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By Alameda County Environmental Health 11:26 am, Jun 17, 2016

Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502-6577

Re: Document Transmittal
German Autocraft, 301 East 14th Street, San Leandro, California
AC LOP Case # 2783; Fuel Leak Case No. RO0000302; Global ID T0600100639

Dear Sir or Ma'am:

I declare, under penalty of perjury, that the information contained in the attached document / report are true and correct, to the best of my knowledge.

Sincerely,

Lee Seung
Owner, German Autocraft

STRATUS
ENVIRONMENTAL, INC.

3330 Cameron Park Drive, Ste 550
Cameron Park, California 95682
(530) 676-6004 ~ Fax: (530) 676-6005

June 13, 2016
Project No. 2076-0301-01

Mr. Mark Detterman, P.G., C.E.G.
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Re: **Corrective Action Work Plan**
German Autocraft Facility
301 East 14th Street
San Leandro, California

Dear Mr. Detterman:

Stratus Environmental, Inc. (Stratus) has prepared this *Corrective Action Work Plan (Work Plan)*, on behalf of Mr. Seung Lee, for the German Autocraft Facility (the Site), located at 301 East 14th Street, San Leandro, California (see Figures 1 through 3). Subsurface petroleum hydrocarbon impact to soil and groundwater has previously been identified in the vicinity of the site, and Alameda County Environmental Health Department (ACEHD) currently regulates an environmental case at this property. This document was developed at the request of ACEHD personnel, in a letter dated April 26, 2016 and in e-mail correspondence dated June 1, 2016.

This *Work Plan* proposes to use ozone injection (OI) technology to mitigate petroleum hydrocarbon impact to groundwater beneath the site (onsite). Selection of this remedial approach is based, in part, on the findings of a draft *Feasibility Study / Corrective Action Plan* (*FS/CAP*) that was prepared and submitted for the site in December 2012. Details associated with the proposed remediation project, and a rationale for selecting OI for use at the site, are provided in the following subsections of this *Work Plan*.

SITE DESCRIPTION

The property is located on the southern corner of the intersection of East 14th Street and Garcia Avenue in the City of San Leandro (Figure 2). Available records indicate that the property was used as a retail gasoline service station until 1981. According to historical documents prepared by previous consultants representing Mr. Lee, the property has been exclusively used for automotive repair since 1981. Mr. Lee purchased the property on April 15, 1985. In September 1990, six single-walled steel underground storage tanks (USTs) (two 1,000-gallon and two 2,000-gallon USTs previously used to store unleaded gasoline, one 550-gallon UST previously used to store regular gasoline, and one 150-gallon

UST previously used to store waste oil) were removed from the property and properly disposed. In addition, the fuel dispenser island and associated product lines were removed at that time. The general configuration of the site is shown on Figure 2. The area surrounding the site is mixed commercial and moderate density residential.

According to the State Water Resource Control Board's (SWRCB's) GeoTracker database, numerous other contaminated properties under the ACEHD's regulatory oversight are present in the immediate vicinity of German Autocraft. Sunshine Cleaners, a dry cleaning business located at 223 East 14th Street, approximately 130 feet north-northwest of the site, has had an open (but predominately inactive) environmental case since 1993; that site is currently in the assessment phase for chlorinated solvents. San Leandro Chrysler-Plymouth, formerly located at 232 East 14th Street, northeast across 14th Street from German Autocraft, had a leaking UST environmental case open until 1997. In addition, the former Monument Gas station, located at 111 East 14th Street, approximately 375 feet north-northwest of German Autocraft, had a leaking UST case open until 2005. The Monument Gas case assessed groundwater contamination offsite to the southeast of that site (along Farrelly Drive) until closure.

CASE HISTORY

Environmental investigations at the site began in September 1990, when the six former single-walled steel USTs were removed from the property and properly disposed. The five fuel storage USTs were formerly located in a common pit on the north side of the property adjacent to Garcia Avenue; the waste oil UST was located on the south side of the station building/garage. During removal of the USTs, The Environmental Construction Company (TECC) noted that both of the 1,000-gallon USTs and the 550-gallon UST had holes in them and showed signs of extensive corrosion. Soil staining was noted in both the main UST area and the waste-oil UST area during excavation. Following removal of the USTs and product lines, ten soil samples were collected from below the USTs, one soil sample from beneath the former piping, and three samples from stockpiled soil.

The main UST pit was excavated to approximately 44 feet long, by 16 feet wide, and 8 feet deep; the waste oil UST pit was excavated to approximately 6 feet by 5 feet, and 6 feet deep. Historical documentation appears to indicate that the soil excavated from the waste oil UST excavation was removed from the site. When the main UST area excavation was completed, TECC lined the excavation area with plastic, placed the excavated soil back in the excavation pit, and covered it with plastic as an intended temporary containment measure. Analytical results of soil samples collected during the UST removal activities indicated the presence of highly impacted soil (total petroleum hydrocarbons as gasoline [TPHg]/gasoline-range organics [GRO] and benzene, toluene, ethylbenzene, and total xylenes [BTEX] only) in the main UST pit. No detectable concentrations of GRO, total petroleum hydrocarbons as diesel (TPHd)/diesel-range organics (DRO), BTEX, oil and grease, or purgeable halocarbons were reported in the soil sample collected at the base of the waste oil UST excavation (though stockpile samples of excavated soil indicated some oil and grease impact).

In December 1990, TECC advanced three onsite soil borings (B-1, B-2, and B-3) to depths of about 35 feet below ground surface (bgs), and in December 1991 installed one groundwater monitoring well (MW-1) screened (25 to 45 feet bgs) across first-encountered water (approximately 30 to 35 feet bgs) just northeast of the main former UST excavation. Soil and groundwater samples from these borings and the monitoring well indicated GRO and BTEX impact at all four locations. A table summarizing soil boring and well construction details is included as Table 1.

In December 1994, Chemist Enterprises (renamed in 1995 as Environmental Testing and Management [ETM]) advanced two additional onsite soil borings (CE-1 and CE-2) and installed two additional onsite groundwater monitoring wells (MW-2 and MW-3) to further evaluate soil and groundwater impact. Boring CE-2 was advanced within the former UST excavation/backfill to assess impact directly beneath the former USTs. Soil and groundwater impact were found to be highest within the smear zone and at the water table surface (approximately 20 to 30 feet bgs).

In June 1994, Mr. Lee applied and was accepted in the SWRCB's UST Cleanup Fund as a priority B claimant.

In August 1995, following the detection of liquid-phase hydrocarbons (LPH) in boring CE-1, one additional groundwater monitoring well (MW-4) was installed by ETM within the former UST excavation for the purpose of removing LPH. LPH was reported in well MW-4 after development; a passive skimmer system was subsequently installed in the well for removal of LPH. The thickness of LPH at well MW-4 prior to installation of the skimmer system on September 22, 1995, was 0.10 feet. The skimmer system was maintained between September 1995 and June 1998, during which time, no measurable quantities of LPH were reportedly removed from well MW-4 (only water with a hydrocarbon sheen). Following numerous attempts to redevelop the well and extract additional LPH from the vicinity of well MW-4, the skimmer system was removed and the well was added to the regular monitoring and sampling program. During the third quarter 1995, a routine quarterly groundwater monitoring and sampling program was established at the site.

Between November 1995 and April 1996, ETM advanced thirty-nine (39) additional on- and off-site soil borings (ETM-1 through ETM-40, with ETM-16 attempted, but not completed) throughout the surrounding residential neighborhood. Soil conditions were logged in borings ETM-1, ETM-2, ETM-5, ETM-6, ETM-7, ETM-10, ETM-11, ETM-17, ETM-19, ETM-21, and ETM-22. Soil samples were collected for laboratory analyses from borings ETM-1, ETM-2, and ETM-7. Grab groundwater samples were collected from all thirty-nine borings (except ETM-6 which did not yield water). Analytical results indicated hydrocarbon impact to groundwater was found to be extensive in the area downgradient (west-northwest) of the site; thirty of the thirty-eight grab groundwater samples were reported to contain GRO and/or benzene. In addition, LPH was reported during the sampling of boring ETM-38, located on West Broadmoor Boulevard, approximately 320 feet northwest of the site. Well MW-1A was later installed immediately adjacent to boring ETM-38, and no LPH have been noted in this well during historical monitoring.

While canvassing the neighborhood to acquire access to properties for the investigation, ETM discovered a private residential irrigation well located at the residence at 141 Farrelly Drive, approximately 440 feet northwest (downgradient) of the site. The owner of the well (and the property), Mr. Mitch Ramirez, had been using the well for landscape irrigation; upon the discovery of LPH in boring ETM-38, approximately 115 feet southeast of the 141 Farrelly Drive irrigation well, ACEHD requested that Mr. Ramirez discontinue use of his well. In April 1996, ETM collected a groundwater sample from the 141 Farrelly Drive well; results indicated the well was not impacted by petroleum hydrocarbons. With Mr. Ramirez's permission, the irrigation well was added to the periodic monitoring and sampling program.

In May 1997, the City of San Leandro contracted AllCal Property Services (AllCal) to install one groundwater monitoring well near the location of boring ETM-38. The well was designated MW-1, but is now referred to as MW-1A to avoid confusion with German Autocraft's onsite well MW-1. Initial sampling results of well MW-1A indicated GRO/BTEX impact (but LPH was not present).

In November 1997, the depression in the UST pits caused by the settling of the excavated soil was filled in with approximately 16 cubic yards of clayey silt soil and covered with Class II base rock.

In August 1998, ETM installed onsite monitoring well MW-5 and offsite monitoring wells MW-6, MW-8, MW-9, MW-10, and MW-11, to further evaluate the downgradient extent of GRO/BTEX impact in Garcia Avenue and the residential city block between Garcia Avenue and Broadmoor Boulevard. Well MW-7 was not installed due to a utility obstruction in Garcia Avenue. Initial analytical results from the wells indicated impact to all six new wells.

In January 2001, three additional off-site groundwater monitoring wells (MW-12, MW-13, and MW-14) were installed by ETM to continue delineation of the groundwater impact offsite. Initial analytical results from well MW-12 indicated impact; wells MW-13 and MW-14 indicated little to no impact to the southwest of the site in the vicinity of Lafayette Avenue.

In November 2007, Groundwater Cleaners, Inc. (GCI) prepared and submitted a *Corrective Action Plan* (CAP) that provided technical and cost effectiveness evaluations of monitored natural attenuation (MNA), soil excavation, dual phase extraction (DPE)/air sparging (AS), and bioremediation. Results of their evaluation indicated that DPE/AS would be most viable and cost-effective, and recommended that a 5-day DPE/AS pilot test be performed. In a letter dated December 28, 2007, ACEHD indicated their concurrence with the proposed DPE/AS feasibility study; however, due to the data gap related to potential risk associated with the vapor intrusion pathway, the ACEHD requested that further site characterization be performed; specifically, a soil vapor investigation. GCI prepared a *Work Plan for Soil Vapor Investigation*, dated February 14, 2008, and a *Work Plan for DPE/AS Feasibility Study*, dated February 15, 2008. Both work plans were conditionally approved by ACEHD in a letter dated October 23, 2008.

In January 2009, GCI advanced eight on- and off-site soil borings (SV-1 through SV-8) and collected grab groundwater samples. In immediately adjacent boreholes, GCI installed temporary dual-completion soil vapor sampling points (at depths of approximately 5.0 to 6.0 feet bgs and approximately 12.0 to 14.0 feet bgs). The shallow points were installed within clayey soil, while the deeper points were placed across a 1-foot thick sandy unit identified during continuous core of the adjacent borings. Analytical results of the soil vapor samples were compared to the Regional Water Quality Control Board, San Francisco's (RWQCB-SF) Environmental Screening Levels (ESLs) established for commercial land use (for the onsite auto repair business) and residential land use (for the predominant off-site land use) for GRO, BTEX, and methyl tertiary butyl ether (MTBE). Analytical results of samples collected at the 5-foot depths did not exceed the onsite commercial or off-site residential ESLs, with the exception of SV-8 (which exceeded the residential ESL for GRO) and SV-2 (which exceeded the residential ESL for benzene). Based on the results of the soil vapor sampling, GCI concluded that significant vertical attenuation is occurring and that results indicate that vapor intrusion concerns are unlikely based on commercial onsite and residential off-site uses.

In February and March 2009, GCI conducted the approved 5-day DPE remediation feasibility test at the site. DPE testing was performed using onsite wells MW-1, MW-2, MW-3, and MW-4, both individually and as a group, while using outlying wells MW-5, MW-6, and MW-8 to check for vacuum influences. GCI's *DPE/AS Feasibility Report,* dated March 31, 2009, stated that the DPE testing generally failed (too much water and not enough vapor flow) and concluded that only horizontal DPE wells would be appropriate (AS was never attempted). In response to this report, ACEHD issued a letter dated October 27, 2009, requesting a work plan for installation of DPE wells (and several additional items). GCI submitted a *Work Plan for Additional Investigation,* dated January 15, 2010, in which they partially addressed ACEHD's issues outlined in the October 2009 letter; ACEHD never formally reviewed the document, and shortly thereafter Stratus assumed consulting responsibilities for the site.

On July 22, 2010, a meeting was held between ACEHD and Stratus to review the current status of the project, to discuss the October 2009 ACEHD letter and GCI January 2010 response/work plan, and to discuss steps to immediately begin remediation efforts at the site. During this meeting, it was agreed that a Site Conceptual Model (SCM)/Interim Remedial Action Plan (IRAP) would be prepared and would include a comprehensive data tabulation of all historic work performed at the site, would identify data gaps that require additional work, would propose any additional onsite wells/borings needed to complete onsite lateral and vertical soil assessment, and would include a proposal to excavate impacted soil at the former UST area as a preliminary remedial step before the initiation of DPE remediation. This approach was agreed upon by ACEHD, and was meant to expedite ACEHD's review time on the SCM/IRAP.

On January 25, 2011, Stratus oversaw the destruction of two groundwater monitoring wells (MW-1 and MW-4), which were located within the limits of the proposed excavation. During the same drilling mobilization, Stratus directed the advancement of soil borings B-4 and B-5, to a depth of approximately 32 feet bgs. These borings were performed in order to assess subsurface conditions near a former fuel dispenser and waste oil UST. Between May 17 and June 17, 2011, Stratus oversaw the excavation of approximately 788 tons of soil from the former site UST area. The excavation extended to a maximum depth of about 12 feet below surface grade. After removing this soil, clean backfill material was placed within the excavation cavity. In November 2011, offsite well MW-6 was destroyed due to casing damage related to pavement subsidence and vehicle traffic. It was not deemed necessary to replace the well.

On December 6, 2012, Stratus prepared and submitted a draft FS/CAP for the site. The document evaluated the technical viability and cost of three potential remedial alternatives (OI, groundwater extraction and treatment, and application of Regenesis™ products by direct push borings). Based on this comparison, OI was recommended as the preferred alternative. This recommendation assumed that MNA would not allow the site to be managed to closure in a reasonable period of time.

In 2014, an additional site investigation was performed, which consisted of installing monitoring well MW-15, installing five soil vapor sampling probes (VP-1, VP-2, VP-7, VP-8, and VP-9), advanced an onsite shallow soil boring (B-6), and advanced two offsite soil borings (HP-1 and HP-2). A report documenting the findings of this work was prepared and submitted on December 15, 2014. Table 1 presents a summary of information pertaining to soil borings and wells installed at the site to date.

In 2015, information regarding water wells near the site was re-reviewed by Stratus personnel. Reports were prepared and submitted in January and March 2015 to summarize the findings of a Department of Water Resources (DWR) well record review, and a door-to-door field reconnaissance for water wells.

GEOLOGY

The site lies on the East Bay Plain approximately one mile west of the Oakland/San Leandro Hills and the northwest-trending Hayward Fault, and approximately three miles east of the San Francisco Bay. The site is at an elevation of approximately 50 feet above mean seal level (msl) with local topography predominately flat and sloping gently towards the west.

Local subsurface soil stratigraphy has been investigated by the drilling of approximately 50 vertical soil borings at the site and immediately surrounding area on behalf of Mr. Lee, which have been logged by an array of different geologists over the past 15+ years. Most of the historic borings were logged on 5-foot intervals, although the eight soil borings drilled in 2009 (SV-1 through SV-8) were continuously cored (to approximately 14 feet bgs). According to available geologic boring logs related to the site, subsurface soils have been logged to a maximum depth of approximately 45 feet bgs.

From the surface to approximately 25 feet bgs, the soil generally consists of fine-grained materials (clay and sandy clay). Beneath the upper fine-grained material, from approximately 25 to 35 feet bgs (ranging from 3 to 13 feet in apparent thickness), a sandy unit of apparent higher permeability is present (clayey and silty sands with some clean sands). It is within this sandy layer that groundwater is first encountered. In general, the sandy water-bearing unit appears to thicken and coarsen to the west and northwest of the site (offsite, downgradient). Notably, the sandy layer appears to be thin (to absent) in the center of the site property itself (B-1, B-2, B-3, MW-1, and ETM-7) and to the northeast of the site across 14th Avenue (ETM-10, ETM-11). Beneath the sandy water-bearing unit, additional fine-grained soils have been encountered (clays). In both the upper and lower clayey layers, thin (1 to 4 feet in apparent thickness), discontinuous, sandy layers are reportedly interbedded. Notably, within the thick upper section of vadose zone clays, an approximate 1-foot thick sand, clay with sand, clayey gravel. or gravelly clay was encountered between 11 and 14 feet bgs (targeted in deep soil gas sample locations).

HYDROGEOLOGY

A total of fifteen permanent groundwater monitoring wells (MW-1 through MW-6, MW-8 through MW-15, and MW-1A) have been screened to depths of between 20 and 40 feet bgs to monitor groundwater occurrence and quality in the first encountered water-bearing zone. The monitoring well array has included five onsite wells, and nine offsite wells spanning the city block west-northwest of the site, from Garcia Avenue to Broadmoor Boulevard (wells MW-1, MW-4, and MW-6 were destroyed in 2011). Historically, groundwater in the monitoring well array has been measured as shallow as 15.05 feet bgs to as deep as 30.25 feet bgs, with a historical average of about 25 feet bgs. Seasonal fluctuations in water table levels on the order of 5 to 10 feet are typical. Lowest groundwater levels were observed in the early 1990's.

Historically, the dominant groundwater flow in the vicinity of the site has been generally west and west-northwest at an average gradient of approximately 0.002 foot per foot (ft/ft). However, onsite groundwater flow is variable, with a consistent secondary gradient to the southwest in the direction of well MW-2 from wells MW-1, MW-3, and MW-4.

EXTENT OF IMPACT TO SOIL

TPHg/GRO and BTEX compounds are identified as the primary chemicals of concern (COCs) at the site. One of the USTs formerly used at the site stored leaded gasoline (550 gallon capacity) and, when removed, was noted to have holes and corrosion (tank no. 3). Lead, although reported in some soil samples collected at the site, is generally not mobile in groundwater at the pH levels found at the site, and is therefore not identified as a COC at this time.

Prior to excavation, petroleum hydrocarbon impact to the vadose zone (above 15 feet bgs) was limited to areas within approximately 5 to 10 feet of the USTs and fuel delivery/storage equipment in the northern portion of the site. Excavation work appears to have removed nearly all of these fuel contaminants from the subsurface, and thus data regarding former petroleum hydrocarbon impact to the vadose zone is not discussed further in this report.

Seasonal groundwater fluctuations in the area of the site indicate that the water table surface fluctuates between the two main lithologic zones; i.e., the upper fine-grained layer, and the mostly continuous sandy layer beneath it. Impacted groundwater present within the fine-grained sediments (whether fully saturated or capillary fringe) has likely resulted in adsorption/re-adsorption of hydrocarbons to clayey soils, resulting in a 'smearing' of the soil impact within the bottom 5 to 7 feet of the upper fine-grained unit. This 'smear-zone' is apparent in data collected from borings MW-1, MW-2, MW-3, MW-8, MW-10, MW-15, CE-1, CE-2, B-1, ETM-1, ETM-2, and ETM-7. Soil from these borings was tested, either in the field using handheld photo/flame ionization detectors or through laboratory analysis, and hydrocarbon impact was not detected until just above groundwater.

In general, the highest concentrations of petroleum hydrocarbons in soil appear to be present between approximately 25 and 35 feet bgs, which is the area approximately 5 feet above and below the historical low groundwater level observed in the monitoring well network. Historical data indicates that elevated concentrations of petroleum hydrocarbons in soil were detected in the northern portion of the site, near the former UST and fuel dispenser area, with relatively minimal offsite impact to soil. An exception to this is the area near well boring MW-2, which is located approximately 50 to 70 feet southwest of the former USTs, and indicated the presence of GRO and benzene at maximum levels of 6,300 milligrams per kilogram (mg/Kg) and 110 mg/Kg, respectively. It should be noted that most of the on-site soil samples used to assess the concentrations and locations of fuel contaminants in soil were collected during the 1990's, and since most of the petroleum hydrocarbon mass appears to be situated in the upper portion of the saturated interval, some re-distribution of contaminants in soil is likely to have occurred. Given this condition, the ability to precisely illustrate the current distribution of fuel contaminants in soil within the 'smear zone' is limited. However, based on our understanding of site geological conditions and more recent data available for the site, we believe that most of the petroleum hydrocarbon mass remains in soil within the smear zone in the northern portion of the site.

During the 1994/1995 assessments, soil samples from borings MW-2, MW-3, MW-4, CE-1, and CE-2 were analyzed for total lead. Sixteen of eighteen samples collected had total lead concentrations ranging from 4.0 to 7.9 mg/Kg. Assuming this concentration can be considered a background measurement of the naturally-occurring levels of lead in soil beneath the site, the concentrations of 23.5 and 12.4 mg/Kg detected in boring CE-2 at 5 feet and 20 feet, respectively, may be indicative of impact from leaded gasoline.

In the 2014 site investigation, relatively high concentrations of fuel contaminants were detected in samples collected beneath the base of the excavation cavity (about 20 feet bgs) and 30 feet bgs at boring MW-15. Maximum GRO, benzene, and naphthalene concentrations were reported at 3,200 mg/Kg, 3.2 mg/Kg, and 78 mg/Kg, respectively. Naphthalene was not detected in any of the shallow soil samples (testing required by Low Threat Closure Policy criteria). Low levels of GRO were detected in samples collected from boring HP-2 (6.7 and 4.6 mg/Kg at 30 feet and 33 feet bgs, respectively); all other analytes were reported below laboratory instrument detection limits in the HP-1 and HP-2 soil samples.

EXTENT OF IMPACT TO GROUNDWATER

A total of fifteen permanent groundwater monitoring wells (MW-1 through MW-6, MW-8 through MW-15, and MW-1A) have been installed and sampled to evaluate the lateral extent of impact to the first encountered water-bearing zone beneath the site and site vicinity, although three of the wells (MW-1, MW-4, and MW-6) have now been abandoned. A routine quarterly groundwater monitoring and sampling program was initiated at the site during the third quarter 1995. GRO and benzene concentrations detected in groundwater at the site, based on a first quarter 2016 groundwater sampling event, are included on Figures 4 and 5, respectively.

Historically, GRO and BTEX impact has been reported in all existing monitoring wells installed at the site to monitor the lateral extent of impact, with the exception of the

141 Farrelly Drive irrigation well. In the mid-1990s, when groundwater monitoring and sampling was first initiated, GRO and BTEX levels were high in samples collected from on-site monitoring wells MW-1, MW-2, and MW-3. Maximum GRO and benzene concentrations of 1,100,000 micrograms per liter (µg/L) and 29,000 µg/L, respectively, were reported in samples collected from well MW-1 in 1995/1996. Over the approximately 20 year routine monitoring/sampling period, GRO and benzene concentrations have decreased in all wells. During first quarter 2016 well sampling, GRO concentrations in the monitoring wells ranged from 110 µg/L (MW-5) to 52,000 µg/L (MW-15), and benzene concentrations ranged from 2.7 µg/L (MW-3) to 160 µg/L (MW-10).

Stratus has prepared figures that illustrate the approximate limits of the GRO and benzene contaminant plumes over time, using data collected during 2000, 2006, and 2010; these figures are presented in Appendix A. The figures illustrate that the orientation of the contaminant plumes in the northwest direction (downgradient and towards the 141 Farrelly Drive well) has remained relatively consistent over time. The figures show that by approximately 2006, the GRO and benzene contaminant plumes appear to have impacted the largest area of the subsurface, including the areas near wells MW-11 and MW-13. Since 2006, the lateral margins of the contaminant plumes appear to have shrunk, as recent samples from wells MW-11 and MW-13 are absent of petroleum hydrocarbons.

Although the area of impacted groundwater appears to have decreased over time, petroleum hydrocarbons (in particular GRO) impact a relatively large area of the subsurface. The GRO plume is over 500 feet in length, and impacts the furthest downgradient monitoring wells from the site (MW-12 and MW-1A). While GRO concentrations over time appear to be decreasing, concentrations of GRO remain moderately high. Benzene impact to groundwater during the site monitoring period has decreased significantly, as evidenced by both declines in concentrations and the lateral area of impact over time. Given the available data, benzene appears to be attenuating more quickly than GRO.

SUMMARY OF SITE CONDITIONS AND ASSUMPTIONS FOR DEVELOPING THE WORK PLAN:

- The site is an active automotive repair facility.
- The USTs and fuel delivery system were removed in 1990 and never replaced.
- Mixed residential and commercial land development surrounds the site.

- The site is located on the East Bay Plain, approximately one mile west of the Oakland/San Leandro Hills and 3 miles east of San Francisco Bay.
- A plume of groundwater contaminants (GRO/BTEX) impacts the onsite property and extends offsite approximately 400 to 500 feet west-northwest of the site.
- Most of the offsite plume is situated beneath residential property that may significantly limit access for performing aggressive remedial efforts.
- A majority of the petroleum hydrocarbon impact to shallow soil has been excavated and removed from the site.
- Available data suggests that the majority of remaining fuel contaminants are situated within the 'smear zone' and shallow saturated interval.
- The site does not qualify for closure under the LTCP criteria established by the SWRCB.
- Active remediation appears necessary in order to manage the environmental case towards closure.
- Remediation at the site in 'phases' is acceptable to ACEHD; the proposed scope of work is not designed to enable delivery of ozone to the entire GRO/BTEX contaminant plume.

PROJECT APPROACH

Stratus is proposing to initiate OI onsite, where elevated concentrations of GRO and BTEX remain in groundwater. This document proposes to drill and install 10 injection wells onsite, and then initiate delivery of ozone to the saturated interval through these wells. Ozone will be delivered to each well for approximately 20 minutes, completing a 200 minute (3 hour and 20 minute) cycle. During drilling, our intention is to carefully observe soil types and field evidence for petroleum hydrocarbon impact in order to select the depth at each borehole where injection of ozone will occur. Our intention is to deliver ozone into the saturated zone between the depths of approximately 30 and 35 feet, preferentially targeting delivery of ozone into sandy (permeable) strata which should allow for diffusion/migration of ozone away from the injection well.

Stratus intends to utilize an H_2O Engineering, Inc. OSU10-52 OI system, or similar, to complete remediation at the site. Ozone generated from this equipment will be delivered to each well through subgrade tubing/conveyance piping. Ozone will be injected in to the subsurface through a 24-inch length gas diffusor attached to the base of the injection well casing; the location of the 10 proposed injection wells (IW-1 through IW-10) are included on Figure 2. The remediation equipment will be stored in a secure area in order to prevent unwanted access.

The ACEHD recently determined that is was appropriate to move the site from a quarterly to a semi-annual monitoring program (letter dated April 26, 2016). However, following initiation of OI remediation, Stratus will sample onsite wells MW-2, MW-3, and MW-15 on a quarterly basis, in order to collect additional data to evaluate remedial performance. In addition to testing for GRO and BTEX, samples collected from wells MW-2, MW-3, and MW-15 will be tested for hexavalent chromium, in order to ensure that this undesirable potential byproduct does not occur as a result of initiation of OI. The exact length of remediation will be dependent upon the findings of future well sampling events. Tentatively, we anticipate that OI will be completed for approximately 12 to 24 months; however the necessity of performing remediation will be evaluated on an ongoing basis. Quarterly reports will be prepared and submitted to ACEHD to document remedial efforts and present groundwater analytical results for well sampling work.

SCOPE OF WORK

The proposed scope of work has been subdivided into six tasks, as outlined below. All work will be conducted under the direct supervision of a State of California Professional Geologist or Professional Engineer, and will be conducted in accordance with standards established by the *Tri-Regional Board Staff Recommendations of Preliminary Investigation and Evaluation of Underground Tank Sites* (Regional Water Quality Control Board [RWQCB], April 2004).

Task 1: Pre-field Activities

Following approval of this *Work Plan* by ACEHD, and performance of a public comment period required for the proposed corrective action measures (if necessary), the following activities will be completed:

- Obtain a drilling permit from Alameda County Public Works Department (ACPWD).
- Retain and schedule a licensed C-57 drilling contractor.
- Update the site specific Health and Safety Plan.
- Mark boring locations and contact Underground Service Alert to locate underground utilities in the vicinity of the work site.
- Notify ACEHD, ACPWD, and Mr. Lee of the proposed work schedule.

Task 2: Field Activities (Drilling and Well Installation)

Task 2A: Soil Borings

A C-57 licensed drilling contractor will complete the drilling activities using a limited access hollow stem auger drill rig equipped with 8-inch diameter hollow stem augers. The initial portion of each soil boring will be advanced with hand tools, as conditions allow, to reduce the possibility of damaging underground utilities. A general description of field practices and procedures that will be utilized during drilling work is included in Appendix B.

Soil samples will be collected at 2.5-foot or 5-foot intervals from borings IW-1 through IW-10 using a California-type, split-spoon sampler equipped with three pre-cleaned brass or stainless steel sleeves. Above 25 feet bgs, soil sampling will be performed in 5-foot intervals. Below 25 feet bgs, soil samples will be collected in 2.5-foot intervals in order to assist in the evaluating the well construction (targeting coarser grained strata). The ends of the bottom-most, intact tube from each sample interval will be lined with Teflon™ sheets, capped, and sealed. Each sample will then be labeled, placed in a resealable plastic bag, and stored in an ice-chilled cooler. Strict chain-of-custody procedures will be followed from the time the samples are collected until the time the samples are relinquished to the laboratory. Stratus will submit a minimum of two samples from the well borings for chemical analyses; additional samples may be submitted for analytical testing at the discretion of the registered professional overseeing the project.

Soil will be classified on-site using the Unified Soil Classification System and recorded, along with other pertinent geologic information, on a geologic log. Soil from each sampled interval will also be placed and sealed in plastic bags to allow the accumulation of volatile organic compound (VOC) vapors within the airspace in the bags. A portable photoionization detector (PID) will be used to measure VOC concentrations from each sample in parts per million (ppm), and will be recorded on the boring log.

Task 2B: Injection Well Installation

Wells IW-1 through IW-10 will be constructed through 8-inch diameter hollow stem augers using 1-inch diameter blank Schedule 80 PVC casing connected to a gas diffusor specifically designed for ozone sparging. The ozone injection gas diffusor will be situated between the depths of approximately 30 and 35 feet bgs, with the exact depth to be determined in the field based upon soil types and subsurface conditions encountered during drilling. A filter pack of #2/12 sand will be placed around the gas diffuser, to about 2 to 3 feet above the top of the diffuser. Approximately two feet of bentonite chips or coated bentonite pellets will be placed above the filter pack sand and hydrated with clean water as a transition seal for the well. Neat cement will be used to backfill the remaining annular space around the well casing to surface grade. A slip cap will be placed over the top of the well casing, and a traffic-rated vault box will be installed over the top of the well. Actual well construction may be modified in the field based on conditions encountered at the time of the investigation.

Task 2C: Waste Management

Drill cuttings and wastewater generated during drilling activities will be stored in DOT-approved 55-gallon steel drums. The waste material storage containers will be appropriately labeled and stored at the site pending proper disposal. A licensed contractor will transport the soil and wastewater to an appropriate facility for disposal.

Task 3: Analytical Testing

Soil samples will be forwarded to a state-certified laboratory for chemical analysis. The soil samples will be analyzed for GRO using U.S. Environmental Protection Agency (USEPA) Method 8015/8260, and for BTEX using USEPA Method 8260.

Task 4: Well Installation Report Preparation

Following completion of the drilling activities, a report will be prepared to document the work completed and the findings associated with this work. The report will include, but not be limited to, a scaled site plan, soil boring logs, well details, tabulated analytical results, and certified analytical results. The report will be uploaded to GeoTracker and the ACEHD database upon finalization.

Task 5: Remediation System Installation and Supplemental Groundwater Monitoring

Stratus intends to utilize an H_2O Engineering, Inc. OSU10-52 ozone injection system, or similar, to complete *in-situ* chemical oxidation (ISCO) remediation at the site. The OSU10-52 system includes a self-contained cabinet housing an ozone generation system, an oxygen concentrator, an ozone delivery pump, and a distribution system with associated instrumentation. The OSU10-52 system operates on a 240-volt, 30 amps, and single-phase electrical requirement. The ozone generation system is capable of generating up to 2.7 pounds per day (lbs/day) at a concentration of 6% by weight, and can be injected at flow rates of up to 24 standard cubic feet per hour at pressures up to 50 pounds per square inch (psi). The remediation system will be installed inside of a locked gated enclosure at the site in order to provide security for the equipment and connection to an existing electrical panel situated inside of the building.

Injection of ozone will be completed on a continuous basis (24-hour period) through subgrade tubing and conveyance piping connected to wells IW-1 through IW-10. Stratus proposes to initiate injection of ozone-enriched air at a flow rate of 3 to 5 cubic feet per minute (cfm), at low injection pressures (approximately 100% to 125% of the static head breakthrough pressure or approximately 4 to 6 psi, depending on water levels). The operating parameters will be optimized to achieve steady state conditions based on data collected from the monitoring wells. The remediation system will be programmed to inject ozone for a 20-minute time period into the 10 wells connected to this system, completing a 200-minute injection cycle.

Stratus will continue to visit the site approximately twice per month to conduct O&M visits. During this time, Stratus will measure groundwater parameters (dissolved oxygen, pH, temperature, oxidation reduction potential, and conductivity) from the monitoring well network located near the remediation area (wells MW-2, MW-3, MW-5, and MW-15).

As stated earlier, Stratus is proposing to evaluate the performance of remediation by sampling wells MW-2, MW-3, and MW-15 on a quarterly basis. Samples collected from these wells will be analyzed for GRO and BTEX, consistent with the current well sampling plan for the site, and also hexavalent chromium (analysis using EPA Method 7199, or similar).

Task 6: Reporting

Data regarding operation of the OI equipment will be provided in quarterly remediation and groundwater monitoring and sampling status reports. The reports will include tabulated field and laboratory data, a summary of work activities performed during each quarter, and a discussion of remedial effectiveness and progress. The reports will also include recommendations regarding future work activities, and eventually a recommendation as to when OI remediation should be discontinued onsite. The reports will be uploaded to GeoTracker and the ACEHD database.

LIMITATIONS

This document was prepared in general accordance with accepted standards of care that existed at the time this work was performed. No other warranty, expressed or implied, is made. Conclusions and recommendations are based on field observations and data obtained from this work and previous investigations. It should be recognized that definition and evaluation of geologic conditions is a difficult and somewhat inexact science. Judgments leading to conclusions and recommendations are generally made with an incomplete knowledge of the subsurface conditions present. More extensive studies may be performed to reduce uncertainties. This document is solely for the use and information of our client unless otherwise noted.

If you have any questions or comments concerning this *Work Plan*, please contact Trevor Hartwell at (530) 313-9966.

Sincerely,
STRATUS ENVIRONMENTAL, INC.

PROFESSIONAL GEOLOGIST
TREVOR M. HARTWELL
No. 8774
STATE OF CALIFORNIA

Scott G. Bittinger, P.G.
Project Geologist

Trevor M. Hartwell, P.G.
Project Manager

Attachments:

Table 1	Well Construction Details
Figure 1	Site Location Map
Figure 2	Site Plan
Figure 3	Site Vicinity Map
Figure 4	GRO Iso-Concentration Contour Map, 1st Quarter 2016
Figure 5	Benzene Iso-Concentration Contour Map, 1st Quarter 2016
Appendix A	Annual Average GRO and Benzene in Groundwater Iso-Concentration Contour Maps, 2000, 2006, and 2010
Appendix B	Field Practices and Procedures

cc: Mr. Seung Lee, German Autocraft

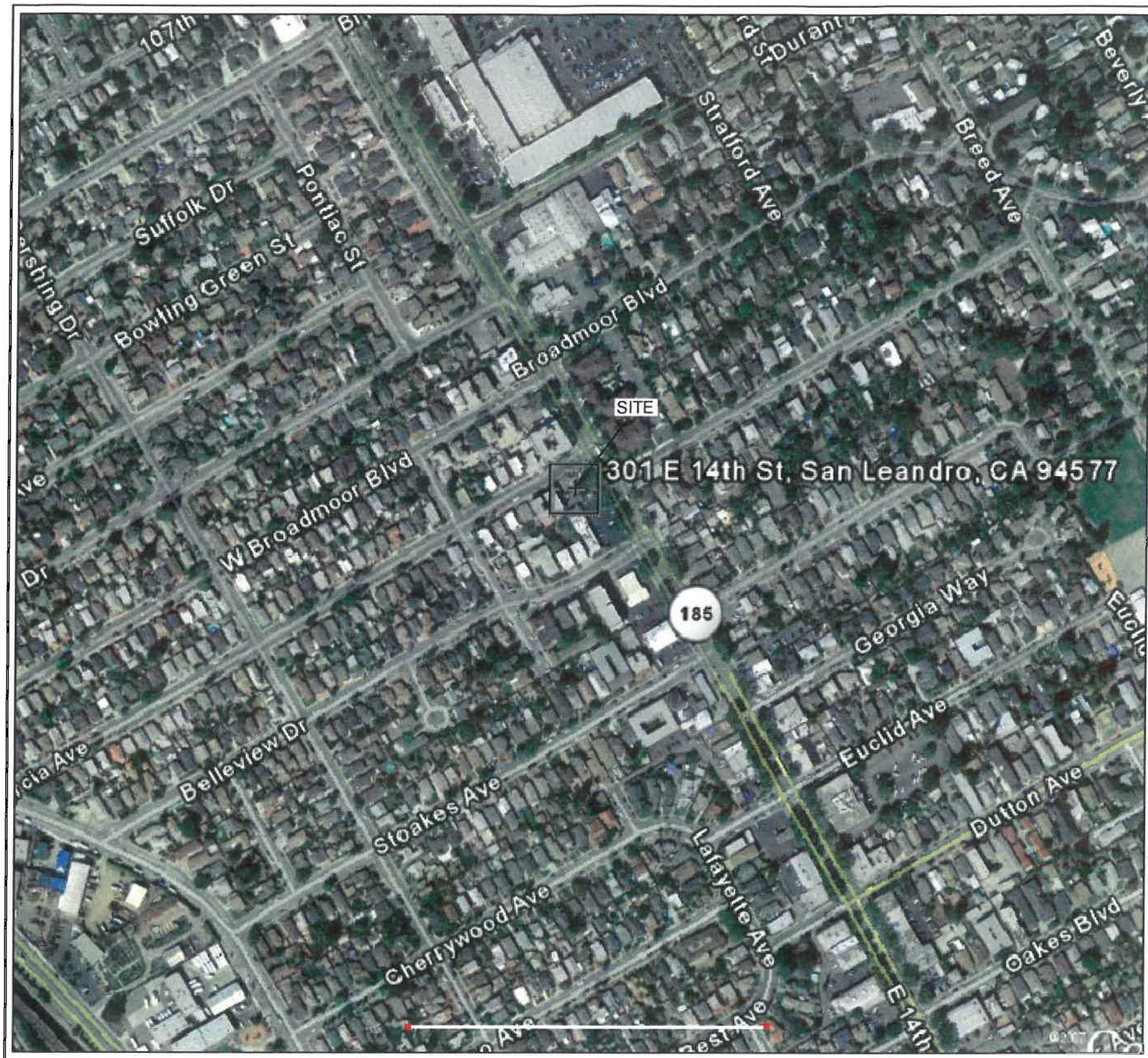
TABLE 1
WELL CONSTRUCTION DETAILS
German Autocraft, 301 E. 14th Street, San Leandro, California

Boring/Well I.D.	Date	Boring Depth (feet bgs)	Boring Diameter (inches)	Well Diameter (inches)	Well Depth (feet)	Screen Interval (feet bgs)	Slot Size (inches)	Drilling Method	Consultant
Groundwater Monitoring Wells									
MW-1*	12/17/91	45	8	2	45	25-45	0.02	HSA	Environmental Const. Co.
MW-2	12/12/94	38	8	2	34	24-34	0.010	HSA	Chemist Enterprises
MW-3	12/12/94	38	8	2	35.5	25.5-35.5	0.010	HSA	Chemist Enterprises
MW-4*	08/31/95	36.5	8	2	34	24-34	0.010	HSA	Chemist Enterprises
MW-1A	05/21/97	35	8	2	35	20-35	0.010	HSA	ALLCAL Prop. Serv. Inc.
MW-5	08/28/98	31.5	8	2	30	20-30	0.020	HSA	Env. Testing & Mgmt.
MW-6**	08/27/98	36.5	8	2	35	20-35	0.020	HSA	Env. Testing & Mgmt.
MW-8	08/27/98	31.5	8	2	30	20-30	0.020	HSA	Env. Testing & Mgmt.
MW-9	08/31/98	36.5	8	2	35	20-35	0.020	HSA	Env. Testing & Mgmt.
MW-10	08/28/98	41.5	8	2	40	20-40	0.020	HSA	Env. Testing & Mgmt.
MW-11	08/28/98	36.5	8	2	35	20-35	0.020	HSA	Env. Testing & Mgmt.
MW-12	01/30/01	39.5	8	2	38	23-38	0.020	HSA	Env. Testing & Mgmt.
MW-13	01/30/01	39.5	8	2	38	23-38	0.020	HSA	Env. Testing & Mgmt.
MW-14	01/31/01	31.5	8	2	30	20-30	0.020	HSA	Env. Testing & Mgmt.
MW-15	09/27/14	35	8	2	35	20-35	0.020	HSA	Stratus Environmental, Inc.
141 Farrelly	Prior to 1949	--	--	6	65	25-65	unknown	unknown	
Soil Borings [1]									
B-1	12/11/90	35	8	--	--	--	--	HSA	Environmental Const. Co.
B-2	12/10/90	35	8	--	--	--	--	HSA	Environmental Const. Co.
B-3	12/10/90	35	8	--	--	--	--	HSA	Environmental Const. Co.
CE-1	12/13/94	30	8	--	--	--	--	HSA	Chemist Enterprises
CE-2	12/13/94	24.5	8	--	--	--	--	HSA	Chemist Enterprises
ETM-1	11/28/95	37	1	--	--	--	--	Geoprobe	Env. Testing & Mgmt.
ETM-2	11/28/95	30	1	--	--	--	--	Geoprobe	Env. Testing & Mgmt.
ETM-5	11/28-29/95	27	1	--	--	--	--	Geoprobe	Env. Testing & Mgmt.
ETM-6	11/29/95	29	1	--	--	--	--	Geoprobe	Env. Testing & Mgmt.
ETM-7	11/29/95	28	1	--	--	--	--	Geoprobe	Env. Testing & Mgmt.
ETM-10	11/30/95	27.3	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.
ETM-11	11/30/95	27.3	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.
ETM-17	03/25/96	30	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.
ETM-19	03/25/96	30	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.
ETM-21	03/26/96	24.5	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.
ETM-22	03/26/96	24.5	1.5	--	--	--	--	Pneumatic	Env. Testing & Mgmt.

TABLE 1
WELL CONSTRUCTION DETAILS
German Autocraft, 301 E. 14th Street, San Leandro, California

Boring/Well I.D.	Date	Boring Depth (feet bgs)	Boring Diameter (inches)	Well Diameter (inches)	Well Depth (feet)	Screen Interval (feet bgs)	Slot Size (inches)	Drilling Method	Consultant
Soil Borings [1]									
B-4	01/24/11	32	1.5	--	--	--	--	Geoprobe	Stratus Environmental, Inc.
B-5	01/24/11	32	1.5	--	--	--	--	Geoprobe	Stratus Environmental, Inc.
B-6	10/23/14	6	3	--	--	--	--	Hand Auger	Stratus Environmental, Inc.
HP-1	09/28/14	38	1.5	--	--	--	--	Geoprobe	Stratus Environmental, Inc.
HP-2	09/28/14	35	1.5	--	--	--	--	Geoprobe	Stratus Environmental, Inc.
Soil Vapor Points									
SV-1	01/06/09	30	2	0.25	6.0	5.5-6.0	--	Stratoprobe	Groundwater Cleaners, Inc.
					13.5	13.0-13.5	--		
SV-2	01/06/09	30	2	0.25	6.0	5.5-6.0	--	Stratoprobe	Groundwater Cleaners, Inc.
					13.0	12.5-13.0	--		
SV-3	01/08/09	30	2	0.25	5.5	5.0-5.5	--	Stratoprobe	Groundwater Cleaners, Inc.
					13.5	13.0-13.5	--		
SV-4	01/08/09	14.5	2	0.25	5.25	4.75-5.25	--	Stratoprobe	Groundwater Cleaners, Inc.
					14.5	14.0-14.5	--		
SV-5	01/07/09	24	2	0.25	5.25	4.75-5.25	--	Stratoprobe	Groundwater Cleaners, Inc.
					14.0	13.5-14.0	--		
SV-6	01/07/09	35	2	0.25	5.5	5.0-5.5	--	Stratoprobe	Groundwater Cleaners, Inc.
					12.0	11.5-12.0	--		
SV-7	01/06/08	30	2	0.25	6.0	5.5-6.0	--	Stratoprobe	Groundwater Cleaners, Inc.
					13.0	12.5-13.0	--		
SV-8	01/08/09	14	2	0.25	5.25	4.75-5.25	--	Stratoprobe	Groundwater Cleaners, Inc.
					14.0	13.5-14.0	--		
VP-1	09/27/14	6	2	0.25	6.0	5.5	--	Geoprobe	Stratus Environmental, Inc.
VP-2	09/27/14	6	2	0.25	6.0	5.5	--	Geoprobe	Stratus Environmental, Inc.
VP-7	09/27/14	6	2	0.25	6.0	5.5	--	Geoprobe	Stratus Environmental, Inc.
VP-8	09/27/14	6	2	0.25	6.0	5.5	--	Geoprobe	Stratus Environmental, Inc.
VP-9	09/27/14	6	2	0.25	6.0	5.5	--	Geoprobe	Stratus Environmental, Inc.

Notes:
ft bgs = feet below ground surface
HSA = hollow stem auger
* = monitoring wells properly destroyed on January 25, 2011
** = monitoring well properly destroyed on November 21, 2011
[1] = soil borings without existing boring logs and/or construction details have been omitted.



QUADRANGLE LOCATION

N

0 1,000 FT

APPROXIMATE SCALE

STRATUS ENVIRONMENTAL, INC.	GERMAN AUTOCRAFT 301 EAST 14th STREET SAN LEANDRO, CALIFORNIA SITE LOCATION MAP	FIGURE 1 PROJECT NO. 2076-0301-01

STRATUS ENVIRONMENTAL, INC.

PATH NAME: German Auto
DRAFTER INITIALS: DMG
DATE LAST REVISED: June 03, 2016
FILENAME: German Auto Siteplan

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

SITE PLAN

FIGURE 2

PROJECT NO. 2076-0301-01

STRATUS ENVIRONMENTAL, INC.

PATH NAME: German Auto
DRAFTER INITIALS: DMG
DATE LAST REVISED: November 05, 2015
FILENAME: German Auto Site Vicinity Map

0 60 FT
SCALE

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

SITE VICINITY MAP

FIGURE
3

PROJECT NO.
2076-0301-01

STRATUS ENVIRONMENTAL, INC.

PATH NAME: German Auto\Quarterly Figures
DRAFTER INITIALS: DMG
DATE LAST REVISED: May 26, 2016
FILENAME: German Auto Quarterly

0 60 FT
SCALE

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

GRO ISO-CONCENTRATION CONTOUR MAP
1st QUARTER 2016

FIGURE
4

PROJECT NO.
2076-0301-01

STRATUS ENVIRONMENTAL, INC.

PATH NAME: German Auto\Quarterly Figures
DRAFTER INITIALS: DMG
DATE LAST REVISED: May 26, 2016
FILENAME: German Auto Quarterly

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

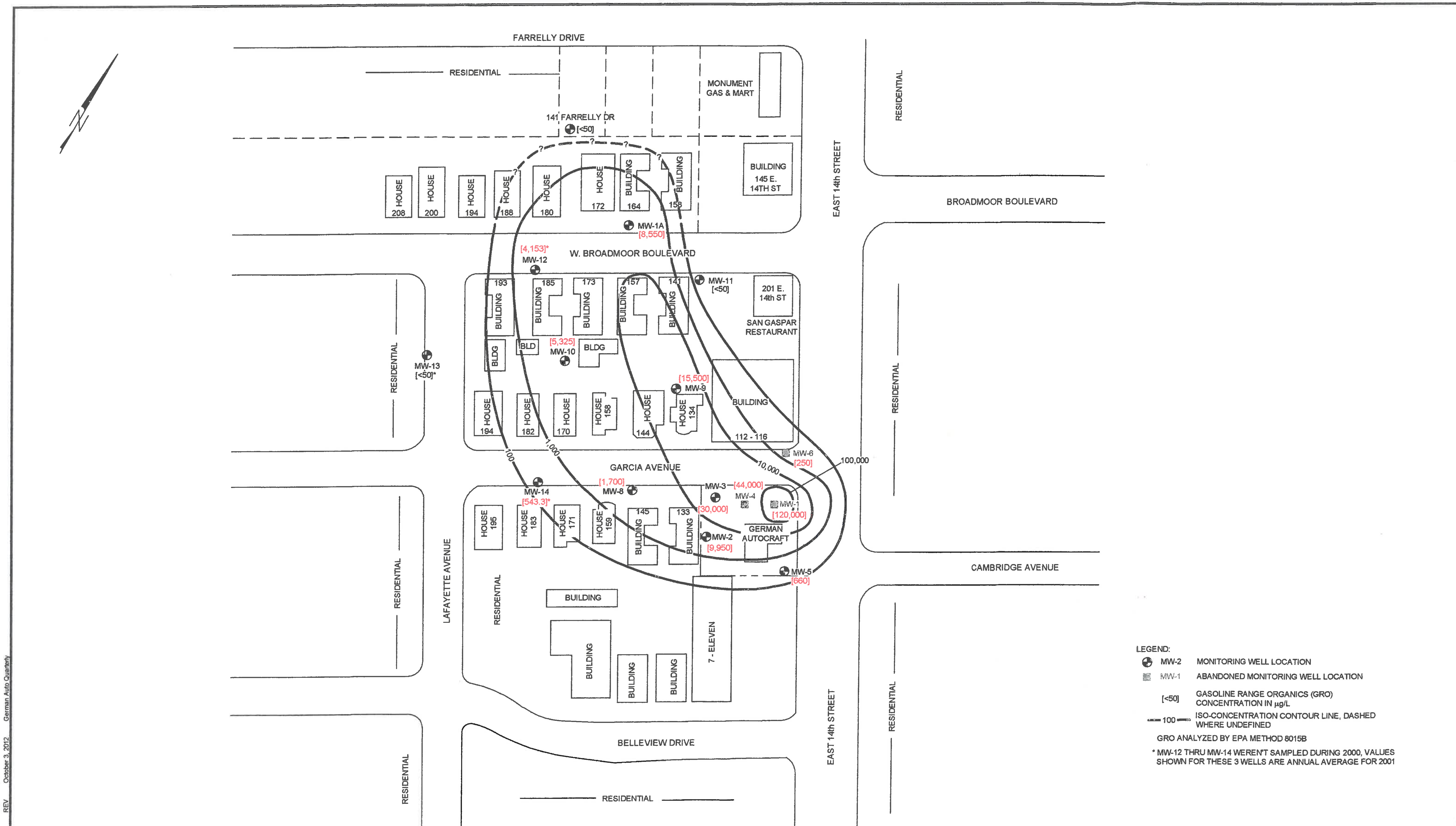
BENZENE ISO-CONCENTRATION CONTOUR MAP
1st QUARTER 2016

FIGURE
5

PROJECT NO.
2076-0301-01

APPENDIX A

ANNUAL AVERAGE GRO AND BENZENE IN GROUNDWATER ISO-CONCENTRATION CONTOUR MAPS, 2000, 2006, AND 2010



STRATUS ENVIRONMENTAL, INC.

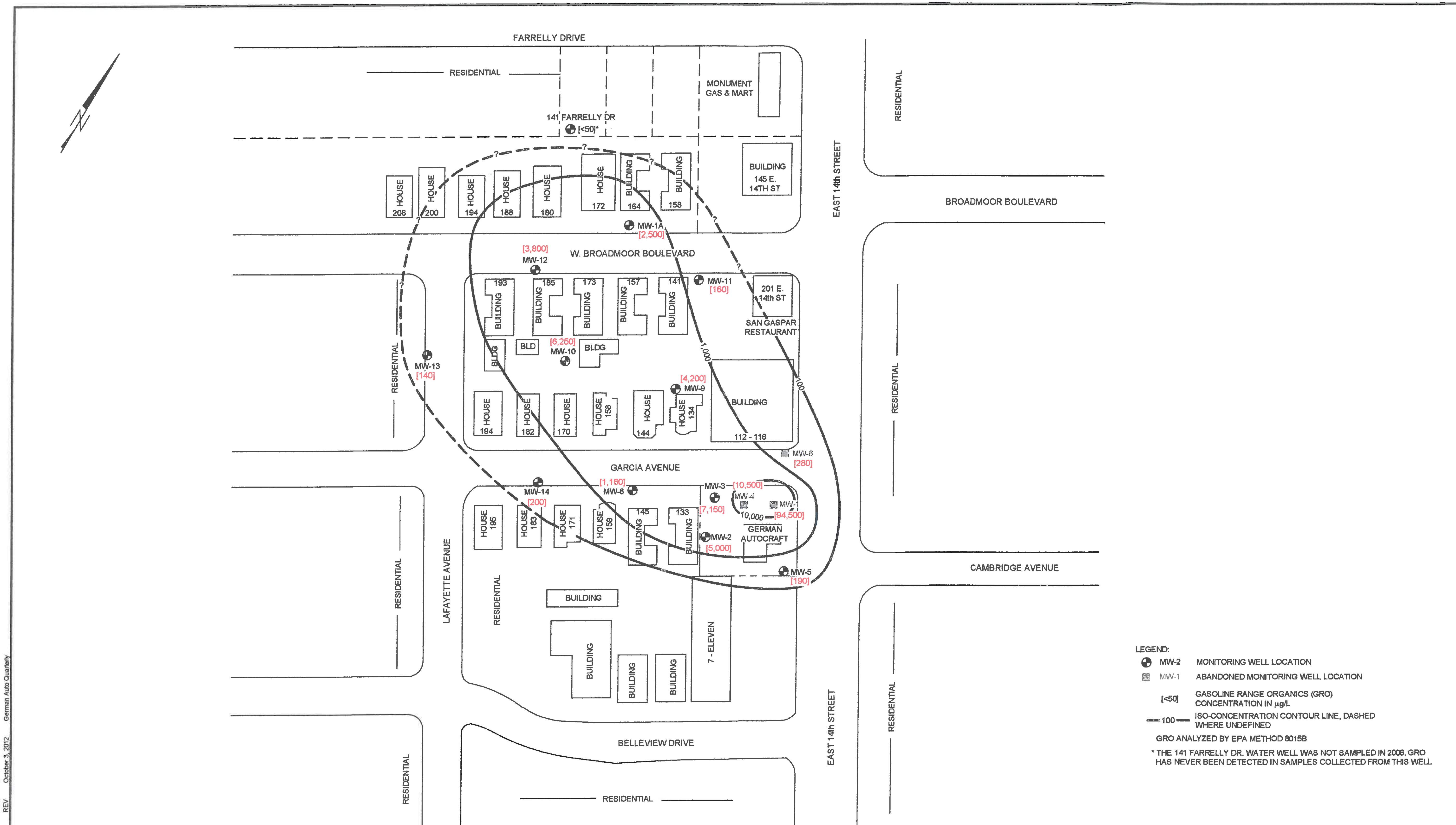
GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE GRO ISO-CONCENTRATION COUNTOUR MAP, 2000

FIGURE
A

PROJECT NO.
2076-0301-01

German AutoCAP JMP REV October 3, 2012 German Auto Quarterly



STRATUS ENVIRONMENTAL, INC.

0 100 FT
SCALE

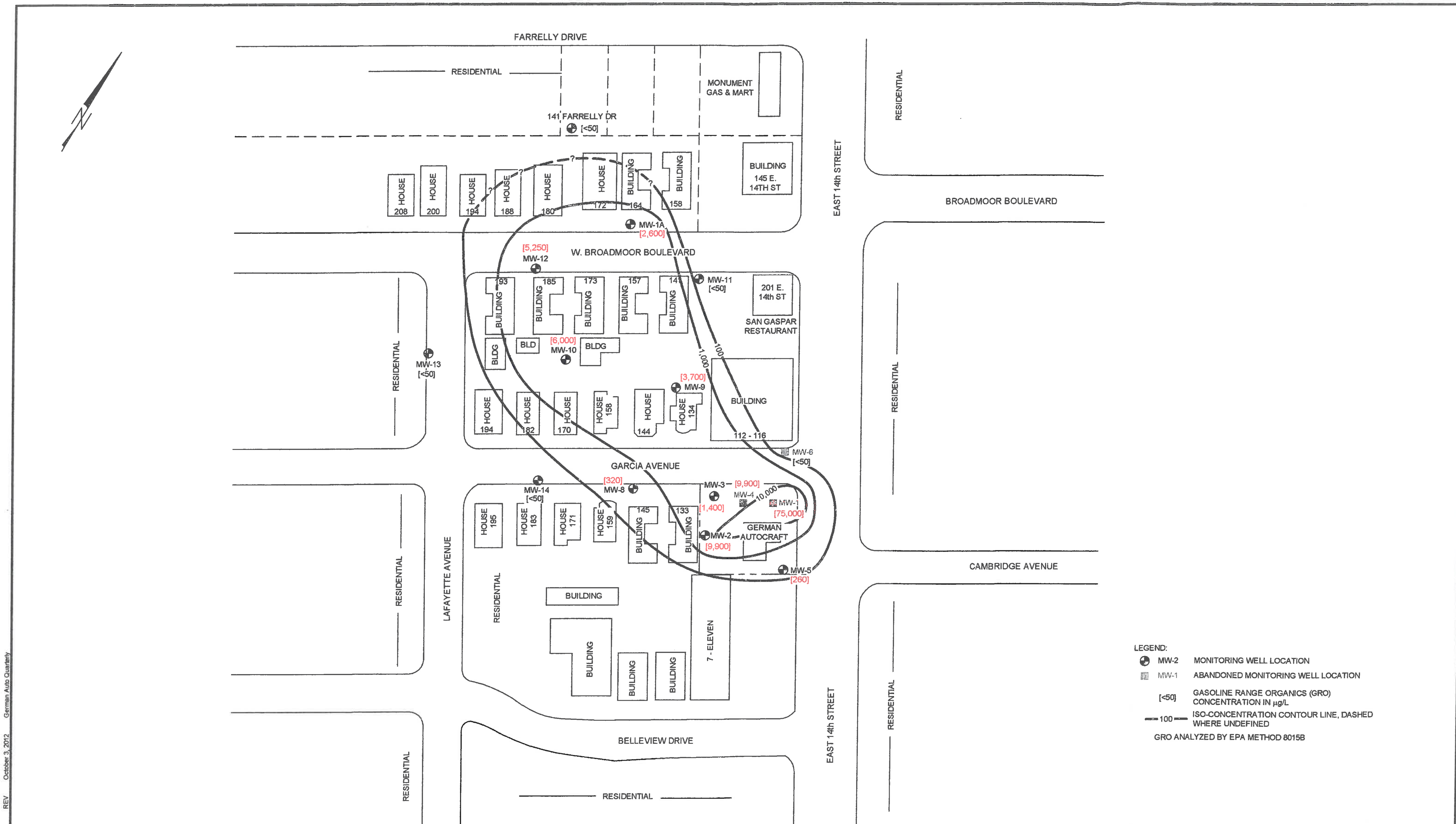
GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE GRO ISO-CONCENTRATION CONTOUR MAP, 2006

FIGURE
B

PROJECT NO.
2076-0301-01

German AutoCAP JMP REV October 3, 2012 German Auto Quarterly



German AutoCAP JMP REV October 3, 2012 German Auto Quarterly

STRATUS ENVIRONMENTAL, INC.

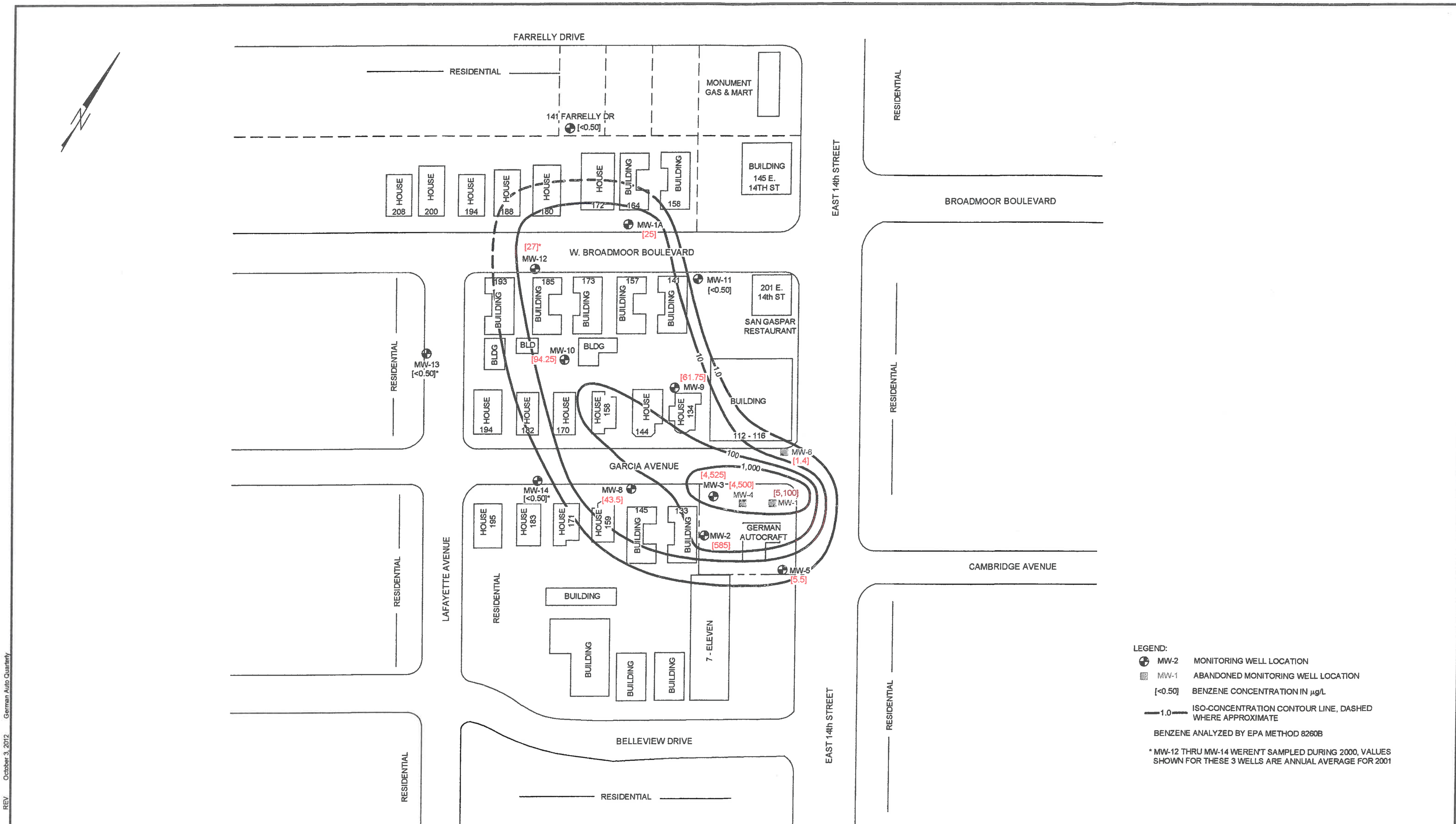
0 100 FT
SCALE

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE GRO ISO-CONCENTRATION CONTOUR MAP, 2010

FIGURE
C

PROJECT NO.
2076-0301-01



German AutoCAP | JMP | REV | October 3, 2012 | German Auto Quarterly

STRATUS ENVIRONMENTAL, INC.

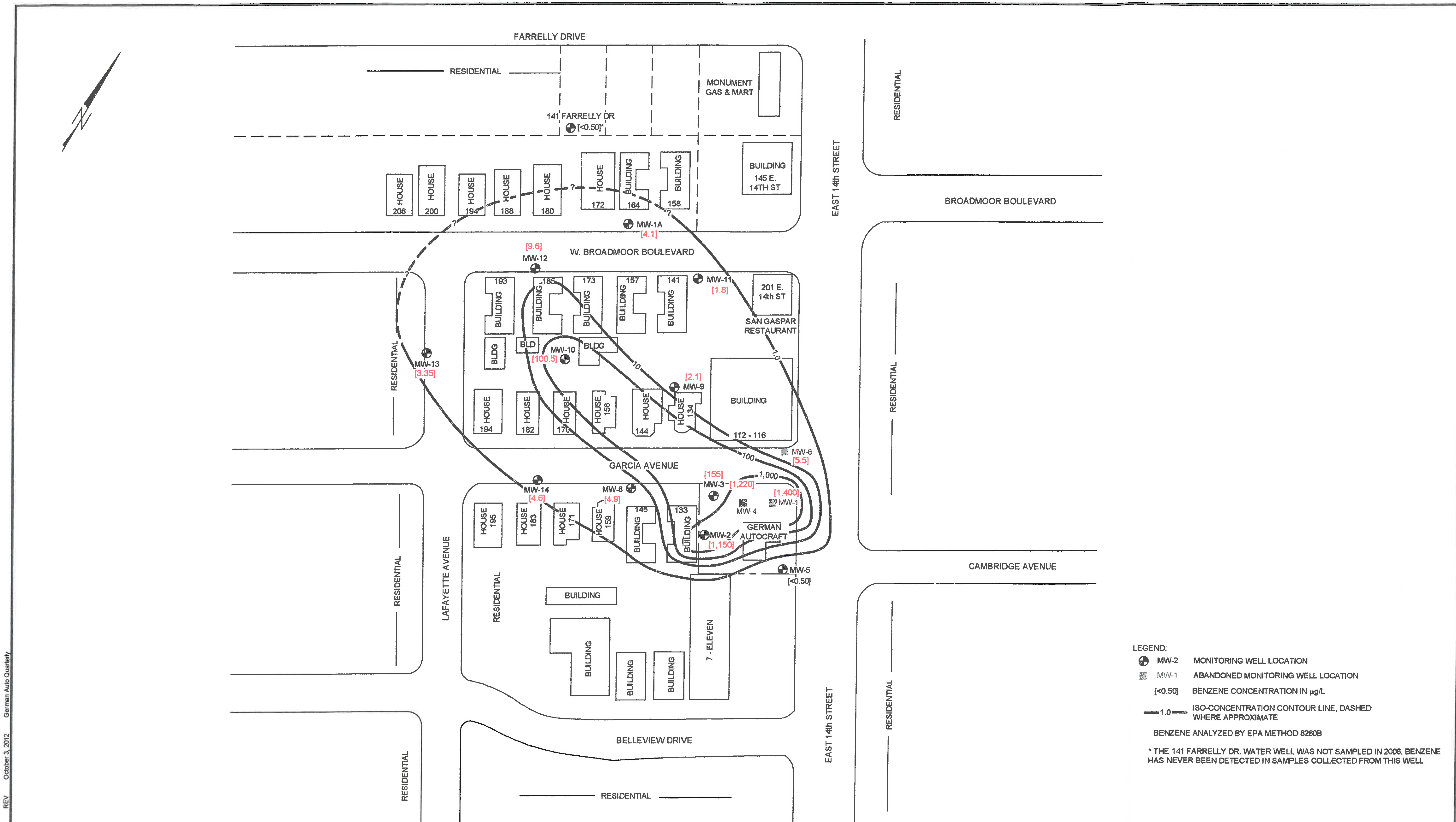
0 100 FT
SCALE

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE BENZENE ISO-CONCENTRATION CONTOUR MAP, 2000

FIGURE
D

PROJECT NO.
2076-0301-01



STRATUS ENVIRONMENTAL, INC.

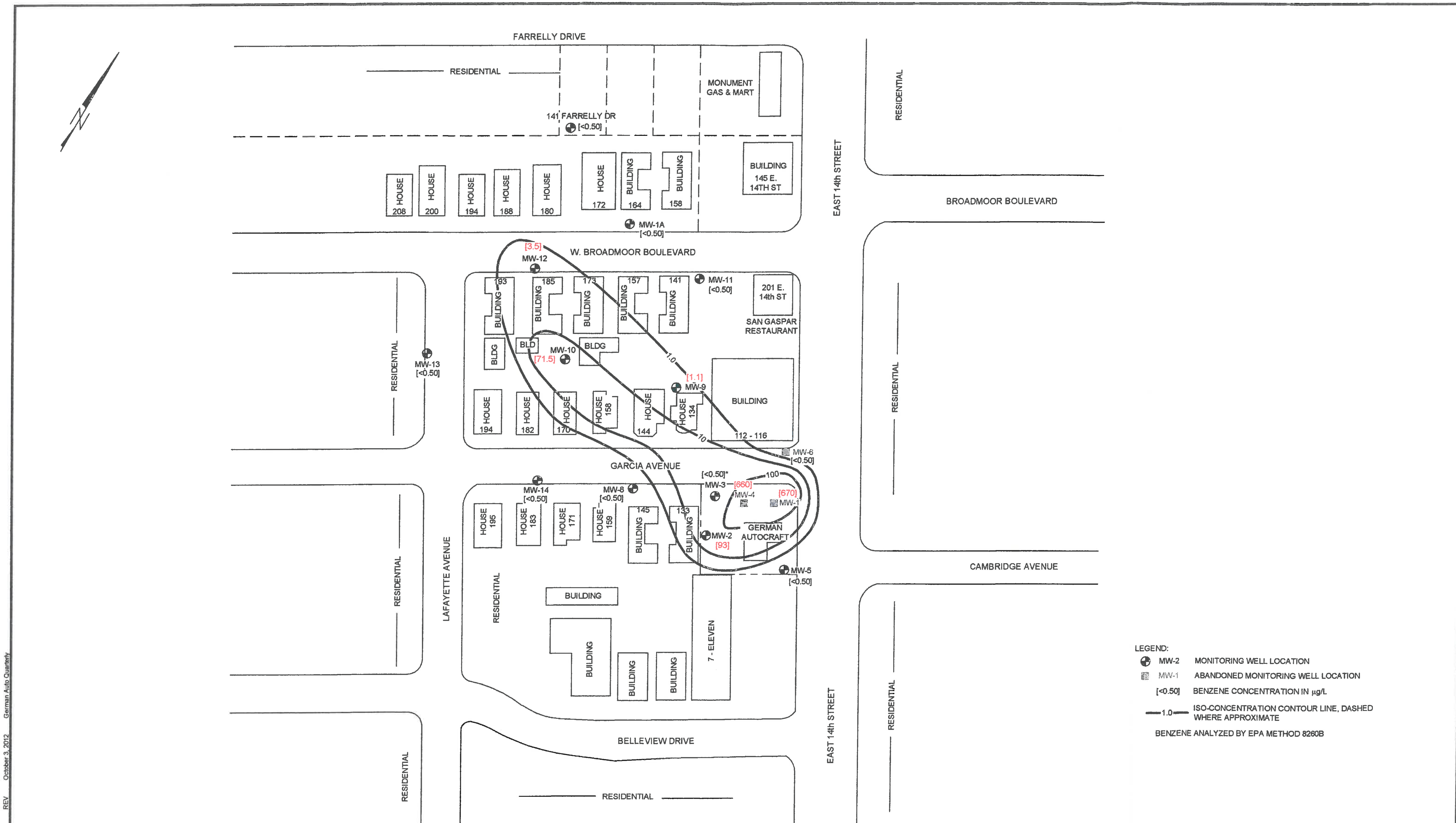
GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE BENZENE ISO-CONCENTRATION CONTOUR MAP, 2006

FIGURE E

PROJECT NO. 2076-0301-01

German AutoCAP JMP REV October 3, 2012 German Auto Quarterly



STRATUS ENVIRONMENTAL, INC.

German AutoCAP JMP REV October 3, 2012 German Auto Quarterly

GERMAN AUTOCRAFT
301 EAST 14th STREET
SAN LEANDRO, CALIFORNIA

ANNUAL AVERAGE BENZENE ISO-CONCENTRATION CONTOUR MAP, 2010

FIGURE
F

PROJECT NO.
2076-0301-01

APPENDIX B

FIELD PRACTICES AND PROCEDURES

FIELD PRACTICES AND PROCEDURES

General procedures used by Stratus in site assessments for drilling exploratory borings, collecting samples, and installing monitoring wells are described herein. These general procedures are used to provide consistent and reproducible results; however, some procedure may be modified based on site conditions. A California state-registered geologist supervises the following procedures.

PRE-FIELD WORK ACTIVITIES

Health and Safety Plan

Field work performed by Stratus at the site is conducted according to guidelines established in a Site Health and Safety Plan (SHSP). The SHSP is a document which describes the hazards that may be encountered in the field and specifies protective equipment, work procedures, and emergency information. A copy of the SHSP is at the site and available for reference by appropriate parties during work at the site.

Locating Underground Utilities

Prior to commencement of any work that is to be below surface grade, the location of the excavation, boring, etc., is marked with white paint as required by law. An underground locating service such as Underground Service Alert (USA) is contacted. The locating company contacts the owners of the various utilities in the vicinity of the site to mark the locations of their underground utilities. Any invasive work is preceded by hand augering to a minimum depth of five feet below surface grade to avoid contact with underground utilities.

FIELD METHODS AND PROCEDURES

Exploratory Soil Borings

Soil borings will be drilled using a truck-mounted, hollow stem auger drill rig. Soil samples for logging will be obtained from auger-return materials and by advancing a modified California split-spoon sampler equipped with brass or stainless steel liners into undisturbed soil beyond the tip of the auger. Soils will be logged by a geologist according to the Unified Soil Classification System and standard geological techniques. Drill cuttings will be screened using a portable photoionization detector (PID) or a flame ionization detector (FID). Exploratory soil borings not used for monitoring well installation will be backfilled to the surface with a bentonite-cement slurry pumped into the boring through a tremie pipe.

Soil sampling equipment will be cleaned with a detergent water solution, rinsed with clean water, and equipped with clean liners between sampling intervals. Augers and samplers will be steam cleaned between each boring to reduce the possibility of cross contamination. Steam cleaning effluent will be contained in 55-gallon drums and temporarily stored on site. The disposal of the effluent will be the responsibility of the client, unless authorized by the client for disposal by Stratus.

Drill cuttings generated during the drilling procedure will be stockpiled on site or contained in labeled and sealed 55-gallon drums. Stockpiled drill cuttings will be placed on and covered with plastic sheeting. The stockpiled soil is typically characterized by collecting and analyzing composite samples from the stockpile. Stratus Environmental will recommend an appropriate method for disposition of the cuttings based on the analytical results. The client will be responsible for disposal of the drill cuttings.

Soil Sample Collection

During drilling, soil samples will be collected in cleaned brass, two by six inch tubes. The tubes will be set in an 18-inch-long split-barrel sampler. The sampler will be conveyed to bottom of the borehole attached to a wire-line hammer device on the drill rig. When possible, the split-barrel sampler will be driven its entire length, either hydraulically or by repeated pounding a 140-pound hammer using a 30-inch drop. The number of drops (blows) used to drive the sampler will be recorded on the boring log. The sampler will be extracted from the borehole, and the tubes containing the soil samples will be removed. Upon removal, the ends of the lowermost tube will be sealed with Teflon sheets and plastic caps. Soil samples for chemical analysis will be labeled, placed on ice, and delivered to a state-certified analytical laboratory, along with the appropriate chain-of-custody documentation.

Soil Classification

As the samples are obtained in the field, they will be classified by the field geologist in accordance with the Unified Soil Classification System. Representative portions of the samples will be retained for further examination and for verification of the field classification. Logs of the borings indicating the depth and identification of the various strata and pertinent information regarding the method of maintaining and advancing the borehole will be prepared.

Soil Sample Screening

Soil samples selected for chemical analysis will be determined from a head-space analysis using a PID or an FID. The soil will be placed in a resealable plastic bag, sealed, and allowed to reach ambient temperature, at which time the PID probe will be inserted into the resealable plastic bag. The total volatile hydrocarbons present are detected by the PID and reported in parts per million by volume (ppmv). The PID will be calibrated to an isobutylene standard.

Generally two soil samples from each soil boring will be submitted for chemical analysis unless otherwise specified in the scope of work. Soil samples selected for analysis typically represent the highest PID reading recorded for each soil boring and the sample just above first-encountered groundwater.

Drill Cuttings and Soil Sampling

Soil generated during drilling operations will be stockpiled on-site or contained in labeled and sealed 55-gallon drums. The stockpile will be set on and covered by plastic sheeting in a manner to prevent rain water from coming in contact with the soil. Prior to collecting soil samples, Stratus personnel will calculate the approximate volume of soil in the stockpile. The stockpile will then divided into sections, if warranted, containing the predetermined volume sampling interval. Soil samples will be collected at 0.5 to 2 feet below the surface of the stockpile. Four soil samples will be collected from the stockpile and composited into one sample by the laboratory prior to analysis. The soil samples will be collected in cleaned brass, two by six inch tubes using a hand driven sampling device. To reduce the potential for cross-contamination between samples, the sampler will be cleaned between each sampling event. Upon recovery, the sample container will be sealed at each end with Teflon sheeting and plastic caps to minimize the potential of volatilization and cross-contamination prior to chemical analysis. The soil sample will be labeled, placed on ice, and delivered to a state-certified analytical laboratory, along with the appropriate chain-of-custody documentation.

Direct-Push Technology, Soil Sampling

Direct-push is a drilling method of advancing small diameter borings without generating soil cuttings. The system consists of an approximately 2-inch diameter, 4- or 5-feet long, stainless steel soil sampling tool that is hydraulically advanced into subsurface soils by a small rig. The sampling tool is designed similar to a California-modified split-spoon sampler, and lined with a sample tube that enables continuous core sampling.

To collect soil samples, the sampler is advanced to the desired sampling depth. The mouth of the sampling tool is plugged to prevent soil from entering the sampler. Upon reaching the desired sampling depth, the plug at the mouth of the sample tool is disengaged and retracted, the sampler is advanced, and the sampler is filled with soil. The sample tool is then retrieved from the boring, and the sample tube removed. The sample tool is then cleaned, a new tube is placed inside and the sampling equipment is advanced back down the borehole to the next sample interval.

The Stratus geologist describes the entire interval of soil in the tube. The bottom-most 6-inch long section is cut off and retained for possible chemical analysis. The ends of the chemical sample are lined with Teflon sheets, capped, labeled, and placed in an ice-chilled cooler for transport to California Department of Health Services-certified analytical laboratory under chain-of-custody.

Direct Push Technology, Water Sampling

A well known example of direct push technology for water sampling is the Hydropunch. For the purpose of this field method the term hydropunch will be used instead of direct push technology for water sampling.

The hydropunch is typically used with a drill rig. A boring is drilled with hollow stem-augers to just above the sampling zone. In some soil conditions the drill rig can push directly from the surface to the sampling interval. The hydropunch is conveyed to the bottom of the boring using drill rods. Once on bottom the hydropunch is driven a maximum of five feet. The tool is then opened by lifting up the drill rod no more than four feet. Once the tool is opened, water enters and a sample can be collected with a bailer or tubing utilizing a peristaltic pump. Soil particles larger than silt are prevented from entering the tool by a screen within the tool. The water sample is collected, labeled, and handled according to the Quality Assurance Plan.

Monitoring Well Installation

Monitoring wells will be completed by installing 2 to 6 inch-diameter Schedule 40 polyvinyl chloride (PVC) casing. The borehole diameter for a monitoring well will be greater than four inches larger than the outside diameter of the casing. The 2-inch-diameter flush-threaded casing is generally used for wells dedicated for groundwater monitoring purposes.

A monitoring well is typically cased with threaded, factory-perforated and blank Schedule 40 PVC. The perforated interval consists of slotted casing, generally with 0.01 or 0.02 inch-wide by 1.5-inch-long slots, with 42 slots per foot. The screened sections of casing are factory machine slotted and will generally be installed approximately 5 feet above and 10 feet below first-encountered water level. The screened interval will allow for seasonal fluctuation in water level and for monitoring floating product. A threaded or slip PVC cap is secured to the bottom of the casing. The slip cap can be secured with stainless steel screws or friction; no solvents or cements are used. Centering devices may be fastened to the casing to ensure even distribution of filter material and grout within the borehole annulus. The well casing is thoroughly washed and/or steam cleaned, or may be purchased as pre-cleaned, prior to completion.

A filter pack of graded sand will be placed in the annular space between the PVC casing and the borehole wall. Sand will be added to the borehole through the hollow stem of the augers to provide a uniform filter pack around the casing and to stabilize the borehole. Generally the sand pack will be placed to a maximum of 2 feet above the screens, followed by a minimum 1- to 2-foot seal consisting of bentonite pellets.

Cement grout containing a maximum of 5 percent bentonite powder will be placed above the bentonite seal to the ground surface. A concrete traffic-rated vault box will be installed over the monitoring well(s). A watertight locking cap will be installed in the top of the well casing. Reference elevations for each monitoring well will be surveyed when more than two wells will be located on site. Monitoring well elevations will be surveyed by a California licensed surveyor to the nearest 0.01-foot relative to mean sea level (MSL). Horizontal coordinates of the wells will be measured at the same time. Exploratory boring logs and well construction details will be prepared for the final written report.