DEPARTMENT OF
ECOLOGY
State of Washington

Health Impact Assessment Recommendation Document for

McKinley Paper Company
Stock Preparation Project
Port Angeles, Washington

June 2019

Publication and Contact Information

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Executive Summary

This health impact assessment review evaluates and summarizes the health risks from increased emissions of toxic air pollutants resulting from upgrades to the existing pulping and stock preparation system at McKinley Paper Company (McKinley) in Port Angeles, WA. In general, increases in toxic air pollutant impacts in the area near McKinley will not likely contribute to any short- or long-term health effects. Ecology concludes that the health risk is acceptable and recommends approval of the project.

McKinley's proposed project will enable them to use more recycled material and produce heavier and stronger paper grades. As part of the project, McKinley will:

- Replace an existing old newsprint pulper with a new single-line continuous pulper with a maximum capacity of 900 tons of pulp per day.
- Decommission the existing old cardboard container tub pulper.
- Decommission two existing thermo-mechanical pulp refiner lines.
- Increase use of existing paper machines.
- Upgrade pulp cleaning, screening, reject and dewatering systems.

McKinley determined that their increased toxic air pollutant emissions may cause ambient formaldehyde impacts to exceed its acceptable source impact level. As a result, McKinley submitted a second tier petition under WAC 173-460-090. A second tier petition requires a health impact assessment that describes the health risks posed by McKinley's increased emissions of formaldehyde.

McKinley hired Ramboll US Corporation (Ramboll) to prepare an HIA (Ramboll, 2019). In this assessment, Ramboll estimated long-term cancer risk and acute and chronic noncancer hazards to people potentially exposed to McKinley's increased toxic air pollutant emissions.

Conclusions

- The highest increased cancer risk of about 0.9 in one million occurs at commercial location east of McKinley. In assessing cancer risk to off-site workers, Ecology assumes that workers are exposed to McKinley's increased emissions eight hours per day, five days per week, for 40 years.
- The maximum risk for a resident is 0.02 in one million and occurs at a home located south of McKinley. Ecology assumes continuous lifetime exposure in assessing residents' increased cancer risks from exposure to project-related formaldehyde emissions.
    - The state of Washington allows an increased risk of up to 10 in one million from new sources of air pollutants. This risk can also be expressed as the number of cancers that might occur in addition to those normally expected in a population of one million people.

The cancer risk estimates reported here are for increases in risk above a baseline lifetime risk of cancer of about 4 in 10 in the United States.

- McKinley's emissions will add to existing air pollutant exposures. This increase in emissions is not likely to contribute to long- or short-term health hazards near the facility.

2nd tier review recommendation

Ecology recommends approval McKinley's proposed project because:

- The emission controls for the new and modified emission units represent tBACT.
- The cancer risk from increased toxic air pollutant emissions alone is less than the maximum risk allowed by a second tier review, which is 10 in one million.
- The non-cancer hazard is acceptable.

Second Tier Review Processing and Approval Criteria

The health impact assessment (HIA) for McKinley submitted by Ramboll is part of the second tier toxics review process under WAC 173-460 (Ramboll, 2019). Ecology is responsible for processing and reviewing second tier review petitions statewide.

Second tier review processing requirements

In order for Ecology to review the second tier petition, each of the following regulatory requirements under Chapter 173-460-090 must be satisfied:

(a) The permitting authority has determined that other conditions for processing the Notice of Construction (NOC) Order of Approval have been met and has issued a preliminary approval order.

(b) Emission controls contained in the preliminary NOC approval order represent at least best available control technology for toxics (tBACT).

(c) The applicant has developed an HIA protocol that has been approved by Ecology.

(d) The ambient impact of the emissions increase of each toxic air pollutant (TAP) that exceed acceptable source impact levels (ASILs) has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

(e) The second tier review petition contains an HIA conducted in accordance with the approved HIA protocol.

Acting as the "permitting authority" for this project, Olympic Regional Clean Air Agency (ORCAA) satisfied item (a) above on May 17, 2019 (ORCAA, 2019). Ecology's engineer concurred that tBACT requirement was met and verified item (b).[1] Ecology approved an HIA protocol (item (c)), and the final HIA (item (e)) was received by Ecology on May 1, 2019. Ecology's modeler confirmed that refined modeling (item (d)) was conducted appropriately.[2]

Second tier review approval criteria

As specified in WAC 173-460-090(7), Ecology may recommend approval of a project that is likely to cause an exceedance of ASILs for one or more TAPs only if it:

(a) Determines that the emission controls for the new and modified emission units represent tBACT.

[1] Scott Inloes, "RE: McKinley Paper – Health Impact Assessment Report," email to Gary Palcisko, May 9, 2019.
[2] Tesfamichael Ghidey, "RE: McKinley Paper- Health Impact Assessment Report" email to Gary Palcisko, May 9, 2019.

(b) The applicant demonstrates that the increase in emissions of TAPs is not likely to result in an increased cancer risk of more than one in one hundred thousand.

(c) Ecology determines that the non-cancer hazard is acceptable.

tBACT determination

Ecology's second tier review engineer concurred with ORCAA's determination that McKinley's proposed tBACT limits will be met through pollution prevention measures and permit conditions that limit the amount of TAPs emitted. The proposed project use less chemical additives and no bleach. TAP emissions per ton of pulp and paper produced will actually be reduced compared to the existing processes (ORCAA, 2019).

Health Impact Assessment Review

As described above, the applicant is responsible for preparing the HIA under WAC 173-460-090. Ecology's project team consisting of an engineer, a toxicologist, and a modeler review the HIA to determine if the methods and assumptions are appropriate for assessing and quantifying the surrounding community's risk from a new project.

The HIA focused mainly on health risks attributable to formaldehyde as this was the TAP with modeled concentrations in ambient air that exceeded its respective ASIL. Ramboll also estimated health risks from another TAP (methylene chloride) that exceeded the small quantity emission rate (SQER) and may contribute to increased cancer risk. Impacts from methylene chloride near McKinley are minimal. Therefore, Ecology does not consider the methylene chloride impacts from this project to contribute substantially to cancer risk.

Formaldehyde health effects summary

Low levels of formaldehyde can cause irritation of the eyes, nose, throat, and skin. It is possible that people with asthma exposed to formaldehyde can experience respiratory symptoms such as wheezing, shortness of breath, and reduced pulmonary function consistent with bronchoconstriction (CalEPA, 2008). At concentrations that typically occur in ambient air, effects may occur in tissues where formaldehyde enters the body (i.e., nose or mouth). At higher levels, coughing, wheezing, bronchitis, nasal obstruction, pulmonary edema, choking, dyspnea, and chest tightness may occur.

People chronically exposed to formaldehyde by inhalation have experienced respiratory symptoms and eye, nose, and throat irritation. Animal studies have reported effects on the nasal respiratory epithelium and lesions in the respiratory system from chronic inhalation exposure to formaldehyde. In animal studies, rats exposed to high levels of formaldehyde in air developed cancer in a type of epithelial cell in the nose (nasal squamous cell carcinoma). Some studies of people exposed to formaldehyde in workplace air found more cases of cancer of the nose and throat than expected. United States Department of Health and Human Services (DHHS) has determined that formaldehyde is a known human carcinogen based on human and animal inhalation studies (DHHS, 2014). EPA has classified formaldehyde as a Group B1, probable human carcinogen.

Toxicity reference values

Several agencies, EPA, California Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA), and the Agency for Toxic Substances and Disease Registry (ATSDR), developed toxicological values for assessing non-cancer hazards and cancer risk from exposure to formaldehyde. These values were derived largely from studies of animals that were exposed to a known formaldehyde concentration. Some values were derived based on human epidemiological studies and short-term exposure studies in which human volunteers were

exposed in an experimental chamber. Table 1 shows toxicity values considered by Ecology for quantifying potential health hazards and cancer risks from exposure to formaldehyde.

To derive non-cancer reference values for the TAPs evaluated in the HIA, the agencies applied various uncertainty factors to toxic effect levels that were observed in toxicity studies. The resulting values (i.e., EPA's reference concentration [RfC],[3] OEHHA's reference exposure level [REL],[4] or ATSDR's minimal risk level [MRL]),[5] defined in detail in the footnotes, are concentrations in air at or below which non-cancer health effects are not expected from exposure to these pollutants. For assessing cancer risk from exposure to most potentially carcinogenic chemicals, there is theoretically no level of exposure for such a chemical that does not pose a small, but finite, probability of generating a carcinogenic response. To develop values for assessing cancer risk, agencies often extrapolate from high exposure concentrations that were used in animal experiments to the origin (where there are zero doses and zero responses). The slope of the line is used to estimate risk at exposure levels that are much lower than those used in the animal experiments. This resulting slope is used to derive a unit risk factor (URF)[6] for assessing cancer risk from exposure to very low levels that might be experienced in the environment.

[3] The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious non-cancer effects during a lifetime. It is not a direct estimator of risk but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfC, the potential for adverse health effects increases. Lifetime exposure above the RfC does not imply that an adverse health effect would necessarily occur.
[4] The concentration level at or below which no adverse health effects are anticipated for a specified exposure duration is termed the reference exposure level (REL). RELs are based on the most sensitive, relevant, adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of margins of safety. Since margins of safety are incorporated to address data gaps and uncertainties, exceeding the REL does not automatically indicate an adverse health impact.
[5] An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure. These substance specific estimates, which are intended to serve as screening levels, are used to identify contaminants and potential exposures that may be of concern at a given location.
[6] The unit risk factor (URF) is the upper-bound excess lifetime cancer to result from continuous exposure to an agent at a concentration of 1 µg/m³ in air. The interpretation of unit risk would be as follows: if unit risk = 2×10^{-6} per µg/m^3, two excess cancer cases (upper bound estimate) might develop per 1,000,000 people if exposed daily for a lifetime to 1 µg/m^3 concentration of the chemical in air.

Table 1: Toxicity Values or Comparison Values Considered in Assessing and Quantifying Non-Cancer Hazard and Cancer Risk

Chemical	Agency	Chronic	Non-cancer				Cancer URF
			Chronic (Workplace Scenario)	Organ System/ Endpoint	Acute	Organ System/ Endpoint	
Formaldehyde	EPA	N/A	N/A	Resp.	N/A	N/A	1.3 E-5 per µg/m^3 Nasal squamous cell carcinoma
	OEHHA	REL = 9 µg/m^3	8-hr REL = 9 µg/m^3	Resp.	Acute REL = 55 µg/m^3	Eyes (sensory irritation)	6.6E-6 per µg/m^3 Nasal squamous cell carcinoma
	ATSDR	MRL = 10 µg/m^3	N/A	Resp.	Acute MRL = 50 µg/m^3	Resp.	N/A
Toxicity value references: ATSDR, 1999; CalEPA, 2008; CalEPA, 2011; EPA, 1989							

Community/receptors

McKinley is an existing facility located in an area that is broadly designated as "heavy industrial." Much of the facility's property is surrounded by water bodies with Port Angeles Harbor to the east and southeast and the Strait of Juan de Fuca to the west and north. Residential parcels are located to the south of the facility's boundary (Ecology, 2019).

Dispersion modeling indicated that proposed formaldehyde emissions could result in concentrations exceeding ASILs over a small area around the facilities boundary and on a road that passes through the facility (Figure 1).

To determine if the impacts of McKinley's emissions are acceptable, Ecology requires that sources estimate exposures and health risks for those that are most likely to receive the highest exposures. Ramboll identified maximally impacted boundary, commercial, and residential receptors (MIBR, MICR, and MIRR, respectively) for evaluating acute and chronic exposure to formaldehyde emitted from their facility (Figures 2, 3, and 4).

Ramboll also identified areas where sensitive individuals could be exposed to McKinley's formaldehyde emissions. These locations included schools, medical facilities, nursing homes, and community centers. These sensitive receptors were generally impacted less by McKinley's

emissions than the MIBR, MICR, or MIRR. Evaluation of exposures at the maximally impacted locations adequately addresses lower exposures that might occur at sensitive receptor locations.

Increased cancer risk

Ramboll assessed the increased risk of cancer from lifetime exposure to TAPs emitted from McKinley's increased formaldehyde emissions. Cancer risk was characterized in a manner consistent with EPA guidance for inhalation risk assessment (EPA, 2009). Risks were quantified using the following equations:

Risk = IUR x EC

Where:

IUR ($\mu g/m^3)^{-1}$ = inhalation unit risk (i.e., unit risk factor); and

EC ($\mu g/m^3$) = exposure concentration

EC = (CA x ET x EF x ED)/AT

Where:

EC (EC ($\mu g/m^3$) = exposure concentration;

CA ($\mu g/m^3$) = contaminant concentration in air;

ET (hours/day) = exposure time;

EF (days/year) = exposure frequency;

ED (years) = exposure duration; and

AT (ED in years x 365 days/year x 24 hours/day) = averaging time

Cancer risk attributable to increased formaldehyde emissions

Table 2, adapted from the HIA (Ramboll, 2019), shows the estimated McKinley project-specific increased cancer risk at each of the receptors evaluated. Risks were calculated using the unit risk factor derived by EPA. The highest increase in risk attributable to project-related formaldehyde emissions is about **0.9 per million** for the MICR located east of McKinley.

For residential exposure scenarios, the MIRR may have increased risks of about 0.02 per million, and the MIBR may have increased risks of about 0.2 per million.

Cancer risk attributable to background exposure to formaldehyde

When reviewing increases in TAP emissions under second tier review, WAC 173-460-090 specifies that:

- Background concentrations of TPAs will be considered as part of a second tier review.
- Background concentrations can be estimated using:
    - The latest National Ambient Toxics Assessment data for the appropriate census tracts; or
    - Ambient monitoring data for the project's location; or
    - Modeling of emissions of the TAPs subject to second tier review from all stationary sources within 1.5 kilometers of the source location.

Ramboll chose to evaluate background using the most recent publically available National Ambient Toxics Assessment (NATA) (EPA, 2018). Generally, the residential receptor's background risk attributable to existing formaldehyde exposures is much higher (13 in one million) than risk attributable to project-related increases (0.02 in one million).

Table 2: Increased Cancer Risk Attributable to McKinley's Increased Formaldehyde Emissions

Exposure Parameter	MIRR	MICR	MIBR
$CA_{McKinley}$ - Concentration in air from McKinley's emissions ($\mu g/m^3$)	**0.0016**	**0.55**	**0.73**
$CA_{background}$ - Concentration in air from "background" sources ($\mu g/m^3$)	0.97	0.97	0.97
ET – Exposure Time (hours per day)	24	8	2
EF – Exposure Frequency (days per year)	365	250	250
ED – Exposure Duration (years)	70	40	30
AT – Averaging Time (hours)	613200	613200	613200
$EC_{McKinley}$ – McKinley Project Related Exposure Concentration ($\mu g/m3$)	**0.0016**	**0.071**	**0.018**
$EC_{background}$ – Background source related Exposure Concentration ($\mu g/m^3$)	0.97	0.13	0.024
IUR – Inhalation Unit Risk $(\mu g/m^3)^{-1}$	1.3E-05	1.3E-05	1.3E-05
Cancer risk from McKinley's increased emissions	**2.1E-08**	**9.3E-07**	**2.3E-07**
Cancer risk from "background" sources	1.3E-05	1.7E-06	3.1E-07
Total cancer risk from formaldehyde near McKinley	1.3E-05	2.6E-06	5.4E-07
Note: Risk = IUR x EC; EC = (CA x ET x EF x ED)/AT Ramboll also estimated a negligible increased cancer risk related to methylene chloride exposure (<0.01 per million).			

Non-cancer hazard

In order to evaluate the potential for non-cancer adverse health effects that may result from exposure to air pollutants, exposure concentrations at each receptor location are compared to relevant non-cancer toxicity values (i.e., RfC, REL, and MRL). If a concentration exceeds the toxicity value, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. This comparison is known as a hazard quotient (HQ) and is given by the equation below:

$$\frac{\text{HQ = time weighted average concentration of pollutant in air } (\mu g/m^3)}{\text{Time interval specific RfC, MRL, or REL } (\mu g/m^3)}$$

An HQ of one or less indicates that the exposure to a substance is not likely to result in adverse non-cancer health effects. As the HQ increases above one, the likelihood of human health effects increases by an undefined amount.

Acute hazards (1-hour and 24-hour exposures)

Acute exposure to formaldehyde (1-hour duration and 24-hour duration) at all locations are not likely to result in eye and upper respiratory tract irritation as HQs are less than one even when adding project related and background exposures.

Chronic hazards (8-hour occupational exposures at the MIBR/MIR and MICR)

For sources like McKinley that are assumed to operate near continuously, an off-site worker is assumed to breathe the long-term annual average concentration during their work shift (OEHHA, 2015). If 8-hour reference exposure levels are available, as is the case for formaldehyde, then long-term hazards for off-site workers are estimated by dividing the annual average concentration by the 8-hour REL.

Off-site workers exposed to McKinley project-related formaldehyde (long-term) at the MICR are not likely to experience adverse respiratory health effects as the HQ is less than one. The addition of McKinley's formaldehyde emissions to an assumed background concentration (Table 3) does not result in an HQ greater than unity.

Chronic hazards (long-term exposures at the MIRR)

The chronic HQ for maximally impacted residents exposed to McKinley-related formaldehyde emissions is lower than one, therefore adverse respiratory health effects are not expected. The addition of McKinley's TAP emissions to an assumed background concentration (Table 3) does not result in a HQ greater than unity; therefore, exposure to formaldehyde in the area is not likely to result in adverse respiratory health effects.

Table 3: Estimated Non-cancer Hazards Attributable to McKinley and "Background" Emissions at Key Locations near the Facility

Receptor	Increased Formaldehyde Concentration (µg/m^3)	Background Formaldehyde Concentration (µg/m^3)	Total Formaldehyde Concentration (µg/m^3)	REL of MRL (µg/m^3)	HQ McKinley Project	HQ McKinley Project & Background
1-hr Duration						
MIRR	1.1	0.97	2.1	55	0.02	0.04
MIBR & MICR	5.6		6.6	55	0.10	0.12
24-hr Duration						
MIRR	0.12	0.97	1.1	50	<0.01	0.02
MICR	1.4		2.4	50	0.03	0.05
MIBR	2.0		3.0	50	0.04	0.06
Chronic Duration – Commercial Receptor: Annual Average Concentration Compared to 8-hr REL						
MICR	0.55	0.97	1.5	9	0.06	0.17
Chronic Duration – Residential Receptor Annual Average Concentration Compared to Chronic REL						
MIRR	0.0016	0.97	0.97	9	<0.01	0.11
HQ = time weighted average concentration of pollutant in air (µg/m^3) / time interval specific RfC, MRL, or REL (µg/m^3)						

Uncertainty

Uncertainty may be defined as our inability to know for sure. In risk assessments that are intended to inform regulatory decisions, many uncertainties are encountered. Knowledge of these uncertainties allows us to assess the robustness of decisions.

Evaluating the impacts from the McKinley 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 contains uncertain science and measurement variability that prevents absolute confidence in predictions about adverse health impacts of this project.

Exposure uncertainty

It is difficult to characterize the amount of time that people can be exposed to McKinley's emissions. For simplicity, Ramboll and Ecology assumed a residential receptor is at one location for 24 hours per day, 365 days per year for 70 years. These assumptions tend to overestimate exposure.

Emissions uncertainty

Emissions estimates from the proposed project were based on emission factors developed by the National Council of Air and Stream Improvement. While the exact amount of pollutants emitted by McKinley's proposed project is uncertain, ORCAA and Ecology determined that emissions estimates based on these factors to be reasonable.

Air dispersion uncertainty

The transport of pollutants through the air is a complex process. Regulatory air dispersion models are developed to estimate the transport and dispersion of pollutants as they travel through the air. The models are frequently updated as techniques that are more accurate become known but are written to avoid underestimating the modeled impacts. Even if all of the numerous input parameters to an air dispersion model are known, random effects found in the real atmosphere will introduce uncertainty. With regard to the ambient impact analysis, Ecology's air dispersion modeler determined that Ramboll appropriately modeled emissions of TAPs from McKinley so as not to underestimate exposure.

Toxicity uncertainty

One of the largest sources of uncertainty in any risk evaluation is associated with the scientific community's limited understanding of the toxicity of most chemicals in humans following

exposure to the low concentrations generally encountered in the environment. Many risk-based concentrations are based on animal studies at high levels of exposure. To account for uncertainty when developing toxicity values (e.g., RfCs, RELs, MRLs), agencies apply "uncertainty" factors to doses or concentrations that were observed to cause adverse non-cancer effects in animals or humans. Agencies apply these uncertainty factors so that they derive a toxicity value that is considered protective of humans including susceptible populations.

Formaldehyde is a probable human carcinogen based on limited evidence in humans, and sufficient evidence in animals. 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 may be lower. The URFs derived for formaldehyde by EPA and OEHHA are quantitatively different. One may be more realistic than the other, but information required in order to determine which are more accurate than others is not available. The risks presented in this document were based on EPA's URF, which is more conservative than OEHHA's.

Conclusions and Recommendation

The project review team has reviewed the HIA and determined that:

(a) The TAP emissions estimates presented by Ramboll represent a reasonable estimate of the project's future emissions.

(b) Emission controls for the new and modified emission units meet the tBACT requirement.

(c) The ambient impact of the emissions increase of each TAP that exceeds ASILs has been quantified using refined air dispersion modeling techniques as approved in the HIA protocol.

(d) The HIA submitted by Ramboll on behalf of McKinley adequately assesses project-related increased health risk attributable to TAP emissions.

The project review team concludes that the HIA presents an appropriate estimate of potential increased health risks posed by McKinley's TAP emissions. Increased formaldehyde emissions could result in an increased cancer risk of up to **0.9 per million** for the MICR located east of McKinley. This risk was calculated assuming workers are exposed eight hours per day, 250 days per year for 40 years. Increased cancer risk to nearby residential and boundary receptors is lower (0.02 and 0.2, respectively). These risks fall below Ecology's threshold of maximum acceptable risk (i.e., one per one hundred thousand or 10 per million) as defined in Chapter 173-460 WAC.

Acute eye and upper respiratory tract irritation hazards are not likely to occur at any off-site location. Chronic long-term exposure to McKinley's project-related formaldehyde increased emissions is not likely to cause or appreciably contribute to adverse health effects.

In summary, McKinley's TAP 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 are 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, McKinley, has satisfied all requirements for approval of the second tier petition. The risk manager may recommend approval of the proposed project because project-related health risks are permissible under WAC 173-460-090(7).

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Figure 1: Extent of area in which McKinley's formaldehyde emissions may cause impacts that exceed the ASIL

Figure 2: Location of key receptors evaluated in the HIA relative to McKinley's project-related annual formaldehyde concentration

(Note: Impacts from recycled paper plant reflect negative emissions due to decommissioning of refiner lines.)

Figure 3: Location of key receptors evaluated in the HIA relative to McKinley's project-related maximum 24-hr formaldehyde concentration

(Note: Impacts from recycled paper plant reflect negative emissions due to decommissioning of refiner lines.)

Figure 4: Location of key receptors evaluated in the HIA relative to McKinley's project-related maximum 1-hr formaldehyde concentration

(Note: Impacts from recycled paper plant reflect negative emissions due to decommissioning of refiner lines.)