APPENDIX A -- POTENTIAL SURVEY DATA, mV vs. $Cu/CuSO_4$ REFERENCE ELECTRODE

APPENDIX A -- Potential Survey Data, mV vs $Cu/CuSO_4$ Reference Electrode

EAST Side (Sections 1 and 2 combined)

Grid ID	in	ft	m	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	in			3	9	15	21	27	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117
		ft		0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75
			m	0.076	0.229	0.381	0.533	0.686	0.838	0.991	1.143	1.295	1.448	1.600	1.753	1.905	2.057	2.210	2.362	2.515	2.667	2.819	2.972
A	3	0.25	0.076	-355	-351	-372	-410	-373	-324	-295	-440	-403	-405	-428	-376	-376	-378	-488	-388	-375	-388	-396	-392
B	9	0.75	0.229	-256	-398	-474	-488	-489	-437	-411	-415	-411	-396	-396	-366	-355	-348	-342	-332	-366	-372	-383	-380
C	15	1.25	0.381	-411	-436	-479	-480	-470	-427	-372	-382	-369	-364	-350	-347	-319	-319	-346	-329	-326	-325	-319	-329
D	21	1.75	0.533	-427	-431	-440	-437	-433	-396	-373	-371	-389	-393	-354	-348	-324	-332	-349	-348	-331	-324	-304	-303
E	27	2.25	0.686	999	-430	-411	-424	-432	-408	-371	-375	-384	-374	-347	-394	-405	-432	-419	-411	-394	-363	-330	-325
F	33	2.75	0.838	999	-384	-413	-426	-428	-431	-422	-473	-419	-389	-354	-434	-461	-479	-461	-456	-476	-444	-408	-414
G	39	3.25	0.991	999	999	-420	-450	-431	-435	-432	-466	-442	-382	-356	-394	-418	-468	-478	-493	-518	-485	-462	-429

Grid ID	in	ft	m	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	in			123	129	135	141	147	153	159	165	171	177	183	189	195	201	207	213	219	225	231	237
		ft		10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25	18.75	19.25	19.75
			m	3.124	3.277	3.429	3.581	3.734	3.886	4.039	4.191	4.343	4.496	4.648	4.801	4.953	5.105	5.258	5.410	5.563	5.715	5.867	6.020
A	3	0.25	0.076	-398	-403	-424	-403	-385	-377	-373	-370	-366	-386	-411	-424	-417	-379	-371	-355	-354	-356	-359	-385
B	9	0.75	0.229	-392	-407	-416	-392	-379	-371	-360	-368	-359	-374	-417	-421	-406	-390	-373	-362	-359	-356	-375	-386
C	15	1.25	0.381	-335	-369	-377	-330	-330	-324	-315	-345	-344	-347	-405	-382	-374	-370	-319	-341	-349	-352	-356	-368
D	21	1.75	0.533	-310	-319	-310	-302	-299	-305	-285	-287	-308	-298	-361	-337	-317	-316	-309	-310	-319	-300	-298	-296
E	27	2.25	0.686	-310	-337	-358	-308	-312	-298	-292	-310	-305	-310	-403	-340	-307	-322	-302	-336	-378	-369	-337	-308
F	33	2.75	0.838	-357	-354	-388	-348	-342	-321	-312	-325	-340	-336	-371	-371	-324	-335	-340	-382	-472	-438	-368	-335
G	39	3.25	0.991	-405	-388	-425	-390	-383	-352	-339	-380	-459	-394	-380	-390	-402	-378	-385	-407	-480	-461	-391	-386

Grid ID				41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	in			243	249	255	261	267	273	279							321	327	333	339	345	351	357
		ft		20.25	20.75	21.25	21.75	22.25	22.75	23.25							26.75	27.25	27.75	28.25	28.75	29.25	29.75
			m	6.172	6.325	6.477	6.629	6.782	6.934	7.087							8.153	8.306	8.458	8.611	8.763	8.916	9.068
A	3	0.25	0.076	-390	-401	-414	-393	-390	-398	-399							-317	-285	-298	-309	-278	-294	-272
B	9	0.75	0.229	-386	-410	-429	-372	-388	-387	-387							-315	-314	-310	-314	-308	-311	-289
C	15	1.25	0.381	-385	-407	-342	-347	-379	-379	-380							-311	-312	-310	-310	-305	-315	-300
D	21	1.75	0.533	-317	-313	-327	-353	-353	-364	-389							-290	-290	-306	-310	-310	-319	-302
E	27	2.25	0.686	-335	-336	-337	-351	-351	-349	-373							-320	-332	-339	-318	-330	-329	-333
F	33	2.75	0.838	-350	-334	-355	-395	-410	-375	-376							-339	-352	-359	-334	-362	-366	-364
G	39	3.25	0.991	-355	-354	-362	-417	-447	-397	-389							-428	-418	-392	-407	-404	-425	-435

Grid ID				61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
	in			363	369	375	381	387	393	399	405	411	417	423	429	435	441	447	453	459	465	471	477
		ft		30.25	30.75	31.25	31.75	32.25	32.75	33.25	33.75	34.25	34.75	35.25	35.75	36.25	36.75	37.25	37.75	38.25	38.75	39.25	39.75
			m	9.220	9.373	9.525	9.678	9.830	9.982	10.135	10.287	10.440	10.592	10.744	10.897	11.049	11.202	11.354	11.506	11.659	11.811	11.964	12.116
A	3	0.25	0.076	-268	-277	-308	-310	-317	-318	-330	-344	-355	-346	-351	-354	-341	-328	-331	-301	-318	-331	-331	-343
B	9	0.75	0.229	-294	-294	-306	-320	-323	-318	-331	-345	-350	-345	-341	-346	-341	-343	-356	-329	-339	-334	-338	-347
C	15	1.25	0.381	-290	-313	-321	-321	-320	-319	-322	-338	-341	-341	-345	-349	-350	-355	-349	-350	-367	-328	-338	-345
D	21	1.75	0.533	-296	-298	-309	-320	-323	-330	-310	-324	-339	-339	-346	-376	-358	-373	-352	-373	-377	-356	-342	-324
E	27	2.25	0.686	-318	-313	-328	-340	-333	-334	-302	-326	-330	-343	-355	-351	-352	-391	-378	-374	-387	-372	-353	-343
F	33	2.75	0.838	-350	-328	-356	-362	-350	-344	-331	-343	-338	-352	-362	-356	-362	-336	-349	-374	-388	-396	-377	-369
G	39	3.25	0.991	-407	-401	-397	-380	-369	-369	-366	-364	-358	-380	-394	-395	-390	-366	-384	-409	-415	-433	-389	-395

Grid ID				81	82	83	84	85	86	87	88	89	90	91	92	93	94
	in			483	489	495	501	507	513	519	525	531	537	543	549	555	561
		ft		40.25	40.75	41.25	41.75	42.25	42.75	43.25	43.75	44.25	44.75	45.25	45.75	46.25	46.75
			m	12.268	12.421	12.573	12.726	12.878	13.030	13.183	13.335	13.488	13.640	13.792	13.945	14.097	14.250
A	3	0.25	0.076	-350	-354	-327	-324	-323	-334	-344	-314	-299	-304	-314	-315	-330	-307
B	9	0.75	0.229	-342	-340	-331	-326	-331	-329	-329	-308	-291	-298	-299	-310	-313	-312
C	15	1.25	0.381	-346	-351	-345	-331	-317	-308	-311	-302	-291	-296	-304	-325	-321	-312

D	21	1.75	0.533	-327	-335	-324	-326	-326	-312	-317	-330	-321	-321	-324	-342	-335	-313
E	27	2.25	0.686	-342	-350	-336	-339	-344	-333	-327	-324	-336	-345	-341	-340	-347	-327
F	33	2.75	0.838	-363	-363	-357	-359	-360	-372	-367	-340	-379	-406	-396	-389	-382	-371
G	39	3.25	0.991	-401	-389	-380	-393	-414	-423	-410	-387	-414	-458	-443	-463	-432	-395

WEST Side (Sections 1 and 2 combined)

Grid ID				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	in			3	9	15	21	27	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117
		ft		0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75
			m	0.076	0.229	0.381	0.533	0.686	0.838	0.991	1.143	1.295	1.448	1.600	1.753	1.905	2.057	2.210	2.362	2.515	2.667	2.819	2.972
A	3	0.25	0.076	-342	-314	-341	-288	-277	-281	-260	-245	-233	-260	-246	-253	-298	-274	-258	-320	-327	-346	-345	-329
B	9	0.75	0.229	-294	-338	-301	-290	-325	-291	-361	-310	-306	-291	-288	-283	-302	-288	-256	-349	-383	-325	-330	-293
C	15	1.25	0.381	-399	-391	-373	-430	-438	-413	-375	-359	-358	-347	-332	-338	-330	-325	-341	-364	-399	-356	-362	-325
D	21	1.75	0.533	-401	-358	-422	-463	-475	-440	-369	-340	-341	-334	-321	-334	-324	-343	-364	-369	-359	-355	-330	-312
E	27	2.25	0.686	-414	-372	-408	-468	-444	-429	-353	-361	-348	-342	-350	-352	-330	-331	-371	-400	-387	-356	-330	-322
F	33	2.75	0.838	-423	-420	-400	-464	-483	-457	-441	-394	-359	-345	-368	-359	-334	-341	-352	-380	-390	-383	-370	-364
G	39	3.25	0.991	-413	-428	-432	-467	-489	-478	-498	-406	-356	-345	-364	-358	-352	-356	-366	-358	-374	-394	-382	-378

Grid ID				21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	in			123	129	135	141	147	153	159	165	171	177	183	189	195	201	207	213	219	225	231	237
		ft		10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25	18.75	19.25	19.75
			m	3.124	3.277	3.429	3.581	3.734	3.886	4.039	4.191	4.343	4.496	4.648	4.801	4.953	5.105	5.258	5.410	5.563	5.715	5.867	6.020
A	3	0.25	0.076	-306	-325	-357	-369	-382	-385	-393	-401	-387	-400	-391	-380	-398	-378	-365	-357	-360	-360	-356	-356
B	9	0.75	0.229	-342	-352	-367	-385	-361	-363	-395	-412	-393	-416	-407	-382	-368	-374	-366	-360	-366	-344	-351	-350
C	15	1.25	0.381	-321	-338	-349	-363	-379	-404	-376	-364	-348	-398	-395	-365	-344	-355	-330	-325	-320	-320	-316	-334
D	21	1.75	0.533	-300	-311	-336	-350	-359	-374	-343	-326	-309	-326	-352	-327	-337	-327	-323	-328	-340	-346	-342	-349
E	27	2.25	0.686	-325	-321	-330	-322	-317	-320	-313	-306	-325	-306	-210	-318	-326	-329	-321	-345	-361	-371	-362	-352
F	33	2.75	0.838	-374	-345	-356	-358	-360	-338	-320	-334	-336	-318	-174	-320	-337	-340	-340	-371	-392	-396	-369	-367
G	39	3.25	0.991	-435	-357	-338	-376	-418	-364	-350	-379	-409	-355	-242	-352	-361	-355	-370	-388	-426	-414	-382	-376

Grid ID			41	42	43	44	45	46	47	54	55	56	57	58	59	60
	in		243	249	255	261	267	273	279	321	327	333	339	345	351	357
		ft	20.25	20.75	21.25	21.75	22.25	22.75	23.25	26.75	27.25	27.75	28.25	28.75	29.25	29.75

			m	6.172	6.325	6.477	6.629	6.782	6.934	7.087	8.153	8.306	8.458	8.611	8.763	8.916	9.068
A	3	0.25	0.076	-364	-355	-362	-370	-391	-404	-413	-318	-333	-367	-369	-295	-331	-261
B	9	0.75	0.229	-347	-342	-356	-368	-371	-397	-405	-308	-350	-366	-371	-349	-338	-329
C	15	1.25	0.381	-309	-326	-335	-344	-365	-379	-403	-327	-345	-373	-385	-363	-364	-325
D	21	1.75	0.533	-344	-331	-339	-344	-373	-381	-364	-329	-320	-377	-415	-368	-346	-327
E	27	2.25	0.686	-360	-360	-357	-356	-367	-377	-355	-304	-301	-333	-343	-339	-350	-351
F	33	2.75	0.838	-372	-354	-378	-374	-378	-360	-357	-330	-308	-323	-311	-342	-375	-352
G	39	3.25	0.991	-345	-298	-355	-404	-416	-392	-387	-373	-389	-349	-366	-376	-381	-385

Grid ID				61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
	in			363	369	375	381	387	393	399	405	411	417	423	429	435	441	447	453	459	465	471	477
		ft		30.25	30.75	31.25	31.75	32.25	32.75	33.25	33.75	34.25	34.75	35.25	35.75	36.25	36.75	37.25	37.75	38.25	38.75	39.25	39.75
			m	9.220	9.373	9.525	9.678	9.830	9.982	10.135	10.287	10.440	10.592	10.744	10.897	11.049	11.202	11.354	11.506	11.659	11.811	11.964	12.116
A	3	0.25	0.076	-268	-291	-312	-316	-320	-333	-346	-336	-329	-335	-320	-337	-372	-348	-358	-314	-333	-361	-349	-334
B	9	0.75	0.229	-318	-310	-315	-306	-316	-333	-323	-331	-341	-333	-334	-337	-359	-393	-336	-304	-312	-313	-338	-311
C	15	1.25	0.381	-315	-330	-323	-320	-314	-332	-329	-351	-344	-328	-320	-282	-296	-401	-315	-268	-281	-294	-311	-312
D	21	1.75	0.533	-308	-334	-328	-323	-330	-324	-328	-333	-341	-323	-337	-324	-301	-349	-348	-319	-346	-325	-341	-342
E	27	2.25	0.686	-318	-318	-329	-382	-387	-340	-307	-320	-342	-344	-346	-338	-340	-349	-333	-346	-364	-347	-363	-366
F	33	2.75	0.838	-347	-371	-371	-401	-383	-359	-312	-339	-341	-336	-359	-362	-373	-375	-377	-394	-388	-379	-382	-408
G	39	3.25	0.991	-398	-372	-400	-399	-374	-381	-357	-357	-356	-376	-383	-418	-412	-399	-423	-454	-429	-417	-411	-438

Grid ID				81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
	in			483	489	495	501	507	513	519	525	531	537	543	549	555	561	567
		ft		40.25	40.75	41.25	41.75	42.25	42.75	43.25	43.75	44.25	44.75	45.25	45.75	46.25	46.75	47.25
			m	12.268	12.421	12.573	12.726	12.878	13.030	13.183	13.335	13.488	13.640	13.792	13.945	14.097	14.250	14.402
A	3	0.25	0.076	-329	-351	-344	-360	-341	-328	-327	-311	-317	-307	-255	-240	-233	-294	-270
B	9	0.75	0.229	-312	-334	-344	-334	-302	-280	-281	-281	-255	-224	-224	-203	-195	-194	-197
C	15	1.25	0.381	-302	-299	-334	-341	-328	-289	-284	-281	-263	-252	-238	-222	-224	-211	-184
D	21	1.75	0.533	-339	-328	-340	-330	-334	-317	-309	-305	-303	-313	-314	-264	-269	-304	-320
E	27	2.25	0.686	-347	-341	-330	-329	-315	-323	-327	-320	-313	-327	-349	-352	-335	-356	-349
F	33	2.75	0.838	-417	-394	-379	-349	-323	-334	-348	-350	-339	-354	-373	-364	-397	-401	-415
G	39	3.25	0.991	-439	-434	-407	-400	-365	-369	-371	-369	-386	-404	-384	-390	-432	-439	999

APPENDIX B -- CONCRETE PETROGRAPHY

APPENDIX B – Concrete Petrography: Component Definitions

B.1 FINE AGGREGATE DEFINITIONS

B.1.1 Rock fragments

Chert, cryptocrystalline or microcrystalline SiO_2, is a very abundant constituent of the fine aggregate. There is a continuous gradation of crystal sizes from too small to be resolved under a light microscope to distinguishable crystals. Larger crystals grade into quartzite. Some grains have iron oxide filling fractures or permeating the rock. Clay or micaceous inclusions and alignment of mica flakes in some grains indicates that some of the chert borders on being schist. This category includes agate, represented by a few fibrous microcrystalline quartz particles present in a thin section from core 69A/B.

Diorite and *andesite* consist primarily of plagioclase feldspar with ferromagnesian silicates, and small amounts of quartz. Diorite has larger mineral grains, and andesite finer ones.

Gneiss is a medium-grained metamorphic rock similar in mineralogy to schist, but having alternating layers of light and dark minerals. [**Note:** Many of the schist and gneiss fragments appear to have been derived from previously existing impure sandstones (graywacke); they contain similar mineral and rock fragments. Alignment of micaceous or acicular minerals is stronger in the metamorphic rocks.]

Granite consists primarily of coarse quartz and feldspar, with small amounts of ferromagnesian silicates. One fragment of rhyolite, the fine-grained equivalent of granite, was identified in a thin section from core 27F and is included in this category.

Graywacke is a sandstone that contains large proportions of minerals other than quartz. Mineral grains are usually quite angular, and the matrix is hematite and clay.

Mafic igneous and miscellaneous *metamorphic rocks* consist of pyroxene and other ferromagnesian silicate minerals, chromite and/or magnetite, olivine and/or serpentine. Iron oxide is generally abundant in these rock fragments.

Quartzite is similar to chert, with larger crystals of quartz intergrown with one another. Boundaries between crystals tend to be sutured, as is characteristic of metamorphic forms of quartz. Again, fracture fillings of iron oxide are common and there are some inclusions. Quartzite is another abundant constituent.

Sandstone contains grains of sub-angular to sub-rounded chert and quartz, with small amounts of feldspar and ferromagnesian silicates. Grains are bound together with hematite (iron oxide) and/or calcite.

Schist is a fine-grained metamorphic rock containing two or more of the following minerals (in order of abundance): quartz, mica, feldspar, iron oxides, ferromagnesian silicates, carbonate minerals, and opaque minerals (mostly pyrite and magnetite). In some cases, heavy iron oxide staining is present. Micaceous or acicular minerals are aligned, creating a direction of preferred breakage. Rock fragments are frequently elongated in this direction. Schist grains tend to be larger than other fine aggregate constituents in the Rocky Point concrete.

Serpentinite is a metamorphic rock consisting predominantly of serpentine and residual olivine grains. Serpentine is a fibrous or micaceous silicate mineral that is a common product of the alteration of olivine-rich rocks.

Shale and *slate* are uncommon aggregate fragments; they are very fine grained and laminated. Their mineralogy includes clays and iron oxide.

Undifferentiated rock fragments were obscured by heavy iron oxide staining in some cases. Others apparently consist entirely of clay and iron oxide.

B.1.2 Mineral constituents

Carbonate includes fine-grained and coarse-grained calcite or dolomite ($(Ca,Mg)CO_3$). Fragments may be fine-grained limestone, coarse-grained vein carbonate, or portions of shells.

Feldspar is a group of silicate minerals; those in these cores are usually orthoclase (K feldspar), although some plagioclase (Ca-Na) feldspar is also present. Some are very altered and have clay minerals along cleavage planes or dispersed throughout the grain.

Ferromagnesian silicates are silicate minerals rich in iron, magnesium, and sometimes calcium. If exposed to weathering, they may deteriorate rapidly into iron oxide and clays.

Opaque minerals do not transmit light. It is not possible to determine optical properties for these minerals; however, examination of the sections under a binocular microscope shows that the dominant opaque species are pyrite and magnetite.

Quartz refers to individual crystals of SiO_2. Many of them demonstrate optical properties that are indicative of metamorphic quartz.

B.1.3 Other constituents

Holes fall into two categories: those that were present in the concrete before sample preparation, and those that were created during sample preparation by grain plucking. Only pores that were circular or nearly so were counted, in order that those created during sample preparation were not included. The concrete porosity may be underestimated by this method of determination.

Slag fragments occur only in the two sections prepared from patch concrete cores 30B and 36A. These are almost completely devitrified and have some angular edges, indicating that the fine aggregate was prepared by crushing coarser material.

Wood is a rare constituent.

B.2 COARSE AGGREGATE DEFINITIONS

B.2.1 Rock constituents

Chert and quartzite. (see Fine Aggregate, Rock Fragments)

Clay balls are the result of extreme alteration of fine-grained igneous rocks. They consist of clay, iron oxide, and sometimes quartz, and differ from shale and slate in that they are not laminated and are usually reddish or tan in color.

Granite, diorite, and andesite. (see Fine Aggregate, Rock Fragments)

Mafic igneous rocks. (see Fine Aggregate, Rock Fragments)

Sandstone and graywacke sandstone. In the coarse aggregate, some graywacke fragments contain large grains of metamorphic and igneous rock types, including schist, chert, and diorite, in addition to the mineral fragments named in the description of the fine aggregate. These sedimentary rocks are cemented with iron oxides and clays, but sometimes have micaceous minerals between the grains. They have been apparently affected by a degree of metamorphism in the geologic past.

Schist and gneiss. Close examination of the schist fragments show that there are two varieties of schist: a muscovite mica schist, in which the fabric of the schist is delineated by bands of white muscovite mica, and a chlorite schist, in which green chlorite is the micaceous mineral present. Some aggregate fragments consist of chlorite schist interlayered with quartzite. The dominant lithology was used to categorize the fragment in these cases.

Serpentinite. (see Fine Aggregate, Rock Fragments)

Shale and slate. (see Fine Aggregate, Rock Fragments)

B.2.2 Other constituents

Wood. (see Fine Aggregate, Other Constituents)

B.2.3 Key to coarse aggregate mineral identification

The key to the labels in Figures 4.16 through Figure 4.21 is as follows:

Ch - chert
G - granitic to dioritic igneous rocks (both fine and coarse grained)
F - rock of indeterminate type, permeated with iron oxide
H - hole
Q - quartz or quartzite

S	-	schist
S/Q	-	intermixed schist and quartz
Ss	-	sandstone or graywacke sandstone
Serp	-	serpentinite
W	-	wood

B.3 DETAILED PETROGRAPHY RESULTS

B.3.1 Fine aggregate

Most of the thin sections were made from original concrete cores. The two made from two-inch cores are known to be from patch concrete. The fine aggregate in a thin section from three-inch core 69A was significantly different in mineralogy from that of the original concrete or of the known patch concrete.

The following sections describe the mineral and rock fragments found in the fine aggregate fraction of the concrete. The mean abundance and standard deviation for each fine aggregate component were derived from grain counts and are shown in Table 4.2. Variation in the abundance of less common constituents resulted, in some instances, in standard deviations larger than the mean values.

An immediately obvious difference between the fine aggregate components of the original and patch concretes, from a petrographic viewpoint, was the presence of devitrified slag particles in the known patch material (Patch 1 in Table 4.2). In comparison with the original concrete, the fine aggregate of the Patch 1 concrete contained more grains in the following categories: serpentinite, quartz, and feldspar. It contained fewer grains in the categories of chert and quartzite (silica); granite, diorite, and andesite; and fewer holes.

The average grain size of the patch concrete fine aggregate appeared somewhat coarser than the original concrete fine aggregate, although no quantitative size measurements were made. The aggregate-to-cement ratio was higher in the patch concrete, and much of the aggregate was iron-stained. Patch 1 concrete had relatively few holes in the cementitious matrix, and large areas of anisotropic matrix, i.e., the matrix had different optical properties in different coordinate directions.

The thin section from 3-inch core 69A/B (section ME3646A) was suspected to represent a different patch concrete mix than the known patch concrete, and was quite different from the original concrete. This different patch concrete mix was labeled Patch 2 in Table 4.2. Percentages of grains in the five categories that were most populated in Patch 2 material were greater than one standard deviation from the mean values for the same categories of the original concrete. Not enough grains were counted in the known patch concrete (Patch 1) thin sections to draw conclusions about the statistical likelihood that the two patch concrete mixtures were different. However, there were no slag fragments in the thin section of Patch 2. In addition, schist and gneiss were much more abundant and quartz much less common in Patch 2 than in the

Patch 1 sections. Thus, it is suspected that the thin section of Patch 2 represents another patch concrete mix, perhaps used in a repair at a different time, or in a repair at the same time but from a different contractor or a different batch or concrete.

B.3.2 Coarse aggregate

The lithology of coarse aggregate fragments (greater than 2 mm) was determined in ten cores of original concrete and three cores of known patch concrete. A statistically significant number of aggregate particles was counted for the original concrete only.

Many constituents of the coarse aggregate fraction of the concrete are the same as those in the fine aggregate. Results of grain counts are shown in Table 4.3. Color photographs of the three-inch cores are paired with matching black-and-white versions, Figures 4.16 through 4.21. The coarse aggregate grains are visible in both photographs and are identified on the black-and-white version using the key given in Appendix B.2.3.

The differences between coarse aggregate constituents of the original and patch concretes are less obvious than they are for the fine aggregate. The apparent differences in abundance of chert/quartzite and granite/diorite are not statistically significant. In a qualitative visual comparison of the concrete cores, the coarse aggregate of the patch concrete was determined to have a smaller maximum size than that of the original concrete. No examination was made of the coarse aggregate in core 69A/B (Patch 2 in the discussion of fine aggregate).

B.3.3 Reaction products

When deterioration reactions occur in concrete, the reaction products fill cracks, pores, and voids and cross-cut pre-existing structures, occasionally pushing aggregate aside or splitting it along weak planes. Very few areas of the thin sections studied microscopically produced evidence of significant reaction products. However, traces of reaction products were observed in both the original concrete and the patch concrete cores.

Deteriorated areas of the Viaduct concrete, including areas under loosened aggregate grains, were examined macroscopically by ultra-violet light using a standard uranyl acetate application to reveal the presence of significant ASR products. None of the concrete exhibited the yellow-green fluorescence distinctive of ASR products.

No sodium-rich gel products or reaction rims were found by microscopic study that would indicate either ASR or ACR reactions had occurred in either the original concrete or in the patch areas studied. However, in all of the samples, fine aggregate materials in the cement include abundant quantities of cryptocrystalline quartz (some of which is of metamorphic origin), quartz-rich rocks, and plagioclase feldspar. These types of materials are considered to be important components of known ASR occurrences.

Another reaction mechanism that is known to cause damage to concrete is the formation of gypsum or ettringite through the sulfation reaction of calcium and aluminum. The reaction can result in the formation of relatively large crystals which results in expansive forces causing the concrete to crack. No sulfate minerals were detected in the concrete samples, although small pyrite crystals, a ready source of sulfur, were observed in some of the larger aggregate rock.

A thin section of concrete from near a corroded portion of the rebar showed significant hydrated iron oxide infusion of local areas of the concrete. The iron oxide stained the cement in its vicinity, forced its way into cracks in nearby aggregate materials, and caused nearby aggregate to shift position slightly within the concrete.

Sparse areas in a thin section from the original concrete and a thin section from Patch 2 had cross-cutting veins of calcium carbonate material that indicate some reaction with carbonic, hydrochloric, or other acid. Both of these areas also contained fragments of shell material that were in the process of being solubilized and recrystallized into the carbonate veins. The carbonate veins were mixed with residual calcium oxide and calcium silicate hydrate cement material. The presence of shells suggests the source for some of the fine aggregate was beach sand. This fact would suggest the opportunity existed for contamination of the concrete by sea salt from the use of unwashed beach sand in the concrete mix.

Reactions within the aggregate materials themselves that occurred prior to incorporation into the concrete mixture were confined to individual grains. These veins and fracture fillings of such materials as quartz, opal, calcite, clays, and iron oxide minerals are common in aggregate materials, as are reaction rims, and are not part of the concrete deterioration process. They are formed from reactions between the original rock and altering solutions such as mineralized or acidic waters, either in their original depositional environments or under weathering or transport conditions.

In summary, the composition of the original concrete included a high amount of cryptocrystalline silica, sources of sodium in plagioclase feldspar and sea salt, and a source of sulfur in pyrite. These constituents are known to contribute to the formation of significant reaction products in hardened concrete. However, the petrographic results suggested that deterioration of the Rocky Point Viaduct was not due to their presence. The petrographic results indicated that chloride incorporation (from probable sea salt introduced with sand components), chloride penetration (from salt spray and fogs), and possibly some carbonation resulting in liberation of bound chlorides, caused corrosion of the rebar and deterioration of the original concrete.

Spot analysis indicated that the patch cement had an average composition higher in reactive Al_2O_3 and MgO than the original concrete. Elevated amounts of chloride penetrated both the original and patch concrete near the outside surface of the beam. Since chloride penetration rates depend primarily upon cement paste composition and type, the higher Al_2O_3 and MgO in the patch concrete may explain the higher amount of penetrated chloride in weathered surfaces of the patch concrete compare to the original concrete.

APPENDIX C -- SURFACE AIR PERMEABILITY, SCCC

APPENDIX C -- Surface Air Permeability, standard cubic centimeter/minute (mL/min)
EAST Side (Section 1)

Grid ID				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	in			3	9	15	21	27	33	39	45	51	57	63	69	75	81	87	93	99	105	111	117
		ft		0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75
			m	0.08	0.23	0.38	0.53	0.69	0.84	0.99	1.14	1.30	1.45	1.60	1.75	1.91	2.06	2.21	2.36	2.51	2.67	2.82	2.97
A	3	0.25	0.076	999	999	999	999	999	999	999	999	999	999	999	999	999	40.6	999	999	62.2	999	59	58
B	9	0.75	0.229	999	999	999	999	999	999	37	54.3	999	27.4	999	999	999	999	999	999	999	999	47	999
C	15	1.25	0.381	999	999	999	47.6	999	31.9	999	999	37.6	46.9	999	999	42.6	15.7	999	53.2	17.5	999	999	24.1
D	21	1.75	0.533	999	30.2	999	52.9	59.8	999	999	999	999	999	999	999	999	999	999	999	999	49.6	999	999
E	27	2.25	0.686	999	999	999	999	999	38.6	999	49.9	999	54.3	999	999	999	999	52.6	999	999	61.9	999	999
F	33	2.75	0.838	999	999	999	999	62.8	32	999	36	54.7	999	999	999	999	999	999	57.9	999	999	999	999
G	39	3.25	0.991	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	65.2	999	999	999	999

Grid ID				21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	in			123	129	135	141	147	153	159	165	171	177	183	189	195	201	207	213	219	225	231	237
		ft		10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25	18.75	19.25	19.75
			m	3.12	3.28	3.43	3.58	3.73	3.89	4.04	4.19	4.34	4.50	4.65	4.80	4.95	5.11	5.26	5.41	5.56	5.72	5.87	6.02
A	3	0.25	0.076	999	999	999	999	55.2	999	999	999	999	999	999	53.8	999	57.2	999	48.7	999	999	64.9	999
B	9	0.75	0.229	999	999	50.6	999	999	999	999	29.6	999	999	999	999	999	37.7	999	57.4	999	57.4	999	999
C	15	1.25	0.381	999	999	999	999	43.9	999	999	999	999	62.4	999	999	999	999	35.9	999	999	999	999	999
D	21	1.75	0.533	999	999	999	52.4	999	999	999	999	999	999	58.3	999	999	35	999	999	999	999	36	999
E	27	2.25	0.686	53.9	999	57.1	999	999	999	999	61.4	999	999	999	37.6	999	999	999	28.5	39.4	999	999	39.3
F	33	2.75	0.838	999	26.8	999	57.2	999	42.4	999	999	999	999	999	999	999	999	999	999	999	999	999	999
G	39	3.25	0.991	999	999	999	999	999	999	999	999	999	999	999	52.3	999	999	999	18.4	999	999	35.6	999

Grid ID				41	42	43	44	45	46	47
	in			243	249	255	261	267	273	279
		ft		20.25	20.75	21.25	21.75	22.25	22.75	23.25
			m	6.17	6.32	6.48	6.63	6.78	6.93	7.09
A	3	0.25	0.076	999	55.4	999	999	999	999	999
B	9	0.75	0.229	999	999	999	999	999	999	999
C	15	1.25	0.381	999	999	999	999	999	32.8	999
D	21	1.75	0.533	53.6	999	999	999	999	999	999
E	27	2.25	0.686	999	999	999	999	999	999	999
F	33	2.75	0.838	999	999	999	999	999	999	999
G	39	3.25	0.991	29.5	999	999	999	999	32	999

999 = missing data; no measurement.