snakes, birds, or other small animals from nesting inside the motors. In areas where they are prevalent, precautions must be taken to prevent insects, such as mud dauber wasps, from gaining access to the interior of the motor.

E. Inspect the rust preventative coating on all external machined surfaces, including shaft extensions. If necessary, recoat the surfaces with a rust preventative material, such as Rust Veto No. 342 (manufactured by E.F. Houghton Co.) or an equivalent. The condition of the coating should be checked periodically and surfaces recoated as needed.

F. Bearings:

1) Grease lubricated cavities must be completely filled with lubricant during storage. Remove the drain plug and fill cavity with grease until grease begins to purge from drain opening. Refer to the section on "LUBRICATION" in the Installation/Maintenance Instruction and/or review motor's lubrication nameplate for correct lubricant.

CAUTION

Do not attempt to grease bearings with drain closed, or when unit Is In operation.

2)Oil lubricated motors are shipped without oil and must be filled to the maximum capacity as indicated on the oil chamber sight gauge window immediately upon receipt. Fill reservoir to maximum level with a properly selected oil containing rust and corrosion inhibitors such as Texaco Regal Marine #77, Mobil Vaprotec Light, or an equivalent.

NOTE: Motor must not be moved with oil in reservoir. Drain oil before moving to prevent sloshing and possible damage, then refill when at new location

G. To prevent moisture accumulation, some form of heating must be utilized to prevent condensation. This heating should maintain the winding temperature at a minimum of 5°C above ambient. If space heaters are supplied, they should be energized. If none are available, single phase or "trickle" heating may be utilized by energizing one phase of the motor's winding with a low voltage. Request the required voltage and transformer capacity from Nidec Motor Corporation. A third option is to use an auxiliary heat source and keep the winding warm by either convection or blowing warm air into the motor.

3. Periodic Maintenance.

A. Oil should be inspected monthly for evidence of moisture or oxidation. The oil must be replaced whenever contamination is noted or every twelve months; whichever occurs first.

B. Grease lubricated bearings must be inspected once a month for moisture and oxidation by purging a small quantity of grease through the drain. If any contamination is present, the grease must be completely removed and replaced.

C. All motors must have the shaft rotated once a month to insure the maintenance of a coating lubricant film on the bearing races and journals.

D. Insulation History:

The only accurate way to evaluate the condition of the winding insulation is to maintain a history of the insulation readings . Over a period of months or years these readings will tend to indicate a trend. If a downward trend develops, or if the resistance drops too low, thoroughly clean and dry the windings, retreating if necessary, by an authorized electrical apparatus service shop.

The recommended insulation resistance test is as follows:

(1) Using a megohm meter, with winding at ambient temperature, apply DC voltage (noted below) for sixty seconds and take reading.

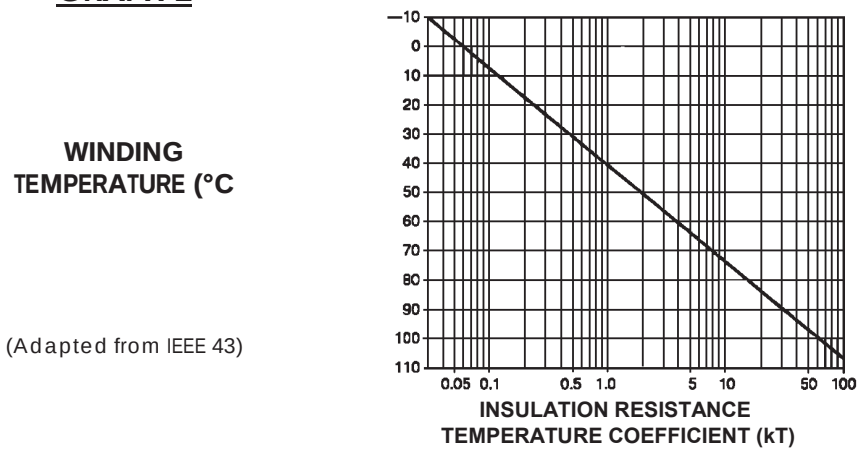
Rated Motor Voltage	Recommended DC Test Voltage
600 and less	500 VDC
601 to 1000 (incl.)	500 to 1000 VDC
1001 and up	500 to 2500 VDC (2500 VDC optimum)

(2) For comparison, the reading should be corrected to a 40°C base temperature. This may be done by utilizing the following:

R40C = Kt X Rt

Where R40C = insulation resistance (in megohms) corrected to 40°C
Rt = measured insulation resistance (in megohms)
Kt = temperature coefficient (from Graph 1)

GRAPH 1



(Adapted from IEEE 43)

(3) Insulation resistance readings must not drop below the value indicated by the following formula:

Rm = Kv + 1

Rm = minimum insulation (in megohms) at 40°C
Kv = rated motor voltage in kilovolts

(4) Dielectric absorption ratio:

In addition to the individual test reading, a dielectric absorption ratio may be required. The dielectric absorption ratio is obtained by taking megohm meter readings at a one minute and ten minute interval, or when hand powered megohm meters are used, at a thirty second and sixty second interval. The voltage should be the same as outlined in item 3D, part 1.

The ratio is obtained by dividing the second reading by the first reading and is based on a good insulation system increasing its resistance when subjected to a test voltage for a period of time. The ratios are as follows:

10 Minute: 1 Minute
Dangerous = Less than 1.0
Poor = 1.0 to 1.4
Questionable = 1.5 to 1.9
Fair = 2.0 to 2.9
Good = 3.0 to 4.0
Excellent = Over 4.0

60 Second: 30 Second
Poor = Less than 1.1
Questionable = 1.1 to 1.24
Fair = 1.25 to 1.3
Good = 1.4 to 1.6
Excellent = Over 1.6

If a lower insulation resistance reading is obtained in either the individual test or dielectric absorption ratio test, thoroughly clean and dry the windings. Recheck insulation resistance and dielectric absorption ratio.

NOTE: Slightly lower dielectric absorption ratios may be acceptable when high initial insulation resistance readings are obtained (1000 + megohms). Refer any questions to Product Service department.

For additional information on insulation testing, refer to IEEE Transaction No. 43.

4. Start-up Preparations After Storage.

A. Motor should be thoroughly inspected and cleaned to restore to an "As Shipped" condition.

B. Motors which have been subjected to vibration must be disassembled and each bearing inspected for damage.

C. Oil and/or grease must be completely changed using lubricants and methods recommended on the motor's lubrication plate, or in the section titled "LUBRICATION" in the Installation/Maintenance manual.

D. The winding must be tested to obtain insulation resistance and dielectric absorption ratio as described in section III. item 3.

E. If storage has exceeded one year, the Quality Assurance Department must be contacted prior to equipment start-up.