

**Pinellas Environmental Restoration Project
Northeast Site Non-Aqueous Phase Liquids
Interim Measures Progress Report**

October through December 2002

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Prepared by
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Acronyms and Abbreviations

°C	degrees Celsius
DNAPL	dense non-aqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
LNAPL	light non-aqueous phase liquid
NAPL	non-aqueous phase liquid
STAR Center	Young - Rainey Science, Technology, and Research Center

1.0 Introduction

This report is the second quarterly report for the in-situ thermal remediation at the Northeast Site. The previous report covered the period from May 2002 through September 2002. It provided background information for the site, a description of the remediation process, and descriptions of the activities and events that took place to construct the remediation system for Area A.

This report describes the activities that occurred from October 2002 through December 2002. All activities during this period relate to remediation at Area A. Activities during this period included operation of the system.

2.0 Summary of Activities

Construction of the in-situ thermal remediation system was initiated on May 20, 2002, and completed on September 23, 2002. A Readiness Review for operations was completed on September 24 and 25, 2002, and initial operation of the system started on September 26, 2002. Before operations began, an Operations Oversight Team was established to evaluate, monitor, and set direction for activities during operations phase. Team members consisted of the SteamTech Project Manager, SteamTech Lead Engineer, SteamTech Operations Advisor, McMillan-McGee Electrical Engineer, McMillan-McGee Data Manager, Stoller Non-Aqueous Phase Liquid (NAPL) Technical Lead, and Stoller Pinellas Project Manager. The Operations Oversight Team held a weekly conference call to discuss the operational status, review data and process information, discuss future decision, and agree on the next course of action.

For the first week of operations, the only activities involved establishing hydraulic and pneumatic control. There was no heating with the resistive heating system or injection of steam during this period. By October 3, 2002, hydraulic control had been achieved, as indicated by a significant drawdown of the aquifer within in the remediation area. Also, a good flow of vapor from the vapor extraction wells had been established which indicated pneumatic control.

The initial heating of the remediation area was done using only the resistive heating electrodes. Electrodes that are set in the top of the Hawthorn and bottom of the surficial sands and around the perimeter of the remediation area were used to preheat these areas. Preheating the areas with resistive heating would allow the steam injection in these areas to be more effective. After about a week of heating only the Hawthorn and perimeter area with resistive heating, electrodes within the interior of the remediation area were energized to preheat that area. Heating with only the electrical resistive heating system continued until October 22, 2002. Steam injection around the perimeter of the remediation system was initiated on October 23, 2002.

Steam injection around the perimeter was done to form a barrier around the contamination and push it toward the extraction wells on the interior of the remediation area. Preheating the areas with resistive heating allowed the steam to preferentially sweep through the preheated regions and not be hampered by the formation of a condensation front. Steam injection around the perimeter of the remediation area continued throughout the period.

During injection of steam around the perimeter, heating with the electrodes in the Hawthorn, around the perimeter, and in the interior continued. Also, at all times during operations, ground water and vapor extraction was ongoing. Ground water extraction averaged 20 to 30 gallons per

minute and was generally 25 percent more than what was injected via steam and as cooling water for the electrodes. [Figures 1 and 2](#) show the water balance comparing how much water was injected and how much water was extracted.

The next phase of operations was to heat the entire site. This phase started on November 6, 2002. It involved steam injection around the perimeter, steam injection at the interior wells, electrical heating in the perimeter, electrical heating in the Hawthorn, and electrical heating in the interior of the remediation area. Aggressive extraction of ground water and vapors continued during this phase. The minimum temperature of 84°C throughout the remediation area was reached on November 15, 2002. Significantly higher temperatures (up to 115°C) were reached in the Hawthorn and in the lower portion of the remediation area. [Figure 3](#) shows the energy balance for the remediation. It compares and shows the energy applied by steam injection and electrical heating, the total energy injected, and the energy extracted.

Pressure cycling, the next phase of operations, began on November 16, 2002, after the entire site reached the minimum temperature. This operational phase involved inducing a pressure change in the formation by varying the steam injection pressure, the electrical heating rate, and the applied vacuum. This was done to increase the amount of contaminants that are removed from the subsurface. The pressure cycling phase continued through the end of December 2002 and will continue until the anticipated end of the active heating period on January 31, 2003.

A pressure cycle lasts approximately 1 week. It involves injecting steam at a relatively high pressure for a few days and then reducing the steam pressure and increasing the vapor extraction rate. The first three pressure cycles resulted in a significant mass of contaminants being released and captured by the vapor extraction system, [Figures 4 and 5](#). Subsequent pressure cycles resulted in less dramatic contaminant removals because the majority of the contaminants had been removed by this time. As shown in [Figure 5](#), by the end of December 2002, approximately 5,500 pounds of contaminants had been removed from Area A. This mass estimate is calculated based on readings taken with an organic vapor analyzer equipped with a photoionization detector.

Throughout operations, the temperature of the subsurface was monitored with thermocouples. These temperatures were monitored real time via a website and were used to “fine tune” the operations. The temperature data were used to determine where additional energy was needed and where less energy was needed. The temperature of the extracted vapor and ground water was also monitored to evaluate the subsurface temperature. [Figure 6](#) shows the average temperature of the vapor and liquid extracted from the remediation area.

3.0 Deviations

There were no deviations from the general concept of the remediation. However, there were enhancements and changes made to the remediation system in response to operational problems. An air stripper was added to the ground water treatment system. This was added to reduce the amount of contaminants that were sent to the liquid carbon adsorption vessels. The reasons for the change and problems associated with this issue are discussed in Section 4.0, “Problems.” The air stripper is located downstream of the clarifier and upstream of the liquid carbon adsorption vessels. [Figure 7](#) is a simplified process flow diagram showing the location of the air stripper in the system. The effluent air from the stripper is sent to either the primary vapor phase carbon

vessels, which are regenerated on site with steam, or to a polishing carbon vessel. Also, additional carbon was added to the carbon adsorption vessels to ensure wastewater discharges to the Young - Rainey Science, Technology, and Research Center (STAR Center) Wastewater Neutralization Facility did not exceed allowable levels. The as-built condition of the carbon vessels had 3,000 pounds of carbon in three vessels. After the modification, there were 6,000 pounds of carbon in three vessels and an additional 1,000 pounds in a fourth polishing carbon vessel.

Another change made to the treatment system was to add a NAPL separation tank. The design and as-built condition of the treatment system called for light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) to be separated in the clarifier and sent from there to the LNAPL and DNAPL waste storage tanks. In addition, LNAPL and DNAPL collected during regeneration of the vapor phase carbon would be sent to the waste storage tanks. However, the clarifier and the collection tank for the vapor phase carbon did not work well at separating the NAPL. Most of the NAPL remained suspended in the water. Therefore, an additional process tank, a NAPL separation tank, was added to the system. Condensate from regeneration of the vapor carbon is sent to this 20,000-gallon tank, where the NAPL should have sufficient time to separate from the water.

A change made to the well field was to convert the ground water extraction wells to dual phase extraction wells. When the subsurface temperatures increased to the point where there was live steam in the subsurface, the pumps on the extraction wells would no longer pump water. To continue to extract water phase from the subsurface, the wells were modified to be dual phase extraction wells. This allowed the liquid phase to be extracted with the vapor, which worked well. Figure 2 shows that the extraction rate for the water has remained steady or increased over time.

A final change was to replace the steam injection screens on three wells, SE-11, SE-18, and SE-20 and abandon one steam injection well, SE-1. Problems with electrically isolating the steam hoses from the electrodes in the wells caused the subsurface portions of the screens to fail. This issue is discussed more in Section 4.0, "Problems."

4.0 Problems

Although the remediation has proceeded well, there were operational problems. Perhaps the most significant problem was with the ground water treatment system. Initially, there was more methylene chloride in the extracted ground water than what was estimated in the design. The carbon adsorption system became saturated with methylene chloride sooner than was anticipated or realized. This resulted in higher than allowable levels of total toxic organics (primarily methylene chloride) in the wastewater discharged to the STAR Center Wastewater Neutralization Facility. The levels of total toxic organics sent to the Publicly Owned Treatment Works were not above planned levels and, therefore, not a permit violation. To address this problem, the liquid treatment system was modified by adding an air stripper and more carbon to the carbon adsorption vessels, described in Section 3.0. Also, the frequency of sampling the liquid stream was increased and a fourth carbon vessel was added as a final polishing step.

Another problem was in electrically isolating the steam hoses in the "SE" wells. The "SE" wells contain a resistive heating electrode and a steam injection hose and screen. When energy was

applied to the electrodes in the wells, the subsurface steam hoses in some wells were not electrically isolated. This resulted in the subsurface portion of the steam hoses and fiberglass screens failing. As described above, the corrective action was to install a new steam injection well for three of the wells. The steam injection well that was not replaced was not considered critical.

On November 11, 2002, there was a spill of up to 50 gallons of treated water from the clean water holding tank. Although this was not a permit or regulatory violation, corrective measures were taken to ensure a spill did not occur again. A warning light, visible from the operations trailer, was added to the system to notify the operators whenever levels become too high.

A problem previously discussed in Section 3.0, "Deviations," was the difficulty in separating the NAPL from the water. Although changes have been made to the system, resolution of this problem is ongoing.

Lastly, the electrical resistive tomography did not work as well as expected. It was designed to give a three-dimensional temperature profile of the subsurface. However, interpretation of the data to define a subsurface temperature profiles could not be done. In addition, operation of the electrical resistive tomography system required that the resistive heating be shut down to take readings. This proved to be labor intensive. Because of the problems with electrical resistive tomography, it was not used for operational decisions or monitoring. Temperature monitoring was done completely with the thermocouples. The thermocouples were placed close enough to provide an excellent subsurface temperature profile and not having the electrical resistive tomography data did not hinder operations.

5.0 Upcoming Activities

Pressure cycling will continue in January 2003. According to the current schedule, the active heating phase will end on January 31, 2003. After the active heating phase is complete, the site will be cooled to approximately 95° to 90°C. The cooling phase will last 2 to 3 weeks. Demobilization of the well field and treatment will follow the cooling phase. Demobilization activities will last approximately 2 months. Waste management operations that generate hazardous waste will continue into February 2003 and possibly into March 2003.

The final activities for Area A are confirmatory sampling and the final report. Confirmatory sampling of the ground water and soil will be done to ensure contaminant levels are below the target cleanup standards. Three confirmatory sampling rounds will occur, one at approximately four weeks after active heating is complete, one at 12 weeks after active heating, and one at 24 weeks after active heating. Results from sampling completed during remediation and the confirmatory sampling will be included in the Final Report.

The initial activities for remediation of Area B will start in Spring 2003. These activities will involve evaluation of the permitting and environmental compliance requirements and some preliminary activities associated with the conceptual design.

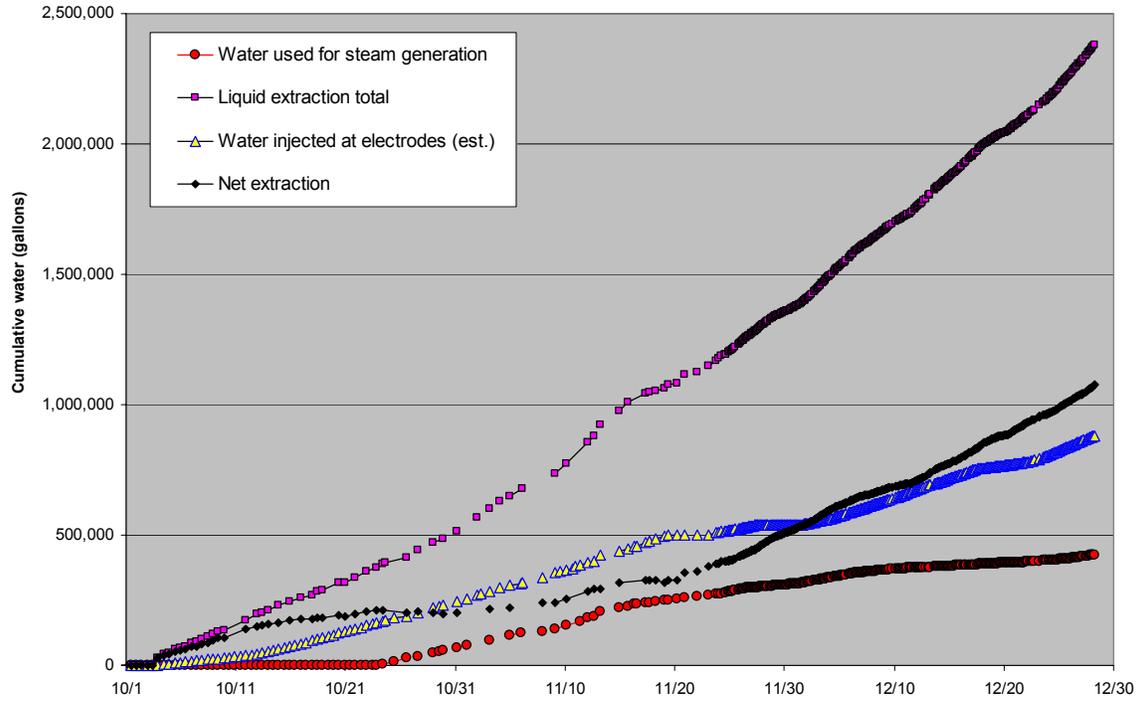


Figure 1. Water Balance for Area A

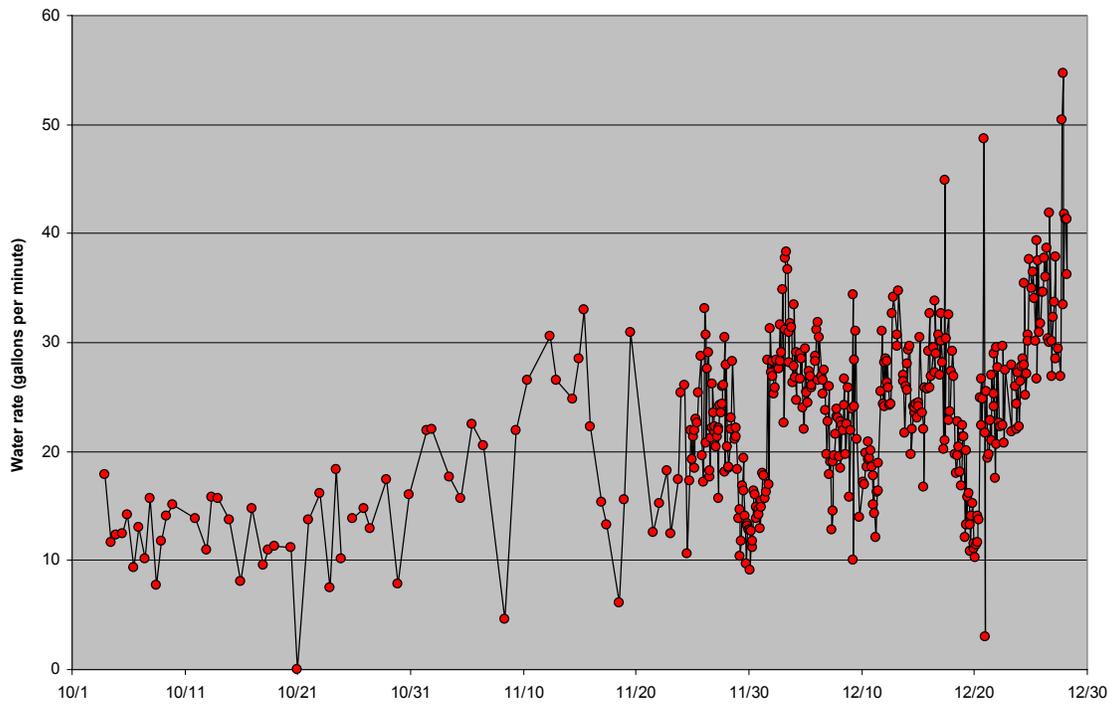


Figure 2. Total Liquid Extraction Rate

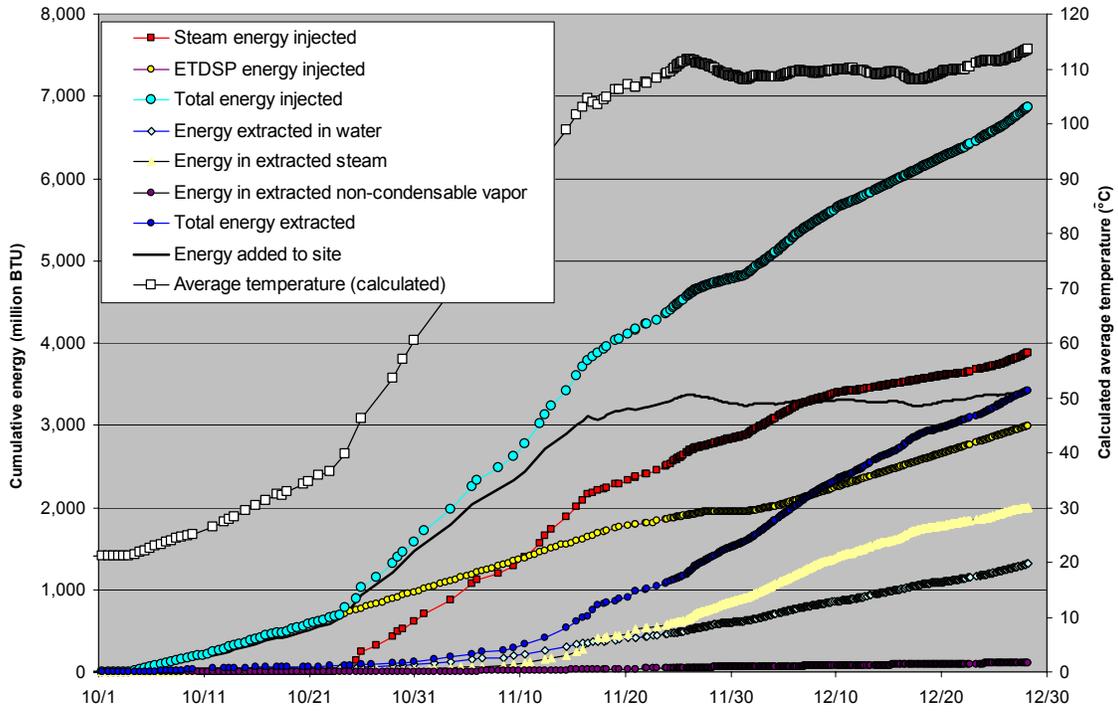


Figure 3. Energy Balance

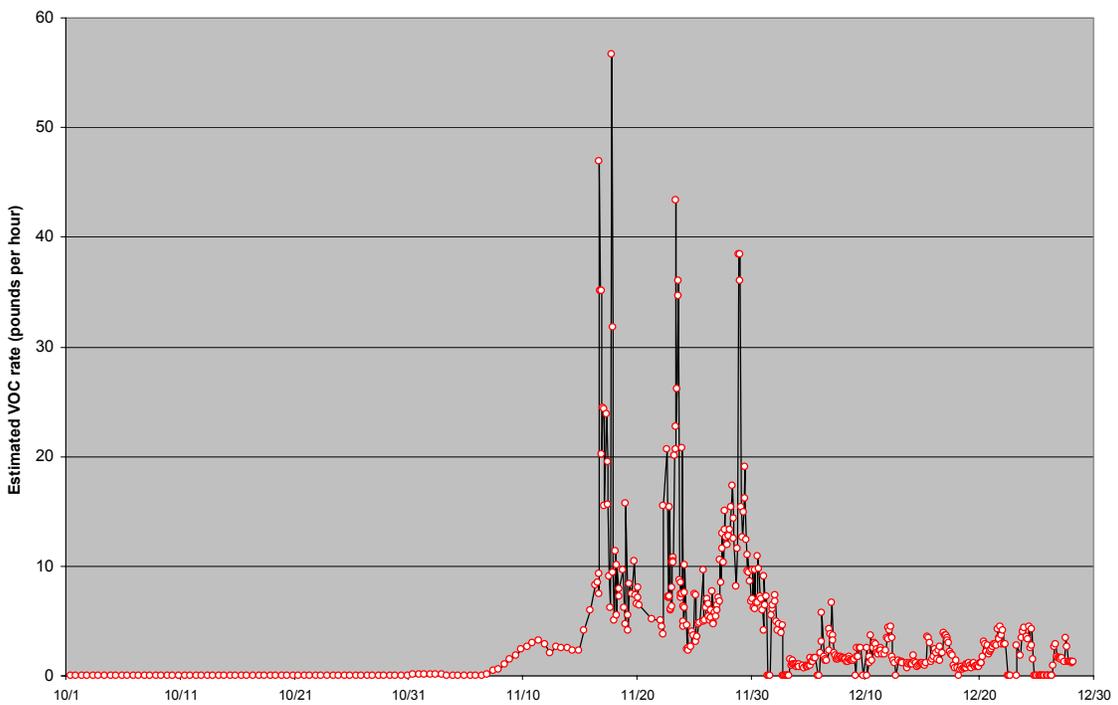


Figure 4. Estimated VOC Removal Rate Based on PID Readings at Sample Port V-1 (untreated vapor)

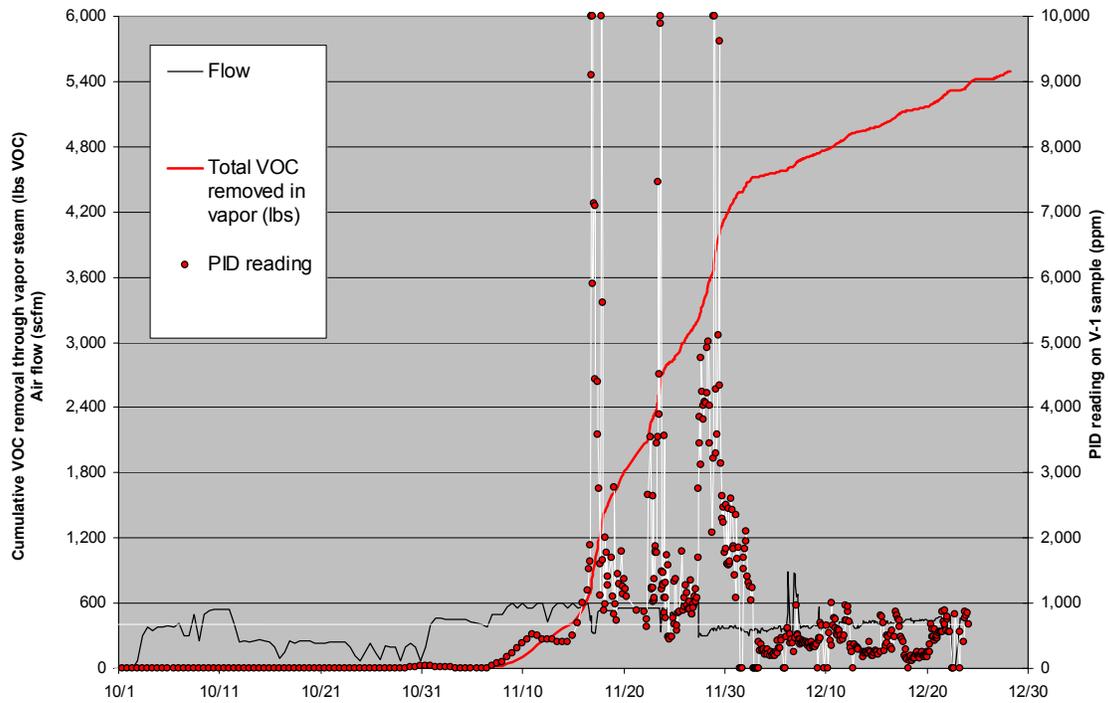


Figure 5. Estimated Cumulative VOC Removal in Vapor Based on PID Readings on V-1

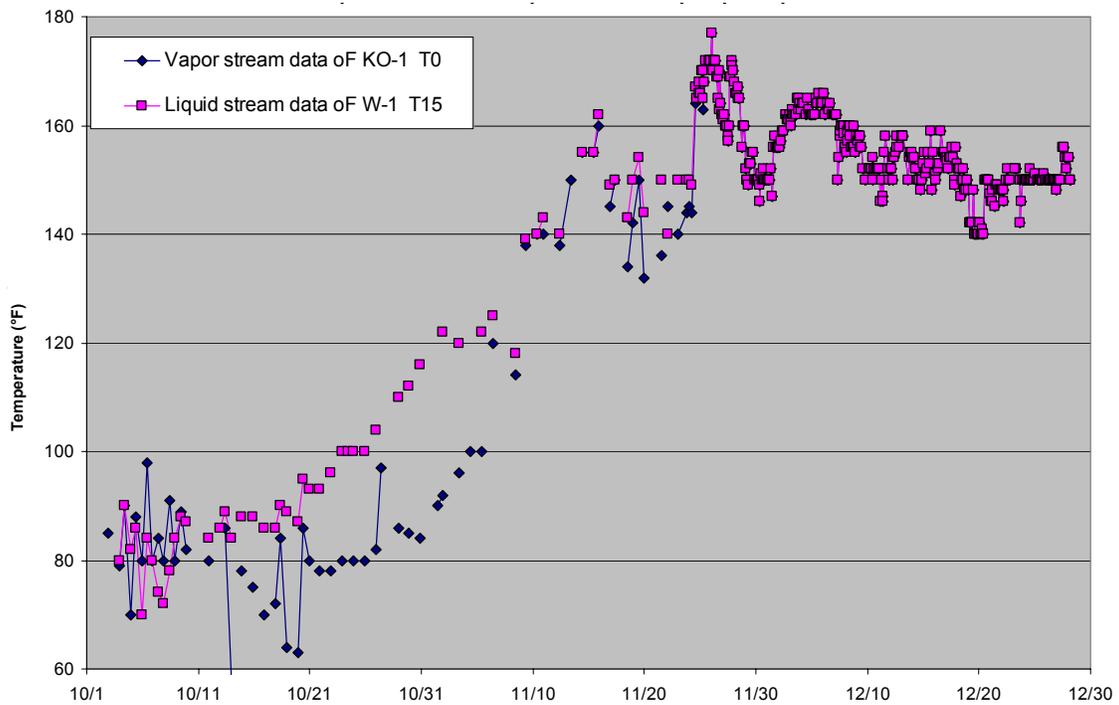


Figure 6. Temperatures of Total Vapor Stream and Pumped Liquid

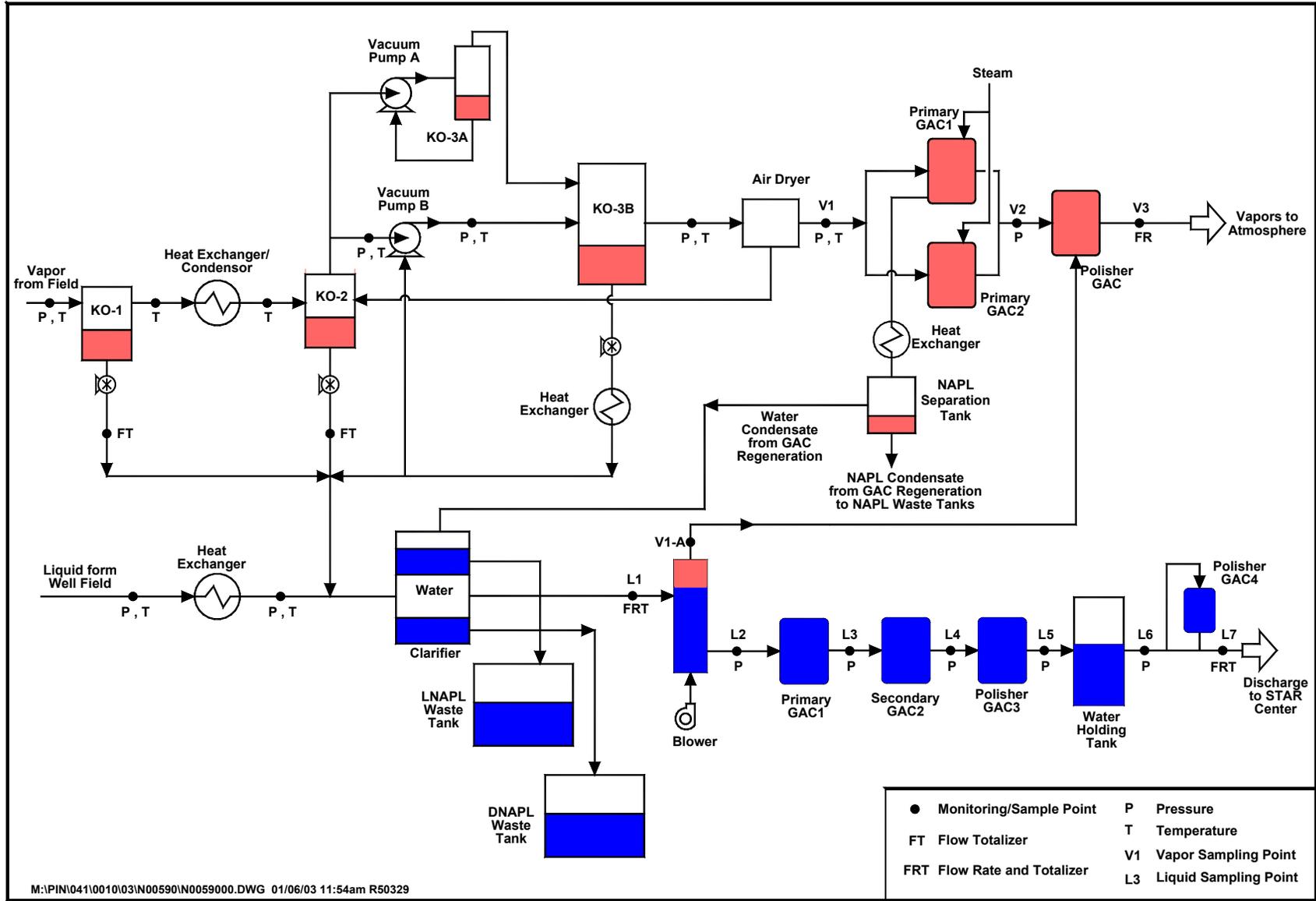


Figure 7. Treatment System Process Flow Diagram