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September 22, 1982
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FSI File No. 81-7

Mr. Henry Oberhelman
Intel Corporation
WW2-651
19460 SW Shaw Road
Aloha, OR 97007

SUBJECT: ADDENDUM REPORT, SOLVENT SPILL STUDY, INTEL CORPORATION ALOHA FABRICATION FACILITIES, ALOHA, OREGON

Dear Mr. Oberhelman:

At the request of Intel Corporation, Foundation Sciences, Inc. (FSI) performed a subsurface investigation and geohydrological study in connection with the solvent spill that was discovered in early July, 1982 at the Intel Fabrication Facilities, Aloha, Oregon. We understand that xylene, n-butyl acetate and 1,1,1-trichloroethane were the solvents involved in the spill.

BACKGROUND

This study was performed in two phases. Phase I consisted of a qualitative evaluation of solvent migration based on a series of 25 shallow borings made to depths ranging from 3 to 11.5 ft. By sniffing soil samples obtained during the Phase I work, we estimated the migration paths and direction of the solvent. Phase II was directed toward quantifying the concentrations of the solvents in the soil-water regime and toward better defining the direction and mechanism of flow. The Phase II work included the installation of five groundwater monitoring wells to depths ranging from 39.5 to 49.0 ft. Quantitative

analyses of groundwater gradients, soil permeabilities and solvent concentrations in both soil and groundwater were made for Phase II.

A detailed description of the Phase I work and the initial stages of the Phase II work, including the results of that work, were transmitted to Ms. Cathryn Young in a letter report dated August 11, 1982. That report, which was copied to you, included:

1) a description of the Aloha facilities site,
2) a summary of the field methods utilized in making the borings and installing the observation wells,
3) a description of the soil and groundwater conditions observed in the borings,
4) the results of two soil permeability tests,
5) the results of gas chromatograph (GC) analyses made on seven soil samples from Phase I borings, and
6) a discussion of our preliminary conclusions and recommendations.

This addendum report documents the work performed by FSI since that time. Please refer to the August 11 report for complete details concerning the work discussed in it, and the figures and tables which are referenced in this addendum report.

The following sections of this report present the results of:

1) GC analyses made on soil samples from the well borings;
2) details concerning well development, groundwater sampling and gas chromatograph-mass spectrometry (GC-MS) analyses made on the groundwater samples from each well; and
3) our present conclusions and recommendations.

GC ANALYSES OF WELL BORING SOIL SAMPLES

The five observation wells, designated WB-1 through WB-5, were drilled on July 15 and 16, 1982. The August 11 letter report shows the wells' locations (Figure 2) and documents the subsurface conditions observed in them (Figures 3 through 7).

On August 3, 1982, FSI submitted 15 soil samples, three from each well boring, to MEI-Charlton (MEI) in Portland, Oregon for analysis. These samples were taken from the top, middle and bottom of the well borings. MEI analyzed the samples for xylene, n-butyl acetate, and 1,1,1-trichloroethane contamination using purge and trap gas chromatography. No solvent contamination was detected by their analyses in any of the soil samples. These results were presented to FSI in the form of a letter dated August 19, 1982. This letter is included in the Appendix A, Laboratory Test Results (attached).

WELL DEVELOPMENT, SAMPLING AND TESTING

The following is a general discussion of the sequence of well development, sampling and testing performed to determine solvent concentrations in the groundwater. The construction of each well is documented in the August 11 letter report (Table 3 and Figure 8).

August 4 -- An FSI technician collected a groundwater sample from well WB-1 using a hand bailer, without prior bailing of the well. The sample was submitted to MEI for analysis.

August 5 -- The groundwater sample collected on August 4 was analyzed by MEI using flame ionization detection with solvent extraction gas chromatography. Compounds analyzed for and quantified in parts per million (ppm) included: xylene (9 ppm), n-butyl acetate (<2 ppm) and 1,1,1-trichloroethane (4 ppm). MEI's report to FSI is presented in the Appendix A, Laboratory Test

Results. Based on the results of this analysis, Intel determined that any groundwater pumped during well development could be disposed of into Intel's Aloha campus sanitary sewer system.

August 5 and 6 -- All wells were developed by pumping with a vacuum truck provided and operated by Crosby and Overton of Portland, Oregon. FSI personnel observed and directed the work. Water was withdrawn from near the bottom of each well by means of a 1-in. I.D. PVC pipe attached to the vacuum line. Water was stored temporarily in the vacuum truck's storage tank, then discharged into Intel's sanitary sewer systems.

August 9 -- All wells were sampled by an FSI technician using a hand bailer. The groundwater samples were stored in a cooler on "Blue Ice" and shipped by bus the same day to Lauck's Testing Laboratories (Lauck's) in Seattle, Washington.

August 16 -- Groundwater samples collected on August 9 were analyzed by Lauck's using purge and trap gas chromatography-mass spectrometry. Compounds analyzed for and quantified were 1,1,1-trichloroethane, n-butyl acetate and ortho-, meta-, and para-xylene. Other volatile peaks were also identified and estimates were made of the identified compound's concentrations.

August 24 and 25 -- FSI personnel further developed all wells by pumping them with a typical contractor's pump unit. Water was withdrawn from near the bottom of each well by means of a 1 in. hose attached to the pump inlet. The water was pumped into 55 gal. drums and disposed of into Intel's sanitary sewer system.

September 1 -- An FSI technician pumped wells WB-1 through WB-4 prior to sampling using the contractor's pump arrangement described above. The water was pumped into 55 gal. drums and disposed of into Intel's sanitary sewer system. Groundwater samples

were collected directly from the pump's discharge outlet. The samples were stored in a cooler on "Blue Ice" and shipped the same day by bus to Lauck's in Seattle.

September 8 -- Groundwater samples collected on September 1 were analyzed by Lauck's using the methods described above for August 16.

A more detailed discussion of well development and sampling history is given for each well in Appendix B, Well Development and Sampling History.

GC-MS ANALYSES OF GROUNDWATER TEST SAMPLES

The results of the gas chromatography-mass spectrometry tests performed on groundwater samples that were collected August 9 and September 1 are summarized in Table 1. The results are presented in micrograms per liter, or parts per billion (ppb) by weight. Copies of Lauck's testing certificates, which transmitted these results to FSI, are included in the Appendix A, Laboratory Test Results.

As shown in Table 1, the test results from the two different sampling times are similar and probably can be considered identical within sampling and testing errors. The results show that only groundwater from wells WB-1 and WB-3 contain detectable concentrations of solvent.

CONCLUSIONS AND RECOMMENDATIONS

Contamination from the solvent spill has spread generally down the groundwater gradient from the original spill area in the SE corner of FAB IV. Based on groundwater levels measured in the observation wells, we estimate the groundwater table has a gradient in the range of 0.6% to 2.5%, sloping generally toward the east or southeast.

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Based on the solvent concentration levels observed in groundwater test samples from the observation wells, we believe the direction of groundwater flow is probably more to the east, than southeast. We conclude that groundwater originating up-gradient from the spill area contains no solvents.

Based on our observations and the results of GC testing on soil samples (refer to August 11 report), we believe that xylene concentrations are greatest in the open green area just south of the driveway from 198th Avenue and in the paved entrance area into the service courtyard. Xylene concentrations were observed to be highest near the service courtyard and decrease in the direction toward 198th Avenue. Concentrations of 1,1,1-trichloroethane appear relatively uniform in all soil samples tested (0.5 ppm). N-butyl acetate concentrations are variable and appear to have no discernable pattern.

Based on the results of soil sample and groundwater analyses, we believe that xylene contamination has been relatively contained because it has a lower specific gravity than water and negligible solubility. Therefore, it tends to stay near the top of the groundwater table in the less permeable upper silts. We believe that the xylene has been transported away from the spill area primarily by flowing on top of groundwater in the more permeable backfills along the various buried utilities extending east from the spill area. The two major xylene seepage paths observed during the Phase I work were the water lines in the vicinity of B-24, B-12 and B-17, and the 8-in. sewer line in the vicinity of borings B-21, B-20 and B-15 (refer to Site Plan, Figure 2, August 11 report). This reasoning also serves to explain the xylene concentrations observed in well WB-1, but not WB-3.

We conclude that 1,1,1-trichloroethane has migrated further than the xylene, probably due to its higher specific gravity and solubility. These physical properties have allowed it to penetrate into

the more permeably sandy silts/silty sands at depth, where groundwater velocities are higher. The width of the 1,1,1-trichloroethane contamination plume is probably in the range of 300 to 600 ft wide along 198th Avenue.

Since the entire saturated thickness of the more permeable sandy silt/silty sand unit is screened in each monitoring well, the vertical extent or thickness of the contamination plume can not be easily determined. Also for this reason, the solvent concentrations given in Table 1 should be considered composite averages over the aquifer thickness. The possibility exists that vertically localized solvent concentrations may be higher than those shown. We believe, however, that the results given on Table 1 are representative of the solvent contaminations which would be experienced by a nearby, shallow producing well, if one were present. In our opinion, it is unlikely that any solvents have penetrated vertically through the very stiff gray clayey silts observed in the bottom of each well boring.

Should you have any questions concerning the information presented in this or our August 11 report, or require any additional information, please contact us at your convenience.

Respectfully submitted for,

FOUNDATION SCIENCES, INC.

John B. Creveling
Project Engineer

David D. Driscoll
Vice President

JBC/mmd

cc: Ms. Cathryn Young

TABLE 1. SUMMARY OF GC-MS ANALYSES ON GROUNDWATER TEST SAMPLES

Well	Sample Date	µg/L 1,1,1-Trichloroethane	N-butyl acetate	Ortho-xylene	Meta-xylene	Para-xylene
WB-1	8-9-82	140	ND	130	ND	ND
	8-9-82 (dup.)	140	ND	130	ND	ND
	9-1-82	240	ND	110	ND	ND
WB-2	8-9-82	ND	ND	ND	ND	ND
	9-1-82	ND	ND	ND	ND	ND
WB-3	8-9-82*	360	ND	ND	ND	ND
	9-1-82**	360	ND	ND	ND	ND
	9-1-82 (dup.)	280	ND	ND	ND	ND
WB-4	8-9-82	ND	ND	ND	ND	ND
	9-1-82	ND	ND	ND	ND	ND
WB-5	8-9-82	ND	ND	ND	ND	ND

* Sample WB-3, 8-9-82: Two additional volatile peaks were found and identified as 1,1,2-trichloro-1,2,2-triflouroethane and 1,1-dichloroethane at estimated concentrations of 200 to 300 µg/L each.

** Sample WB-3, 9-1-82: One additional volatile peak was found and identified as 1,1-dichloroethane at an estimated concentration of 50 µg/L.