Technical Support Document for the Second Tier Analysis

for

Socco Forest Products Wood-Fired Boiler and Kiln Project Sumas, Washington

August 3, 2010

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1. EXECUTIVE SUMMARY

Socco Forest Products (Socco) owns and operates a lumber drying and processing facility at 601 A West Front Street in Sumas (Whatcom County), Washington. Socco submitted a Notice of Construction (NOC) permit application to the Northwest Clean Air Agency (NWCAA) on August 31, 2009, for the installation of a new fluidized-bed wood-fired boiler and two double track dry kilns at the Socco facility.

Washington Administrative Code (WAC) 173-400-113(5) requires a proposed new source or modification to comply with the toxic air pollutant (TAP) regulations in Chapter 173-460 WAC. Air dispersion modeling of Socco's proposed emissions showed that two toxic air pollutants (TAPs), acrolein and acetaldehyde, could be emitted at levels that exceed their regulatory trigger levels called Acceptable Source Impact Levels (ASILs). Because acrolein and acetaldehyde concentrations could exceed their ASILs, a Second Tier analysis, per WAC 173-460-090, is required to evaluate health impacts associated with those two TAPs.

Socco retained ENVIRON International Corp. (ENVIRON) to complete the Second Tier analysis. Review of the Health Impacts Assessment (HIA) conducted by ENVIRON indicated that TAP emissions from Socco could result in an increased nasopharyngeal cancer risk of up to 1.73×10^{-6} (1.73 in one million). This risk level is less than Ecology's threshold of maximum acceptable increased risk level (one in one hundred thousand) as defined in chapter 173-460 WAC. Additionally, acute and chronic exposure to TAP emissions from the proposed project are not likely to result in significant adverse non-cancer health effects, but minor eye and upper respiratory tract irritation is possible at the potential maximally exposed off-site boundary and commercial locations.

Therefore, on the basis of the Second Tier analysis described below, and the modeled acrolein and acetaldehyde concentrations, the Washington State Department of Ecology (Ecology) has determined the health risks are within the range that Ecology may approve for proposed new sources of toxic air pollutants under Chapter 173-460 WAC. Ecology recommends approval of the proposed project.

This document describes the technical analysis performed by Ecology.

2. PERMITTING PROCESS OVERVIEW

2.1. The Regulatory Process

The requirements for performing a toxics screening are established in Chapter 173-460 WAC. This regulatory code requires a review of any increase in toxic emissions for all new or modified stationary sources in the state of Washington.

2.1.1. The Three Tiers of Permitting Toxic Air Pollutants

The objectives of permitting toxic air pollutants are to establish the systematic control of new sources emitting toxic air pollutants in order to prevent air pollution, reduce emissions to the

extent reasonably possible, and maintain such levels of air quality as will protect human health and safety.

There are three levels of review when processing a new or modified emissions unit emitting TAPs: (1) First Tier (toxic screening), (2) Second Tier (health impacts assessment), and (3) Third Tier (risk management decision).

All projects are required to undergo a toxics screening (First Tier analysis) as required by WAC 173-460-040. There are two ways to perform a First Tier analysis. If proposed emissions are below the Small Quantity Emission Rates (SQERs) found in WAC 173-460-150, no further analysis is required. If emissions are greater than the SQERs, those emissions must be modeled and the resultant ambient concentration compared against the appropriate ASIL. If the ambient concentration is below the ASIL, then no further analysis is required.

A Second Tier analysis, promulgated in WAC 173-460-090, is a site-specific health impacts assessment. The objective of a Second Tier analysis is to quantify the increase in lifetime cancer risk for persons exposed to the increased concentration of any carcinogenic TAP and to quantify other increased health hazards from any TAP in ambient air that would result from the proposed project. Once quantified, the cancer risk is compared to the maximum risk allowed by a Second Tier analysis, which is one in one hundred thousand, and the concentration of any TAP that would result from the proposed project is compared to non-cancer health risk-based concentration values (RBC).

If the emissions of a toxic pollutant results in additional cancer risk of greater than one in one hundred thousand or Ecology finds that other health hazards are not acceptable, an applicant may request Ecology perform a Third Tier analysis. A Third Tier analysis is a risk management decision made by the director of Ecology about whether or not the health risks posed by a project are acceptable. The decision is based on determination that emissions will be maximally reduced through available preventive measures, assessment of environmental benefits, disclosure of risks at a public hearing and related factors associated with the facility and the surrounding community.

2.2. Processing Requirements

Processing requirements for Second Tier petitions are found in WAC 173-460-090(2). Ecology shall evaluate a source's Second Tier analysis only if:

(i) The permitting authority (Northwest Clean Air Agency, NWCAA) submits to Ecology a preliminary order of approval that addresses all applicable new source review issues with the exception of the outcome of the Second Tier review, State Environmental Policy Act review, public notification, and Prevention of Significant Deterioration review (if applicable);

(ii) Emission controls contained in the preliminary approval order represent at least Best Available Control Technology for Toxics (tBACT);

(iii) The applicant (Socco) has developed a health impact assessment protocol that has been approved by Ecology;

(iv) The ambient impact of the emissions increase of each TAP that exceeds acceptable source impact levels has been quantified using refined air dispersion modeling techniques as approved in the health impact assessment protocol; and

(v) The Second Tier petition contains a health impact assessment conducted in accordance with the approved health impact assessment protocol.

NWCAA submitted a preliminary order of approval to Ecology on April 19, 2010. Ecology considers the preliminary order of approval to satisfy items (i) and (ii) above.

Socco submitted a health impacts analysis (HIA) protocol to Ecology on April 6, 2010. The HIA protocol presented an overview of the proposed refined air dispersion modeling and health impacts assessment methodology that was used to generate air quality impact predictions and subsequent risk-based exposure assessments for the Socco Sumas wood-fired boiler and kilns project. Ecology approved the HIA protocol on April 14, 2010, subject to a list of changes that have been incorporated into the final HIA. The Second Tier petition submitted by ENVIRON contains a health impact assessment conducted in accordance with the approved health impact assessment protocol.

Therefore, Socco and NWCAA have satisfied the five items listed above.

3. FACILITY INFORMATION

3.1. Facility Location

The Socco facility is located approximately a quarter mile southwest of Sumas, Washington, and less than one mile south of the U.S. and Canadian border in Whatcom County, Washington. Figure 1 shows the facility in relation to the surrounding area.

The existing Socco facility is located about five miles due south of Abbotsford, British Columbia in Canada. The Sumas city population in the year 2000 was 960 people, with an estimated 28.3 percent increase in population through July 2008 to 1,232 (City-Data, 2009). The median age of residents in Sumas in 2000 was 30.6 years, with 7.5 percent under 5 years of age, 10.2 percent 65 years or older, and 65.0 percent over 18 years of age (U.S. Census Bureau, 2009).

Figure 1. Satellite photo of Socco facility and surroundings. Inset diagram of Socco facility, buildings (black lines), boundary line (blue), and proposed emission points (red).

Although there are variations in production and work schedules, the Socco facility primarily operates 24 hours per day, five days per week, and up to 52 weeks per year. The boiler will operate continuously during its periods of operation.

3.2. Permitting History

NWCAA issued Order of Approval to Construct (OAC) #963 to Socco on May 24, 2006, for the construction of two, double-track dry kilns at the facility. However, OAC #963 is now invalid because construction did not commence within 18 months of issuance.

3.3. The Proposed Project

The project consists of the installation and operation of a wood-fired boiler rated at 40,000 lb steam/hr and two double track kilns with an annual throughput not to exceed 40,020 thousand board feet (mbf) per year.

The NOC permit application submitted to NWCAA explains that Socco plans to supplement its existing source of steam by installing a wood-fired fluidized-bed combustion (FBC) boiler. The

wood-fired boiler is designed for a maximum heat input of 58.4 MMBtu/hr and a maximum steam generation rate of 40,000 lb/hr at 100 PSIG. The boiler is rated at 200 PSIG; however, under normal operating conditions, steam generated will be regulated from 135 PSI to 35 PSI to interface with existing process steam distribution components at the facility. The boiler is equipped with one natural gas burner, rated at 5 MMBtu/hr, used exclusively for start up and flame stabilization. The boiler design incorporates a selective non-catalytic reduction (SNCR) system to reduce emissions of oxides of nitrogen (NO_X) and a baghouse to control particulate matter emissions. The boiler will be fired by a wood fuel combination consisting of wet and dry wood shavings and sawdust. Wood from logs stored or transported in salt water will not be combusted.

Socco will primarily purchase fuel and has a dedicated source of residual wood. Socco will implement a complete turnkey system for receiving the wood fuel, processing the fuel to the desired blend, and feeding the fuel to the boiler.

Socco plans to increase the facility's capacity to dry lumber by installing two 76-foot double-track dry kilns manufactured by Wellons. Each kiln will have eight roof-top vents equally spaced along each side of its roof. A computerized controller will operate the kiln fans and dampers so that eight vents per kiln are drawing ambient air into the kiln while the other eight are releasing moisture-laden air from the kiln.

Table 1 presents the facility's current maximum kiln drying throughput and charge data by wood species, which will be used to determine the species mix for the new kilns. Hemlock, fir, cedar, and limited quantities of alder will be the designated wood species dried in the new kilns.

Table 1. Facility Kiln Drying Throughput and Charge Data by Wood Species for the Proposed New Kilns

Wood Species	Max BF/Charge	Hours/ Charge	Charges/ Year	mbf/yr per track	Potential Total (mbf/yr)	Species Mix % (3-yr average)	Projected Species Mix Total mbf/yr (3-yr average)
Hemlock	69,000	72	120	8,280	33,120	54.02	17,891
Fir	69,000	60	145	10,005	40,020	24.85	9,945
Cedar	69,000	168	52	3,588	14,352	17.82	2,558
Alder	38,000	144	60	2,280	9,120	3.31	302

4. Pollutant Screening

4.1. Emissions

Using unique emission factors for the burning and drying of three common tree species, Socco estimated its emissions from the project. The emission factors for burning of hemlock were

larger than for the fir or cedar. It is likely that a mixture of species will be processed at any given time. Conservatively, the emissions for hemlock are compared to the SQERs as shown in Table 2.

The emission rates in Table 2 are consistent with the tBACT determination made by NWCAA in the preliminary Order of Approval to Construct (OAC), dated April 19, 2010.

Emissions of 25 TAPs (1,2-dichloroethane, acetaldehyde, acrolein, ammonia, arsenic, benzene, beryllium, bromomethane, cadmium, carbon monoxide, carbon tetrachloride, chlorine, chloroform, hexavalent and total chromium, cobalt, copper & copper compounds, formaldehyde, hydrogen chloride, manganese, mercury, nitrogen dioxide, sulfuric acid mist, sulfur dioxide and vinyl chloride) exceed the values listed in SQER tables. The applicant then modeled these TAPs and compared them to their respective ASILs as shown in Table 3.

Table 2. Comparison of Total Emissions to SQERs

Toxic Air Pollutant	CAS Reg. Number	SQER			Total Emissions From Boiler and Kilns		Emissions Above SQER?
		Conc. Weighted Avg. Time Period	lb/hr	lb/yr	lb/hr	lb/yr	
1,1,1-Trichloroethane	71-55-6	24-hr	0.22833	2000.2	0.0018	15.7291	No
1,2-Dichloroethane	107-06-2	year	0.00084	7.39	0.00171	14.9444	Yes
1,2-Dichloropropane	78-87-5	year	0.00219	19.2	0.00195	17.0428	No
3-Methylcholanthrene	91-57-6	year	3.5E-06	0.0305	0	0	No
7,12-Dimethylbenz (a) anthracene	57-97-6	year	3.1E-07	0.00271	0	0	No
Acetaldehyde	75-07-0	year	0.00811	71	0.4282	3751.03	Yes
Acid Mist	7664-93-9	24-hr	0.00023	2.0002	0.351	3070.77	Yes
Acrolein	107-02-8	24-hr	0.00033	2.87985	0.00789	69.1371	Yes
Ammonia	7664-41-7	24-hr	0.01617	141.62	84.715	742102	Yes
Arsenic	7440-38-2	year	6.6E-06	0.0581	1.3E-05	0.10952	Yes
Benzene	71-43-2	year	0.00076	6.62	0.00149	13.0508	Yes
Benzo(a)anthracene	56-55-3	year	0.0002	1.74	1.7E-07	0.00152	No
Benzo(a)pyrene	50-32-8	year	2E-05	0.174	1.7E-05	0.14689	No
Benzo(b)fluoranthene	205-99-2	year	0.0002	1.74	2.2E-08	0.00019	No
Benzo(j,k)fluoranthene	205-82-3	year	0.0002	1.74	9.1E-06	0.0796	No
Benzo(k)fluoranthene	207-08-9	year	0.0002	1.74	1.7E-07	0.00152	No
Beryllium	7440-41-7	year	9.1E-06	0.08	0.00016	1.36649	Yes
Bis(2-ethylhexyl)phthalate	117-81-7	year	0.00091	8	2.7E-06	0.0238	No
Bromomethane	74-83-9	24-hr	0.00114	10.001	0.00164	14.3302	Yes
2-Butanone (MEK)	78-93-3	24-hr	27.375	239805	0.00523	45.8146	No
Cadmium	7440-43-9	year	5.2E-06	0.0457	1.3E-05	0.11285	Yes
Carbon Monoxide	1330-20-7	1-hr	0.00575	50.4	11.7	102358.8	Yes
Carbon Tetrachloride	56-23-5	year	0.00052	4.57	0.00265	23.2355	Yes
Chlorine	7782-50-5	24-hr	4.6E-05	0.4015	0.0078	68.3245	Yes
Chlorobenzene	108-90-7	24-hr	0.22833	2000.2	0.00194	16.9916	No

Chloroform	67-66-3	year	0.00095	8.35	0.00161	14.0829	Yes
Chloromethane	74-87-3	24-hr	0.02054	179.945	0.00135	11.8225	No
Chromium, hexavalent	C7440-47-3	year	1.5E-07	0.00128	3.5E-06	0.0302	Yes
Chromium, total	7440-47-3	year	1.5E-07	0.00128	3.5E-05	0.30273	Yes
Chrysene	218-01-9	year	0.00199	17.4	0	0	No
Cobalt	7440-48-4	24-hr	2.3E-05	0.20002	4.4E-05	0.38359	Yes
Copper & copper compounds	C7440-50-8	1-hr	2.5E-05	0.219	4.4E-05	0.38359	Yes
Dibenzo(a,h) anthracene	53-70-3	year	1.8E-05	0.16	1.7E-07	0.00152	No
Dichloromethane	75-09-2	year	0.02192	192	0.01677	146.911	No
Ethylbenzene	100-41-4	year	0.00877	76.8	0.00183	16.0192	No
Fluorene	7782-41-4	24-hr	0.00361	31.609	0	0	No
Formaldehyde	50-00-0	year	0.00365	32	0.00556	48.7113	Yes
Hexane	110-54-3	24-hr	0.15958	1397.95	0	0	No
Hydrogen chloride	7647-01-0	24-hr	0.00205	17.9945	0.07666	671.538	Yes
Indeno(1,2,3-c,d) pyrene	193-39-5	year	0.0002	1.74	1.2E-05	0.10799	No
Lead	7439-92-1	year	0.00183	16	0.00015	1.29996	No
Manganese	7439-96-5	24-hr	9.1E-06	0.07994	0.00066	5.80887	Yes
Mercury	7439-97-6	24-hr	2.1E-05	0.17995	0.0001	0.90856	Yes
Methanol	67-56-1	24-hr	0.9125	7993.5	0.19973	1749.59	No
Naphthalene	91-20-3	year	0.00064	5.64	1.1E-05	0.09333	No
Nickel	7440-02-0	year	9.2E-05	0.806	7.1E-05	0.62439	No
Nitrogen Dioxide	75-69-4	1-hr	0.00012	1.03	5.8424	51179.4	Yes
PCBs	1336-36-3	year	3.8E-05	0.336	1E-07	0.00089	No
Pentachlorophenol	87-86-5	year	0.00475	41.6	1.3E-06	0.01162	No
Phenol	108-95-2	24-hr	1.09583	9599.5	0.00829	72.6578	No
Phosphorus	7723-14-0	24-hr	0.00458	40.15	0.00113	9.87763	No
Selenium	7782-49-2	24-hr	0.00458	40.15	2.7E-05	0.23491	No
Styrene	100-42-5	24-hr	0.20542	1799.45	0.10867	951.937	No
Sulfur Dioxide	7440-65-5	24-hr	0.00608	53.29	4.67392	40943.5	Yes
TCDD-2378	1746-01-6	year	5.8E-10	5.1E-06	9.4E-11	8.2E-07	No
Tetrachloroethene	127-18-4	year	0.0037	32.4	0.00223	19.5676	No
Toluene	108-88-3	24-hr	1.14167	10001	0.00124	10.8756	No
Trichloroethene	79-01-6	year	0.01095	95.9	0.00177	15.5202	No
2,4,6-Trichlorophenol	88-06-2	year	0.0011	9.59	6.6E-07	0.00581	No
Vanadium	1314-62-1	24-hr	4.6E-05	0.4015	3.5E-05	0.30401	No
Vinyl Chloride	75-01-4	year	0.00028	2.46	0.00108	9.41701	Yes

4.2. tBACT

NWCAA is responsible for establishing BACT and tBACT for the two new kilns. NWCAA has determined that tBACT for acrolein and acetaldehyde emissions from the dry kilns consist of a computerized steam management system to control kiln temperatures at or below 200°F. For the boiler, tBACT is good combustion controls. As a result, NWCAA has proposed numerical emission limits for emissions of acrolein and acetaldehyde emissions from the wood-fired boiler and dry kilns. In addition, the preliminary order of approval proposes an opacity limit for the new kilns at 10% to be measured using Ecology Method 9A.

Ecology concurs with NWCAA's tBACT determination.

4.3. Air Dispersion Modeling

Socco conducted air dispersion modeling for one wood-fired boiler designed to provide process steam to the facility, and two double track dry kilns. The boiler was modeled as a single point source while the kiln vents were modeled as 16 discharge points. Socco used AERMOD (Version 09292), with EPA's PRIME algorithm for building downwash, to determine the potential ambient impacts of acrolein, acetaldehyde, and those TAPs that exceed their SQERs.

Terrain elevations and hill height scales for receptors were prepared using EPA's terrain processor AERMAP (Version 06341) referencing 7.5-minute digital elevation models (DEMs) developed by the United States Geological Survey (USGS) and ENVIRON. Receptors were spaced 100 meters (m) apart covering a 10 kilometer (km) square simulation domain, with a 4-km by 4-km nested receptor grid at 50-m spacing, and a 1.6-km by 1.6-km nested receptor grid at 25-m spacing. All receptor grids were centered on the facility. Receptors were also located at 25-m intervals along the boundary of the facility. Sensitive receptors were also incorporated into the receptor grid.

A representative meteorological modeling data set was prepared using a combination of surface data and upper air sounding data collected between January 1, 2001 and December 31, 2005 at the Abbotsford International Airport. Wind speed, wind direction, temperature, ceiling height, and cloud cover data were extracted from the University Corporation for Atmospheric Research's (UCAR's) ds472.0 hourly surface data archive. Radiosonde data collected by the upper air station in Quillayute, Washington were obtained from the National Climatic Data Center (NCDC) and Forecast Systems Laboratory (FSL) web site (http://raob.fsl.noaa.gov). Annual average surface characteristics including surface roughness length, albedo, and Bowen ratio were characterized for the area surrounding the Abbotsford Airport, British Columbia using EPA's guidance with a combination of British Columbia land use data (Baseline Thematic Mapping version 1 [BTM1]) and USGS 2001 National Land Cover (NLCD2001) land use data.

The AERMOD simulations provided concentration impacts of acrolein, acetaldehyde, and TAPs exceeding the SQER at applicable short- and long-term averaging periods. Except for ammonia, background concentrations were estimated using the latest National Ambient Toxics Assessment (NATA) data from 2002 for Census Tract 102 in Whatcom County, Washington, and added to the facility emission impacts. Socco used 17 parts per billion (ppb) as the background ammonia concentration, which corresponds to 11 $\mu g/m^3$ on a mass basis. This concentration is based on measurements in southern British Columbia, and is considered conservative.

Maximally impacted residential receptors (MIRR) were determined based on the concentration gradients of acrolein and acetaldehyde modeling results for the highest 1-hour, 24-hour and annual concentrations. Those residential homes that lay in the wake of the highest concentration gradients were designated as the maximally impacted residential receptors.

4.4. Point of Compliance

The Socco property fence line with neighboring Puget Sound Energy (PSE) is the assumed point of maximum public exposure (nearest point of ambient air) to the proposed emissions. Of the 25 TAPs that were noted previously, the maximum modeled concentration of each TAP near this fence line are shown in Table 3 with the corresponding ASIL.

4.5. Maximum TAP Concentrations

Below are the modeled results of TAP concentrations off site. These results were provided to Ecology by ENVIRON on behalf of Socco. Only those TAPs that exceeded the SQERs are shown. The highest modeled concentration of each TAP is compared to its respective ASIL.

Table 3. Comparison of Modeled Concentration to ASIL

TAP	CASRN	Averaging Time	Maximum Off-site Modeled Concentration (µg/m^3)	ASIL (µg/m^3)	Over the ASIL?
Acetaldehyde	75-07-0	annual	5.62151	0.37	Yes
Acrolein	107-02-8	24-hr	0.69294	0.06	Yes
Arsenic	7440-38-2	annual	1.44E-06	0.000303	No
1,2-Dichloroethane	107-06-2	annual	0.00019615	0.0385	No
Acid Mist	7664-93-9	24-hr	0.292910692	1	No
Ammonia	7664-41-7	24-hr	70.78643178	70.8	No
Benzene	71-43-2	annual	0.000171296	0.0345	No
Beryllium	7440-41-7	annual	1.79E-05	0.000417	No
Bromomethane	74-83-9	24-hr	0.00136691	5	No
Cadmium	7440-43-9	annual	1.48E-06	0.000238	No
Carbon Monoxide	1330-20-7	1-hr	31.20895	2.30E+04	No
Carbon Tetrachloride	56-23-5	annual	0.000304974	0.0238	No
Chlorine	7782-50-5	24-hr	0.006517234	0.2	No
Chloroform	67-66-3	annual	0.000184843	0.0435	No
Chromium, hexavalent	C7440-47-3	annual	3.96E-07	6.67E-06	No
Chromium, total	7440-47-3	annual	3.97E-06	6.67E-06	No
Cobalt	7440-48-4	24-hr	3.66E-05	0.1	No
Copper & Compounds	C7440-50-8	1-hr	0.000792707	100	No
Formaldehyde	50-00-0	annual	0.07373	0.167	No
Hydrogen Chloride	7647-01-0	24-hr	0.064055618	9	No
Manganese	7439-96-5	24-hr	0.000554087	0.04	No
Mercury	7439-97-6	24-hr	8.67E-05	0.09	No
Nitrogen Dioxide	75-69-4	1-hr	0.67175	470	No
Sulfur Dioxide	7440-65-5	24-hr	3.90546	26.7	No
Vinyl Chloride	75-01-4	annual	0.000123602	0.0128	No

4.6. Pollutants Subject to Second Tier Analysis

The air dispersion modeling analysis presented in the air permit application predicted that maximum off-site concentrations of acetaldehyde (5.62 $\mu g/m^3$) and acrolein (0.69 $\mu g/m^3$) would exceed the ASILs for acetaldehyde (0.37 $\mu g/m^3$) and acrolein (0.06 $\mu g/m^3$) for an annual averaging period and a 24-hour averaging period, respectively.

Emissions of acetaldehyde and acrolein are subject to review under this Second Tier analysis. In addition, several TAPs that will be emitted at rates that exceed respective SQERs and that can cause (1) nasopharyngeal cancer, or (2) eye and respiratory tract irritation or epithelial lesions, are also subject to review under this Second Tier analysis. The presence of ammonia, bromomethane, chlorine, hexavalent chromium, copper & copper compounds, formaldehyde, hydrogen chloride, sulfuric acid mist, sulfur dioxide, or vinyl chloride may add to the risks of the effects posed by acetaldehyde and acrolein.

5. HEALTH IMPACTS ASSESSMENT

5.1. Introduction

A health impacts assessment was prepared by ENVIRON on behalf of Socco. It addressed the public health risk associated with exposure to acetaldehyde, acrolein, and related emissions from lumber production. It was then reviewed by an Ecology Air Quality Program engineer, toxicologist, and meteorologist. Their reviews constitute the basis for the Ecology risk manager's permit decision.

5.2. Hazard Identification

Hazard identification is the process of gathering information on potential adverse health effects associated with TAPs that exceed their SQERs. Hazard identification takes account of the knowledge of these TAPs toxic effects in human health, and other organisms. Our principal sources of this information are the IRIS, ATSDR, OEHHA toxic air contaminants databases. Table 4 below summarizes the potential effects of each TAP proposed to be emitted by Socco in amounts greater than its respective SQER.

Table 4. Potential Adverse Effects of TAPs to be Emitted in Amounts Above SQERs

Socco TAP Emissions That Exceed SQERs	Potential Effects and Hazard Index Targets
Acetaldehyde	Sensory irritation, redness, and swelling of the eye; broncoconstriction; degenerative, inflammatory, and hyperplastic changes of the nasal mucosa; nasal and laryngeal tumors and cancer by hyperplasia mechanism Hazard index targets: nose and throat (nasopharyx), eye, and bronchus
Acrolein	Hazard index targets: eye and entire respiratory tract
1,2-dichloroethane	Gavage treatments in rats and mice increased incidences of forestomach squamous-cell carcinomas, circulatory system hemangiosarcomas, mammary adenocarcinoma, alveolar/bronchiolar adenomas, endometrial stromal polyps and sarcomas, and hepatocellular carcinomas.
Ammonia	Eye, nose, and upper respiratory tract irritation Hazard index targets: eye, nose, and upper respiratory tract
Arsenic	Mutagenic effects likely to result in progression of initiated lung cancers. Hazard index targets: skin, cardiovascular system, nervous system, development
Benzene	Reproductive, developmental, and leukemogenic effects Hazard index targets: hematopoietic and immune systems
Beryllium	Alimentary effects; immune and respiratory system sensitization; chronic beryllium disease; tracheal and lung cancers Hazard index targets: respiratory tract, immune system, liver
Bromomethane	Respiratory irritation and lesions of the olfactory epithelium. High chronic exposures cause adverse nervous system, reproductive, and developmental effects. Hazard index targets: respiratory tract and olfactory epithelia
Cadmium	Reduced forced vital capacity and reduction in peak expiratory flow rate. Weak association with lung cancer—possible interference with spindle formation. Hazard index targets: kidney and respiratory tract
Carbon Monoxide	Carboxyhemoglobinemia Hazard index targets: cardiovascular system
Carbon Tetrachloride	CNS; reproductive and developmental toxicity; liver cancer Hazard index targets: liver, CNS, gonad and fetus
Chlorine	Irritant to eyes; upper respiratory tract and lungs Hazard index targets: eye, respiratory tract
Chloroform	CNS depression at high exposures; hepatitis and jaundice; CNS

Socco TAP Emissions That Exceed SQERs	Potential Effects and Hazard Index Targets
	depression and irritability; kidney toxicity from chronic exposures; decreased fetal weight; hepatic and renal cancer at cytotoxic exposure levels Hazard index targets: liver, kidney, CNS, fetus
Chromium, hexavalent	Hematologic effects; perforations and ulcerations of the septum; nasal itching and soreness; bronchitis; pneumonia; decreased pulmonary function and asthma; lung cancer Hazard index targets: blood, respiratory tract, nose
Chromium, total	Nasal mucosa and upper respiratory tract. May impair pulmonary macrophage function. Hazard index targets: nose, respiratory tract, pulmonary macrophage
Cobalt	Excess exposure causes allergic contact dermatitis and occupational asthma. Hazard index targets: skin and respiratory tract
Copper & copper compounds	Irritation of the eyes, nose, and upper respiratory tract Hazard index targets: eye, nose, and upper respiratory tract
Formaldehyde	Irritation of mucous membranes of eyes, nose, and throat; inflammation; epithelial degeneration; respiratory epithelial hypertrophy; and squamous metaplasia. Acute high exposure may lead to eye, nose, throat, and respiratory tract irritation, nasal obstruction, pulmonary edema, and dyspnea. Prolonged or repeated exposures are associated with allergic sensitization, cough, wheeze, dyspnea, histopathological changes in respiratory epithelium, and decrements in lung function. Chronic exposure in children, especially those with asthma, is more likely to induce symptoms and impair pulmonary functioning than in adults. Nasopharyngeal and respiratory tract cancer; possibly brain cancer and leukemia. Hazard index targets: nasopharynx, respiratory tract
Hydrogen Chloride	Acute inhalation exposure causes pulmonary irritation, lesions of the upper respiratory tract, and laryngeal and pulmonary edema. Chronic exposure causes gastritis, chronic bronchitis, dermatitis, and photosensitization. Prolonged low concentrations exposure may also cause hyperplasia of the nasal mucosa, larynx, and trachea, lesions in the nasal cavity, and dental discoloration and erosion. Hazard index targets: eye, teeth, nasopharynx, respiratory tract, skin
Manganese	Excess can cause a range of neurological disorders, impaired thiamin and ascorbate metabolism, and iron and copper deficiencies. Hazard index targets: CNS, PNS, kidney
Mercury	Long-term exposure or short, heavy exposure to vapor can cause CNS effects including tremors, impaired cognitive skills, sleep

Socco TAP Emissions That Exceed SQERs	Potential Effects and Hazard Index Targets
	disturbance, brain and peripheral neuropathy, and death. The brain is the most sensitive organ. Other organs affected as exposures increase. Particularly toxic to fetuses and infants. Hazard index targets: CNS, PNS, kidney, mouth, fetal and perinatal development
Nitrogen Dioxide	Reacts with water in the respiratory tract to form nitric acid, which is a corrosive irritant. It impairs lung function and causes an array of respiratory problems including airway inflammation in healthy people, and increased symptoms in people with asthma. Children, elderly, and asthmatic people are particularly sensitive. It probably also increases allergic responses to inhaled pollens. Hazard index target: respiratory tract
Sulfuric Acid Mist	Bronchial function impairment (especially in people with asthma); bronchiolar epithelial hyperplasia and thickening Hazard index target: respiratory tract
Sulfur Dioxide	Reacts with water in the respiratory tract to form sulfurous acid, an irritant, and inhibitor of mucociliary transport. Causes sneezing, sore throat, wheezing, shortness of breath, chest tightness, dyspnia, bronchoconstriction, and asthma in sulfite sensitive asthmatics. Chronic exposure can result in an altered sense of smell and increased tolerance to low levels of sulfur dioxide, increased susceptibility to respiratory infections, chronic bronchitis, and accelerated decline in pulmonary function. Children, elderly, and asthmatic people are particularly sensitive. Hazard index target: respiratory tract
Vinyl Chloride	Hepatic angiosarcoma and CNS depression. Low level exposure is slightly irritating to the eyes and respiratory tract, and may cause kidney, testicular, and peripheral nervous system damage. Hazard index targets: liver, CNS, PNS, eye, kidney, respiratory tract, male reproductive tract

Depending on exposure levels, the two TAPs that exceed ASIL concentrations, i.e., acetaldehyde and acrolein, can adversely affect the nose and throat (nasopharyx), the eyes, and the entire respiratory tract, including the bronchi. Additionally, acetaldehyde exposure may cause nasal and laryngeal cancer.

The primary acute effects of human exposure to acetaldehyde in air consist of irritation to the eyes, skin, and respiratory tract.[1] Asthmatics exposed to acetaldehyde may experience a decrease in lung function due to bronchoconstriction.

There is little information regarding health outcomes in humans related to long-term exposure to acetaldehyde. In animals, chronic inhalation exposure to acetaldehyde has produced changes in the mucus membranes of the nose and trachea, growth retardation, slight anemia, and increased kidney weight. EPA derived a reference concentration based on the degeneration of a layer of cells lining the tissue responsible for smell in the noses (olfactory epithelium) of rats.[2] There is currently insufficient human data regarding the carcinogenic effects of acetaldehyde. Animal studies involving inhalation of acetaldehyde have shown an increased rate of nasal tumors in rats and laryngeal tumors in hamsters. EPA has classified acetaldehyde as a Group B2, probable human carcinogen.

Acrolein is an irritant to skin and mucous membranes. Effects of acrolein typically occur at the point of exposure (i.e., nasal passages, eyes) and upper respiratory tract. Short-term exposure to acrolein can cause eye and nasal irritation at relatively low concentrations (< 1ppm [≤ 2.3 mg/m^3]) in air.[3] Higher concentrations may also irritate the entire respiratory tract. Water soluble fine particulates may potentiate the irritancy of acrolein. Accidental exposures to extremely high levels of acrolein result in high fever, dyspnea, coughing, foam expectoration, cyanosis, pulmonary edema, and death.[4] Animals exposed to higher acrolein concentrations showed signs of lesions in the respiratory tract and respiratory distress. These effects became more severe with increasing concentrations. At higher levels, respiratory distress resulted in death.

There are no available studies of humans exposed to acrolein over long periods. Longer-term studies in laboratory animals at higher concentrations have demonstrated severe nasal lesions as well as pronounced adverse effects on lung function leading to lethality. Studies indicated that rats were the most sensitive species. The potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or the inhalation route of exposure.

Only those TAPs that can cause effects like those potentially caused by acetaldehyde and acrolein in the same organs are carried forward in the Socco HIA. These TAPs are ammonia, beryllium, cadmium, bromomethane, chlorine, total chromium, hexavalent chromium, cobalt, copper & copper compounds, formaldehyde, hydrogen chloride, nitrogen dioxide, sulfuric acid mist, sulfur dioxide, and vinyl chloride.

[1] http://www.arb.ca.gov/toxics/id/summary/acetaldehyde_b.pdf
[2] http://www.epa.gov/ncea/iris/subst/0290.htm
[3] http://www.oehha.ca.gov/air/toxic_contaminants/pdf_zip/acrolein_112508.pdf
[4] http://www.atsdr.cdc.gov/toxprofiles/tp124.html

5.2.1. Terrestrial Fate

Acetaldehyde will volatilize rapidly in near surface and surface soils.[5] Acrolein can be mobile in soil, but a large portion is expected to volatilize or be broken down by microorganisms or other reactive processes.[6] Therefore, neither of these chemicals is likely to build up in soil if emitted in the small amounts as intended by Socco.

5.2.2. Aquatic Fate

Acetaldehyde dissolves in water, but will not reside long in surface water as it either will volatilize or be broken down by microbes. Degradation half-life of 9.3 hours has been reported as typical for rivers.[7] Acrolein dissolves readily in water but levels are reduced through volatilization, aerobic biodegradation, and hydration to other chemicals that subsequently biodegrade. Degradation half-lives are <1 to 3 days for small amounts of acrolein in surface water. As emitted from Socco, these chemicals are unlikely to build up in aquatic environments.

5.2.3. Atmospheric Fate

Generally, acetaldehyde and acrolein are not persistent in air. They react with other chemicals in air (mainly sunlight-derived radicals). The estimated half-life for the reaction of acetaldehyde with the hydroxyl radical produced by ultra violet light is 6.2 hours. In air, acrolein is broken down by chemicals generated in sunlight producing carbon monoxide, formaldehyde, and glycolaldehyde. Acrolein also reacts with nitrogen oxides to form peroxynitrate and nitric acid. The half-life for the reaction of acrolein with the hydroxyl radical is 15 to 20 hours.[8]

5.3. Exposure Assessment

In order for pollutants to cause harm, people must be exposed. The exposure assessment step of the HIA involves measuring or estimating concentrations, durations, and frequencies of exposures to agents present in the environment, and the estimation of hypothetical exposures that might arise from the release of TAPs into the air outside of space controlled by the permit applicant. Exposure assessment is characterization of past, current, and expected TAP exposures. Ambient air is publicly accessible air in the vicinity of a proposed project.
In the case of Socco's kiln and boiler emissions, inhalation, and dermal exposure (eye irritation) are the primary routes of exposure because acetaldehyde and acrolein emission from the project are not likely to build up in food, soil, and water.

[5] http://www.inchem.org/documents/ehc/ehc/ehc167.htm
[6] http://www.atsdr.cdc.gov/toxprofiles/tp124-c6.pdf
[7] http://www.epa.gov/chemfact/s_acetal.txt
[8] http://www.atsdr.cdc.gov/toxprofiles/tp124-c6.pdf

5.3.1. Multi-Route Exposures

The following paragraph and table is from the California OEHHA's Air Toxics Hotspots Risk Assessment Guidance.

> *"Table [5] shows the multipathway substances that, based on available scientific data, can be considered for each non-inhalation exposure pathway. The exposure pathways that are evaluated for a substance depend on two factors: 1) whether the substance is considered a multipathway substance for the Hot Spots Program (Table 5.1), and 2) what the site-specific conditions are. A multipathway substance may be excluded from a particular exposure pathway because its physical-chemical properties can preclude significant exposure via the pathway. For example, some water-soluble chemicals do not appreciably bioaccumulate in fish; therefore, the fish pathway is not appropriate. In addition, if a particular exposure pathway is not impacted by the facility or is not present at the receptor site, then the pathway is not evaluated. For example, if surface waters are not impacted by the facility, or the water source is impacted but never used for drinking water, then the drinking water pathway is not evaluated."*

Table 5. Specific Pathways to be Analyzed for Each Multipathway Substance

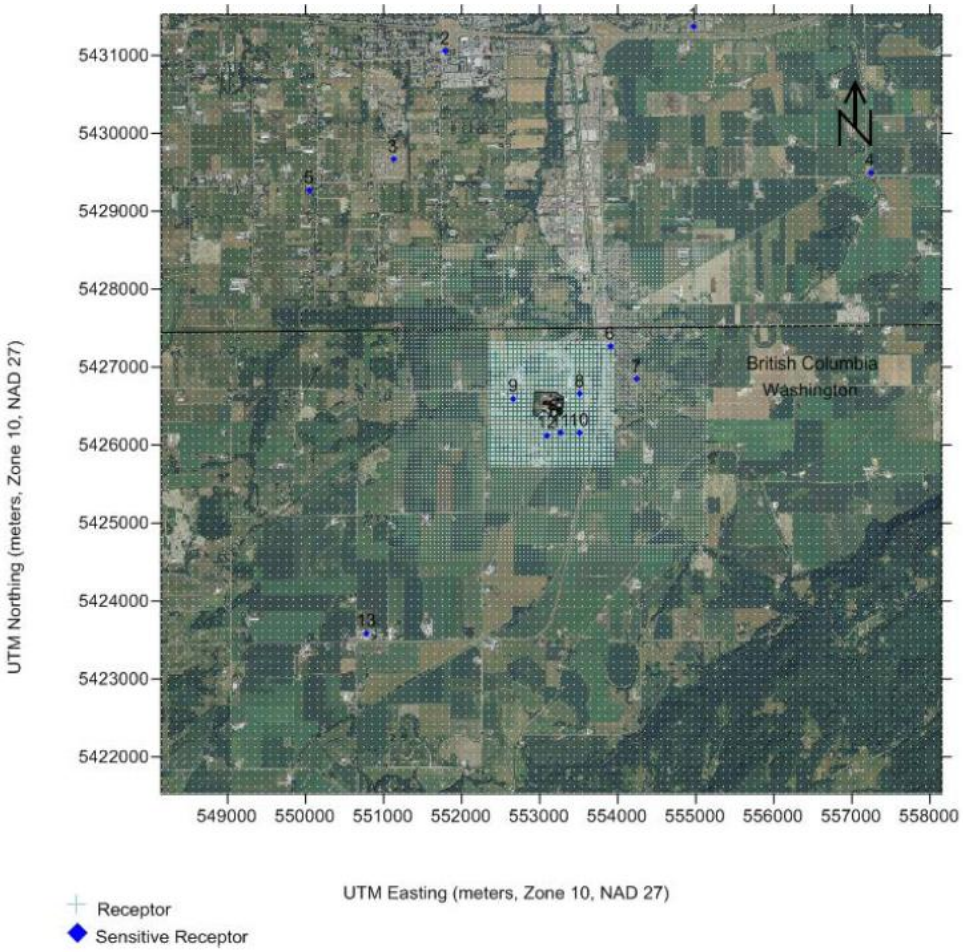
Substance	Soil Ingestion	Dermal	Meat, Milk & Egg Ingestion	Fish Ingestion	Exposed Vegetable Ingestion	Leafy Vegetable Ingestion	Protected Vegetable Ingestion	Root Vegetable Ingestion	Water Ingestion	Breast Milk Ingestion
4,4'-Methylene dianiline	X	X		X	X	X	X	X	X	
Creosotes	X	X	X	X	X	X			X	
Diethylhexylphthalate	X	X		X	X	X	X	X	X	
Hexachlorocyclohexanes	X	X		X	X	X			X	
PAHs	X	X	X	X	X	X			X	
PCBs	X	X	X	X	X	X	X	X	X	X
Cadmium & compounds	X	X	X	X	X	X	X	X	X	
Chromium VI & compounds	X	X	X	X	X	X	X	X	X	
Inorganic arsenic & compounds	X	X	X	X	X	X	X	X	X	
Beryllium & compounds	X	X	X	X	X	X	X	X	X	
Lead & compounds	X	X	X	X	X	X	X	X	X	
Mercury & compounds	X	X	X	X	X	X	X	X	X	
Nickel	X	X	X		X	X	X	X	X	
Fluorides (Including hydrogen fluoride)	To be determined									
Dioxins & furans	X	X	X	X	X	X	X		X	X

Socco will emit acrolein and acetaldehyde in amounts that exceed the ASIL but these do not biomagnify or persist in the environment.

5.3.2. Identification of Exposed Populations

To assess exposure to TAPs of concern and ultimately estimate potential health risks to people exposed to Socco's emissions, ENVIRON identified locations where people might be exposed.

Residential and commercial buildings near Socco, as well as the locations of buildings where sensitive populations are likely to be concentrated are indicated on the photograph below.



#	Receptor Name	#	Receptor Name
1	Cascade Court Retirement Facility	8	Residence 5
2	Central Heights Preschool	9	Residence 4
3	Abbotsford Medical Center	10	Residence 3
4	Upper Sumas Elementary School	11	Residence 2
5	South Poplar Elementary School	12	Residence 1
6	Sumas Medical Clinic	13	Nooksack Valley High School
7	Sumas Elementary School		

Figure 2. Satellite photo of Socco's facility and surroundings. Figure shows AERMOD grid points (white dots), Socco's facility (center), off-site houses, and other buildings (blue dots).

ENVIRON attempted to locate sensitive populations identified as school age children, people living in retirement facilities, and people receiving treatment at medical facilities.

- Children under five years of age are 7.5 percent of the Sumas population. The closest daycare (Central Heights Preschool) is about 2.9 miles north (in Abbotsford Canada) of Socco facility.

- There are three public elementary schools and one public high school located in the Sumas/Abbotsford area. The closest school (Sumas Elementary) is approximately 0.7 miles east-northeast of the facility.

- The closest retirement facility (Cascade Court) is about 3.2 miles northeast (in Abbotsford) of the Socco facility.

- The Socco facility is approximately 0.7 miles southwest of the nearest medical clinic (Sumas Medical Clinic) and 2.3 miles southeast of the nearest hospital (Abbotsford Medical Center).

ENVIRON also identified the maximally impacted residential receptors (MIRR), the maximally impacted commercial receptors (MICR) and the maximally impacted boundary receptors (MIBR). These are the receptors that would experience the highest concentrations of acetaldehyde and acrolein. Among these, the highest exposure is generally at a point on the Socco fence line boundary between land owned by Socco and publicly accessible land.

5.3.3. Estimates of Exposure Durations of Identified Populations

Exposure duration influences the levels and types of health risks posed by chemicals. In most cases, a person continuously exposed to a chemical cannot tolerate as high of concentrations as a person that is exposed for only a short time. People who work at commercial or industrial locations near Socco are likely only to be exposed for up to the duration of their workday (e.g., eight hours per day). Residents living near Socco have the potential to be exposed for a longer period (e.g., 24 hours per day). Residents and occupants of commercial properties both have the opportunity to be exposed for short-term durations (e.g., one hour).

In order to estimate the exposure times of various populations to the TAPs of concern, standard values were used. These values are estimates of how much time people using the MIBR, MICR, and MIRR locations might be in those locations. The exposure durations used in this assessment are:

- One hour for TAPs possessing published acute risk-based concentrations.

- Eight hours for TAPs possessing published average work shift acute risk-based concentrations.

- Twenty-four hours for TAPs possessing certain published acute and chronic risk-based concentrations.

- One year for TAPs possessing cancer potency factors and certain published chronic risk-based concentrations.

Risk-based concentrations are discussed in Section 5.4. Exposure durations of one hour, 24 hours, and one year are most applicable as starting points to estimate health risks at the MIRR. Exposure durations of one hour, eight hours, and one year are most applicable as starting points to estimate risks at the MICR. Exposure durations of one hour and eight hours are most applicable as starting points to estimate risks at the MIBR.

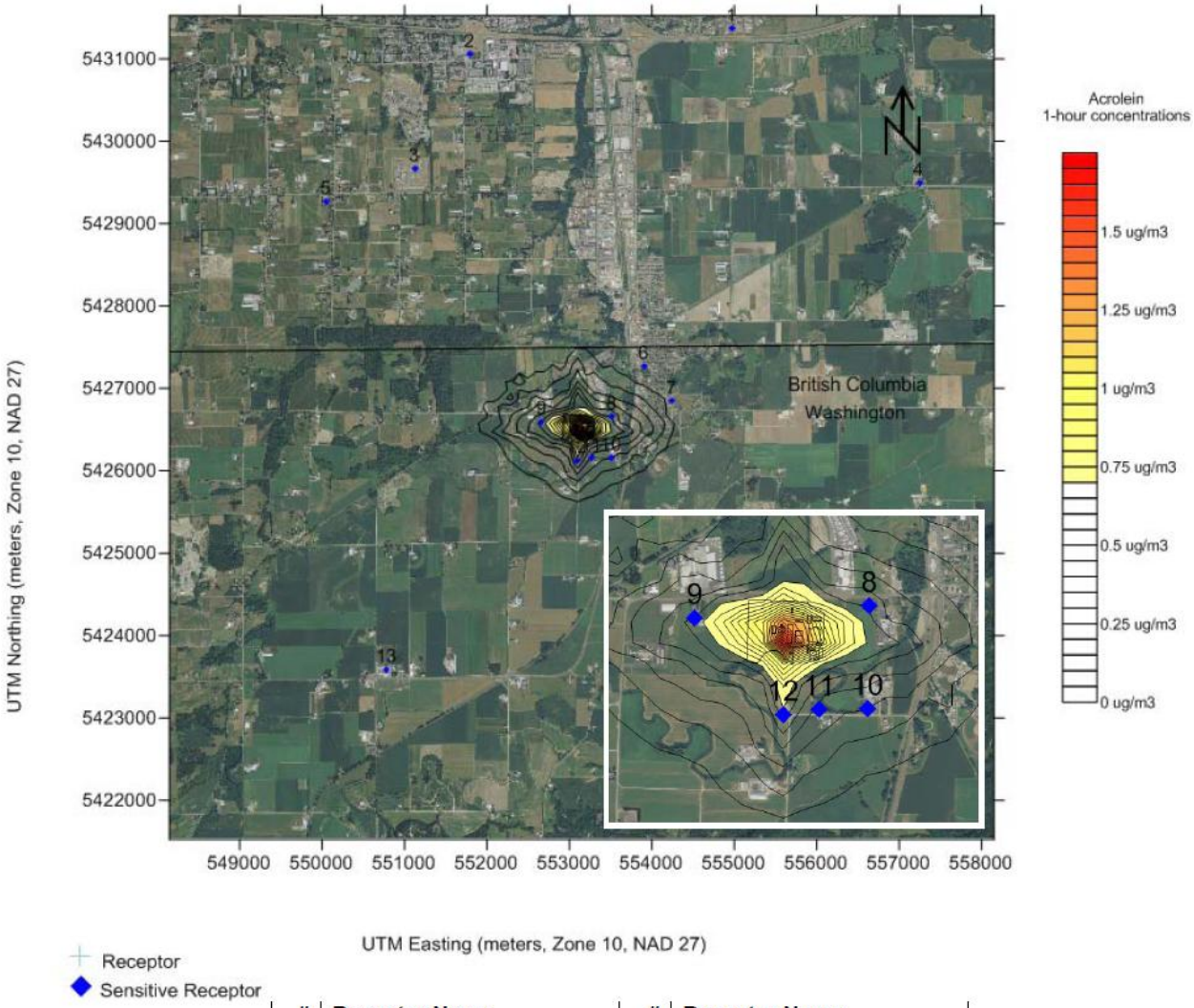
For certain acutely toxic TAPs, the frequency of exposures to higher than normal concentrations is also explored. The first through sixth highest concentration modeling results for these TAPs at each receptor were reviewed.

5.3.4. TAP Concentration Estimates

To assess human exposure to TAPs attributable to Socco, ENVIRON modeled the maximum 1-hour, 8-hour, and 24-hour concentrations, and average annual concentrations of acetaldehyde, acrolein, and several other TAPs in breathing zone air near Socco. The model used emissions rate estimates of the project along with meteorological data. The results provided estimates of worst-case and average concentrations at grid points outside the Socco facility property boundary.

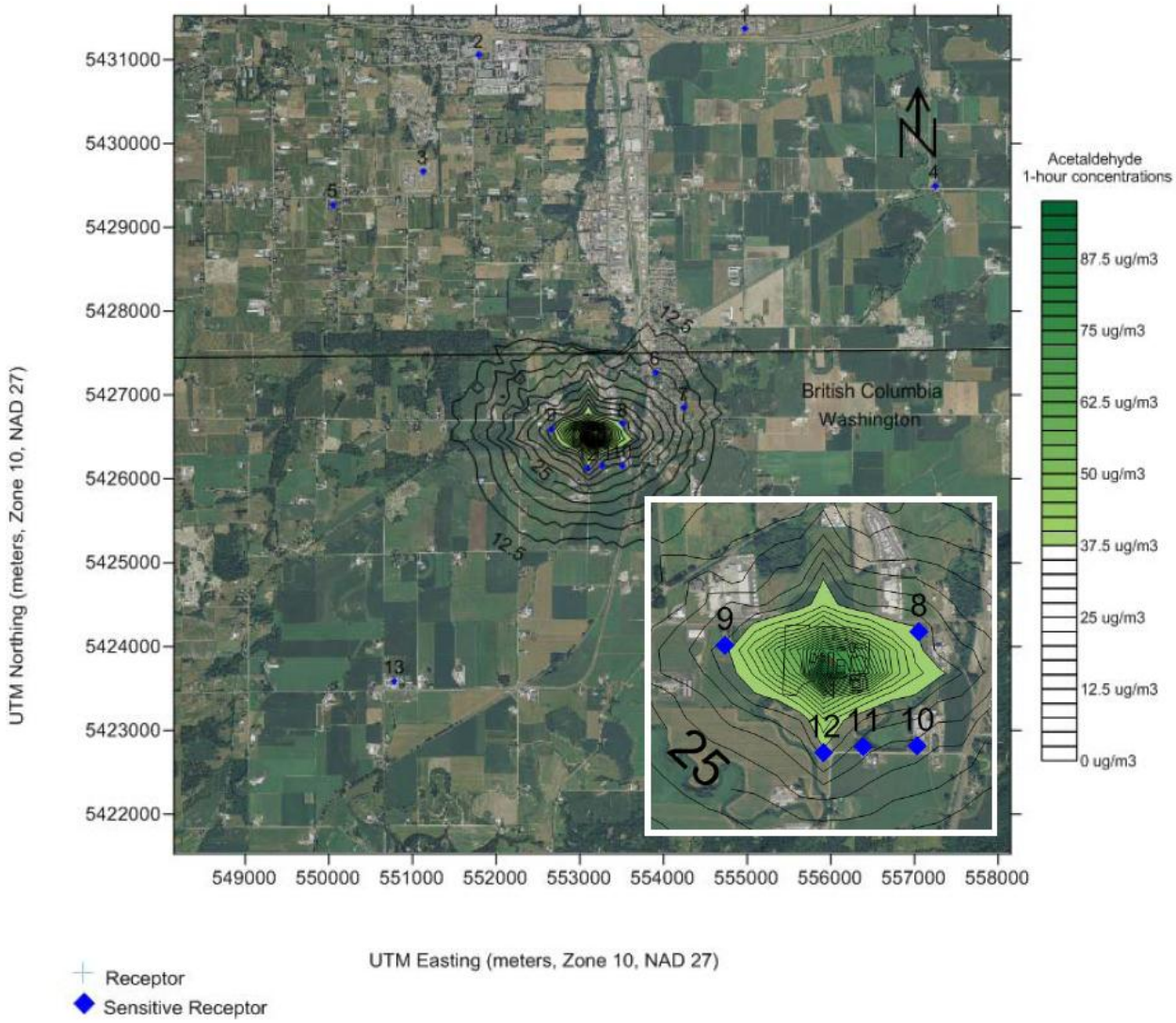
ENVIRON examined the estimates of concentrations at grid points to locate the points of highest TAP concentrations. A single place along the fence line was reported to be the maximally impacted boundary receptor. Similarly, they examined the concentrations at grid points corresponding to the commercial and residential buildings near Socco to determine the buildings with the highest TAP concentrations.

Acetaldehyde and acrolein concentrations resulting from emissions from the new kilns and the hog fuel boiler are presented in the figures below.



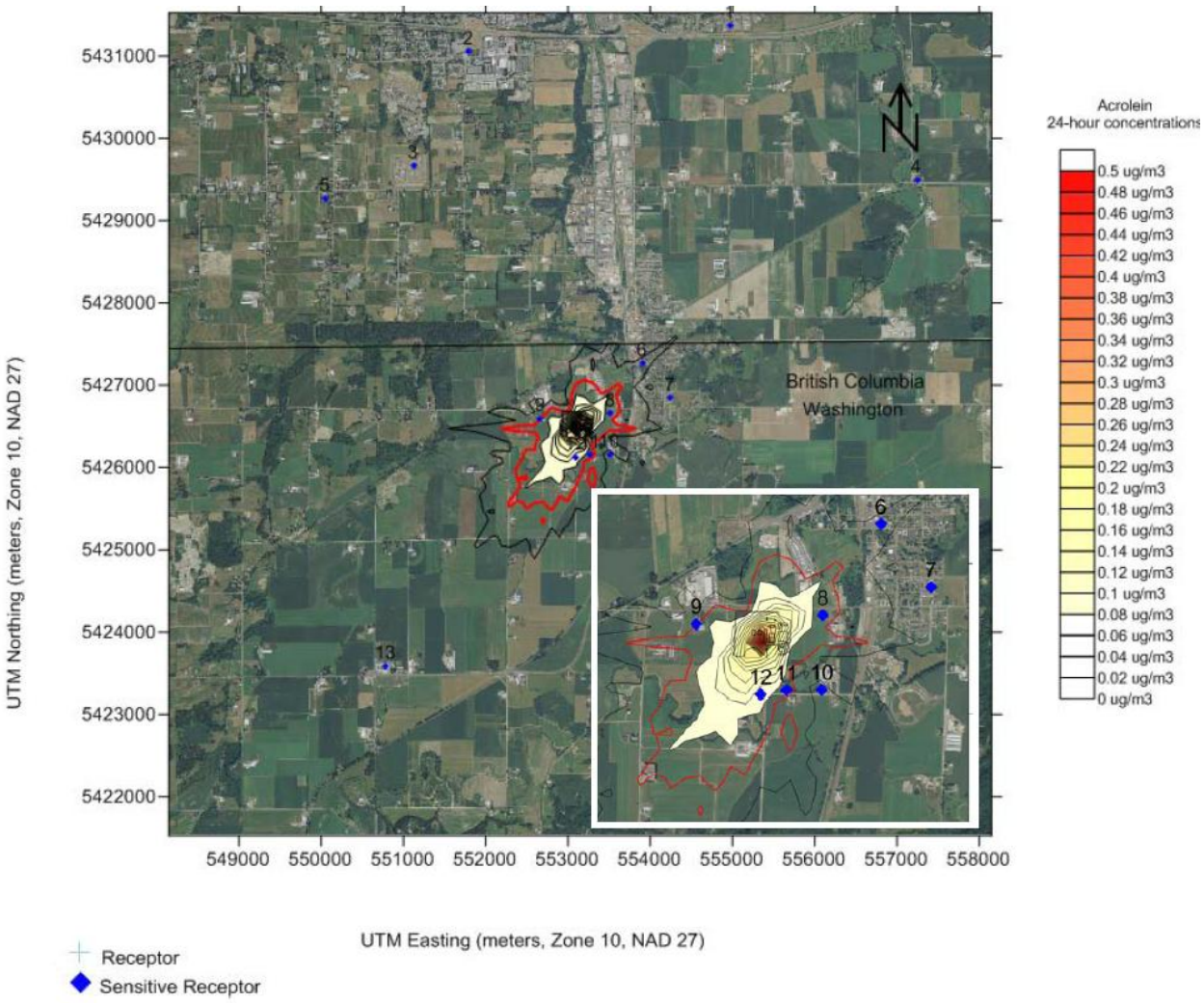
#	Receptor Name	#	Receptor Name
1	Cascade Court Retirement Facility	8	Residence 5
2	Central Heights Preschool	9	Residence 4: Maximally Impacted Residential Receptor (MIRR)
3	Abbotsford Medical Center		
4	Upper Sumas Elementary School	10	Residence 3
5	South Poplar Elementary School	11	Residence 2
6	Sumas Medical Clinic	12	Residence 1
7	Sumas Elementary School	13	Nooksack Valley High School

Figure 3. Contour plot for 1-hour averaging time for acrolein (includes magnified inset).



#	Receptor Name	#	Receptor Name
1	Cascade Court Retirement Facility	8	Residence 5
2	Central Heights Preschool	9	Residence 4: Maximally Impacted Residential Receptor (MIRR)
3	Abbotsford Medical Center		
4	Upper Sumas Elementary School	10	Residence 3
5	South Poplar Elementary School	11	Residence 2
6	Sumas Medical Clinic	12	Residence 1
7	Sumas Elementary School	13	Nooksack Valley High School

Figure 4. Contour plot for 1-hour averaging time for acetaldehyde (includes magnified inset).



#	Receptor Name	#	Receptor Name
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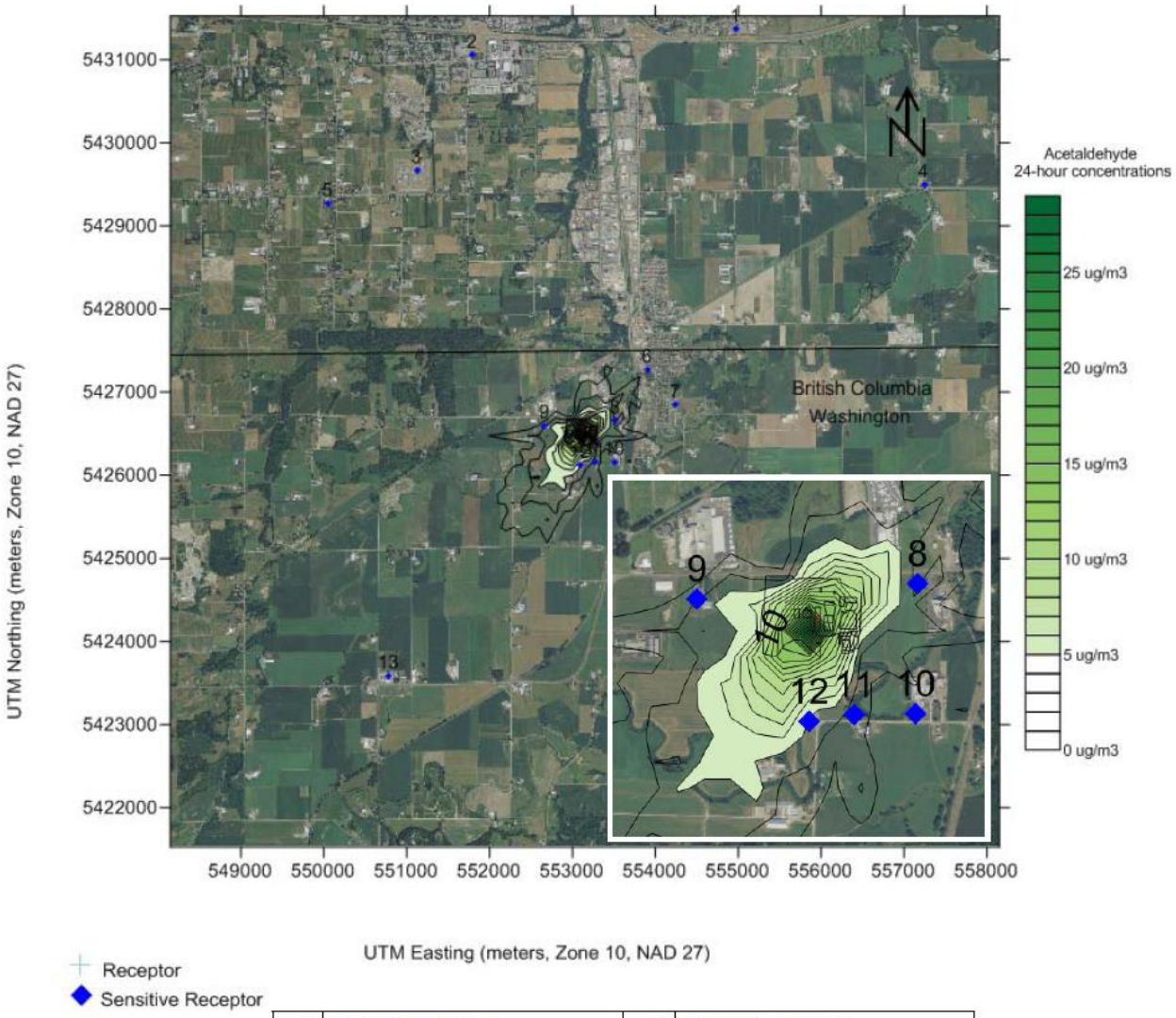
2	Central Heights Preschool	9	Residence 4
3	Abbotsford Medical Center	10	Residence 3
4	Upper Sumas Elementary School	11	Residence 2
5	South Poplar Elementary School	12	Residence 1: Maximally Impacted Residential Receptor (MIRR)
6	Sumas Medical Clinic		
7	Sumas Elementary School	13	Nooksack Valley High School

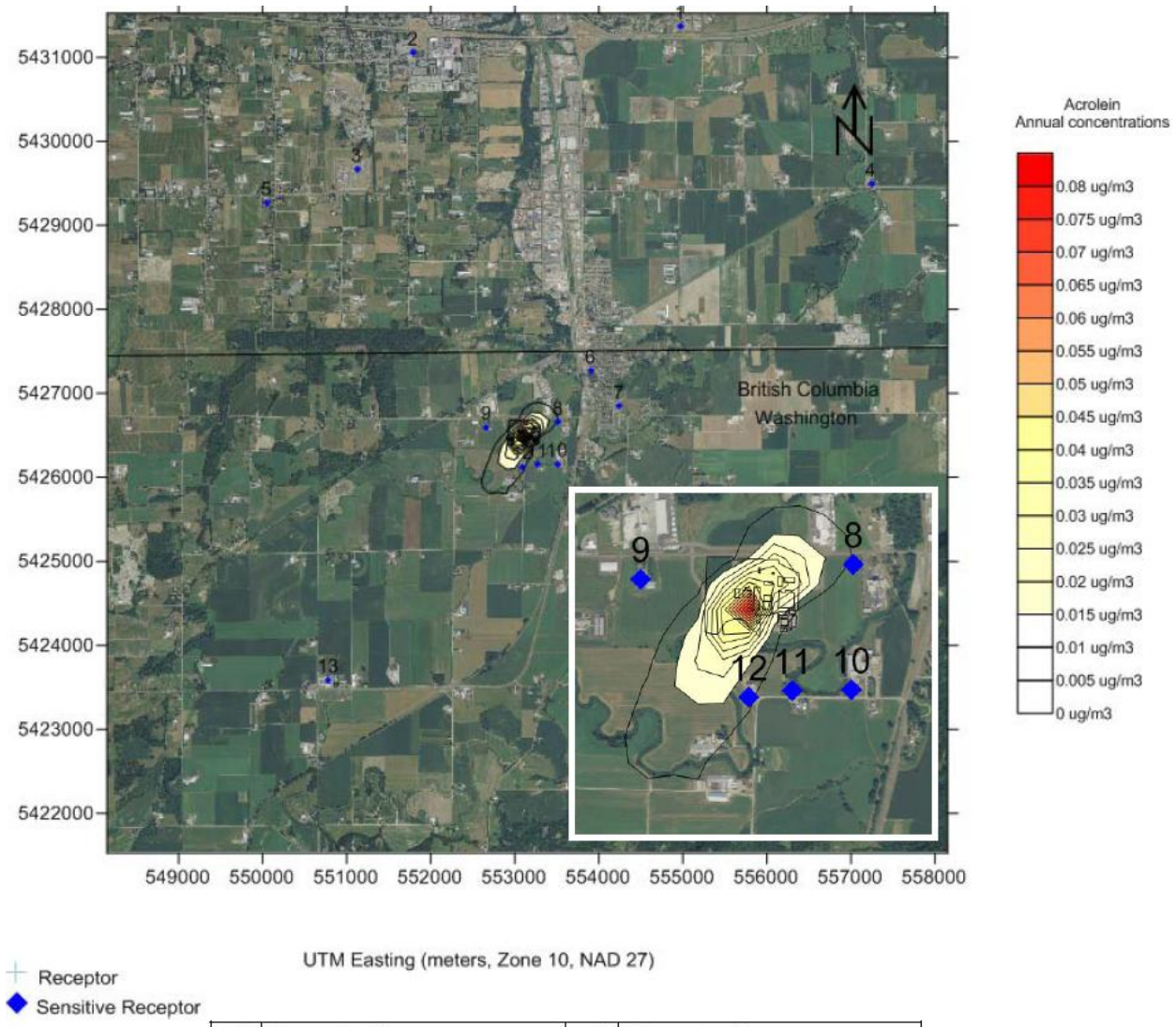
Figure 5. Contour plot for 24-hour averaging time for acrolein (includes magnified inset). ASIL contour line is shown in red.



#	Receptor Name	#	Receptor Name
1	Cascade Court Retirement Facility	8	Residence 5: Maximally Impacted Residential Receptor (MIRR)
2	Central Heights Preschool		
3	Abbotsford Medical Center	9	Residence 4
4	Upper Sumas Elementary School	10	Residence 3
5	South Poplar Elementary School	11	Residence 2
6	Sumas Medical Clinic	12	Residence 1
7	Sumas Elementary School	13	Nooksack Valley High School

Contour Plot for 24-Hour Averaging Time for Acetaldehyde (includes magnified inset

Figure 6. Contour plot for 24-hour averaging time for acetaldehyde (includes magnified inset).



#	Receptor Name	#	Receptor Name
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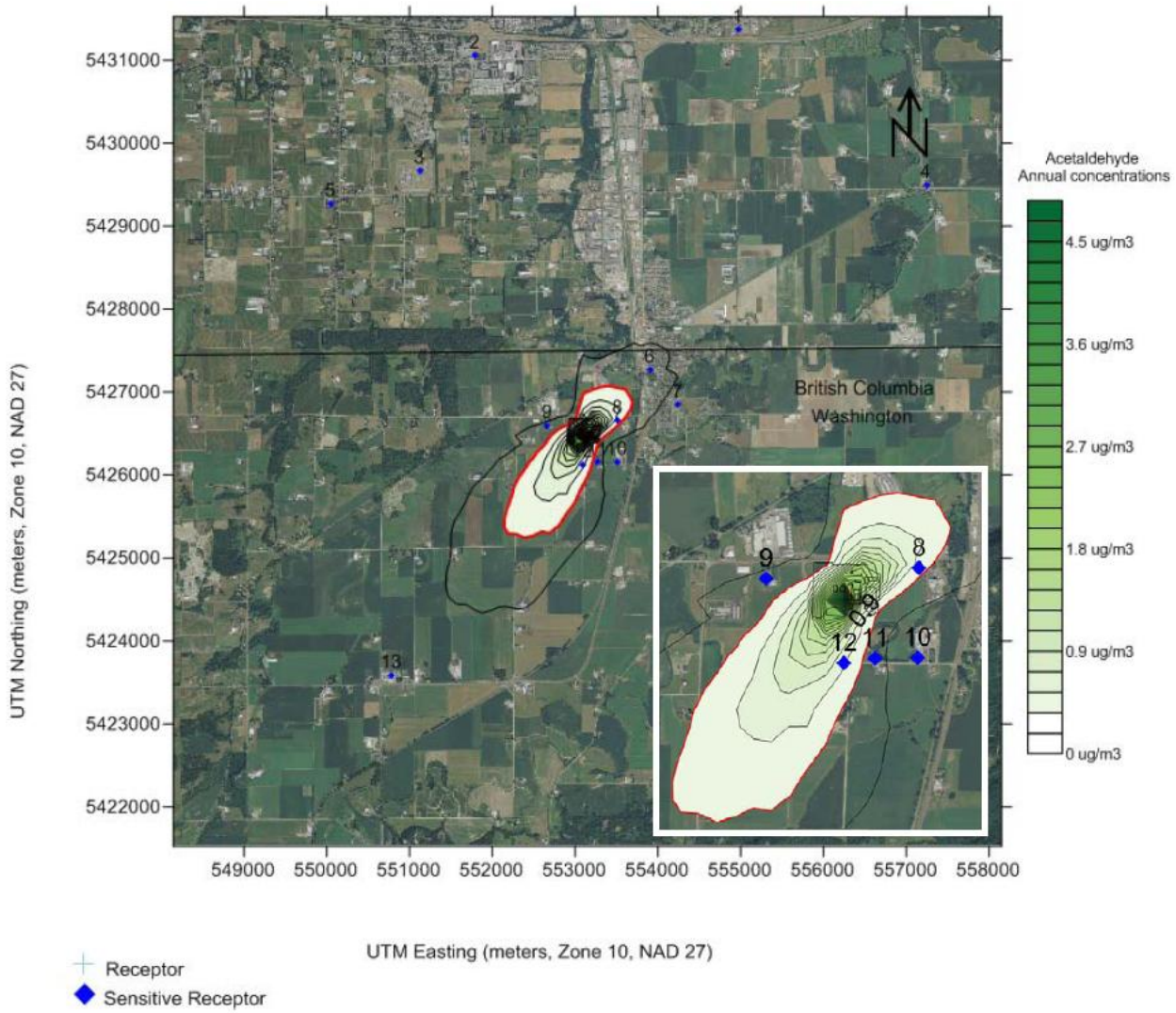
2	Central Heights Preschool	9	Residence 4
3	Abbotsford Medical Center	10	Residence 3
4	Upper Sumas Elementary School	11	Residence 2
5	South Poplar Elementary School	12	Residence 1: Maximally Impacted Residential Receptor (MIRR)
6	Sumas Medical Clinic		
7	Sumas Elementary School	13	Nooksack Valley High School

Figure 7. Contour plot for annual averaging time for acrolein (includes magnified inset).



#	Receptor Name	#	Receptor Name
1	Cascade Court Retirement Facility	8	Residence 5
2	Central Heights Preschool	9	Residence 4
3	Abbotsford Medical Center	10	Residence 3
4	Upper Sumas Elementary School	11	Residence 2
5	South Poplar Elementary School	12	Residence 1: Maximally Impacted Residential Receptor (MIRR)
6	Sumas Medical Clinic		
7	Sumas Elementary School	13	Nooksack Valley High School

Contour Plot for Annual Averaging Time for Acetaldehyde (includes magnified inset view).
ASIL contour line shown in red.

Figure 8. Contour plot for annual averaging time for acetaldehyde (includes magnified inset). ASIL contour line is shown in red.

Table 6 shows the predicted maximum 1-hour, 8-hour, 24-hour, and average annual time-weighted average TAP concentrations at the MIBR, MICR, and MIRR locations. Some TAP-location-TWA concentrations are listed as a single value. These ones were mentioned just once in the HIA or, if mentioned more than once, were equal.

For most TAPs, ENVIRON reported different concentrations at the MICR than at the MIBR. However, they reported the concentrations of some TAPs at the MICR equal to the MIBR. Evidently, the TAP concentration estimates for a maximally impacted commercial building and boundary point differed for those TAPs that were emitted at one but not both emission points (kilns or boiler).

Table 6. Predicted Maximum 1-hr, 8-hr, 24-hr, and Average Annual Time-Weighted Average TAP Concentrations (µg/m^3) at the MIBR, MICR, and MIRR Locations

TWA	Location	Acetaldehyde	Acrolein	Ammonia	Methyl Bromide	Chlorine	Copper	Formaldehyde	HCl	NO_2	SO_2	H_2SO_4	Vinyl Chloride
1-hr	MIBR	139	2.49	123.9	0.00239	0.01	0.01	2	0.11	8.52	6.8	0.51	0.00157
	MICR	139	2.49	105.4	0.00203	0.00968	0.000184	2	0.0951	7.25	5.8	0.435	0.00133
	MIRR	38	0.69	99.9	0.00193	0.0091	0.000175	0.559	0.09	6.88	5.5	0.41	0.00127
8-hr	MIBR		1.20										
	MICR	66.3	1.20	4.0	0.0000775	0.000369	0.0000073	0.979	0.00363	0.277	0.2	0.0166	0.0000509
	MIRR	14	0.26					0.21					
24-hr	MIBR	36.6	0.7	45.9	0.000885	0.00422	0.0000803	0.57	0.04	3.16	2.5	0.19	0.000581
	MICR	36.6	0.7	27.8	0.000535	0.00255	0.0000485	0.569	0.0251	1.91	1.5	0.115	0.000352
	MIRR	4.9	0.09	29.4	0.000566	0.0027	0.0000514	0.076	0.027	2.02	1.6	0.121	0.000372
1-yr	MIBR	5.62	0.09	9. 5	0.000183	0.000875	0.000875	0.07*, 0.0000166	0.00860	0.655	0.5	0.04	0.000121
	MICR	4.58	0.08	4.3	0.0000833	0.000397	0.00000755	0.06*, 0.0639	0.0039	0.297	0.238	0.0178	0.0000547
	MIRR	0.57	0.01	6.8	0.000131	0.000624	0.0000119	0.01*, 0.009	0.00613	0.00467	0.4	0.028	0.000086

The 8-hour TWA data are from ENVIRON's HIA Table 8-2. Other data are from Tables 10-3(a), 10-3(b), and 10-3(c), except records marked (*), which are from HIA Tables 8-2 and 9-2. The annual average concentration of formaldehyde at the MICR is widely divergent between Tables 9-2 and 10-3(c). The differences in formaldehyde concentrations reported in Table 9-2 and Tables 10-3(a) and 10-3(b) result from differing mathematical rounding. It was not clear which concentration was correct. On June 18, 2010, ENVIRON submitted completely revised NO_2 concentration estimates and supplemental 8-hour TWA concentrations for those TAPs not reported in the original HIA. This information did not resolve the formaldehyde concentration

discrepancies issue. Therefore, the higher one was used for subsequent calculations in this review.

Several TAPs' predicted 8-hour TWA maxima are lower than corresponding 24-hour TWA maxima. These were ammonia, methyl bromide, chlorine, copper, HCl, NO_2, SO_2, H_2SO_4, and vinyl chloride. Since this is not mathematically possible, it indicates errors were made in calculating or reporting some concentrations. Examination of the proportions of concentrations between each TWA period shown in Table 6 suggests some 8-hour TWAs are incorrect, but concentrations at other TWAs are correct. Fortunately, none of the affected TAPs has an acute REL for use with an 8-hour TWA concentration, and we could therefore ignore these errors.

5.3.5. Existing Background Levels of the TAPs of Concern

Acetaldehyde, acrolein, and most of the other TAPs to be emitted by Socco are released into the atmosphere by various human activities and natural processes. Socco emission will add to the existing level of these TAPs. Knowledge of currently existing atmospheric TAP levels is needed for predicting how much TAP exposure there will be from both existing and proposed emissions. Quantities of these pollutants in ambient air can be measured by sampling and laboratory analyses (monitoring) or calculated by using information on process rates, emissions factors (emissions inventories) and meteorological conditions.

Ecology is unaware of any ambient acetaldehyde, acrolein, or other TAP monitoring data collected recently in the Sumas area that could be used as background concentrations in the vicinity of Socco.

The U.S. Environmental Protection Agency (EPA) National-Scale Air Toxics Assessment (NATA) contains calculated concentrations of 177 Federal Clean Air Act-listed Hazardous Air Pollutants in most U.S. census tracts. In the absence of monitoring data, the median concentrations reported in the most recent NATA (for 2005)[9] are the only available estimates of acetaldehyde and acrolein levels. The EPA NATA contains modeled concentration estimates in the census tract that contains Sumas (10200), Whatcom County. EPA obtained these estimates primarily by using emissions inventory information. To a lesser extent, they used ambient monitoring data. They estimated that average concentrations of acetaldehyde and acrolein in 2005 were 1.10412 $\mu g/m^3$ and 0.01144 $\mu g/m^3$, respectively.

5.4. Exposure-Response Assessment

Exposure-response assessment is the process of characterizing the potential incidence of adverse health effects in humans resulting from exposure and uptake of toxicants. The process often involves establishing risk-based toxicity values or criteria to use in assessing potential health risk

[9] Still under review.

from each toxicant. Exposure-response assessment attempts to consider time-changing exposure magnitudes in whole populations and in theoretically maximally exposed individuals.

The EPA, California's Office of Environmental Health Hazard Assessment (OEHHA), and the Agency for Toxic Substances and Diseases Registry (ATSDR) have developed toxicological values for the chemicals evaluated in this project. These values are derived from laboratory studies of animals and humans and from human epidemiological studies.

Some of the toxicological values concern adverse effects other than cancer. The inhalation reference concentration (RfC), OEHHA reference exposure levels (RELs) and ATSDR minimal risk level (MRLs) are derived by methods that are believed to yield exposure concentrations for specified time frames below which non-cancer toxic effects are not expected to happen. The lack of such effects in all humans at these exposure concentrations cannot be confirmed; however, the closer a chemical concentration is to an RfC, REL, or MRL, the closer it may be to a toxic effect threshold level.

In addition to RfCs, RELs and MRLs, there are toxicological values derived for estimating toxicant-exposure-enhanced cancer risk. Nearly a third of all people develop some form of cancer at some point in life. The additional risk of cancer posed by exposure to TAPs to be emitted by the project is calculated using these cancer potency values, which are called unit risk factors (URFs).

The toxicological values for the chemicals of potential concern (identified in Section 5.2) are shown below in Section 5.4.1.

5.4.1. Risk-Based Concentrations for Exposed Populations

To evaluate possible non-cancer health effect hazards from exposure to acetaldehyde, acrolein, and potentially co-acting TAPs that will be emitted by Socco, modeled concentrations were compared with the corresponding risk-based concentration values shown in Table 7. The concentrations of NO_2 and SO_2 were also compared to their National Ambient Air Quality Standards (NAAQS).

Table 7. Risk-Based Concentration Values for Comparison With the Modeled Concentrations

Chemical	Agency	Type	Value
Acetaldehyde	EPA	RfC	9 µg /m^3
		URF	2.2x10^{-6} per ug/m^3
	OEHHA	Acute REL	470 µg/ m^3
		REL (8-hr)	300 µg/m^3
		Chronic REL	140 µg/m^3
		URF	2.7x10^{-6} per µg/m^3
Acrolein	EPA	RfC	0.02 µg/m^3
	OEHHA	Acute REL	2.5 µg/m³
		Chronic REL	0.35 µg/m³
		REL (8-hr)	0.70 µg/m³
	ATSDR	Acute MRL	6.9 µg/m^3 (0.003 ppm)
		Intermediate MRL	0.09 µg/m^3 (0.00004 ppm)
Ammonia	EPA	RfC	100 µg/m^3
	OEHHA	Chronic REL	200 µg/m^3
		Acute REL (1-hr)	3200 µg/m^3
	ATSDR	Chronic MRL	70.8 µg/m^3 (0.1 ppm)
		Acute MRL	1204 µg/m^3 (1.7 ppm)
Beryllium and Compounds	EPA	RfC	0.00002 µg/m^3
		URF	0.0024 per µg/m^3
	OEHHA	Chronic REL	0.007 µg Be/m^3
		URF	0.0024 per µg/m^3
Bromomethane	EPA	RfC	5 µg/m^3
	OEHHA	Acute REL (nerve)	3900 µg/m^3
		Chronic REL	5 µg/m^3
	ATSDR	Acute MRL	197 µg/m^3 (0.05 ppm)
		Intermediate MRL	197 µg/m^3 (0.05 ppm)
		Chronic MRL	19.7 µg/m^3 (0.005 ppm)
Cadmium	EPA	URF	1.8E-3 per µg/m^3
	OEHHA	URF	0.0042 per µg/m^3
		Chronic REL	0.02 µg/m^3
	ATSDR	Acute MRL (resp.)	0.03 µg/m^3
		Chronic MRL (renal)	0.01 µg/m^3
Chlorine	OEHHA	Acute REL (1-hr)	210 µg/m^3
		Chronic REL	0.2 µg/m^3
	ATSDR	Acute MRL	206-µg/m^3 (0.07 ppm)
		Intermediate MRL	5.9-µg/m^3 (0.002 ppm)
		Chronic MRL	0.147-µg/m^3 (0.00005 ppm)
Total and Hexavalent Chromium	EPA	Cr VI RfC	8E-6 mg/m^3
		Cr VI URF	1.2E-2 per µg/m^3
	OEHHA	Cr VI URF	0.15 per µg/m^3
		Cr VI Chronic REL	0.2 µg/m^3
		Chromic trioxide Chronic REL	0.002 µg/m^3
	ATSDR	Intermediate MRL	Soluble Cr III 0.0001 mg/m^3
			Insoluble Cr III 0.005 mg/m^3
			Cr VI mist 0.000005 mg/m^3

Chemical	Agency	Type	Value
			Cr VI particles 0.0003 mg/m^3
		Chronic MRL	Cr VI mist 0.000005 mg/m^3
Cobalt	ATSDR	Chronic MRL	0.0001 mg/m^3
Copper & copper compounds	OEHHA	Acute REL (1-hr)	100 µg/m^3
Formaldehyde	EPA	URF	1.3 x 10^{-5} per µg/m^3
	OEHHA	Acute REL (3-hr)	55 µg/m^3
		REL (8-hr)	9 µg/m^3
		Chronic REL	9 µg/m^3
		URF	0.000006 per µg/m^3
	ATSDR	Acute MRL	0.04 ppm (49 µg/m^3)
		Intermediate MRL	0.03 ppm (37 µg/m^3)
		Chronic MRL	0.008 ppm (9.8 µg/m^3)
Hydrogen Chloride	EPA	RfC	20 µg/m^3
	OEHHA	Acute REL (1-hr)	2100 µg/m^3
		Chronic REL	9 µg/m^3
Nitrogen Dioxide	OEHHA	Acute REL (1-hr)	470 µg/m^3
	EPA NAAQS	Annual (arithmetic average)	53 ppb (102 µg/m^3)
		1-hr	100 ppb (192 µg/m^3)
Sulfur Dioxide	EPA NAAQS	Annual (arithmetic average)	0.03 ppm (80 µg/m^3)
		24-hr	0.14 ppm (373 µg/m^3)
		1-hr	75 ppb (200 µg/m^3)
Sulfuric Acid Mist	OEHHA	Acute REL (1-hr)	120 µg/m^3
		Chronic REL	1 µg/m^3
Vinyl Chloride	EPA	RfC	100 µg/m^3
		URF Continuous lifetime exposure from birth	8.8E-6 per µg/m^3
		URF Continuous lifetime exposure during adulthood	4.4E-6 per µg/m^3
	OEHHA	Acute REL (1-hr)	180,000 µg/m^3
		URF	0.000078 per µg/m^3

5.5. Risk Characterization

In the risk characterization, conclusions about hazards and exposure-responses are integrated with the exposure assessments conclusions. Non-cancer health hazards and cancer risks are quantified and attempts are made to estimate increased likelihoods of these effects in populations exposed to anticipated TAP emissions. In addition, confidence about these conclusions, including information about the uncertainties associated with each aspect of the assessment, is highlighted.

5.5.1. Estimating Cancer Risks

Some chemicals have the ability to cause cancer. Acetaldehyde, which may be emitted by Socco in amounts that exceed its ASIL, is one such chemical. With sufficient exposure, it may cause bronchial and oral cavity tumors in humans. It's known to cause cancer in some animal species

with inhalation. Cancer may result from genotoxicity and or prolonged hyperplasia. Formaldehyde, which will be emitted at a rate that exceeds its SQER, can cause nasopharyngeal and cancer, and possibly cancers originating in other regions of the respiratory tract, by these mechanisms.

Additional cancer risk may be estimated by estimating the concentrations of a given carcinogen in a location (receptor point) multiplied by the carcinogen's unit risk factor (URF). A URF is expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to an agent at a concentration of one microgram per cubic meter [i.e., ($\mu g/m^{3)-1}$].

Some URFs are derived from epidemiological human population data. Others are derived from laboratory animal studies involving doses or concentrations higher than likely to be encountered in the environment. When certain assumptions are made, animal data may be used to derive a URF by extrapolation of the cancer potency obtained from a high-dose study to an expected exposure.

Because URFs are usually calculated as continuous lifelong exposure (70 years), it may be necessary to factor different exposure duration and exposure frequency to estimate risk for people exposure primarily in occupational or other less than continuous lifelong exposure scenarios. In general, the formula for determining cancer risk is as follows:

$$\textit{Additional Cancer Risk} = \frac{C_{AIR}\,(\mu g/m^3) \times \sum \textit{Exposure time}}{URF\,(\mu g/m^3)^{-1}}$$

Where: C_{Air} = Concentration in air at place(s) where people will be exposed to each carcinogen ($\mu g/m^3$); ∑Exposure time = (hours/24 hours) x (days/7 days) x (weeks/52 weeks) x (years/70 years); URF = Cancer Unit Risk Factor $(\mu g/m^3)^{-1}$ based on continuous life-long (70-year) exposure to 1-$\mu g/m^3$

Cancer risks from the nasopharyngeal carcinogens are considered to be additive. The health risk assessment is facility specific. Also, existing TAPs concentration estimates from EPA's NATA are included separately then in combination with proposed Socco emissions.

5.5.2. Cancer Risk

Cancer risks are reported using scientific notation. The values quantify the increased cancer risk for hypothetically maximally exposed people. For example, a cancer risk of 1.0E-06 means that if 1,000,000 people were exposed to a carcinogen at the given concentration, one additional cancer case might occur in that population. Each person in the population would have their chance of getting cancer increase by 0.0001 percent. Note that these estimates are of cancer risks that might result in addition to those normally expected in an unexposed population. Cancer risks quantified in this document are an upper-bound theoretical estimate.

The number of additional cancers that might result in the exposed population is not calculated because the population in the vicinity of Socco is too small. When small populations are exposed, population risk estimates tend to be very small. For example, if 100 people were exposed to a carcinogen at a level estimated to cause an additional individual lifetime cancer risk of 10^{-4}, the expected number of additional cancer cases would be 0.01. In such situations, individual risk estimates, but not population risk estimates, are usually more meaningful for decision-makers. The number of additional cancer cases in a given population is not an actuarial prediction of cases in the population. Actuarial predictions are statistical predictions based on a great deal of empirical data.

Table 8 shows ranges of estimated worst-case residential and off-site worker cancer risks from exposure to acetaldehyde and formaldehyde near the Socco facility. EPA's and OEHHA's URFs were used to estimate a range of risks to off-site residential receptors and to workers in commercial and Socco property boundary maximum annual pollutant concentration points.

Table 8. Ranges of Estimated Worst-Case Residential and Off-Site Worker Cancer Risks From Exposure to Acetaldehyde and Formaldehyde Near the Socco Facility

	Location	C_{AIR} (µg/m^3)	Fraction of a 70-year Continuous Exposure	Lower URF	Higher URF	Additional Cancer Risk Range		
Acetaldehyde	Socco	5.62	0.0245	2.20E-06[A]	2.70E-06[B]	3.03E-07	to	3.72E-07
	Tract	1.336				7.21E-08	to	8.85E-08
Formaldehyde	Socco	2.02		6.60E-06[B]	1.30E-05[A]	1.13E-08	to	2.23E-08
	Tract	1.247				2.02E-07	to	3.98E-07
Maximally Impacted Boundary Receptor	Sum of cancer risk from Socco alone					3.15E-07	to	3.95E-07
	Sum of cancer risk from census tract background (NATA) alone					2.74E-07	to	4.86E-07
	Combined cancer risks of Socco and background					5.89E-07	to	8.81E-07
Repeated exposures of 2 hr/day for 250 days/yr for 30 years are assumed for the MIBR. Based on this frequency, the additional cancer risks that would occur if the average concentrations of both acetaldehyde and formaldehyde occurred every time a maximally exposed person was in the MIBR location.								
	Location	**C_{AIR} (µg/m^3)**	**Fraction of a 70-year Continuous Exposure**	**Lower URF**	**Higher URF**	**Additional Cancer Risk Range**		
Acetaldehyde	Socco	4.58	0.1308	2.20E-06	2.70E-06	1.32E-06	to	1.62E-06
	Tract	1.336				3.85E-07	to	4.72E-07
Formaldehyde	Socco	0.0639		6.60E-06	1.30E-05	5.52E-08	to	1.09E-07
	Tract	1.247				1.08E-06	to	2.12E-06
Maximally Impacted Commercial Receptor	Sum of cancer risk from Socco alone					1.37E-06	to	1.73E-06
	Sum of cancer risk from census tract background (NATA) alone					1.46E-06	to	2.59E-06
	Combined cancer risks of Socco and background					2.83E-06	to	4.32E-06

	Location	C_{AIR} (µg/m^3)	Fraction of a 70-year Continuous Exposure	Lower URF	Higher URF	Additional Cancer Risk Range		
Repeated exposures of 8 hr/day for 250 days/yr for 40 years are assumed for the MICR. Based on this frequency, the additional cancer risks that would occur if the average concentrations of both acetaldehyde and formaldehyde occurred every time a maximally exposed person was in the MICR location.								
	Location	**C_{AIR} (µg/m^3)**	**Fraction of a 70-year Continuous Exposure**	**Lower URF**	**Higher URF**	**Additional Cancer Risk Range**		
Acetaldehyde	Socco	0.57	1	2.20E-06	2.70E-06	1.25E-06	to	1.54E-06
	Tract	1.336				2.94E-06	to	3.61E-06
Formaldehyde	Socco	0.01		6.60E-06	1.30E-05	6.60E-08	to	1.30E-07
	Tract	1.247				8.23E-06	to	1.62E-05
Maximally Impacted Residential Receptor	Sum of cancer risk from Socco alone					1.32E-06	to	1.67E-06
	Sum of cancer risk from census tract background (NATA) alone					1.12E-05	to	1.98E-05
	Combined cancer risk of Socco and background					1.25E-05	to	2.15E-05
A continuous exposure 24 hr/day for 365 days/yr for 70 years is assumed for the MIRR. Based on such a 70-year exposure, the additional cancer risks that would occur if the average concentrations of both acetaldehyde and formaldehyde continue to occurred in the MIRR location.								

[A] EPA IRIS, [B] OEHHA

Cancer risks attributable to Socco's proposed project alone are less than the 1.0E-05 risk level considered acceptable in Chapter 173-460 WAC.

- The additional risk of nasopharyngeal cancer attributable to Socco alone would be as high as 3.72E-07 for a person exposed intermittently for 2 hr/day for 250 days/yr for 30 years at the location identified as the MIBR.

- The additional risk of nasopharyngeal cancer attributable to Socco alone would be as high as 1.73E-06 for a person exposed intermittently for 8 hr/day for 250 days/yr for 40 years at the location identified as the MICR.

- The additional risk of nasopharyngeal cancer attributable to Socco alone would be 1.67E-06 at most for a person exposed continuously for 70 years at the location identified as the MIRR.

Socco's acetaldehyde and formaldehyde emissions will increase the concentrations of each chemical in the air in the vicinity of the project. The additional risk of nasopharyngeal cancer attributable to a 70 years long continuous exposure to background sources of acetaldehyde and

formaldehyde in the census tract where the Socco project will be located is believed to be 1.98E-05 at most. This risk estimate is crude and likely to change as the accuracy and continuity of NATA estimates change over time.

The sum of nasopharyngeal cancer risk from levels of acetaldehyde and formaldehyde existing alone (as reported in the 2002 NATA) is 1.98E-05 at most for a person exposed continuously for 70 years in the Sumas area census tract. This is the risk without inclusion of new emissions from the Socco project. Actual cancer risk for exposed people depends on how often and how long they remain in the same census tract with Socco, and on other factors that affect exposure. In addition, it is not clear which of the two URFs developed for each of the two aldehydes in question is more accurate. For each, the risk based on the higher URF is discussed henceforth in order to avoid underestimation of risks.

Assuming the higher URFs are more accurate than the lower ones, and that the most recent NATA estimates of background aldehyde levels are accurate and will continue to be so for 70 years, the combined nasopharyngeal cancer risk posed by Socco, together with existing acetaldehyde and formaldehyde levels, will be highest at the MIRR 2.15E-05. Ninety-two percent of this combined risk is from existing background acetaldehyde and formaldehyde levels.

5.5.3. Hazard Quotient/Hazard Index

Many air pollutants can harm health in ways other than cancer. Common "non-cancer effects" include problems such as eye and throat irritation, cough, and headache. Effects less commonly include more severe problems such as bronchitis, shortness of breath, and heart arrhythmias, for example. In addition to these, most other organs systems can be affected some type of air pollutant too.

To determine if Socco's TAP emissions will pose any significant non-cancer effect risks, we screened the TAPs that will be emitted in amounts greater than their SQERs. We limited the screening to TAPs that can affect the same organs that can affected by TAPs that exceed their ASILs. The organs and organ systems that can be affected by low concentrations of acrolein and acetaldehyde are the eyes and respiratory tract (see Section 5.2 above).

The screening procedure entailed calculating a hazard quotient (HQ) for each TAP at each exposure concentration likely to occur for given durations. We used the basic equation:

$$\textit{Hazard Quotient} = \frac{\textit{Time-weighted average concentration } (\mu g/m^3)}{\textit{Risk-based concentration } (\mu g/m^3)}$$

There will be several TAPs emitted by Socco at rates higher than their SQERs. Some may cause sensory irritation, redness and swelling of the eye, broncoconstriction, and degenerative, inflammatory and hyperplastic changes of the nasal mucosa like acetaldehyde can, or may cause eye irritation and respiratory epithelium lesions like acrolein can. We screened the combined

risk of these effects that may be posed by exposure to these TAPs. We did this for the maximally exposed boundary, commercial and residential receptor locations in relation to the Socco facility.

The screening procedure entailed calculation of a hazard index (HI) for increasing exposure durations. In each case, the HI for effects in these organs and tissues was the sum of HQs for each TAP. We calculated these separately for maximum 1-hour, 8-hour, 24-hour, and long-term (1 yr) time weighed average (TWA) hazards using the basic equation:

$$Hazard\ Index_{effect} = HQ_{chemcal\ a} + \cdots + HQ_{chemcal\ z}$$

Tables 9 to 11 show modeled concentrations, RBCs, and HQs at each receptor point. All predicted concentrations and risk-based concentrations are in µg/m^3. Some TAPs possess more than one RBC for given exposure intervals. Such RBCs were derived by different organizations using slightly different methods and, in some cases, different toxicity data. HQs were calculated for each RBC. For each exposure duration interval, at each maximally exposed receptor, the sum of HQs is the assumed index of potential adverse effects. The HI for each interval is shown at the end of each receptor's table section.

Table 9. Non-Cancer Hazards of Socco Emissions at the Maximally Exposed Boundary Receptor

Acetaldehyde Concentration	139 (max. 1-hr TWA)		36 (max. 24-hr TWA)	5.62 (max. 1-yr TWA)	
RBC	REL			RfC	REL
	470			9	140
HQ	3.0E-01			6.2E-01	4.0E-02
Acrolein Concentration	2.49 (max. 1-hr TWA)	1.2 (max. 8-hr TWA)	0.7 (max. 24-hr TWA)	0.09 (max. 1-yr TWA)	
RBC	REL	REL	MRL	RfC	REL
	2.5	0.7	6.9	0.02	0.35
HQ	1.0E+00	1.7E+00	1.0E-01	4.5E+00	2.6E-01
Ammonia Concentration	123.9 (max. 1-hr TWA)	45.9 (max. 24-hr TWA)	9.5 (max. 1-yr TWA)		
RBC	REL	MRL	RfC	REL	MRL
	3200	1204	100	200	70.8
HQ	3.9E-02	3.8E-02	9.5E-02	4.8E-02	1.3E-01
Chlorine Concentration	0.01 (max. 1-hr TWA)		0.00422 (max. 24-hr TWA)	0.000875 (max. 1-yr TWA)	
RBC	REL		MRL	REL	MRL
	210		206	0.2	0.147
HQ	4.8E-05		2.0E-05	4.4E-03	6.0E-03

Copper Concentration	0.01 (max. 1-hr TWA)		8.03E-5 (max. 24-hr TWA)		8.75E-4 (max. 1-yr TWA)
RBC	REL				
	100				
HQ	1.0E-04				
Formaldehyde Concentration	2.02 (max. 1-hr TWA)		0.57 (max. 24-hr TWA)		0.07 (max. 1-yr TWA)
RBC	REL (3-hr TWA)		MRL		REL
	55		49		9
HQ	3.7E-02		1.2E-02		7.8E-03
Hydrogen Chloride Concentration	0.11 (max. 1-hr TWA)		0.04 (max. 24-hr TWA)	0.0086 (max. 1-yr TWA)	
RBC	REL			RfC	REL
	2100			20	9
HQ	5.2E-05			4.3E-04	9.6E-04
Methyl Bromide Concentration	0.00239 (max. 1-hr TWA)		0.000885 (max. 24-hr TWA)	0.000183 (max. 1-yr TWA)	
RBC			MRL	RfC and REL	MRL
			197	5	19.7
HQ			4.5E-06	3.7E-05	9.3E-06
Nitrogen Dioxide Concentration	8.52 (max. 1-hr TWA)		3.16 (max. 24-hr TWA)		0.655 (max. 1-yr TWA)
RBC	REL	NAAQS			NAAQS
	470	192			102
HQ	1.8E-02	4.4E-02			6.4E-03
Sulfur Dioxide Concentration	6.8 (max. 1-hr TWA)		2.5 (max. 24-hr TWA)		0.5 (max. 1-yr TWA)
RBC	NAAQS (1-hr)	REL	NAAQS	MRL	NAAQS (annual average)
	200	660	373	27	80
HQ	3.4E-02	1.1E-02	6.7E-03	9.3E-02	6.3E-03
Sulfuric Acid Concentration	0.51 (max. 1-hr TWA)		0.19 (max. 24-hr TWA)		0.04 (max. 1-yr TWA)
RBC	REL				REL
	120				1
HQ	4.3E-03				4.0E-02
Vinyl Chloride Concentration	0.00157 (max. 1-hr TWA)		5.81E-4 (max 24-hr TWA)		0.000121 (max. 1-yr TWA)
RBC	REL				RfC

	180,000				100
HQ	8.7E-09				1.2E-06

		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	1.40	1.71	0.16	0.41
	Higher	1.45		0.24	5.33

Table 10. Non-Cancer Hazards of Socco Emissions at the Maximally Exposed Commercial Receptor

Acetaldehyde Concentration	139 (max. 1-hr TWA)	66.3 (max. 8-hr TWA)	36.6 (max. 24-hr TWA)	4.58 (max. 1-yr TWA)	
RBC	REL	REL		RfC	REL
	470	300		9	140
HQ	3.0E-01	2.2E-01		5.1E-01	3.3E-02

Acrolein Concentration	2.49 (max. 1-hr TWA)	1.2 (max. 8-hr TWA)	0.7 (max. 24-hr TWA)	0.08 (max. 1-yr TWA)	
RBC	REL	REL	MRL	RfC	REL
	2.5	0.7	6.9	0.02	0.35
HQ	1.0E+00	1.7E+00	1.0E-01	4.0E+00	2.3E-01

Ammonia Concentration	105.4 (max. 1-hr TWA)	27.8 (max. 24-hr TWA)	4.3 (max. 1-yr TWA)		
RBC	REL	MRL	RfC	REL	MRL
	3200	1204	100	200	70.8
HQ	3.3E-02	2.3E-02	4.3E-02	2.2E-02	6.1E-02

Methyl Bromide Concentrations	0.00203 (max 1-hr TWA)	7.75E-5 (max. 8-hr TWA)	0.000535 (max. 24-hr TWA)	0.0000833 (max. 1-yr TWA)	
RBC			MRL	RfC and REL	Chronic MRL
			197	5	19.7
HQ			2.7E-06	1.7E-05	4.2E-06

Chlorine Concentrations	0.00968 (max. 1-hr TWA)	0.000369 (max. 8-hr TWA)	0.00255 (max. 24-hr TWA)	0.000397 (max. 1-yr TWA)	
RBC	REL		MRL	REL	MRL
	210		206	0.2	0.147
HQ	4.6E-05		1.2E-05	2.0E-03	2.7E-03

Copper Concentrations	0.000184 (max. 1-hr TWA)	7.3E-6 (max. 8-hr TWA)	4.85E-5 (max. 24-hr TWA)	7.55E-6 (max. 1-yr TWA)	
RBC	REL				
	100				
HQ	1.8E-06				

Formaldehyde Concentration	2.02 (max. 1-hr TWA)	0.979 (max. 8-hr TWA)	0.569 (max. 24-hr TWA)		0.0639 (max. 1-yr TWA)
RBC	REL (3-hr)	REL	MRL		REL
	55	9	49		9
HQ	3.7E-02	1.1E-01	1.2E-02		7.1E-03

Hydrogen Chloride Concentration	0.0951 (max. 1-hr TWA)	0.00363 (max. 8-hr TWA)	0.0251 (max. 24-hr TWA)	0.0039 (max. 1-yr TWA)	
RBC	REL			RfC	REL
	2100			20	9
HQ	4.5E-05			2.0E-04	4.3E-04

Nitrogen Dioxide Concentration	7.25 (max. 1-hr TWA)		0.277 (max. 8-hr TWA)	1.91 (max. 24-hr TWA)	0.297 (max. 1-yr TWA)
RBC	REL	NAAQS			NAAQS
	470	192			102
HQ	1.5E-02	3.8E-02			2.9E-03

Sulfur Dioxide Concentration	5.8 (max. 1-hr TWA)		1.5 (max. 24-hr TWA)		0.238 (max. 1-yr TWA)
RBC	NAAQS (1-hr)	REL	NAAQS	MRL	NAAQS (annual average)
	200	660	373	27	80
HQ	2.9E-02	9.7E-03	4.0E-03	5.6E-02	3.0E-03

Sulfuric Acid Concentration	0.435 (max. 1-hr TWA)	0.0166 (max. 8-hr TWA)	0.115 (max. 24-hr TWA)		0.00178 (max. 1-yr TWA)
RBC	REL				REL
	120				1
HQ	3.6E-03				1.8E-02

Vinyl Chloride Concentration	0.00133 (max. 1-hr TWA)	5.09E-5 (max 8-hr TWA)	3.52E-4 (max. 24-hr TWA)		0.0000547 (max. 1-yr TWA)
RBC	REL				RfC
	180,000				100
HQ	7.4E-09				5.5E-07

		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	1.39	2.04	0.14	0.32
	Higher	1.43		0.19	4.60

Table 11. Non-Cancer Hazards of Socco Emissions at the Maximally Exposed Residential Receptor

Acetaldehyde Concentration	38 (max. 1-hr TWA)	14 (max. 8-hr TWA)	4.9 (max. 24-hr TWA)	0.57 (max. 1-yr TWA)	
RBC	REL	REL		RfC	REL
	470	300		9	140
HQ	8.1E-02	4.7E-02		6.3E-02	4.1E-03

Acrolein Concentration	0.69 (max. 1-hr TWA)	0.26 (max. 8-hr TWA)	0.09 (max. 24-hr TWA)	0.01 (max. 1-yr TWA)	
RBC	REL	REL	MRL	RfC	REL
	2.5	0.7	6.9	0.02	0.35
HQ	2.8E-01	3.7E-01	1.3E-02	5.0E-01	2.9E-02

Ammonia Concentration	99.9 (max. 1-hr TWA)	29.4 (max. 24-hr TWA)	6.8 (max. 1-yr TWA)		
RBC	REL	MRL	RfC	REL	MRL
	3200	1204	100	200	70.8
HQ	3.1E-02	2.4E-02	6.8E-02	3.4E-02	9.6E-02

Methyl Bromide Concentrations	0.00193/hr	0.000566 (max. 24-hr TWA)		0.000131 (max. 1-yr TWA)	
RBC		Acute MRL		RfC and REL	Chronic MRL
		197		5	19.7
HQ		2.9E-06		2.6E-05	6.6E-06

Chlorine Concentration	0.0091 (max. 1-hr TWA)	0.0027 (max. 24-hr TWA)		0.000624 (max. 1-yr TWA)	
RBC	REL	MRL		REL	MRL
	210	206		0.2	0.147
HQ	4.3E-05	1.3E-05		3.1E-03	4.2E-03

Copper Concentration	0.000175 (max. 1-hr TWA)		5.14E-5 (max. 24-hr TWA)		1.19E-5 (max. 1-yr TWA)
RBC	REL				
	100				
HQ	1.8E-06				

Formaldehyde Concentration	0.559 (max. 1-hr TWA)	0.21 (max 8-hr TWA)	0.076 (max. 24-hr TWA)		0.01 (max. 1-yr TWA)
RBC	REL (3-hr)	REL	MRL		REL
	55	9	49		9
HQ	1.0E-02	2.3E-02	1.6E-03		1.1E-03

Hydrogen Chloride Concentration	0.09 (max. 1-hr TWA)		0.027 (max. 24-hr TWA)	0.00613 (max. 1-yr TWA)	
RBC	REL			RfC	REL

	2100			20	9
HQ	4.3E-05			3.1E-04	6.8E-04

Nitrogen Dioxide Concentration	6.88 (max. 1-hr TWA)		2.02 (max. 24-hr TWA)		0.00467 (max. 1-yr TWA)
RBC	REL	NAAQS			NAAQS
	470	192			102
HQ	1.5E-02	3.6E-02			4.6E-05

Sulfur Dioxide Concentration	5.5 (max. 1-hr TWA)		1.6 (max. 24-hr TWA)		0.4 (max. 1-yr TWA)
RBC	NAAQS (1-hr)	REL	NAAQS	MRL	NAAQS (annual average)
	200	660	373	27	80
HQ	2.8E-02	9.2E-03	4.3E-03	5.9E-02	5.0E-03

Sulfuric Acid Concentration	0.41 (max. 1-hr TWA)		0.121 (max. 24-hr TWA)		0.028 (max. 1-yr TWA)
RBC	REL				REL
	120				1
HQ	3.4E-03				2.8E-02

Vinyl Chloride Concentration	0.00127 (max. 1-hr TWA)				0.000086 (max. 1-yr TWA)
RBC	REL				RfC
	180,000				100
HQ	7.1E-09				8.6E-07

		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	0.43	0.44	0.04	0.10
	Higher	0.47		0.10	0.70

All predicted concentrations and risk-based concentrations are in $\mu g/m^3$.

5.5.4. Hazard Indexes Discussion

Effect hazard indexes (HIs) greater than one exist at the maximally exposed boundary and commercial receptor locations at times. An HI greater than one does not necessarily indicate adverse effects will occur, just that they are possible. The greater an HI is above one, the greater the probability there is of adverse health effects under the defined exposure condition. In the other cases, HIs are less than one, and therefore adverse effects are unlikely. An HI of one or less indicates that adverse health effects are not expected to result from exposure to emissions of the TAPs being evaluated.

The maximum 1-hour exposure estimate at the MIBR results in lower and higher acute hazard indexes of 1.4 and 1.45, respectively. The maximum 1-hour exposure estimate at the MICR results in lower and higher acute hazard indexes of 1.39 and 1.43, respectively.

Acute eye and upper respiratory tract irritation effects hazards will exist at times at the MIBR and MICR, but not the MIRR, mostly due to short-term exposures to acrolein. Due to its lower water solubility, acrolein is more irritating to the upper respiratory tract than equal amounts of formaldehyde or acetaldehyde. Examination of the 1st through 6th highest acrolein, formaldehyde, and acetaldehyde concentration events, shown in Tables 12, 13, and 14, and Figures 9, 10, and 11, suggests 1-hour TWA concentration extremes are frequent at the maximally exposed boundary and commercial receptors. Acrolein and formaldehyde estimates decrease slightly over their six highest 1-hour extreme events. Acetaldehyde shows no decrease in concentration estimates over six highest events.

Table 12. Acrolein Exposure Extremes

*i*th Highest 1-hour Event	Maximum Boundary and Commercial Receptor Concentrations (µg/m^3)	Maximum Residential Concentrations (µg/m^3)
1	2.49	0.69
2	2.48	0.66
3	2.47	0.66
4	2.45	0.66
5	2.43	0.66
6	2.40	0.65

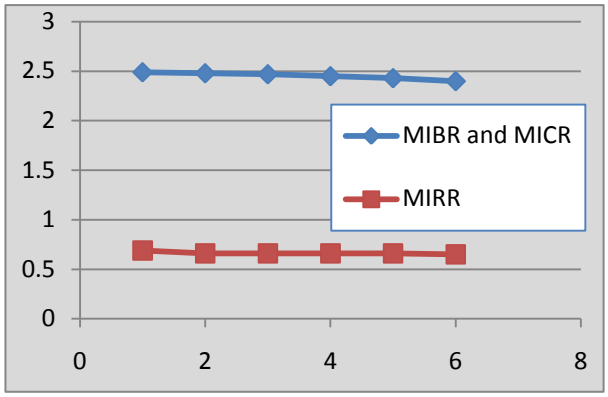


Figure 9. Acrolein exposure extremes

Table 13. Formaldehyde Exposure Extremes

*i*th Highest 1-hour Event	Maximum Boundary and Commercial Receptor Concentrations (µg/m^3)	Maximum Residential Concentrations (µg/m^3)
1	2.02	0.56
2	2.02	0.54
3	2.00	0.53
4	1.99	0.53
5	1.98	0.53
6	1.95	0.53

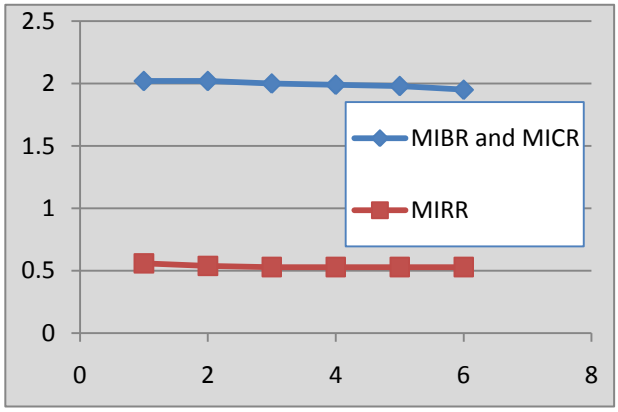


Figure 10. Formaldehyde exposure extremes

Table 14. Acetaldehyde Exposure Extremes

*i*th Highest 1-hour Event	Maximum Boundary and Commercial Receptor Concentrations (µg/m^3)	Maximum Residential Concentrations (µg/m^3)
1	139.27	37.97
2	139.27	37.97
3	139.27	37.97
4	139.27	37.97
5	139.27	37.97
6	139.27	37.97

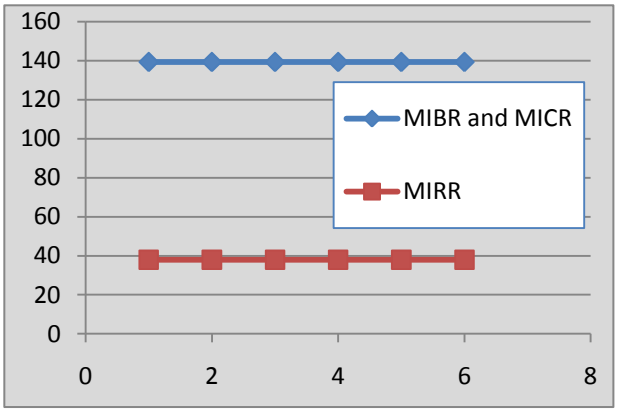


Figure 11. Acetaldehyde exposure extremes

The maximum 1-hour exposure estimate at the MIRR results in lower and higher acute hazard indexes of 0.43 and 0.47, respectively, indicating that adverse health effects are not expected to result from brief exposures to Socco TAP emissions at that location.

The maximum 8-hour exposure estimates at the MIBR and MICR result in an acute hazard indexes of 1.71 and 2.04, respectively, mostly due to acrolein. Examination of the highest 8-hour TWA acrolein concentration events (Table 15 and Figure 12) suggests the 0.7-µg/m^3 acute REL will rarely be exceeded. However, these HIs indicate a potential for eye and upper respiratory tract irritation will exist. They are also consistent with the suggestion that 1-hour TWA concentration extremes may be frequent at the maximally exposed boundary and commercial receptors.

Table 15. Acrolein 8-Hour TWA Exposure Extremes

*i*th Highest 8-hour Event	Maximum Boundary and Commercial Receptor Concentrations (µg/m^3)
1	1.2
2	1.1
3	0.9
4	0.9
5	0.9
6	0.8

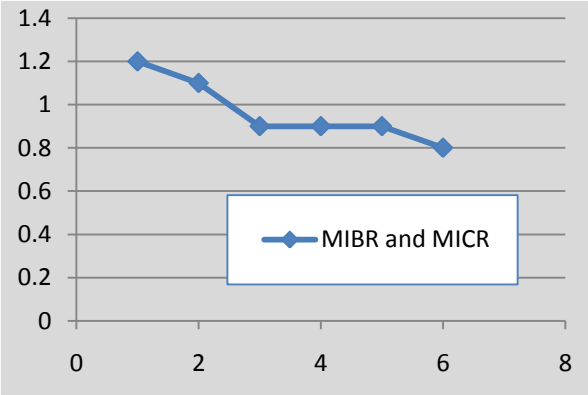


Figure 12. MIBR and MICR acrolein exposure extremes

The maximum 8-hour exposure estimate at the MIRR results in an acute HI of 0.44, indicating that adverse health effects are not expected to result from short-term exposures to Socco TAP emissions at that location.

Exposure estimates at the MIBR result in lower and higher maximum 24-hour acute HIs of 0.15 and 0.24, respectively. Exposure estimates at the MICR result in lower and higher maximum 24-hour acute HIs of 0.14 and 0.19, respectively. Exposure estimates at the MIRR result in lower and higher maximum 24-hour acute HIs of 0.04 and 0.1, respectively. Adverse acute health effects that might develop after exposure for 24 hours or longer to TAPs emitted by Socco are not expected to result any of the three maximally impacted receptor locations.

Estimates of potential long-term concentrations at the MIBR and MICR are higher than one of the two chronic RBCs considered. Long-term average concentrations of TAPs at the MIBR result in lower and higher chronic HIs of 0.41 and 5.33, respectively, mostly due to acrolein. Long-term concentration estimates at the MICR result in lower and higher chronic HIs of 0.32

and 4.6, respectively. The large difference in the lower and higher HIs indicates a lack of consensus on the concentration exposure threshold for chronic effects, mainly concerning acrolein. However, even if effects are likely to arise in people exposed at levels close to the lower RBC, it is unlikely anyone will be in these locations long enough to develop chronic toxicity.

Exposure estimates at the MIRR result in lower and higher chronic HIs of 0.1 and 0.7, respectively, indicating that adverse health effects are not expected to result from long-term exposures to Socco TAP emissions at that location.

5.5.5. Socco's Additions to Existing Toxic Air Pollutants

EPA's NATA estimates of average concentrations of acetaldehyde and acrolein in 2005 were 1.10412-µg/m^3 and 0.01144-µg/m^3, respectively. Applying the hazard quotient and hazard index calculation procedures to these background concentration levels yield numerically small hazards (shown in Table 16).

EPA's NATA estimates of average concentrations of acetaldehyde and acrolein in 2005 were 1.10412-µg/m^3 and 0.01144-µg/m^3, respectively. Applying the hazard quotient and hazard index calculation procedures to these background concentration levels yield numerically small hazards (shown in Table 16).

Table 16. Existing Background Acetaldehyde and Acrolein Hazards

Average Background Acetaldehyde Concentration (µg/m^3)	1.10412				
RBC	REL (1-hr)	REL (8-hr)		RfC	Chronic REL
	470	300		9	140
HQ	0.002	0.004		0.123	0.008

Average Background Acrolein Concentration (µg/m^3)	0.01144				
RBC	REL (1-hr)	REL (8-hr)	MRL (24-hr)	RfC	Chronic REL
	2.5	0.7	6.9	0.02	0.35
HQ	0.005	0.016	0.002	0.572	0.033

Background Hazard Index	1-hr	8-hr	24-hr	Long-term	
HQ	0.007	0.020	0.002	Lower 0.04	Higher 0.70

Assuming these average concentration levels will exist steadily and add to the levels at each identified Socco-affected receptor, the combined irritation effects HI (Table 17) will be slightly higher than from Socco alone, mainly due to acrolein.

Table 17. Background HI Plus Socco HI at Maximally Exposed Receptor Locations

MIBR		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	1.41	1.73	0.16	0.45
	Higher	1.46		0.24	6.02

MICR		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	1.40	2.06	0.14	0.36
	Higher	1.44		0.19	5.29

MIRR		Max. 1-hr Acute Hazard	Max. 8-hr Acute Hazard	Max. 24-hr Acute Hazard	Max. 1-yr Chronic Hazard
Hazard Index	Lower	0.44	0.46	0.04	0.14
	Higher	0.48		0.10	1.39

5.6. Uncertainty Characterization

Uncertainty may be defined as imperfect knowledge concerning the present and future conditions of a system under consideration. In risk assessments undertaken in support of regulatory decisions, many uncertainties are encountered. Knowledge of these uncertainties allows us to assess the robustness of decisions.

Evaluating the impacts from the Socco project involves several key elements, including emissions rate assumptions, air dispersion and fate modeling, estimates of resulting environmental concentrations, exposure modeling to estimate received doses, and exposure-response relationships to estimate the possibilities of different types of health impacts. Each of these elements is encumbered by uncertain science and measurement variability that prevents absolute confidence in predictions about adverse health impacts of this project.

The largest sources of uncertainty and variability are:

5.6.1. Emissions Uncertainty

Emissions uncertainty includes measurement uncertainty and process variability. The emissions factors used to estimate emission rates from this project are estimates of central tendency of measured emissions from comparable industrial processes measured at other facilities. As applied to Socco, these EFs are just as likely to underestimate as to overestimate TAP emissions. No quantitative description of uncertainty and variability consistent with available data are

available in this situation. The effects of emissions rates uncertainties may result in underestimates or overestimates of TAP concentrations that will result from Socco emissions.

5.6.2. TAP Concentration Modeling Uncertainty

TAP concentration modeling uncertainty results from uncertainties about future meteorology, and the measurement variability and applicability of past meteorological conditions from Shell Oil's Puget Sound Refinery in Anacortes, the NWS upper air data from Quillayute, and observations from Whidbey Island Naval Air Station, Arlington Municipal Airport, and Burlington-Skagit Regional Airport. Additionally, TAP concentrations uncertainty arises from uncertainty in the precision and accuracy of the air quality dispersion model used—EPA's AERMOD and associated pre- and post-processors. The results of TAP concentration modeling in the Socco situation are just as likely to be underestimates as to overestimates to the best of our knowledge. They are central estimates of long-term concentrations and of extreme of short-term concentrations. No quantitative descriptions of uncertainty and variability consistent with available data are available. The effects of these uncertainties may be underestimates or overestimates of TAP concentrations that will result.

5.6.3. Background TAP Concentration Estimates Uncertainties

Background TAP concentration estimates uncertainties, which result from the uncertainty about the validity of EPA's Assessment System for Population Exposure Nationwide, or ASPEN model[10], and from the possibility that toxic air emissions have changed since 2005 (the most recent NATA year). Further uncertainty arises from the geographic scale of the NATA concentration model, which is too large to provide precise results at single census tract scale. NATA results are most reliable when analyzed on a national or state scale, and have increasing uncertainty at smaller county and census tract levels. Therefore, concentration estimates at the census tract level may be misleading. Another limitation is that, while EPA has issued Maximum Achievable Control Technology (MACT) standards that are expected to reduce emissions of air toxics from stationary sources, other source categories emissions are generally increasing. The NATA background concentrations estimates are unlikely to exist at steady levels but are likely to generally increase or decrease in long-term trends. We have no data about future background levels other than EPA's analysis on which to base predictions. The overall effect of these uncertainties is to reduce our confidence in estimates of existing and future air toxics concentrations in the vicinity of Socco from sources other than Socco itself.

[10] ASPEN is the computer simulation model used to estimate toxic air pollutant concentrations for NATA. For details, see http://www.epa.gov/ttn/atw/nata/aspen.html.

5.6.4. Exposure Uncertainty

Exposure uncertainty results from potential inaccuracies of assumptions about the time people will spend in various locations. Concerning locations that will be affected by Socco's emissions, we assume a defined intermittent exposure pattern for a hypothetical worker entering the MIBR location routinely. We also assume a defined intermittent exposure pattern for workers entering the MICR, and that a person occupying the MIRR will have continuous life-long exposure at that location. The need to ensure that uncertainty and variability are addressed is met by ensuring that the maximal exposures are not underestimated. However, each exposure pattern assumption is likely to overestimate what will actually occur.

5.6.5. Toxicity Uncertainty

Toxicity uncertainty results from potential inaccuracies in the risk-based concentrations used in a risk assessment. RBCs are based on inherently variable toxicological studies. In the process of developing RBCs, there are uncertainties in the assumptions used to extrapolate these data, especially for chemicals with little or no human exposure-response data. Many RBCs are based on animal studies at high levels of exposure.

Acetaldehyde is a probable human carcinogen based on increased incidence of nasal tumors in male and female rats and laryngeal tumors in male and female hamsters after inhalation exposure. Formaldehyde is a probable human carcinogen based on limited evidence in humans, and sufficient evidence in animals. The URFs[11] for these chemicals may be inaccurate. EPA and OEHHA base most of the URFs they have published upon upper confidence limits of response data or of fitted curves, to avoid underestimating the true cancer potency. In this way, they attempt to ensure that uncertainty and variability are addressed, and to avoid underestimating actual risks.

The nasopharyngeal cancer risks quantified in this technical analysis are upper-bound theoretical estimates. Actual risks are likely to be lower. Both acetaldehyde and formaldehyde have quantitatively different URFs from EPA and OEHHA. One is likely more realistic than the other, but information required in order to determine which are more accurate than others is not available. The estimates of increased cancer risks are the best possible estimates of the upper extremes. These estimates are for excess cancers that might result in addition to those normally expected in an unexposed population.

Calculation of non-cancer adverse health effects risks is based on comparisons of possible exposure concentrations and durations to appropriate RELs, RfCs, MRLs, and NAAQS. These

[11] A URF is the upper bound of a confidence interval around, most typically, a mean of expected carcinogenic response at a given concentration. The 95 percent confidence interval for a mean is the range of values that will contain the true population mean 95 percent of the time.

RBCs are estimates of inhalation exposures for humans (including sensitive subgroups) likely to be without appreciable risks of adverse effects for defined durations.

This assessment raises concern that chronic health risk may arise at the MIRR due to long-term acrolein exposure. EPA qualifies RfCs as values having uncertainty "spanning perhaps an order of magnitude." Risk assessments should provide a quantitative, or at least qualitative, description of uncertainty and variability consistent with available data. The information required to determine if the acrolein RfC is more accurate than the corresponding OEHHA REL is not available. However, it is unlikely that there will be a significant risk of eye and upper respiratory irritation at the MIRR.

The difference in the acrolein chronic RBCs are due to use by EPA and OEHHA of different uncertainty factors (UFs).[12] Uncertainty factors should not be ignored. The exposure-response effect summarized as an RBC is not necessarily best reflected in its underlying unadjusted toxicity test data. UFs are used to adjust for differences in individual human sensitivities, for humans' generally greater sensitivity than test animals on a micrograms-per-kilogram basis, for the fact that chemicals typically induce harm at lower doses with longer exposures, and so on. There is no evidence that use of UFs has resulted in overly conservative RBCs. Further, the use of UFs to develop RBCs from toxicity test data does not guarantee safety of all humans who could be exposed at RBC levels.

To the extent that people may be exposed to emissions of acetaldehyde, acrolein, and other TAPs from the proposed Socco project, and despite the uncertainties in concentration estimates, exposure estimates, cancer potency estimates, and irritation hazards, potential health risks appear to be acceptable. Quantitative assessments of the effects of Socco air toxic emissions impacts on human health cannot be made with greater confidence. As in any risk assessment, this risk assessment of the Socco project involves circumstances of incomplete scientific information.

6. CONCLUSION

Socco's proposed emissions of acetaldehyde and formaldehyde could increase nasopharyngeal cancer risk by up to 1.73×10^{-6} (1.73 in one million) for a hypothetical person(s) frequently in the maximally impacted commercial location. Likewise, the increased cancer risks from Socco for people frequently in maximally impacted boundary and residential locations are less than two in one million.

Acute eye and upper respiratory tract irritation hazards will exist at times at the maximally impacted boundary and commercial locations, but not at the maximally impacted residential location, mostly due to short-term elevations of acrolein concentrations resulting from emissions by Socco. The maximum 8-hour exposure estimates at the MIBR and MICR result in an acute

[12] The term "uncertainty factor" is applied to the adjustments made to calculate an RBC in order to address species differences, human variability, data gaps, study duration, and other issues.

hazard indexes greater than one. The highest, 2.04, is mostly due to acrolein. If people do experience effects from these short-term elevations of TAP concentrations, the effects will most likely be limited to minor eye and upper respiratory tract irritation. Though sufficient exposures are unlikely, we cannot completely rule out the possibility people with asthma who might be exposed to the aldehydes from Socco in maximally affected boundary and commercial locations may experience respiratory symptoms such as wheezing, shortness of breath, and reduced pulmonary function with bronchoconstriction. Chronic long-term exposures to acrolein, acetaldehyde, and other TAP emissions from the proposed project are not likely to result in adverse non-cancer health problems for people at nearby locations. Existing local concentrations of acetaldehyde and acrolein, as estimated by EPA, may add slightly to health risks posed by the new emissions from Socco.

In summary, Socco's emissions are unlikely to result in excessive cancer risk or in any significant adverse non-cancer health problems to people at nearby residences or commercial locations. The increased risks from the proposed project appear to be permissible because they fall within the limits defined in WAC 173-460-090(7). Based on our analysis, the Washington State Department of Ecology finds that the applicant, Socco Forest Products, has satisfied all requirements for approval of the Second Tier petition. The project review team recommends approval of the proposed project in accordance with WAC 173-460-090(7).

7. PROJECT REVIEW TEAM

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8. LIST OF ACRONYMNS AND ABBREVIATIONS

AERMOD	Air dispersion model
ASIL	Acceptable Source Impact Level
ATSDR	Agency for Toxic Substances and Diseases Registry
BACT	Best Available Control Technology
BF	Board Feet
C	Celsius
C_{Air}	Concentration in air
Ecology	Washington State Department of Ecology, Headquarters Office
EPA	United States Environmental Protection Agency
HQ	Hazard Quotient
hr	Hour
LOAEL	Lowest Observable Adverse Effect Level
Max.	Maximum
mbf	Thousand Board Feet
$\mu g/m^3$	Micrograms per Cubic Meter
mg/m^3	Milligrams per Cubic Meter
MIBR	Maximally Impacted Boundary Receptor
MICR	Maximally Impacted Commercial Receptor
MIRR	Maximally Impacted Residential Receptor
MMBtu/hr	One Million British Thermal Units per Hour
MRL	ATSDR Minimal Risk Level
NAD27	North American Data of 1927
NATA	National-scale Air Toxics Assessment
NOC	Notice of Construction Order of Approval
NWCAA	Northwest Clean Air Agency
NWS	National Weather Service
OAC	Order of Approval to Construct
OEHHA	California's Office of Environmental Health Hazard
PSD	Prevention of Significant Deterioration
RBC	Risk-based Concentration
REL	OEHHA Reference Exposure Level
RfC	Reference Concentration
Socco	Socco Forest Products, Sumas, Washington
SQER	Small Quaintly Emission Rate
TAP	Toxic Air Pollutant
tBACT	Best Available Control Technology for Toxics
UF	Uncertainty Factor
URF	Unit Risk Factor
WAC	Washington Administrative Code
yr	Year