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SUBJECT: WORKPLAN FOR PUMPING AND VAPOR EXTRACTION TEST TO ADDRESS HYDROCARBONS RELATED TO THE FORMER UNDERGROUND STORAGE TANKS AT THEFORMER BILL CHUN SERVICE STATION @ 2301 SANTA CLARA AVENUE, ALAMEDA, CA 94501

Dear Barney:

This report is a workplan for a groundwater pumping test to be conducted in tandem with a soil vapor extraction test to be performed at the aforementioned site. The purpose of these tests will be to determine the degree to which the water table can be lowered to expose as much of the smear zone as possible to facilitate the proposed dual phase extraction of gasoline contaminants in soil and groundwater. The field data provided by these tests will help to better define the screen lengths for the proposed vapor extraction wells within the exposed smear zone during sustained groundwater extraction. In addition, the field data should provide optimal groundwater extraction rates, the zone of effective drawdown around the wells chosen for remediation extraction, strategic placement of additional wells, if indicated, and the relative coverage that the proposed remediation system will provide in intercepting the current distribution of subsurface contaminants.

Since the groundwater gradient has been demonstrated to be relatively flat with a propensity for significant changes in groundwater flow direction, the hydrogeological field data provided by the previously performed slug tests does not provide information representative enough to demonstrate how the site specific hydrogeologic characteristics will respond to the operation of the proposed groundwater remediation system between wells points. For this reason utilization of observations wells will be required during the pumping test in order to more realistically simulate what will be encountered during the proposed groundwater remediation process activities. Multiple observation wells will also provide storativity values, necessary for the proper design of the groundwater remediation system.

In addition, existing groundwater monitoring wells will be used as observation wells will have to be monitored for drawdown verses time in all directions, away from the central extraction wells, to accommodate the fact that the groundwater gradient flow direction has changed dramatically (north, northwest, and east) through time according to the results of past groundwater monitoring events. For instance, the latest groundwater monitoring report shows dissolved contaminants traveling to the east in the direction of the measured groundwater gradient flow direction, however, past groundwater monitoring reports have shown the

groundwater gradient flow direction in the opposite direction. This could be more a function of what the predominant groundwater gradient flow direction is relative to seasonal and temporal variations, etc. A rose diagram summation of all past groundwater monitoring events should be performed along with the next groundwater report.

For this reason, three (3) four inch diameter extraction wells will be place within the center of the current groundwater monitoring well network to perform the aquifer test.

If you have any questions, please call.

Sincerely,

Franklin J. Goldman
State Registered Geologist No. 5557
State Certified Hydrogeologist No. 466
CEO/GeoSolv, LLC

REGISTERED GEOLOGIST
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Engineering Design & Implementation

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General Description of Dual Extraction

Based upon preliminary review of past subsurface testing, dual phase (soil vapor and dissolved groundwater contaminants) extraction has been determined to be the most feasible application for remediation of gasoline contaminants at the site. The proposed soil vapor extraction and groundwater pumping/aquifer tests are being performed to verify and more accurately define the critical parameters, as well, as provide new field data not provided previously, which are necessary to design a reliable and effective remediation system. The extraction of soil gases from the area of contamination has long been recognized as an effective means for removal of volatile subsurface hydrocarbons. This technique is commonly used to remove contaminants, such as those found at this site, from the soil that is above the water table and cannot be reached by groundwater pumping and treating system. Soil gases are typically extracted by subjecting wells to a negative pressure using a centrifugal vacuum blower. The applied vacuum creates a pressure gradient through the zone of contamination which forces gases in the interstitial spaces of the sand, silts and many clays to migrate towards the extraction wells where they are recovered and treated by surface equipment. The natural vapor pressure of the subsurface contaminants will cause the contaminants molecules to continually evaporate into the soil gas. Overtime, as the soil gases are moved through the zone of contamination by the imposed pressure gradient, the concentrations of the more volatile subsurface contaminants will gradually decrease. By combining soil vapor extraction with groundwater pumping and treating, the time it takes to reach safe levels of subsurface contaminants can be greatly reduced due to greater exposure of the gasoline saturated soils former residing within the capillary fringe of the water table which existed prior to pumping of groundwater.

Factors/Parameters Necessary for Design of a Vapor Extraction System

In order to design, construct and operate an effective soil gas removal and treating system, several important factors must be determined with accuracy. One of the most critical factors is determining the relationship between soil gas flow rate and vacuum pressure applied to the dual-phase extraction wells (DPE Wells). This relationship is critically dependent on permeability of the soil throughout the zone of contamination and the total perforated surface area exposed to the vacuum pressure. Since the degree of permeability often varies across the site both vertically and horizontally, some wells may generate higher volumes of soil gas for a given vacuum applied than others. Also, if the water table significantly covers the perforated sections of the well casings, very little soil gas may be collected due to the decreased surface area exposed to the vacuum. If these characteristics are not accurately determined prior to selecting the vacuum blower and treating system, the efficacy of the remediation system will be critically diminished.

Factors/Parameters to be Determined by Vapor Extraction Testing

The three most important parameters to be determined for each Dual Phase Extraction well are: 1) Soil Gas Flow as a Function of Applied Vacuum, 2) Soil Gas Flow as a Function of Exposed Perforated Area, and 3) Lateral Influence as a Function of Applied Vacuum. In order to adequately determine these relationships, vapor extraction tests must be performed to generate data that can be analyzed and correlated into these functions. The critical data to be collected will be soil gas flow rate, wellhead vacuum and depth of exposed perforation. The following items describe in further detail each test that will be performed:

- For each dual phase extraction test well (DPE Test Well), various levels of vacuum will be applied and the rate of soil gas extracted will be measured. At each level of vacuum applied, the vacuum will be measured in each of the other DPE test wells and in selected groundwater monitoring wells. At the beginning and end of test, soil gas samples will be taken and analyzed in an off-site laboratory to determine TPHg concentrations.

- For each DPE Test Well, a constant level of vacuum will be applied. The water table will then be lowered in the Test Well to approximately 12 ft. BGS, where possible, and allowed to stabilized. The rate of soil gas extracted will be recorded along with the vacuum measured in each of the other DPE Test Wells and selected groundwater monitoring wells. The water table will then be lowered approximately 3 additional feet, where possible, allowed to stabilize, and then the test will be repeated. If after three tests, the increase in soil gas rate is negligible or the ratio of volume extracted over perforated surface area (exposed) is relatively constant, then the test will be terminated.

Analysis of Field Vapor Extraction Test Data

Field data will be collected and graphically plotted for each well. A correlation between Applied Vacuum vs. Soil Gas Flow Rate will be numerically derived for each well. The numerical correlations will then be incorporated into a hydraulic model of the proposed surface distribution piping which will then be used to determine the design parameters for selection of the Soil Vapor Extraction Blower. From these design parameters, various manufacturers of vacuum blowers will submit models for selection by the project engineer. The performance curve of the selected blower will be numerically derived and incorporated into the hydraulic model. This final hydraulic model will be used by the project engineer and hydrogeologist to examine various extraction patterns to optimize the effectiveness of the vapor extraction system.

WELL REQUIREMENTS FOR VES TESTING

An analysis of the existing wells within the property boundary of the Chun site indicates there are seven (7) 2" monitoring wells (MW-1 through 7), one (1) 4" vapor well (SV-1) and three (3) temporary groundwater monitoring wells (TWP-6 through 8). These wells were installed sometime between 1993 and 1997. Although some of these centrally located 2" well casings, such as MW-2, might be suitable for a pumping test, alone, they will not be adequate for performing dual phase extraction testing. Dual Phase Vapor Extraction testing requires a minimum well diameter of 4 inches. This minimum diameter is necessary to allow all of the components to be placed in the well together, such as the groundwater pump and power cord, the groundwater extraction tube, the soil vapor extraction tube, the water level transducer, and the wellhead vacuum sensing port. Since the Chun property is approximately only 50 ft. x 80 ft., a minimum of three (3) new four inch (4)" diameter dual phase extraction wells will have to be installed on the site. Each well will be completed according to a standard DPE well design and should be screened between the interval of 7 ft. and 25 ft. BGS. Each well will be fitted with a cap capable of providing a sealed "pass-thru" for the tubing, power and testing devices (See Figure 1 for the proposed well locations and Figure 2 for well construction details) (See Appendix A for Well Excavation & Construction and Sampling Procedures).

SURFACE EQUIPMENT REQUIREMENTS FOR VES TESTING

A portable trailer or skid mounted Soil Vapor Extraction Unit (SVE) will be placed at a suitable location on the property. The suitability of the location will be determined by examining the locations of available utilities such as electrical power and fresh water, existing structures, and access to the wells. The portable Soil Vapor Extraction Unit will be equipped with a 250 standard cubic feet per minute (SCFM) vacuum blower, an in-line flow meter and blower suction moisture separator. Soil gases collected by the vacuum blower will be treated by discharging them through activated carbon canisters. Prior to performing these tests, The Bay Area Air Quality Management District will require notification and any appropriate permits obtained.

PUMPING TEST WELL CONFIGURATION RELATIVE TO SITE HYDROGEOLOGY

Based upon past subsurface investigations, the smear zone is located between 9 and 11 feet bgs. It is predominantly clayey sand and silty sand and the soils beneath the smear zone are predominantly silty sands with some interbeds of clayey sand (See ENSR Corrective Action Evaluation and Feasibility Study, lithologic cross sections, Figures 7 & 8). It is these silty sands below eleven (11) feet bgs that the dissolved benzene would migrate laterally most readily in groundwater. During the VES test, groundwater will be pumped from the extraction wells to maintain the smear zone exposed.

The current configuration of monitoring wells (i.e. 25 foot deep wells onsite and 15 foot deep perimeter wells) appears to be sufficient to support the requirements for implementation of the pumping test. The screened intervals in each well appear to be correlative and consistent enough with those of adjacent wells, based upon the field information provided by previous subsurface investigations, to generate distance versus drawdown data in the field which can be interpreted by applicable methods of analysis (e.g. Kruseman and de Ridder, Dominical & Schwartz, etc. to determine the site specific hydrogeologic conditions and parameters.)

PRE-PUMPING TEST ACTIVITIES & GENERAL PROCEDURES TO BE EMPLOYED

Prior to the pumping test a baker tank large enough to accommodate the volume of contaminated water generated from the pumping test will be placed on site (i.e. approximately 8,000 gallons). Arrangements will be made to transport the contaminated groundwater to a recycling facility due to the high concentrations of dissolved contaminants and gasoline product expected to be encountered.

Prior to pumping, the static water levels will be measured in all eleven (11) wells monitoring wells and the three (3) newly installed four inch diameter extraction wells with an electric water level sounder. The test will begin with a four (4) to eight (8) hour pre-pump/step test in order to calibrate equipment, measure initial changes in water levels, and to define an appropriate pumping rate. Flow will be measured by a cumulative flow meter. Water levels in the observation wells will be continuously measured with down hole pressure transducers and a data logger recorder as well as manually with an electronic water level sounder. The discharged water will be controlled at a constant rate by an adjustable water flow valve or variable rate pump motor, through a hose connected to the baker tank. The discharge rate will be maintained relatively constant, monitored, and adjusted accordingly as the rate has a tendency to drop over time. A cumulative rate water flow meter will be calibrated with statistically valid samplings with a five gallon bucket and a stop watch to maintain accuracy.

STEP, CONSTANT DISCHARGE, AND RECOVERY AQUIFER TESTING ACTIVITIES

It is estimated, based upon the types of hydrogeologic conditions anticipated, that the groundwater extraction phase of the constant discharge aquifer test will be run for approximately 48 hours. Drawdown verses time data will be continuously evaluated relative to standard type curves based upon applicable methods of analysis. Hydrogeological conditions such as unconfined, confined, semi-confined, hydraulic barriers, recharge and discharge areas, etc. can then be identified during the course of the test based upon the reaction of the aquifer to pumping.

Determination of aquifer characteristics and parameters will then be further refined predominantly from the water level recovery data which will be collected over the course of the third and possibly the fourth day of the pumping test. Recovery water level data will be used to circumvent the anomalies caused by turbulent well losses in the pumping well and well bore skin effects (i.e. well loses and well bore storage), so that transmissivity can be calculated.

The frequency of water level measurements will be scheduled according to standard procedures outlined in professional hydrogeology texts and will be recorded on pre-printed forms (e.g. field notes, drawdown versues time data, log-log paper, and simi log-log plots), for use in the field and to be submitted as field data sheets in the final report. Depth to water, time in minutes, pumping rate, equipment used, personnel involved, and significant changes in work activities will all be recorded.

A variable rate pump which can be pumped at a rate of between 1 and 9 gallons per minute will be used to establish the highest specific capacity (i.e. gallons per minute/foot of drawdown in the well) associated with the pumping rate (i.e. gallons per minute) which can maintain a sustained yield.

Each pumping rate will be maintained until the well stabilizes or until it is apparent that other factors are encountered which discount the application of that pumping rate (i.e. including but not limited to such factors as the well going dry or no significant drop in water levels, etc.). The step test will focus on only the few pumping rates necessary to fulfill the practical requirements of a proposed groundwater extraction system. An optimal sustained pumping rate would be one in which the water table could be continuously lowered to an artificial static water level drawdown to expose as much of the smear zone to vapor extraction as possible. Our intention is to identify the best pumping rate, based on the highest specific capacity, from the constant discharge test. Pumping associated with the step test will continue, unabridged, into the constant discharge aquifer test pumping process to provide a continuous flow to avoid aberrations caused by recovery during the transition phase of these two operations. Rate of flow will be further controlled by an external water flow valve in conjunction with the variable rate adjustment on the flow meter.

It is anticipated, that testing of one well will suffice to get reasonable estimate of the aquifer parameters. If an additional tests would be needed they will be conducted in one or the two remaining extraction wells together with the VES test to reduce the total discharge of contaminated water.

REPORTING

The field data to be generated by the step test, constant discharge aquifer test and the recovery test should provide sufficient information to determine the type of hydrogeological environment such as confined, semi-confined, unconfined, aquifer parameters such as transmissivity, storativity, and hydraulically conductivity. The field data should also reveal the applicable methods of analysis such as Neuman-Witherspoon or Boulton and Streltsova associated with each type of aquifer condition identified, etc. and capture zone analysis. In this way corrections for such conditions such as partially penetrating wells, hydraulic barriers, and other anomlaies can be employed to obtian the best groundwater remediation scenario.

Soil vapor extraction data, analysis, and evaluation will be integrated into the final report. The report will include a hydrogeologic setting including maps and figures, a detailed description of test procedures, and reporting of lab results and field data in a digestible format composed of tables and graphs. Special attention will be focused on the evaluation of the pump test data, the estimated water demand and impacts on local water users. Regional impacts which include estimation of the storage of the subject aquifer, as well as other criteria, will reflect the limited and variable hydrogeological information available. Conclusions and recommendations will culminate the final report.

LIMITATIONS

This report has been prepared in accordance with generally accepted environmental, geological and engineering practices. No warranty, either expressed or implied, is made as to the professional advice presented herein. The analyses, conclusions and recommendations contained in this report are based upon site conditions as they existed at the time of the investigation and they are subject to change.

The conclusions presented in this report are professional opinions based solely upon visual observations of the site and vicinity, and interpretation of available information as described in this report. GeoSolv, LLC, recognizes that the limited scope of services performed in execution of this investigation may not be appropriate to satisfy the needs, or requirements of other state agencies, or of other users. Any use or reuse of this document or its findings, conclusions or recommendations presented herein, is done so at the sole risk of the said user.

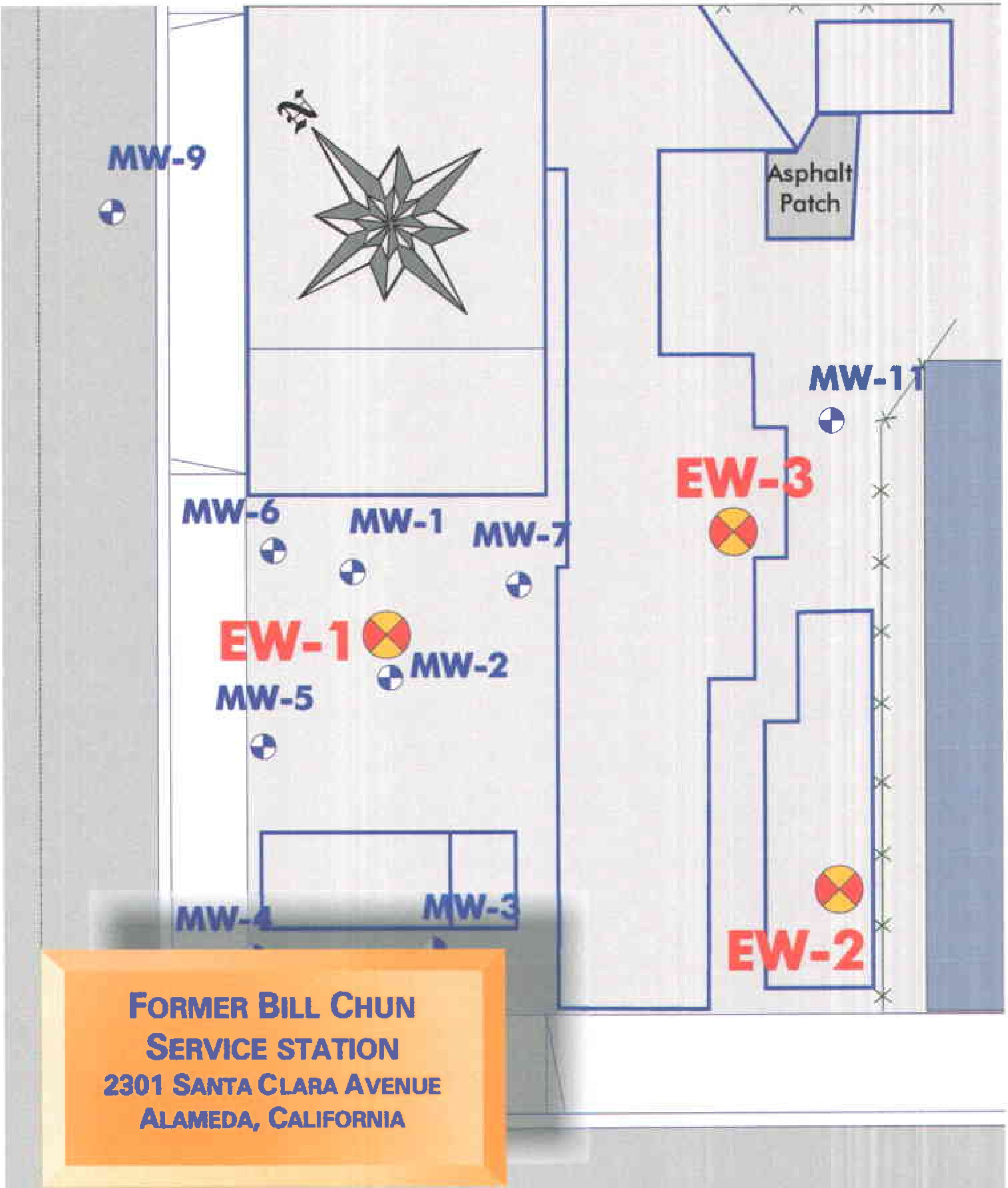

Figure 1. Proposed Well Locations

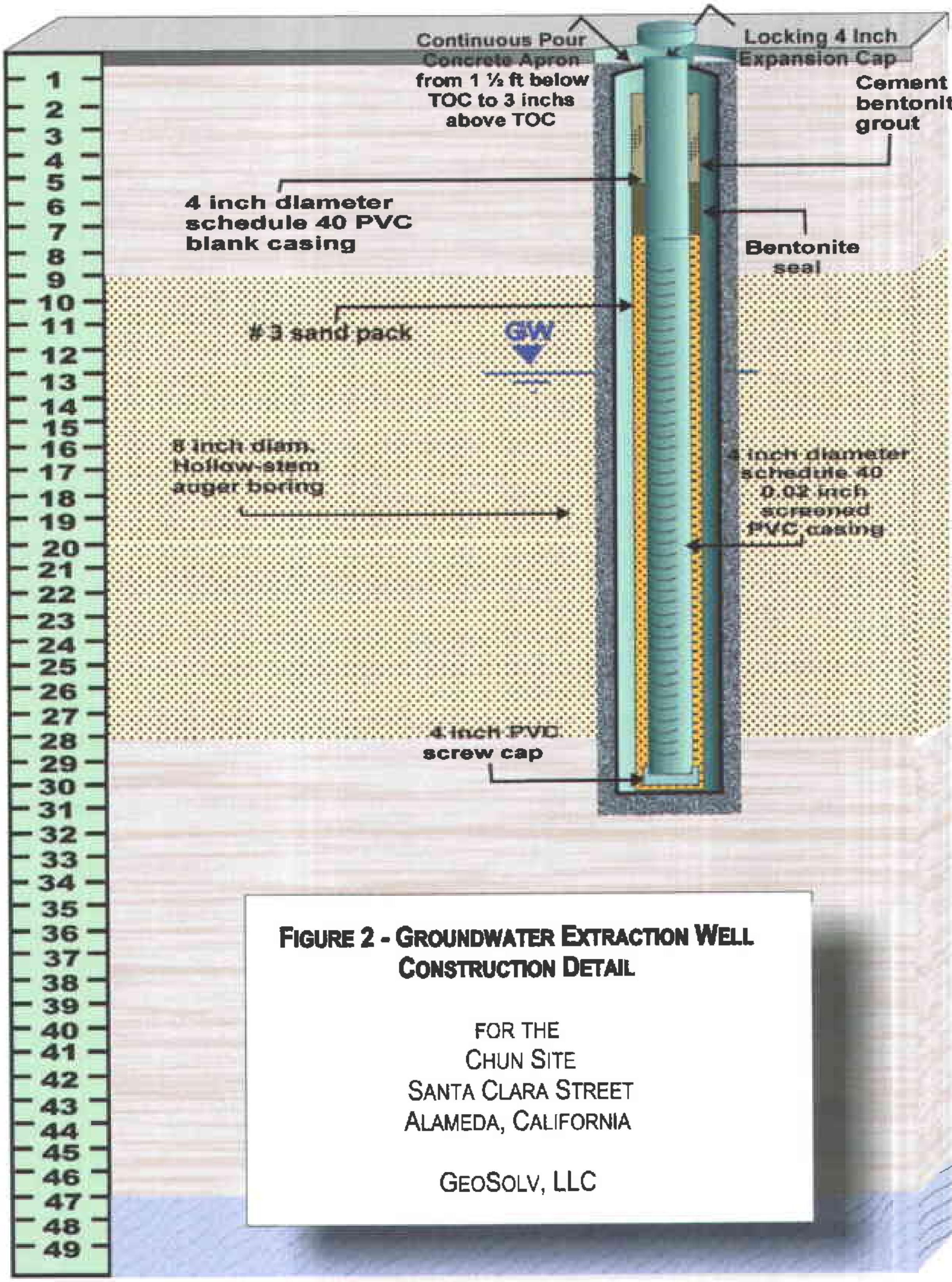

FIGURE 2 - GROUNDWATER EXTRACTION WELL CONSTRUCTION DETAIL

FOR THE
CHUN SITE
SANTA CLARA STREET
ALAMEDA, CALIFORNIA

GEOSOLV, LLC

Appendix A

Groundwater Extraction Well Installation Plan

1.0 Schedule of Investigation Field Activities

The following activities will proceed according to the following schedule:

- Submit this Work Plan to Alameda County Health for concurrence.
- Obtain soil boring/well permits from Local Agency.
- Physically mark the proposed well locations in the field with white paint a minimum of two (2) days prior to the commencement of field work to allow Underground Service Alert to mark underground utility lines.
- Notify Underground Service Alert, 48 hours prior to initiation of site work to have the site marked for underground utility obstructions to drilling. Meet on site with utility representatives, if necessary, if they inform consultant by FAX and/or telephone, in a timely manner, if obstructions to drilling are apparent.
- Schedule a field appointment with the Alameda County Health inspector prior to initiation of site work.
- Arrive onsite and have a safety meeting with the drillers and consultant personnel. Screen each proposed well location with a magnetometer to identify obvious subsurface metal utilities which could pose obstructions to drilling. Pre-drill by hand auguring soil borehole locations to a depth of a minimum of five (5) feet below ground surface (bgs) to minimize the potential of damaging subsurface utilities. Collect soil samples and screened with a PID to determine if further sample analysis is warranted. The soil borings will be converted to groundwater monitoring wells to be sampled with disposable plastic bailors to obtain representative groundwater samples.
- All soil and groundwater samples collected in the field will be placed on ice at 4 degrees centigrade under a proper chain-of-custody, to a State certified laboratory, for analysis within proper applicable EPA holding times.
- The wells will be measured for depth to groundwater after the static water level is established with an electronic water level sounder relative to a certified land survey of well locations and top of casing elevations.
- Soil and groundwater sampling will produce soil drill cuttings and rinseate and purge water to be stored on-site in 55 gallon drums. All drums will be properly labeled to identify the contents and provide the date that the waste material was collected as well as contact information. The waste soil and water will be left onsite pending laboratory analyses to be manifested to a legal point of disposal.
- A final technical report on the subsurface investigation will be prepared and submitted to Alameda County Health which will present data obtained (e.g. original laboratory data sheets with QA/QC, laboratory summary tables, boring logs), summaries and interpretations of all findings, and will provide conclusions and recommendations.

2.0 Rationale for Continuous Coring

Three (3) soil borings will be drilled using an appropriate drill rig utilizing a drilling contractor who possesses a C-57 drilling license (See Figure 1 for Water

Table Groundwater Monitoring Well Location Map). **All borehole logging will be performed under the supervision of a State Certified Hydrogeologist who will keep a detailed hydrostratigraphic log of each borehole, noting lithologic changes, hydrogeological characteristics, sample locations, and well construction. Soil sampling will be performed on the day of the subsurface investigation and groundwater sampling will be performed after the groundwater monitoring wells have been purged and developed. Soil sampling will be performed wherever appropriate in order of identify significant changes in soil hydrostratigraphy. The wells will be sampled at a minimum of every five (5) vertical feet.**

3.0 Soil Sampling Procedures for Hollow Stem Auger Drilling

Soil samples will be collected with a two (2) inch inner diameter, five (5) foot long, split spoon sampler depending upon the soil stratigraphy and contaminants encountered. The soil samples will be obtained by the compressive force of a 140 lb hammer dropped from a height of 18 inches. The soil samples will be extruded into six (6)-inch long steel sample liners.

Soil within sample liners, will be collected from depths where there is obvious olfactory and/or visual evidence of hydrocarbon contamination, will be extruded and placed inside a plastic Zip-Loc bag so that a small volume of disturbed soil can release hydrocarbon volatiles into the bag for approximately two to five minutes. A properly calibrated photo ionization detector (PID) will be used to screen the soil samples, inside each bag, for the presence of gasoline constituents. Corresponding soil samples immediately adjacent to the disturbed samples with the highest PID readings, which are undisturbed in their sample liners will be selected for further laboratory analysis.

Each soil sample collected will be covered at each end of the metal cylinder with Teflon tape, plastic end caps, and sealed with non-VOC "duct tape" to adhere the caps to the liners at each end, to hermetically seal the samples. The soil samples will be labeled with an ink field marker as to the depth and location the sample was collected, the sample number, and the project name and inserted into a plastic Zip-Lock bag and then placed into an ice chest for transport back to the laboratory. The chain-of-custody will be similarly designated and included the date and time the sample was collected as well as the depth interval. The soil samples will be selected at specific vertical intervals based on the location of the capillary fringe, at significant changes in lithology, and/or at contact with noticeable (e.g. obvious olfactory and visual evidence) hydrocarbon contamination. The sampler was decontaminated before and after each use by rinsing with an Alconox solution wash and fresh tap water rinse. All rinseate water will be stored in 55 gallon DOT approved drums. The drum will be properly labeled and stored onsite until sampling is authorized to establish a legal point of disposal.

4.0 Soil and Groundwater Sampling Schedule

The minimum number of soil and groundwater samples obtained during drilling and the groundwater monitoring well sampling to ensue will be analyzed according to the following list:

<u>**Three (3) Water Table Wells**</u>

Laboratory analytical for soil samples collected from three (3) water table well boring excavations drilled to a depth of 25 feet bgs. A minimum of five (5) soil samples will be analyzed from each boring

Corresponding soil sampling analysis schedule
soil TPH(g)/BTEX/MTBE (a minimum of 15 samples)

In addition, a minimum of four (4) soil samples will be collected from representative intervals for porosity, moisture content, fraction of organic carbon, and bulk density lab testing. If any relatively undisturbed soil samples are collected from key aquifer zones, they will undergoe head permeameter lab testing to confirm vertical and lateral field hydraulic conductivities obtained from field pump testing.

Corresponding groundwater sampling analysis schedule for three (3) groundwater monitoring wells.

water TPH(g)/BTEX (3 samples)
water EPA 8260 for MTBE and five oxygenates and two lead scavengers (3 samples)) add the other wells?

5.0 Construction of Water Table Wells

Three (3) soil borings will be drilled to a depth of 25 feet bgs with a hollow stem auger and groundwater monitoring wells will be constructed with a screened interval 7 to 25 feet bgs. The soil borings will be sampled with a three foot long split spoon sampler so that sampling intervals of concern can be physically examined.

The groundwater monitoring wells will be constructed with 0.02 inch PVC schedule 40 slotted casing and schedule 40, 4 inch diameter PVC blank casing. No. 3 silica sand pack will be placed in the annular space between the screened casing and the open borehole to one (1) foot above the top of the screen. The bentonite seals will be one foot thick and will be placed on top of the sand pack in the annular space. A Type II Cement bentonite grout will then be tremmied from the bottom up to within approximately 1 ½ feet of the top of the surface cover. A continuous concrete pour was then made on top of the grout to the surface where it was finished with a 3 inch high concrete apron around a Boart Longyear well box and locking well cap (See Figure 2 for Water Table Groundwater Monitoring Well Construction Detail).

6.0 Well Development

Groundwater monitoring wells will be developed a minimum of 72 hours after construction in the field. Water levels will be measured prior to development with a surge block by a qualified field technician under the supervision of a State Certified Hydrogeologist. The wells will be purged and sampled a minimum of 72 hours after well development.

A Slope Indicator water level meter will be used to measure the depth to groundwater. The measurements will be read to the nearest 100th of an inch. All wells will be surveyed by a certified land surveyor for relative elevation and location. Each well will be sampled after purging approximately three (3) borehole volumes from each well, allowing the water level to recover to at least 80% of the original, static level. The purging will be performed by the use of a steel bailer and/or a peristaltic pump with disposable tubing. Temperature, electrical conductivity, and pH will be monitored during each purging, so that the three parameters are within a 10% error difference from one another, over three consecutive readings. The data will be used to verify that water had been removed from well casing storage and that the well water was representative of the aquifer, prior to sampling.

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