Olivia Chen Consultants, Inc.
Civil • Environmental • Geotechnical

August 26, 1997

Mr. Brian McCloud
East Bay Municipal Utility District
Engineering Services Division
375 Eleventh Street
Oakland, CA 94607-2420

Subject: Pardee Dam, South Spillway Modification
Geologic Mapping, Scour Holes
OCC Project No. J1057

Dear Mr. McCloud:

This letter report presents the results of geologic mapping of the two scour holes below the South Spillway of Pardee Dam and includes geologic maps of each scour hole, a description of the geologic units mapped, explanations of the geologic symbols and terms used in the descriptions, tabulations of attitudes of rock mass discontinuities (fractures), and photoplates of each scour hole. The geologic mapping, consultations, and preparation of this letter were performed by Ernest Solomon, Principal Geologist, Olivia Chen Consultants, Inc., under contract to Woodward-Clyde Consultants.

General

The two scour holes, referred to as "north scour hole" and "south scour hole", were located at the foot of the concrete slab portion of South Spillway, and have been filled with concrete as part of the interim modifications to the spillway. All loose or otherwise unsuitable materials were removed from the holes prior to placing the concrete. The locations of the scour holes are shown on Figure 1, Location Map.

Site visits were made by the principal geologist between July 23, 1996 and October 9, 1996. In general, the visits were made at the request of Mr. James Smith, Resident Engineer for East Bay Municipal Utility District (EBMUD), to observe, approve, and otherwise consult on foundation rock quality and/or preparation, to map foundation prepared for concrete placement, and to meet with representatives of the Federal Energy Regulatory Commission (FERC) and California Division of Safety of Dams (DSOD). Geologic mapping was performed at or near the end of the cleaning operation. The south scour hole was mapped September 26, September 27, and September 30, 1996. The north scour hole was mapped October 8 and October 10, 1996.

Geologic Mapping

The cleaned rock surface was mapped at a scale of 1 inch equals 10 feet. Horizontal control (for location) was established by reference to spillway joints, numbered from north to south, and offset, measured in the downstream direction from the edge of the spillway slab. Surveyed

control points were established in and around the scour holes to facilitate determining location during mapping.

The mapping recorded the attitudes (dip and strike) of joints, foliation, and small faults, the presence of seeps, quartz veins, areas of rock defined by differing physical characteristics, e.g. weathering, strength, and the density of rock mass discontinuity (foliation, jointing), and geologic contacts, i.e. between the rock sub-units. Discontinuity attitudes are summarized in Tables 1 and 2. Geologic maps are included as Figures 2, 3, 4, and 5.

Geology

Metavolcanic rock, a metamorphosed lapilli-tuff identified as Jurassic-age Gopher Ridge Volcanics, comprised the rock exposed in the scour holes. The metavolcanic rock varied from gray to greenish gray, where fresh, to pale yellowish brown to light brown to pale orange, where moderately weathered. Rock mass strength varied from weak to very strong; much of the rock was moderately strong to strong. Rock hardness ranged from moderately hard to very hard. Large areas of the mapped surface were little fractured to massive; intense to close fracturing occurred along relatively narrow zones, some of which could be traced across or around the scour hole. A definition of terms is included in Figure 6, Explanation. The small faults exposed in the excavations have not been dated but are post-Gopher Ridge and are not known to be associated with any capable faults in the region. Photographs showing prominent joint and/or foliation surfaces and features of each scour hole are included as Photoplates 1, 2, 3, and 4.

Closure

This letter report has been prepared for the exclusive use of the East Bay Municipal Utility District, Woodward-Clyde Consultants, the FERC, and the DSOD for application only to the foundation conditions in the "north" and "south" scour holes at Pardee Dam South Spillway. The report was prepared in accordance with generally accepted engineering geology practices. There is no other warranty either expressed or implied.

Very truly yours,
OLIVIA CHEN CONSULTANTS, INC.

Ernest Solomon, RG No. 916, CEG No. 350

Reviewed by: Mark Freitas, Project Manager, Woodward-Clyde Consultants

Attachments

TABLE 1: SOUTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
1	Joint	N20°E, 80°SE	#1-#12, mapped on 9/26/96
	Joint	N55°W, 90°	
2	Small Fault	N46°W, 55°SW	0.02'-0.1'clay
3	Small Fault	N15°W, 90°	smooth
4	Small Fault	N13°W, 42°SW	smooth
5	Joint	N55°W, 30°NE	
6	Joint	N50°W, 32°NE	
7	Small Fault	N60°W, 18°NE	w/gouge
8	Joint	N58°W, 40°NE	prominent
	Joint	N48°W, 59°SW	prominent
9	Joint	N62°W, 40°NE	
	Joint	N55°W, 90°	prominent
10	Joint	N11°W, 90°	prominent
11	Joint	N10°W, 90°	prominent
	Joint	N65°W, 25°SW	
	Foliation	N09°W, 72°NE	
12	Joint	E-W, 63°S	
	Joint	N05°W, 73°SW	
	Foliation	N15°W, 66°NE	
13	Foliation	N26°W, 70°NE	#13-#71, mapped on 9/27/96
	Fault	N86°W, 73°SW	small shear
14	Joint	N20°W, 90°	prominent
15	Foliation	N05°W, 54°NE	
	Joint	N25°W, 85°NE	
16	Joint	N55°W, 58°SW	clean
	Joint	N02°E, 86°NW	stained
17	Joint	N65°W, 61°SW	prominent
18	Foliation	N20°W, 50°NE	
	Joint	N78°W, 60°SW	prominent
19	Joint	N-S, 90°	prominent
	Joint	N50°W, 65°SW	
	Joint	N60°E, 80°NW	
20	Joint	N17°W, 90°	prominent
	Joint	N62°W, 56°SW	
	Foliation	N05°W, 63°NE	
21	Joint	N68°W, 78°NE	
	Joint	N10°W, 60°NE	
	Foliation	N-S, 58°E	
22	Joint	E-W, 70°S	open 0.05'-0.2', w/soil
23	Joint	N07°E, 90°	open w/soil
24	Joint	N85°W, 70°SW	see #21, continuation of #21
	Foliation	N20°W, 45°NE	
25	Joint	N15°W, 76°SW	
	Joint	N76°W, 86°SW	
26	Small Fault	N35°W, 55°SW	
27	Joint	N10°W, 85°NE	
	Joint	N58°W, 56°SW	
	Foliation	N05°E, 61°SE	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 1: SOUTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
28	Joint	N20°W, 88°NE	
	Small Fault	N55°W, 55°SW	
29	Foliation	N05°W, 55°NE	
	Joint	N10°W, 90°	prominent
	Joint	N55°W, 55°SW	
30	Joint	N05°W, 90°	prominent
	Joint	N65°W, 60°SW	prominent
31	Joint	N10°W, 90°	prominent
	Joint	N65°W, 60°SW	prominent, see #30-2, same feature
32	Joint	N80°W, 62°SW	prominent
	Joint	N10°W, 90°	prominent
33	Joint	N05°E, 75°NW	
34	Joint	N10°W, 90°	
	Foliation	N10°W, 50°NE	
35	Small Fault	N80°W, 68°SW	see #24, same feature
	Joint	N15°W, 90°	prominent
36	Small Fault	N65°W, 70°SW	
	Joint	N14°W, 90°	
37	Joint	N10°W, 90°	
	Small Fault	N75°W, 70°SW	see #34, same feature
38	Joint	N15°W, 90°	
	Foliation	N30°W, 55°NE	
39	Joint	N17°W, 90°	
	Small Fault	N10°W, 68°SW	
	Foliation	N30°W, 57°NE	
40	Joint	N05°E, 85°NW	
	Joint	N75°W, 65°SW	
41	Small Fault	N82°W, 60°SW	
	Joint	N85°W, 50°NE	
42	Small Fault	N60°W, 65°SW	
43	Joint	N20°W, 78°NE	
44	Small Fault	N20°W, 62°SW	
45	Small Fault	N38°W, 70°SW	
	Joint	N88°W, 61°SW	
46	Foliation	N05°E, 74°SE	
47	Small Fault	E-W, 85°N	
	Joint	N18°W, 90°	
	Joint	N88°E, 43°SE	
48	Foliation	N08°E, 75°SE	
	Small Fault	N35°W, 78°SW	0.01'-0.1' clay, crushed
49	Foliation	N20°W, 52°NE	
	Small Fault	N48°W, 51°SW	see #48, same feature
50	Small Fault	N35°W, 75°SW	see #48, same feature
51	Foliation	N30°W, 70°NE	
	Joint	N70°W, 75°SW	
52	Small Fault	N15°E, 35°SE	
	Small Fault	N05°W, 90°	
	Joint	N05°W, 82°SW	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 1: SOUTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
53	Small Fault	N05°W, 39°NE	see #52-1, same feature
	Joint	N64°E, 86°NW	
	Foliation/Joint	N05°E, 87°SE	
54	Joint	N15°W, 90°	
55	Small Fault	N42°W, 75°SW	
	Small Fault	N17°W, 90°	
	Joint	N44°W, 52°SW	
56	Small Fault	N-S, 90°	gouge 0.05'-0.20' thick
57	Joint	N52°W, 20°SW	
	Joint	N35°W, 78°NE	
58	Joint	N19°E, 90°	
	Joint	N52°W, 50°SW	
59	Joint	N20°E, 81°SE	see #58-1, same feature
	Joint	N30°W, 90°	
60	Joint	N15°W, 45°SW	
	Joint	N85°E, 60°SE	
	Joint	N22°E, 80°SE	see #58-1, same feature
61	Joint	N85°E, 60°SE	see #60-2, same feature
	Joint	N10°W, 90°	
62	Small Fault	N10°W, 78°NE	
	Joint	N15°W, 50°NE	
63	Joint	N45°W, 90°	
	Small Fault	N55°W, 45°SW	
64	Joint	N75°W, 90°	
65	Joint	N10°W, 90°	
	Joint	N68°W, 90°	
	Small Fault	N55°W, 50°SW	see #63-2, same feature
66	Joint	N15°W, 90°	
67	Small Fault	N35°W, 65°SW	
	Joint	N32°E, 82°SE	
68	Small Fault	N-S, 90°	
	Joint	N60°W, 48°SW	
69	Small Fault	N10°W, 90°	
70	Joint	N12°W, 90°	
	Joint	N80°W, 45°SW	
71	Joint	N80°W, 45°SW	
	Joint	N-S, 78°W	
72	Joint	N20°W, 90°	#72-#115, mapped on 9/30/96
	Joint	N05°E, 90°	
	Foliation	N20°W, 50°NE	
73	Joint	N70°E, 85°SE	
74	Joint	N20°W, 90°	see #72-1, same feature
75	Joint	N15°W, 85°SE	
76	Joint	N70°E, 82°SE	
	Joint	N10°W, 80°NE	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 1: SOUTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
77	Small Fault	N35°W, 60°W	±0.2', w/crushed rock, clay
	Joint	N35°W, 45°SW	
	Foliation	N25°W, 68°NE	
	Joint	N40°E, 75°SE	
78	Joint	N20°W, 80°NE	
	Small Fault	N05°E, 90°	~10' long
79	Small Fault	N-S, 58°W	~0.4', dip changes along strike
80	Small Fault	N35°E, 80°SE	0.4-0.7' crushed zone
81	Small Fault	N12°W, 65°SW	
	Joint	N20°W, 62°NE	
82	Joint	N75°E, 78°NW	
	Foliation	N25°W, 75°NE	
83	Small Fault	N-S, 80°	crushed zone
84	Joint	N10°W, 85°SW	
	Joint	E-W. 75°S	
85	Small Fault	N05°W, 90°	
86	Joint	N10°W, 80°SW	
	Joint	N80°W, 70°SW	
	Joint	N20°E, 15°NW	
87	Joint	N22°W, 68°NE	
	Joint	N25°W, 70°SW	
88	Joint	N60°E, 90°	
	Foliation	N22°W, 63°NE	
	Joint	N25°W, 90°	
89	Small Fault	N50°W, 55°SW	offsets 89-2
	Small Fault	N20°E, 20°SE	offset by 89-1 fault
90	Small Fault	N15°W, 70°SW	
91	Small Fault	N55°W, 56°SW	
	Joint	N80°E, 74°SE	
92	Joint	N70°E, 75°SE	
	Foliation	N10°W, 50°NE	
	Joint	N80°E, 35°NW	
93	Joint	N40°W, 50°NE	w/clay, 0.05'
94	Small Fault	N52°W, 55°NE	w/clay, 0.05'
	Joint	E-W, 75°S	
	Joint	N20°E, 12°SE	
95	Small Fault	N15°W, 55°SW	
	Joint	N55°W, 25°SW	
96	Joint	N30°W, 55°SW	
	Joint	N72°E, 90°	
97	Joint	N08°W, 77°NE	
	Joint	N35°W, 90°	
	Joint	N30°W, 35°SW	
98	Small Fault	N48°W, 70°SW	
99	Small Fault	N15°W, 90°	
100	Small Fault	N09°E, 75°SE	
101	Joint	N80°E, 90°	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 1: SOUTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
102	Small Fault	N48°W, 58°SW	
	Joint	N20°W, 90°	
	Joint	N58°E, 90°	
	Joint	N56°W, 32°SW	
103	Foliation	N24°W, 78°NE	
	Joint	N72°E, 90°	
104	Foliation	N31°W, 72°NE	
	Joint	N66°E, 90°	
	Joint	N15°EW, 20°SW	
105	Joint	N75°E, 90°	
	Foliation	N15°W, 76°NE	
106	Joint	N05°W, 63°SW	
	Joint	N45°W, 66°NW	
107	Joint	N36°W, 60°SW	
	Foliation	N19°W, 49°NE	
108	Joint	N15°W, 90°	
	Joint	N80°E, 90°	
	Joint	N80°E, 45°SE	
109	Joint	N50°W, 50°SW	
	Joint	N86°E, 80°SE	
110	Small Fault	N62°W, 64°SW	
111	Joint	N20°E, 90°	
112	Joint	N20°W, 90°	
	Joint	E-W, 54°S	
113	Joint	N42°W, 70°NE	
114	Joint	N10°W, 90°	
115	Joint	N72°E, 90°	

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* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 2: NORTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
1	Joint	N62° E, 86° SE	#1-#42, mapped on 10/8/96
	Joint	N20° W, 29° SW	open to 0.5'
	Joint	N18° W, 72° NE	
2	Foliation	N32° W, 64° NE	
	Joint	N56° E, 90°	
3	Joint	N20° W, 18° SW	open, prominent
	Joint	N70° E, 76° SE	
4	Joint	N10° W, 24° SW	broad surface
	Joint	E-W, 54° S	prominent
5	Joint	E-W, 70°	
	Joint	N17° W, 17° SW	
	Joint	N25° W, 72° NE	
	Foliation	N25° W, 72° NE	
6	Joint	N24° W, 51° NE	prominent
7	Small Fault	N60° W, 49° SW	crushed w/some clay
8	Joint	N22° W, 66° NE	developed on foliation
	Foliation	N22° W, 66° NE	
	Joint	N12° W, 77° SW	
9	Small Fault	N47° W, 74° SW	
	Joint	N70° E, 90°	
10	Joint	N15°W, 83°SW	
	Joint/foliation	N15° W, 56° NE	
11	Small Fault	N50° W, 77° SW	
	Joint	N35° W, 50° NE	
12	Joint	N10° W, 21° SW	broad surface
13	Joint	N25° W, 90°	
14	Joint	N54° E, 78° SE	
15	Small Fault	N75° E, 40° SE	
16	Joint	E-W, 60° S	
	Joint	N20° W, 90°	
	Foliation	N17° W, 56° NE	
17	Joint	N82° W, 70° SW	
	Foliation	N16° W, 61° NE	
18	Joint	N05° W, 85° SW	
19	Joint	N81° W, 65° SW	
	Joint	N21° W, 90°	
	Foliation	N30° W, 55° NE	
20	Joint	E-W, 72° S	
21	Joint	N65° W, 70° SW	
	Joint	N70° W, 66° NE	
22	Joint	N10°W, 79°SW	
	Joint	N80° W, 40° NE	
	Joint	N15° W, 90°	
23	Joint	N10° W, 79° SW	
	Joint	N72° W, 75° NE	
	Foliation	N11° W, 65° NE	
24	Joint	N-S, 76° W	
	Small Fault	N76° W, 56° SW	~10' long
25	Joint	N05° E, 5° SE	w/clay, quartz
	Joint	N17° W, 86° SW	
26	Small Fault	N50° W, 75° SW	0.05' clay
	Joint	N17° W, 76° SW	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 2: NORTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
27	Small Fault	N80° W, 84° SW	see #26, same feature
28	Joint	N56° W, 62° SW	
29	Joint	N20° W, 90°	
	Joint	N65° W, 55° SW	
30	Small Fault	N05° E, 80° SE	0.05'-0.2' gouge
	Joint	N60° W, 75° SW	
31	Joint	E-W, 24° S	
	Joint	N60° W, 74° SW	
32	Joint	N12° W, 34° SW	
33	Small Fault	N80° W, 70° SW	
34	Joint	N60° W, 66° SW	
35	Joint	N85° W, 65° SW	
36	Joint	N64° E, 70° SE	
	Joint	N60° W, 75° SW	
	Joint	N20° W, 25° SW	
37	Joint	N10° W, 72° SW	
	Joint	N65° E, 67° NW	
	Joint	N-S, 24° W	
38	Joint	N15° W, 24° SW	
	Joint	N15° W, 85° NE	
39	Joint	E-W, 58° S	
	Joint	N70° W, 75° SW	
	Joint	N15° W, 24° SW	
	Joint	N42° W, 80° NE	
40	Joint	N20° W, 75° NE	
	Joint	N08° W, 22° SW	
	Joint	N60° W, 85° SW	
41	Small Fault	N25° E, 80° NW	
	Joint	N05° W, 22° SW	
	Joint	N35° W, 65° NE	
42	Joint	N10° W, 82° NE	
43	Foliation	N25° W, 54° NE	#43-#100, mapped on 10/9/96
	Joint	N14° W, 81° SW	
44	Small Fault	N60° W, 74° SW	
	Joint	N16° W, 80° SW	
45	Joint	N74° W, 59° SW	
	Foliation	N20° W, 64° NE	
	Joint	N19° W, 76° SW	
46	Small Fault	N68° W, 75° NE	
	Joint	N10° W, 74° SW	
47	Joint	N80° W, 67° SW	
	Small Fault	N65° W, 72° NE	
	Joint	N65° W, 42° NE	
48	Small Fault	N85° W, 65° SW	
	Joint	N12° W, 22° SW	broad surface
49	Joint	N80° W, 60° SW	
	Joint	N11° W, 90°	
50	Joint	N45° W, 28° SW	
	Foliation	N30° W, 45° NE	
51	Joint	N12° W, 20° SW	
	Joint	N20° W, 72° NE	
52	Contact	N10° W, 72° NE	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 2: NORTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
53	Small Fault	N30° W, 76° SW	
54	Small Fault	N38° W, 85° NE	see #53, same feature
	Joint	N40° W, 08° SW	w/quartz
55	Joint	N45° W, 18° SW	
	Joint	N60° W, 75° SW	
	Joint	N15° E, 75° SE	
56	Joint	N73°W, 69°SW	
	Joint	N30° E, 84° SE	
	Joint	N45° W, 19° SW	
57	Joint	N40° E, 86° NW	
	Joint	N14° W, 26° SW	
	Joint	N70° W, 71° SW	
58	Joint	N58° E, 70° SE	
	Joint	N26° W, 86° NE	
59	Joint	N40° W, 42° NE	
60	Joint	N14° W, 40° SW	
	Joint	N33° W, 80° NE	
	Joint	N58° W, 73° NE	
61	Joint	N25° W, 20° SW	
62	Joint	N22° W, 25° SW	
63	Small Fault	N20° E, 80° SE	0.05'-0.1'
64	Joint	N15° W, 90°	see #38, same feature
65	Joint	N10° W, 26° SW	
66	Joint	N-S, 25° W	
67	Joint	N15° W, 30° SW	
68	Joint	N27° W, 56° NE	
	Joint	N70° E, 90°	
69	Contact	N28° W, 65° NE	
	Joint	N45° W, 45° SW	
70	Small Fault	N40° W, 68° SW	
71	Small Fault	N40° W, 86° SW	
72	Small Fault	N42° W, 76° SW	
73	Small Fault	N24° W, 70° SW	
	Foliation	N30° N, 62° NE	
74	Small Fault	N20° W, 80° SW	
75	Small Fault	N53° W, 56° SW	
76	Joint	N20°W, 48°NE	
	Small Fault	N25° W, 63° SW	
	Joint	N15° E, 90°	
77	Foliation	N26° W, 68° NE	
	Small Fault	N55° W, 72° SW	
	Joint	N62° E, 90°	
78	Joint	N18° W, 20° SW	
	Small Fault	N60° W, 60° SW	
79	Small Fault	N40° W, 56° SW	
	Foliation	N35° W, 72° NE	
	Joint	N70° E, 90°	
80	Joint	N15°, 40° NE	
	Joint	N76° E, 86° SE	
81	Joint	N38° E, 78° SE	
	Joint	N52° W, 52° SW	
	Joint	N34° W, 55° NE	

* Prominent indicates a joint that was traceable over a broad area of the scour hole

TABLE 2: NORTH SCOUR HOLE DISCONTINUITY ATTITUDES

Field Note Number	Type	Attitude	Remarks
82	Joint	N85° W, 65° SW	
	Joint	N45° W, 78° SW	
83	Small Fault	N50° W, 74° SW	
	Joint	N72° E, 90°	
84	Small Fault	N70° W, 76° SW	
85	Joint	N52° E, 56° NW	
	Small Fault	N40° W, 80° SW	
86	Small Fault	N40° W, 72° SW	
	Joint	N40° E, 90°	
87	Contact	N-S, 66° E	
88	Foliation	N12° W, 50° NE	
	Joint	N48° E, 85° SE	
	Joint	N20° W, 90°	
89	Small Fault	N10° E, 74° SE	
90	Foliation	N20° W, 60° NE	
	Joint	N15° W, 90°	
	Joint	N20° E, 90°	
91	Foliation	N25° W, 52° NE	
	Joint	N15° W, 90°	
	Joint	N40° E, 90°	
92	Joint	N60° W, 50° SW	
	Joint	N10° W, 90°	
	Contact	N20° W, 65° NE	
93	Joint	N15° W, 85° SW	
	Joint	N80° W, 62° SW	
	Small Fault	N75° W, 48° NE	
94	Small Fault	N20° W, 90°	
	Foliation	N27° W, 62° NE	
95	Joint	N82° E, 90°	
	Joint	N85° W, 52° NE	
	Joint	N10° W, 90°	
96	Joint	N12° W, 80° SW	
	Joint	N75° E, 85° SE	
	Foliation	N20° W, 60° NE	
97	Joint	E-W, 60° S	
98	Joint	N27° W, 55° NE	
	Joint	N47° W, 25° SW	
99	Joint	N30° E, 70° SE	
	Joint	N45° W, 75° SW	
	Joint	N35° W, 45° NE	
100	Joint	N40° E, 80° NW	
	Joint	N62° E, 90°	

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* Prominent indicates a joint that was traceable over a broad area of the scour hole

N

0 20 40 80

SCALE IN FEET

NORTH SCOUR HOLE

SOUTH SCOUR HOLE

EL 490.9

EL 487.84

EL 485.52

EL 485.32

EXISTING CUTOFF WALL

EL 485.60

EL 487.65

EL 491.8

EXISTING CONTOURS

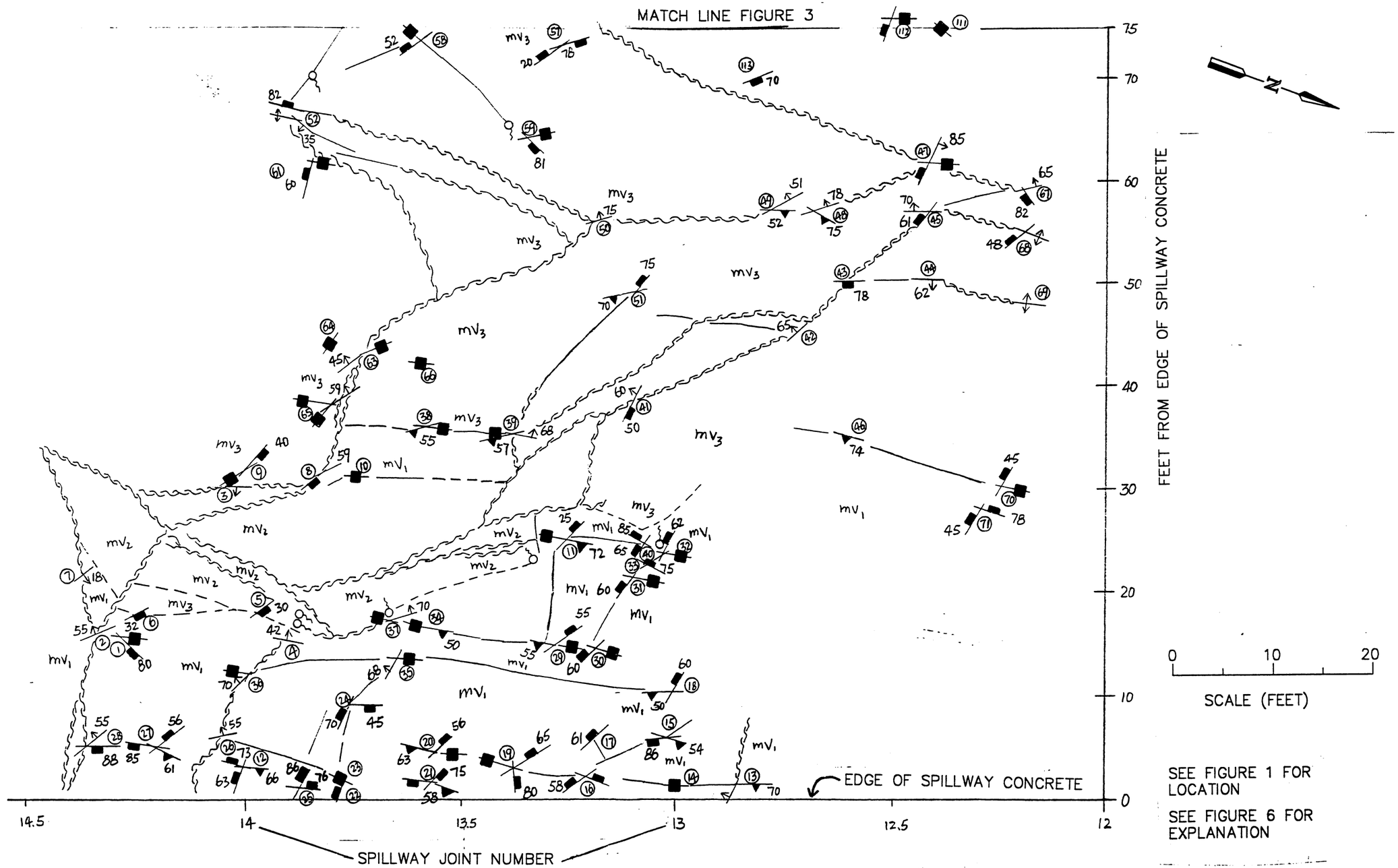
EXISTING EXPANSION JOINT (TYP)

EXISTING OVERHEAD-ELEC

EXISTING SPILLWAY CHUTE

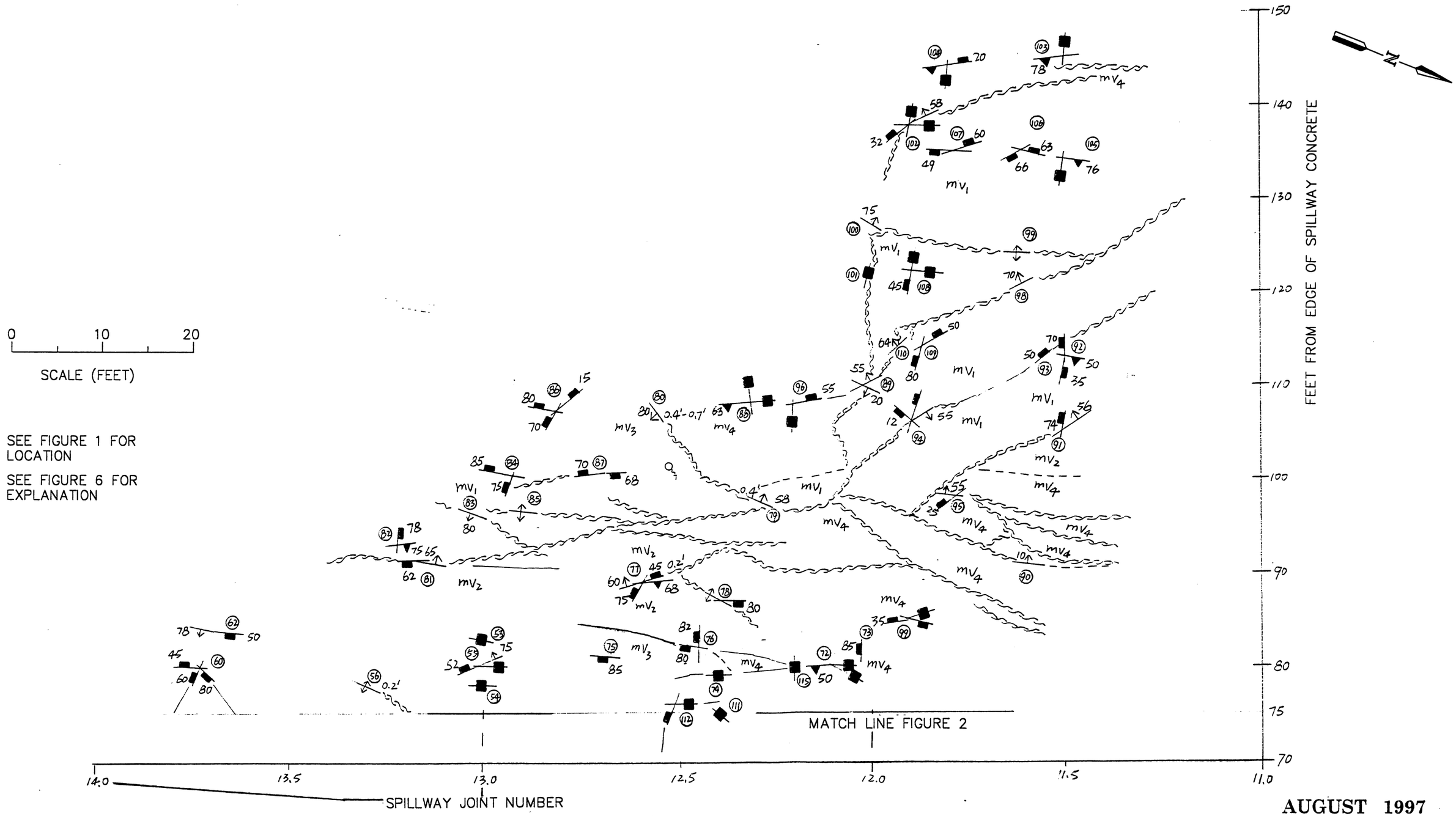
SPILLWAY JOINT NO. 15 14 13 12 11 10 9 8 7 6 5 SPILLWAY JOINT NO.

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		SCOUR HOLE LOCATION PLAN	Figure 1
Olivia Chen Consultants, Inc.	Woodward-Clyde Consultants		



AUGUST 1997

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		GEOLOGIC MAP	Figure
Olivia Chen Consultants, Inc.	Woodward-Clyde Consultants	SOUTH SCOUR HOLE	2



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PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		GEOLOGIC MAP	Figure
Olivia Chen Consultants, Inc.	Woodward-Clyde Consultants	SOUTH SCOUR HOLE	3

MATCH LINE FIGURE 5

N_4 (boulder)

FEET FROM EDGE OF SPILLWAY CONCRETE

90 80 70 60 50 40 30 20 10 0

N

EDGE OF SPILLWAY CONCRETE

8 7.5 7 6.5 6 5.5

SPILLWAY JOINT NUMBER

0 10 20

SCALE (FEET)

SEE FIGURE 1 FOR LOCATION

SEE FIGURE 6 FOR EXPLANATION

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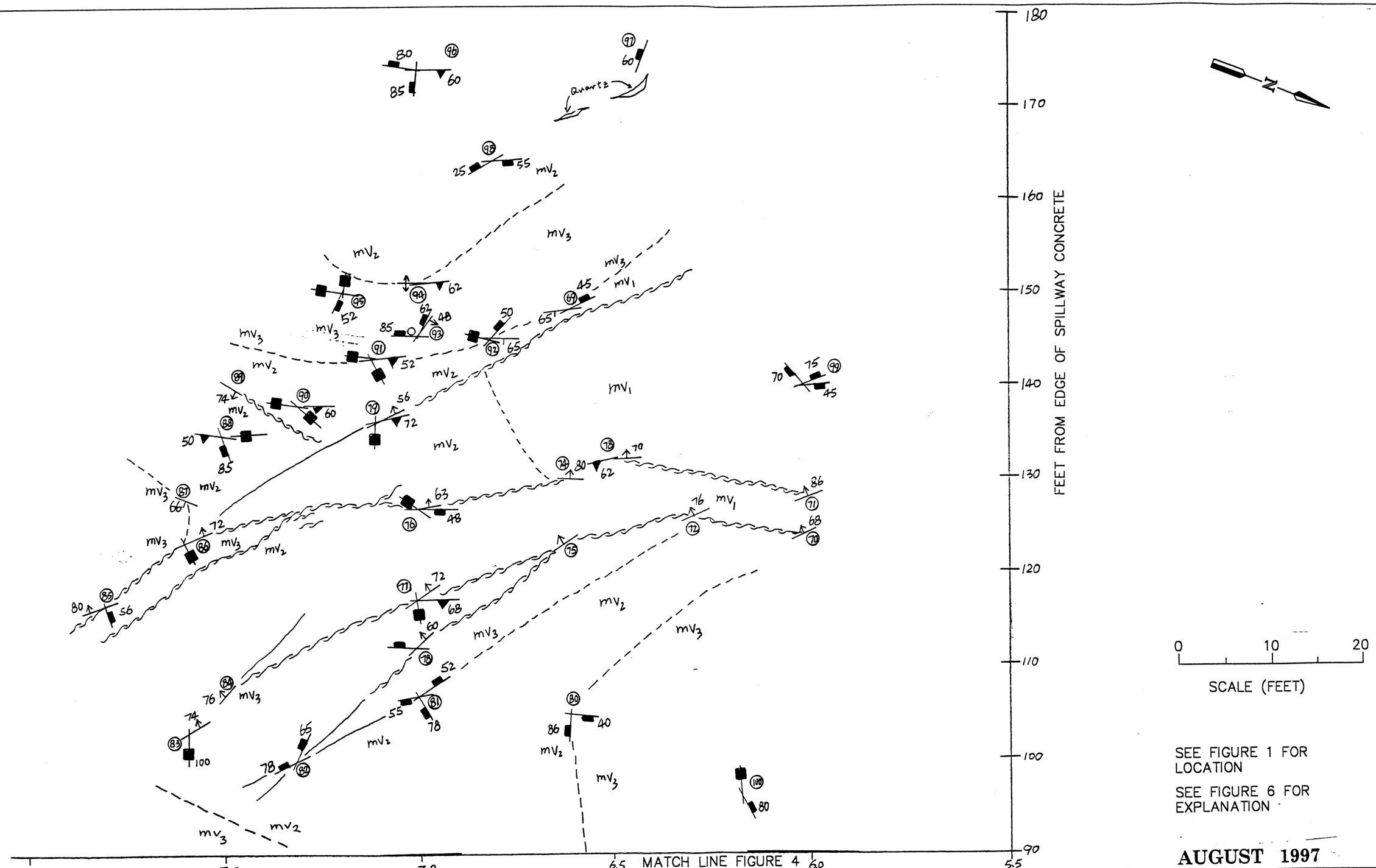
PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		GEOLOGIC MAP NORTH SCOUR HOLE	Figure 4
Olivia Chen Consultants, Inc.	Woodward-Clyde Consultants		



PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		GEOLOGIC MAP NORTH SCOUR HOLE	Figure 5
Olivia Chen Consultants, Inc.	Woodward-Clyde Consultants		

DEFINITION OF TERMS

HARDNESS

VERY SOFT:	EASILY CRUMBLED OR DEFORMED BY HAND.
SOFT:	MAY BE BROKEN USING BOTH HANDS, OR IF PLASTIC, DEFORMED BY HAND. MAY BE CUT WITH DIFFICULTY WITH KNIFE. EASILY POWDERED WITH PICK, DULL THUD WHEN STRUCK WITH HAMMER.
MODERATELY HARD:	MAY BE SCRATCHED WITH KNIFE, TO SHALLOW DEPTH. DULL RING WHEN STRUCK WITH HAMMER.
VERY HARD:	CANNOT BE SCRATCHED WITH KNIFE. SHARP RING WHEN STRUCK.

STRENGTH

PLASTIC:	CAN BE DEFORMED BY HAND.
FRIABLE:	CRUMBLES BY RUBBING WITH FINGERS.
WEAK:	AN UNFRACTURED OUTCROP OF SUCH MATERIAL WOULD CRUMBLE UNDER LIGHT HAMMER BLOWS.
MODERATELY STRONG:	OUTCROP WOULD WITHSTAND A FEW FIRM BLOWS BEFORE BREAKING.
STRONG:	OUTCROP WOULD WITHSTAND A FEW HEAVY RINGING HAMMER BLOWS BUT WILL YIELD LARGE FRAGMENTS.
VERY STRONG:	OUTCROP WOULD RESIST HEAVY RINGING HAMMER BLOWS AND WILL YIELD WITH DIFFICULTY ONLY DUST AND SMALL FRAGMENTS.

WEATHERING

EXTENT	DECOMPOSITION	DISINTEGRATION	DISCOLORATION	FRACTURE CONDITION
SEVERE	MODERATE TO COMPLETE ALTERATION OF MINERALS, FELDSPARS ALTERED TO CLAY, ETC.	GENERALLY FRIABLE, BUT ROCK TEXTURE AND STRUCTURE ARE PRESERVED.	EXTENSIVE AND THOROUGH	ALL FRACTURES EXTENSIVELY COATED WITH OXIDES, CARBONATES, OR CLAY.
MODERATE	SLIGHT ALTERATION OF MINERALS, CLEAVAGE SURFACES LUSTERLESS AND STAINED.	MOST CEMENTATION IS AFFECTED; MAY BE LOCALLY FRIABLE.	MODERATE OR LOCALIZED AND INTENSE	THIN COATINGS OR STAINS.
SLIGHT	NO MEGASCOPIC ALTERATION OF MINERALS.	LITTLE TO NO EFFECT ON NORMAL CEMENTATION.	SLIGHT AND INTERMITTENT AND LOCALIZED	FEW STAINS ON FRACTURE SURFACES.
FRESH	UNALTERED, CLEAVAGE SURFACE GLISTENING.	CEMENTATION UNAFFECTED.	NO DISCOLORATION	NO STAINS

ROCK MASS DISCONTINUITIES

EXTENT	ENGLISH SIZE RANGE	METRIC SIZE RANGE
CRUSHED (MAY CONTAIN CLAY)	LESS THAN 0.05'	LESS THAN 1.5 cm.
INTENSELY FRACTURED	0.05' TO 0.1'	1.5 cm. TO 3 cm.
CLOSELY FRACTURED	0.1' TO 0.5'	3 cm. TO 15 cm.
MODERATELY FRACTURED	0.5' TO 1.0'	15 cm. TO 30 cm.
LITTLE FRACTURED	1.0' TO 3.0'	30 cm. TO 100 cm.
MASSIVE	3.0' AND LARGER	1 m. AND LARGER

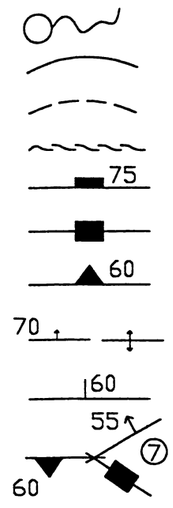
DISCONTINUITY COATINGS

EXTENT	THICKNESS
UNSTAINED OR CLEAN: NEARLY ALL SURFACE CLEAN	STAINED: NO PERCEPTIBLE THICKNESS
SMALL: COVERS LESS THAN 10% OF FRACTURE SURFACE	THIN: BARELY PERCEPTIBLE
MODERATE OR PATCHY: COVERS 10% TO 50% OF SURFACE	MEDIUM: UP TO 2 mm
EXTENSIVE: COVERS MORE THAN 50% OF SURFACE	THICK: OVER 2 mm

STRATIFICATION

STRATIFICATION (OR PARTING)	CROSS-STRATIFICATION	APPROXIMATE THICKNESS	
		ENGLISH	METRIC
VERY THICK-BEDDED (-PARTED)	VERY THICKLY CROSS-BEDDED	OVER 3 ft.	OVER 1 m.
THICK-BEDDED (-PARTED)	THICKLY CROSS-BEDDED	1-3 ft.	30-100 cm.
MEDIUM-BEDDED (-PARTED)	MEDIUM CROSS-BEDDED	4-12 in.	10-30 cm.
THIN-BEDDED (-PARTED)	THINLY CROSS-BEDDED	1-4 in.	3-10 cm.
VERY THIN-BEDDED (-PARTED)	VERY THINLY CROSS-BEDDED	0.5-1 in.	1-3 cm.
LAMINATED (THINLY PARTED)	CROSS-LAMINATED	0.1-0.5 in.	0.3-1.0 cm.
THINLY LAMINATED (VERY THINLY PARTED)	THINLY CROSS-LAMINATED	LESS THAN 0.1 in.	LESS THAN 0.3 cm.

GEOLOGIC SYMBOLS



spring or seep

continuous joint

geologic contact

small fault

strike and dip of joint

strike and dip of vertical joint

strike and dip of foliation

strike and dip of small fault, vertically dipping small fault

strike and dip of geologic contact

several fracture attitudes measured at one point, with field note number

GEOLOGIC UNITS

mv_1: metavolcanic rock with some lapilli; medium gray–greenish gray; slightly weathered to fresh; hard to very hard; strong to very strong; closely to little fractured to massive; fracture surfaces stained various shades of brown.

mv_2: metavolcanic rock with some lapilli; pale yellowish brown to very pale orange; moderately weathered; moderately hard; weak to moderately strong; closely to moderately fractured; fracture surfaces extensively stained.

mv_3: metavolcanic rock with abundant coarse lapilli and bombs (>64mm); pale to medium yellowish brown (on surface); slightly weathered to fresh; hard; strong; moderately fractured to massive; fracture surfaces often stained.

mv_4: metavolcanic rock with abundant coarse lapilli and bombs; pale yellowish brown, very pale orange to light brown; moderately weathered; moderately hard; weak to moderately strong; closely fractured; fracture surfaces extensively stained.

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PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION

Olivia Chen Consultants, Inc. | Woodward-Clyde Consultants

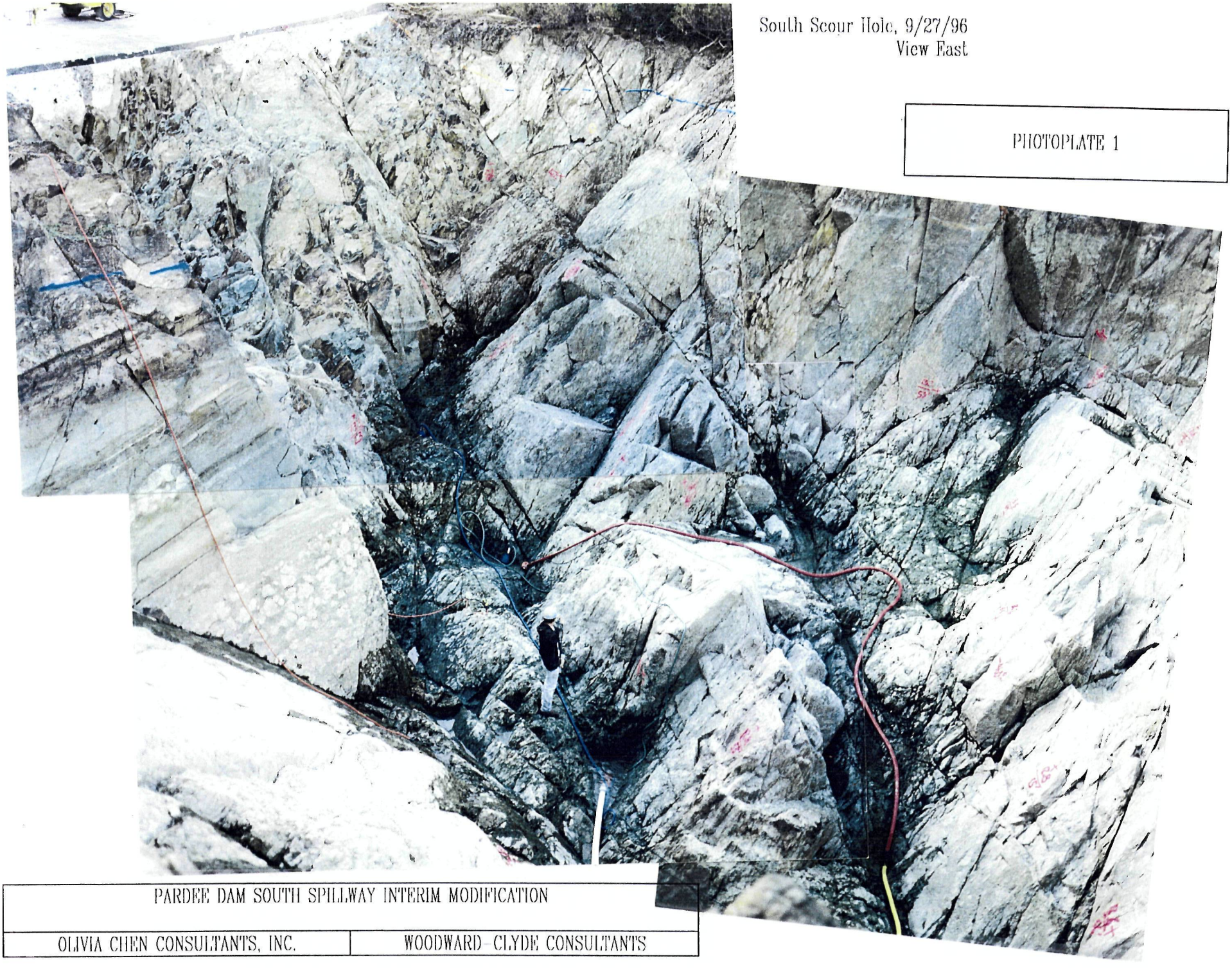
EXPLANATION

Figure 6

JOB No: J1057

South Scour Hole, 9/27/96
View East

PHOTOPLATE 1



PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION	
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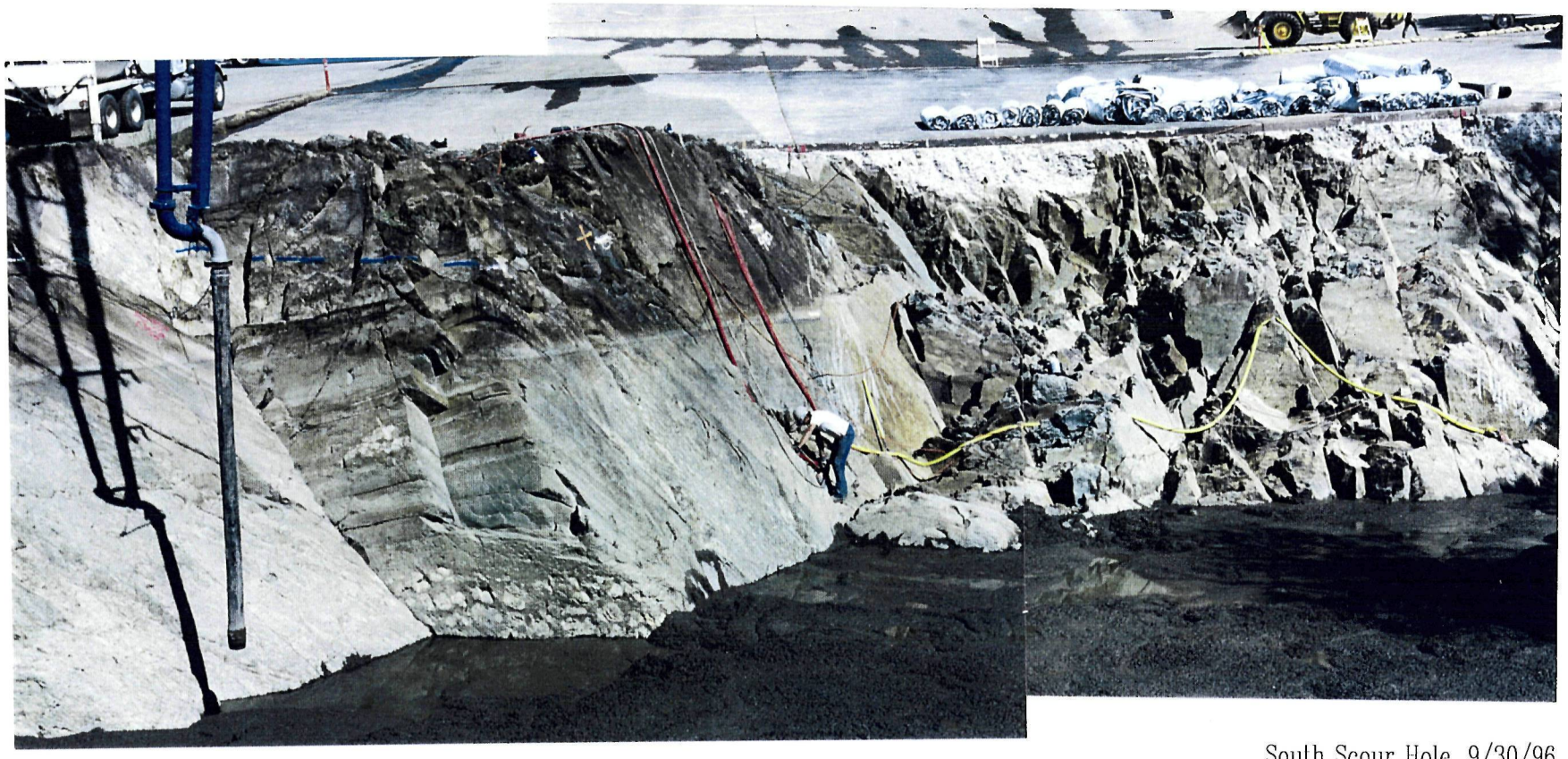
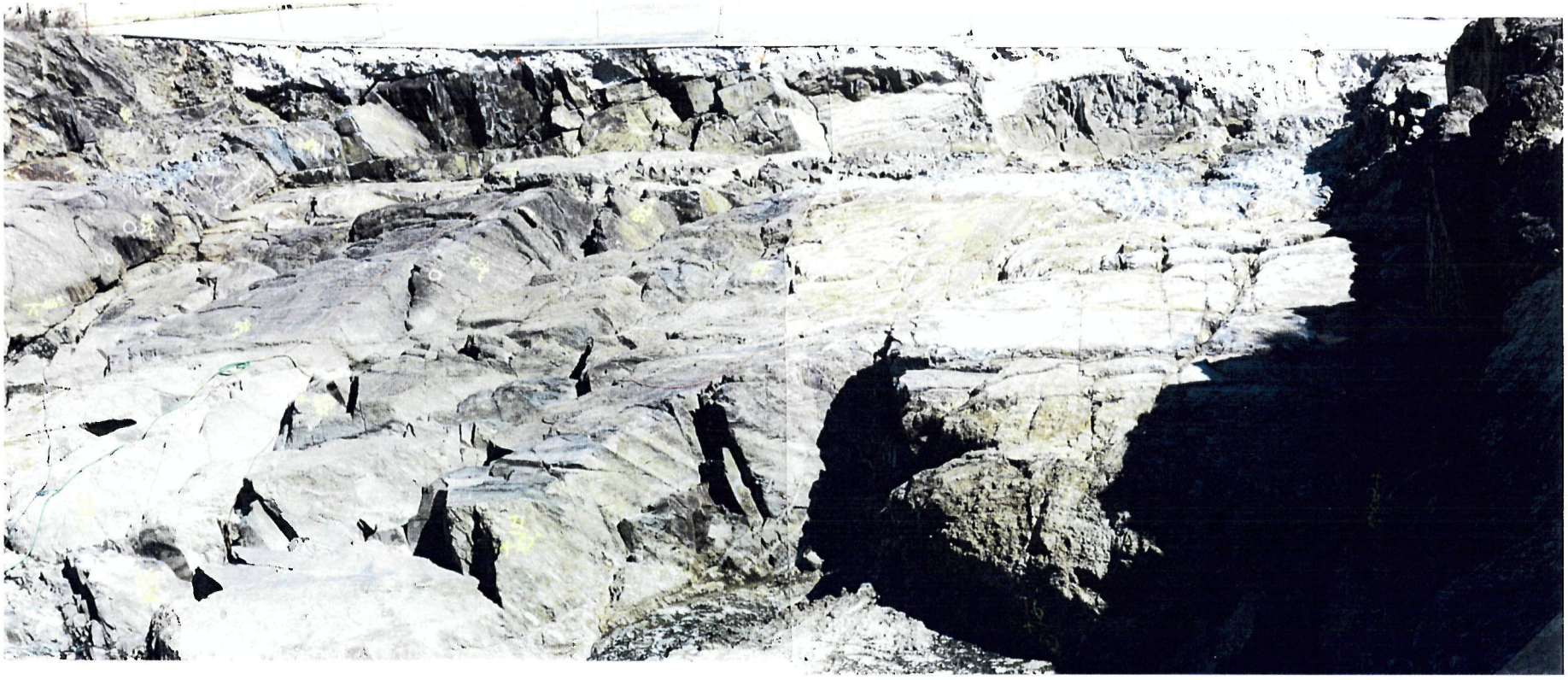


South Scour Hole, 9/30/96
View Northeast

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		PHOTOPLATE 2
OLIVIA CHEN CONSULTANTS, INC.	WOODWARD-CLYDE CONSULTANTS	



North Scour Hole, 10/9/96
View Northeast/Upstream
Prominent Joint Surface

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		PHOTOPLATE 3
OLIVIA CHEN CONSULTANTS, INC.	WOODWARD-CLYDE CONSULTANTS	

North Scour Hole, 10/8/96
View North-Northeast
Concrete/Rock Contact at Upstream Edge of Scour Hole; Spillway Joint Number 5 Center of Photo

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		PHOTOPLATE 4
OLIVIA CHEN CONSULTANTS, INC.	WOODWARD-CLYDE CONSULTANTS	

North Scour Hole, 10/8/96
View South, Downstream to Right.; Prominent Joint Surfaces; Boulder N-4 Center Right

PARDEE DAM SOUTH SPILLWAY INTERIM MODIFICATION		PHOTOPLATE 5
OLIVIA CHEN CONSULTANTS, INC.	WOODWARD-CLYDE CONSULTANTS	