October 31, 2001

JEGEL 101041

DRAFT FINAL REPORT
FOR REVIEW AND DISCUSSION

REJUVASEAL EVALUATION
CFB COLD LAKE AND CFB WAINWRIGHT

Prepared For

ECHELON INDUSTRIES, INC.

By

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REJUVASEAL EVALUATION
CFB COLD LAKE AND CFB WAINWRIGHT

EXECUTIVE SUMMARY

John Emery Geotechnical Engineering Limited, Consulting Engineers (JEGEL), conducted environmental analyses to assess the Sand RejuvaSeal applications completed at CFB Wainwright and CFB Cold Lake. Sand RejuvaSeal consists of RejuvaSeal proprietary coal-tar rejuvenator sealer plus a frictional sand (angular, clean, durable fine aggregate such as fine boiler slag or nonferrous slag). The work was completed at the request of Bill Vandemark of Echelon Industries, Inc.

Evaluations of the Sand RejuvaSeal applications at CFB Wainwright and CFB Cold Lake have been performed by JEGEL and others, including the Department of National Defence. These evaluations include: compositional analyses of RejuvaSeal and sweeper samples supplied to Echelon Industries, Inc. by DND; sweeper dust and snow/sweepings sampling by Jacques Whitford and Associates Limited; and hydrocarbon/PAH analyses of a water sample supplied by DND to Norwest Labs. A work plan was developed by JEGEL and implemented to investigate potential environmental impacts of the Sand RejuvaSeal, and is also described.

The results of the Sand RejuvaSeal evaluations are briefly summarized in the following paragraphs.

Compositional Analyses of RejuvaSeal and Sweeper Samples – Two samples of sweeper dust and a sample of the RejuvaSeal rejuvenator sealer were analysed to determine both organic and inorganic constituents. The analyses consisted of general composition by pyrolysis @ 550EC to determine the proportion of organic and inorganic constituents; volatile organic constituents by gas chromatograph (RejuvaSeal sample only) and non-volatile constituents by infrared spectrometer; and analysis of the inorganic residue for metallic oxides by plasma spectrometer (ICAP Total Oxide Analysis). The analyses indicate that the volatile organic constituents (solvents) consist of a mixture of hydrocarbon fractions containing both aliphatic and aromatic compounds similar in composition to Varsol. The infrared analysis results for the non-volatile organic constituents (resins) of the sealer indicated that the sample consisted of a mixture of hydrocarbon polymers, mostly aliphatic compounds. The analyses of the non-volatile constituents of the two sweepings samples indicated that the two samples were identical in composition and consisted of a mixture of hydrocarbon polymers containing aromatic and aliphatic rubber-like compounds. It is speculated that the presence of rubber-like compounds may be attributable to rubber build-up from aircraft tires. DND provided a sample of a typical aircraft tire for comparative compositional analysis, but the results of the comparative analysis were not conclusive.

Jacques Whitford Sweeper Dust and Snow/Sweepings Sampling – On February 23/01, samples of the sweeper dust and snow/sweepings were obtained at CFB Cold Lake by Jacques Whitford. A summary report describing this site visit, RejuvaSeal inspection and sampling details has been prepared, and includes photographs of the runway surfaces, snow banks, and the sweeper equipment and equipment maintenance facilities. A total of 6 liquid and 7 solid samples were taken, representing sweeper residue (dust) and melt water from snow banks. Upon receipt at JEGEL, it was determined that the individual snow samples, once melted, did not provide sufficient liquid to permit individual analyses of the organic constituents to be completed. Samples of the snow melt were submitted for inorganic analysis.

Hydrocarbon/PAH Analysis of Water Samples – A sample(s) obtained by DND in the vicinity of Building 85 was submitted to Norwest Labs for analysis of non-halogenated aromatics (BTEX), total purgeable hydrocarbons and total extractable hydrocarbons. The precise nature of the sample is not known and DND has been contacted for additional details. The sample was also analysed for polyaromatic hydrocarbons (PAH). Comparison of the analysis results with the Canadian Council of Environment Ministers (CCME) Water Quality Guidelines for the Protection of Aquatic Life indicated several exceedances of PAH criteria.

JEGEL Field Sampling and Laboratory Testing Program - JEGEL has developed a program of field sampling in order to obtain samples of the sealed pavements at CFB Cold Lake and CFB Wainwright for laboratory evaluation of the RejuvaSeasl-treated asphalt concrete surface physical properties in accordance with the application contract requirements, and to obtain additional samples of RejuvaSeal-treated and untreated pavement for environmental testing.

The field sampling (coring) work was sub-contracted to Shelby Engineering of Edmonton. The proposed analyses included bulk analyses of major oxides, determination of volatile and non-volatile organic constituents. In addition, both distilled water and acid leach testing were carried out, both on intact cores and 'crushed' cores, for comparison purposes.

Environmental monitoring of the RejuvaSeal treatments at CFB Cold Lake and CFB Wainwright coordinated by JEGEL, with independent laboratory testing of asphalt concrete cores, sweeping material and asphalt pavement surface runoff (treated areas and untreated control areas) has shown no significant exceedances of applicable environmental criteria (CCME for instance), particularly when treated and untreated areas are compared (some natural mineral constituents and/or operational activities such as de-icing can cause exzceedances).

TABLE OF CONTENTS

REJUVASEAL EVALUATION
CFB COLD LAKE AND CFB WAINWRIGHT

INTRODUCTION

At the request of Bill Vandemark of Echelon Industries, Inc., John Emery Geotechnical Engineering Limited, Consulting Engineers (JEGEL), undertook an environmental evaluation of the RejuvaSeal rejuvenator sealer material (actually Sand RejuvaSeal consisting of RejuvaSeal coal-tar rejuvenator sealer and a frictional fine aggregate (nonferrous slag)) and its application at Department of National Defence (DND) airport facilities at CFB Cold Lake and CFB Wainwright.

Sand RejuvaSeal was applied to the runway and taxiway pavements at CFB Cold Lake in September 2000. The CFB Wainwright runway and taxiway pavements had been previously sealed with RejuvaSeal in 1997. DND personnel at CFB Cold Lake expressed concern with the RejuvaSeal materials when a significant amount of the fine slag aggregate and RejuvaSeal material was apparently observed have been removed by winter snow/ice control operations (relatively aggressive 'sweeping' with heavy steel-wire brooming equipment).

This report summarizes the work completed by DND and others, previously presented by JEGEL ("Progress Report, RejuvaSeal Evaluation, CFB Cold Lake and CFB Wainwright", dated March 26, 2001), and describes the supplementary JEGEL investigation/evaluation of the CFB Cold Lake and CFB Wainwright pavements where the Sand RejuvaSeal had been applied.

PREVIOUS REJUVASEAL FIELD AND LABORATORY EVALUATIONS

Compositional Analysis Of RejuvaSeal And Sweeper Samples Supplied To JEGEL By DND

Samples of the RejuvaSeal rejuvenator sealer and sweepings from CFB Cold Lake supplied by Ray Clement of DND were submitted by JEGEL to Cambridge Material Testing Limited in Mississauga, Ontario for compositional analysis to determine both organic and inorganic constituents. One sample of the RejuvaSeal rejuvenator sealer and two samples of sweepings (described as solid/granules & dust from Sweeper #24010 and Sweeper #78132) were submitted on February 22/01. The analyses consisted of general composition by pyrolysis @ 550EC to determine the proportion of organic and inorganic constituents; volatile organic constituents by gas chromatograph (RejuvaSeal sample only) and non-volatile constituents by infrared spectrometer; and analysis of the inorganic residue for metallic oxides by plasma spectrometer (ICAP Total Oxide Analysis). The complete results of the analyses are given in Appendix A (Cambridge Materials Testing Limited Laboratory Report No. 273760-01, dated March 9/01).

The analysis results for RejuvaSeal rejuvenator sealer indicated that the volatile organic constituents (solvents) consist of a mixture of hydrocarbon fractions containing both aliphatic and aromatic compounds similar in composition to Varsol[1]. The infrared analysis results for the non-volatile organic constituents (resins) of the sealer indicated that the sample consisted of a mixture of hydrocarbon polymers, mostly aliphatic compounds.

The analyses of the non-volatile constituents of the two sweepings samples indicated that the two samples were identical in composition and consisted of a mixture of hydrocarbon polymers containing aromatic and aliphatic rubber-like compounds. It was speculated that the rubber compounds found in the sweepings may have originated from the aircraft tire rubber built up on the runway surface. Subsequently, a sample of CF-18 aircraft tire was supplied by DND for comparative analysis. The results of the aircraft tire analysis (Appendix D) showed the material to consist of polyurethane-type elastomer. Consequently, it does not appear that the aromatic and aliphatic rubber-like compounds found in the sweepings are the same as the CF-18 aircraft tire rubber sample supplied; however, there are apparently other types of tires used at CFB Cold Lake that could potentially be a source of the rubber compounds identified in the sweepings.

1 *Varsol™* refers to a premium commercial, industrial and household solvent that is commonly used as a paint thinner/cleaner and degreaser. It is a petroleum distillate of the aliphatic hydrocarbon family.

Jacques Whitford Sweeper Dust And Snow/Sweepings Sampling – February 23/01

Samples of the sweeper dust and snow/sweepings were also obtained at CFB Cold Lake on behalf of Echelon Industries, Inc. by Jacques Whitford and Associates Limited, Calgary. Jacques Whitford has prepared a summary report describing this site visit and RejuvaSeal inspection (their Project No. ABC10632, dated February 27/01). The report (given in Appendix B) summarizes the site visit and sampling details, with photographs of the runway surfaces, snow banks, and the sweeper equipment and equipment maintenance facilities. Samples were obtained on February 23/01 then shipped to JEGEL in Toronto on February 28/01 (received March 2/01). A total of 13 samples were taken, 6 liquid and 7 solid, described as:

JARS

1. From Snow Banks On Runway 04/22
2. From Snow Banks on Inner Runway, High Speed Area
3. From Snow Banks outside the Heavy Equipment Building (Bldg. No. 85) – 2 jars
4. From Sweeping Machine, while working on Hammerhead 31L on Outer Runway
5. From Sweeping Machine, Taken Outside the Heavy Equipment Building (machine just came back from sweeping job on Inner Runway)

Not Numbered: De-Icing Fluid (mainly potassium acetate) from storage tank

BAGS

Not Numbered: De-Icing Salt (mainly sodium formate) from storage

6. Dust from Machines (parked inside the Heavy Equipment Building)
7. Dust from Machine (taken outside the Heavy Equipment Building) – machine just came back from sweeping job on Inner Runway)
8. Dry Crust from Broom of Sweeping Machine (parked inside Heavy Equipment Building)
9. Dry Crust from Shop Floor of the Heavy Equipment Building (where sweeping machine was parked)
10. Sludge from Fresh Footprints in Corridor of the Heavy Equipment Building
11. Paper Cloth Wiped On (Machine plus Hand Sweeped) Surface on Inner Runway, High Speed Area (close to where Sample #2 was taken).

Upon receipt of the samples at JEGEL, the samples were inventoried and inspected for analysis potential. Of particular interest for these samples was the organic constituents, with polyaromatic hydrocarbons of main concern. It was determined through JEGEL discussion with Cambridge Materials Testing Limited that the jars did not contain sufficient liquid to permit individual analyses of the organic constituents to be completed (JEGEL advised Echelon Industries, Inc. of this on March 7/01). However, three samples of the snow melt were selected by JEGEL and submitted to Cambridge for general analysis to the extent possible given the small samples size:

1. From Snow Banks On Runway 04/22
2. From Snow Banks on Inner Runway, High Speed Area
3. From Snow Banks outside the Heavy Equipment Building (Bldg. No. 85).

These samples were submitted on March 21/01. Because of the small sample size, it was only possible to test the samples for inorganic constituents (metals). The test results are summarized in Table 1, with the full analysis results presented in Appendix E. The test results for all three samples exhibit relatively high concentrations of potassium and sodium (near the heavy equipment building only) that are attributed to the use of potassium acetate and sodium formate de-icing chemicals.

Norwest Labs Report Of Hydrocarbon/PAH Analysis Of February 8/01 Sample

Jacques Whitford also forwarded a copy of the results of laboratory testing of a sample completed by Norwest Labs of Calgary (Appendix C). The Jacques Whitford notes states that "...to appraise possible health and environmental risks samples of the suspect material were taken on February 08, 2001". This sample(s) had been obtained Drew Craig, Wing Environmental Technologist, 4 Wing Cold Lake and submitted for non-halogenated aromatics (benzene, toluene, ethylbenzene and total xylene), total purgeable hydrocarbons (C_5 to C_{10}) and total extractable hydrocarbons (C_{11} to C_{40+}). The sample was also analysed for polyaromatic hydrocarbons (PAH). Other than the descriptor, "Bldg 85", no details were provided indicating the type of sample(s) or its location, i.e. whether it is a sample of the RejuvaSeal itself, or snowbank meltwater containing RejuvaSeal residue/sweepings. Hand-written notes beside the individual test results indicate that there are no exceedances of non-halogenated aromatic hydrocarbons criteria for fresh water and community water. It is our understanding that the analysis results have been compared with the Canadian Council of Environment Ministers (CCME) Water Quality Guidelines for the Protection of Aquatic Life (Freshwater). Several exceedances of PAH criteria are indicated in comparison with these criteria. The PAH exceedances suggest that this testing may have been carried out on the RejuvaSeal rejuvenator

TABLE 1
SUMMARY OF SNOWBANK SAMPLE ANALYSIS RESULTS

Parameter	Analysis of Water Samples from Snowbanks, mg/L			CCME Criteria µg/L
	Runway 04/22	Inner Runway	Heavy Equipment Building	
Aluminum	0.01	0.11	0.83	5 – 100
Antimony	< 0.01	< 0.01	< 0.01	
Arsenic	< 0.01	< 0.01	< 0.01	5.0
Barium	0.08	0.12	0.15	
Beryllium	< 0.01	< 0.01	< 0.01	
Boron	< 0.01	0.01	0.16	
Cadmium	0.02	0.07	0.04	0.017
Calcium	11.54	18.29	34.07	
Chromium	< 0.01	< 0.01	< 0.01	
Cobalt	< 0.01	< 0.01	< 0.01	
Copper	< 0.01	< 0.01	< 0.01	2 – 4
Iron	0.81	3.59	1.88	300
Lead	< 0.01	< 0.01	< 0.01	1 – 7
Magnesium	2.32	2.62	0.39	
Manganese	0.29	0.05	0.02	
Molybdenum	0.05	0.07	0.08	73
Nickel	< 0.01	< 0.01	< 0.01	
Phosphorous	< 0.01	0.10	0.41	
Potassium	259.18	882.22	702.61	
Selenium	< 0.01	< 0.01	< 0.01	
Silicon	4.05	2.33	8.62	
Silver	< 0.01	< 0.01	< 0.01	
Sodium	23.50	30.22	435.59	
Strontium	0.03	0.06	0.17	
Tin	0.23	0.26	0.06	
Titanium	< 0.01	< 0.01	0.06	
Vanadium	< 0.01	0.01	< 0.01	
Zinc	0.08	0.13	0.17	
Zirconium	< 0.01	< 0.01	< 0.01	

sealer itself, but this should be confirmed by DND.

JEGEL FIELD SAMPLING AND LABORATORY TESTING PROGRAM

JEGEL developed a program of field sampling in order to obtain samples of the sealed pavements at CFB Cold Lake and CFB Wainwright for evaluation of the treated asphalt concrete surface physical properties (in accordance with the application contract requirements), and to obtain additional samples for environmental testing. The field sampling (coring) work was sub-contracted to Shelby Engineering of Edmonton. The coring work commenced at CFB Cold Lake on March 21/01, and was completed at CFB Wainwright on April 1/01 (coring work was suspended between March 23 and March 26/01 due to extremely cold weather).

The field sampling program consisted of the following elements:

1. At each location where samples were required for asphalt properties determinations, the cores were obtained as indicated below:

Treated Area

± ± ± ± ± ± ± ±

=--------------------------< 3 m ---------------------------<

3 m maximum

Untreated Area

± ± ± ± ± ± ± ±

Each corehole was properly reinstated using cold-mix asphalt that has been properly placed and well compacted.

2. Cores for asphalt properties testing were packaged conventionally for shipping to the JEGEL Toronto laboratory – the cores obtained for asphalt properties testing were placed in suitable-size clean cylinder moulds for shipping to prevent damage to the cores.

Prior to obtaining core samples for environmental testing, and between core sampling locations, the core barrel was properly cleaned with acetone, then carefully rinsed with distilled water, and dried. Cores to be used for environmental testing were not placed in plastic or metal containers, but were individually wrapped in plain (uncoated) brown (unbleached) paper bags, then placed in closed cardboard boxes so that the samples were not exposed to sunlight.

The core locations for each facility are described as follows:

CFB Cold Lake Sampling

Cores for Asphalt Properties Testing

On each of the three runways, an untreated section was left open for sampling up to one year after construction. At each of these locations, samples of the untreated and treated runway surfaces were obtained as per the above sketch.

Cores for Environmental Testing

On each of the three runways and the major taxiway, ten cores were obtained from a broomed area near the centreline of the runway and ten from the adjacent edge where there has been relatively little brooming. An additional ten cores were obtained from an untreated area of the runway for comparative analysis purposes.

CFB Wainwright Sampling

Cores for Asphalt Properties Testing

On Runway 11/29, there were several untreated sections left open for sampling. Shelby Engineering, which was previously involved in coring at this facility, located the cores for asphalt properties testing close to the same location where these previous cores were obtained.

Cores for Environmental Testing

On Runway 11/29, cores were obtained from each of two locations on the runway. The runway is to be divided into two equal length sections, then one location will be selected within each section. Ten cores were obtained from an area of the runway where significant brooming has been completed, and ten cores from the adjacent edge where there has been relatively little brooming.

ENVIRONMENTAL TESTING AND ANALYSES

Selected cores from CFB Cold Lake and CFB Wainwright were submitted for environmental analyses as follows. For each facility, representative cores were selected from a Sand RejuvaSeal treated area at the centre of the runway (where pavement brooming/sweeping activity is most concentrated) and at the adjacent edge (relatively little brooming/sweeping), and from an untreated area of the runway/taxiway. After general examination in the JEGEL laboratory, the top 10 to 15 mm of the core was removed by sawcutting and then split into specimens of approximately equal mass (about 100 g each). The specimens were then submitted to Cambridge Materials Testing Limited where the following testing was carried out:

1. Samples of the cores were analyzed for general composition by pyrolysis at 550°C to determine the proportion of organic and inorganic constituents. The volatile organic constituents were analyzed by gas chromatograph, and the inorganic constituents analyzed by infrared spectrometer. The inorganic residue (ash) was also analyzed by plasma spectrometer for metal oxides (composition); and

2. Distilled water and acid leach testing were carried out, both on intact pieces of the cores and pieces that were 'crushed' in the laboratory. The current Ontario Ministry of the Environment Ontario Regulation 347 (Amended Regulation 558) leachate extraction procedure was adopted for the acid leach testing. This test procedure is similar to the US EPA Toxicity Characteristics Leachate Procedure (TCLP). In addition, distilled (pure de-ionized) water leach tests were also carried out on similar bulk and crushed samples. The results of the acid and distilled water leach tests were then compared with the CCME Environmental Water Quality Guidelines for the Protection of Freshwater Aquatic Life.

ENVIRONMENTAL ANALYSIS RESULTS

The environmental analysis results for CFB Cold Lake and CFB Wainwright core samples are presented in Table 2, Tables 3A through 3F, and in Appendix E.

The compositional analysis results for the inorganic residues for the cores, and previous results for sweeper samples supplied by DND, are summarized in Table 2 for comparison. The test results indicate that the sweepings samples contain substantially higher concentrations of iron, zinc, barium, copper, vanadium and cobalt in comparison with the core samples from CFB Cold Lake and CFB Wainwright. The main constituents of the sweeper residues are silica and iron, with smaller quantities of calcium and zinc also present. The higher iron and zinc concentrations are most probably due to broom 'wear and tear', with the copper, vanadium and cobalt probably attributable to the nonferrous slag sand applied in conjunction with the RejuvaSeal application. The compositional analysis results for the inorganic residues for both treated and untreated surfaces at CFB Cold Lake and treated and untreated surfaces at CFB Wainwright are for all intents and purposes identical, with the major constituents being silica and smaller amounts of alumina and calcium.

The core analysis results also indicate:

- All of the Sand RejuvaSeal-treated and untreated cores tested by gas chromatography for organic composition showed either trace or no detectable concentrations of aliphatic hydrocarbons, and no detectable concentrations of polyaromatic hydrocarbons (PAH);
- The infrared analysis of the non-volatile organic constituents confirmed that the non-volatile material consists of a mixture of partially oxidized hydrocarbon resin;
- The total oxide analyses of the inorganic constituents (whole rock analyses of major oxides and metals) confirmed that the compositions of the treated and untreated cores from both CFB Cold Lake and CFB Wainwright were virtually identical, reflecting mainly the aggregate components. There was no obvious difference in the mineral compositions of the treated and untreated pavements from either facility.

The results of the leachate analyses of both bulk and 'crushed' core samples indicated the following:

- Neither the distilled water or acid leachate testing indicated the presence of polyaromatic hydrocarbons, phenols or volatile organics in the Sand RejuvaSeal treated or untreated cores;
- The leachate analyses confirmed several metals exceedances of the CCME criteria. However, in all cases, the same exceedances were generally observed for both treated and untreated cores at both facilities. In particular, the concentration of aluminum was observed to be high in almost all of the cores, and especially for the distilled water leachate testing of 'crushed' samples;
- the concentration of iron was observed to be high in almost all of the cores, and particularly for the distilled water testing of 'crushed' samples;

TABLE 2
COMPOSITIONAL ANALYSES OF INORGANIC RESIDUE (ASH)
CFB COLD LAKE AND CFB WAINWRIGHT

Constituent	Sample 1 RejuvaSeal	Building 85 – CFB Cold Lake		CFB Cold Lake			CFB Wainwright		
		Sample 2 Sweeper Residue	Sample 3 Sweeper Residue	Sample 4C Core 29 Centre/Treated	Sample 5C Core 35 Edge/Treated	Sample 6C Core 14 Untreated	Sample 7C Core 36 Centre/Treated	Sample 8C Core 42 Edge/Treated	Sample 9C Core 5 Untreated
Major Oxides, percent									
Silica	4.62	38.40	41.79	67.23	65.39	67.63	67.48	66.80	64.85
Aluminum	0.67	4.52	4.43	8.37	8.69	8.65	5.71	6.16	6.15
Iron	0.32	**28.18**	**38.64**	2.31	2.54	1.92	3.76	4.37	3.37
Calcium	0.28	6.15	8.13	4.53	4.63	4.52	6.15	6.19	6.17
Magnesium	1.88	1.00	0.97	2.27	2.13	2.04	1.44	1.25	2.56
Sodium	0.04	0.97	0.57	2.07	2.48	2.16	1.29	1.29	1.28
Potassium	0.06	2.00	1.46	2.08	2.58	2.04	1.40	1.94	1.76
Titanium	0.02	0.17	0.20	0.20	0.25	0.19	0.15	0.13	0.16
Manganese	< 0.01	0.18	0.24	0.03	0.16	0.03	0.12	0.24	0.09
Phosphorous	< 0.02	0.18	0.22	0.08	0.16	0.12	0.56	0.22	0.16
Zinc	< 0.01	**3.08**	**2.63**	-	-	-	-	-	-
Minor Constituents, µg/g									
Barium	30	**1950**	**3130**	620	730	550	510	520	500
Strontium	30	250	250	230	240	210	160	140	150
Zirconium	15	45	75	90	100	100	100	80	60
Yttrium	< 2	8	12	10	22	10	12	14	10
Scandium	< 1	2	3	4	5	4	4	4	4
Niobium	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30	< 30
Beryllium	< 1	2	4	4	4	3	4	3	3
Nickel	< 5	25	< 5	40	30	35	45	25	35
Chromium	< 5	415	245	410	170	230	575	470	425
Copper	15	**1065**	**1655**	50	60	40	80	55	30
Vanadium	25	**95**	**155**	55	65	60	60	60	60
Cobalt	5	**80**	**65**	15	20	20	1	5	15
Zinc	-	-	-	20	90	20	90	65	30
LOI	91.90	14.59	< 0.01	10.47	9.30	10.49	11.36	10.90	12.81
Total	99.81	99.41	99.30	99.63	99.32	99.79	99.41	99.50	99.36

TABLE 3A
CORES 28 AND 29
CFB COLD LAKE – CENTRE TREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 28	Crushed Sample Core 29	Bulk Sample Core 28	Crushed Sample Core 29	
Aluminum	< 1	40	**1150**	**35960**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	< 1	< 1	< 1	< 1	2 – 4
Iron	**290**	**11210**	**360**	**12750**	300
Lead	**20**	< 1	< 1	**40**	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	< 1	73
Nickel	< 1	80	10	10	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	30	**60**	< 1	30	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

TABLE 3B
CORES 34 AND 36
CFB COLD LAKE – EDGE TREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 34	Crushed Sample Core 36	Bulk Sample Core 34	Crushed Sample Core 36	
Aluminum	**180**	40	**1560**	**29870**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	< 1	< 1	< 1	**20**	2 – 4
Iron	< 1	**2040**	**540**	**17520**	300
Lead	**20**	< 1	< 1	**40**	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	< 1	73
Nickel	< 1	< 1	< 1	20	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	< 1	20	< 1	**40**	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

TABLE 3C
CORE 14
CFB COLD LAKE – UNTREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 14	Crushed Sample Core 14	Bulk Sample Core 14	Crushed Sample Core 14	
Aluminum	80	< 1	**410**	**29660**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	< 1	< 1	< 1	**20**	2 – 4
Iron	< 1	**3300**	< 1	**14470**	300
Lead	**30**	< 1	< 1	**40**	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	< 1	73
Nickel	< 1	< 1	< 1	20	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	10	30	< 1	**60**	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

TABLE 3D
CORES 35 and 36
CFB WAINWRIGHT – CENTRE TREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 35	Crushed Sample Core 36	Bulk Sample Core 35	Crushed Sample Core 36	
Aluminum	**180**	**260**	**390**	**20520**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	**30**	< 1	< 1	**10**	2 – 4
Iron	90	**9490**	**710**	**24540**	300
Lead	**20**	< 1	< 1	< 1	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	< 1	73
Nickel	10	30	< 1	10	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	< 1	30	< 1	30	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

TABLE 3E
CORES 41 and 42
CFB WAINWRIGHT – EDGE TREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 41	Crushed Sample Core 42	Bulk Sample Core 41	Crushed Sample Core 42	
Aluminum	20	**160**	**280**	**29470**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	< 1	< 1	< 1	**10**	2 – 4
Iron	< 1	**2260**	**250**	**24520**	300
Lead	< 1	**20**	< 1	**40**	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	60	73
Nickel	10	40	< 1	20	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	20	< 1	< 1	10	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

TABLE 3F
CORE 5
CFB WAINWRIGHT – UNTREATED

Parameter	O.Reg. 347 LEP, :g/L		Distilled Water LEP, :g/L		CCME Criteria :g/L
	Bulk Sample Core 5	Crushed Sample Core 5	Bulk Sample Core 5	Crushed Sample Core 5	
Aluminum	< 1	80	**560**	**59940**	5 – 100
Arsenic	< 1	< 1	< 1	< 1	5.0
Cadmium	< 1	< 1	< 1	< 1	0.017
Chromium^{III+}	< 5	< 5	< 5	< 5	4.9
Chromium^{VI+}	< 5	< 5	< 5	< 5	8.0
Copper	< 1	< 1	< 1	**30**	2 – 4
Iron	< 1	**2940**	**3020**	**60290**	300
Lead	**30**	< 1	< 1	**80**	1 – 7
Mercury	< 1	< 1	< 1	< 1	0.1
Molybdenum	< 1	< 1	< 1	< 1	73
Nickel	10	20	< 1	40	25 - 150
Selenium	< 1	< 1	< 1	< 1	1.0
Silver	< 1	< 1	< 1	< 1	0.1
Zinc	< 1	10	< 1	**60**	30
PAHs	< 5	< 5	< 5	< 5	
Phenols	< 1	< 1	< 1	< 1	4.0
Total VOCs	< 5	< 5	< 5	< 5	
Cyanide	< 5	< 5	< 5	< 5	5.0
Nitrate	< 10	< 10	< 10	< 10	Narrative
Nitrite	< 10	< 10	< 10	< 10	60

- the concentration of lead was observed to be high in some of the cores, with the 'crushed' samples generally exhibiting somewhat higher concentrations than the bulk sample results; and
- occasional exceedances in the concentration of zinc were noted at both CFB Cold Lake and CFB Wainwright for 'crushed' samples only, and in the concentration of copper at CFB Wainwright only.

As similar CCME exceedances were observed for both Sand RejuvaSeal-treated and untreated cores, the high (in comparison to CCME criteria) test results are attributed to the mineral constituents or other operational activities (such as de-icing chemical application for instance), not the Sand RejuvaSeal treatments.

CLOSING REMARKS

This report on the evaluation of the Sand RejuvaSeal treatments of the CFB Cold Lake and CFB Wainwright pavements has been prepared by JEGEL and is intended for use by representatives of Echelon Industries, Inc. and the Department of National Defence.

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APPENDIX A

CAMBRIDGE MATERIALS TESTING LIMITED
COMPOSITIONAL ANALYSIS RESULTS

APPENDIX B

JACQUES WHITFORD ASSOCIATES LIMITED
SUMMARY REPORT OF SITE VISIT

APPENDIX C

NORWEST LABS REPORT
HYDROCARBON/PAH ANALYSIS

APPENDIX D

CAMBRIDGE MATERIALS TESTING LIMITED
INFRARED ANALYSIS OF TIRE RUBBER

APPENDIX E

CAMBRIDGE MATERIALS TESTING LIMITED
ENVIRONMENTAL ANALYSIS REPORT