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10 May 2006 GeoSyntec Ref: TR0162

Todd Slater
Legacy Site Services LLC
468 Thomas Jones Way
Exton, PA
9341-2528

Reference: Results of Phase 1 Vadose Zone Perchlorate Distribution Assessment and Proposed Locations for Phase 2
ECSI No. 398

Dear Mr. Slater:

This letter is intended to: i) provide results from the Phase I vadose zone perchlorate distribution assessment that has recently been completed for the Former Atofina Chemicals Site, Portland, Oregon (the Site); and ii) notify Arkema and the Oregon Department of Environmental Quality (ODEQ) of proposed changes to the Phase II vadose zone sampling program, and to gain approval for implementation of the Phase II program in May 2006. The goal of the vadose zone soil sampling program is to delineate the potential distribution of perchlorate in the vadose zone soils that may serve as a potential long-term source of perchlorate to groundwater. A hydraulic testing program was run concurrently to the Phase I vadose zone investigation. Data collected from this program will be forwarded under separate cover to Arkema and ODEQ.

Details regarding the Phase I sampling program were previously provided in the document titled "Workplan for a Pilot Test of *In Situ* Bioremediation of Perchlorate in Groundwater at the Former Atofina Chemicals Site, Portland, Oregon" (dated March 2006). Briefly, the Phase I sampling program consisted of collection of soil cores from four locations (shown on Figure 1) to a depth of about 30 feet below ground surface (feet bgs), to assess the potential correlation between soil lithology and perchlorate distribution in the vadose zone and shallow aquifer, and to evaluate whether extended vadose zone delineation was warranted. Soil samples were collected at three-foot intervals from each soil core for analysis of perchlorate, chlorate, anions (chloride, nitrite, nitrate, sulfate, bromide and phosphate), electrical conductivity and pH. Additionally, soil samples were collected at five-foot intervals during the installation of shallow aquifer pump test well PT-3 and intermediate aquifer monitoring well MWA-70i (see Figure 1 for well locations).

Table 1 summarizes the results of perchlorate, chlorate and anion analyses for the six locations sampled. Table 2 summarizes the results of electrical conductivity and pH measurements for the six locations sampled. Perchlorate results can be summarized as follows:

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- P1B-1: Perchlorate was detected at relatively low levels (less than 3.8 mg/kg) to a depth of 16 feet (water table approximately 15 feet bgs). Perchlorate concentrations in the soils were highest (28 to 81 mg/kg) in the shallow aquifer, from a depth of 19 to 28 feet bgs. These data suggest that this area does not represent a vadose zone perchlorate source. Perchlorate concentrations in the shallow aquifer in this area appear to be related to migration from upgradient areas.

- P1B-2: Perchlorate was not detected in the upper 22 feet, indicating that this area does not represent a vadose zone perchlorate source (water table approximately 13 feet bgs). Perchlorate concentrations (24 to 61 mg/kg) detected in the shallow aquifer at depths of 25 to 31 feet bgs appear to be related to migration from upgradient areas.

- P1B-3: Perchlorate was not detected in any of the soil samples from this location, either in the vadose zone (water table approximately 12 feet bgs) or the shallow aquifer, to a depth of 31 feet.

- P1B-4: Perchlorate was not detected (with one exception) in the soil samples from this location, to a depth of 25 feet (water table approximately 16.7 feet bgs). Low levels of perchlorate (0.47 to 1.3 mg/kg) were detected from 28 to 31 feet, related to migration from upgradient areas.

- PT-3: Perchlorate concentrations were generally low (non-detect or less than 1 mg/kg), with the exception of a single detection of 23 mg/kg at a depth of 15 feet (water table approximately 23 feet bgs).

- MWA-70i: Perchlorate was detected at elevated concentrations (25-26 mg/kg) in the upper 10 feet (water table approximately 20 feet bgs), suggesting the presence of a vadose zone perchlorate source beneath the Former Chlorate Cell Room.

Based on these results, it appears that the presence of perchlorate in the vadose zone is predominantly limited to the area beneath the Former Chlorate Cell Room, and as such, GeoSyntec recommends revising the proposed Phase 2 vadose zone sampling locations to specifically target the area beneath and immediately surrounding the Former Chlorate Cell Room, as shown in Figure 1. The Phase II program will include twelve soil borings. Continuous soil cores will be collected from each borehole to a depth approximately 4 to 5 feet below the water table at each location (approximately borehole depths of 20 to 24 feet bgs), and samples will be collected from the soil cores at 4 ft intervals for analysis of perchlorate, chlorate, anions, pH and electrical conductivity by SiREM Laboratories in Guelph, Ontario.

Implementation of the Phase 2 soil sampling program is tentatively scheduled for the week of May 22, 2006. Should you have any comments on the Phase I results or the proposed revisions to the Phase II vadose zone sampling program, we request that you contact GeoSyntec at your earliest convenience.

Sincerely,
GeoSyntec Consultants Incorporated

Evan E. Cox, M.Sc.
Principal

cc: Larry Patterson – Arkema Group
Erik Ipsen – ERM

\Attch.

TABLE 1
PERCHLORATE, CHLORATE AND ANION ANALYTICAL RESULTS FROM PHASE 1 VADOSE ZONE INVESTIGATION
Arkema Facility, Portland, Oregon

Sample Location	Date Collected	Sample ID	Depth to Water (ft bgs)[1]	Depth (ft bgs)	Concentration (mg/kg)[2]							
					Perchlorate	Chlorate	Chloride	Nitrite-N	Nitrate-N	Sulfate	Bromide	Phosphate
P1B-1	4-Apr-06	P1-B1-4	15	4	3.5	83	83	<0.12	1.4	32	1.5	<0.57
	4-Apr-06	P1-B1-7		7	0.09 J	9.2	22	<0.12	0.37	9.2	0.63	<0.57
	4-Apr-06	P1-B1-10		10	<0.20	0.61	63	<0.12	0.13	14	0.73	<0.57
	4-Apr-06	P1-B1-13		13	<0.20	<0.31	166	<0.12	<0.10	5.2	0.64	<0.57
	4-Apr-06	P1-B1-16		16	3.8	90	298	<0.12	0.14	7.0	0.74	<0.57
	4-Apr-06	P1-B1-19		19	81	2105	420	<0.12	0.12	137	1.2	<0.57
	4-Apr-06	P1-B1-22		22	40	1019	203	<0.12	<0.10	68	<0.39	<0.57
	4-Apr-06	P1-B1-25		25	28	557	126	<0.12	<0.10	82	<0.39	<0.57
	4-Apr-06	P1-B1-28		28	67	1381	371	<0.12	<0.10	238	1.5	<0.57
	4-Apr-06	P1-B1-31		31	1.9	95	839	<0.12	<0.10	28	0.85	<0.57
P1B-2	5-Apr-06	P1-B2-1	13	1	<0.20	<0.31	1648	<0.12	0.48	52	1.3	<0.57
	5-Apr-06	P1-B2-4		4	<0.20	<0.31	102	<0.12	0.29	10	<0.39	<0.57
	5-Apr-06	P1-B2-7		7	<0.20	<0.31	66	<0.12	0.18	3.6	<0.39	3.9
	5-Apr-06	P1-B2-10		10	<0.20	<0.31	195	<0.12	<0.10	11	<0.39	<0.57
	5-Apr-06	P1-B2-13		13	<0.20	<0.31	510	<0.12	<0.10	11	<0.39	<0.57
	5-Apr-06	P1-B2-16		16	<0.20	<0.31	644	<0.12	<0.10	10	<0.39	<0.57
	5-Apr-06	P1-B2-19		19	<0.20	<0.31	943	<0.12	<0.10	11	<0.39	<0.57
	5-Apr-06	P1-B2-22		22	<0.20	<0.31	100	<0.12	<0.10	1.3	<0.39	<0.57
	5-Apr-06	P1-B2-25		25	24	344	166	<0.12	<0.10	325	<0.39	<0.57
	5-Apr-06	P1-B2-28		28	38	554	243	<0.12	<0.10	414	<0.39	<0.57
	5-Apr-06	P1-B2-31		31	61	1197	323	<0.12	<0.10	339	<0.39	<0.57
P1B-3	5-Apr-06	P1-B3-1	12	1	<0.20	<0.31	13	<0.12	0.13	2.8	<0.39	<0.57
	5-Apr-06	P1-B3-4		4	<0.20	<0.31	15	<0.12	<0.10	2.9	<0.39	22
	5-Apr-06	P1-B3-7		7	<0.20	<0.31	58	<0.12	0.20	8.3	<0.39	19
	5-Apr-06	P1-B3-10		10	<0.20	<0.31	206	<0.12	<0.10	15	<0.39	3.5
	5-Apr-06	P1-B3-13		13	<0.20	<0.31	20	<0.12	<0.10	17	<0.39	20
	5-Apr-06	P1-B3-16		16	<0.20	<0.31	12	<0.12	<0.10	7.1	<0.39	12
	5-Apr-06	P1-B3-19		19	<0.20	<0.31	14	<0.12	<0.10	22	<0.39	7.6
	5-Apr-06	P1-B3-22		22	<0.20	<0.31	162	<0.12	<0.10	114	<0.39	<0.57
	5-Apr-06	P1-B3-25		25	<0.20	<0.31	105	<0.12	<0.10	76	<0.39	<0.57
	5-Apr-06	P1-B3-28		28	<0.20	<0.31	149	<0.12	<0.10	191	<0.39	<0.57
	5-Apr-06	P1-B3-31		31	<0.20	<0.31	181	<0.12	<0.10	388	2.4	23
P1B-4	5-Apr-06	P1-B4-1	16.7	1	<0.20	<0.31	2.8	<0.12	<0.10	1.2	<0.39	8.6
	5-Apr-06	P1-B4-4		4	<0.20	<0.31	2.8	<0.12	<0.10	3.0	<0.39	14
	5-Apr-06	P1-B4-7		7	<0.20	<0.31	2.5	<0.12	<0.10	1.6	<0.39	8.3
	5-Apr-06	P1-B4-10		10	<0.20	<0.31	4.8	<0.12	0.24	2.5	<0.39	3.9
	5-Apr-06	P1-B4-13		13	<0.20	<0.31	88	<0.12	0.32	17	<0.39	1.1
	5-Apr-06	P1-B4-16		16	0.20	<0.31	81	<0.12	0.47	115	<0.39	<0.57
	5-Apr-06	P1-B4-19		19	<0.20	<0.31	7.7	<0.12	<0.10	144	<0.39	<0.57
	5-Apr-06	P1-B4-22		22	<0.20	<0.31	4.8	<0.12	<0.10	177	<0.39	<0.57
	5-Apr-06	P1-B4-25		25	<0.20	<0.31	29	<0.12	<0.10	74	6.1	<0.57
	5-Apr-06	P1-B4-28		28	1.3	<0.31	26	<0.12	<0.10	124	<0.39	6.2
	5-Apr-06	P1-B4-31		31	0.47	<0.31	319	<0.12	<0.10	560	0.57	<0.57
PT-3	4/12/2006	PT-3-5	23	5	<0.20	1.3	536	<0.12	0.92	28	<0.39	<0.57
	4/12/2006	PT-3-10		10	<0.20	0.66	944	<0.12	1.0	54	1.0	<0.57
	4/12/2006	PT-3-15		15	23	944	179	<0.12	0.32	33	<0.39	<0.57
	4/12/2006	PT-3-20		20	0.31	8.4	982	<0.12	0.51	40	<0.39	<0.57
	4/12/2006	PT-3-25		25	<0.20	<0.31	410	<0.12	<0.10	157	<0.39	<0.57
	4/12/2006	PT-3-27		27	<0.20	<0.31	199	<0.12	<0.10	115	<0.39	<0.57
	4/12/2006	PT-3-28.5		28.5	<0.20	<0.31	180	<0.12	<0.10	121	<0.39	<0.57
MWA-70i	4/13/2006	MWA-70i-5	20	5	25	540	165	<0.12	0.94	30	<0.39	<0.57
	4/13/2006	MWA-70i-10		10	26	713	252	<0.12	0.53	46	<0.39	1.9
	4/13/2006	MWA-70i-15		15	<0.20	1.6	1011	<0.12	0.78	36	<0.39	<0.57
	4/13/2006	MWA-70i-20		20	0.68	48	58	<0.12	<0.10	19	0.61	<0.57
	4/13/2006	MWA-70i-25		25	0.54	16	38	<0.12	<0.10	22	<0.39	<0.57
	4/13/2006	MWA-70i-30		30	2.7	2.3	759	<0.12	<0.10	99	1.6	<0.57
	4/13/2006	MWA-70i-32.5		32.5	0.48	53	1263	<0.12	<0.10	38	0.48	<0.57
	4/13/2006	MWA-70i-35		35	<0.20	<0.31	1427	<0.12	<0.10	10	0.37	9.9
	4/13/2006	MWA-70i-37.5		37.5	<0.20	<0.31	876	<0.12	<0.10	1.1	<0.39	<0.57
	4/13/2006	MWA-70i-40		40	<0.20	<0.31	340	<0.12	<0.10	2.7	<0.39	<0.57
	4/13/2006	MWA-70i-42.5		42.5	<0.20	<0.31	57	<0.12	<0.10	1.6	<0.39	<0.57
	4/13/2006	MWA-70i-45		45	<0.20	<0.31	14	<0.12	<0.10	1.7	<0.39	<0.57

Notes:

[1] Approximated for P1B-1, P1B-2, P1B-3 and P1B-4 from borehole log soil descriptions and for PT-3 and MWA-70i from water level data collected before continuous pump tests on 19 and 24 April 2006

[2] Analyses by SiREM Laboratory, Guelph, ON, Canada (ion chromatography)

J - estimated value, compound detected at concentration below quantitation limit

< - non-detect, associated value is the quantitation limit

ft bgs - feet below ground surface

mg/kg - milligrams per kilogram; equivalent to milligrams per liter (mg/L) since soil extractions ratio 1:1 soil to water

TABLE 2
pH AND CONDUCTIVITY DATA FROM PHASE 1 VADOSE ZONE INVESTIGATION
Arkema Facility, Portland, Oregon

Sample Location	Date Collected	Sample ID	Depth to Water (ft bgs)[1]	Depth (ft bgs)	pH[2]	Conductivity (mS/cm)[2]
P1B-1	4-Apr-06	P1-B1-4	15	4	8.67	0.68
	4-Apr-06	P1-B1-7		7	8.46	0.23
	4-Apr-06	P1-B1-10		10	7.87	0.4
	4-Apr-06	P1-B1-13		13	8.11	0.66
	4-Apr-06	P1-B1-16		16	7.97	1.23
	4-Apr-06	P1-B1-19		19	7.92	3.96
	4-Apr-06	P1-B1-22		22	8.56	2.02
	4-Apr-06	P1-B1-25		25	10.53	1.8
	4-Apr-06	P1-B1-28		28	8.57	3.5
	4-Apr-06	P1-B1-31		31	6.01	2.29
P1B-2	5-Apr-06	P1-B2-1	13	1	7.38	5.31
	5-Apr-06	P1-B2-4		4	8.32	0.4
	5-Apr-06	P1-B2-7		7	8.33	0.35
	5-Apr-06	P1-B2-10		10	8.29	0.96
	5-Apr-06	P1-B2-13		13	8.15	1.88
	5-Apr-06	P1-B2-16		16	7.90	2.21
	5-Apr-06	P1-B2-19		19	8.76	3.12
	5-Apr-06	P1-B2-22		22	8.37	0.37
	5-Apr-06	P1-B2-25		25	4.72	1.68
	5-Apr-06	P1-B2-28		28	5.42	2.38
	5-Apr-06	P1-B2-31		31	5.39	3.05
P1B-3	5-Apr-06	P1-B3-1	12	1	9.46	0.94
	5-Apr-06	P1-B3-4		4	8.23	0.22
	5-Apr-06	P1-B3-7		7	8.46	0.44
	5-Apr-06	P1-B3-10		10	8.02	0.81
	5-Apr-06	P1-B3-13		13	8.61	0.36
	5-Apr-06	P1-B3-16		16	9.99	0.39
	5-Apr-06	P1-B3-19		19	8.79	0.23
	5-Apr-06	P1-B3-22		22	7.79	0.87
	5-Apr-06	P1-B3-25		25	7.41	0.65
	5-Apr-06	P1-B3-28		28	6.30	1.12
	5-Apr-06	P1-B3-31		31	6.92	2.09
P1B-4	5-Apr-06	P1-B4-1	16.7	1	8.05	0.04
	5-Apr-06	P1-B4-4		4	8.30	0.11
	5-Apr-06	P1-B4-7		7	8.10	0.06
	5-Apr-06	P1-B4-10		10	8.02	0.08
	5-Apr-06	P1-B4-13		13	7.53	0.4
	5-Apr-06	P1-B4-16		16	4.86	0.73
	5-Apr-06	P1-B4-19		19	3.49	0.51
	5-Apr-06	P1-B4-22		22	4.11	0.56
	5-Apr-06	P1-B4-25		25	7.01	0.59
	5-Apr-06	P1-B4-28		28	7.98	0.65
	5-Apr-06	P1-B4-31		31	6.26	2.57
PT-3	4/12/2006	PT-3-5	23	5	9.55	2.96
	4/12/2006	PT-3-10		10	10.19	3.46
	4/12/2006	PT-3-15		15	8.74	3.46
	4/12/2006	PT-3-20		20	7.90	3.38
	4/12/2006	PT-3-25		25	7.78	1.77
	4/12/2006	PT-3-27		27	7.88	1.01
	4/12/2006	PT-3-28.5		28.5	8.06	1.12
MWA-70i	4/13/2006	MWA-70i-5	20	5	10.11	2.06
	4/13/2006	MWA-70i-10		10	10.61	2.46
	4/13/2006	MWA-70i-15		15	10.43	2.33
	4/13/2006	MWA-70i-20		20	11.15	1.32
	4/13/2006	MWA-70i-25		25	11.00	1.29
	4/13/2006	MWA-70i-30		30	7.01	2.74
	4/13/2006	MWA-70i-32.5		32.5	6.16	4.24
	4/13/2006	MWA-70i-35		35	6.19	4.55
	4/13/2006	MWA-70i-37.5		37.5	4.92	2.72
	4/13/2006	MWA-70i-40		40	5.16	1.14
	4/13/2006	MWA-70i-42.5		42.5	6.39	0.29
	4/13/2006	MWA-70i-45		45	6.66	0.17

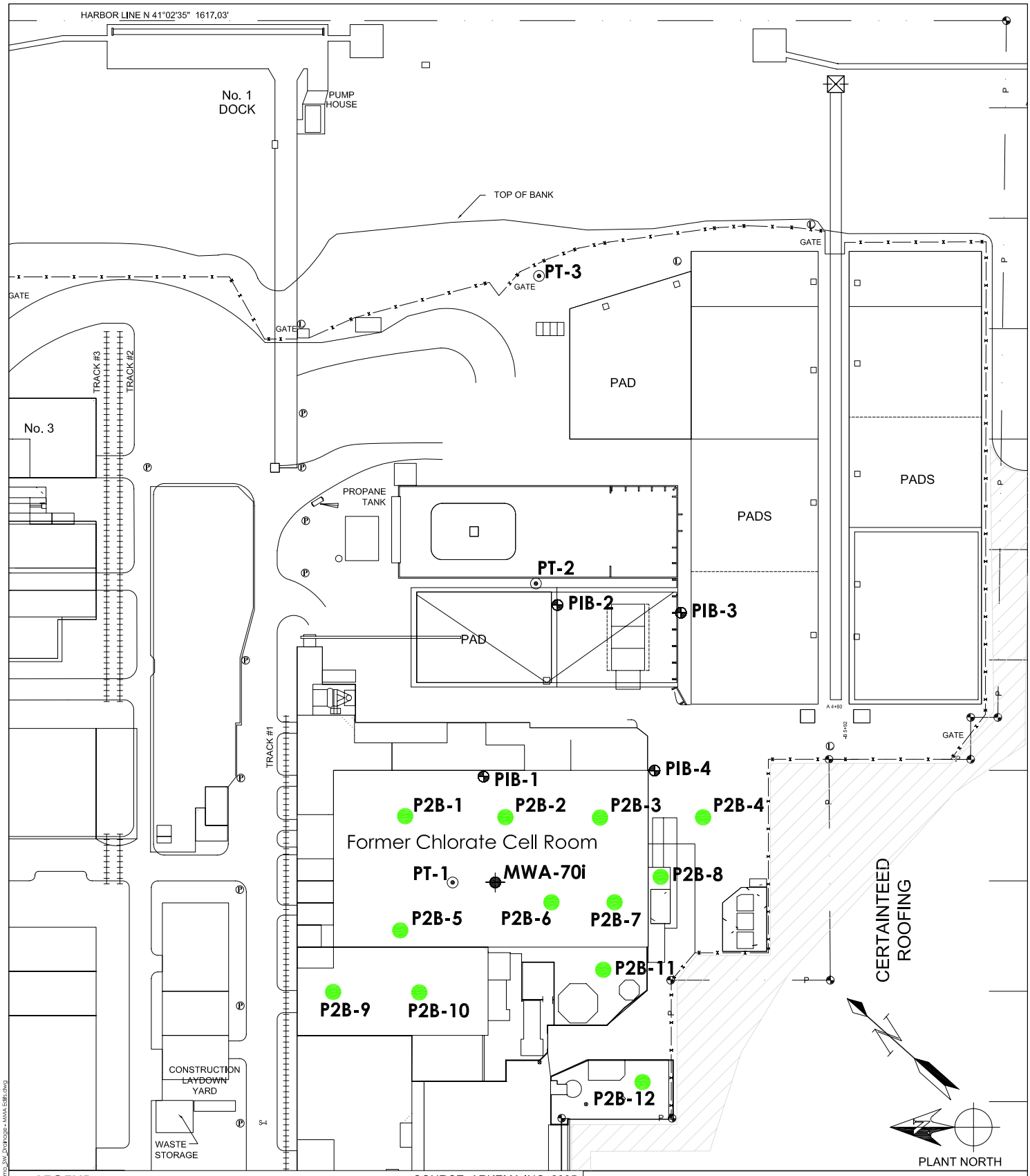
Notes:

[1] Approximated for P1B-1, P1B-2, P1B-3 and P1B-4 from borehole log soil descriptions and for PT-3 and MWA-70i from water level data collected before continuous pump tests on 19 and 24 April 2006

[2] Analyses by SiREM Laboratory, Guelph, ON, Canada

ft bgs - feet below ground surface

mS/cm - millisiemens per centimeter



SOURCE: ARKEMA INC. 2005

LEGEND

- LEGAL BOUNDARY, EASEMENT
- RAILROAD
- FENCE
- LIGHT POLE, POWER POLE
- NEW INTERMEDIATE DEPTH MONITORING WELL
- LOCATION OF PHASE I SOIL BOREHOLES OR MONITORING WELLS
- PROPOSED PHASE II SOIL BOREHOLE LOCATION
- NEW SHALLOW PUMP TEST WELL

0 100 200
Scale (ft)

Proposed Phase II
Vadose Zone Sampling Locations
Arkema Facility, Portland, Oregon

May 2006 | Figure: 1 | GeoSyntec Consultants

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