Electro-
Coatings
Inc.

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815 Marina Vista
Martinez, CA 94553
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July 27, 1995

Susan L. Hugo
Alameda County Dept. of Environmental Health
Environmental Protection Division
1131 Harbor Bay Parkway, #250
Alameda, CA 94502-6577

Dear Susan:

Thank you for taking time to meet with us and our consultants from Geraghty & Miller on July 14. We are now looking forward to proceeding with the pilot study which we discussed that day. Enclosed is a copy of the work plan for that pilot study.

Yours very truly,

Judy Garvens
Administrative Manager

HUGO5.WPS

GERAGHTY
& MILLER, INC.
Environmental Services

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July 18, 1995
Project No. RC0304.001

Ms. Judy Garvens
Administrative Manager
Electro-Coatings Inc.
P.O. Box 310
815 Marina Vista
Martinez, California 94553

SUBJECT: Work Plan for Pilot Study, Electro-Coatings, Inc. Facility, 1401 and 1421 Park Avenue, Emeryville, California.

Dear Ms. Garvens:

This letter presents the work plan for the pilot study to be performed at the Electro-Coatings, Inc. (ECI) facility referenced above. The objective of this work plan is to evaluate an innovative groundwater remediation technique involving the in-situ bioremediation of chromium. This in-situ biological reduction method could potentially be used to significantly reduce the levels of dissolved chromium in the groundwater at the ECI site.

The technique involves changing the oxidation/reduction (redox) potential and other aspects of the subsurface environment through the enhancement of a natural in-situ biological process. The resulting decrease in the redox potential induces dissolved chromium in the groundwater to precipitate as insoluble chromium sulfides. The chromium sulfides are not sensitive to redissolution and become inert mineral components of the soil matrix. The technique involves the addition of a dilute molasses solution to the impacted groundwater such that naturally occurring bacteria feed on the sugars, consuming the available dissolved oxygen (DO) in the groundwater. Consumption of the DO reduces the redox potential, which in turn induces the chromium to precipitate out as an inert mineral solid.

Geraghty & Miller will conduct a small-scale pilot study at the site to evaluate the effectiveness of the in-situ biological reduction method for achieving a significant reduction of chromium levels in the groundwater near the source area. The results of the pilot study will be used to evaluate whether an in-situ chromium reduction process is a viable remediation technique to treat the groundwater at the site. This work plan presents the technical approach

that will be followed to promote a successful in-situ chromium reduction pilot study at the ECI site.

Recent and historical data show the presence of trichloroethene (TCE) in the groundwater at the site. It is our experience that TCE can be dechlorinated in a reductive dehalogenation reaction under anaerobic conditions, resulting in the production of ethene and other daughter products. This ancillary degradation process will be monitored during the pilot study and will be evaluated for its potential benefits.

A key consideration in developing the injection and monitoring well network for the pilot study is whether there will be adequate mixing of the molasses substrate as a result of the groundwater flow through the study area. The hydrogeology of the site is complex, and groundwater flow velocities within the interbedded sand and clay units will vary. It is anticipated that the network of wells that has been designed for the pilot test will be screened across the sand and gravel interbed that was encountered at approximately 17 to 28 feet below grade at existing Monitoring Well MW-12. If the sand interbed is not present at the proposed locations for the monitoring wells, then an alternate well network arrangement may need to be considered. A decision on whether an alternate well network will need to be considered will be made following completion of the initial soil borings associated with the installation of the monitoring wells.

OVERVIEW OF PILOT STUDY

Several innovative techniques are currently being developed for the in-situ remediation of chromium-contaminated groundwater. These in-situ remediation techniques are based on the chemical or biological reduction of hexavalent chromium to trivalent chromium (i.e., the oxidation state of the chromium is changed from +6 [oxidized] to +3 [reduced]). This reduction process yields significant remedial benefits because trivalent chromium is less toxic, less mobile, and precipitates out of solution more readily than hexavalent chromium. Geraghty & Miller, on behalf of ECI, will conduct a small-scale pilot study at the ECI site to assess the effectiveness of an in-situ biological reduction method in treating the source area groundwater. The in-situ chromium reduction pilot study has an anticipated test duration of 1 to 6 months. For the purposes of this work plan, it is assumed that the pilot study will be performed for a period of 2 months.

The pilot study will require installation of two monitoring wells and a drivepoint. The monitoring wells will be installed in the eastern paved area and upgradient of existing

Monitoring Well MW-12 (Figure 1). The newly installed monitoring wells will be shallow wells screened from approximately 5 to 20 feet below grade. In addition, a drivepoint will be installed upgradient of existing Monitoring Well MW-10 to explore a potentially cost-effective alternative to drilled injection wells.

To promote the in-situ biological reduction of hexavalent chromium to trivalent chromium, a dilute molasses solution (at an anticipated feed rate of 50 gallons per month) will be introduced into a shallow portion of the impacted aquifer via existing well MW-11. The carbohydrates, which consist mostly of sucrose, will be readily degraded by the indigenous heterotrophic microorganisms in the aquifer. This metabolic degradation process will utilize the available DO in the groundwater. Depletion of the available DO in the groundwater will cause reducing conditions to develop. As a result, the hexavalent chromium will be reduced to trivalent chromium. The trivalent chromium will then react with available sulfides or hydroxides to form either chromium sulfides or chromium hydroxide precipitates. The precipitates will be retained by the soil particles within the aquifer.

It is Geraghty & Miller's experience that precipitation of the trivalent chromium ion as an insoluble chromium sulfide precipitate provides a greater degree of irreversibility than the hydroxide reactions discussed above. If a sufficient concentration of sulfur, in the form of sulfate or sulfide, is not naturally present in the groundwater, a supplemental source of sulfate will be introduced into the aquifer. To account for potentially insufficient levels of sulfate in the groundwater, Geraghty & Miller proposes using blackstrap molasses which, in addition to containing a source of readily degradable carbohydrates, also contains available sulfate ions. Under the induced reducing conditions in the aquifer, the sulfate ions present in the injected solution would be reduced to sulfide ions, which would then be available for the formation of trivalent chromium sulfide precipitates. The slightly acidic conditions created by the reducing environment will favor the formation of chromium sulfide precipitates over the formation of hydroxide precipitates.

To confirm that there is an adequate population of indigenous heterotrophic microorganisms in the groundwater at the site to induce the required reducing conditions within the aquifer, a water sample will be collected from existing Well MW-12 prior to the installation of the monitoring wells. The water sample will be analyzed to determine the bacteriological content of the groundwater.

Prior to initiating the pilot test, groundwater samples will be collected from MW-10, MW-12, MW-3B and the newly installed monitoring wells and analyzed for pH, DO, redox

potential, sulfate, nitrate, nitrite, hexavalent chromium, total chromium, and halogenated volatile organic compounds. For the duration of the pilot study, the wells will be monitored in the field for pH, DO, and redox at closely spaced intervals (daily to weekly as needed). The effectiveness of the in-situ chromium reduction technology will be assessed based on the reduction achieved in the concentrations of hexavalent chromium and total chromium measured in the monitoring wells. Periodic groundwater samples will be collected from the monitoring wells and analyzed for hexavalent chromium, total chromium, and halogenated volatile organic compounds.

SCOPE OF WORK

Prior to initiating the pilot study, two wells will be installed upgradient of existing Well MW-12, and one drivepoint will be installed upgradient of existing well MW-10. The well design and installation details are described in the following tasks.

TASK 1: WELL INSTALLATION AND LABORATORY ANALYSIS

Prefield Permitting, Scheduling, and Health & Safety

Geraghty & Miller will obtain all necessary permits for the pilot study implementation. Geraghty & Miller will negotiate all subcontracts and schedule site work as necessary. Geraghty & Miller will prepare all site health and safety plans necessary for the field activities.

Drilling and Well Installation

To promote the development of microbially-induced reducing conditions necessary to achieve the biological reduction of hexavalent chromium to trivalent chromium, a source of organic carbon needs to be injected into the affected portion of the aquifer. Geraghty & Miller will use an environmentally benign, dilute molasses solution as the source of organic carbon. Existing monitoring well MW-11, upgradient of Monitoring Well MW-12 (Figure 1), will serve as the injection well during the pilot test.

A total of two new monitoring wells will be installed to allow for the monitoring of groundwater immediately downgradient of the injection well. The monitoring wells will be spaced approximately 10 feet apart, downgradient of the injection well, and approximately 5 feet crossgradient from Monitoring Well MW-3B (Figure 1).

The two borings for the monitoring well installations will be drilled using 8-inch diameter hollow-stem auger drilling equipment. All equipment that enters the borings will be steam-cleaned prior to drilling each boring. During drilling, continuous coring will be performed and soil samples collected by advancing a modified split-spoon sampler, equipped with brass liners, into the undisturbed soil beyond the tip of the augers. The soils will be logged by a Geraghty & Miller geologist. Soil samples for laboratory analysis will be retained in the brass liners, sealed with Teflon™ tape and plastic end caps, placed on ice, and transported to Sequoia Analytical Laboratory (Sequoia) in Walnut Creek, California, along with the appropriate chain-of-custody documentation. Two soil samples from a depth of approximately 10 feet below the ground surface (bgs) will be submitted to the laboratory and analyzed for total chromium (USEPA Method 200.7) and hexavalent chromium (USEPA Method 7196).

It is anticipated that groundwater will be encountered at a depth of approximately 8 feet bgs and that the borings will extend approximately 10 feet below first encountered water. Upon completion, the borings will be converted into groundwater monitoring wells by installing 2-inch diameter Schedule 40 PVC casings. The wells will be screened from approximately 5 to 20 feet below grade. Figure 2 illustrates the anticipated installation details for monitoring wells.

Drivepoint Installation

A drivepoint will be installed upgradient of MW-10 to assess the feasibility of injecting the molasses solution via a drivepoint rather than a well. A drivepoint is essentially a small-diameter screened PVC conduit, fitted with a retractable tip (the drivepoint), inserted under pressure directly into the subsurface. When the desired depth is achieved, the rigid drive casing is retracted, exposing the screened portion of the drivepoint. A minimal amount of sand and grout backfill material is required for completion and little, if any, soil is generated during the installation process.

Groundwater Sampling and Analysis

Prior to beginning the pilot test, Geraghty & Miller will perform a bacteriological assessment on groundwater samples collected from Monitoring Well MW-12. The collected sample will be submitted to Geraghty & Miller's Bio-Treatability Laboratory in Research Triangle Park, North Carolina for heterotrophic plate count (HPC) analysis. The results of the

HPC analysis will be used to confirm that there is an adequate indigenous population of heterotrophic bacteria to induce the required reducing conditions.

To establish baseline conditions (i.e., groundwater conditions prior to the start of the pilot study), an initial round of groundwater samples will be collected from existing Wells MW-10, MW-12, MW-3B and the newly installed monitoring wells. These wells comprise the well network for the pilot study.

Prior to sampling, depth-to-water-measurements will be obtained for each well and each well will be developed by purging a minimum of three casing volumes of water. Prior to and after purging, field measurements will be made of pH, DO, and redox potential. The purged water will be stored onsite in 55-gallon drums for proper disposal by ECI. All equipment that will enter the wells will be washed in a solution of phosphate-free detergent and water, and triple-rinsed in potable water. Following purging, groundwater samples will be collected using a disposable polyethylene bailer. A new bailer will be used for each well. Groundwater samples for laboratory analysis will be collected into appropriate USEPA-approved containers, placed on ice, and transported to Sequoia along with the appropriate chain-of-custody documentation.

The water samples will be analyzed for total chromium (USEPA Method 200.7), hexavalent chromium (USEPA Method 7196), halogenated volatile organic compounds (USEPA Method 8010), and sulfate, nitrate, and nitrite (USEPA Method 300). Measurements for pH, DO, and redox potential will be performed in the field. The samples will be submitted to the laboratory on a standard turnaround time (ten working days).

For the duration of the pilot study, water samples will be collected from these five wells at appropriate intervals and analyzed for the above-listed parameters to monitor the progress of the pilot study. The sampling interval will be determined based upon the results of the field measurements that will be conducted on a daily to weekly basis. These field measurements are described in the pilot study section of this work plan (below). For the purposes of this work plan, it is assumed that a total of three sampling events, including the initial event prior to initiating the pilot study, will be performed.

TASK 2: IMPLEMENTATION OF THE PILOT STUDY

As stated above, a source of carbohydrates needs to be added to the groundwater within the study area to promote the development of microbially induced reducing conditions. Geraghty & Miller has developed a proprietary approach in which a dilute molasses solution is

used as the source of carbohydrates. Details regarding the solution feed system are presented below.

The molasses feed solution will consist of a dilute mixture of potable water and blackstrap molasses. Typical blackstrap molasses contains approximately 30% sucrose, 20% reducing sugars, 10% sulfated ash, 20% organic nonsugars, and 20% water (Sax and Lewis, 1987). All of the constituents contained in blackstrap molasses are fully soluble in water. The dilute molasses solution will be mixed in 5-gallon increments and introduced directly into the injection well.

After the initial introduction of the molasses feed solution, the injection well and four monitoring wells that comprise the well network for the pilot study will be monitored daily for the first one to two weeks, or until significant changes are observed in DO, redox potential, and pH. Monitoring for these parameters will be done through the use of submersible probes inserted in the wells. The DO/redox/pH probe will be gradually lowered over the full depth of each of the wells to establish if these parameters vary with depth. The monitoring results for DO and redox levels in the wells will be used to assess whether microbially-induced reducing conditions have developed within the study area. The DO and redox levels will decrease as reducing conditions develop within the groundwater.

TASK 3: DATA EVALUATION AND REPORT PREPARATION

During the pilot study, the data being generated will be summarized and evaluated. Following completion of the pilot study, a report will be prepared summarizing the results from this study. The report will present all of the analytical data collected during the pilot study and an assessment of whether this in-situ chromium reduction process would be a viable remedial approach if implemented on a full-scale basis at this site.

TASK 4: PROJECT MANAGEMENT/LIAISON WITH CLIENT AND AGENCIES

On behalf of ECI, Geraghty & Miller will submit a copy of the Pilot Study Work Plan designed to introduce the remediation concept to the regulatory agency. Once regulatory approval for the approach has been obtained, Geraghty & Miller will initiate the tasks outlined in this work plan.

Geraghty & Miller appreciates this opportunity to be of service to ECI. If you have any questions regarding this budget estimate, please do not hesitate to call.

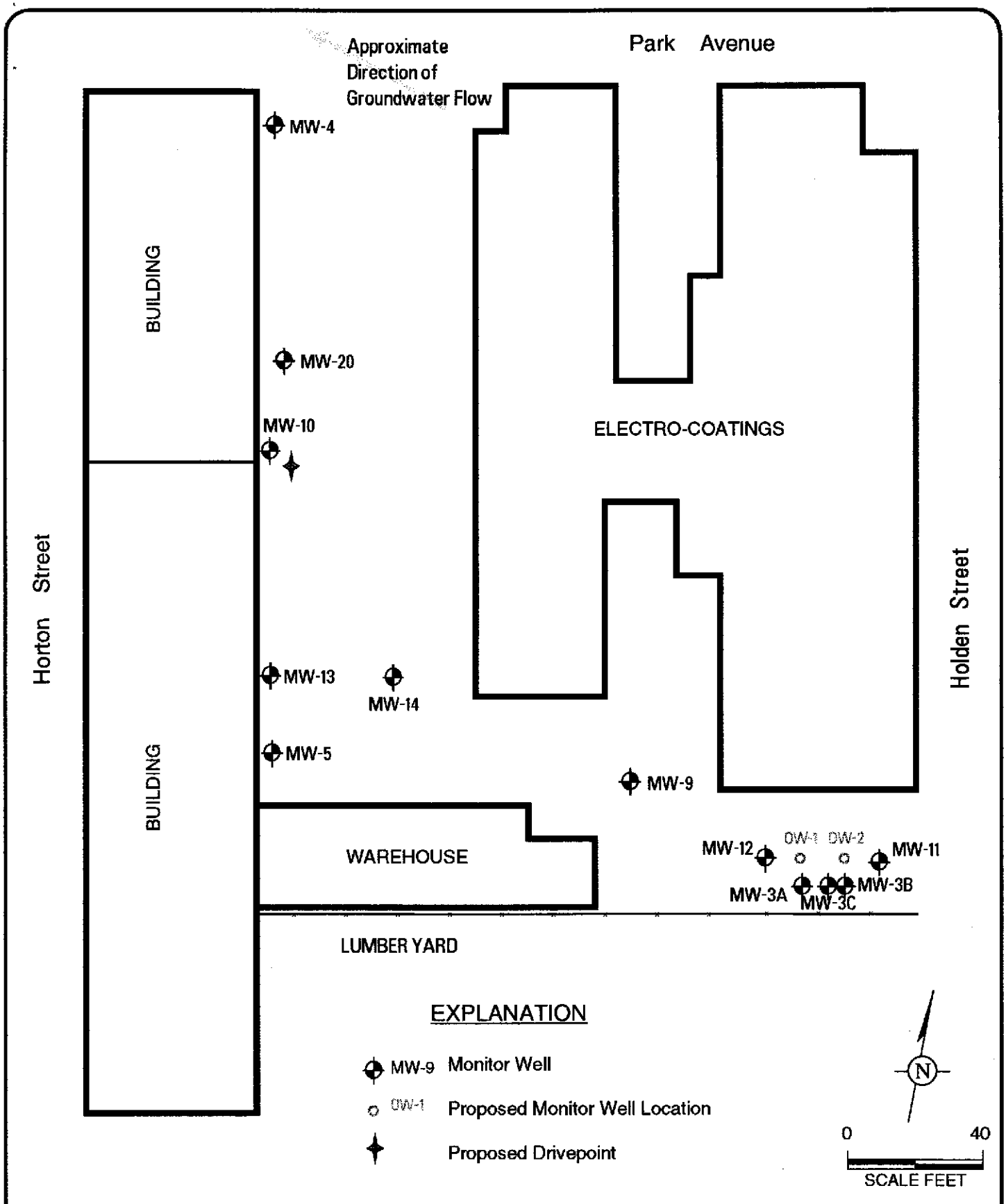
Sincerely,
GERAGHTY & MILLER, INC.

Edward H. Crump
Engineer

Jeffrey W. Hawkins, R.G.
Senior Geologist/Project Manager

Gary W. Keyes, P. E.
Principal Engineer/Associate
Richmond, California Office Manager

Attachments: Figure 1 Proposed Pilot Test Well Locations
Figure 2 Proposed Monitoring Well



GERAGHTY & MILLER, INC.
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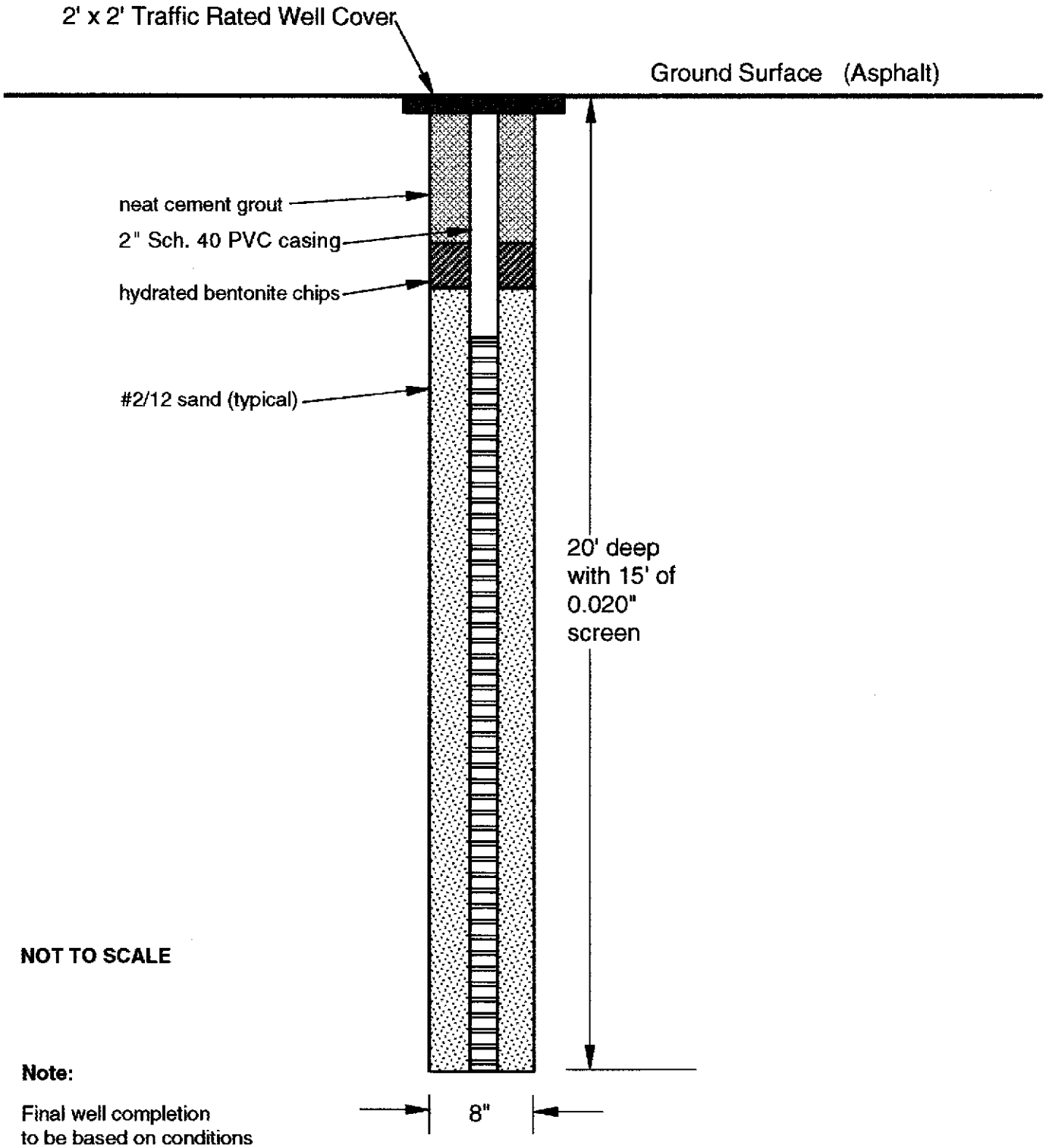
Project No. RC0304.001

PROPOSED PILOT TEST WELL LOCATIONS
ELECTRO-COATINGS, INC.
1401 and 1421 Park Avenue
Emeryville, California

FIGURE
1



NOT TO SCALE

Note:

Final well completion to be based on conditions encountered in the field.

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PROPOSED MONITORING WELL
ELECTRO-COATINGS, INC.
1401 and 1421 Park Avenue
Emeryville, California

FIGURE
2