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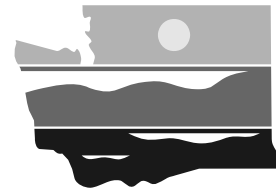
Draft Cleanup Action Plan

**Bothell Service Center Simon & Son
18107 Bothell Way NE Bothell,
Washington**

**FSID # 33215922
VCP # NW2946**

Issued By:

**Washington State Department of Ecology
Toxics Cleanup Program
Northwest Regional Office
3190 160th Avenue SE
Bellevue, Washington 98008**



DEPARTMENT OF
ECOLOGY
State of Washington

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1.0 INTRODUCTION

This draft Cleanup Action Plan (dCAP) was prepared by Kane Environmental, Inc., (Kane Environmental) for the Bothell Service Center Simon & Son Site (BSCSS; the Site) in Bothell, Washington. This dCAP was prepared for the Washington State Department of Ecology (Ecology) in collaboration with the City of Bothell. A vicinity map and Site location are shown on Figure 1. This dCAP has been prepared to meet the requirements of the Model Toxics Control Cleanup Act (MTCA) administered by Ecology under Chapter 173-340 of the Washington Administrative Code (WAC). This dCAP describes Ecology's proposed cleanup action for this site and sets forth the requirements that the cleanup must meet.

The property containing the source of contamination was previously owned by Bothell Service Center Associates (BSCA) and managed by NLO Property Management (BSCA property). The City of Bothell is the current owner of the BSCSS property and the City owns roadways and other parcels adjacent to the BSCSS property which are also part of the Site. The City is in the process of obtaining a Consent Decree to implement this Cleanup Action Plan for the Site with Ecology and the Attorney General's Office.

The BSCSS property address is 18107 Bothell Way NE, Bothell, WA 98011. The King County Assessor's Office lists the parcel number as 237420-0065. The BSCSS property previously included a one-story, masonry, commercial building approximately 8,410 square feet in area, containing five tenant suites. The building on the BSCSS property and associated aboveground features were demolished in August 2016. The BSCSS property currently contains the concrete at-grade floor of the previous demolished building, and the asphalt paving is also still present.

Kane Environmental completed a draft Remedial Investigation and Feasibility Study for the Site dated August 25, 2017. The Remedial Investigation delineated the extent of halogenated volatile organic compound (HVOC) impacts to both soil and groundwater at the site. The primary source of current HVOC contamination on the Site is from releases associated with historical dry cleaning operations on the BSCA property. The Contaminants of Concern (COCs) in soil and groundwater are Tetrachloroethene (PCE), Trichloroethene (TCE), Cis-1,2 Dichloroethene (DCE) and Vinyl Chloride (VC).

Four remedial alternatives were evaluated in the draft Feasibility Study (draft FS) and are summarized below:

Alternative 1 – Limited Source Soil Excavation and Bioremediation. Emulsified oil product (EOS®) is injected into the groundwater in order to remediate the groundwater through reductive dechlorination.

Alternative 2 – Electrical Resistance Heating (ERH) Bioremediation and Recirculation. Electrical resistance heating (ERH) is used to heat the soil and ground water at the source area. The volatilized

contaminants are removed by soil vapor extraction. An array of wells will remove contaminated groundwater and treat it with activated carbon, amended with a bioremediation product, Carbstrate[®]. It is then re-injected into the aquifer to stimulate anaerobic bioremediation of PCE and its breakdown products.

Alternative 3 – Air Sparging and Soil Vapor Extraction (AS/SVE). Air sparging introduces compressed air into the groundwater to enhance volatilization of contaminants in groundwater and soils. Volatilized contaminants are then recovered via vapor extraction of the overlying vadose zone. The vapors are run through a remediation system, and then discharged into the atmosphere following state and local permit requirements.

Alternative 4 – Excavation to Depth of Glacial Till and Monitored Natural Attenuation. Excavation would remove the source of contamination to its full vertical extent (down to 55 feet). Clean, compacted imported fill material will replace the excavated contaminated soil. Following source soil removal activity, monitored natural attenuation (MNA) would be implemented to remediate the groundwater plume.

Preferred Alternative

Alternative 2 – Electrical Resistance Heating (ERH) Bioremediation and Recirculation

Based on the results of the remedial investigation and feasibility study conducted under MTCA and the application of the selection of remedy criteria, the Preferred Alternative chosen is Alternative 2, Electrical Resistance Heating (ERH) Bioremediation and Recirculation, developed in accordance with WAC 173-340-350 through 173-340-390. Alternative 2 will be the primary alternative supplemented with limited and targeted soil excavation and disposal, and soil vapor extraction in the vadose zone. Additionally, contingency-based focused and targeted excavations may be utilized if post-ERH soil confirmation sampling determines that residual HVOC-impacted soils remain in the vadose zone soils in the area of the ERH activity on the BSCA property. Use of engineering controls and institutional controls are included on a contingency basis and may be used after the remedial action has been completed. Potential vapor intrusion, associated with future development, will be mitigated by the installation of vapor barriers and passive venting systems, or other vapor intrusion mitigation methods and documented in an environmental covenant.

1.1 Purpose

This document is the draft Cleanup Action Plan (dCAP) for the Bothell Service Center Simon & Son Site located Bothell, Washington. The general location of the Site is shown in Figures 1 and 2. A CAP is required as part of the site cleanup process under Chapter 173-340 WAC, Model Toxics Control Act

(MTCA) Cleanup Regulations. The purpose of the dCAP is to describe the preferred cleanup alternative for the Site determined from the RI/FS. More specifically, this plan:

- Describes the Site;
- Summarizes current site conditions;
- Summarizes the cleanup action alternatives considered in the remedy selection process;
- Describes the selected cleanup action for the Site and the rationale for selecting this alternative;
- Identifies site-specific cleanup levels and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action;
- Identifies applicable state and federal laws for the proposed cleanup action;
- Discusses performance and compliance monitoring requirements; and
- Presents the schedule for implementing the dCAP.

Ecology has made a preliminary determination that a cleanup conducted in conformance with this dCAP will comply with the requirements for selection of a remedy under WAC 173-340-360.

1.2 Regulatory Framework

The Site is listed in Ecology's database as Bothell Service Center (BSC), and also as Simon & Son Fine Drycleaning. The Site is assigned facility number 33215922 for dry cleaning solvent contamination in soil and groundwater. The VCP number for the Site is NW2946 and Cleanup Site ID No. 427. It should be noted that the Site was formerly in the VCP as project number NW0794 from 2001 to 2006.

Ecology lists the Site Discovery/Release Report having been received on August 1, 2001 (Ecology, 2015a). On February 16, 2015, the City of Bothell entered the Site into Ecology's Voluntary Cleanup Program.

Implementation of this cleanup plan will be under a consent decree that settles only for the Bothell Service Center Simon & Son Site HVOC contamination and does not ascribe regulatory compliance and settlement for other contaminated sites located on Lot D such as the Schuck's/Wexler and Bothell Former Hertz sites.

2.0 SITE DESCRIPTION

2.1 Site History

The property containing the source of contamination was previously owned by Bothell Service Center Associates (BSCA) and managed by NLO Property Management (BSCA property). The City of Bothell is the current owner of the BSCSS property and the City owns roadways and other parcels adjacent to the BSCSS property, which are also part of the Site. The City is in the process of obtaining a Consent Decree to implement a Cleanup Action Plan for the Site with Ecology and the Attorney General's Office.

The BSCSS property address is 18107 Bothell Way NE, Bothell, WA 98011. The King County Assessor's Office lists the parcel number as 237420-0065. The BSCSS property previously included a one-story, masonry, commercial building approximately 8,410 square feet in area, containing five tenant suites. The building on the BSCA property and associated aboveground features were demolished in August 2016. The BSCA property currently contains the concrete at-grade floor of the previous building, and the asphalt paving is also still present.

Per MTCA, a "Site" is "any site or area where a hazardous substance...has been deposited, stored, disposed of, or placed, or otherwise come to be located". Figure 2 shows the approximate extent of the Site as defined by the extent of HVOC, primarily the dry cleaning solvent PCE, at concentrations greater than Washington's Model Toxics Control Act (MTCA) Method A groundwater and soil cleanup levels. The HVOC plume originating from the former Simon & Son Fine Drycleaning facility on the BSCSS property is known to exist beneath the BSCSS property and extend onto adjacent and downgradient properties, including (from up- to down-gradient):

- 98th Avenue NE, located to the west and southwest of the BSCA property;
- The vacated portion of State Route 522 located immediately south of the BSCA property;
- The adjoining former Al's Auto Bothell Wexler property to the east, now owned by the City;
- The location of the Bothell Former Hertz Facility (former Hertz property) south of the vacated portion of SR522, now vacant, undeveloped, and also owned by the City.

2.2 Human Health and Environmental Concerns

The RI/FS identified exposure pathways of COCs at the Site. Based on the nature and the extent of contamination, the likely greatest potential risk to human receptors is dermal contact of soil and/or groundwater to construction workers during soil-disturbing activities. The second most likely exposure risk is inhalation of vapors during soil-disturbing activities or by commercial workers.

These risks can be mitigated under a cleanup action that either removes the contaminants to levels that are protective to receptors or that places institutional or engineering controls to prevent exposure, following MTCA requirements.

Based on the nature and extent of contamination, the likely greatest potential risk to ecological receptors include incidental soil ingestion and dermal contact, as well as ingestion and direct contact with groundwater. Based on the exposure pathways analysis, the land use on the Site and the surrounding area make wildlife exposure unlikely.

See Figure 3 for the Conceptual Site Model.

2.3 Cleanup Standards

The COCs in soil and groundwater are Tetrachloroethene (PCE), Trichloroethene (TCE), Cis-1,2 Dichloroethene (DCE) and Vinyl Chloride (VC).

The selected cleanup levels for the identified Constituents of Concern in soil are as follows:

- MTCA Method A Soil Cleanup Levels for Unrestricted Land Uses (WAC 173-340-900, Table 740-1), and MTCA Method B Direct Contact values:
 - PCE 0.05 mg/kg
 - TCE 0.03 mg/kg
 - Cis-1,2 DCE 160 mg/kg (MTCA Method B)
 - VC 175 mg/kg (MTCA Method B)
- MTCA Method A Cleanup Levels for Groundwater (WAC 173-340-900, Table 720-1), and MTCA Method B Noncancer:
 - PCE 5 ug/L
 - TCE 5 ug/L
 - Cis-1,2 DCE 16 ug/L (MTCA Method B)
 - VC 0.2 ug/L

The points of compliance are the locations at which cleanup levels for the Contaminants of Concern (COCs) must be attained to meet the requirements of MTCA and support issuance of a satisfaction of Order or Decree for the Site and subsequent delisting. In accordance with WAC 173-340-740(6), the point of compliance for soil is all soil within the boundaries of the Site. In accordance with WAC 173-

340-720(8), the point of compliance for groundwater is all groundwater within the boundaries of the Site.

A Remediation Level of 1 ppm for PCE in soil will be used in case the MTCA Method A Soil Cleanup Level is not achieved in the ERH remedial action area.

3.0 DESCRIPTION OF SELECTED REMEDY

An array of electrical resistance heating (ERH) wells will be installed in the area of the former dry cleaning operation, and will extend to the west along the east side of 98th Avenue NE, south beyond the former BSC building footprint, and east to approximately half the distance of the former BSC building footprint. The ERH system will operate for approximately six months. Concurrently, injection and extraction wells will be installed in the remaining area of the PCE plume. The injection wells will place a bioremediation product into the subsurface groundwater, and at the same time, remove groundwater from edge of the plume. This will create groundwater recirculation cycle will be controlled by pumps located in an aboveground trailer. The extracted groundwater will be run through activated carbon, and then this clean groundwater will be amended with the bioremediation product, and re-injected into the groundwater. Groundwater performance monitoring will be conducted during both activities (ERH and Bioremediation). There is also an area of PCE contaminated soil in the eastern portion and adjacent to the east perimeter of the former BSC building, that will be removed by soil vapor extraction (SVE). The SVE system will be separate from the ERH and Bioremediation systems and operate for approximately six months. Also, localized, targeted soil excavation of PCE contaminated soil will be conducted in near-surface soil in the eastern area of the former BSC building footprint that was identified during site characterization.

3.1 General Description of the Cleanup Action

Based on the results of the remedial investigation and feasibility study conducted under MTCA (Kane Environmental, 2017) and the application of the selection of remedy criteria, the Preferred Alternative is Alternative 2 (Electrical Resistive Heating/Bioremediation with Groundwater Recirculation), augmented by targeted soil excavation and soil vapor extraction, developed in accordance with WAC 173-340-350 through 173-340-390. Alternative 2 will be implemented as the primary alternative for source control and plume remediation. Figure 4 shows the layout for the ERH thermal remediation, Soil Vapor Extraction, and Groundwater Bioremediation and Recirculation systems.

Remediation of other areas of contamination outside of the electrical resistive heating (ERH) remediation zone will be addressed by groundwater bioremediation and recirculation, targeted soil excavation and disposal, and soil vapor extraction in the vadose zone. Use of additional vadose soil excavation and removal in the source area (ERH treatment zone) engineering controls and institutional controls are included on a contingency basis if the MTCA Method A soil cleanup levels in the vadose zone soils are

not met. Furthermore, a vapor barrier and passive venting system, or other vapor intrusion mitigation measures, will be implemented in the areas of the building development as part of the environmental covenant.

3.2 Electrical resistance heating (ERH)

ERH involves heating the soil and groundwater using electrodes installed in wells in the source area, and connected to a source of electricity, resulting in heating of the subsurface soil and groundwater. The subsurface is heated to a range of 80 to 100 degrees Centigrade (°C), which then volatilizes the contaminants into the unsaturated zone where they are removed by soil vapor extraction.

Installation of the ERH system includes drilling boreholes, installing electrodes and temperature monitoring probes, and soil vapor extraction screens in each borehole, and staging and connecting operating equipment (power control unit, transformer, power cables, vapor recovery lines, activated carbon, steam condenser, blower, and cooling tower). One of the six 55-foot deep ERH electrode will be placed at monitoring well location MW-9 where DNAPL was encountered. The boreholes are drilled in a triangular grid pattern (typically 15-foot spacing) that is located to optimize electrical and thermal distribution in the subsurface. The backfill around the electrode/vapor screen consists of a conducting material such as a sand and graphite or sand and steel shot mix. The electrodes are in electrical contact with the soil matrix throughout the target soil zone. The vapor extraction screen would be positioned over the target interval, in the unsaturated zone.

Once the electrode and vapor recovery system is constructed, including connection of all electrical and vapor lines at the surface, then the system would undergo functional testing. After testing is successfully completed, the system would be turned on. Electrical power is supplied continuously to the electrodes to heat up the subsurface. Heating the soil to the target temperature of 80°C to 100°C usually takes about 1 month. After the target temperature is achieved in approximately one month, it would be maintained for a period of 4 to 5 months to complete the thermal treatment. During the entire heating period, the vapor extraction system would be operating. As the soil is heated, contaminant vapor flow in the recovery system would progressively increase as the volatility of the contaminants increases. When the soil temperatures get close to the target, a significant amount of water would start to vaporize, which creates a steam-stripping effect for the volatiles. This steam is subsequently condensed in the steam condenser. Because of the heat and the steam-stripping effect, the removal of volatile contaminants from low-permeability silty soils is much more effective than standard air sparging and soil vapor extraction.

The progress of treatment with ERH is monitored through soil temperature monitoring of the subsurface, periodic collection and analysis of extracted vapors, and soil sampling for treatment confirmation. Thermocouples located at 5-foot intervals spanning the vertical target treatment zone would be used to track the subsurface soil temperature profile as it approaches and attains the target temperature. Air samples

collected weekly from the vapor recovery line, after the condenser and before the activated carbon treatment, would be used along with vapor recovery stream flow-rate readings, to track the total amount of volatile contaminants removed from the subsurface as thermal treatment progresses. Performance air samples will provide data to ensure that the activated carbon treatment system is not saturated by elevated recovery. The soil samples, typically collected at 60, 90, and 100 percent of the thermal treatment cycle, would be used to verify the extent of contaminant removal indicated by the air sampling results. The soil compliance sampling is conducted approximately 4 to 6 months after starting the system. The soil compliance monitoring plan will be included in the Engineering Design Report.

3.3 Post-ERH Remediation

Although the ERH treatment is expected to attain MTCA cleanup levels for groundwater and soil under optimal conditions, a remediation level of 1 ppm PCE in soil will be set as a targeted remediation goal for this component of the cleanup. If this is not met at the end of the treatment schedule, a decision can be made to either extend the duration of thermal treatment for a limited time or implement a contingency involving targeted vadose soil excavation in the ERH treatment area. Following this step, residual soil and groundwater contamination in the ERH treatment area will be addressed by engineered and institutional controls using an environmental covenant. Similarly, other areas of the site containing residual contamination not in compliance with cleanup levels despite remediation efforts in the CAP (bioremediation, groundwater treatment and recirculation, SVE) will also have engineered and institutional controls (environmental covenant) in order to be protective.

3.4 Bioremediation and Groundwater Recirculation System Approach

3.4.1 Process Overview

The groundwater recirculation system is an automated, programmable treatment process to extract contaminated groundwater, run the groundwater through activated carbon to remove HVOCs, add a remedial substrate (bioremediation), and reinject the groundwater/substrate mixture back into the aquifer. This recirculation provides a continuous supply of remedial substrate to be utilized by the established microbial community responsible for the Reductive Dechlorination (RD) process. Through operating injection vertical wells in conjunction with vertical extraction wells, artificial groundwater gradients can be produced within a groundwater plume to induce the cycling of biologically-active and remedial substrate-rich treatment water uniformly throughout the contaminated zone. In addition, the substrate injections promote desorption of the majority contaminant mass present on the soil matrix, thereby dissolving this mass into the groundwater and furthering the overall RD remedial process. The microbial community responsible for RD requires dissolved contamination as mass adsorbed to the soil matrix is not readily bioavailable to these microbes. The recirculation loop has the added benefit of providing a degree of hydraulic control to mitigate downgradient migration of the contaminated groundwater plume.

One groundwater recirculation system will be installed and used to operate in the Shallow, Intermediate and Deep portion of the aquifer at the same time. In addition, when the system is initially turned on and the extraction pumps are all extracting, groundwater elevations will be collected to evaluate the degree of communication with key monitoring locations and radius of influence.

As an example, dextrose is a substrate that binds to certain microbial enzymes and, in the presence of oxygen (what the microorganisms need to “breathe”), produces carbon dioxide and water (i.e. mineralization). This process is called aerobic oxidation. Anaerobic biodegradation can occur also, but is significantly different because the microorganisms have to use other compounds, in the absence of oxygen, to “breathe”. Microorganisms have a preference for which compounds they want to use for respiration, and these are referred to as terminal electron acceptors (TEAs). The generally accepted order of these TEAs, from most desired to least desired, are as follows:

Oxygen > Nitrate > Manganese (+4) > Iron (+3) > Sulfate > Carbon Dioxide

Since this is a predictable and reliable sequence these parameters can be measured/observed in groundwater to evaluate and characterize the microbial community in impacted saturated zones. Chlorinated solvents can be utilized by microorganisms as a TEA also, but their placement in this sequence varies widely. However, general academic research has shown that PCE and TCE tend to be utilized as a TEA at about the same time as nitrate and iron/manganese, while cis-DCE and VC tend to utilize about the same time as sulfate and carbon dioxide. So, complete dechlorination to ethene requires either sulfate-reducing or methanogenic conditions (i.e. when carbon dioxide is reduced to methane).

When all of the TEAs are utilized for microbial respiration they are ‘reduced’ because they are taking on electrons (negative charge) that come from the utilization of the primary substrate (i.e. electron donor and energy source). The reduction of these compounds causes the formation of different products. For instance, nitrate is reduced to nitrogen gas, ferric iron is reduced to ferrous iron (soluble form), sulfate is reduced to hydrogen sulfide, and carbon dioxide is reduced to methane. For the chlorinated solvents, a chlorine atom is replaced with a hydrogen atom, causing a change in the molecular structure (i.e. dechlorination). The final byproducts are ethene and/or ethane, which are benign, and are not recalcitrant because they are rapidly mineralized by microbes as a carbon/energy source.

The ultimate goal is to obtain contact between the substrate and the >95% chlorinated solvent mass sorbed to the organic fraction of the soil matrix in order to stimulate ERD where the bulk of the contaminant are sorbed. Without contact there is no reaction. Therefore, delivery of the substrate to the subsurface is paramount, which is why a groundwater recirculation approach was selected. Slug injections fail to achieve effective contact due to the generation of preferential flow pathways, while a long-term recirculation approach minimizes this problem. By inducing hydraulic gradients via

injection/extraction, a user can push/pull the amended groundwater to any location desired, even under existing buildings/roads. The most transmissive zones in the saturated zone will be the first to receive the amended groundwater, which will cause microbes to grow in the effective pore space. As they grow in the pore space they foul it with biomass, reducing the effective porosity in that zone, and facilitating fluid transport to the less transmissive zones.

The initial substrate, Carbstrate product, initiates the ERD process and causes the bulk of the pore space to be lightly fouled with biomass. At the end of the system operation substrate addition ceases causing the microbial death rate to increase, and the dead biomass begins to decay. This biomass then becomes a secondary, long-term substrate that sustains ERD for at least 1.5 - 2 years due to the rotting/decaying biomass generated from the substrate (behaves like an electron donor). Academic literature (Yang and McCarty, 2004) supports this concept that decaying biomass yields better ethene/ethane generation rates than primary substrates like lactate or soybean oil.

Chlorinated solvent retardation rates decrease from PCE to VC, so there will be varying rates of contaminant migration towards the extraction wells. Typically, cis-DCE and VC are observed at higher concentrations at the extraction well locations due to their higher solubility values and lower sorption coefficients. Each location is going to have its own unique baseline conditions, and we will be plotting the VOC data over time to evaluate contaminant transport/breakthrough and biotransformation at all locations. The main benefit of anaerobic dechlorination is that it enhances the desorption of the VOCs, making them more soluble and bioavailable.

One potential risk with this method is the possibility for biofouling, which occurs when bacteria, supported by the injected substrate, accumulate and grow around the well screen, inhibiting the productivity and function of the well. However, the proposed recirculation system is designed with precautionary measures and operational procedures in place to prevent biofouling, by adding the substrate using weekly injections, not on an on-going basis.

3.4.2 Substrate

Carbstrate™, a nutrient-amended carbohydrate amendment, is proposed as the electron donor substrate. Its qualities include high water solubility, no particulate matter, low viscosity, and a low retardation factor in order to ensure mobility within the target treatment zone. If the substrate has a low solubility or significant retardation factor, then delivery via induced hydraulic gradients would require multiple pore volumes of recirculation prior to achieving site-wide delivery. In addition to its solubility and low-retardation factor, it is a non-toxic, food-grade product that includes the macro-nutrients that will be necessary for effective microbial growth (i.e. nitrogen and phosphate) as well as a specific suite of trace

metals that have been shown to be critical for active anaerobic microbial activity. It is also a dry substrate, which helps prevent fouling of injection points and equipment components.

3.4.3 Substrate Concentrations

The proposed remedial approach is to pulse-inject a nutrient-amended carbohydrate to a re-circulating groundwater system to overcome the terminal electron acceptor (TEA) sinks (i.e. dissolved oxygen, nitrate, sulfate, etc.) and create sulfate-reducing and/or methanogenic conditions throughout the desired saturated zone. Either of these conditions will promote the transfer of electrons to the chlorinated solvents, which will reduce their concentrations and remediate the target area. The Site-wide delivery of the substrate throughout the saturated zone will be optimized via groundwater recirculation facilitated by the automated system.

The desired substrate concentration was calculated using stoichiometric ratios of carbohydrate to TEAs and chlorinated solvents at the Site. Terminal Electron Acceptors are estimated and the mass of substrate is calculated to overcome this estimate (Attachment B). Vendor experience, system capacity, and ongoing data will be used for substrate dosing. The proposed system will *pulse-inject* a higher concentration of nutrient/carbohydrate-amended groundwater throughout the target zone (saturated and smear zones) to achieve a 50-200 mg/L TOC concentration. This concentration of TOC has been shown to be the effective concentration to achieve robust anaerobic dechlorination. The goal is to not only fully dechlorinate the minor mass of chlorinated solvents dissolved in groundwater, but also fully dechlorinate the majority of the chlorinated solvent mass sorbed onto the organic fraction in the soil as it partitions into the groundwater. A copy of the Material Safety Data Sheets (SDS) for Carbstrate™ is located in Attachment C.

3.4.4 Groundwater Recirculation System

This section describes the groundwater recirculation pilot system to be installed and operated at the Site. This full-scale system will include: a remediation equipment enclosure; vertical injection wells; vertical extraction wells; monitoring wells; and conveyance/conduit lines.

The drawdowns observed during the aquifer tests indicate that hydraulic control at the BSCA property is feasible at modest pumping rates. The proposed remedial approach will utilize six extraction wells in the Shallow zone, four extraction wells for the Intermediate zone, and four extraction wells for the Deep zone (Figure 4). Pump test data is provided in Attachment D. The remedial approach uses hydraulic control/capture to primarily distribute the substrate across a large area via displacement and advective flow at very low flow rates (<10 gpm total combined flow). The low system flow rate, and programmed injection timeframes in the system, keep injection wells only receiving flow for a limited time (usually a few minutes) before it ceases injection and allows the well to pressurize and sit idle for 15 to 20 minutes. This

pulsed, low flow delivery approach is more a volumetric approach that needs to recirculate at least 3 to 6 pore volumes in order to achieve effective distribution/contact of the substrate across the bulk of the impacted soil matrix (where the bulk of the solvents are sorbed) to achieve remedial goals. For the Shallow aquifer zone (dimensions of 150 feet x 100 feet x 10 feet saturated thickness, 0.15 effective porosity), there are approximately 170,000 gallons of groundwater in one pore volume. A recirculation system operating at 3 to 6 gpm will recirculate one pore volume in 0.65 to 1.3 months. Over the anticipated bioremediation remedial timeframe of an estimated 2 to 3 years, the system will recirculate dozens of pore volumes, obtaining a high degree of contact/distribution, without generating significant hydraulic head to drive the plume offsite. Lower groundwater extraction rates in the Shallow zone will not inhibit the remedial process, and will help remediate that upper solvent mass without pulling it deeper (or causing short-circuiting) into the Intermediate zone. Heated water flushing may not be prevented, but it is not considered a major concern. The concern is substrate distribution across a large area under slow flow conditions in the pore space, and active displacement is the only way obtain mixing/contact with the substrate can be achieved.

All extraction wells will be four-inch diameter wells, which will increase the yield and hydraulic control at the BSCA property during full-scale remediation. The bulk of the contaminant mass resides in the Shallow zone, where the groundwater extraction rates were the lowest (<0.2 to 0.6 gpm) and the drawdown was the highest. As mentioned, MW-06 is screened deeper than the other Shallow wells, which is why it had a higher sustainable yield. MW-25 did not yield a sustainable extraction rate at less than 2 gpm (only operated for 4 minutes, yielding 7 to 8 gallons), but it did recharge 6.5 feet in one minute during the recovery phase, showing groundwater extraction at that location with a programmable submersible pump is feasible. A programmable pump will have a dwell time entry to pulse the extraction wells on and off, which could be set at 1 to 5 minutes for this site. If the wells recharge that quickly, they will yield a moderate extraction rate with a fixed system. The larger diameter extraction wells will likely yield at least 0.5 to 1 gpm sustainable pumping rates, and a large radius of influence (ROI) as it is pumped on over a large timeframe. The placement of the three extraction wells on Figure 4 are approximately on 50 foot centers along the western BSCA property line between MW-9 to MW-39, which will provide a high degree of hydraulic control on this end of the plume. The 50-foot centers were chosen based on the lithology and drawdown information. The Shallow zone test showed an influence of at least a 50-foot ROI using a 2-inch diameter well. Based on this data, the hydraulic control in this area will be very high. The extraction wells at 25 feet away will come into competition with the other well, reducing their yields, but providing a higher degree of hydraulic control. If the extraction wells are moved too close together they will start to dewater each other. Therefore, the three proposed extraction wells and their placement are appropriate. These three wells pumping at the same time will create a larger ROI, that will extend beyond the known VOC impacts in the Shallow zone, based on the total observed ROI during pumping tests. In addition, there are three extraction wells distributed to the east and south of the BSCA

property to provide hydraulic control and substrate distribution at the distal end of the plume. Both the Intermediate and Deep zones have four extraction wells that are placed in accordance with the contaminant plumes onsite to provide a high degree of hydraulic control/capture. We expect these extraction wells to yield a much higher pumping rate (4 to 6 gpm), and maintain a high degree of hydraulic control/capture.

Remedial product injection into the vertical injection wells will be feasible due to the sufficient hydraulic conductivity and medium dense nature of the soils. The ability to extract groundwater at sustainable rates, and then re-inject that groundwater containing the amendments is implementable and appropriate for this site.

The placement of the extraction wells surrounding the injection wells is done in a manner that will provide a high degree of plume containment. With these low flow rates and the highly sorbed nature of the chlorinated solvents, chlorinated solvent mass will not migrate beyond the extraction wells. Extraction wells will be monitored for VOC concentrations. In addition, selected monitoring wells downgradient of the extraction wells will be used as performance monitoring wells for off-property plume migration and treatment.

3.4.5 Remediation Equipment Enclosure

The groundwater recirculation system will be operated using aboveground equipment housed in a secure weatherproof enclosure. The remediation equipment enclosure will be situated on the Site. Equipment contained within this enclosure will include: a 200-gallon poly tank to contain the concentrated Substrate injection solution (“solution tank”); an air compressor; a programmable logic controller (PLC) system; and injection and extraction manifolds, with their respective pressure gauges, ball valves, flow meters and sampling ports. In addition, a 1,000-gallon poly tank to hold the extracted groundwater (“holding tank”) and a 150-gallon activated carbon drum will be located immediately outside the enclosure.

The groundwater extraction pumps located in an aboveground trailer, approximately 10 feet long, 8 feet wide, and 8 feet high, will send groundwater from the extraction wells to the pre-treatment holding tank. The pre-treatment holding tank will contain a high/high, high, and low float for logic control. A transfer pump will pump the groundwater from the pre-treatment tank through GAC vessels (in series), and into the post-treatment holding tank (also containing three floats for logic control). The in-situ delivery (ISD) system will pull treated groundwater from the post-treatment holding tank, and amend it automatically using a metering peristaltic pump connected to a small substrate solution/mixing 50-gallon tank located inside the aboveground trailer. The concentrated substrate solution will be metered into the injection header at a specified rate when the system is in the injection mode. The ISD system will inject the groundwater containing the substrate to the desired injection wells, based on set times and rates dictated

by the operator. The proposed injection schedule, and the performance and confirmation monitoring plans will be included in the Engineering Design Report. Substrate will be added one time per week to the solution/mixing tank via field technicians during their weekly site visits.

Attachment F provides the general layout of the remediation equipment enclosure and presents the process and instrumentation diagram of this bioremediation system.

3.4.6 Well Installations

The bioremediation system will include the installation of vertical injection wells and vertical extraction wells. These wells will be installed by a Washington state licensed well driller. Prior to conducting the well installations, Underground Service Alert (USA) will be notified as required by Washington law at least 48 hours in advance of the field activities.

3.4.7 Vertical Injection and Extraction Wells

Vertical injection wells will be used for the Intermediate and Deep portion of the aquifer. The wells will be installed in an array that will provide substrate throughout the entire Intermediate and Deep HVOC plume. It is possible that some of the existing groundwater monitoring wells will be used as injection wells, which will be evaluated in the Engineering Design report.

Because the existing monitoring wells on Site are either not the proper diameter, or not screened to the target pilot system depths, or not strategically located in the most optimal location, a series of new Shallow, Intermediate, and Deep extraction wells will be installed for the remedial approach. An estimated six new 4-inch diameter Shallow extraction wells (SEWs) will be installed and screened from 5-20 ft bgs. An estimated six 4-inch diameter Intermediate extraction wells (IEWs) will also be installed and screened from 25-35 ft bgs. An estimated four 4-inch diameter Deep extraction wells (DEWs) will be installed and screened from 40-55 ft bgs. The vertical extraction well locations were selected to correspond for the Shallow portion of the aquifer, and are spaced based on the observed ROIs for each zone during the 2017 pump tests. Figure 4 depicts the preliminary locations of the injection and extraction wells.

The vertical extraction wells will be installed using sonic drilling technology, which advances a non-perforated steel conductor casing, thereby mitigating potential cross-contamination of the aquifer zones. In addition, sonic drilling will limit the exposure of vapors emanating from the open borehole and generated from the soil cuttings. The vertical extraction wells will be constructed in 8-inch diameter borings using 4-inch diameter, Schedule 40 PVC. The screened sections for all zones will be constructed using 0.010-inch machine slotting. Each well will be hung within the center of the borehole, with sand filter pack (#2/12 sand, or equivalent) placed within the annular space as the conductor casing is removed.

The sand filter pack will extend 1 ft. above the screen intervals, followed by 1 foot of hydrated bentonite, and then cement to the ground surface. Each well will be completed in a concrete vault, with camlock fittings installed on the well heads for connecting with the remediation system's conveyance lines.

The down-hole drilling equipment will be decontaminated following each well installation using a high-pressure rinse. The used decontamination rinse water will be stored within 55-gallon steel drums or a poly tank pending offsite disposal.

Development of the extraction wells will proceed no sooner than 48 hours following the well installation activities to allow time for the cement surface seal to set. Each well will be developed using a surge block to remove the fines from the filter pack. Following the surging, groundwater within each well will be pumped out and monitored for pH, turbidity, electrical conductivity (EC) and temperature. The pumping will continue until these parameters stabilize to within a 10 percent fluctuation or until a maximum of 10 well casing volumes are purged.

Following the completion of the development activities, each well head will be retrofitted to support the extraction equipment. For the pilot system, this equipment will include: a 3-inch diameter, stainless steel submersible pump (Grundfos Redi-Flo3, or equivalent); electrical line; and 1-inch diameter discharge hose.

3.4.8 Groundwater Monitoring Wells

Because all of the vertical extraction wells will be used for extraction only, selected extraction wells will be utilized as groundwater compliance monitoring locations in addition to selected existing groundwater wells. These wells will be sampled for MNA parameters and VOCs to assess the performance of the remedial action. Groundwater performance samples will be collected from all key monitoring locations throughout the ERH and bioremediation remedial action. See Section 3.7 for chemical parameters and analytes to assess the bioremediation treatment performance.

3.4.9 Conveyance Lines

Below ground conveyance lines will be installed connecting to the injection and extraction wells. The lines will be installed in trenches approximately 16-inches wide by 2 feet deep. The conveyance lines will merge into a common trench near the treatment system compound that will be approximately 3 feet wide by 2 feet deep. These conveyance lines will be constructed using 1-inch diameter PVC pipe electrical conduit for the extraction well pumps will also be included within the conveyance line trenches. Waste material associated with trenching activity, including concrete and soil, will be assumed to be investigation derived waste (IDW). The handling and disposal of IDW is discussed below.

3.5 IDW

Investigation derived waste (IDW) generated from the installation of the remediation system trenching and drilling activities will include drill cuttings from extraction and injection well installation, soil and concrete excavated from the construction of the directional drilling entry pits and the injection trenches, well development water, and decontamination rinse water. This IDW will be stored in either water-proof roll-off containers or 55-gallon drums that will be labeled, and sampled for waste characterization and profiling, and stored on Site pending receipt of the analytical data. It is assumed that the generated IDW may be disposed as Contained-In designation, and some IDW may potentially require disposal as RCRA hazardous waste.

3.6 Permitting

The installation of the ERH and groundwater Bioremediation/Recirculation system will be properly permitted through the appropriate regulatory agencies. An electrical permit will be obtained by from the City of Bothell to install the 100 amp 120/240v single-phase temporary service required for the operation of this system. In addition, a UIC permit from the Washington State Department of Ecology will be required to re-inject extracted and treated groundwater containing Carbstrate.

3.7 System Performance Criteria and Performance Monitoring

For baseline and system performance monitoring data, groundwater samples will be collected from the key monitoring wells proposed herein. The performance and compliance groundwater monitoring plan will be included in the Engineering Design report. All key monitoring wells will be analyzed for the following:

- VOCs (limited chlorinated solvent suite, EPA 8260B).
- Ammonia-nitrogen (EPA 350.1).
- Sulfate-sulfur (EPA 375.4 MOD).
- Methane/ethene/ethane (low level analysis via Microseeps, Inc.).
- Total organic carbon (TOC, multiple methods).
- Dissolved iron and chloride

In addition, groundwater quality parameters (i.e. Conductivity, ORP and pH) should be taken during sampling events. These parameters will be sampled and analyzed every month the first quarter, followed by quarterly collection. The key groundwater monitoring wells to be sampled will include:

- Shallow Zone: MW-3, MW-21, MW-30, MW-37, HZ-MW-16, HZ-MW-19 and HZ-MW-22
- Intermediate Zone: MW-12, MW-20, MW-36, HZ-MW-23, and HZ-MW-29
- Deep Zone: MW-31, MW-32, MW-35, MW-38, and HZ-MW-25
- 3 Extraction Wells from different aquifer depths

Extraction wells will be sampled in a manner to minimize any aeration of groundwater samples. The extraction pumps can be operated manually using the PLC of the system by the field technicians. Each extraction well conveyance line will have its own flow meter and gate valve to control the extraction flow rate. In addition, each line will have its own sample port and tubing to collect samples from. Once the pump is turned on, the conveyance line will be evacuated/filled and the pump flow rate will be reduced using the gate valve (to about 1-2 gpm). Once the flow rate is reduced, the sample port will be opened to flush the line and check for air bubbles. If no air bubbles are observed, then a sample will be collected. If bubbles are observed, the flow rate will be reduced until no bubbles are observed. All extraction wells will be sampled for baseline conditions prior to system startup.

3.8 Schedule

The construction of the infrastructure and subsequent installation of the groundwater recirculation system will immediately commence following the approval of this draft Cleanup Action Plan. It is anticipated that the permitting and mobilization activities will require up to one month. The well installation and development activities are expected to require another 4 to 6 weeks, which will be followed by the initial system start-up (2 weeks).

3.9 Targeted Soil Excavation and SVE System

Limited soil excavation will be conducted during the installation of the remediation systems on the BSCSS property. Limited Soil Excavation has been included in the Preferred Alternative to address any potential additional HVOC soil that may be found during system installations. Soils will be sampled and designated for disposal following Ecology requirements. See Figure 4 for locations. These limited vadose zone soil excavation locations are the PCE hot spots discussed in the RI/FS report.

Following thermal (ERH) treatment, confirmation vadose zone soil samples will be collected in the ERH treatment and Bioremediation/Groundwater Recirculation areas to confirm if remediation levels and/or cleanup standards were met in the soil vadose zone source area. This hot soil sampling will be completed following a specific health & safety protocol for hot soil sampling. As a contingency, if soil cleanup standards and/or remediation levels were not attained, targeted vadose zone soil excavation and removal will be carried out to achieve cleanup standards in the ERH treatment area as much as

practicable and following a work plan to be approved by Ecology. See also Section 7.0 for additional details on performance and compliance monitoring.

A Soil Vapor Extraction system will be installed in the eastern portion of the BSCA property to remediate vadose zone soils contaminated and impacted by PCE, found in proximity to the former BSC sewer line near the sewer manhole to the east of the former building. The SVE system installation would occur at the same time as the Bioremediation system, and air blowers will be connected to electrical power for the Bioremediation system. Compliance air sampling will be conducted on a monthly basis until concentrations are synoptic, then confirmation soil sampling will be conducted. See Figure 4 for locations of the SVE systems. Detailed engineering specifications will be provided in the Engineering Design Report.

4.0 HEALTH AND SAFETY PLAN

Kane Environmental has prepared a Site-specific Health and Safety Plan (HASP) to be followed when performing field activities at the Site. This HASP, which will be available in the Engineering Design Report, was prepared to comply with the requirements of Title 29 of the Code of Federal Regulations, Part 1910 (20 CFR 1910), collectively referred to as “Hazardous Waste Operations and Emergency Response (HAZWOPER)”. The HASP identifies physical, industrial, chemical and biological hazards, establishes hazard monitoring action levels, specifies the required Personal Protective Equipment (PPE), and includes a map showing the route to the nearest hospital with an emergency medical facility. A copy of the HASP will be maintained on the Site, and all visitors to the Site will be provided a health and safety briefing prior to commencing with their activities.

5.0 APPLICABLE, RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)

Potential ARARs were identified for each medium of potential concern. The primary ARARs relating to the cleanup action include:

- MTCA, Chapter 70.105D of the Revised Code of Washington (RCW);
- Cleanup Regulations, WAC 173-340;
- Dangerous Waste Regulations, WAC 173-303, and
- State Environmental Policy Act (SEPA) Checklist [RCW 43.21C.030(2)(a) and (2)(b)].

These primary ARARs are anticipated to be the most applicable to the cleanup action because they provide the framework for the cleanup action, including applicable and relevant regulatory guidelines, cleanup standards, waste disposal criteria, references for additional ARARs, and standards for documentation of the cleanup action.

Other applicable ARARs and guidance documents for cleanup of the Site may include:

- Occupational Safety and Health Act, Part 1910 of Title 29 of the Code of Federal Regulations;
- Safety Standards for Construction Work, WAC 296-155;
- Solid Waste Management, Reduction and Recycling, RCW 70.95;
- Construction Stormwater General Permit
- Minimum Functional Standards for Solid Waste Handling, WAC 173-304;
- Criteria for Municipal Solid Waste Landfills, WAC 173-351;
- Minimum Standards for Construction and Maintenance of Wells, WAC 173-160
- Accreditation of Environmental Laboratories, WAC 173-50; and
- Underground Injection Control Program, WAC 173-218.

6.0 RESTORATION TIMEFRAME

The ERH operation is estimated to take 6 months from site mobilization to ERH system demobilization. The bioremediation process will start at approximately the same time as the ERH start, and will be operational for an estimated 2 to 3 years. Performance groundwater monitoring will be conducted during the remedial action activity, and groundwater compliance monitoring will be conducted after completion of the performance groundwater monitoring. The estimated timeframe for the total remedial action is 5 to 6 years, including groundwater performance and compliance monitoring.

7.0 PERFORMANCE AND COMPLIANCE MONITORING

Groundwater performance monitoring will be conducted in selected wells during the ERH system operation, at approximately 4 to 6 months after system startup. Up to two groundwater performance wells will be installed within the ERH treatment zone to monitor PCE and its breakdown products concentrations during the treatment activity. The wells will be designed to withstand the heated water and have special surface completions for sampling following health and safety requirements.

Soil performance monitoring will only be conducted in the area of the ERH system approximately 4 months after ERH startup and following shutdown of the ERH system, approximately 6 months after ERH startup in vadose zone soils. Vadose zone soil samples will be collected in selected areas in the ERH treatment area to determine if the ERH system has reduced PCE, and its breakdown products, to concentrations below their cleanup levels. The soil sampling will be conducted using hot soil sampling techniques following health and safety requirements. Soil samples will be collected and sent to an Ecology-approved environmental laboratory for analysis of Halogenated VOCs (HVOCs) by EPA Method

8260. Results at the end of thermal treatment will be evaluated according to whether the remediation level and/or cleanup standards are achieved by the thermal remediation. Contingent vadose zone soil excavation and removal will be conducted at the soil source area based on the results, based on a work plan to be approved by Ecology.

Performance groundwater monitoring will be continued during the Bioremediation system operation until PCE, and its breakdown products, concentrations in groundwater are below their applicable cleanup levels.

Groundwater compliance monitoring will start at the time when PCE, and its breakdown products, groundwater concentrations have reached their applicable cleanup levels in the selected performance monitoring wells. Groundwater compliance monitoring will be conducted quarterly for 2 years. A groundwater compliance monitoring contingency will be provided in the Engineering Design Report in case groundwater compliance monitoring is continued after 2 years. The City of Bothell and Ecology will have with long-term access to the extent necessary to operate, maintain and monitoring remedial systems and the cleanup, and compliance groundwater monitoring.

A total of eight (8) groundwater wells will be selected, based on the results of the remedial actions, to provide performance and compliance groundwater monitoring for the Site. A groundwater compliance contingency, which would extend the groundwater biannual compliance monitoring for one year, will be started at the end of the proposed compliance monitoring in June 2022 if COC groundwater cleanup levels have not been reached. After one additional year, if COC groundwater cleanup levels have not been reached, an environmental covenant will include a 5-year compliance sampling event for the duration of the environmental covenant. Groundwater analytical results are needed for the 5-year periodic review. The five year groundwater compliance monitoring is only required if cleanup levels are not achieved and institutional controls through the environmental covenant on groundwater use are needed.

Furthermore, potential vapor intrusion, associated with future development, will be mitigated by the installation of vapor barriers and passive venting, or other vapor intrusion mitigation methods and included in the environmental covenant. The environmental covenant will include annual sampling events of indoor air for three years, to be conducted after the ERH remedial action and during tenant occupancy following sampling protocol provided in Ecology's Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action (Review Draft Revised February 2016) or the current guidance at the time of sampling to confirm the selected vapor mitigation.

Following completion of the Bioremediation and Groundwater Recirculation remedial action, one round of soil vapor sampling will be conducted and subsurface soil vapor data results will be compared to soil vapor screening levels.

8.0 SCHEDULE FOR REMEDIATION SYSTEMS IMPLEMENTATION

The schedule for the implementation is provided in the Consent Decree.

9.0 INSTITUTIONAL/ENGINEERING CONTROLS

If residual contamination remains on the BSCSS property after cleanup, or any of the other criteria for triggering an institutional control under WAC 173-340-440 are met, institutional controls may be implemented, and included in an environmental covenant. Institutional controls may also be implemented prior to completion of remedial actions at the BSCSS property.

Vapor intrusion risks at the site will be addressed by the active remediation of contaminated soil and groundwater at the site and direct mitigation through engineering controls. Engineering controls, such as vapor barriers and passive venting, or other vapor intrusion mitigation methods, will be implemented for the new development structures and included in the environmental covenant.

10.0 PUBLIC PARTICIPATION

This criterion considers whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns. This process includes concerns from individuals, community groups, local governments, federal and state agencies, or any other organization that may have an interest in or knowledge of the Site. A Public Participation Plan and Fact Sheet has been prepared for review during the public comment period for the consent decree as required under MTCA.

11.0 REFERENCES

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Figures

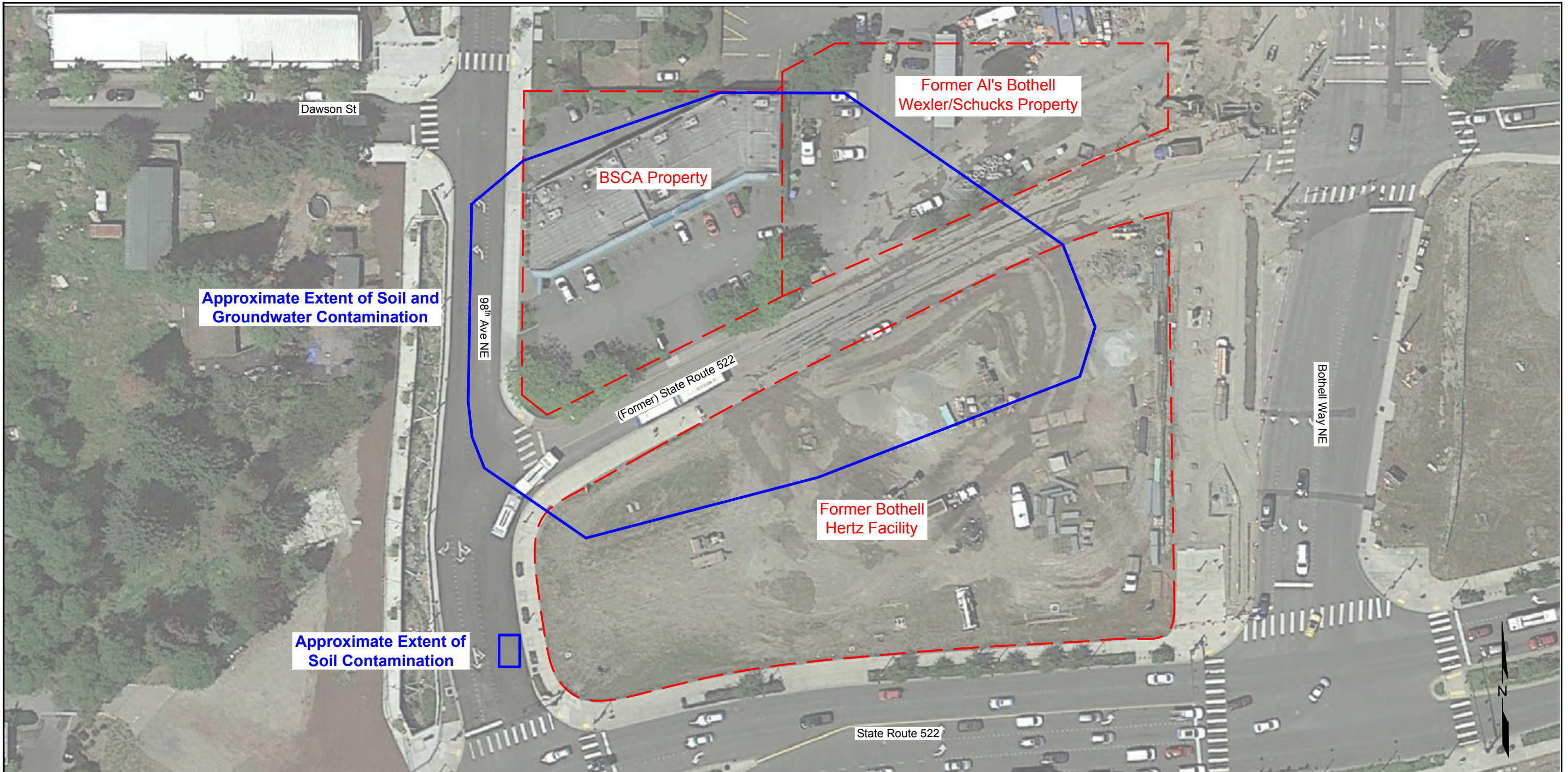


Site



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Bothell Service Center
18107 Bothell Way NE
Bothell, Washington

Figure 1
Vicinity Map

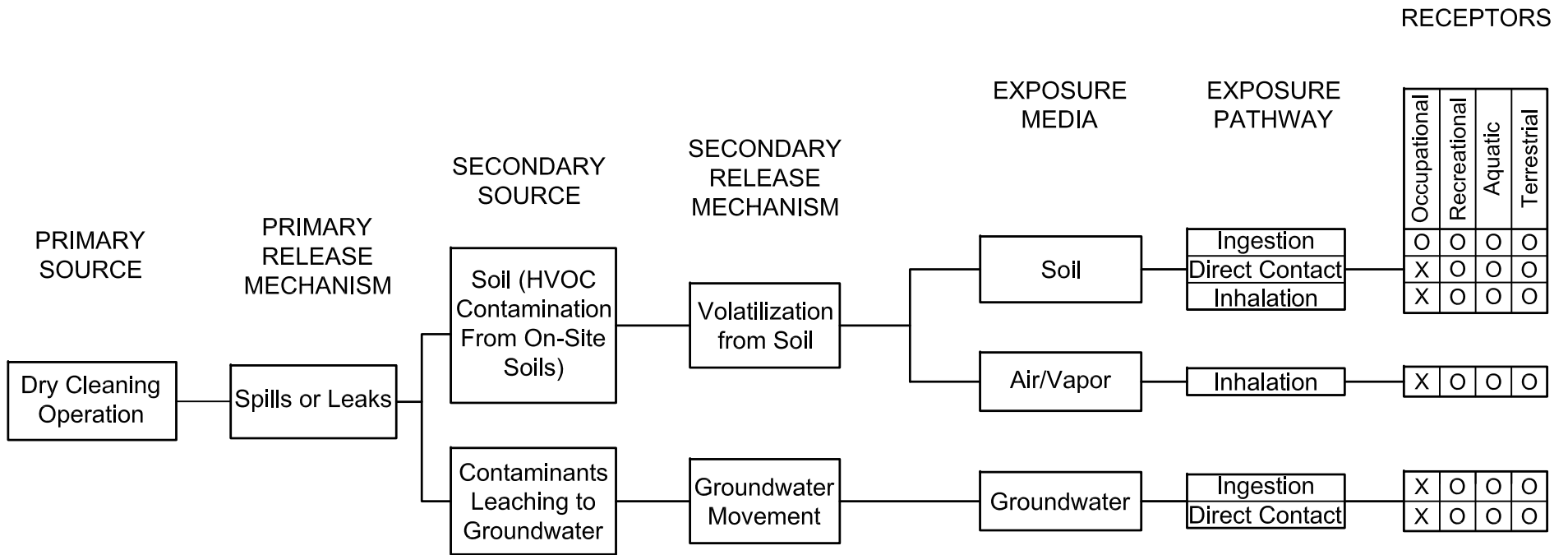


LEGEND

- Approximate Location of Site Boundary
- - - Various Property Boundaries

Aerial Photo Source: Google Earth Pro
Aerial Photo Date: June 27, 2016

0 60 120
Approximate Scale in Feet



LEGEND

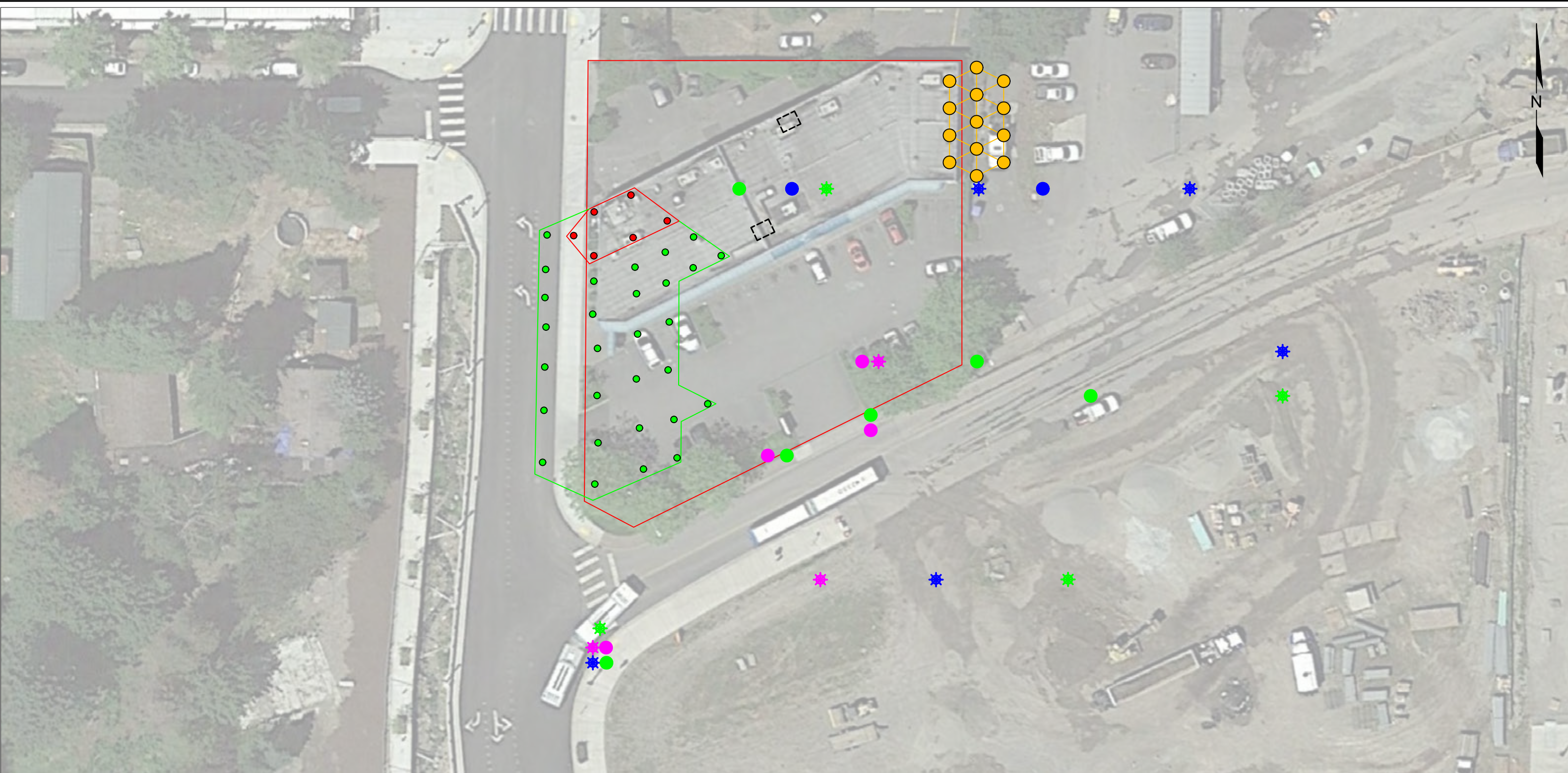
X - Complete
O - Incomplete



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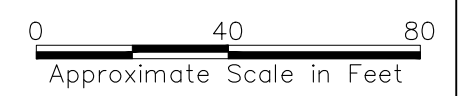
Figure 3
Conceptual Site Model



LEGEND

- BSCA Property Boundary
- Approximate Location of ERH Probe (5-25 ft bgs)
- Approximate Location of ERH Probe (5-55 ft bgs)
- Approximate Location of Soil Excavation
- Approximate Location of Soil Vapor Extraction (SVE) Well
- ★ Proposed Extraction Well (Shallow 5-25 ft bgs)
- Proposed Injection Well (Shallow 5-25 ft bgs)
- ★ Proposed Extraction Well (Intermediate 25-35 ft bgs)
- Proposed Injection Well (Intermediate 25-35 ft bgs)
- ★ Proposed Extraction Well (Deep 35-55 ft bgs)
- Proposed Injection Well (Deep 35-55 ft bgs)

Aerial Photo Source: Google Earth Pro
Aerial Photo Date: June 27, 2016



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**Attachment A
Previous Studies Summary**

ATTACHMENT A
PREVIOUS STUDIES

Interim Site Characterization Summary, Environmental Resources Management (ERM), October 17, 2001.

ERM conducted subsurface soil and groundwater investigation activities at the Site between December 1999 and July 2001 (ERM, 2001). Hand-auger borings HA-1, HA-2, and HA-3 were advanced in December 1999 to assess soil conditions in the vicinity of the former dry cleaning equipment in the Bothell Service Center building.

Interim Site Remediation Summary, ERM, March 25, 2002.

In 2001 and 2002, after a technology feasibility evaluation process, ERM conducted two remedial action events consisting of application of in-situ chemical oxidation at the Site to address concentrations of PCE in soil and groundwater.

Subsurface Investigation Report, Farallon Consulting (Farallon), January 27, 2003.

Farallon conducted a subsurface investigation at the Site in September and October 2002 that included drilling and installation of groundwater monitoring wells MW-8 and MW-9, and one groundwater monitoring event.

Engineering Design Report, Farallon, July 9, 2004.

Farallon performed additional subsurface investigations at the Site in September and October 2003 to address data gaps and provide information for the design of a remediation system. The additional subsurface investigations included advancing soil borings SB-2 through SB-6; advancing boring MW-10 to a total depth of 47.5 feet bgs and completing the boring as a 25-foot-deep groundwater monitoring well; advancing borings VE-1 and VE-2 to total depths of 21.5 feet bgs and completing the borings as vapor extraction wells; conducting a soil vapor extraction (SVE) pilot test; and collecting soil and groundwater samples for laboratory analyses.

Cleanup Action Progress Report June 2006 through June 2007, Farallon, March 12, 2008.

Based on results from the subsurface investigations, the ERM remedial action, and a soil vapor extraction (SVE) pilot test, Farallon implemented an additional remedial action approach incorporating several elements, including a SVE system to remove soil vapors containing concentrations of PCE in the subsurface, injection of a chemical oxidant into groundwater in three monitoring wells at the Site to reduce residual HVOC concentrations in groundwater, and long-term monitoring of the natural attenuation of HVOCs in groundwater.

Interim Action Status Report November 2007 through August 2008, Farallon, November 4, 2008.

In 2007, Farallon evaluated the progress of the chemical oxidation cells and reconsidered the range of remedial technologies assessed in November 2002. The feasibility assessment concluded that Site conditions appeared to be amenable to enhanced in-situ bioremediation and that a bioremediation approach had potential to be more effective in a shorter restoration time frame than chemical oxidation.

Phase II Environmental Site Assessment, Schuck's Auto Supply, Floyd & Snider, September 10, 2010.

Floyd & Snider conducted a Phase II investigation in August 2010, associated with three former gasoline USTs located on the former Schucks property, immediately adjacent to the east of the BSCA property (Floyd & Snider, 2010). One boring location (GP-12, 32.5 feet to the east of the BSCA property) reported soils at 6 feet bgs with gasoline concentrations (5,900 ppm) in exceedance of MTCA Method A cleanup levels (100 ppm). None of the other boring locations reported petroleum concentrations in soil above of state cleanup levels. None of the groundwater samples collected reported concentrations of petroleum products in exceedance of state cleanup levels. Soil samples with reported HVOC exceedances were collected at 8 and 9 feet bgs, below the observed depth of groundwater (approximately 4 to 7 feet bgs), and is within the extent of the HVOC plume characterized in the Remedial Investigation.

Project Status Summary, Farallon, November 18, 2011.

Farallon released a summary of remedial activities conducted at the BSCA property since the November 2008 report (Farallon, 2011). These activities included a second injection event in 2010 and continued groundwater monitoring.

Focused Soil and Groundwater Investigation, Horse Creek Project, Shannon & Wilson, Inc., May 7, 2013.

In October of 2012, Shannon & Wilson advanced several borings along the proposed location of the Horse Creek Channel. Three borings (GP-7 through GP-9) were located to the west of 98th Avenue NE, west of the BSCA property, which has since been excavated and contains the Horse Creek Channel. Soil and groundwater samples were collected from each located and analyzed for HVOCs. HVOCs were reportedly not detected at concentrations above the laboratory reporting limit in any of the groundwater or soil samples analyzed.

Request for "Contained In" Determination for Soils, Storm and Sanitary Sewer System Construction, 98th Avenue Northeast, HWA, June 11, 2014.

In May of 2014, HWA advanced three borings (98-B1 through 98-B3) along 98th Avenue NE, just west of the BSCA property. The borings were collected to assess potential HVOC impacts from the BSCA property and request a “Contained In” determination for soils excavated during the installation of new utility lines along 98th Avenue NE.

Results of October Groundwater Sampling, Dalton, Olmsted, and Fugelvand, Inc. (DOF), November 10, 2014.

In the spring of 2014, DOF performed groundwater monitoring and data analyses for the Site (DOF, 2014). DOF's analytical data are included in Table 2. DOF stated that historic groundwater monitoring data, coupled with the October 2014 results, provided strong evidence that the EOS injection product was successfully facilitating the degradation of PCE at the Bothell Service Center Site.

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**Attachment B
Estimated Substrate Mass and System Flow Calculations**

Attachment B
Estimated Substrate Mass and System Flow Calculations

ESTIMATED TREATMENT AREA

150 ft
 200 ft
 50 ft
 1500000 ft³
 55555.6 CY

0.15
 47222.2 CY

225000 ft³
 6373.9 m³
 6373937.677 L

1683999.4 gal

PCE	TCE	DCE
2000	1000	2000

TYPE OF SYSTEM
 Ext. Rate 6 gpm

8640 gal/day
 60480 gal/week
 194.9 days to recirculate one PV
 6.5 months to recirc one PV

259200 gal/month

MW (g/mol)	Est. GW Concentration	Molar Ratio (mol dextrose/mol EA)
32 Avg. DO	4 mg/L	0.16
62 Avg. Nitrate	5 mg/L	0.21
55.9 Avg. iron	10 mg/L	0.04
54.9 Avg. Mn	10 mg/L	0.08
96 Avg. Sulfate	50 mg/L	0.33
180.2 Dextrose		

PCE	TCE	DCE
2000.00	1000.00	2000.00
364	126	59
0.02		
14560	2520	2360 ug/kg
14.56	2.52	2.36 mg/kg
1.8		
3031.2		
1376146789		
1376.146789		

Total
 846.99203 lbs

GROUNDWATER TEA DEMAND
MASS OF DEXTROSE REQ'D

	Moles	g dextrose	lbs dextrose
Oxygen	796.7422096	22971.67139	50.59839513
Nitrate	514.027232	19297.439	42.50537225
Iron	1140.239298	8561.296731	18.85748179
Manganese	1161.008684	17434.48041	38.40193923
Sulfate	3319.759207	199406.8697	439.2221799

Sum 589.5853683 lbs

GROUNDWATER VOC DEMAND

10.17257642 PCE
 4.813393753 TCE
 8.702854339 DCE
23.68882451 lbs

TOTAL DEXTROSE DEMAND 1460.27 lbs.
 The McCarty Factor (30% used) 4867.55 lbs.
 ETEC Factor of 5-10 FOLD 24338 48676 lbs
 1734 mg/L dextrose in 1 PV

566.2744578 123.66742 157.05015 846.99203 lbs

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**Attachment C
MSDS Substrate**

Safety Data Sheet

Revision Date: 05/12/15

Section 1: Product and Company Identification

Product Name: CarBstrate™
MSDS Number: Not Assigned
Chemical Name: Proprietary
Chemical Family: Substrate Mixture

Recommended Use: Anaerobic bioremediation product
Restrictions on Use: No Data

Company: ETEC, LLC
 3830 S Truman Rd. Bldg. 12
 Washougal, WA 98671
 USA

Telephone: (971) 222-3616

Emergency Telephone:	(800) 535-5053
Medical Emergencies:	(800) 301-7976
U.S. Coast Guard National Response Center:	(800) 424-8802

Section 2: GHS Hazards Identification

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Irritant	Category 2
Eye Irritant	Category 2
Specific Target Organ Toxicity - Single Exposure (Respiratory system)	Category 3

Label Elements:

Signal Word: Warning



Hazard Statements:

Causes skin irritation.
Causes eye irritation.
May cause respiratory irritation.

Precautionary Statements:

Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.
Wash skin thoroughly after handling.
Use only outdoors or in a well-ventilated area.
Wear protective gloves/ eye protection/ face protection.
IF ON SKIN: Wash with plenty of soap and water.
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
Call a POISON CENTER or doctor/ physician if you feel unwell.
Specific treatment (see supplemental first aid instructions on this label).
If skin irritation occurs: Get medical advice/ attention.
If eye irritation persists: Get medical advice/ attention.
Take off contaminated clothing and wash before reuse.
Store in a well-ventilated place. Keep container tightly closed.
Store locked up.
Dispose of contents/ container to an approved waste disposal plant.

Hazards not otherwise classified (HNOC) or not covered by GHS - none

Section 3: Composition/Information on Ingredients

Ingredients as defined by 29 CFR 1910.1200:

Chemical Ingredients:	CAS Number:	Percent Range:
Trade Secret	-	~20%

The specific chemical identity and/or exact percentage of the composition has been withheld as Trade Secret in accordance with paragraph (i) of §1910.1200.

Section 4: First Aid Measures**Description of first aid measures:**

Inhalation: Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, give artificial respiration. Call a poison center or doctor/physician if you feel unwell.

Skin Contact: Wash with plenty of soap and water. Take off contaminated clothing and wash before reuse. If skin irritation occurs: Get medical advice/attention.

Eye Contact: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice/attention.

Ingestion: Never give anything by mouth to an unconscious person. Rinse mouth with water.

Most important symptoms and effects, both acute and delayed: See sections 2 and/or 11.

Indication of any immediate medical attention and special treatment needed: No data available.

Section 5: Fire Fighting Measures

Suitable Extinguishing Media: Use any means suitable for extinguishing surrounding fire.

Unsuitable Extinguishing Media: No known information.

Specific Hazards Arising from the chemical/substance: May decompose upon heating to produce corrosive and/or toxic fumes.

Hazardous Combustion Products: Nitrogen oxides, phosphorous oxides, ammonia.

Protective Equipment and Precautions for Fire-Fighters: As in any fire, wear self-contained breathing apparatus and full protective gear.

Section 6: Accidental Release Measures

Personal precautions, protective equipment and emergency procedures: Ensure adequate ventilation. Use personal protective equipment. Avoid dust formation. Do not breathe dust/fume/gas/mist/vapors/spray.

Environmental Precautions: Do not release to the environment. See section 12 for further environmental data.

Methods for Containment/Cleaning Up: Avoid dust formation. Pick up and transfer to properly labeled containers. Ventilate area and wash spill site after material pickup is complete.

Section 7: Handling and Storage

Precautions for Safe Handling: Avoid breathing dust. Use only outdoors or in a well-ventilated area. Wash thoroughly after handling. Keep out of reach of children. Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities:

Storage: Store locked up. Keep in tightly closed container, store in a cool, dry, ventilated place.

Section 8: Exposure Controls/Personal Protection

Exposure Limits: There are no OSHA PEL's, NIOSH REL's, or ACGIH TLV's applicable to this material.

Engineering Controls: Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment:

Eye Protection: Wear appropriate eye protection/face protection.

Hand Protection: Wear appropriate protective gloves.

Skin and Body Protection: Wear appropriate protective clothing to prevent skin exposure. Take off contaminated clothing and wash before reuse.

Respiratory Protection: Use only in a well-ventilated area. Avoid breathing dust. Wear appropriate NIOSH approved respirator if exposure limits are exceeded or irritation occurs.

Hygiene Measures: Wash thoroughly after handling. Handle in accordance with good industrial hygiene and safety practice.

Section 9: Physical and Chemical Properties

Appearance/Physical State:	Crystals
Color:	White to Yellow
Odor:	Not Available
Odor Threshold:	Not Available
pH:	Not Applicable
Melting/Freezing Point:	Not Available
Initial Boiling Point:	Not Available
Flash Point:	Not Available
Evaporation Rate:	Not Applicable
Flammability (solid, gas):	Not Available
Lower Explosive Limit:	Not Available
Upper Explosive Limit:	Not Available
Vapor Pressure:	Not Available
Vapor Density:	Not Applicable
Relative Density:	1.00
Solubility:	Completely soluble in water
Partition Coefficient:	Not Available
Autoignition Temperature:	Not Available
Decomposition Temperature:	Not Available

Section 10: Stability and Reactivity

Reactivity: No information available.

Stability: Stable under ordinary conditions of use and storage.

Possibility of hazardous reactions: No information available.

Conditions to Avoid: Extremes in temperature and direct sunlight.

Incompatible Materials: Strong oxidizing agents, strong acids, strong bases, Magnesium.

Hazardous Decomposition Products: Other decomposition products - No data available. In case of fire: see section 5.

Hazardous Polymerization: Will not occur.

Section 11: Toxicological Information

Information on Likely Routes of Exposure:

Inhalation: May cause respiratory irritation if inhaled.
Ingestion: No information available.
Skin Contact: Causes skin irritation.
Eye Contact: Causes eye irritation.

Toxicity Data:

Chemical Name	LD50 ORAL	LD50 DERMAL	LC50 INHALATION
Trade Secret	6500 mg/kg (Rat)	7950 mg/kg (Rabbit)	No data

Symptoms: No information available.

Delayed and Immediate Effects, Chronic Effects from Short and Long Term Exposure:

Sensitization: No information available.
Mutagenic Effects: No information available.
Reproductive Toxicity: No information available.
STOT – Single Exposure: Respiratory system.
STOT – Repeated Exposure: No information available.
Aspiration Hazard: No information available.
Chronic Exposure: No information available.
Aggravation of Pre-existing Conditions: Asthma

Carcinogenicity:

Component	CAS	NTP	IARC	OSHA
Trade Secret	N/A	Not listed	Not listed	Not listed

Additional Information: To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Section 12: Ecological Information**Ecotoxicity:**

This product is safe for the environment at the concentrations predicted under normal use conditions.

Persistence and Degradability: No information available.

Bioaccumulative Potential: No information available.

Mobility in Soil: No information available.

Other Adverse Effects: No information available.

Section 13: Disposal Considerations

Dispose of contents/container in accordance with all applicable local, state and federal regulations.

Section 14: Transport Information

**For Transportation Emergencies Involving This Material, Call:
ChemTrec 1-800-424-9300 Company Code: E419**

DOT (LAND): Not regulated.

Section 15: Regulatory Information

SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 311/312 Hazard Categories:

Acute Health Hazard	Yes
Chronic Health Hazard	No
Fire Hazard	No
Sudden Release of Pressure Hazard	No
Reactive Hazard	No

SARA 313: The Trade Secret component is subject to reporting levels (>1.0%) established by SARA Title III, Section 313:

State Right-to-Know:

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Trade Secret	-	X	X	-	-

TSCA: Not Applicable

California Prop. 65 Components: This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

Section 16: Other Information

NFPA Rating:

Health Hazard:	2
Fire:	0
Reactivity Hazard:	1

Legend:

ACGIH: American Conference of Governmental & Industrial Hygienists
CAS: Chemical Abstract Service
CFR: Code of Federal Regulations
DOT: Department of Transportation
DSL/NDSL: Domestic Substances List/Non-Domestic Substances List
IARC: International Agency for the Research of Cancer
IATA: International Air Traffic Association
ICAO: International Civil Aviation Organization
IMDG: International Maritime Dangerous Goods

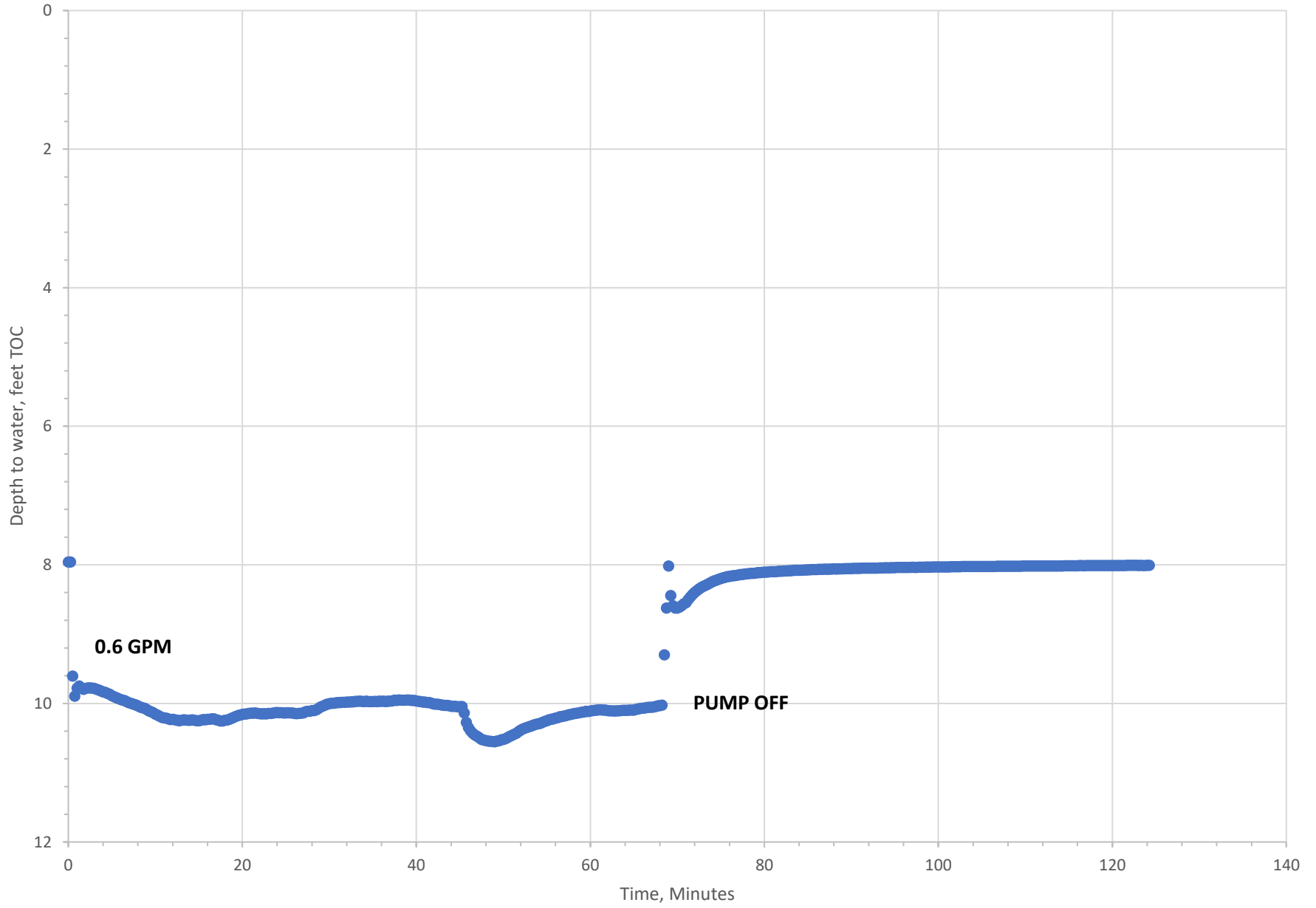
IMO: International Maritime Organizations
NFPA: National Fire Protection Association Health, Flammability & Reactivity; Hazard Scale 0 =minimal/none 4= significant
NTP: National Toxicology Program
OSHA: Occupational Safety & Health Administration
PEL: Permissible Exposure Limits
RCRA: Resource Conservation & Recovery Act
RQ: Reportable Quantity
RTK: Right-To-Know
SARA: Superfund Amendments & Reauthorization Act
STEL: Short Term Exposure Limit
TLV: Threshold Limit Value
TSCA: Toxic Substances Control Act
TWA: Time Weighted Average
TCLP: Toxicity Characteristic Leaching Procedure
VOC: Volatile Organic Compounds

Disclaimer: The information contained in this SDS is presented in good faith and believed to be accurate based on the information provided. The SDS does not purport to be all inclusive, and shall be used only as a guide. While ETEC, LLC believes that the data contained herein comply with 29 CFR 1910.1200, they are not to be taken as a warranty or representation for which ETEC, LLC assumes legal responsibility. ETEC, LLC shall not be held liable or accountable for any loss or damage associated with the use of this material and information. The recommended industrial hygiene and safe use, handling, storage, and disposal procedures are believed to be generally applicable. However, since the use, handling, storage, and disposal are beyond ETEC, LLC control, it is the responsibility of the user both to determine safe conditions for use of this product and to assume liability of loss, damage, or expense arising out of the material's improper use.

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**Attachment D
Pump Test Results**

MW-06 Pumping Test



WELL ID: MW-06-Recovery

Local ID: MW-06

Date: 2/1/2017

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	7.96 Feet
Top of Aquifer	10 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand
FLOW RATE	0.6 GPM

COMPUTED

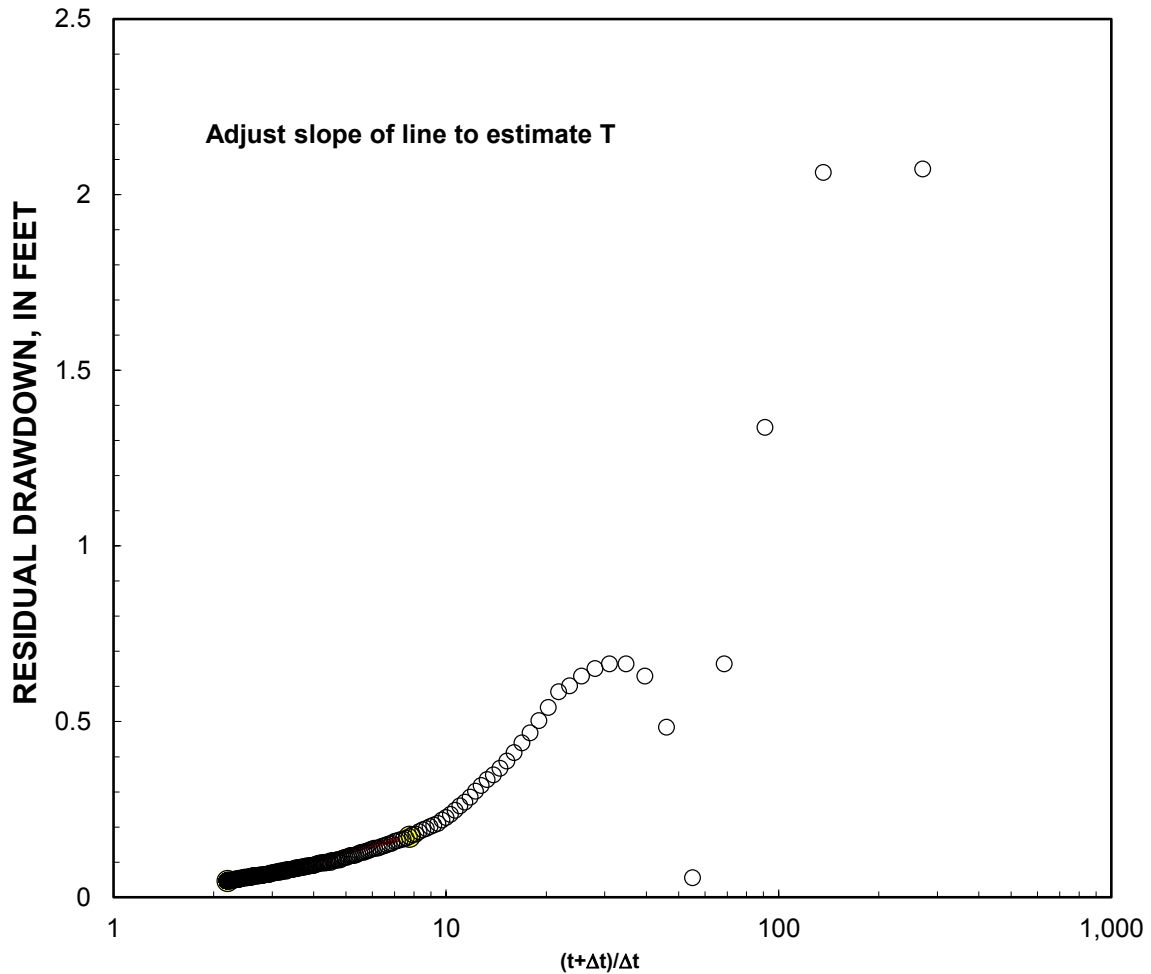
Aquifer thickness = 45 Feet

Slope = 0.230398 Feet/log10

Input is consistent.

K =	2 Feet/Day
T =	92 Feet ² /Day

K= 2 is less than likely minimum of 3 for Fine Sand



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
Entry	Time, Date Hr:Min:Sec	Water Level Feet	Entry	Time, Date Hr:Min:Sec	Water Level Feet
1	1/0/00 0:00:00	7.96	51	1/0/00 1:32:15	8.05
2	1/0/00 1:07:45	10.03	52	1/0/00 1:32:45	8.05
3	1/0/00 1:08:15	9.30	53	1/0/00 1:33:15	8.04
4	1/0/00 1:08:45	8.02	54	1/0/00 1:33:45	8.04
5	1/0/00 1:09:15	8.59	55	1/0/00 1:34:15	8.04
6	1/0/00 1:09:45	8.63	56	1/0/00 1:34:45	8.04
7	1/0/00 1:10:15	8.59	57	1/0/00 1:35:15	8.04
8	1/0/00 1:10:45	8.55	58	1/0/00 1:35:45	8.04
9	1/0/00 1:11:15	8.46	59	1/0/00 1:36:15	8.04
10	1/0/00 1:11:45	8.40	60	1/0/00 1:36:45	8.04
11	1/0/00 1:12:15	8.35	61	1/0/00 1:37:15	8.04
12	1/0/00 1:12:45	8.31	62	1/0/00 1:37:45	8.04
13	1/0/00 1:13:15	8.28	63	1/0/00 1:38:15	8.04
14	1/0/00 1:13:45	8.25	64	1/0/00 1:38:45	8.04
15	1/0/00 1:14:15	8.22	65	1/0/00 1:39:15	8.03
16	1/0/00 1:14:45	8.20	66	1/0/00 1:39:45	8.03
17	1/0/00 1:15:15	8.18	67	1/0/00 1:40:15	8.03
18	1/0/00 1:15:45	8.17	68	1/0/00 1:40:45	8.03
19	1/0/00 1:16:15	8.16	69	1/0/00 1:41:15	8.03
20	1/0/00 1:16:45	8.15	70	1/0/00 1:41:45	8.03
21	1/0/00 1:17:15	8.14	71	1/0/00 1:42:15	8.03
22	1/0/00 1:17:45	8.13	72	1/0/00 1:42:45	8.03
23	1/0/00 1:18:15	8.12	73	1/0/00 1:43:15	8.03
24	1/0/00 1:18:45	8.12	74	1/0/00 1:43:45	8.03
25	1/0/00 1:19:15	8.11	75	1/0/00 1:44:15	8.03
26	1/0/00 1:19:45	8.11	76	1/0/00 1:44:45	8.02
27	1/0/00 1:20:15	8.10	77	1/0/00 1:45:15	8.02
28	1/0/00 1:20:45	8.10	78	1/0/00 1:45:45	8.02
29	1/0/00 1:21:15	8.10	79	1/0/00 1:46:15	8.02
30	1/0/00 1:21:45	8.09	80	1/0/00 1:46:45	8.02
31	1/0/00 1:22:15	8.09	81	1/0/00 1:47:15	8.02
32	1/0/00 1:22:45	8.08	82	1/0/00 1:47:45	8.02
33	1/0/00 1:23:15	8.08	83	1/0/00 1:48:15	8.02
34	1/0/00 1:23:45	8.08	84	1/0/00 1:48:45	8.02
35	1/0/00 1:24:15	8.07	85	1/0/00 1:49:15	8.02
36	1/0/00 1:24:45	8.07	86	1/0/00 1:49:45	8.02
37	1/0/00 1:25:15	8.07	87	1/0/00 1:50:15	8.02
38	1/0/00 1:25:45	8.07	88	1/0/00 1:50:45	8.02
39	1/0/00 1:26:15	8.07	89	1/0/00 1:51:15	8.02
40	1/0/00 1:26:45	8.06	90	1/0/00 1:51:45	8.02
41	1/0/00 1:27:15	8.06	91	1/0/00 1:52:15	8.02
42	1/0/00 1:27:45	8.06	92	1/0/00 1:52:45	8.02
43	1/0/00 1:28:15	8.06	93	1/0/00 1:53:15	8.02
44	1/0/00 1:28:45	8.06	94	1/0/00 1:53:45	8.02
45	1/0/00 1:29:15	8.06	95	1/0/00 1:54:15	8.01
46	1/0/00 1:29:45	8.05	96	1/0/00 1:54:45	8.01
47	1/0/00 1:30:15	8.05	97	1/0/00 1:55:15	8.01
48	1/0/00 1:30:45	8.05	98	1/0/00 1:55:45	8.01
49	1/0/00 1:31:15	8.05	99	1/0/00 1:56:15	8.01
50	1/0/00 1:31:45	8.05	100	1/0/00 1:56:45	8.01

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 10 Feet

Depths to:
water level (DTW) 7.96 Feet
Top of Aquifer 10 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Fine Sand

wetted hole 10 Feet
Aquifer thickness = 45 Feet
Aquifer thickness = 45 feet
Aquifer thickness = 45 Feet
Aquifer thickness = 45 Feet **1**
45

Fraction penetrated = 0.222222

slope points 7.75 0.173
2.2 0.047

FLOW RATE 0.60 GPM
FLOW RATE 115.508 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 0.230398 Feet /log₁₀
Slope = 0.230398 feet/log₁₀

T = 92 ft2/d
91.75946 Feet2/Day **1**
92 Feet2/Day **92**

K = 2.039099 ft/d
2.039099 Feet/Day **0.1**
K = 2 Feet/Day **20**

Absolute Shut Down

Input is consistent.

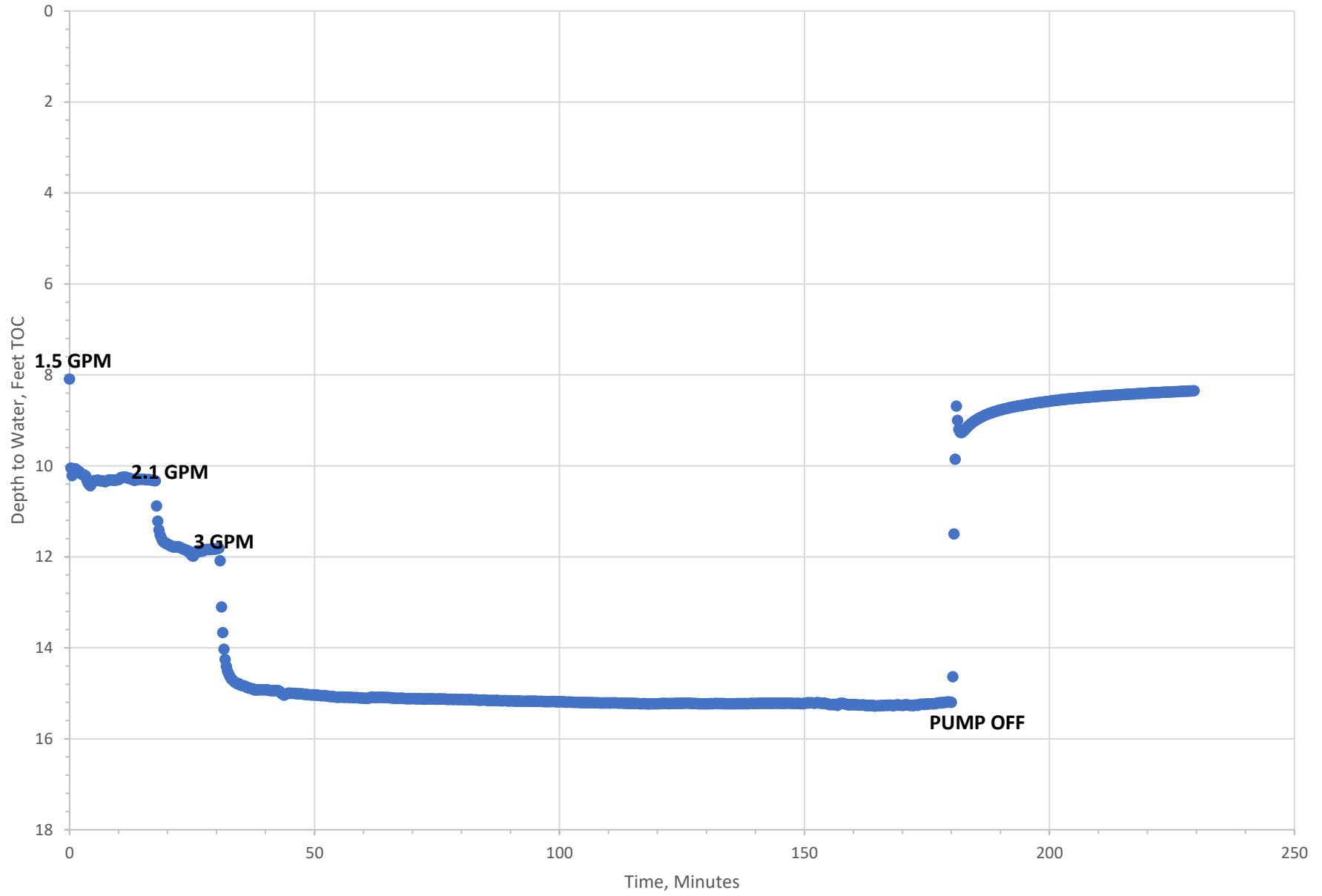
Decision	Option			
	0 Water level is below Base of Aquifer			
	0 Casing diameter is greater than the Annulus			
	0 Top of Aquifer is deeper than Base of Aquifer			
	0 Screen length is less than 1 Feet	1		
	0 Slope will produce a negative K			
	0 K = 2 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
	0 K = 2 is greater than extreme maximum of 20 for Fine Sand	20	1	20
	1 Input is consistent.			
	Error			

WARNING

K = 2 is less than likely minimum of 3 for Fine Sand

Decision	Option			
	0			
	1 K = 2 is less than likely minimum of 3 for Fine Sand	3	0	3
	1 K = 2 is greater than likely maximum of 20 for Fine Sand	20	1	20
	2			

MW-11 Pumping test



WELL ID: MW-11-Recovery

Local ID: MW-11

Date: 1/30/2017

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	8.09 Feet
Top of Aquifer	10 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand
FLOW RATE	3 GPM

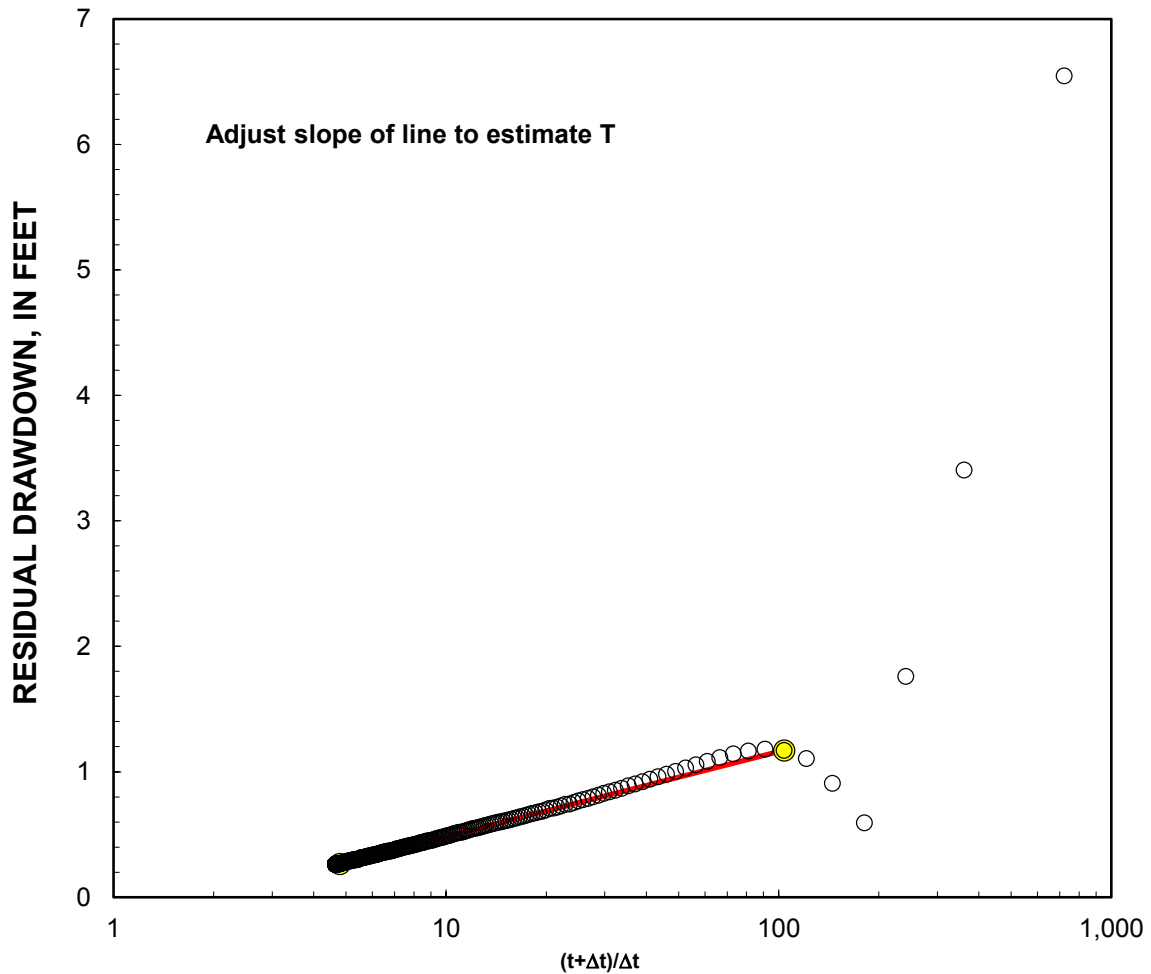
COMPUTED

Aquifer thickness = 45 Feet

Slope = 0.67732 Feet/log10

Input is consistent.

K =	3.5 Feet/Day
T =	160 Feet ² /Day



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
	Time,	Water Level		Time,	Water Level
Entry	Date Hr:Min:Sec	Feet	Entry	Date Hr:Min:Sec	Feet
1	1/0/00 0:00:00	8.09	51	1/0/00 3:12:15	8.71
2	1/0/00 3:00:00	15.20	52	1/0/00 3:12:30	8.71
3	1/0/00 3:00:15	14.64	53	1/0/00 3:12:45	8.70
4	1/0/00 3:00:30	11.50	54	1/0/00 3:13:00	8.70
5	1/0/00 3:00:45	9.85	55	1/0/00 3:13:15	8.69
6	1/0/00 3:01:00	8.69	56	1/0/00 3:13:30	8.69
7	1/0/00 3:01:15	9.00	57	1/0/00 3:13:45	8.68
8	1/0/00 3:01:30	9.20	58	1/0/00 3:14:00	8.68
9	1/0/00 3:01:45	9.26	59	1/0/00 3:14:15	8.67
10	1/0/00 3:02:00	9.27	60	1/0/00 3:14:30	8.67
11	1/0/00 3:02:15	9.26	61	1/0/00 3:14:45	8.66
12	1/0/00 3:02:30	9.23	62	1/0/00 3:15:00	8.66
13	1/0/00 3:02:45	9.20	63	1/0/00 3:15:15	8.66
14	1/0/00 3:03:00	9.18	64	1/0/00 3:15:30	8.65
15	1/0/00 3:03:15	9.15	65	1/0/00 3:15:45	8.65
16	1/0/00 3:03:30	9.12	66	1/0/00 3:16:00	8.64
17	1/0/00 3:03:45	9.10	67	1/0/00 3:16:15	8.64
18	1/0/00 3:04:00	9.07	68	1/0/00 3:16:30	8.63
19	1/0/00 3:04:15	9.05	69	1/0/00 3:16:45	8.63
20	1/0/00 3:04:30	9.03	70	1/0/00 3:17:00	8.62
21	1/0/00 3:04:45	9.01	71	1/0/00 3:17:15	8.62
22	1/0/00 3:05:00	9.00	72	1/0/00 3:17:30	8.62
23	1/0/00 3:05:15	8.98	73	1/0/00 3:17:45	8.61
24	1/0/00 3:05:30	8.96	74	1/0/00 3:18:00	8.61
25	1/0/00 3:05:45	8.95	75	1/0/00 3:18:15	8.61
26	1/0/00 3:06:00	8.93	76	1/0/00 3:18:30	8.60
27	1/0/00 3:06:15	8.92	77	1/0/00 3:18:45	8.60
28	1/0/00 3:06:30	8.90	78	1/0/00 3:19:00	8.59
29	1/0/00 3:06:45	8.89	79	1/0/00 3:19:15	8.59
30	1/0/00 3:07:00	8.88	80	1/0/00 3:19:30	8.59
31	1/0/00 3:07:15	8.87	81	1/0/00 3:19:45	8.58
32	1/0/00 3:07:30	8.86	82	1/0/00 3:20:00	8.58
33	1/0/00 3:07:45	8.85	83	1/0/00 3:20:15	8.57
34	1/0/00 3:08:00	8.84	84	1/0/00 3:20:30	8.57
35	1/0/00 3:08:15	8.83	85	1/0/00 3:20:45	8.57
36	1/0/00 3:08:30	8.82	86	1/0/00 3:21:00	8.56
37	1/0/00 3:08:45	8.81	87	1/0/00 3:21:15	8.56
38	1/0/00 3:09:00	8.80	88	1/0/00 3:21:30	8.56
39	1/0/00 3:09:15	8.80	89	1/0/00 3:21:45	8.55
40	1/0/00 3:09:30	8.79	90	1/0/00 3:22:00	8.55
41	1/0/00 3:09:45	8.78	91	1/0/00 3:22:15	8.55
42	1/0/00 3:10:00	8.77	92	1/0/00 3:22:30	8.55
43	1/0/00 3:10:15	8.76	93	1/0/00 3:22:45	8.54
44	1/0/00 3:10:30	8.76	94	1/0/00 3:23:00	8.54
45	1/0/00 3:10:45	8.75	95	1/0/00 3:23:15	8.54
46	1/0/00 3:11:00	8.74	96	1/0/00 3:23:30	8.53
47	1/0/00 3:11:15	8.74	97	1/0/00 3:23:45	8.53
48	1/0/00 3:11:30	8.73	98	1/0/00 3:24:00	8.53
49	1/0/00 3:11:45	8.73	99	1/0/00 3:24:15	8.53
50	1/0/00 3:12:00	8.72	100	1/0/00 3:24:30	8.52

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 10 Feet

Depths to:
water level (DTW) 8.09 Feet
Top of Aquifer 10 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Fine Sand

wetted hole 10 Feet
Aquifer thickness = 45 Feet
Aquifer thickness = 45 feet
Aquifer thickness = 45 Feet
Aquifer thickness = 45 Feet **1**
45

Fraction penetrated = 0.222222

slope points 4.789474 0.267
103.8571 1.172

FLOW RATE 3.00 GPM
FLOW RATE 577.5401 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 0.67732 Feet /log₁₀
Slope = 0.67732 feet/log₁₀

T = 156 ft2/d
156.0653 Feet2/Day **10**
160 Feet2/Day **16**

K = 3.468117 ft/d
3.468117 Feet/Day **0.1**
K = 3.5 Feet/Day **35**

Absolute Shut Down

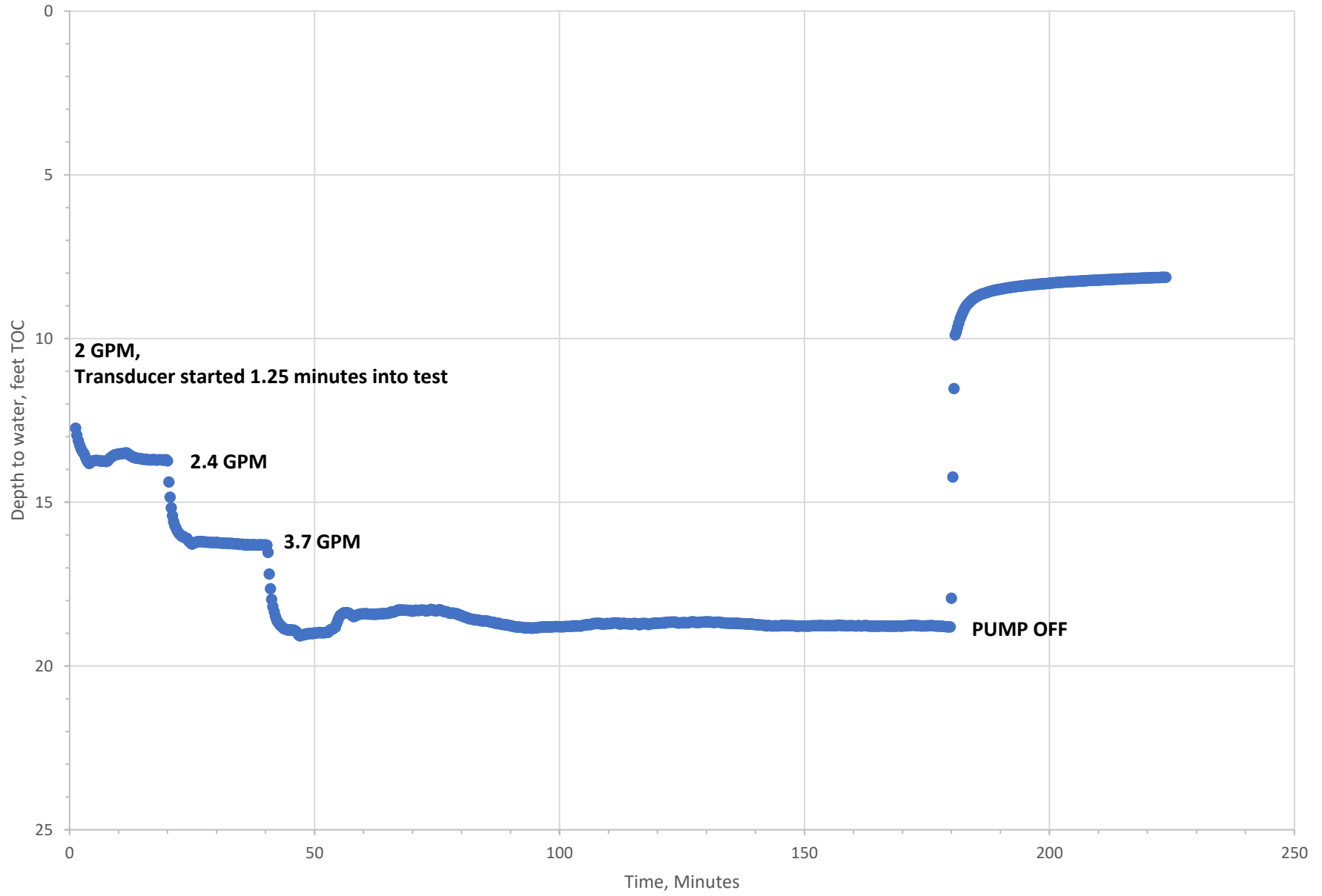
Input is consistent.

Decision	Option			
0	Water level is below Base of Aquifer			
0	Casing diameter is greater than the Annulus			
0	Top of Aquifer is deeper than Base of Aquifer			
0	Screen length is less than 1 Feet	1		
0	Slope will produce a negative K			
0	K = 3.5 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
0	K = 3.5 is greater than extreme maximum of 20 for Fine Sa	20	1	20
1	Input is consistent.			
	Error			

WARNING

Decision	Option			
0				
0	K = 3.5 is less than likely minimum of 3 for Fine Sand	3	0	3
0	K = 3.5 is greater than likely maximum of 20 for Fine Sand	20	1	20
1				

MW-34 Pumping Test



WELL ID: MW-34-Recovery

Local ID: MW-34

Date: 2/2/2017

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	8.05 Feet
Top of Aquifer	10 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand
FLOW RATE	3.7 GPM

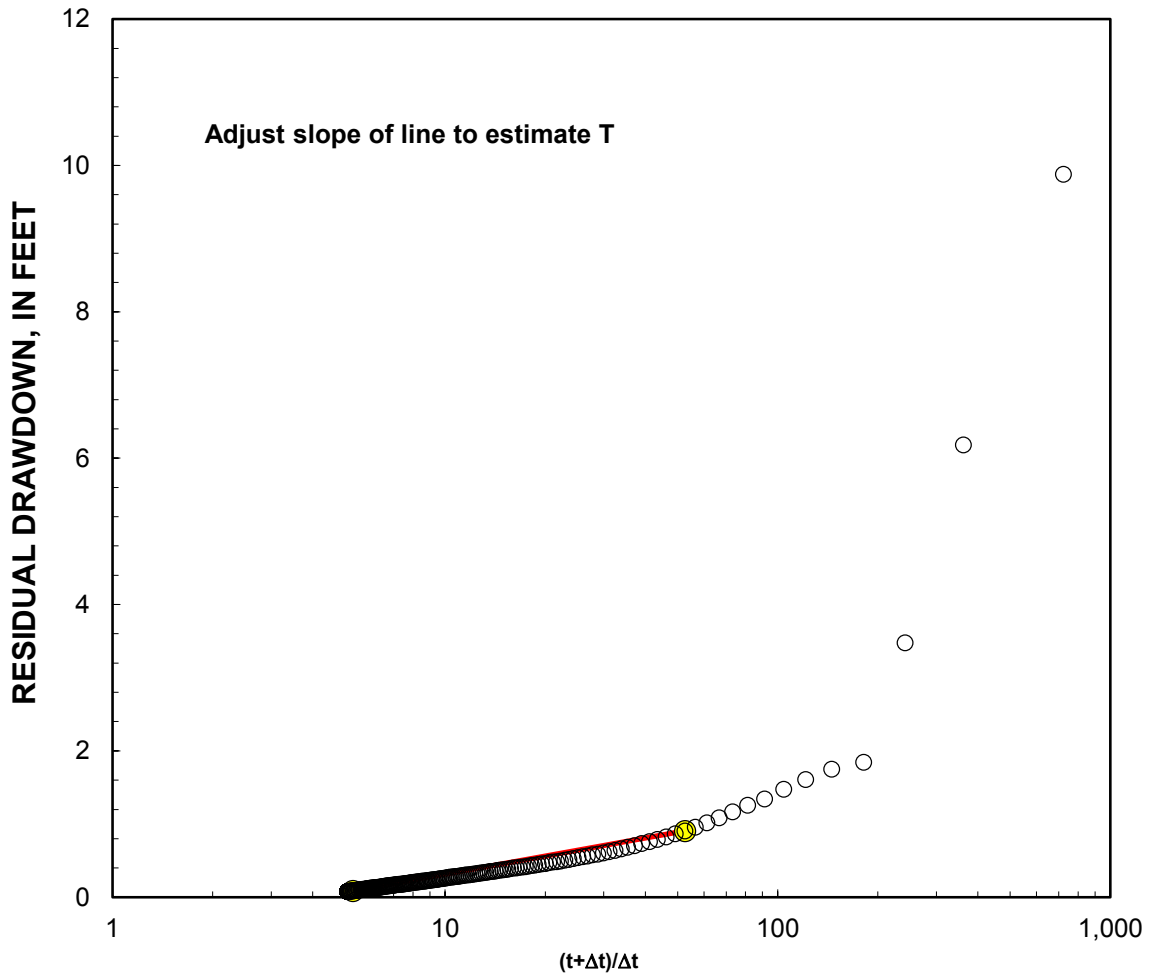
COMPUTED

Aquifer thickness = 45 Feet

Slope = 0.821019 Feet/log10

Input is consistent.

K =	3.5 Feet/Day
T =	160 Feet ² /Day



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
	Time,	Water Level		Time,	Water Level
Entry	Date Hr:Min:Sec	Feet	Entry	Date Hr:Min:Sec	Feet
1	1/0/00 0:00:00	8.05	51	1/0/00 3:12:45	8.44
2	1/0/00 3:00:30	18.81	52	1/0/00 3:13:00	8.44
3	1/0/00 3:00:45	17.93	53	1/0/00 3:13:15	8.43
4	1/0/00 3:01:00	14.23	54	1/0/00 3:13:30	8.43
5	1/0/00 3:01:15	11.53	55	1/0/00 3:13:45	8.42
6	1/0/00 3:01:30	9.90	56	1/0/00 3:14:00	8.42
7	1/0/00 3:01:45	9.80	57	1/0/00 3:14:15	8.41
8	1/0/00 3:02:00	9.66	58	1/0/00 3:14:30	8.40
9	1/0/00 3:02:15	9.53	59	1/0/00 3:14:45	8.40
10	1/0/00 3:02:30	9.39	60	1/0/00 3:15:00	8.40
11	1/0/00 3:02:45	9.31	61	1/0/00 3:15:15	8.39
12	1/0/00 3:03:00	9.22	62	1/0/00 3:15:30	8.39
13	1/0/00 3:03:15	9.14	63	1/0/00 3:15:45	8.38
14	1/0/00 3:03:30	9.07	64	1/0/00 3:16:00	8.38
15	1/0/00 3:03:45	9.01	65	1/0/00 3:16:15	8.37
16	1/0/00 3:04:00	8.96	66	1/0/00 3:16:30	8.37
17	1/0/00 3:04:15	8.92	67	1/0/00 3:16:45	8.37
18	1/0/00 3:04:30	8.88	68	1/0/00 3:17:00	8.36
19	1/0/00 3:04:45	8.84	69	1/0/00 3:17:15	8.36
20	1/0/00 3:05:00	8.81	70	1/0/00 3:17:30	8.36
21	1/0/00 3:05:15	8.78	71	1/0/00 3:17:45	8.35
22	1/0/00 3:05:30	8.76	72	1/0/00 3:18:00	8.35
23	1/0/00 3:05:45	8.74	73	1/0/00 3:18:15	8.34
24	1/0/00 3:06:00	8.71	74	1/0/00 3:18:30	8.34
25	1/0/00 3:06:15	8.69	75	1/0/00 3:18:45	8.34
26	1/0/00 3:06:30	8.67	76	1/0/00 3:19:00	8.33
27	1/0/00 3:06:45	8.66	77	1/0/00 3:19:15	8.33
28	1/0/00 3:07:00	8.64	78	1/0/00 3:19:30	8.33
29	1/0/00 3:07:15	8.63	79	1/0/00 3:19:45	8.33
30	1/0/00 3:07:30	8.62	80	1/0/00 3:20:00	8.32
31	1/0/00 3:07:45	8.60	81	1/0/00 3:20:15	8.32
32	1/0/00 3:08:00	8.59	82	1/0/00 3:20:30	8.32
33	1/0/00 3:08:15	8.58	83	1/0/00 3:20:45	8.31
34	1/0/00 3:08:30	8.57	84	1/0/00 3:21:00	8.31
35	1/0/00 3:08:45	8.56	85	1/0/00 3:21:15	8.30
36	1/0/00 3:09:00	8.55	86	1/0/00 3:21:30	8.30
37	1/0/00 3:09:15	8.54	87	1/0/00 3:21:45	8.30
38	1/0/00 3:09:30	8.53	88	1/0/00 3:22:00	8.29
39	1/0/00 3:09:45	8.52	89	1/0/00 3:22:15	8.29
40	1/0/00 3:10:00	8.51	90	1/0/00 3:22:30	8.29
41	1/0/00 3:10:15	8.51	91	1/0/00 3:22:45	8.29
42	1/0/00 3:10:30	8.50	92	1/0/00 3:23:00	8.29
43	1/0/00 3:10:45	8.49	93	1/0/00 3:23:15	8.28
44	1/0/00 3:11:00	8.48	94	1/0/00 3:23:30	8.28
45	1/0/00 3:11:15	8.48	95	1/0/00 3:23:45	8.28
46	1/0/00 3:11:30	8.47	96	1/0/00 3:24:00	8.27
47	1/0/00 3:11:45	8.46	97	1/0/00 3:24:15	8.27
48	1/0/00 3:12:00	8.46	98	1/0/00 3:24:30	8.27
49	1/0/00 3:12:15	8.45	99	1/0/00 3:24:45	8.27
50	1/0/00 3:12:30	8.45	100	1/0/00 3:25:00	8.26

Absolute Shut Down

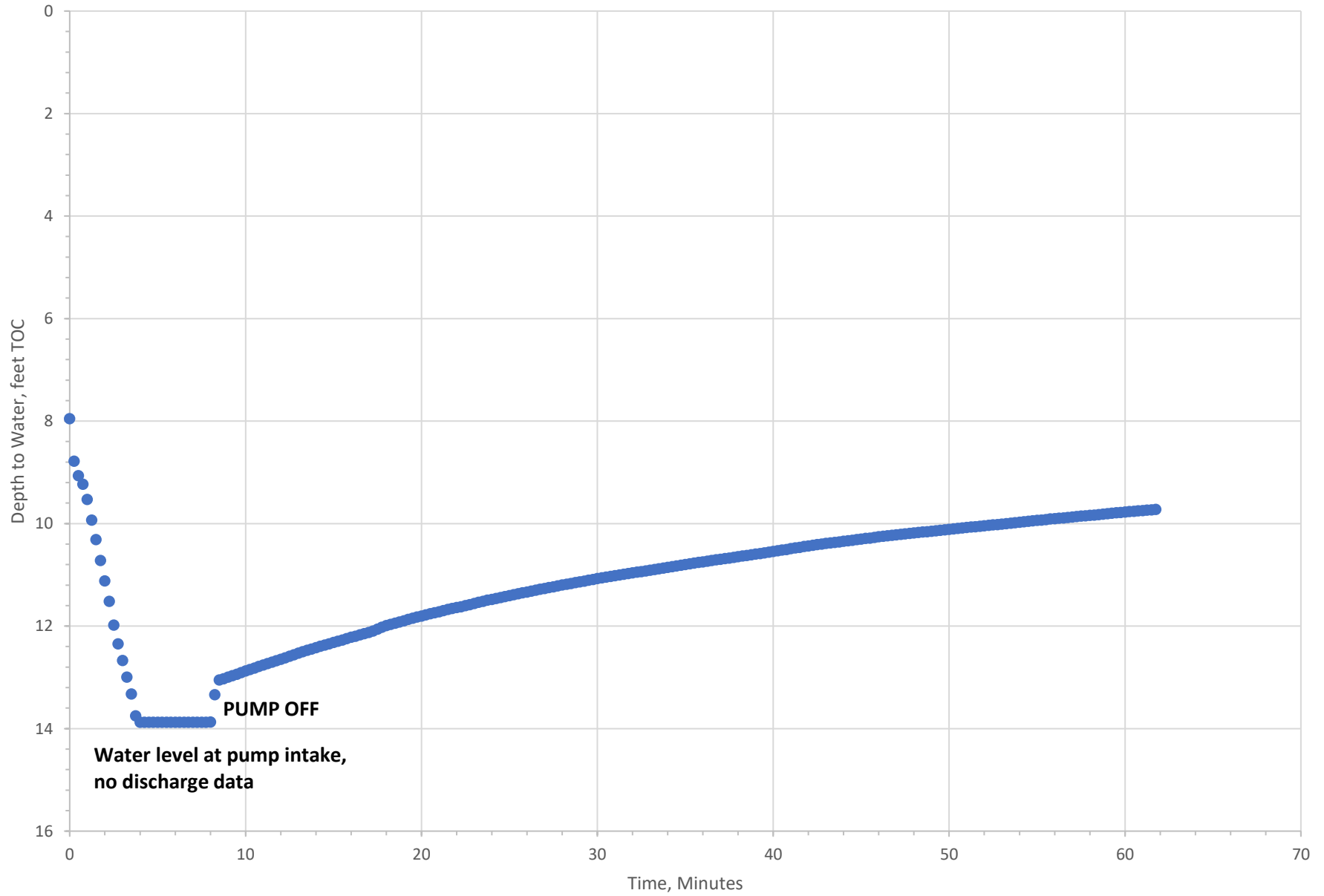
Input is consistent.

Decision	Option			
0	Water level is below Base of Aquifer			
0	Casing diameter is greater than the Annulus			
0	Top of Aquifer is deeper than Base of Aquifer			
0	Screen length is less than 1 Feet	1		
0	Slope will produce a negative K			
0	K= 3.5 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
0	K= 3.5 is greater than extreme maximum of 20 for Fine Sand	20	1	20
1	Input is consistent.			
	Error			

WARNING

Decision	Option			
0				
0	K= 3.5 is less than likely minimum of 3 for Fine Sand	3	0	3
0	K= 3.5 is greater than likely maximum of 20 for Fine Sand	20	1	20
1				

MW-25 Pumping Test



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Vol. 8 No. 2

BOUWER AND RICE SLUG-TEST METHOD & SINGLE WELL SOLUTIONS

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Bouwer and Rice Slug-Test Method

Bouwer and Rice (1976) developed a method of determining the hydraulic conductivity of an unconfined aquifer. This method can be used for both fully and partially penetrating wells. While originally developed for unconfined aquifers, it has been found that it can also be used in confined aquifers, provided the top of the well screen is some distance below the bottom of the upper confining layer.

The equations used to determine the hydraulic conductivity with the Bouwer and Rice method are as follows:

$$K = \frac{r_e^2 \ln(R_e/r_w)}{2L_e} \frac{1}{t} \ln\left(\frac{h_0}{h}\right)$$

where :

K is hydraulic conductivity (L/T)

r_e is the radius of the well casing (L)

r_w is the radius of the well (including gravel envelope) (L)

R_e is the radial distance over which head is dissipated (L)

L_e is the length of the screen (L)

t is the time since $h=h_0$ (T)

h₀ is the drawdown at time $t=0$ (L)

h is the drawdown at time $t=t$ (L)

Bouwer has presented a method of estimating $\ln(R_e/r_w)$:

For partially penetrating wells:

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{A + B \ln[(b - L_w)/r_w]}{L_e/r_w} \right]^{-1}$$

For fully penetrating wells:

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{L_e/r_w} \right]^{-1}$$

where:

L_w is the length of the well in the aquifer

b is the thickness of the saturated material

A, B, C are dimensionless numbers represented in the following diagram:

February 24, 2017

RISC5 & RBCA Tool
Kit
(Risk Assessment)

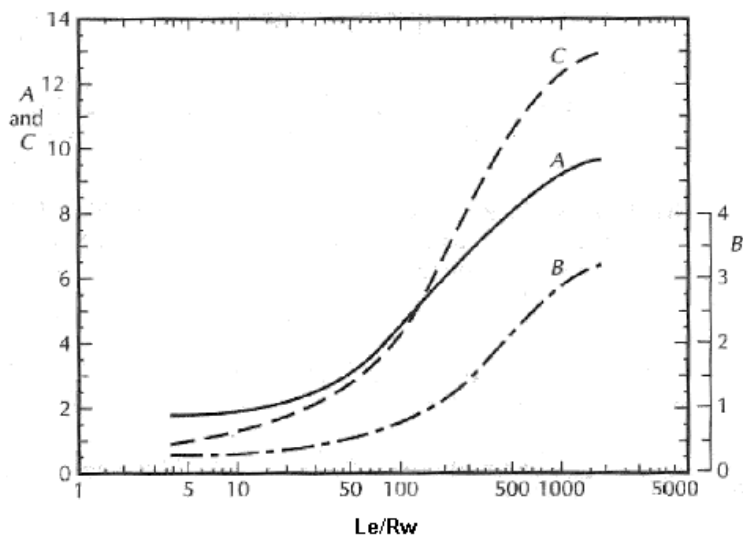


YSI ProPlus
(multiparameter)



Solinst Levelloggers



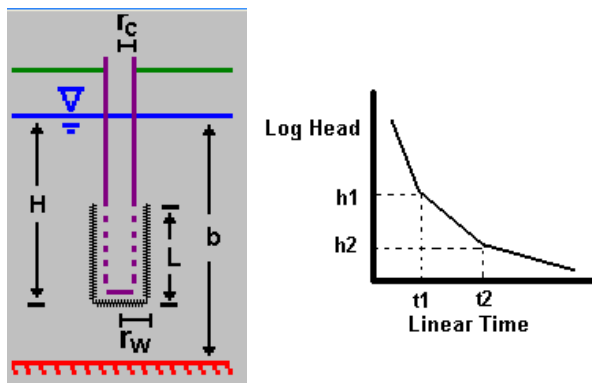


There are many programs available for analyzing slug tests results, including [Single Well Solutions](#)

Bouwer and Rice Slug Test

Calculating conductivity using the Bouwer and Rice slug test method

Graphical Display of Inputs



h_1 (head at time t_1):

h_2 (head at time t_2):

t_1 (time at head h_1):

t_2 (time at head h_2):

[How to get this data](#)

Well Type:

b (Aquifer saturated thickness):

H (distance from water table to bottom of pack):

L (length of the screened interval):

r_c (radius of casing):

r_w (radius of well):

****KEEP UNITS CONSISTENT****

Results

Conductivity:

References

Batu, V. (1998). Aquifer Hydraulics; A Comprehensive Guide to Hydrogeologic Data Analysis. Published by John Wiley & Sons, Inc. New York, NY.

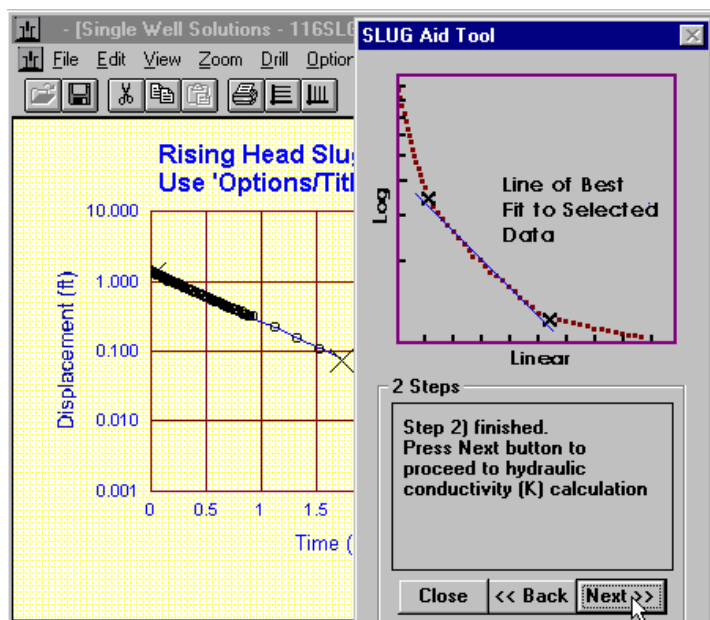
Fetter, C.W. (1994). Applied Hydrogeology; Third Edition. Published by Prentice-Hall, Inc., Englewood Cliffs, NJ.

Schwartz, F.W. and Zhang, H. (2003). Fundamentals of Groundwater. Published by John Wiley & Sons, Inc. New York, NY.

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Single Well Solution

Single Well Solutions is a powerful Windows software product that contains a collection of the most popular analytical solutions from "Analysis and Evaluation of Pumping Test Data," by G.P. Kruseman and N.A. deRidder, second edition (1990), for determining aquifer hydraulic conductivity and pumping well efficiency from single well test data



Wide selection of analysis methods

Single Well Solutions is capable of analyzing single well test data with a variety of methods. These methods include:

Slug Tests:

- Bouwer and Rice (1976)
- Cooper et al. (1967)

Constant Discharge

- Hurr and Worthington (1981)
- Hantush (1964)

Variable Discharge

- Bisroy and Summers (1980) (both Intermittent and Uninterrupted Pumping)

Step Drawdown

- Hantush and Bierschenk (1964)

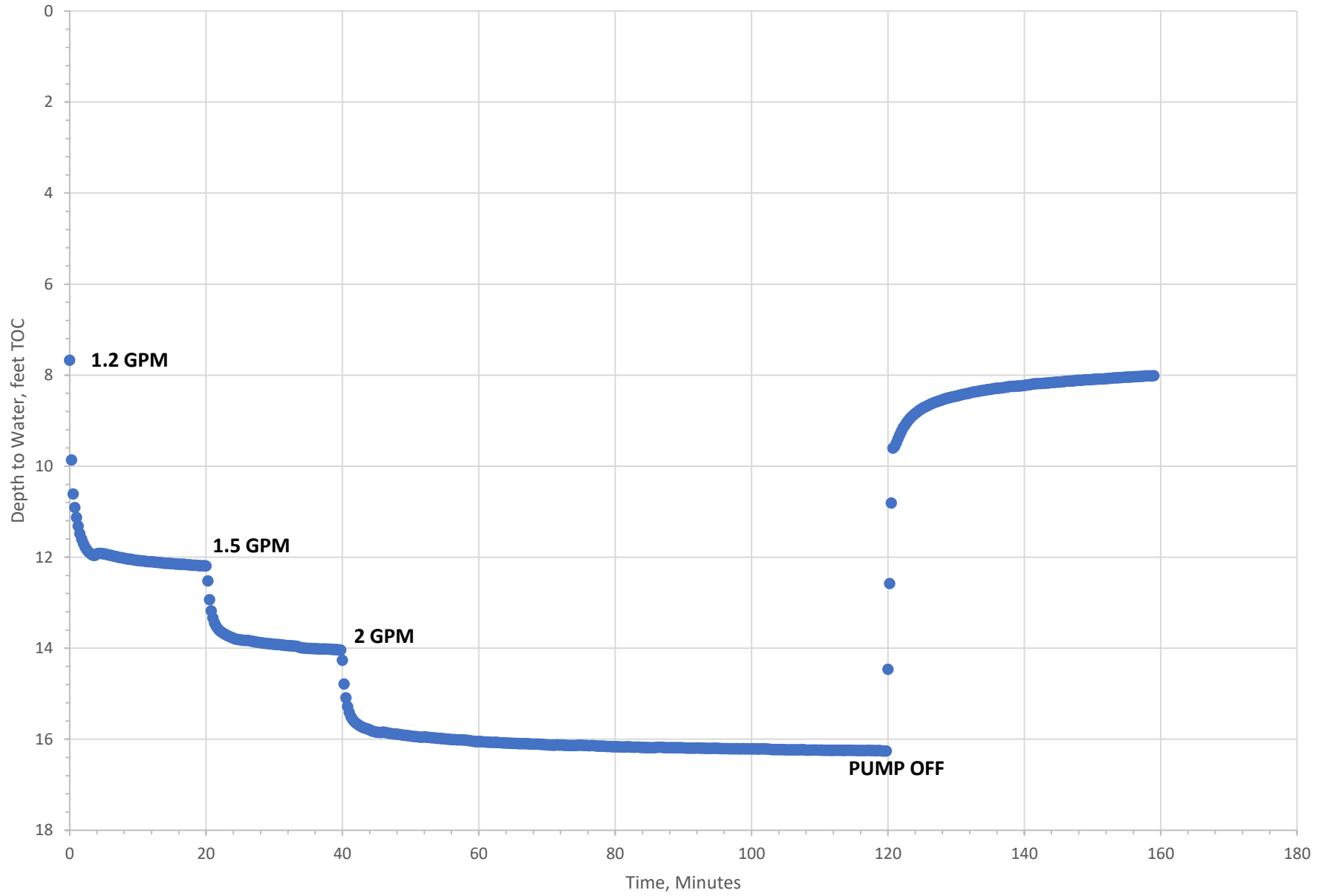
Constant Discharge Recovery

- Theis (1935)

For more info click here: [Single Well Solutions](#)

To demo software click here: [Demo](#)

MW- 26 Pumping Test



WELL ID: MW-26-Recovery

Local ID: MW-25

Date: 2/2/2017

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	7.67 Feet
Top of Aquifer	10 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand
FLOW RATE	2 GPM

COMPUTED

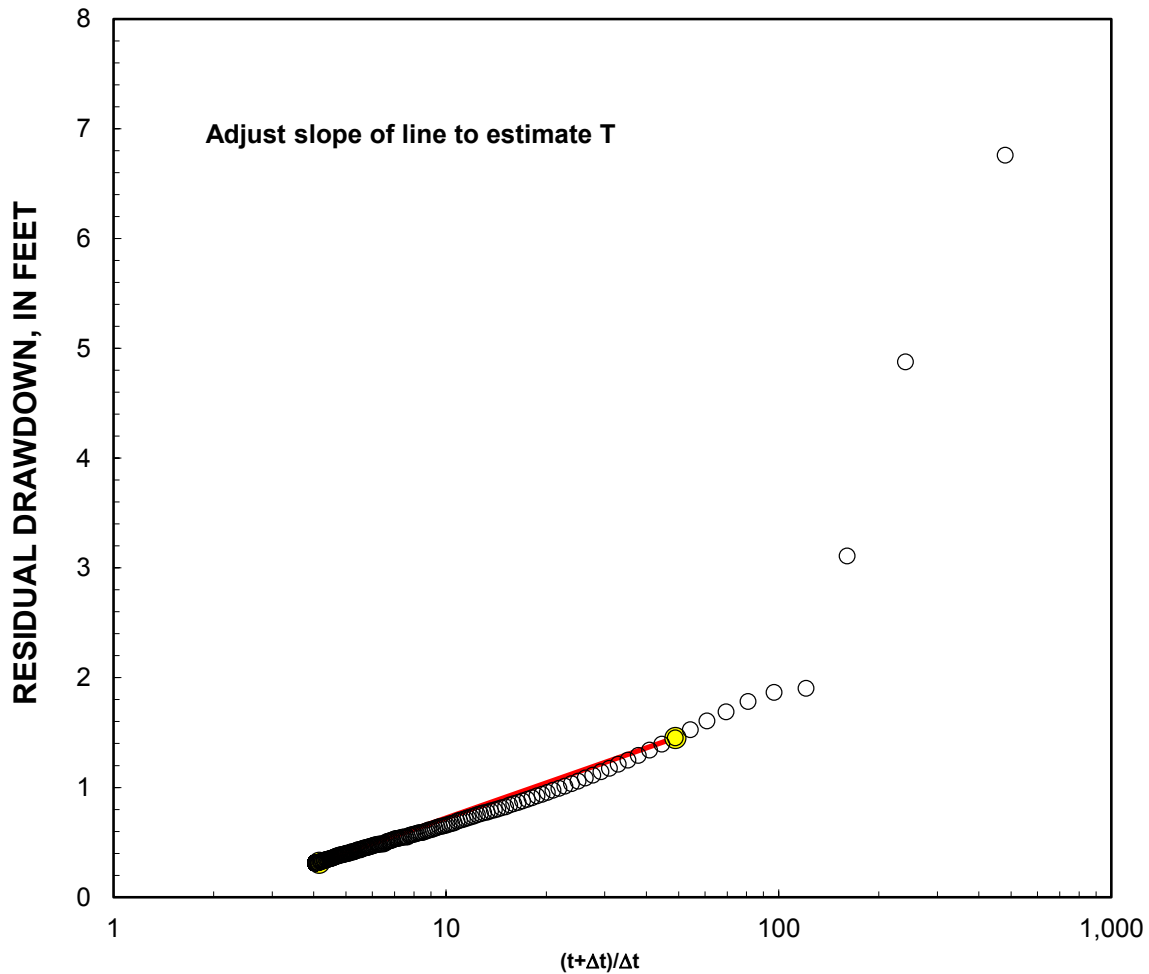
Aquifer thickness = 45 Feet

Slope = 1.060569 Feet/log10

Input is consistent.

K =	1.5 Feet/Day
T =	66 Feet ² /Day

K= 1.5 is less than likely minimum of 3 for Fine Sand



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
Entry	Time, Date Hr:Min:Sec	Water Level Feet	Entry	Time, Date Hr:Min:Sec	Water Level Feet
1	1/0/00 0:00:00	7.70	51	1/0/00 2:12:00	8.39
2	1/0/00 1:59:45	16.26	52	1/0/00 2:12:15	8.38
3	1/0/00 2:00:00	14.46	53	1/0/00 2:12:30	8.37
4	1/0/00 2:00:15	12.58	54	1/0/00 2:12:45	8.37
5	1/0/00 2:00:30	10.81	55	1/0/00 2:13:00	8.36
6	1/0/00 2:00:45	9.60	56	1/0/00 2:13:15	8.35
7	1/0/00 2:01:00	9.57	57	1/0/00 2:13:30	8.35
8	1/0/00 2:01:15	9.48	58	1/0/00 2:13:45	8.34
9	1/0/00 2:01:30	9.39	59	1/0/00 2:14:00	8.34
10	1/0/00 2:01:45	9.31	60	1/0/00 2:14:15	8.33
11	1/0/00 2:02:00	9.23	61	1/0/00 2:14:30	8.32
12	1/0/00 2:02:15	9.15	62	1/0/00 2:14:45	8.32
13	1/0/00 2:02:30	9.10	63	1/0/00 2:15:00	8.31
14	1/0/00 2:02:45	9.04	64	1/0/00 2:15:15	8.30
15	1/0/00 2:03:00	8.99	65	1/0/00 2:15:30	8.30
16	1/0/00 2:03:15	8.95	66	1/0/00 2:15:45	8.29
17	1/0/00 2:03:30	8.91	67	1/0/00 2:16:00	8.29
18	1/0/00 2:03:45	8.88	68	1/0/00 2:16:15	8.29
19	1/0/00 2:04:00	8.84	69	1/0/00 2:16:30	8.28
20	1/0/00 2:04:15	8.81	70	1/0/00 2:16:45	8.28
21	1/0/00 2:04:30	8.79	71	1/0/00 2:17:00	8.27
22	1/0/00 2:04:45	8.76	72	1/0/00 2:17:15	8.27
23	1/0/00 2:05:00	8.74	73	1/0/00 2:17:30	8.26
24	1/0/00 2:05:15	8.71	74	1/0/00 2:17:45	8.25
25	1/0/00 2:05:30	8.69	75	1/0/00 2:18:00	8.25
26	1/0/00 2:05:45	8.68	76	1/0/00 2:18:15	8.25
27	1/0/00 2:06:00	8.66	77	1/0/00 2:18:30	8.25
28	1/0/00 2:06:15	8.64	78	1/0/00 2:18:45	8.24
29	1/0/00 2:06:30	8.62	79	1/0/00 2:19:00	8.24
30	1/0/00 2:06:45	8.61	80	1/0/00 2:19:15	8.24
31	1/0/00 2:07:00	8.59	81	1/0/00 2:19:30	8.24
32	1/0/00 2:07:15	8.58	82	1/0/00 2:19:45	8.23
33	1/0/00 2:07:30	8.57	83	1/0/00 2:20:00	8.23
34	1/0/00 2:07:45	8.55	84	1/0/00 2:20:15	8.22
35	1/0/00 2:08:00	8.54	85	1/0/00 2:20:30	8.22
36	1/0/00 2:08:15	8.53	86	1/0/00 2:20:45	8.21
37	1/0/00 2:08:30	8.52	87	1/0/00 2:21:00	8.21
38	1/0/00 2:08:45	8.50	88	1/0/00 2:21:15	8.20
39	1/0/00 2:09:00	8.50	89	1/0/00 2:21:30	8.19
40	1/0/00 2:09:15	8.49	90	1/0/00 2:21:45	8.19
41	1/0/00 2:09:30	8.48	91	1/0/00 2:22:00	8.19
42	1/0/00 2:09:45	8.47	92	1/0/00 2:22:15	8.18
43	1/0/00 2:10:00	8.46	93	1/0/00 2:22:30	8.18
44	1/0/00 2:10:15	8.45	94	1/0/00 2:22:45	8.18
45	1/0/00 2:10:30	8.44	95	1/0/00 2:23:00	8.18
46	1/0/00 2:10:45	8.43	96	1/0/00 2:23:15	8.18
47	1/0/00 2:11:00	8.43	97	1/0/00 2:23:30	8.17
48	1/0/00 2:11:15	8.42	98	1/0/00 2:23:45	8.17
49	1/0/00 2:11:30	8.41	99	1/0/00 2:24:00	8.17
50	1/0/00 2:11:45	8.40	100	1/0/00 2:24:15	8.16

Absolute Shut Down

Input is consistent.

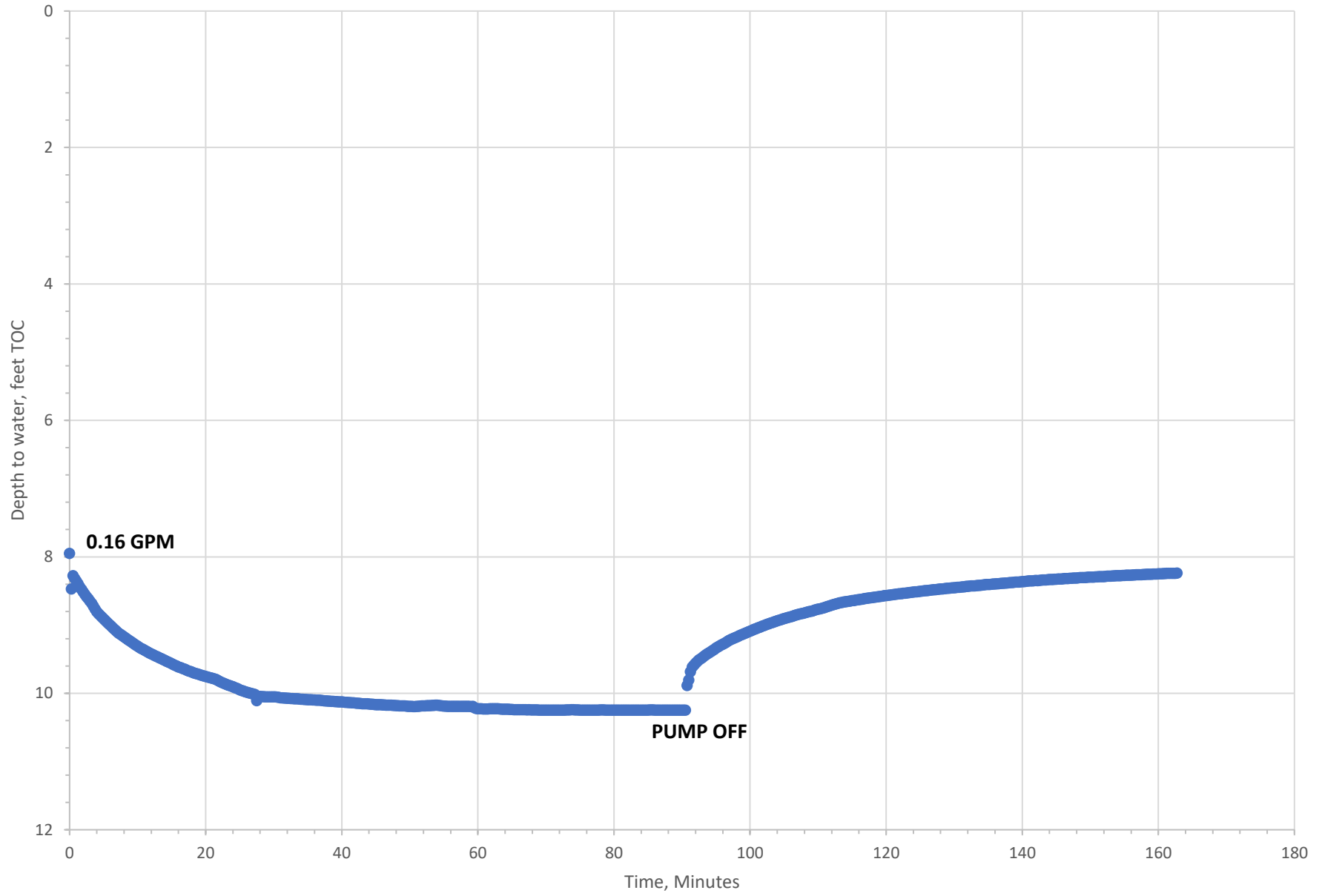
Decision	Option			
0	Water level is below Base of Aquifer			
0	Casing diameter is greater than the Annulus			
0	Top of Aquifer is deeper than Base of Aquifer			
0	Screen length is less than 1 Feet	1		
0	Slope will produce a negative K			
0	K= 1.5 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
0	K= 1.5 is greater than extreme maximum of 20 for Fine Sand	20	1	20
1	Input is consistent.			
	Error			

WARNING

K= 1.5 is less than likely minimum of 3 for Fine Sand

Decision	Option			
0				
1	K= 1.5 is less than likely minimum of 3 for Fine Sand	3	0	3
1	K= 1.5 is greater than likely maximum of 20 for Fine Sand	20	1	20
2				

MW-27 Pumping Test



WELL ID: MW-27-Recovery

Local ID: MW-27

Date: 2/1/2017

Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	7.95 Feet
Top of Aquifer	10 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material --	Fine Sand
FLOW RATE	0.16 GPM

COMPUTED

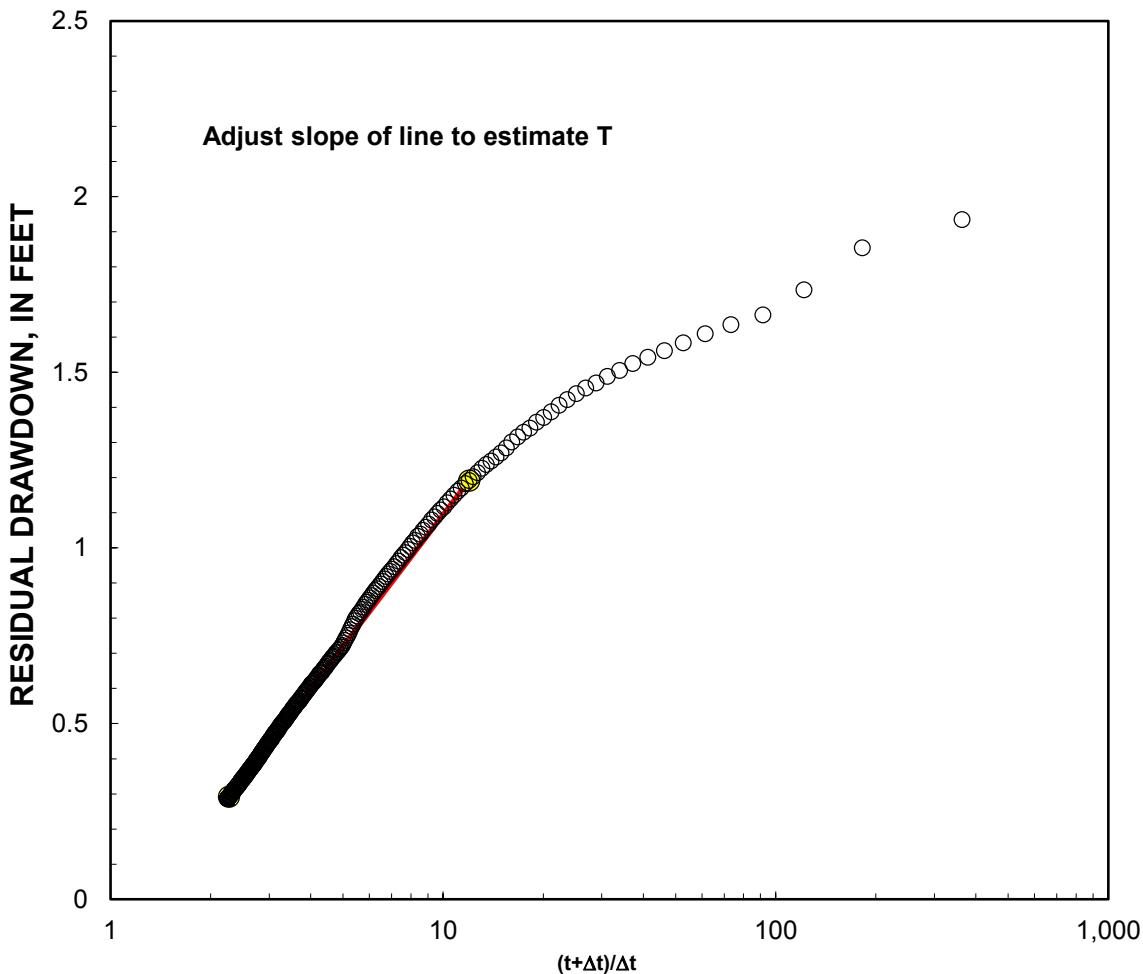
Aquifer thickness = 45 Feet

Slope = 1.246496 Feet/log10

Input is consistent.

K =	0.1 Feet/Day
T =	4.5 Feet ² /Day

K= 0.1 is less than likely minimum of 3 for Fine Sand



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
Entry	Time, Date Hr:Min:Sec	Water Level Feet	Entry	Time, Date Hr:Min:Sec	Water Level Feet
1	1/0/00 0:00:00	7.95	51	1/0/00 1:55:15	8.64
2	1/0/00 1:30:45	9.89	52	1/0/00 1:55:45	8.63
3	1/0/00 1:31:15	9.69	53	1/0/00 1:56:15	8.62
4	1/0/00 1:31:45	9.59	54	1/0/00 1:56:45	8.61
5	1/0/00 1:32:15	9.53	55	1/0/00 1:57:15	8.61
6	1/0/00 1:32:45	9.49	56	1/0/00 1:57:45	8.60
7	1/0/00 1:33:15	9.46	57	1/0/00 1:58:15	8.59
8	1/0/00 1:33:45	9.42	58	1/0/00 1:58:45	8.58
9	1/0/00 1:34:15	9.39	59	1/0/00 1:59:15	8.58
10	1/0/00 1:34:45	9.36	60	1/0/00 1:59:45	8.57
11	1/0/00 1:35:15	9.32	61	1/0/00 2:00:15	8.57
12	1/0/00 1:35:45	9.29	62	1/0/00 2:00:45	8.56
13	1/0/00 1:36:15	9.27	63	1/0/00 2:01:15	8.55
14	1/0/00 1:36:45	9.24	64	1/0/00 2:01:45	8.54
15	1/0/00 1:37:15	9.21	65	1/0/00 2:02:15	8.54
16	1/0/00 1:37:45	9.19	66	1/0/00 2:02:45	8.53
17	1/0/00 1:38:15	9.17	67	1/0/00 2:03:15	8.53
18	1/0/00 1:38:45	9.14	68	1/0/00 2:03:45	8.52
19	1/0/00 1:39:15	9.12	69	1/0/00 2:04:15	8.51
20	1/0/00 1:39:45	9.10	70	1/0/00 2:04:45	8.51
21	1/0/00 1:40:15	9.08	71	1/0/00 2:05:15	8.50
22	1/0/00 1:40:45	9.06	72	1/0/00 2:05:45	8.50
23	1/0/00 1:41:15	9.04	73	1/0/00 2:06:15	8.49
24	1/0/00 1:41:45	9.02	74	1/0/00 2:06:45	8.49
25	1/0/00 1:42:15	9.00	75	1/0/00 2:07:15	8.48
26	1/0/00 1:42:45	8.98	76	1/0/00 2:07:45	8.48
27	1/0/00 1:43:15	8.97	77	1/0/00 2:08:15	8.47
28	1/0/00 1:43:45	8.95	78	1/0/00 2:08:45	8.46
29	1/0/00 1:44:15	8.93	79	1/0/00 2:09:15	8.46
30	1/0/00 1:44:45	8.91	80	1/0/00 2:09:45	8.46
31	1/0/00 1:45:15	8.90	81	1/0/00 2:10:15	8.45
32	1/0/00 1:45:45	8.88	82	1/0/00 2:10:45	8.45
33	1/0/00 1:46:15	8.87	83	1/0/00 2:11:15	8.44
34	1/0/00 1:46:45	8.86	84	1/0/00 2:11:45	8.43
35	1/0/00 1:47:15	8.84	85	1/0/00 2:12:15	8.43
36	1/0/00 1:47:45	8.83	86	1/0/00 2:12:45	8.43
37	1/0/00 1:48:15	8.82	87	1/0/00 2:13:15	8.42
38	1/0/00 1:48:45	8.80	88	1/0/00 2:13:45	8.42
39	1/0/00 1:49:15	8.79	89	1/0/00 2:14:15	8.41
40	1/0/00 1:49:45	8.78	90	1/0/00 2:14:45	8.41
41	1/0/00 1:50:15	8.76	91	1/0/00 2:15:15	8.40
42	1/0/00 1:50:45	8.75	92	1/0/00 2:15:45	8.40
43	1/0/00 1:51:15	8.73	93	1/0/00 2:16:15	8.39
44	1/0/00 1:51:45	8.72	94	1/0/00 2:16:45	8.39
45	1/0/00 1:52:15	8.70	95	1/0/00 2:17:15	8.39
46	1/0/00 1:52:45	8.69	96	1/0/00 2:17:45	8.38
47	1/0/00 1:53:15	8.67	97	1/0/00 2:18:15	8.38
48	1/0/00 1:53:45	8.66	98	1/0/00 2:18:45	8.37
49	1/0/00 1:54:15	8.65	99	1/0/00 2:19:15	8.37
50	1/0/00 1:54:45	8.65	100	1/0/00 2:19:45	8.37

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 10 Feet

Depths to:
water level (DTW) 7.95 Feet
Top of Aquifer 10 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Fine Sand

wetted hole 10 Feet
Aquifer thickness = 45 Feet
Aquifer thickness = 45 feet
Aquifer thickness = 45 Feet 1
Aquifer thickness = 45 Feet 45

Fraction penetrated = 0.222222

slope points 11.9697 1.192
 2.270175 0.292

FLOW RATE 0.16 GPM
FLOW RATE 30.80214 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 1.246496 Feet /log₁₀
Slope = 1.246496 feet/log₁₀

T = 5 ft2/d
 4.522804 Feet2/Day 0.1
 4.5 Feet2/Day 45

K = 0.100507 ft/d
 0.100507 Feet/Day 0.01
K = 0.1 Feet/Day 10

Absolute Shut Down

Input is consistent.

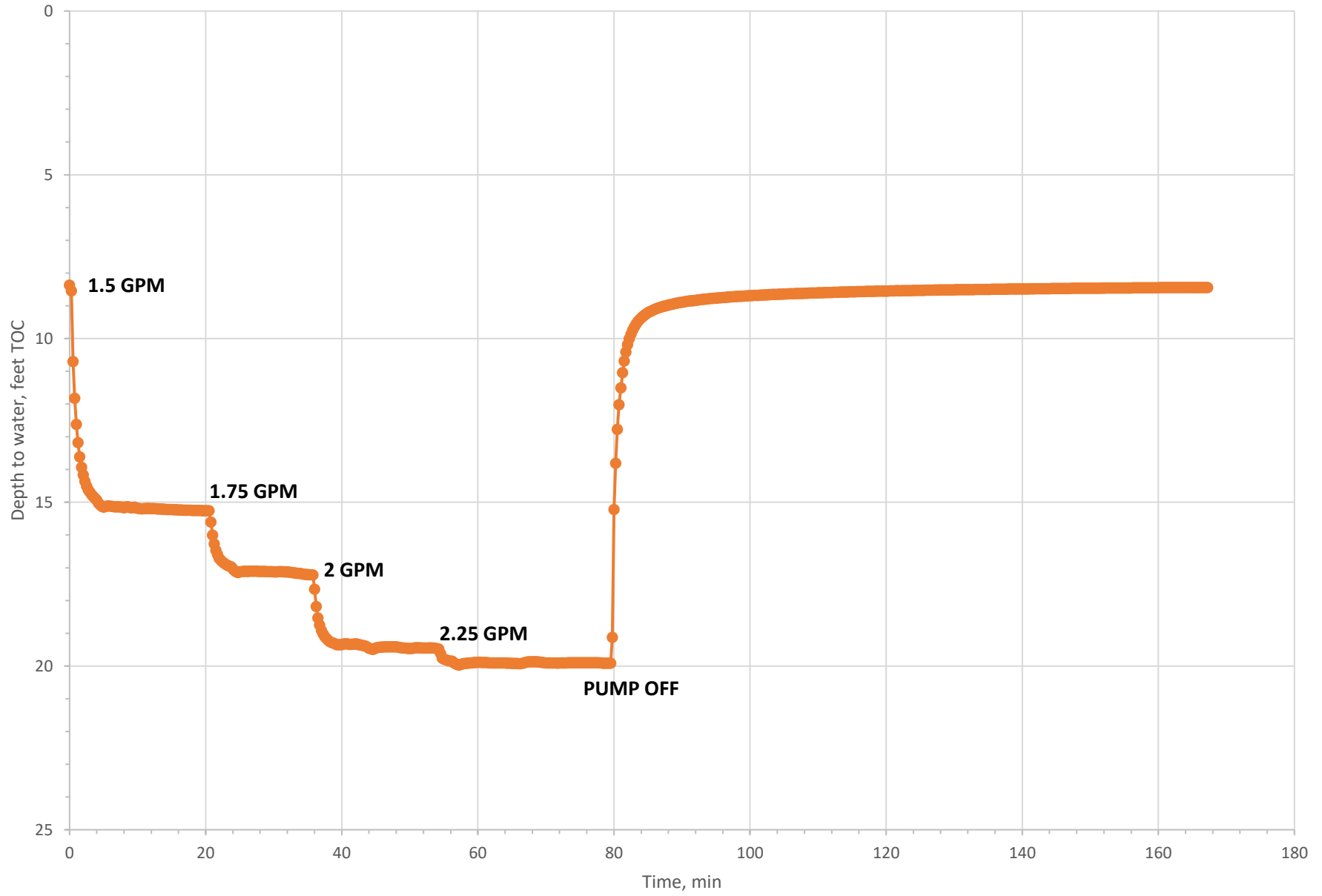
Decision	Option			
	0 Water level is below Base of Aquifer			
	0 Casing diameter is greater than the Annulus			
	0 Top of Aquifer is deeper than Base of Aquifer			
	0 Screen length is less than 1 Feet	1		
	0 Slope will produce a negative K			
	0 K = 0.1 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
	0 K = 0.1 is greater than extreme maximum of 20 for Fine Sa	20	1	20
	1 Input is consistent.			
	Error			

WARNING

K= 0.1 is less than likely minimum of 3 for Fine Sand

Decision	Option			
	0			
	1 K = 0.1 is less than likely minimum of 3 for Fine Sand	3	0	3
	1 K = 0.1 is greater than likely maximum of 20 for Fine Sand	20	1	20
	2			

MW-28



WELL ID: MW-28

Local ID: Hypo-1
 Date: 4/4/2001
 Time: 0:00

INPUT

Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	10 Feet
Depths to:	
water level (DTW)	8.37 Feet
Top of Aquifer	8 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material -- Fine Sand	
FLOW RATE	2.25 GPM

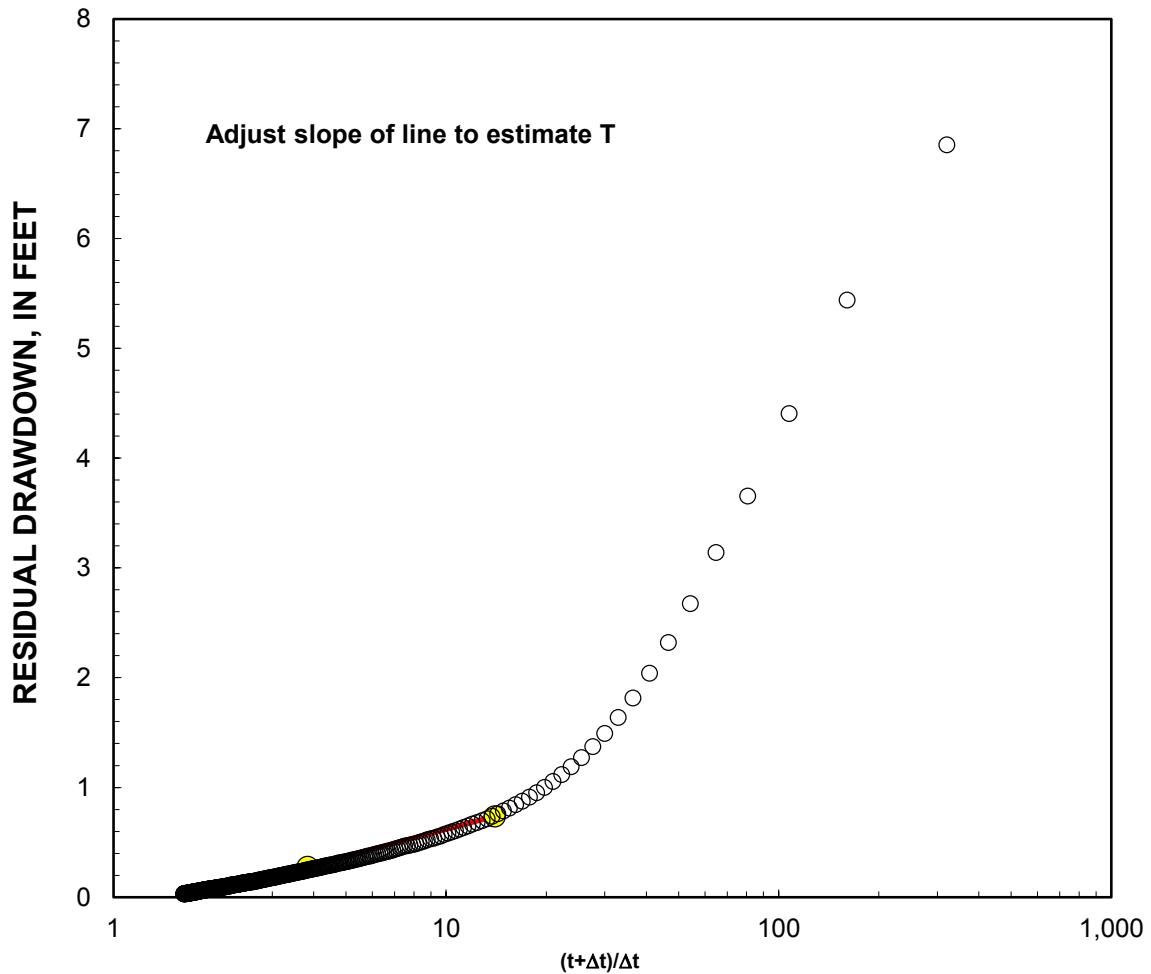
COMPUTED

Aquifer thickness = 47 Feet
 Slope = 0.813601 Feet/log10

Input is consistent.

K =	2.1 Feet/Day
T =	97 Feet ² /Day

K= 2.1 is less than likely minimum of 3 for Fine Sand



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Pumping_Cooper-Jacob_RECOVERY MW-28

Reduced Data					
	Time,	Water Level		Time,	Water Level
Entry	Date Hr:Min:Sec	Feet	Entry	Date Hr:Min:Sec	Feet
1	1/0/00 0:00:00	0.00	51	1/0/00 2:22:00	0.11
2	1/0/00 1:20:45	3.65	52	1/0/00 2:23:15	0.11
3	1/0/00 1:22:00	1.82	53	1/0/00 2:24:30	0.10
4	1/0/00 1:23:15	1.19	54	1/0/00 2:25:45	0.10
5	1/0/00 1:24:30	0.91	55	1/0/00 2:27:00	0.10
6	1/0/00 1:25:45	0.76	56	1/0/00 2:28:15	0.10
7	1/0/00 1:27:00	0.67	57	1/0/00 2:29:30	0.10
8	1/0/00 1:28:15	0.59	58	1/0/00 2:30:45	0.09
9	1/0/00 1:29:30	0.54	59	1/0/00 2:32:00	0.09
10	1/0/00 1:30:45	0.50	60	1/0/00 2:33:15	0.09
11	1/0/00 1:32:00	0.47	61	1/0/00 2:34:30	0.09
12	1/0/00 1:33:15	0.43	62	1/0/00 2:35:45	0.09
13	1/0/00 1:34:30	0.40	63	1/0/00 2:37:00	0.08
14	1/0/00 1:35:45	0.38	64	1/0/00 2:38:15	0.08
15	1/0/00 1:37:00	0.36	65	1/0/00 2:39:30	0.08
16	1/0/00 1:38:15	0.34	66	1/0/00 2:40:45	0.08
17	1/0/00 1:39:30	0.33	67	1/0/00 2:42:00	0.08
18	1/0/00 1:40:45	0.31	68	1/0/00 2:43:15	0.07
19	1/0/00 1:42:00	0.30	69	1/0/00 2:44:30	0.07
20	1/0/00 1:43:15	0.29	70	1/0/00 2:45:45	0.07
21	1/0/00 1:44:30	0.28	71	1/0/00 2:47:00	0.07
22	1/0/00 1:45:45	0.26	72	1/0/00 2:48:15	0.07
23	1/0/00 1:47:00	0.26	73	1/0/00 2:49:30	0.07
24	1/0/00 1:48:15	0.25	74	1/0/00 2:50:45	0.07
25	1/0/00 1:49:30	0.24	75	1/0/00 2:52:00	0.07
26	1/0/00 1:50:45	0.23	76	1/0/00 2:53:15	0.06
27	1/0/00 1:52:00	0.22	77	1/0/00 2:54:30	0.06
28	1/0/00 1:53:15	0.21	78	1/0/00 2:55:45	0.06
29	1/0/00 1:54:30	0.21	79	1/0/00 2:57:00	0.06
30	1/0/00 1:55:45	0.20	80	1/0/00 2:58:15	0.06
31	1/0/00 1:57:00	0.19	81	1/0/00 2:59:30	0.06
32	1/0/00 1:58:15	0.19	82	1/0/00 3:00:45	0.06
33	1/0/00 1:59:30	0.18	83	1/0/00 3:02:00	0.05
34	1/0/00 2:00:45	0.18	84	1/0/00 3:03:15	0.05
35	1/0/00 2:02:00	0.17	85	1/0/00 3:04:30	0.05
36	1/0/00 2:03:15	0.16	86	1/0/00 3:05:45	0.05
37	1/0/00 2:04:30	0.16	87	1/0/00 3:07:00	0.05
38	1/0/00 2:05:45	0.15	88	1/0/00 3:08:15	0.05
39	1/0/00 2:07:00	0.15	89	1/0/00 3:09:30	0.05
40	1/0/00 2:08:15	0.15	90	1/0/00 3:10:45	0.04
41	1/0/00 2:09:30	0.15	91	1/0/00 3:12:00	0.04
42	1/0/00 2:10:45	0.14	92	1/0/00 3:13:15	0.04
43	1/0/00 2:12:00	0.14	93	1/0/00 3:14:30	0.04
44	1/0/00 2:13:15	0.13	94	1/0/00 3:15:45	0.04
45	1/0/00 2:14:30	0.13	95	1/0/00 3:17:00	0.04
46	1/0/00 2:15:45	0.13	96	1/0/00 3:18:15	0.04
47	1/0/00 2:17:00	0.12	97	1/0/00 3:19:30	0.04
48	1/0/00 2:18:15	0.12	98	1/0/00 3:20:45	0.04
49	1/0/00 2:19:30	0.12	99	1/0/00 3:22:00	0.04
50	1/0/00 2:20:45	0.11	100	#N/A	#N/A

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 10 Feet

Depths to:
water level (DTW) 8.37 Feet
Top of Aquifer 8 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Fine Sand

wetted hole 9.63 Feet
Aquifer thickness = 46.63 Feet
Aquifer thickness = 46.63 feet
Aquifer thickness = 46.63 Feet **1**
Aquifer thickness = 47 Feet **47**

Fraction penetrated = 0.206519

slope points	14	0.738
	3.83	0.28

FLOW RATE 2.25 GPM
FLOW RATE 433.1551 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 0.813601 Feet /log₁₀
Slope = 0.813601 feet/log₁₀

T = 97 ft2/d
97.44279 Feet2/Day **1**
97 Feet2/Day **97**

K = 2.089702 ft/d
2.089702 Feet/Day **0.1**
K = 2.1 Feet/Day **21**

Absolute Shut Down

Input is consistent.

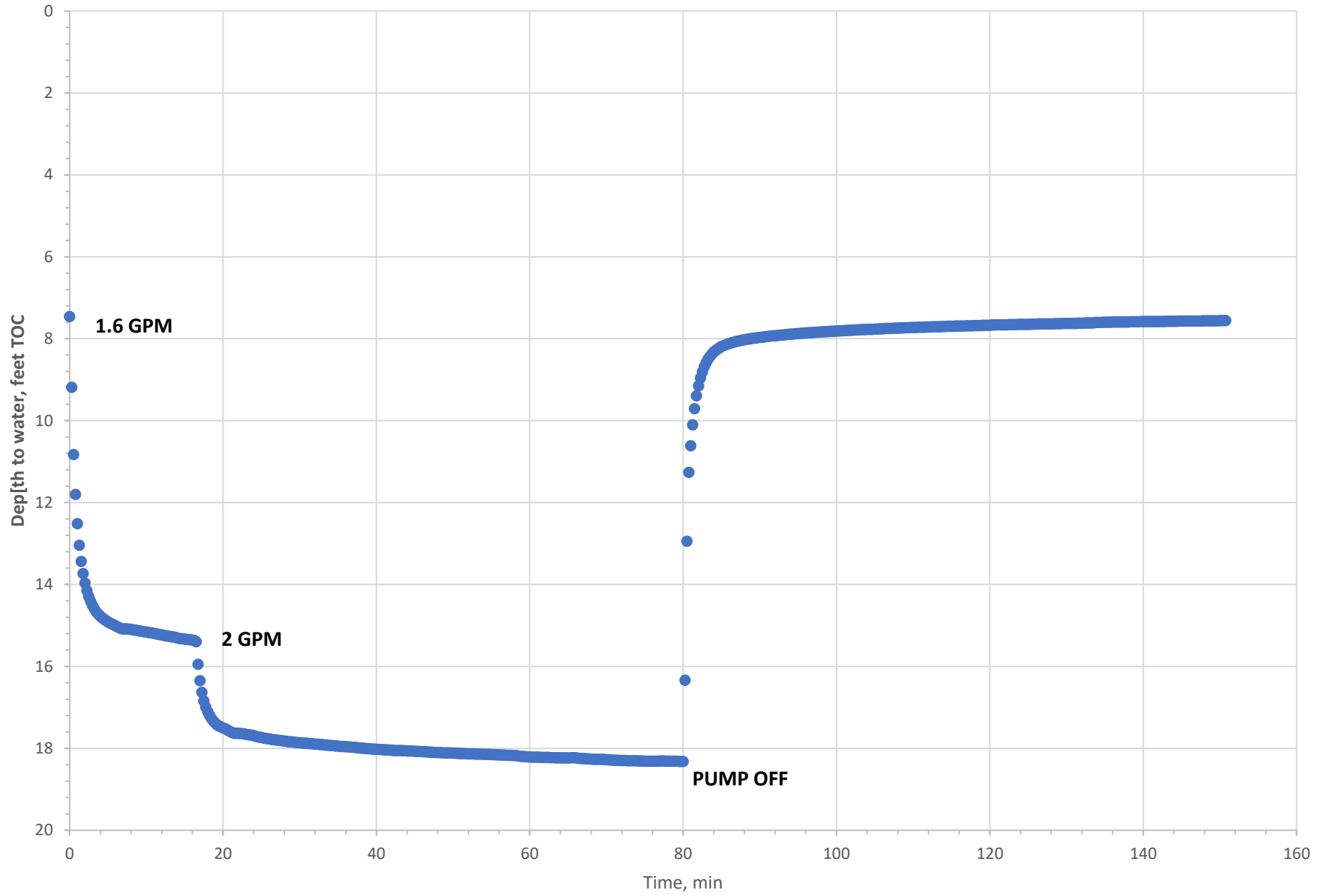
Decision	Option			
	0 Water level is below Base of Aquifer			
	0 Casing diameter is greater than the Annulus			
	0 Top of Aquifer is deeper than Base of Aquifer			
	0 Screen length is less than 1 Feet	1		
	0 Slope will produce a negative K			
	0 K = 2.1 is less than extreme minimum of 0.05 for Fine Sand	0.05	-2	0.05
	0 K = 2.1 is greater than extreme maximum of 20 for Fine Sa	20	1	20
	1 Input is consistent.			
	Error			

WARNING

K= 2.1 is less than likely minimum of 3 for Fine Sand

Decision	Option			
	0			
	1 K = 2.1 is less than likely minimum of 3 for Fine Sand	3	0	3
	1 K = 2.1 is greater than likely maximum of 20 for Fine Sand	20	1	20
	2			

MW-20



WELL ID: MW-20

Local ID: Hypo-1
 Date: 4/4/2001
 Time: 0:00

INPUT

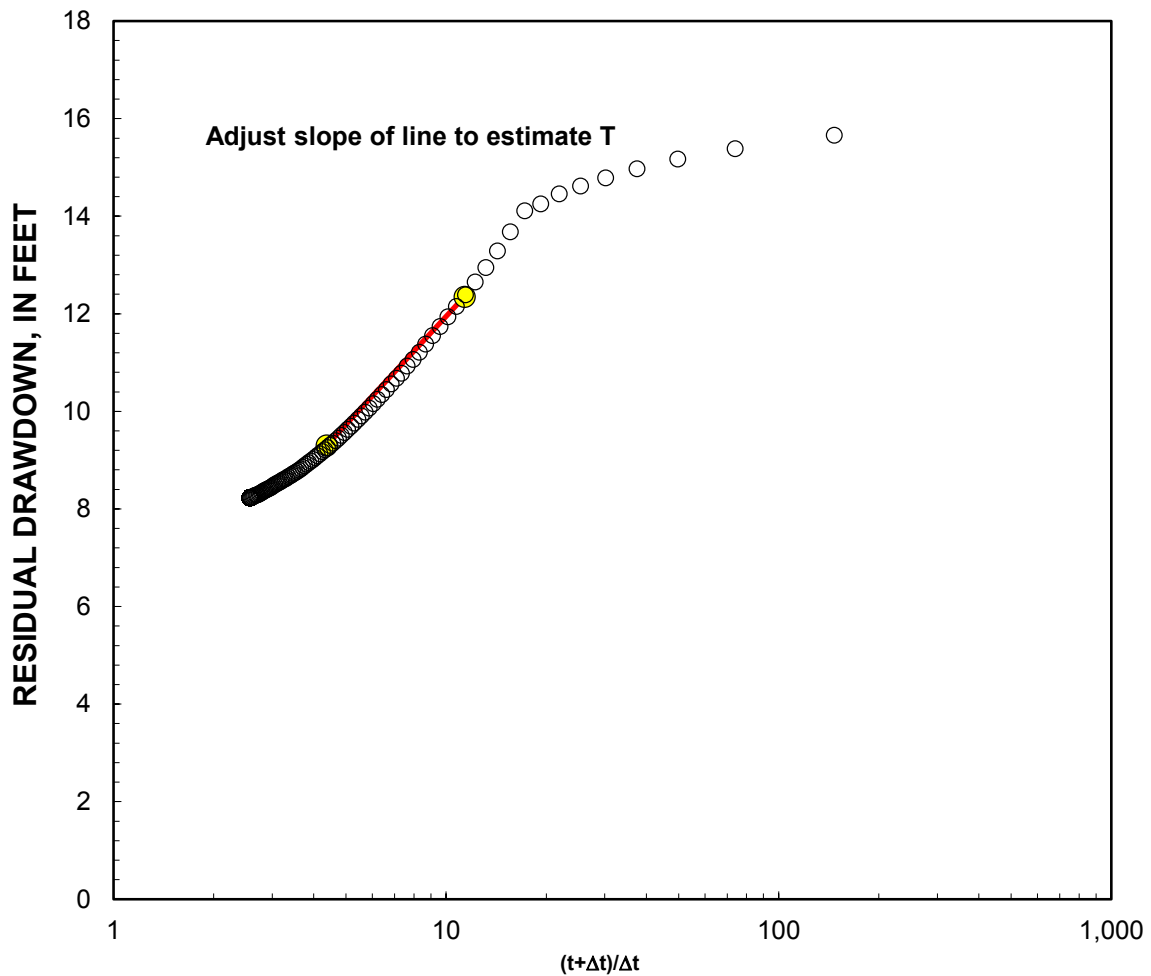
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	5 Feet
Depths to:	
water level (DTW)	7.7 Feet
Top of Aquifer	8 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material -- Silt, Loess	
FLOW RATE	0.5 GPM

COMPUTED

Aquifer thickness = 47 Feet
 Slope = 7.356781 Feet/log10

Input is consistent.

K =	0.051 Feet/Day
T =	2.4 Feet ² /Day



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Pumping_Cooper-Jacob_RECOVERY MW-20

Reduced Data					
Entry	Time, Date Hr:Min:Sec	Water Level Feet	Entry	Time, Date Hr:Min:Sec	Water Level Feet
1	1/0/00 0:00:00	0.00	51	1/0/00 0:48:45	9.02
2	1/0/00 0:36:30	15.96	52	1/0/00 0:49:00	8.98
3	1/0/00 0:36:45	15.66	53	1/0/00 0:49:15	8.95
4	1/0/00 0:37:00	15.39	54	1/0/00 0:49:30	8.92
5	1/0/00 0:37:15	15.17	55	1/0/00 0:49:45	8.89
6	1/0/00 0:37:30	14.98	56	1/0/00 0:50:00	8.86
7	1/0/00 0:37:45	14.79	57	1/0/00 0:50:15	8.83
8	1/0/00 0:38:00	14.62	58	1/0/00 0:50:30	8.80
9	1/0/00 0:38:15	14.46	59	1/0/00 0:50:45	8.77
10	1/0/00 0:38:30	14.26	60	1/0/00 0:51:00	8.74
11	1/0/00 0:38:45	14.11	61	1/0/00 0:51:15	8.72
12	1/0/00 0:39:00	13.68	62	1/0/00 0:51:30	8.70
13	1/0/00 0:39:15	13.29	63	1/0/00 0:51:45	8.68
14	1/0/00 0:39:30	12.95	64	1/0/00 0:52:00	8.66
15	1/0/00 0:39:45	12.65	65	1/0/00 0:52:15	8.64
16	1/0/00 0:40:00	12.39	66	1/0/00 0:52:30	8.62
17	1/0/00 0:40:15	12.15	67	1/0/00 0:52:45	8.60
18	1/0/00 0:40:30	11.94	68	1/0/00 0:53:00	8.59
19	1/0/00 0:40:45	11.74	69	1/0/00 0:53:15	8.57
20	1/0/00 0:41:00	11.55	70	1/0/00 0:53:30	8.55
21	1/0/00 0:41:15	11.38	71	1/0/00 0:53:45	8.53
22	1/0/00 0:41:30	11.21	72	1/0/00 0:54:00	8.52
23	1/0/00 0:41:45	11.06	73	1/0/00 0:54:15	8.50
24	1/0/00 0:42:00	10.93	74	1/0/00 0:54:30	8.48
25	1/0/00 0:42:15	10.79	75	1/0/00 0:54:45	8.46
26	1/0/00 0:42:30	10.68	76	1/0/00 0:55:00	8.44
27	1/0/00 0:42:45	10.56	77	1/0/00 0:55:15	8.43
28	1/0/00 0:43:00	10.45	78	1/0/00 0:55:30	8.42
29	1/0/00 0:43:15	10.34	79	1/0/00 0:55:45	8.40
30	1/0/00 0:43:30	10.25	80	1/0/00 0:56:00	8.39
31	1/0/00 0:43:45	10.16	81	1/0/00 0:56:15	8.38
32	1/0/00 0:44:00	10.07	82	1/0/00 0:56:30	8.36
33	1/0/00 0:44:15	9.99	83	1/0/00 0:56:45	8.35
34	1/0/00 0:44:30	9.91	84	1/0/00 0:57:00	8.33
35	1/0/00 0:44:45	9.84	85	1/0/00 0:57:15	8.32
36	1/0/00 0:45:00	9.76	86	1/0/00 0:57:30	8.31
37	1/0/00 0:45:15	9.70	87	1/0/00 0:57:45	8.29
38	1/0/00 0:45:30	9.63	88	1/0/00 0:58:00	8.29
39	1/0/00 0:45:45	9.57	89	1/0/00 0:58:15	8.28
40	1/0/00 0:46:00	9.51	90	1/0/00 0:58:30	8.28
41	1/0/00 0:46:15	9.45	91	1/0/00 0:58:45	8.26
42	1/0/00 0:46:30	9.40	92	1/0/00 0:59:00	8.25
43	1/0/00 0:46:45	9.35	93	1/0/00 0:59:15	8.24
44	1/0/00 0:47:00	9.30	94	1/0/00 0:59:30	8.23
45	1/0/00 0:47:15	9.26			
46	1/0/00 0:47:30	9.21			
47	1/0/00 0:47:45	9.17			
48	1/0/00 0:48:00	9.13			
49	1/0/00 0:48:15	9.09			
50	1/0/00 0:48:30	9.05			

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 5 Feet

Depths to:
water level (DTW) 7.7 Feet
Top of Aquifer 8 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Silt, Loess

wetted hole 5 Feet
Aquifer thickness = 47 Feet
Aquifer thickness = 47 feet
Aquifer thickness = 47 Feet 1
Aquifer thickness = 47 Feet 47

Fraction penetrated = 0.106383

slope points	11.357	12.353
	4.372	9.303

FLOW RATE 0.50 GPM
FLOW RATE 96.25668 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 7.356781 Feet /log₁₀
Slope = 7.356781 feet/log₁₀

T = 2 ft2/d
 2.394755 Feet2/Day 0.1
 2.4 Feet2/Day 24

K = 0.050952 ft/d
 0.050952 Feet/Day 0.001
K = 0.051 Feet/Day 51

Absolute Shut Down

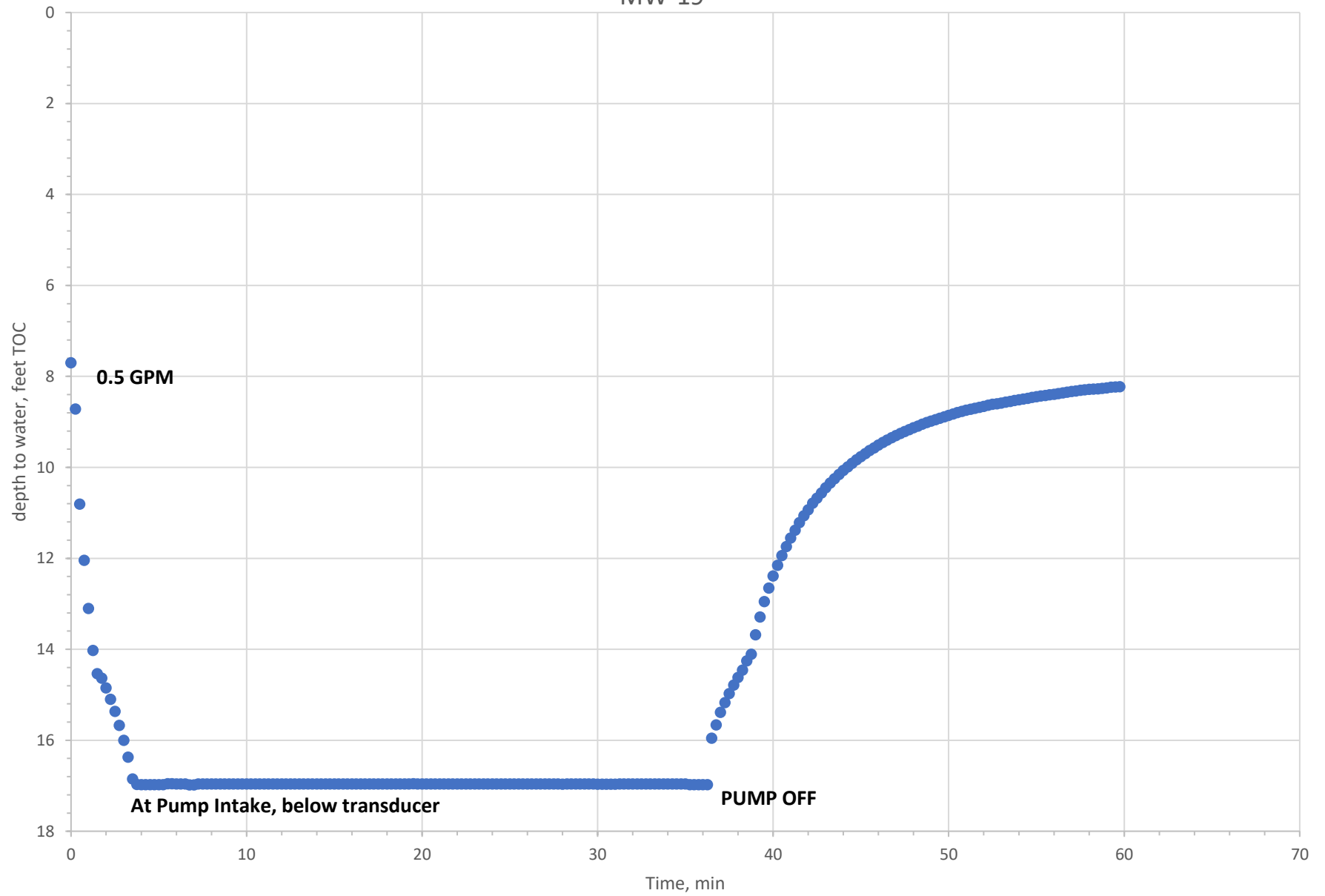
Input is consistent.

Decision	Option			
0	Water level is below Base of Aquifer			
0	Casing diameter is greater than the Annulus			
0	Top of Aquifer is deeper than Base of Aquifer			
0	Screen length is less than 1 Feet		1	
0	Slope will produce a negative K			
0	K = 0.051 is less than extreme minimum of 0.0003 for Silt, L	0.0003	-4	0.0003
0	K = 0.051 is greater than extreme maximum of 6 for Silt, L	6	0	6
1	Input is consistent.			
	Error			

WARNING

Decision	Option			
0				
0	K = 0.051 is less than likely minimum of 0.001 for Silt, L or	0.001	-3	0.001
0	K = 0.051 is greater than likely maximum of 0.1 for Silt, L or	0.1	-1	0.1
1				

MW-19



WELL ID: MW-19

Local ID: Hypo-1
 Date: 4/4/2001
 Time: 0:00

INPUT

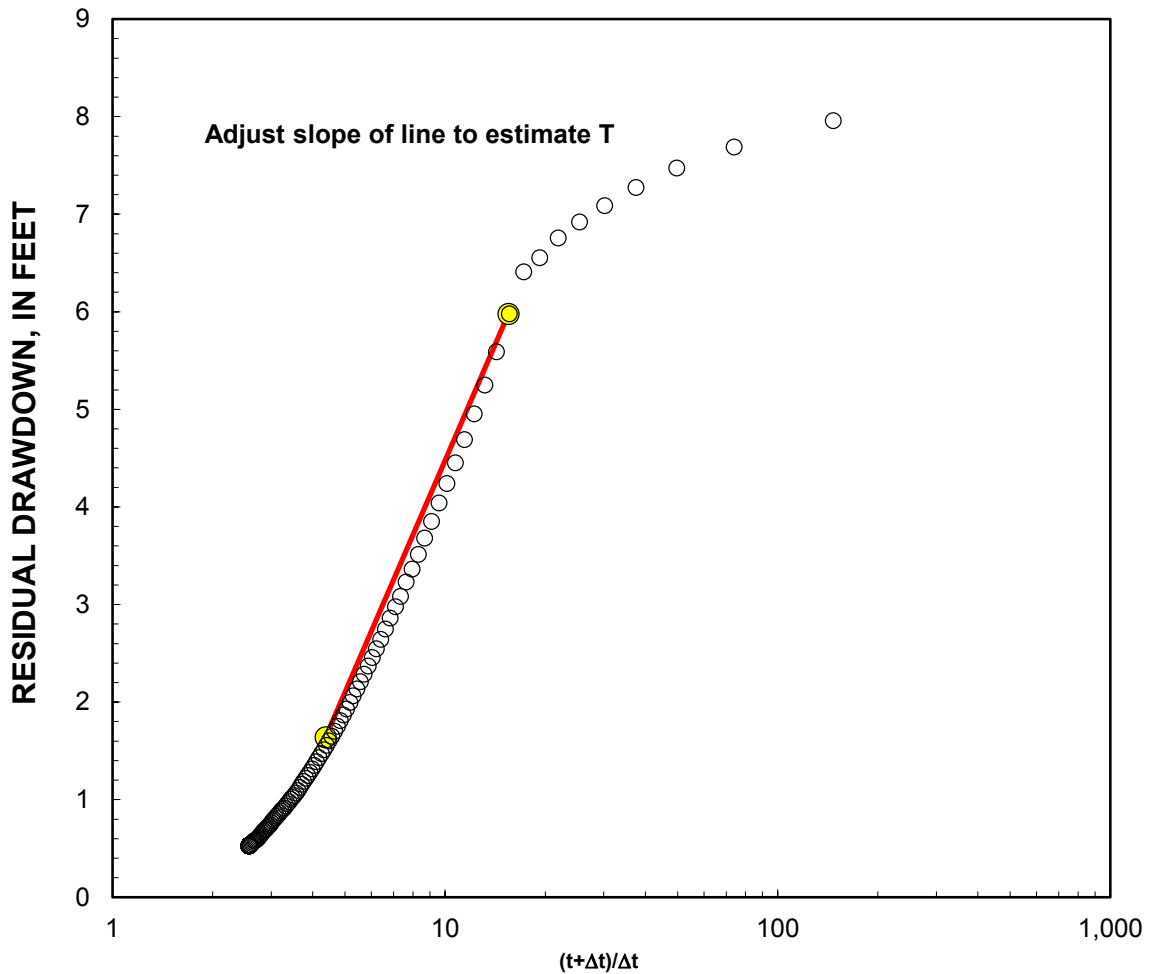
Construction:	
Casing dia. (d_c)	2 Inch
Annulus dia. (d_w)	8 Inch
Screen Length (L)	5 Feet
Depths to:	
water level (DTW)	7.7 Feet
Top of Aquifer	8 Feet
Base of Aquifer	55 Feet
Annular Fill:	
across screen --	Coarse Sand
above screen --	Bentonite
Aquifer Material -- Silt, Loess	
FLOW RATE	0.5 GPM

COMPUTED

Aquifer thickness = 47 Feet
 Slope = 7.894092 Feet/log10

Input is consistent.

K =	0.047 Feet/Day
T =	2.2 Feet ² /Day



REMARKS: Cooper-Jacob recovery analysis of single-well aquifer test

Reduced Data					
Entry	Time, Date Hr:Min:Sec	Water Level Feet	Entry	Time, Date Hr:Min:Sec	Water Level Feet
1	1/0/00 0:00:00	7.70	51	1/0/00 0:48:45	9.02
2	1/0/00 0:36:30	15.96	52	1/0/00 0:49:00	8.98
3	1/0/00 0:36:45	15.66	53	1/0/00 0:49:15	8.95
4	1/0/00 0:37:00	15.39	54	1/0/00 0:49:30	8.92
5	1/0/00 0:37:15	15.17	55	1/0/00 0:49:45	8.89
6	1/0/00 0:37:30	14.98	56	1/0/00 0:50:00	8.86
7	1/0/00 0:37:45	14.79	57	1/0/00 0:50:15	8.83
8	1/0/00 0:38:00	14.62	58	1/0/00 0:50:30	8.80
9	1/0/00 0:38:15	14.46	59	1/0/00 0:50:45	8.77
10	1/0/00 0:38:30	14.26	60	1/0/00 0:51:00	8.74
11	1/0/00 0:38:45	14.11	61	1/0/00 0:51:15	8.72
12	1/0/00 0:39:00	13.68	62	1/0/00 0:51:30	8.70
13	1/0/00 0:39:15	13.29	63	1/0/00 0:51:45	8.68
14	1/0/00 0:39:30	12.95	64	1/0/00 0:52:00	8.66
15	1/0/00 0:39:45	12.65	65	1/0/00 0:52:15	8.64
16	1/0/00 0:40:00	12.39	66	1/0/00 0:52:30	8.62
17	1/0/00 0:40:15	12.15	67	1/0/00 0:52:45	8.60
18	1/0/00 0:40:30	11.94	68	1/0/00 0:53:00	8.59
19	1/0/00 0:40:45	11.74	69	1/0/00 0:53:15	8.57
20	1/0/00 0:41:00	11.55	70	1/0/00 0:53:30	8.55
21	1/0/00 0:41:15	11.38	71	1/0/00 0:53:45	8.53
22	1/0/00 0:41:30	11.21	72	1/0/00 0:54:00	8.52
23	1/0/00 0:41:45	11.06	73	1/0/00 0:54:15	8.50
24	1/0/00 0:42:00	10.93	74	1/0/00 0:54:30	8.48
25	1/0/00 0:42:15	10.79	75	1/0/00 0:54:45	8.46
26	1/0/00 0:42:30	10.68	76	1/0/00 0:55:00	8.44
27	1/0/00 0:42:45	10.56	77	1/0/00 0:55:15	8.43
28	1/0/00 0:43:00	10.45	78	1/0/00 0:55:30	8.42
29	1/0/00 0:43:15	10.34	79	1/0/00 0:55:45	8.40
30	1/0/00 0:43:30	10.25	80	1/0/00 0:56:00	8.39
31	1/0/00 0:43:45	10.16	81	1/0/00 0:56:15	8.38
32	1/0/00 0:44:00	10.07	82	1/0/00 0:56:30	8.36
33	1/0/00 0:44:15	9.99	83	1/0/00 0:56:45	8.35
34	1/0/00 0:44:30	9.91	84	1/0/00 0:57:00	8.33
35	1/0/00 0:44:45	9.84	85	1/0/00 0:57:15	8.32
36	1/0/00 0:45:00	9.76	86	1/0/00 0:57:30	8.31
37	1/0/00 0:45:15	9.70	87	1/0/00 0:57:45	8.29
38	1/0/00 0:45:30	9.63	88	1/0/00 0:58:00	8.29
39	1/0/00 0:45:45	9.57	89	1/0/00 0:58:15	8.28
40	1/0/00 0:46:00	9.51	90	1/0/00 0:58:30	8.28
41	1/0/00 0:46:15	9.45	91	1/0/00 0:58:45	8.26
42	1/0/00 0:46:30	9.40	92	1/0/00 0:59:00	8.25
43	1/0/00 0:46:45	9.35	93	1/0/00 0:59:15	8.24
44	1/0/00 0:47:00	9.30	94	1/0/00 0:59:30	8.23
45	1/0/00 0:47:15	9.26			
46	1/0/00 0:47:30	9.21			
47	1/0/00 0:47:45	9.17			
48	1/0/00 0:48:00	9.13			
49	1/0/00 0:48:15	9.09			
50	1/0/00 0:48:30	9.05			

Inch	0.083333	Second	1.16E-05	GPM	192.5134
Feet		1 Minute	0.000694	ft3/d	1
Meter	3.28084	Hour	0.041667	ft3/s	86400
cm	0.032808	Day	1	m3/d	35.39525
mm	0.003281			m3/s	3058149
PSI	2.31			liters/s	3058.149
				liters/min	50.96915
				cc/s	3.058149
Out Units =					
Convert =		1 Feet2/Day			
Convert =		1 Feet/Day			

Casing dia. (dc) 2 Inch
Annulus dia. (dw) 8 Inch
Screen Length (L) 5 Feet

Depths to:
water level (DTW) 7.7 Feet
Top of Aquifer 8 Feet
Base of Aquifer 55 Feet
Annular Fill:
across screen -- Coarse Sand
above screen -- Bentonite
Aquifer Material -- Silt, Loess

wetted hole 5 Feet
Aquifer thickness = 47 Feet
Aquifer thickness = 47 feet
Aquifer thickness = 47 Feet 1
Aquifer thickness = 47 Feet 47

Fraction penetrated = 0.106383

slope points	15.5	5.979
	4.372	1.64

FLOW RATE 0.50 GPM
FLOW RATE 96.25668 ft³/d

Rc = 0.083333 ft
Rw = 0.333333 ft

Slope = 7.894092 Feet /log₁₀
Slope = 7.894092 feet/log₁₀

T = 2 ft2/d
 2.231756 Feet2/Day 0.1
 2.2 Feet2/Day 22

K = 0.047484 ft/d
 0.047484 Feet/Day 0.001
K = 0.047 Feet/Day 47

Absolute Shut Down

Input is consistent.

Decision	Option			
0	Water level is below Base of Aquifer			
0	Casing diameter is greater than the Annulus			
0	Top of Aquifer is deeper than Base of Aquifer			
0	Screen length is less than 1 Feet		1	
0	Slope will produce a negative K			
0	K = 0.047 is less than extreme minimum of 0.0003 for Silt, L	0.0003	-4	0.0003
0	K = 0.047 is greater than extreme maximum of 6 for Silt, L	6	0	6
1	Input is consistent.			
	Error			

WARNING

Decision	Option			
0				
0	K = 0.047 is less than likely minimum of 0.001 for Silt, L or:	0.001	-3	0.001
0	K = 0.047 is greater than likely maximum of 0.1 for Silt, L or:	0.1	-1	0.1
1				