

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M13-98

DIST. 6 REGION

W.P. No. 88-78-20

CONT. No. 92-40

W. O. No.

STR. SITE No. 37-1328

HWY. No. 407

LOCATION Hwy 407 & Pine Valley Dr.

No of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

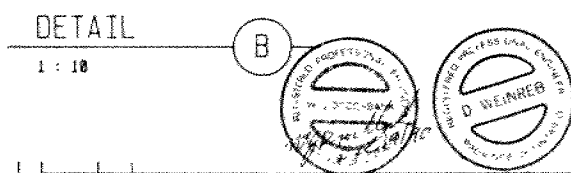
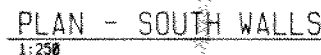


HWY 407 - PINE VALLEY DR.
UNDERPASS
REINFORCED EARTH WALLS
PLAN AND DETAILS

THE

NOTES:

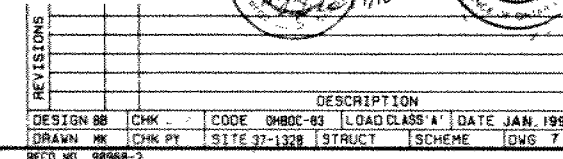
1. ALL DIMENSIONS ARE IN MILLIMETRES; ELEVATIONS ARE IN METRES.
2. ALL PANELS SHOWN ON ELEVATION DWGS ARE TYPE 'A'
UNLESS NOTED OTHERWISE.
3. ALL PANELS ARE 140 mm THICK.
4. ITEMS SUPPLIED BY 'REINFORCED EARTH COMPANY LTD':
- i) PRECAST CONCRETE PANELS AND ALL EMBEDDED HARDWARE
 - ii) GALVANIZED REINFORCING STRIPS
 - iii) GALVANIZED A325 BOLT ASSEMBLIES
 - iv) JOINT FILLER MATERIAL (IE: RUBBER PAOS AND FILTER FABRIC)
 - v) GALVANIZED TIE STRIPS FOR USE IN C.I.P. BARRIER WALL
 - vi) CONCRETE BACKING BLOCK
 - vii) TERRATREL PANELS & TIE STRIPS
5. WALL AREAS:
- | | |
|--------------------------|--------------------------------------|
| i) PRECAST CONCRETE WALL | 279.402 m ² (NORTH) |
| | 307.985 m ² (SOUTH) |
| | <hr/> 587.387 m ² (TOTAL) |
| ii) TERRATREL WALL | 93.000 m ² (NORTH) |
| | 93.000 m ² (SOUTH) |
| | <hr/> 186.000 m ² (TOTAL) |



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 26



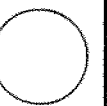
REC'D NO. 98358-2

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

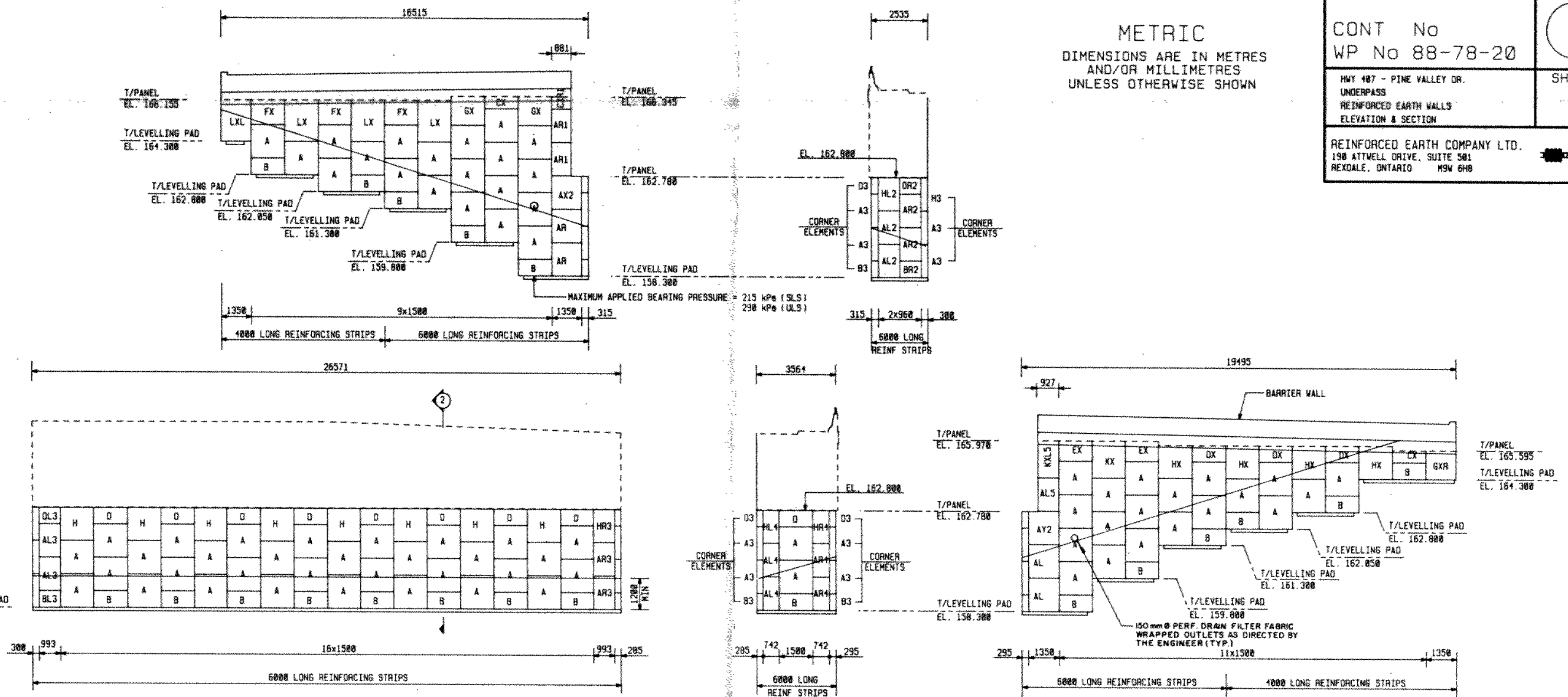
CONT No
WP No 88-78-20

HWY 487 - PINE VALLEY DR.
UNDERPASS
REINFORCED EARTH WALLS
ELEVATION & SECTION

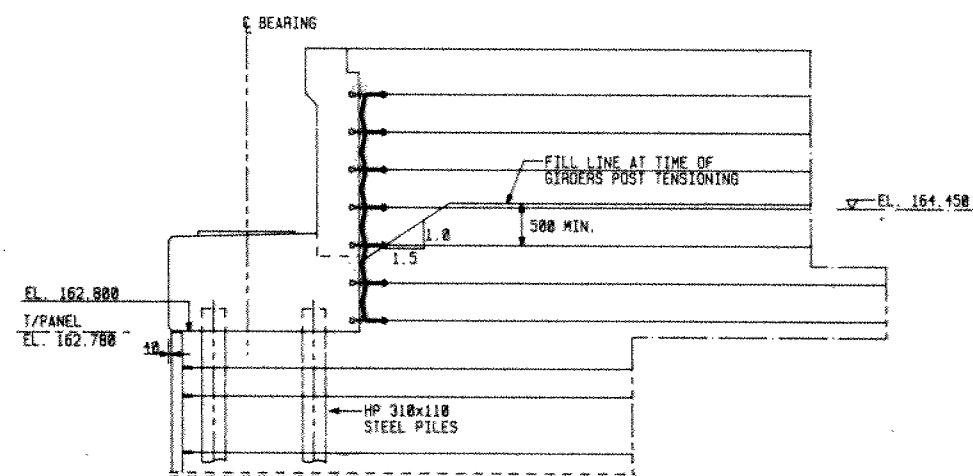
REINFORCED EARTH COMPANY LTD.
190 ATTWELL DRIVE, SUITE 501
HEXDALE, ONTARIO M9W 6H8



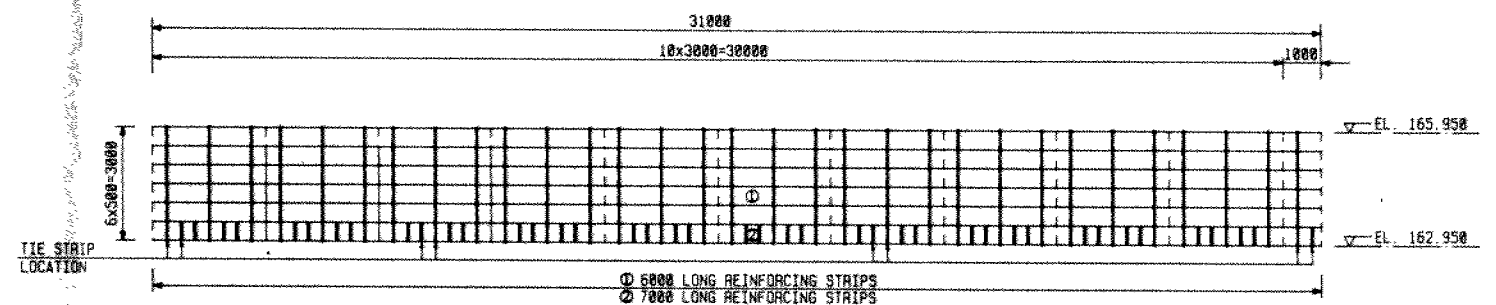
SHEET



FRONT FACE ELEVATION - SOUTH WALL
1:100



SECTION 2
1:50

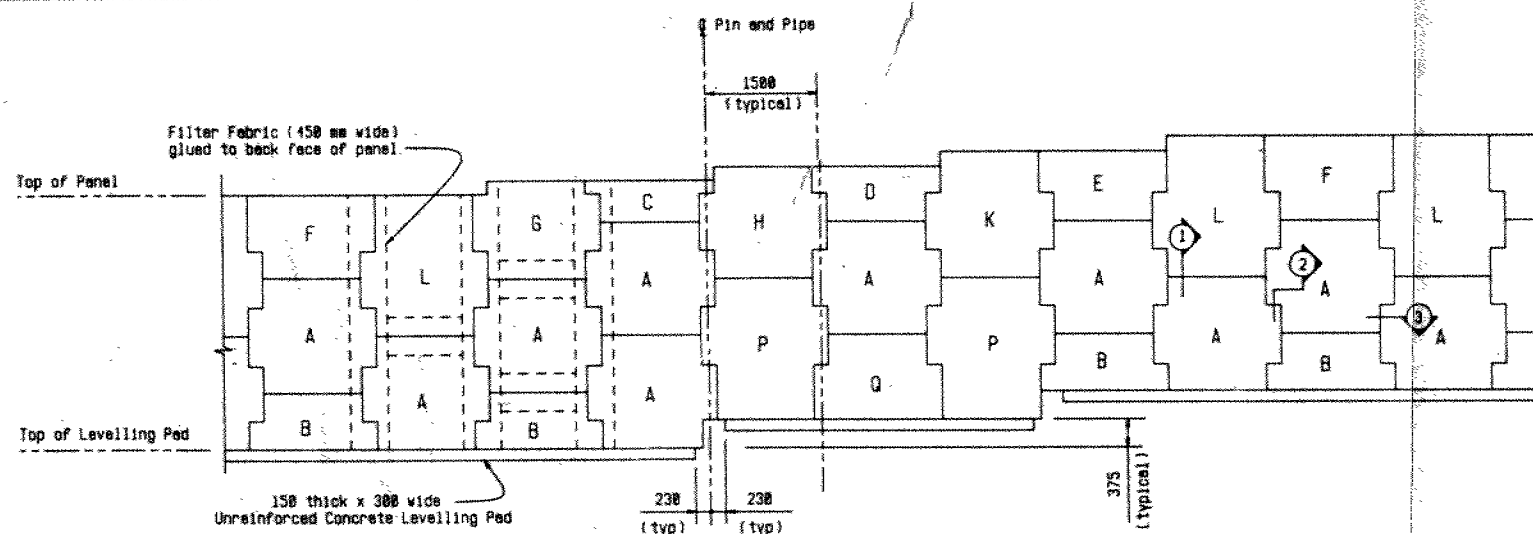


TERRATREL WALL - ELEVATION
1:100

THIS DRAWING CONTAINS INFORMATION PROPRIETARY TO REINFORCED EARTH COMPANY LTD. AND IS FURNISHED EXCLUSIVELY FOR THE USE OF MTO IN CONNECTION WITH THIS PROJECT. EXCEPT AS SPECIFICALLY AUTHORIZED IN WRITING BY REINFORCED EARTH COMPANY LTD., POSSESSION OF THIS DRAWING DOES NOT AUTHORIZE USE OF ITS CONTENTS FOR OTHER THAN THE EXPRESS PURPOSE FOR WHICH IT HAS BEEN PROVIDED NOR TRANSMISSION OF THIS DRAWING OR ITS CONTENTS TO THIRD PARTIES.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

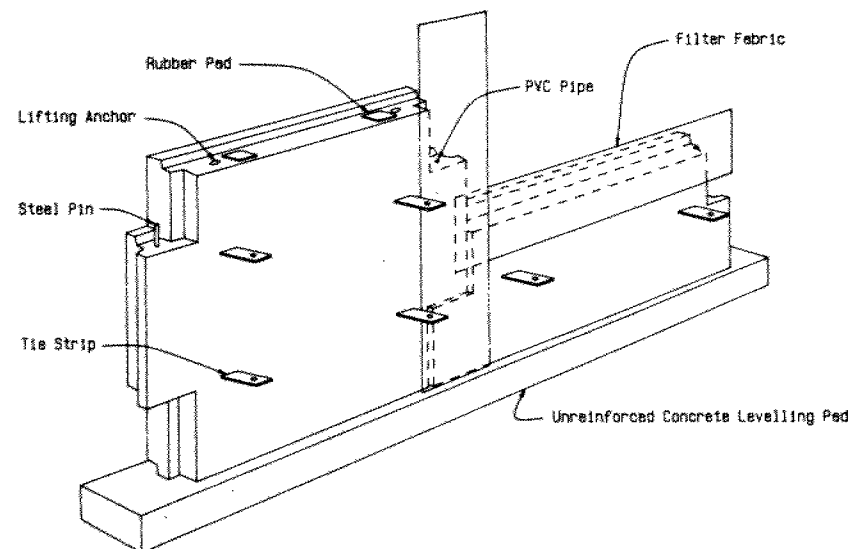
REVISIONS	DESIGN	CHK	CODE	DATE	DESCRIPTION
1	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
2	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
3	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
4	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
5	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
6	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
7	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
8	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
9	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991
10	88	CHK	0880C-83	19/90	LOAD CLASS A DATE JAN. 1991



Panel Type	A	B	C	D	E	F	G	H	K	L	P	Q
Effective Height (mm)	1500	750	545	730	920	1105	1295	1480	1670	1855	1855	1105

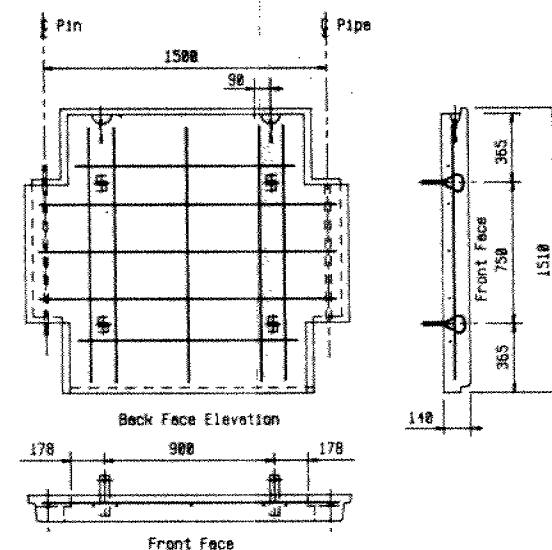
Typical Elevation (Front Face)

1 : 50



Typical General Arrangement

Not to scale

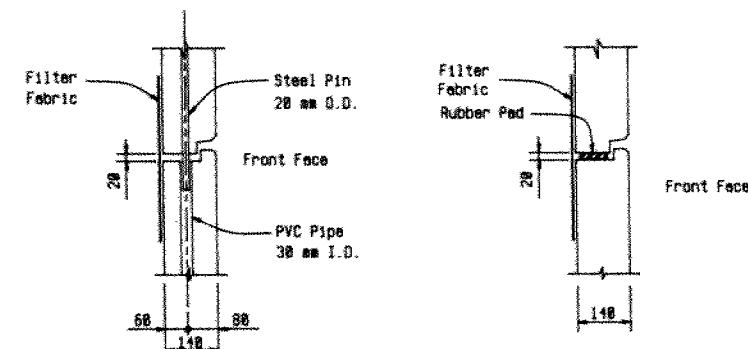


- Note: 1. Concrete compressive strength (f'_c) shall be 38 MPa at 28 days.
 2. Cover to reinforcement shall be 30 mm min.
 3. All reinforcing bars shown are 10M, $f_y = 400$ MPa, conforming to CSA 630.12-M1977.
 4. Clearance between reinforcing bars and galvanized tie strips shall be 30 mm minimum.

Typical Panel

1 : 20

METRIC
 DIMENSIONS ARE IN METRES
 AND/OR MILLIMETRES
 UNLESS OTHERWISE SHOWN

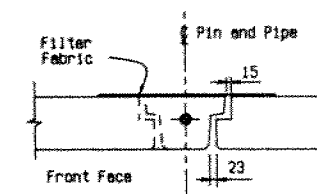


Section 2

1 : 10

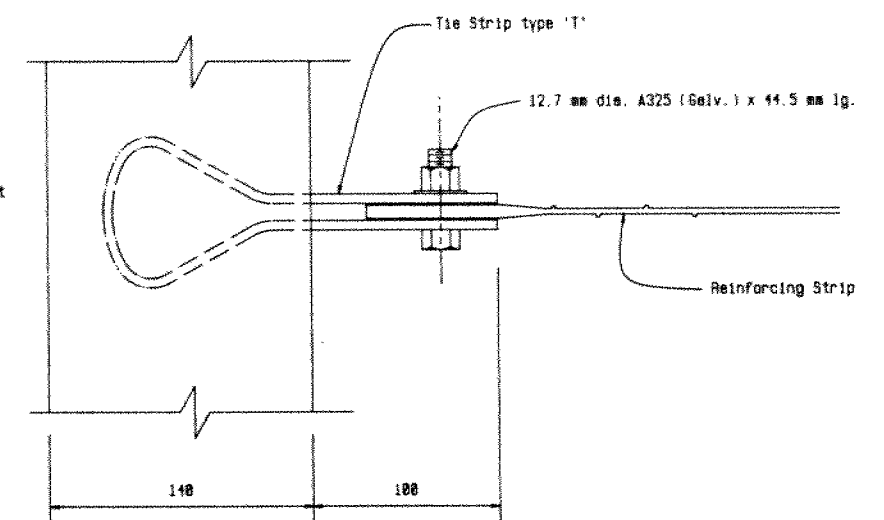
Section 1

1 : 10



Section 3

1 : 10



Tie Strip / Connection Detail

1 : 2

CONT No
 WP No 88-78-20

HWY 407 - PINE VALLEY DR.
 UNDERPASS
 REINFORCED EARTH WALLS
 TYPICAL DETAILS

REINFORCED EARTH COMPANY LTD.
 190 ATTWELL DRIVE, SUITE 501
 REXDALE, ONTARIO M9W 6H8

SHEET

THIS DRAWING CONTAINS INFORMATION PROPRIETARY TO REINFORCED EARTH COMPANY LTD. AND IS FURNISHED EXCLUSIVELY FOR THE USE OF MTD IN CONNECTION WITH THIS PROJECT. EXCEPT AS SPECIFICALLY AUTHORIZED IN WRITING BY REINFORCED EARTH COMPANY LTD., POSSESSION OF THIS DRAWING DOES NOT AUTHORIZE USE OF ITS CONTENTS FOR OTHER THAN THE EXPRESS PURPOSE FOR WHICH IT HAS BEEN PROVIDED NOR TRANSMISSION OF THIS DRAWING OR ITS CONTENTS TO THIRD PARTIES.

DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

REVISIONS	DESIGN	CHK	CODE	QMBD-93	LOAD CLASS 'A'	DATE	JAN. 1991
	DRAWN	HK	CHK	PY	SITE 37-1328	STRUCT	SCHEME
							QVG 9

REC'D NO. 98968-1

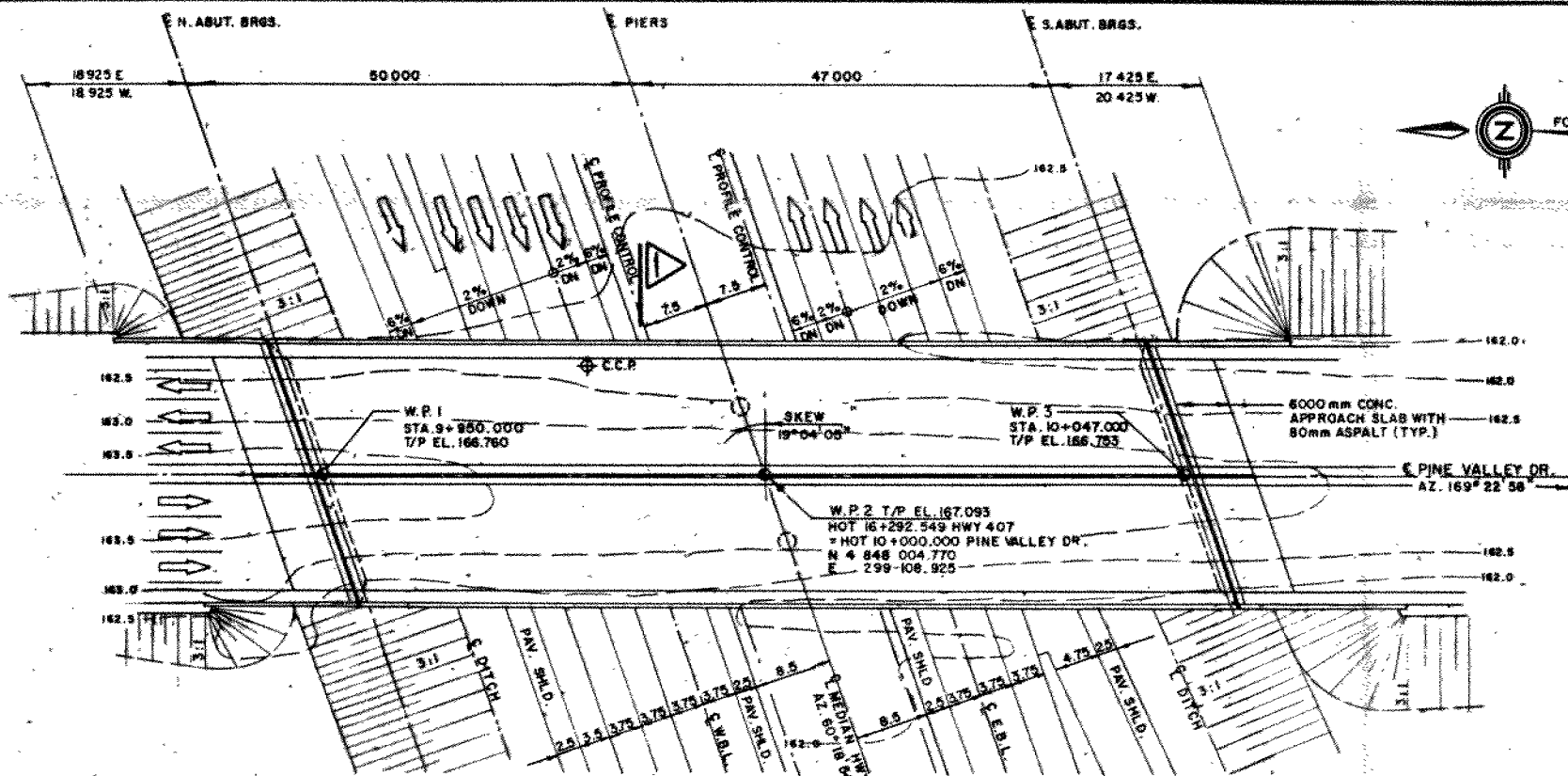
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST No 6
CONT No
WP No 88-78-20



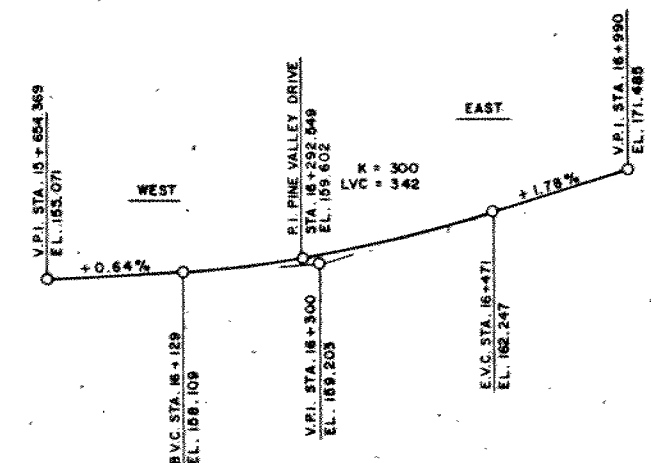
HWY 407-PINE VALLEY DR.
UNDERPASS
GENERAL ARRANGEMENT

Wyllie & Ufnal
consulting engineers

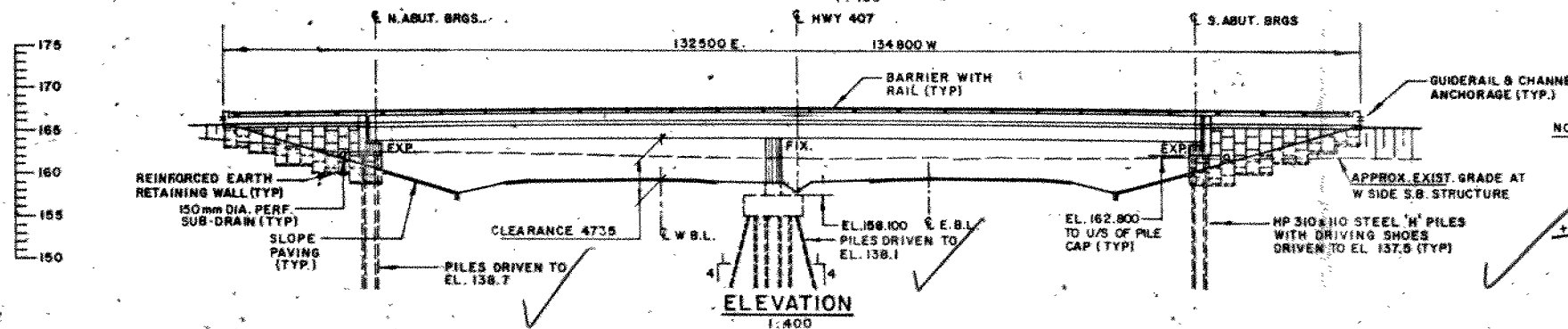


PLAN
1:400

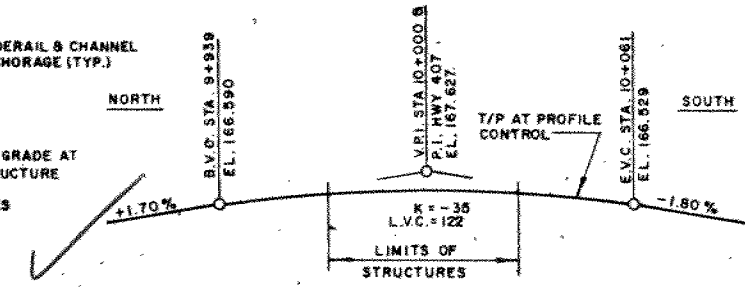
NOTES:
W.P. DENOTES WORKING POINT
T/P TOP OF PAVEMENT
C.C.P. CRITICAL CLEARANCE POINT



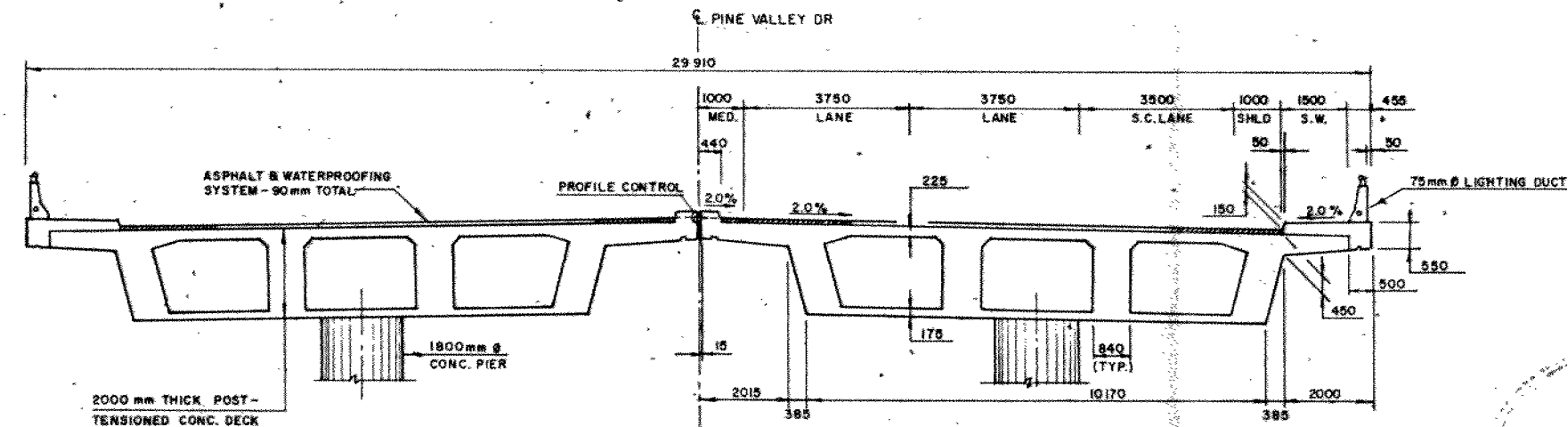
HWY 407 PROFILE
N.T.S.



ELEVATION
1:400



PROFILE - PINE VALLEY DRIVE
N.T.S.



DECK IS SYMMETRICAL
ABOUT C

BM. ELEV. 162.736
CC ON E.RIM OF B.M.
7.91 LT 10+053.3

GENERAL NOTES:

- CLASS OF CONCRETE**
 - PRESTRESSED DECK AND PIERS 35 MPa
 - REMAINDER 30 MPa
- CLEAR COVER TO REINFORCING STEEL**
 - FOOTINGS 100 ± 25
 - ABUTMENTS
 - FRONT FACE 80 ± 20
 - BACK FACE 70 ± 20
 - PIER 80 ± 20
 - DECK
 - TOP 70 ± 20
 - BOTTOM & SIDES 50 ± 10
 - REMAINDER 70 ± 20

UNLESS OTHERWISE NOTED
- REINFORCING STEEL**

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED. BAR MARKS WITH SUFFIX 'C' DENOTE COATED BARS.
- CONSTRUCTION NOTE**

IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

LIST OF DRAWINGS:

- GENERAL ARRANGEMENT
- BORE HOLE LOCATIONS AND SOIL STRATA
- FOOTING AND PILE LAYOUT
- NORTH ABUTMENT
- SOUTH ABUTMENT
- REINFORCED EARTH WALLS - PLAN & DETAILS
- REINFORCED EARTH WALLS - ELEVATION & SECTION
- REINFORCED EARTH WALLS - ELEVATION, SECTION & DETAILS
- REINFORCED EARTH WALLS - TYPICAL DETAILS
- PIER DETAILS
- DECK DETAILS
- TRANSVERSE TENDONS I
- TRANSVERSE TENDONS II
- LONGITUDINAL TENDONS
- DECK REINFORCING I
- DECK REINFORCING II
- DECK REINFORCING III
- BEARING DETAILS
- 6000 mm APPROACH SLAB
- BARRIER WALL ON SIDEWALK - NBL
- BARRIER WALL ON SIDEWALK - SBL
- BARRIER WALLS ON REINFORCED EARTH PANELS
- RAILING FOR BARRIER WALL - NBL
- RAILING FOR BARRIER WALL - SBL
- JOINT ANCHORAGE AND ANCHORING
- AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
- DETAILS OF CONC. SLOPE PAVING
- PILE DRIVING - STEAM AND DIESEL HAMMERS
- STANDARD DETAILS
- QUANTITIES I
- QUANTITIES II

APPLICABLE STANDARD DRAWINGS:
DD-3503 - MINIMUM GRANULAR BACKFILL REQUIREMENTS



REVISIONS	DATE	BY	DESCRIPTION
DESIGN J.C.S.	CHK T.Z.	CODE OHBDC-83	LOAD CL-A
DRAWN G.S.	CHK J.C.S.	SITE 37-1328	STRUCT
			SCHEME
			DWG. I

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 88-78-20

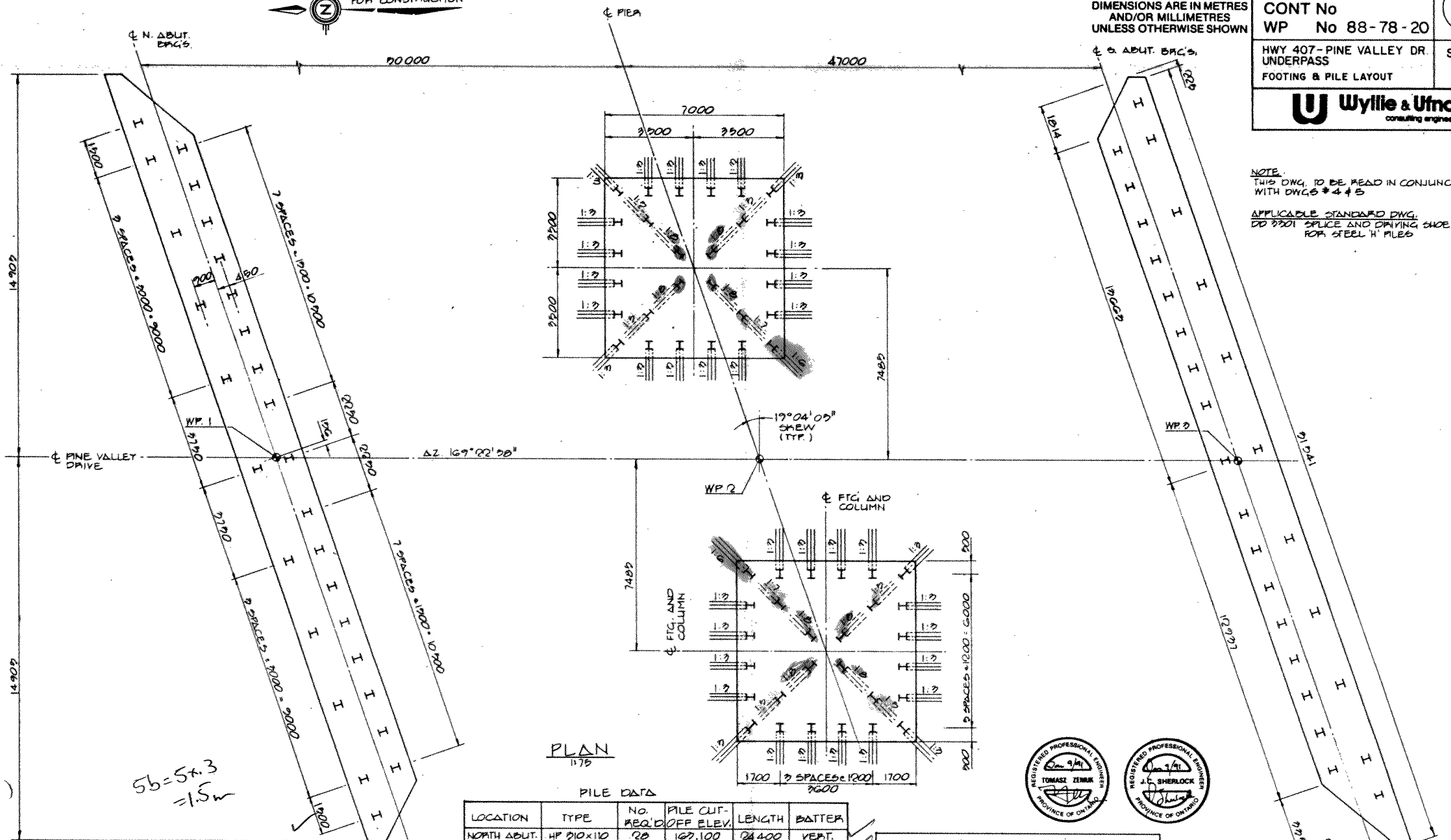
HWY 407-PINE VALLEY DR.
UNDERPASS
FOOTING & PILE LAYOUT

SHEET

Wyllie & Ufnal
consulting engineers

NOTE:
THIS DWG. TO BE READ IN CONJUNCTION
WITH DWGS #4 & 5

APPLICABLE STANDARD DWG.
DD 3301 SPICE AND DRIVING SHOE DETAILS
FOR STEEL 'H' PILES



PLAN
1/75

PILE DATA

LOCATION	TYPE	NO. REQ'D	PILE CUT-OFF ELEV.	LENGTH	BATTER
NORTH ABUT.	HP 310x110	28	167.100	24.400	VERT.
SOUTH ABUT.	HP 310x110	28	169.100	29.600	VERT.
EAST PIER	HP 310x110	19	156.200	19.079	1:3
		7	156.200	18.458	1:3
		1	156.200	18.290	1:3
		4	156.200	18.284	1:3
WEST PIER	HP 310x110	19	156.200	18.241	1:3
		7	156.200	18.668	1:3
		1	156.200	18.224	1:3
		4	156.200	18.082	1:3

PILE DESIGN DATA

LOCATION	BEARING CAPACITY c.d.s. TYPE II	FACTORED CAPACITY c.d.s.
ALL ABUT'S AND PIERS	1150 KN	1600 KN

PILE NOTES:

- PILE LAYOUT DIMENSIONS SIMILAR FOR ABUTMENT AND PIER FOOTING'S ACCORDINGLY
- PILE SPACING IS MEASURED AT THE UNDERSIDE OF FTG'S
- PILE LENGTHS SHOWN IN TABLE ARE THE THEORETICAL LENGTH BELOW CUT-OFF ELEV.
- ALL PILES SHALL HAVE DRIVING SHOES.
- PILES TO BE DRIVEN IN ACCORDANCE WITH STD. SS 102-10 OR SS 102-11 USING AN ULTIMATE CAPACITY OF 2450 KN PER PILE BUT NOT BELOW ELEV. SHOWN ON DWG. 1 WITHOUT APPROVAL OF THE ENGINEER.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN JCS	CHK TZ	CODE OHBC-83	LOAD CL-A
DRAWN ADG	CHK JCS	SITE 37-1328	STRUCT
			SCHEME
			DWG. 3

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 88-78-20 DIST 6
HWY 407 STR SITE 37-1328

Pine Valley Drive - Hwy. 407 Underpass

CONT. 92-40

DISTRIBUTION

V.F. Boehnke (3)
G. Cautillo
J. Cullen (2)
A. Wittenberg
K.G. Bassi
S.J. Dunham
G. Szekreny
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File ✓

FOUNDATION INVESTIGATION REPORT
For
Pine Valley Drive - Hwy. 407 Underpass
W.P. 88-78-20, Site No. 37-1328
Hwy. 407, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a four span structure that will carry Pine Valley Drive over the proposed Hwy. 407. A combination of approximately 4 metre excavation cuts in the native subsoil and up to 3 m of approach fills will be required to facilitate the overpass. The structural cross-section will require 6 lanes (including two ramps) and Pine Valley is to be revised from a two lane roadway to a four lane roadway.

This report describes the subsurface conditions encountered at the site and provides recommendations for the design and construction of the underpass structure and the related earthworks.

SITE DESCRIPTION AND GEOLOGY

The site is located approximately 0.5 km north of the Pine Valley-Steeles intersection south of Hwy. 7 in the Town of Vaughan, Regional Municipality of York. Pine Valley Drive is a two lane roadway bounded by 2-2.5 m unpaved shoulders and 5-6 m outer sodded drainage swales.

CNR tracks are present approximately 0.3 km south of the site running in a eastwest direction and supported on embankment fills approximately 7 m high. A rigid frame-steel girder structure carries the tracks over the existing Pine Valley Drive. A hydro corridor comprised of overhead transmission towers and cable also exists between the site and the existing CNR right-of-way.

The land surrounding the site is generally flat and consists of agricultural farmland, residential and industrial developments. The sector of land east and west of the site is agricultural farmland, whilst a residential development (approximately 10 years or younger) exists north of the site and just south of Hwy. 7, and industrial units are present just south of the CNR tracks.

Physiographically, the site lies in the geological region known as the Peel Plain in the Bolton Area. The Peel Plain is characterized by bevelled till plains interbedded with glaciofluvial silts, sands and gravels. The interbeds are indicative of various stages of glacial advances and retreats that occurred during the Wisconsin glacialation of the Pleistocene epoch.

The Wildfield till deposit is the youngest till in the Bolton area. Although not encountered at the site, in some regions, the Wildfield till is overlapped by younger deposits of deltaic and lacustrine origin. The Wildfield till overlies the Halton Till, usually separated by varying thickness of stratified silts and sands.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation.

FIELD INVESTIGATION

The fieldwork for the investigation was carried out between 89 11 28 and 89 12 13 and consisted of a total of 7 sampled boreholes advanced to depths ranging from 9.6 m to 31.3 m accompanied by 5 dynamic cone penetration tests advanced to depths ranging from 2.1 m to 12.7 m. The boreholes were advanced at the proposed structure foundation locations and corresponding Hwy. 407 approach cut locations.

Conventional hollow stem augering techniques were used to advance the boreholes for the majority of the investigation. Rock coring methods, including the installation of NW casing and a standard NQ core barrel was used to advance the borehole through the boulders that exist at various depths in the stratigraphy. A track mounted CME 55 and CME 75 were both used to advance the boreholes at the site.

In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 5 to 6 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586).

All subsoil samples and rock core were identified in the field and returned to the laboratory for further examination and applicable testing.

Groundwater levels were obtained throughout the duration of the investigation in the open boreholes. All boreholes were backfilled at the completion of the fieldwork.

Survey information related to location and elevation of boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and pertinent properties of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limit
- 2) Grain Size Distribution
- 3) Unit Weights
- 4) Natural Moisture Contents

Laboratory test results have been summarized in the subsequent section of this report and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The general subsurface profile across the site consists of interbedded glacial till and glaciofluvial deposits. Surficially, a till deposit consisting of a clayey silt matrix with some sand and trace of gravel exists. This deposit extends to a maximum thickness of 9.2 m and is generally of stiff consistency.

The surficial cohesive till deposit is underlain by a cohesionless silt with some sand deposit. This stratum extends to a maximum thickness of 4.1 m and is water bearing and generally in a compact state of condition.

A second till deposit composed of a heterogeneous mixture of clayey silt, sand and gravel is found underlying the cohesionless silt deposit. The thickness of this deposit ranges from 9.1 m to 13.6 m. Random modules of silt are also present in this deposit. The deposit is generally of very stiff to hard consistency.

The lower till deposit is in turn underlain by a second glaciofluvial deposit consisting of a silt matrix with traces of sand and gravel and random boulders intermixed in the host matrix. The deposit is generally very dense and was explored to a maximum thickness of 9.6 m.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole Sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 887820-A.

A detailed description of the subsurface conditions encountered is given below.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till - Upper)

The native surficial deposit present at the site consists of a heterogeneous mixture of clayey silt, sand and gravel. The main component of the deposit is the clayey silt matrix that exhibits a cohesive behaviour. Occasional random interbedded sand seams approximately 25 to 50 mm in thickness are also present within the deposit. Traces of organics also exist within the surficial one metre of the deposit.

The thickness of the deposit explored in the investigation ranges from 3.7 m to 9.2 m, with the shallower thickness present in the approach area east of the proposed structure. The deposit is generally oxidized (brown) for the surficial 3 to 4 m and unoxidized (grey) in its lower depths.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 1. The envelope illustrates

that clay and silt percentages in the deposit range from 26-40% and 38-53% respectively. Some sand and traces of gravel are also present in the deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1. Unit weights are also included.

Table 1 - Soil Properties (Upper Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	13-18	6
Liquid Limit (w_L %)	24-35	6
Plasticity Index (I_p %)	11-18	6
Unit Weight (kN/m^3)	19.8-22.8	5

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt. At random zones within the deposit, the soil behaves as a plastic silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 5 blows/0.3 m to 38 blows/0.3 m. In general, 'N' values were in the range of 15 blows/0.3 m to 25 blows/0.3 m for the surficial 3 to 3.5 m indicative of the desiccated very stiff upper crust of the deposit. However, 'N' values were significantly lower in the lower depths of the deposit, typically in the 5 blows/0.3 m to 15 blows/0.3 m range, representative of a firm to stiff consistency.

Silt, some Sand

Underlying the surficial deposit at the site, a stratum of silt with some sand exists. Random sand seams are also present in this deposit. A grain size distribution envelope illustrating the gradation of this stratum is provided in Figure 3 in the Appendix. A grain size distribution curve illustrating an interbedded sand seam is also included in the figure.

The stratum surface exists at an elevation ranging from 160.9 m to 152.4 m and extends for a thickness ranging from 2.1 m to 4.1 m. This cohesionless deposit is water bearing and consequently soil cave-in occurred in the open borehole when the stratum was penetrated due to unbalanced hydrostatic head.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 32 blows/0.3 m. However, the lower values may be attributed to increased sample disturbance induced by unbalanced hydrostatic head. In view of this, the stratum can be categorized as compact.

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till - Lower)

Underlying the silt deposit at a depth ranging from 9.2 m to 12.2 m, or equivalently elevation 153.7 m to 149.4 m, a second till deposit exists consisting of a heterogeneous mixture of clayey silt, sand and gravel. Random zones and modules of silt are also present in this deposit. The deposit extends for a depth ranging from 7.6 m to 15 m.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 4. The envelope illustrates that clay and silt percentages in the deposit range from 17-45% and 49-53% respectively. Some sand and gravel is also present in the deposit.

Atterberg Limit tests were also carried out to define the behaviour and plasticity of the soil. The results are plotted on Figure 5 and a summary of the indices is provided in Table 2.

Table 2 - Soil Properties (Lower Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	11-23	4
Liquid Limit (w _L %)	19-35	5
Plasticity Index (I _p %)	7-21	5
Unit Weight (kN/m ³)	20.9-22.6	3

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt. At random zones within the deposit, the soil behaves as a plastic silt.

Standard Penetration tests carried out in this stratum revealed 'N' values ranging from 16 blows/0.3 m to 120 blows/.08 m. Average 'N' values are in the 35-45 blows/0.3 m throughout the deposit indicating a hard consistency.

Silt

The lower till deposit is underlain by a cohesionless silt deposit that contains some sand and traces of gravel. This stratum also contains random boulders and cobbles suspended in the silt matrix. Rock coring techniques were required to penetrate some of the boulders. The depth to the deposit varies from 24.2 to 25.8 m (El. 138.7 m to 136.3 m) at the proposed north abutment and north pier to 19.8-21.3 m at the centre pier to south abutment locations (El. 140.9 m to 142.7 m). The maximum thickness of the deposit investigated was 9.6 m. The extent of the deposit was not determined in the investigation.

A grain size distribution envelope illustrating the gradation of this stratum is provided in Figure 6 in the Appendix. A grain size distribution curve illustrating the gradation of an interbedded sand seam is also illustrated in the figure.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 28 blows/0.3 m to 120 blows/0.08 m. Although some of the higher 'N' values may be as a result of the larger gravel and boulder sizes, the silt material itself is in a very dense state of condition.

Groundwater Conditions

The groundwater table as obtained by monitoring the water levels in the open boreholes at the time of the investigation varied from elevation 158.1 m to 160.9 m or depths ranging from 3.0 m to 4.6 m below the natural ground surface.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a 4-span Hwy. 407 underpass at Pine Valley Drive. The four spans, a 21 m north span, 37.75 m and 34 m centre spans and a 20.5 m south end span will facilitate the advancement of the proposed Hwy. 407. The structural cross section will require 6 lanes (including two ramps) and two sidewalks.

The proposed profile grade of Hwy. 407 at the proposed structure location is approximately elevation 159.5 m with perimeter drainage swales planned at elevation 158 m. The existing natural ground surface at the site is approximately at elevation 161.5 m to 163.0 m. Consequently, excavation cuts up to 5.0 m will be required along the Hwy. 407. In addition, the proposed profile grade of Pine Valley Drive is approximately at elevation 166.0 m. Hence, up to 3 m of approach fills will be required superimposed on the proposed Hwy. 407 excavation cut.

A 900 mm storm sewer is also proposed in conjunction with the Hwy. 407 advancement. The storm sewer will run roughly parallel to the highway located beneath the north shoulder of the Hwy. 407 westbound lanes. The proposed invert elevation of the storm sewer is 156.7 m.

Recommendations pertaining to the following geotechnical considerations for the design and construction of the Hwy. 407-Pine Valley Drive underpass are included in the scope of this report.

1. Structure Foundations
2. Slope Stability
3. Lateral Earth Pressures on Structure

1. STRUCTURE FOUNDATIONS

In view of the inadequate soil bearing capacity suitable for an economical shallow foundation at the site, it is recommended that all foundations be founded on end-bearing deep foundations within the lower silt deposit. Two types of end bearing deep foundations that are recommended are:

- (1) Driven Steel H-Piles
- (2) Drilled Concrete Caissons

The alternative that proves to be most economical and technically feasible shall be selected for design.

(1) Driven Steel H-Piles

The structure foundations can be founded on steel H-piles driven to the lower silt deposit. For purposes of the O.H.B.D.C., the design axial capacities for vertical piles are given in Table 3 below.

Table 3 - Axial Capacities - Driven Steel H-Piles

<u>Pile Type</u>	<u>Structure</u>	<u>Factored Capacity at U.L.S. (kN)</u>	<u>Bearing Capacity at S.L.S. Type II (kN)</u>	<u>Estimated Pile Tip El. (m)</u>
HP310x110	N. Abutment	1600	1150	138.7±
	N. Pier (#1)	1600	1150	134.7±
	Centre Pier (#2)	1600	1150	138.1±
	S. Pier (#3)	1600	1150	137.2±
	S. Abutment	1600	1150	137.5±
HP310x79	N. Abutment	1150	890	138.7±
	N. Pier (#1)	1150	890	134.7±
	Centre Pier (#2)	1150	890	138.1±
	S. Pier (#3)	1150	890	137.2±
	s. Abutment	1150	890	137.5±

Reductions of axial capacities for inclined loadings shall conform to factors provided in Section 6.8.3.4.3 of the O.H.B.D.C.

The founding pile tip elevations are generally uniform except at the proposed north pier location where the end bearing material was found at a lower elevation. In addition, although attempts should be made in all cases to drive the piles to the estimated pile tip elevation, some piles may terminate in boulders and cobbles suspended in the silt matrix above these elevations. Consequently, to ensure adequate seating of the piles, pile driving shall be carefully monitored and controlled by employing the Hiley Dynamic Pile Driving Formula driven in accordance with MTO Standards SS103-10 or SS103-11 assuming an ultimate capacity as tabulated in Table 4 below.

Table 4 - Ultimate Capacity Employing
Hiley Dynamic Formula

<u>Pile Type</u>	<u>Ultimate Capacity (kN)</u>
HP310x79	2670
HP310x110	3450

It is further recommended that steel H-piles be equipped with reinforced tips to facilitate pile penetration.

In view of the silty composition of the end bearing stratum, a temporary reduction in pore pressure and a corresponding increase in driving resistance will result because of soil dilation caused by driving. Where these factors are significant, a reduction in the bearing capacity may result with time. Consequently, it is essential that the piles be subject to a redriving test no earlier than seven days following initial installation to verify the pile capacity.

Pile spacing shall conform with Section 6.8.3.10 of the O.H.B.D.C. Adjacent piles should be checked for heaving during pile installation. For centrally loaded piles equal load sharing on the deep foundation units can be assumed. The design of eccentric loaded deep foundation units shall comply with Section 6.8.3.4.2 of the O.H.B.D.C.

The lateral resistance for both vertical and battered piles shall be computed in accordance with Section 6.8.3.8 of the O.H.B.D.C.

Drilled Concrete Caissons

Alternatively, structure foundations can be founded on end bearing reinforced concrete caissons installed in drilled shafts to the lower silt deposit. For purposes of the O.H.B.D.C. the following design values are recommended.

Table 5 - Axial Capacities - Concrete Caissons

Caisson Diameter		Factored Capacity at U.L.S.	Bearing Capacity at S.L.S. Type II	Pile Tip Elevation
(m)	Structure	(kN)	(kN)	(m)
0.76	N. Abutment	2250	1500	138.7±
	N. Pier (#1)	2250	1500	134.7±
	Centre Pier (#2)	2250	1500	138.1±
	S. Pier (#3)	2250	1500	137.2±
	S. Abutment	2250	1500	137.5±

Capacities for other caisson diameters can be obtained in proportion to the respective end bearing areas.

Resistance to lateral load shall be computed in accordance with Section 6.8.3.8 of the O.H.B.D.C.

The proposed method of caisson installation shall be based in accordance with OPSS 903.07.03 and subject to review by this office. In view of the water bearing upper silt deposit, precautions must be planned to protect the shaft of the preaugered holes against caving during the installation through this stratum. One method of achieving this is by installing a temporary steel liner and constructing the caisson within the steel liner. After the liner has been cleaned out and the required reinforcing installed, the concrete should be placed in the dry. An overzealous rapid withdrawal of the temporary casing should be avoided to prevent the intrusion of soil in the concrete (necking). Conversely, the temporary liner should not be allowed to get stuck in partial set concrete.

Alternatively, mud drilling and tremie techniques may be employed. The quality of the bentonite slurry (density, viscosity) should be kept under constant control to ensure that it performs satisfactorily.

Frost Protection and Dewatering

All pile caps shall be protected against frost protection by providing a minimum 1.2 m of earth cover. No dewatering problems are anticipated for the construction of pile caps within the surficial cohesive till deposit. Any localized seepage can be readily discharged using conventional sump pumping techniques. Although it not anticipated that the pier pile cap construction will intercept the water bearing silt deposit underlying the surficial till deposit, this office should be contacted for dewatering recommendations should the pile cap construction be anticipated below Elevation 155 m.

Consideration can also be given to perching the abutment pile caps within the embankment fill provided that adequate frost protection cover is given and that particle sizes in the fill immediately beneath the pile locations does not exceed 75 mm. The latter specification is required to avoid pile driving impediment.

2. SLOPE STABILITY

General

The critical condition examined in the evaluation of excavation cuts such as that proposed at the site location is the long term (drained) condition and consequently an effective stress analysis was implemented. Stability computations were carried out using Bishop's method on an in-house mainframe program employing static loading conditions and incorporating a factor of safety of 1.3. The properties of the approach fill material and subsoil and the geometries selected for the Pine Valley Drive approach and the Hwy. 407 cut is shown in Figure 7 in the Appendix.

Drained stability analyses of the slopes are very sensitive to groundwater levels and pore pressures that can develop in the slope. Therefore slope protection and drainage measures will be required to ensure their long-term surficial stability. By employing a 1.2 m thick granular blanket consisting of free draining material such as Granular 'A' material, softening of material due to freeze-thaw cycles and development of excess pore water pressures can be prevented. Inabilities to control these parameters usually result in surficial slope failures.

The granular blankets should be designed in conjunction with a permanent drainage system that will discharge drained water from the slope. It is recommended that toe drains be constructed consisting of a perforated pipe encased with a suitable geotextile filter fabric and in turn surrounded by a suitable granular soil filter material. The toe drains should then be connected to an appropriate integrated drainage system. At the site, the toe drains can be constructed in conjunction with the highway perimeter drainage system.

Normal slope vegetation cover should be established as soon as possible after completion of the excavation cut to control surficial erosion.

Hwy. 407 Approach Cut

Excavation cuts in the order of magnitude of 4 to 5 m primarily in the surficial cohesive clayey silt till deposit will be required in the advancement of Hwy. 407 at the structure foundation location and immediate approaches. The Hwy. 407 profile grade increases in elevation east of the structure and eventually coincides with the existing ground surface. On the other hand, deeper excavation cuts are required to facilitate the highway advancement west of the structure. Stability analyses for excavation cuts exceeding 4 m in depth west of the proposed Pine Valley Drive structure are included in a separate report (WP141-87-00A).

The results of stability analysis indicate the proposed excavation can be advanced at 2H:1V slopes provided that the aforementioned slope surface

treatment is applied, and the Pine Valley Drive approach fills are constructed as recommended below.

Pine Valley Drive Approach Fills

Approaches at Pine Valley Drive will require the placement of up to 3 m of fill material at the surface of the Hwy. 407 excavation cut slope. Based on the results of the stability analysis, it is recommended that the toe of the forward slope approach fill be "benched" a distance of 3.0 m from the crest of the Hwy. 407 excavated slope (see Figure 7 in the Appendix).

Transverse slopes for the approach fills can be constructed at 2H:1V. Any local softened and/or surficial organic soil should be removed within the plan limits of the fill prior to its placement. The fills should be placed and compacted according to MTO Specifications and Standards (OPSS 501). Settlements induced by the fill placement are expected to be negligible.

3. LATERAL EARTH PRESSURES ON STRUCTURE

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up. Design parameters of the soil are given below:

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction (ϕ)	35°	30°
Unit Weight (kN/m ³)	22.8	21.2
Coefficient of Active Earth Pressure (K_a)*	0.27	0.33
Coefficient of Earth Pressure at Rest (K_0)*	0.43	0.5

*Horizontal backfill only.

The earth pressure coefficient at rest is to be used in design if the abutment walls are rigid and unyielding. The tabulated earth pressure coefficients are

applicable to horizontal surfaces only. These values must be modified to represent sloping surfaces. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano and Pamela Marks, Foundation Engineers, and B. Cung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Longyear Drilling.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.



A handwritten signature in cursive script, reading "T. Sangiuliano".

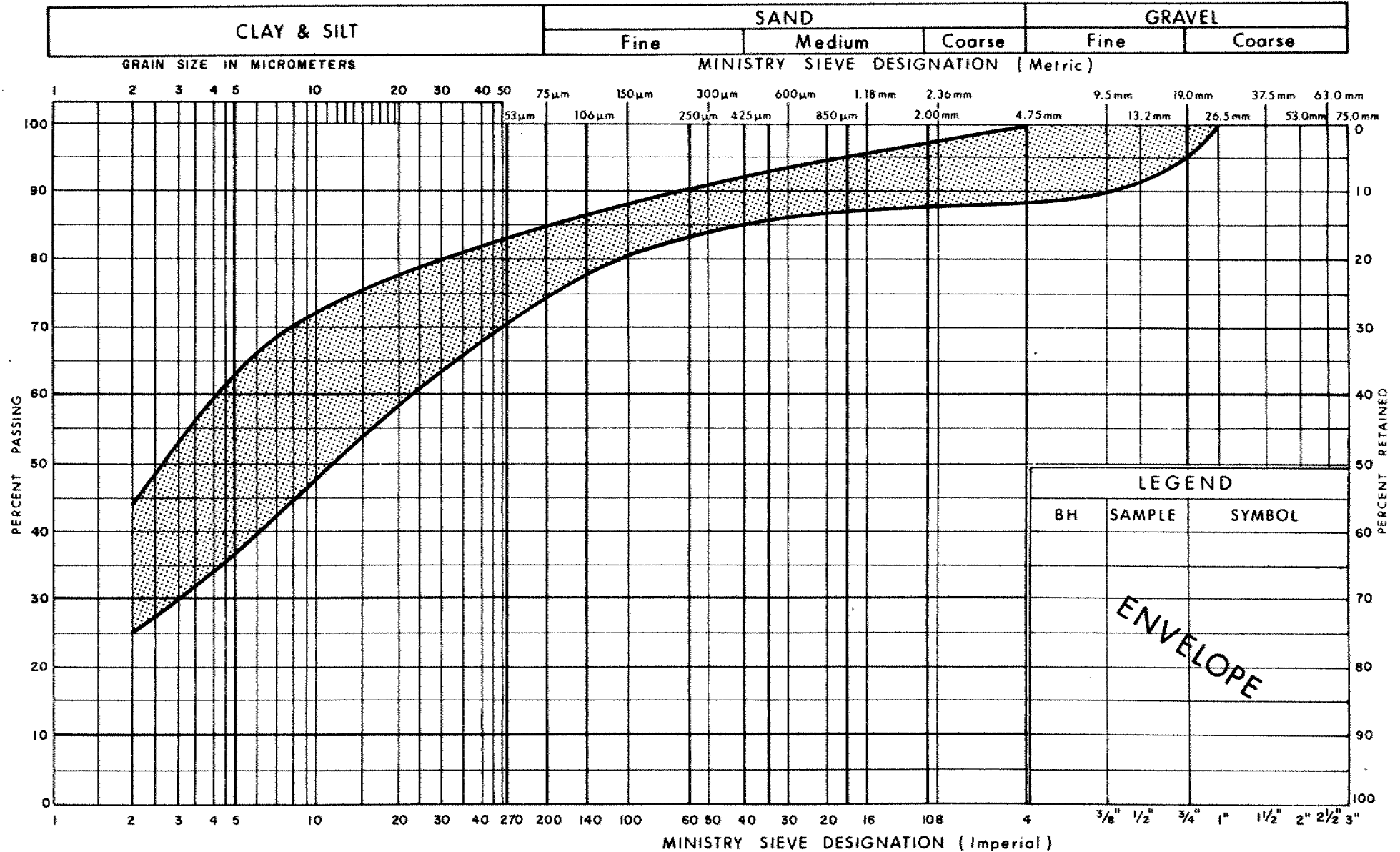
T. Sangiuliano, P.Eng.
Foundation Engineer

A handwritten signature in cursive script, reading "M.S. Devata".

M.S. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

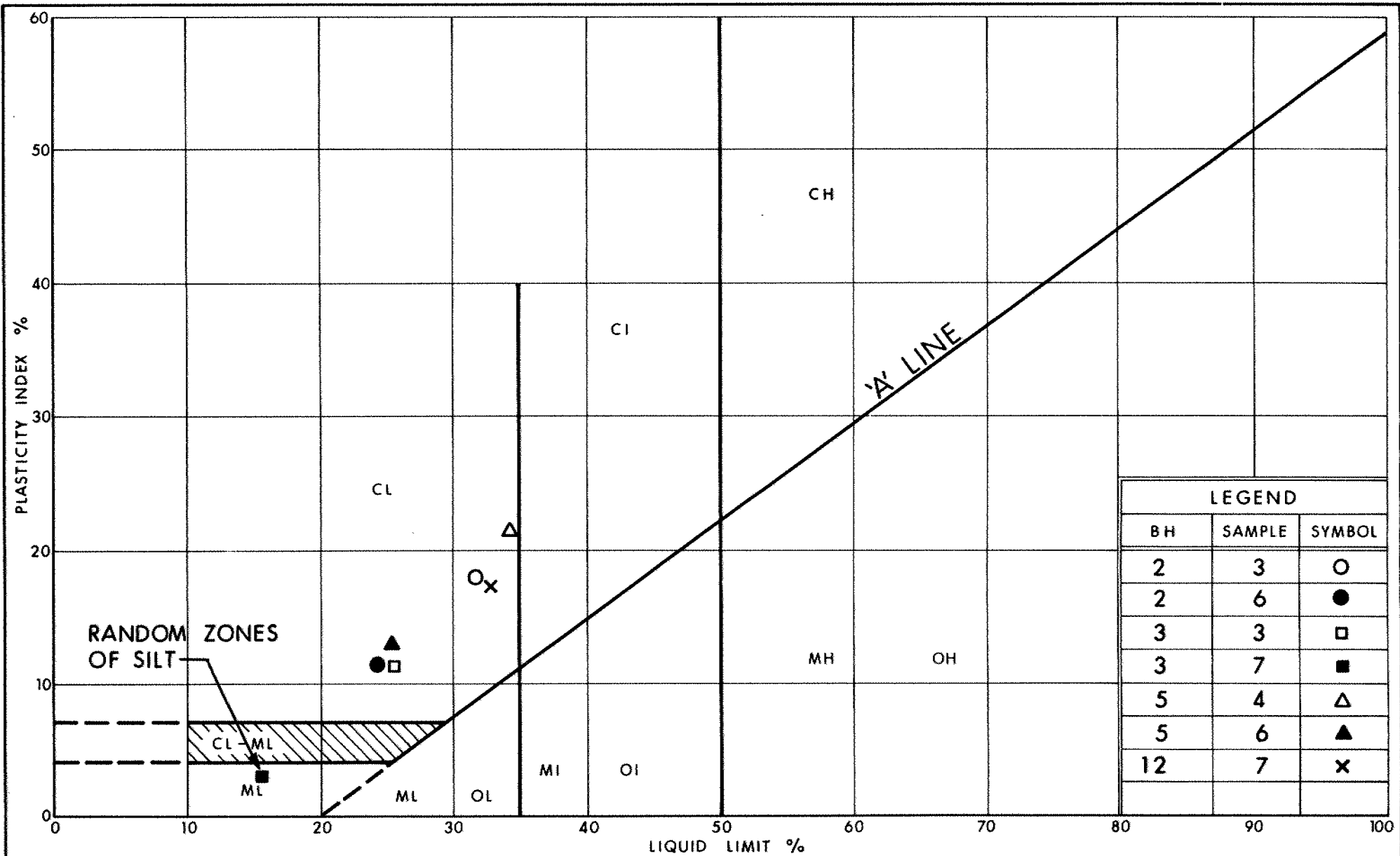


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Upper)

FIG No 1

W P 88-78-20



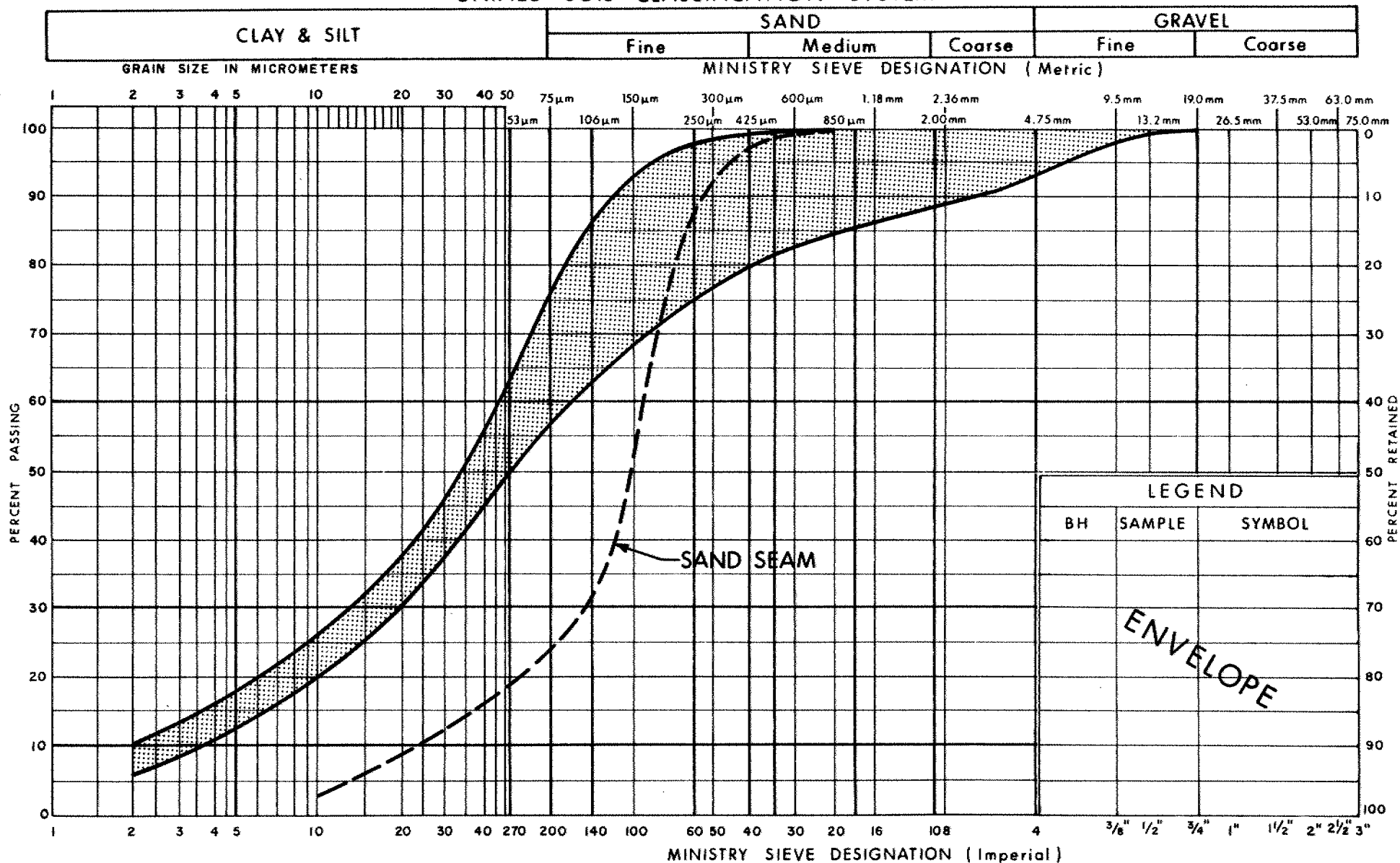
Ministry of
Transportation

PLASTICITY CHART HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL (Glacial Till) (Upper)

FIG No 2

W P 88-78-20

UNIFIED SOIL CLASSIFICATION SYSTEM



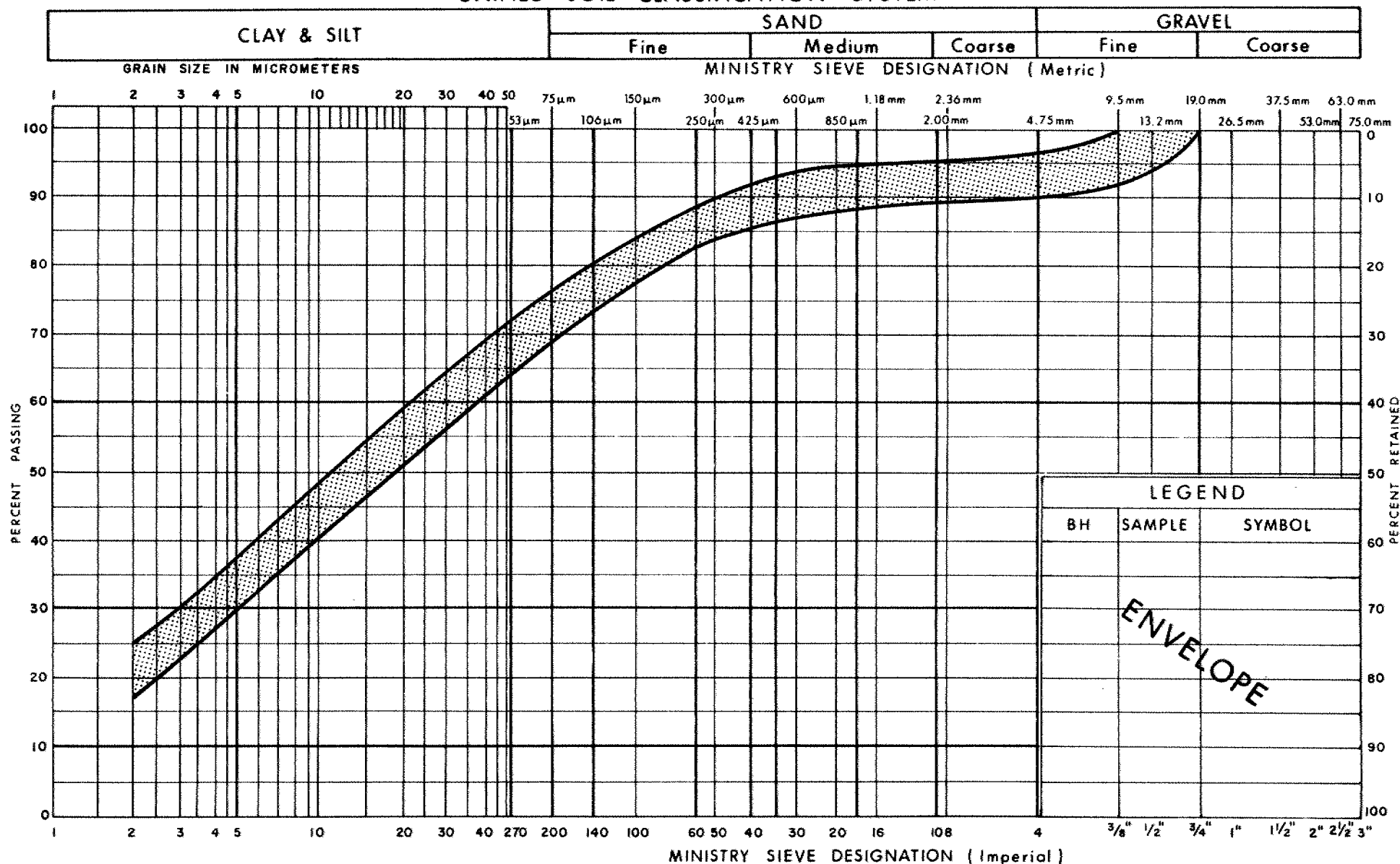
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, SOME SAND, OCC SAND SEAMS
(Upper)

FIG No 3

W P 88-78-20

UNIFIED SOIL CLASSIFICATION SYSTEM

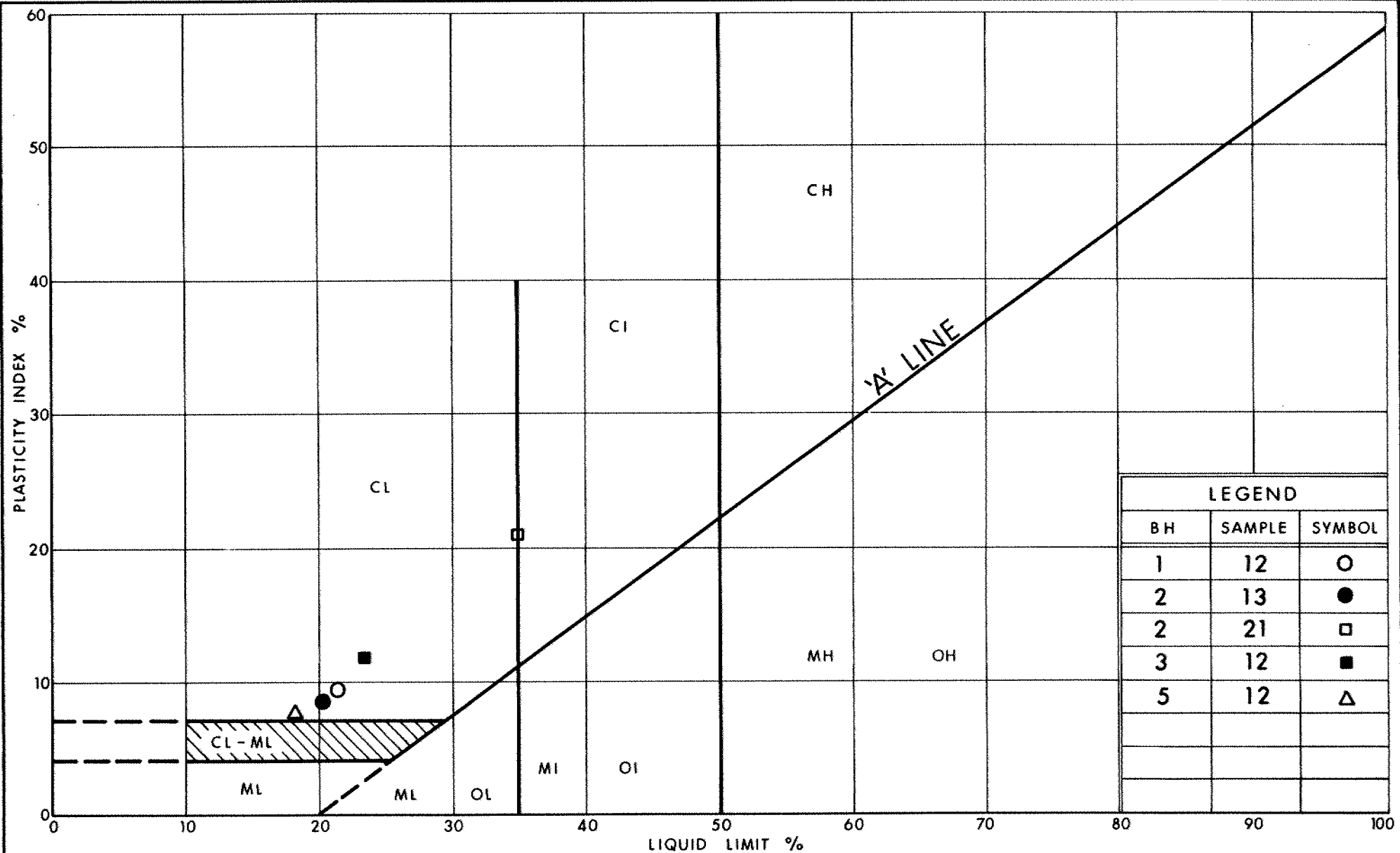


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Lower)

FIG No 4

W P 88-78-20



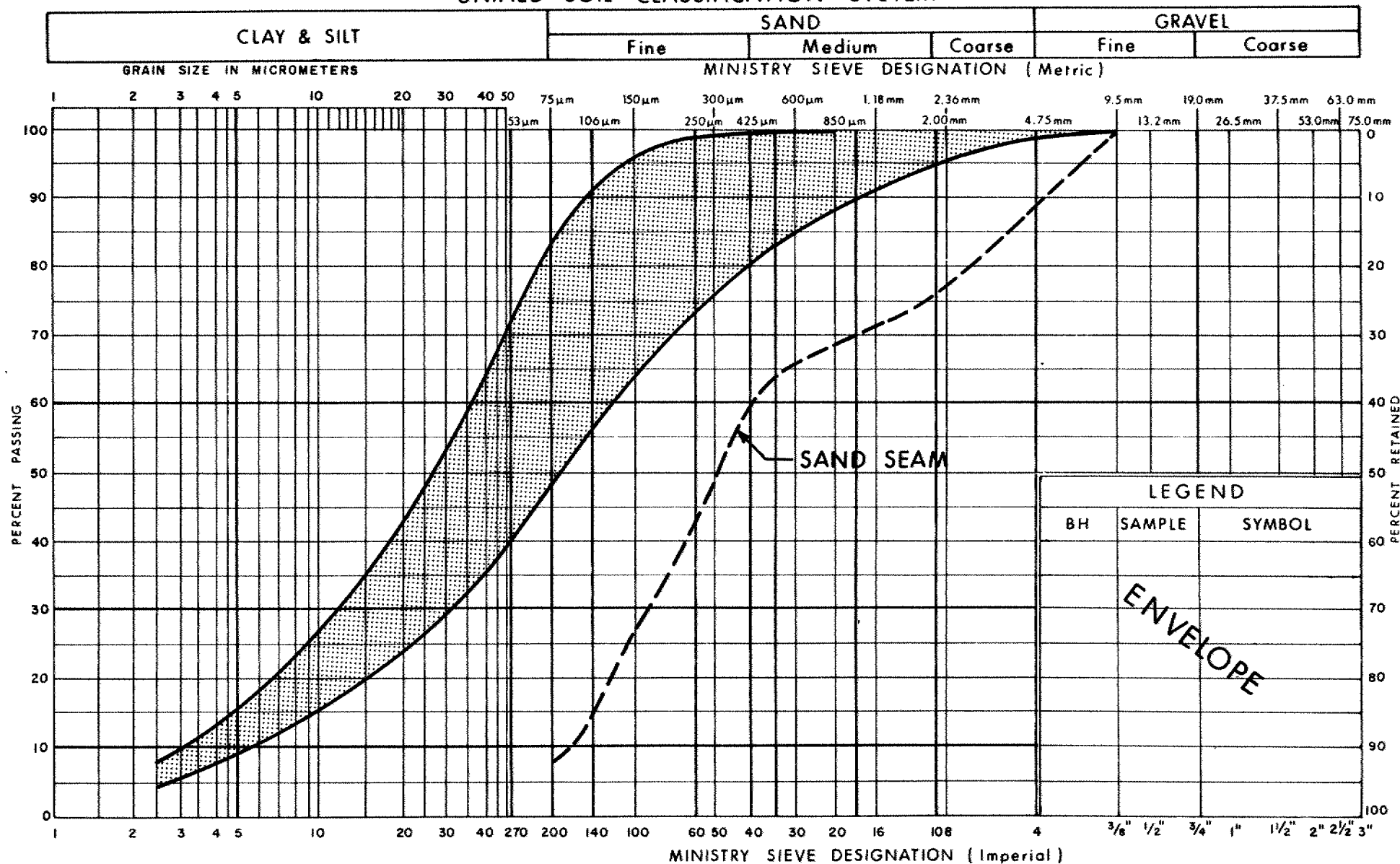
Ministry of
Transportation

PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND AND GRAVEL
(Glacial Till) (Lower)

FIG No 5

W P 88-78-20

UNIFIED SOIL CLASSIFICATION SYSTEM

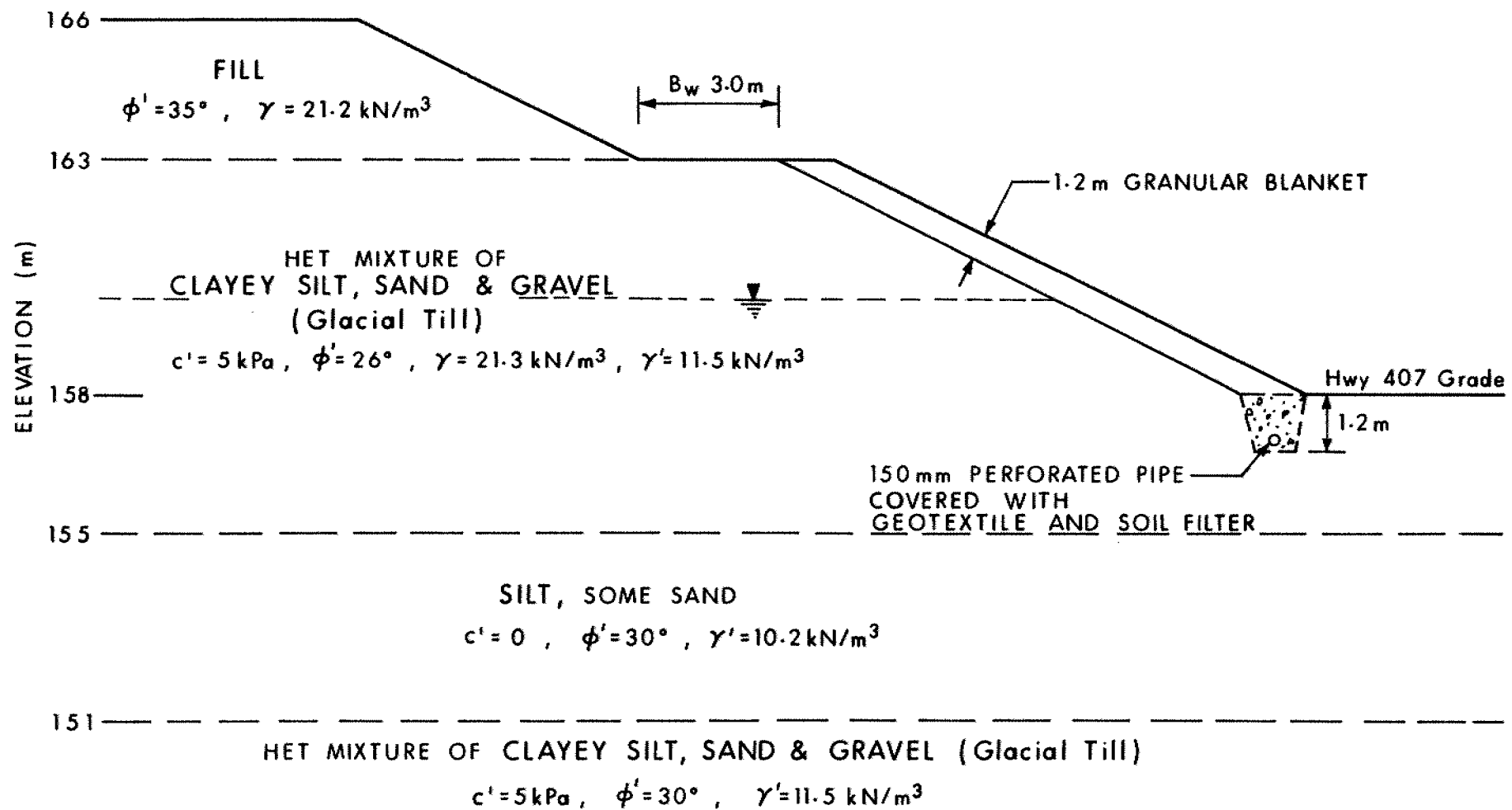


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILT, SOME SAND, OCC SAND SEAMS
 (Lower)

FIG No 6

WP 88-78-20



PINE VALLEY DR APPROACH FILLS / HWY 407 EXCAVATION CUTS SLOPE STABILITY ANALYSES

FIG 7

WP 88-78-20

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
ϕ_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 073.7; E 299 113.6 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 12 11 to 12 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100			W _p
162.9	Ground Surface														
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		1	SS	21										
			2	SS	29										
			3	SS	24										
	Brown Grey		4	SS	15										
	(Glacial Till)		5	SS	14										
157.6	Stiff to V. Stiff		6	SS	23										
5.3	Silt, Some Sand		7	SS	20										1 33 (66)
	Compact		8	SS	18										
			9	SS	12										
153.7			10	SS	32										
9.2	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		11	SS	120	8cm									
	(Glacial Till)		12	SS	29										10 21 49 20
	Random Zones of Silt		13	SS	82										
	V. Stiff to Hard		14	SS	65										
			15	SS	44										
138.7			16	SS	117										
24.2	Silt and Sand		17	SS	142										0 58 (42)
	Very Dense		18	SS	173	8cm									
135.4	End of Borehole														
27.5															

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 033.3; E 299 084.6 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, Rock Core, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 11 28 to 89 12 05 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa						WATER CONTENT (%)
162.1	Ground Surface													GR SA SI CL	
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Brown Grey (Glacial Till) Stiff to Hard		1	SS	25		162						20.7	13 9 38 40	
			2	SS	27		160								
			3	SS	38										
				4	SS	17		158						22.8	2 21 50 27
				5	SS	9									
				6	SS	15		156							
				7	SS	16									
				8	SS	25									
				9	SS	25									
154.0	Silt, Some Sand Grey, Compact		10	SS	17		154						1 36 56 7		
8.1			11	SS	26		152								
			12	SS	11										
149.9	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) V. Stiff to Hard Random Zones of Silt		13	SS	68		150						4 21 53 22		
12.2			14	SS	29		148								
			15	SS	40		146								
				16	SS	23		144						22.3	
				17	SS	56		142							
				18	SS	50		140							
				19	SS	37		138						22.6	
				20	SS	47									
				21	SS	34									
136.3	Silt, Some Sand With Random Boulders and Cobbles		22	SS	45		136						0 2 53 45		
25.8			23	RC	REC 67%		134								
			24	SS	17										
		Clayey Silt		25	SS	91		132						9 82 (9)	
		Some Gravel		26	SS	120/5cm									
130.8															

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 848 014.1; E 299 125.9 ORIGINATED BY PM
DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
DATUM Geodetic DATE 1989 12 05 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa						
162.5	Ground Surface							20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	5		162							1 24 40 35
			2	SS	17		160						20.3	
			3	SS	23		158							
			4	SS	14		156							
			5	SS	8		154							
			6	TW	PH		152							
			7	SS	12		150							
			8	SS	9		148							
154.9	Firm to V. Stiff		9	SS	9		146							
7.6	Random Zones of Silt		10	SS	2		144							
	Silt, Some Sand		11	SS	21		142							0 39 (61)
	Loose		12	SS	27		140							
151.8			13	SS	99		138							
10.7	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		14	SS	33		136							
	Very Stiff to Hard		15	SS	37		134							
			16	SS	19									
142.7			17	SS	23									
19.8	Silt, Some Sand		18	SS	28									
	Compact to Very Dense		19	SS	30									0 31 (69)
			20	SS	120									
			21	SS	118/23cm									7 33 54 6
			22	SS	130									
133.1			23	SS	114									
29.4	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity
20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 959.8; E 299 099.1 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY BC
 DATUM Geodetic DATE 1989 12 06 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
161.6 0.0	Ground Surface														
	Tr. Organics		1	SS	16										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		2	SS	17		160								
			3	SS	29										
	Brown Grey		4	SS	28		158								
			5	SS	19										
	(Glacial Till)		6	SS	7		156								
	Firm to V. Stiff		7	SS	14										
			8	SS	18		154								
			9	SS	28										
152.4 9.2			10	SS	6		152								
	Silt Some Sand Loose to Compact		11	SS	26		150								
149.4 12.2			12	SS	25		148								
	Het. Mixture of Clayey Silt, Sand and Gravel														
	(Glacial Till)						146								
	V. Stiff to Hard		13	SS	32		144								
			14	SS	30		142								
141.8 19.8			15	SS	31		140								0 50 40 10
	Silt, Some/With Sand						138								
	Dense to Very Dense		16	SS	100	15cm	136								0 10 (90)
			17	SS	120	15cm									
133.9 27.7			18	SS	120	13cm	134								
	End of Borehole														

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 956.3; E 299 136.1 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger, NW Casing, Washbore, Rock Core, Cone test COMPILED BY BC
 DATUM Geodetic DATE 1989 11 29 CHECKED BY TS

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100					
162.2	Ground Surface					162							
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown Grey		1	SS	7							21.5	9 7 48 36
			2	SS	7							19.8	4 20 49 27
			3	SS	28								
			4	SS	14								
			5	SS	7								
			6	SS	5								
	Firm to Stiff		7	SS	8								
154.6	Silt Some Sand		8	SS	5								
7.6	Loose		9	SS	8								
152.5			10	SS	46								0 26 68 6
9.7	Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till) V. Stiff to Hard Random Zones of Silt		11	SS	24								
			12	SS	27								
			13	SS	72								3 27 53 17
			14	SS	21							20.9	
			15	SS	16								
			16	SS	32								
140.9	Silt, Some Sand With Random Boulders and Cobbles		17	SS	160								
21.3			18	SS	120/15cm								
			19	RC	REC 20%								RQD = 6%
	V. Dense		20	SS	120/28cm								4 12 (84)
135.5			21	SS	120/8cm								
26.7	End of Borehole					136							

RECORD OF BOREHOLE No 11

METRIC

W P 88-78-20 LOCATION Co-ords: N 4 847 995.8; E 299 184.2 ORIGINATED BY BC
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 12 13 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L			
162.9	Ground Surface													
0.0	Heterogeneous Mixture of Clayey Silt, Sand and Gravel		1	SS	28	*	162							
			2	SS	24									
	Brown Grey (Glacial Till)		3	SS	28		160							
			4	SS	10									
158.3	Random Zones of Silt		5	SS	10									
4.6			6	SS	8		158							
	Silt, Some Sand Loose to Compact		7	SS	6									
			8	SS	12		156							
155.3														
7.6	Het. Mixture of Clayey Silt, Sand and Gravel		9	SS	36		154							
153.3	(Glacial Till), Hard		10	SS	59									
9.6	End of Borehole													
	* Water Level not Established													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 12

METRIC

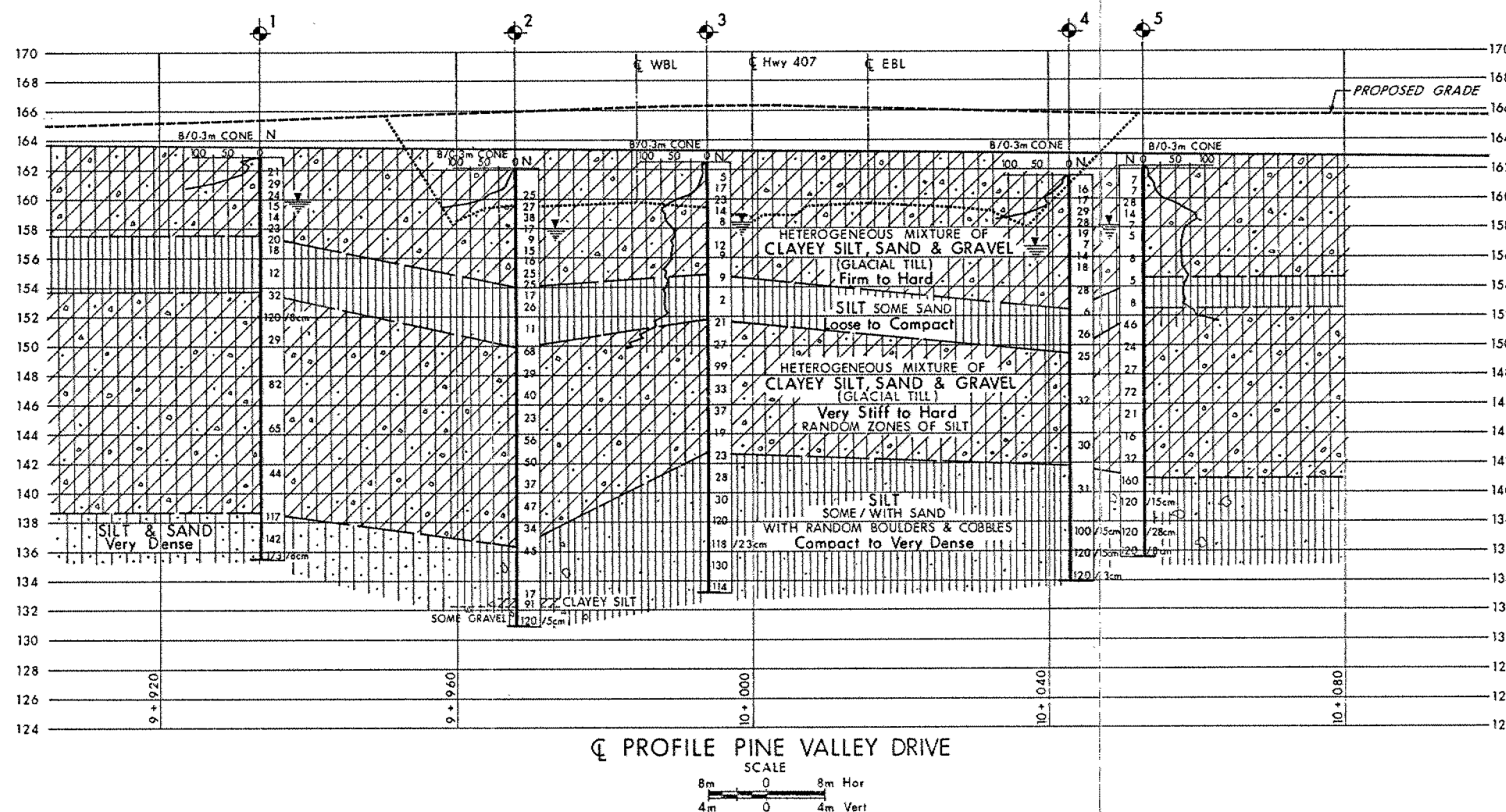
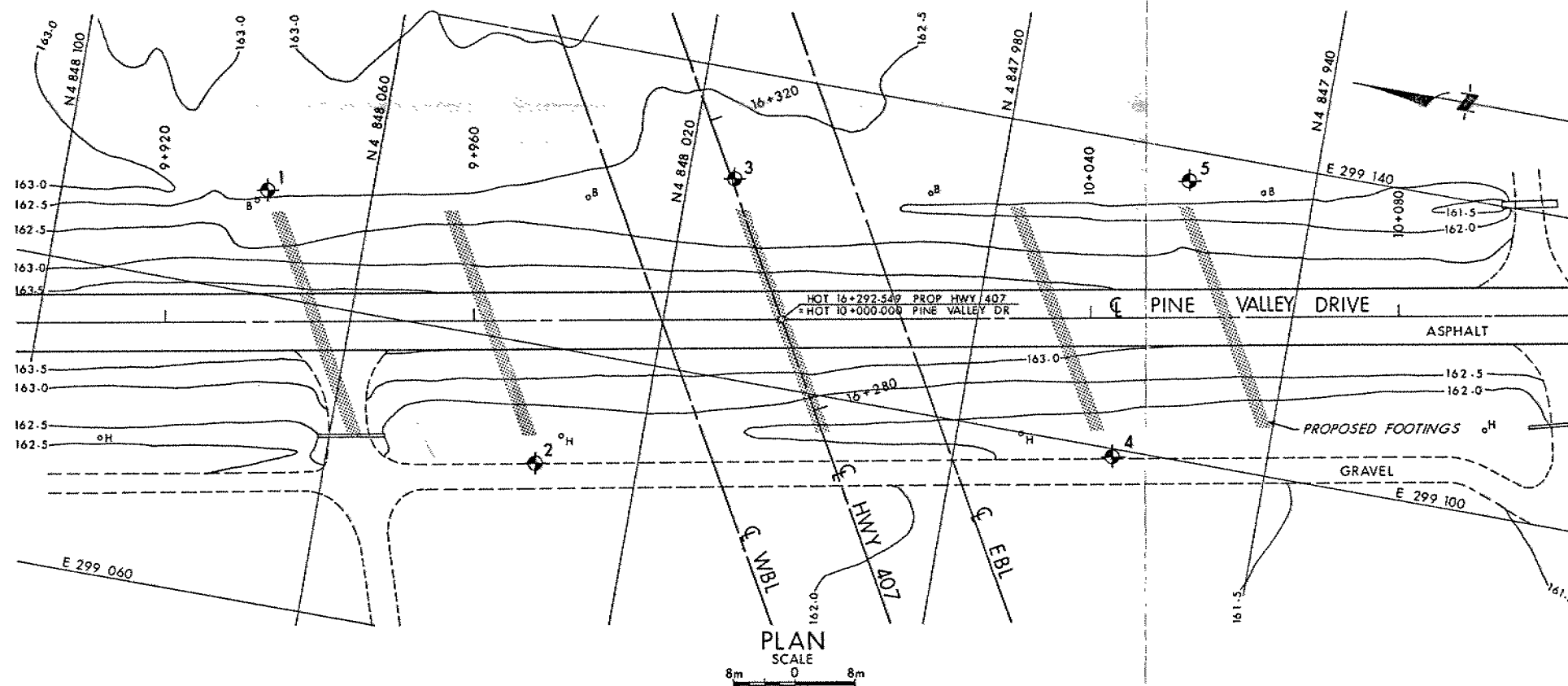
W P 88-78-20 LOCATION Co-ords: N 4 848 094.5; E 299 187.2 ORIGINATED BY GP
 DIST 6 HWY 407 BOREHOLE TYPE H.S. Auger COMPILED BY BC
 DATUM Geodetic DATE 1989 12 06 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)		
164.6	Ground Surface										10 20 30		GR SA SI CL	
0.0	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Brown Hard Grey		1	SS	28		164						0 76 (24)	
			2	SS	30		162							
			3	SS	20									
160.9			4	SS	17									
2.7	Silt and Sand Grey Compact to Dense		5	SS	36									
			6	SS	28		160							
			7	SS	30									
			8	SS	39		158							
157.0	Het. Mixture of Clayey Silt, Sand and Gravel (Glacial Till)		9	SS	42		156							
7.6														
155.0	V. Stiff to Hard		10	SS	26									
9.6	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

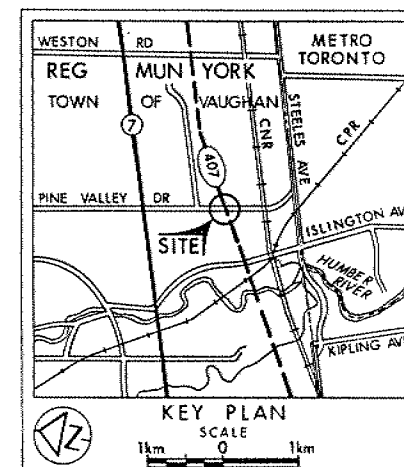
**METRIC**DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.CONT No
WP No 88-78-20

PINE VALLEY DRIVE UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET

**LEGEND**

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 89 11 and 89 12

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	162.9	4 848 073.7	299 113.6
2	162.1	4 848 033.3	299 084.6
3	162.5	4 848 014.1	299 125.9
4	161.6	4 847 959.8	299 099.1
5	162.2	4 847 956.3	299 136.1
11	162.9	4 847 995.8	299 184.2
12	164.6	4 848 094.5	299 187.2

BH'S 11 & 12 ADVANCED IN CONJUNCTION
WITH HWY 407 EAST APPROACH
EXCAVATION NOT SHOWN ON PLAN.
FOR SUBSOIL INFORMATION REFER TO
RECORD OF BOREHOLE SHEETS.

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION
1			
Geocres No 30M13-98			
HWY No 407			
SUBMD TS	CHECKED	DATE 90 03 19	SITE 37-1328
DRAWN DT	CHECKED	APPROVED	DWG 887820-A

NOTE to FILE:

Re: CONTOUR GRADING @ Hwy 407 & PINE VALLEY

CONF 94-37: to cover grading and paving of Hwy 407

Consultant has incorporated contour grading at the approaches to the structure at each quadrant of 407 and Pine Valley — some of it encroaches on the forward slopes to the structure, some of it lengthens existing transverse slopes.

In discussions, with Bob Jeffries (-5515) determined that this issue does not require a meeting of all parties or any in-depth analyses.

Bob Jeffries to ask consultant to change those portions that appear to intrude on forward slopes to the structure; and to add a nominal 1m bench between old and new grading areas.

Bob to forward dwgs with changes to confirm that what was discussed is implemented.

RB.

memorandum



To: K. Bassi
Head, Structural Office
7th Floor, Atrium Tower

Attn: G. Al-Bazi
Design Engineer

From: Foundation Design Section
Room 315, Central Bldg.

Re: Final Design Drawing Review
Hwy. 407 - Pine Valley Dr. U'Pass
W.P. 88-78-20, Site 37-1328
District 6, Toronto

Date: 1991 01 29

The final design drawings and Special Provisions for the aforementioned structure has been reviewed by this office and the following comments are provided.

Structure Foundations

Pile Installation

In view of the variable nature of the founding elevation of the end bearing lower silt deposit, the prudence of monitoring and controlling the pile driving by applying the MTO Hiley Dynamic Formula is hereby reiterated. The Contractor should be made aware of potential aberrations from the theoretical pile lengths.

Pile Layout

An observation of the layout plan for the centre piers reveals batter piles ranging from 1H:3V to 1H:8V. This irregularity in pile batters, although acceptable from a design point of view, can create costly implications as far as installation is concerned. Adjustment and modification of the pile driving equipment to facilitate the installation of these various batters can become a costly operation.

The concept of establishing a design that minimizes the variation in battered piles should be considered in future designs.

Pier Pile Cap Construction

The excavation to facilitate the construction of the centre piers will be advanced in the surficial cohesive heterogeneous mixture of clayey silt, sand and gravel. The excavation will be advanced to an elevation (155.7 m to 155.9 m) such that approximately 0.5 to 1 metre of cover over the upper silt stratum can result. The groundwater table at the time of the investigation revealed piezometric heads equivalent to elevation 158 m to 161 m. As a result of the unbalanced hydrostatic head created by this scenario, a potential basal

instability of the pier pile cap excavation can develop. A non-standard Special Provision should be included in the contract documents such that the Contractor is made aware of this condition. An oversized excavation with perimeter sump pumps may be required to account for this potential dewatering problem. The non-standard Special Provision can be described as follows:

"Excavation for the pier pile caps will penetrate within approximately 0.5 m to 1.0 m above the upper silt stratum. The groundwater table at the time of the investigation ranged from 158.1 m to 160.9 m. Consequently, basal instability accompanied by "boiling" at the base of the excavation is likely as a result of unbalanced hydrostatic head. The Contractor shall therefore plan a dewatering scheme to respond to this potential condition and shall render the excavation stable throughout the footing construction.

If you have any queries regarding the above comments or require any additional information, please do not hesitate to contact this office.



Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

for

M.S. Devata, P. Eng.
Chief Foundation Engineer

MSD/BI\jb

cc: V. Boehnke - Head, Structural Section
(Central Region)

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1990 07 20

Attn: B. Jeffries
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

Re: Alternate Slope Geometries at
Hwy. 407 - Pine Valley Dr. U'Pass (W.P. 88-78-20) ,
and Hwy. 407 - CPR Subway (W.P. 88-78-16)
Hwy. 407, District 6, Toronto


Further to our telephone conversation on 90 07 18, an evaluation of the longitudinal slopes at the aforementioned sites was carried out applying a flatter slope geometry, specifically 3H:IV slopes. The results of additional analyses conducted are summarized in Table 1 below. The results reveal that the slopes can be constructed at 2.5H:IV slopes or flatter without any benches. It is, however, hereby reiterated that the preservation of the long term stability is contingent on an effective surface erosion protection scheme combined with an adequate slope drainage scheme. The application of granular blankets and toe drains are hence an essential requirement.

Table 1 -

<u>Project</u>	<u>Description</u>	<u>Depth of Cut</u> (m)	<u>Height of Fill</u> (m)	<u>Minimum</u> <u>Slope Geometry</u>
W.P. 88-78-16	CPR Subway	10	N/A	*2.5H:IV
W.P. 88-78-20	Pine Valley Dr. U'Pass	4-5	3	*2.5H:IV

* Flatter 3H:IV slopes also acceptable.

If you have any questions regarding the above comments or require additional information, please do not hesitate to contact this office.


T. Sangiuliano, P. Eng.
Foundation Engineer

for

M. Devata, P. Eng.
Chief Foundation Eng.

MD/TS/jb