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HEALTH IMPACT ASSESSMENT OF AN OIL DRILLING PROJECT IN CALIFORNIA

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Abstract
Objectives: The Health Impact Assessment (HIA) was conducted to evaluate the potential community health implications of a proposed oil drilling and production project in Hermosa Beach, California. The HIA considered 17 determinants of health that fell under 6 major categories (i.e., air quality, water and soil quality, upset conditions, noise and light emissions, traffic, and community livability). **Material and Methods:** This paper attempts to address some of the gaps within the HIA practice by presenting the methodological approach and results of this transparent, comprehensive HIA; specifically, the evaluation matrix and decision-making framework that have been developed for this HIA and form the basis of the evaluation and allow for a clear conclusion to be reached in respect of any given health determinant (i.e., positive, negative, neutral). **Results:** There is a number of aspects of the project that may positively influence health (e.g., increased education funding, ability to enhance green space), and at the same time there have been potential negative effects identified (e.g., odor, blowouts, property values). Except for upset conditions, the negative health outcomes have been largely nuisance-related (e.g., odor, aesthetics) without irreversible health impacts. The majority of the health determinants, that had been examined, have revealed that the project would have no substantial effect on the health of the community. **Conclusions:** Using the newly developed methodology and based on established mitigation measures and additional recommendations provided in the HIA, the authors have concluded that the project will have no substantial effect on community health. This approach and methodology will assist practitioners, stakeholders and decision-makers in advancing the HIA as a useful, reproducible, and informative tool.

Key words:
Oil production, Air quality, Health Impact Assessment, HIA, Health effects, Social determinants

INTRODUCTION

The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [1]. This definition is considered an ideal to strive for, and it forms the basic principle, upon which the Health Impact Assessment (HIA) is based. Historically, community health has been a secondary consideration (if it is formally considered at all) in many policy/project decision making processes. When it is included, it tends to be limited to evaluation of health impacts associated with environmental contaminants (e.g., human health risk

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assessment). The Health Impact Assessment is intended to incorporate a wider range of health determinants and their potential effects on health and well-being. Often referred to as the "social determinants of health" does this collection of factors related to health status range from biological characteristics (i.e., age, gender, genetics, etc.) to socioeconomic factors (i.e., education, income, lifestyle factors, etc.) [2].

The HIA typically consists of a series of steps that are intended to provide a structural framework, around which the assessment will be conducted. Although guidance documents from around the world have slight variations on these steps, the process is fundamentally the same [3]. The 1st step of any HIA is the screening step where a rapid review of the available evidence is conducted to determine whether this type of assessment is warranted. Once it has been decided that the HIA is warranted, the scoping step commences. The purpose of the scoping step is to plan the overall approach to the HIA including methods, contents and logistics. Feedback from stakeholder engagement activities (e.g., open houses, public comments, surveys, etc.) may be very useful in identifying important issues for consideration in terms of the HIA.

The next step is the assessment which varies widely depending on the project. The assessment step is where all of the planning in the scoping the phase is carried out to "identify whether impacts are likely to occur and then to quantify or characterize the predicted impacts" [3]. Currently, there is a high degree of inconsistency in the quality of assessments, including scientific basis, transparency and reproducibility [4]. Based on the findings of the assessment, specific recommendations may be made and should include input from key stakeholders to ensure they are politically, socially and technically feasible. The reporting step is self-explanatory to the extent that typical HIAs are written up in a report-style format to be distributed to decision-makers and other stakeholders. Although not always included, the evaluation step is considered to be an important aspect of the HIA since it involves reflection and critical assessment of the process in order to foster improvement. Finally, monitoring is intended to ensure that the control measures and health predictions in the HIA are accurate and effective. However, this is one of the least well-defined steps of the HIA and is seldom implemented.

The majority of information available on the HIA is from government or health agencies, with relatively little scientific research published in the primary literature [3–8]. Those studies that do appear in the literature identify the lack of a consistent methodological approach to the HIA and point to its usefulness as a tool being hindered by a lack of appropriate guidance [9–13]. Without a clear methodological approach that carefully considers the interdisciplinary elements of the HIA, the major inconsistencies and differences will continue to be found in quality and scientific rigor of these important and influential components of the decision-making process [4]. Considering that government officials, members of the public and health practitioners are calling for the HIA to become a mandatory part of assessing major infrastructure projects, it is imperative that a comprehensive, integrated framework be developed to guide practitioners.

One of the most promising research opportunities, as identified in the recent US Environmental Protection Agency (US EPA) report "A review of Health Impact Assessments in the U.S.: Current state-of-science, best practices, and areas for improvement," lies in developing methods to make the HIA more universally applicable and to provide guidance on the practical implementation of specific quantitative and qualitative assessment methods [4]. This paper attempts to address some of the gaps within the HIA practice by presenting the methodological approach and results of the comprehensive HIA conducted on a proposed oil drilling and production project in Hermosa Beach, California.

Project overview

The current boom in the U.S. domestic crude oil production is approaching the historical high of 9.6 million barrels per day, that was achieved in 1970. California remains one of the top producers of crude oil in the country, accounting for almost 1/10 of the total U.S. production [14]. Los Angeles is considered the most urban oil field in the country, with a long history of the petroleum industry operating in non-industrial areas [15]. Since industrial processes are generally not desired in densely populated areas due to environmental and health concerns, many oil drilling sites in Los Angeles have incorporated mitigation measures (e.g., noise muffling, visual barriers, closed-loop systems) to help reduce the potential impacts on surrounding communities.

The proposed project consists of drilling 30 oil wells on a 1.3-acre site currently used as a City maintenance yard in the City of Hermosa Beach. If approved, the proposed project will be completed in 4 the phases [16]. The Phase 1 involves construction activities associated with site preparation for drilling and testing. The Phase 2 consists of drilling and testing of wells in order to estimate the potential productivity and economic viability of the project. If the Phase 2 determines that the project is economically feasible, the Phase 3 would be carried out to prepare the site for permanent oil and gas production facilities and to construct offsite pipelines. The permanent oil production facility will include tanks, vessels, piping, pumps, filters and corresponding metering equipment. The Phase 4 is the final the phase of the project that will maximize oil and gas recovery through the construction of an 87-foot high drill rig, the drilling of the remaining wells, and through the continuous operation of the project. Facility operations and maintenance would continue for approximately 30–35 years, with periodic re-drills during the life of the project [16].

The situation in Hermosa Beach is unique since it permits local residents to vote on whether to lift the existing oil ban and allow the project to proceed. Therefore, in order to inform voters about the potential economic, social, environmental, and health impacts (positive and negative) of the project, the City of Hermosa Beach commissioned the HIA, in addition to a Cost-Benefit Analysis (CBA) and Environmental Impact Report (EIR). The EIR complies with the California Environmental Quality Act, while the CBA and HIA are complementary documents that have been commissioned to provide community members with additional information on the project.

Consequently, the HIA is not intended to be a standalone document; it is rather complementary to the existing information provided in the EIR. The difference lies in the scope of the health impacts considered, with the HIA focusing on a wider range of health determinants, including social and economic aspects which may not have been addressed in the EIR, or may not have focused on human health implications of the project activities. Due to the volume of work required for the detailed assessment of all of the identified health determinants, this paper provides a summary of the HIA; however, these reports are publicly available on the City of Hermosa Beach website.

In California, the HIA is not legally required for this type of project. The rationale for the HIA lies in its unique approach to assessing a multitude of potential impacts (both positive and negative) that could affect community health. The HIA is intended to provide a wider scope, while relying on existing information provided in the EIR, to holistically evaluate health. Although the reports are complementary, in several instances the HIA provides further details on how specific aspects of the project could positively or negatively affect the health of the community, and proposes additional recommendations where necessary.

The approach and methodology developed for this HIA are unique, comprehensive, scientifically-based, and transparent. Due in part to the major inconsistencies among HIAs, which has been identified as a key data gap and issue about the practice, the methods have been designed in such a way that other practitioners working on a variety of projects could use this approach to ensure that future HIAs are more consistent, transparent and reproducible. Specifically, the evaluation matrix and decision-making framework that form the basis of the assessment, allow for a clear conclusion to be reached on any given health determinant (i.e., positive, negative, or neutral effect on health), which will assist practitioners, stakeholders and decision-makers in advancing the HIA as a useful and informative tool.

MATERIAL AND METHODS

The HIA typically consists of a series of steps that are intended to provide a structural framework, around which the assessment will be conducted. Although guidance documents from around the world have slight variations on these steps, they typically include: screening, scoping, assessment, recommendation, reporting, evaluation and monitoring [3].

Study area and population

Founded in 1907, Hermosa Beach is a small 3.7 square kilometer City on Los Angeles (LA) County's South Bay coastline, bordered by Manhattan Beach to the north and Redondo Beach to the south. Known as "The Best Little Beach City," it has a population of approximately 20 000 people, with a high proportion of residents between the age of 25 and 50 [17]. The City is considered to be a desirable place to live for many reasons, especially the year-long mild temperatures ranging from highs of 19°C in winter to 25°C in summer and nighttime temperatures that rarely dip below 10°C.

The City is also known as being a popular place for outdoor activities such as surfing, volleyball, skateboarding, jogging and bicycling, among others. A diverse restaurant and bar scene also create a vibrant nightlife. Together with Manhattan Beach and Redondo Beach, Hermosa is a part of what is known as the "Beach Cities." Hermosa Beach has its own elementary schools and middle school, but high school students are served by either Manhattan Beach or Redondo Beach. Hermosa also shares public transportation and health services with the 2 other Beach Cities. The City of Hermosa has its own police and fire departments, a community theater, and senior center.

Stakeholder engagement

Stakeholder engagement is a key component of the HIA and is particularly useful in the scoping step. Community participation and expert consultation help to ensure that important issues and local knowledge are considered. The following stakeholders have been identified in the HIA:
- the decisions-makers (voting public of Hermosa Beach),
- local government (City of Hermosa Beach),
- non-residents who work, recreate, or otherwise spend time in Hermosa Beach,
- pro-oil and anti-oil activist groups,
- the project Applicant,
- local health agency (Beach Cities Health District).

Specific opportunities for stakeholder involvement included: a Community Dialogue process involving a series of workshops; a public open house; an HIA scoping meeting; and an online survey. All public opportunities for engagement have been advertised to the community via multiple outlets including postcard mailers, announcements in the local newspaper, banners in public spaces, and e-mail blasts to the City mailing list.

The online survey has been conducted to help identify the key issues of concern among community members to ensure their inclusion in the HIA scoping process. The survey has consisted of the same 4 multiple choice questions asking where respondents live, whether there is concern about health impacts of the proposed project, what potential health impacts are of most concern, and if the level of concern depends on the various project the phases. A total of 292 community members have responded.

The majority of the survey participants live in Hermosa Beach near the site of the proposed project. Survey participants have ranked their level of concern for 18 topics as "very concerned," "somewhat concerned," "not concerned" or "no opinion;" participants have also been given the option to specify "other" concerns. Out of the 292 volunteer survey participants, 93% have either been very or somewhat concerned about the potential health impacts of the proposed project. The remaining 7% of participants have either not been concerned about potential health impacts or are not sure. Issues of most concern included explosions/spills, impacts to the ocean or beach, soil contamination, air quality, odor and surface water contamination (Table 1).

The Community Dialogue process has been conducted concurrently with the HIA and intended to identify the values and long-term goals for Hermosa Beach through engaging local residents and business owners. The authors have relied on the stakeholder engagement process to inform the HIA scoping step, including incorporating key quality of life aspects identified by Hermosa Beach community members into the selection of health determinants and evaluation of overall community health and well-being.

Baseline health status

The objectives of the baseline health assessment have been to establish the existing health status of the City of Hermosa Beach community, and to evaluate whether the current profile of the community reveals vulnerabilities to any of a number of health outcomes. Understanding baseline conditions is particularly important when conducting the HIA because pre-existing conditions may

Table 1. Ranking of environment and health areas of concern from community survey

Subject	Respondents [n]				Rating average [points]
	very concerned	somewhat concerned	not concerned	no opinion	
Explosions/Spills/Accidents	254	23	6	1	1.13
Potential impacts to the ocean	259	16	10	1	1.14
Soil contamination	249	27	8	1	1.16
Air quality issues	247	26	9	1	1.17
Odor	248	25	8	2	1.17
Surface water contamination	244	22	11	3	1.19
Truck traffic	230	45	6	2	1.22
Drinking water contamination	234	30	15	4	1.25
Property values	223	33	19	4	1.30
Noise	220	39	21	3	1.32
Land subsidence (sinking)	212	43	16	6	1.34
Less access to community spaces	210	51	16	5	1.35
Earthquakes	207	55	20	2	1.36
Image of the City	210	41	24	4	1.36
Vibration	204	47	25	6	1.41
Parking problems	195	58	23	6	1.43
Lights	177	63	32	6	1.52

influence potential health impacts associated with the proposed project.

The methods used in the baseline health assessment have been based on the Guide for Health Impact Assessment from the California Department of Public Health (CDPH) [6]. According to the CDPH, the selection of indicators for the baseline assessment should include indicators of health status, as well as known social, economic, and environmental health determinants, and should reflect priority health issues being addressed in the HIA. Hermosa-specific health indicators have been compared to either Los Angeles County or the State of California, in that order of preference, depending on which measures have been available. By comparing Hermosa-specific data to that of a larger geographic region, it has been possible to characterize the health status in Hermosa in relation to expected health status. The baseline health assessment results have been used in a comparative analysis of potential health effects within the HIA and have helped to identify potentially vulnerable populations.

Development of the HIA evaluation matrix and decision-making framework

An evaluation matrix was developed for this HIA as a tool to characterize and summarize the predicted health impacts (positive, negative, and neutral) of the project so they could be compared and contrasted. Since there is no globally accepted methodology for health impact characterization in the HIA, the evaluation matrix has been developed in accordance with best practices published in a number of guidance documents [3–7].

The evaluation matrix included consideration of the different characteristics of potential impacts including geographic extent, magnitude, likelihood, adaptability, and others (Table 2). Each of these characteristics has been independently evaluated based on data from the EIR, baseline health status, evidence from the scientific and public health literature, and professional judgment. The evaluation has been conducted based on a scenario where proposed EIR mitigation measures are implemented (post-mitigation), which would be required under the CEQA [16]. Therefore, the assessment has been able to ensure that mitigation measures are adequately protective and, if not, to propose additional recommendations based on the HIA findings.

For each health determinant evaluated in the HIA, a scientific assessment of the potential health impact includes a detailed discussion of all aspects of the evaluation matrix. A specific definition has been used for each element to ensure a consistent and meaningful assessment across all determinants.

The Health Determinant: A determinant is defined as "an element that identifies or determines the nature of

Table 2. Elements of the Health Impact Assessment (HIA) evaluation matrix

Element	Description/Outcome
Health determinant	list the determinant being assessed
Potential health outcome	list potential health outcomes associated with each determinant
Geographic extent	localized or community
Vulnerable populations	list subgroups that could be disproportionately affected by project activities
Magnitude	low, medium, high, or unknown
Adaptability	high, medium, low, or unknown
Likelihood	unlikely, possible, or probable
Post-mitigation health effect	negative, positive, no substantial effect, or unknown
Comments or additional recommended measures	none, or additional recommendations (specific and actionable)

something." In this case, the determinant is an element of the project that has the potential to impact health in a positive or negative manner; however, the determinant itself is non-directional.

The Potential Health Outcome: List and discuss potential health outcomes associated with the determinant (e.g., the toxicology and physical health changes associated with exposure).

The Geographic Extent: How far are the impacts likely to reach?
- Localized – limited to the areas in close proximity to the project site.
- Community – potential for wider scale impacts across the community.

The Vulnerable Populations: Are there populations that could be disproportionately affected (positively or negatively) by project activities?

The Magnitude: What is the extent of the health impact post-mitigation?
- Low – the impact is minor, it is temporary or reversible, and does not pose a hazard/benefit to health.
- Medium – the impact is detectable, it is reversible, and poses a minor to moderate hazard/benefit to health.
- High – the impact is substantial, it is permanent, and poses a major hazard/benefit to health.
- Unknown – the impact is unclear and poses an unknown hazard/benefit to health.

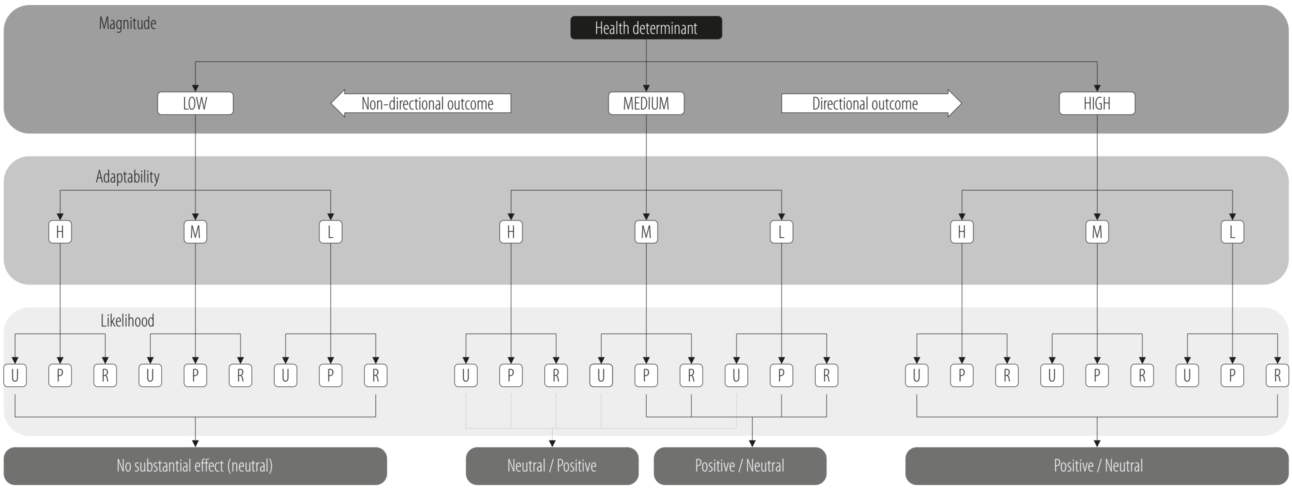
The Adaptability: How resilient is the community to this type of change; are they able to adapt?
- High – people will be able to adapt to the change with ease and maintain pre-project level of health.
- Medium – people will be able to adapt to the change with some difficulty and will maintain pre-project level of health, although some support may be necessary.
- Low – people will not be able to adapt or maintain pre-project level of health.

The Likelihood: What is the probability of the impact occurring based on the expected frequency of the exposure?
- Unlikely – the impact is anticipated to occur rarely, if ever.
- Possible – there is potential for the impact to occur on a regular basis.
- Probable – the impact will almost certainly occur and persist over time.

The Post-Mitigation Health Effect: What is the direction of the post-mitigation effect?
- Positive – the effect is expected to positively influence health following implementation of EIR mitigation measures.
- Negative – the effect is expected to negatively influence health following implementation of EIR mitigation measures.
- No substantial effect – there is no substantial health effect expected following implementation of EIR mitigation measures.
- Unknown – the direction of the effect following implementation of EIR mitigation measures is unknown.

A decision-making framework has been developed as a part of the evaluation matrix to weigh each of the elements (i.e., magnitude, adaptability and likelihood) in order to come to a final conclusion on the "post-mitigation health effect" for each determinant (Figure 1). The elements are arranged in a descending order (top to bottom) of weight and potential influence on the final determination of effect.

For example, magnitude is the most heavily weighted component in determining the "post-mitigation health effect." This is apparent by the fact that classifying magnitude as "low" automatically leads to "no substantial effect" regardless of adaptability and likelihood. Conversely, a "high" magnitude automatically leads to a directional outcome (i.e., either positive or negative). It is only when the magnitude is "medium" that adaptability and likelihood play a role in determination of the "post-mitigation health effect." This is due to the specific nature of the definitions developed for each of the elements:



H – high; M – medium; L – low.
U – unlikely; P – possible; R – probable.

Fig. 1. Decision-making framework for the Health Impact Assessment (HIA) evaluation matrix

magnitude, adaptability and likelihood. Each pathway through the framework leads to a specific overall conclusion that is either directional (i.e., positive or negative) or non-directional/neutral (i.e., no substantial effect). In some cases where professional judgment dictates, it is possible to deviate from the decision making framework; however, a detailed evidence-based rationale is required.

The most heavily weighted aspect of the evaluation matrix is magnitude which comprises the 1st level of the framework. Adaptability is the next level of the evaluation matrix as it relates to resiliency and ability to maintain health status if any impact were to occur. This element is less heavily weighted than magnitude but does influence the final determination of effect. The final level of the matrix is likelihood which is the probability of the impact based on the expected frequency of exposure. Likelihood is less heavily weighted than magnitude but it is similar to adaptability, and it influences the final conclusion, especially in situations where the impact is expected to occur rarely, if ever.

In case an element of the evaluation matrix is classified as "unknown," a discussion of the uncertainty and potential influence of this limitation on the conclusions must be provided. In these scenarios, the determination of effect is situation-specific and largely based on professional judgment and sound rationale; therefore, it has been considered to be outside the scope of the decision-making framework.

Assessment details for the identified health determinants

The HIA considered 17 determinants of health that fall under 6 major categories (i.e., air quality, water and soil quality, upset conditions, noise and light emissions, traffic, and community livability). Consideration has been given to those determinants that had been identified as community priorities and had been most likely to be impacted by the project. Each of these outcomes has been carefully assessed, based on available evidence and proposed mitigation measures identified in the EIR, using a combination of quantitative, semi-quantitative and qualitative approaches, where appropriate (Table 3). Ultimately, the aim of the assessment has been intended to determine whether the project (post-mitigation) could potentially have a negative, positive or no substantial effect on the health of the community.

Table 3. Assessment details for identified health determinants

Health determinant	Assessment	Evidence/Data	Assessment approach	Mitigation measure (from the EIR)
Air quality				
NO_2	quantitative	air emissions inventory from EIR	calculate 1-h and annual average NO_2 to compare to existing air standards: WHO air quality health guidelines, California AAQS, and US EPA NAAQS	NO_X reduction program, limited flaring, and air monitoring plan are specified in the EIR to reduce emissions of NO_2
PM	quantitative	air emissions inventory from EIR	calculate 1-h and annual average $PM_{2.5}$ to compare to existing air standards: WHO air quality health guidelines, California AAQS, and US EPA NAAQS	limited flaring, limited micro-turbine PM emissions, air monitoring plan, and diesel emission requirements are required by the EIR to mitigate PM emissions
TAC	quantitative	air emissions inventory from EIR	calculated cancer risks and non-cancer hazard indices (acute and chronic) and cumulative impacts from chemical mixtures	various air quality management mitigation measures around flares, micro-turbines and fugitive emissions to reduce TAC emissions
H_2S (odor)	semi-quantitative	air emissions inventory from EIR	evaluate odor effect-thresholds, expected frequency and duration of exposure, and proximity of residents	air quality mitigation measures to reduce off-gassing of vapors from drilling muds, and for operational odor controls including an Odor Minimization Plan
Water and soil				
surface water	qualitative	runoff information and mitigation measures discussed in the EIR	potential for site-related runoff to reach the Pacific ocean was evaluated	Storm Water Pollution Prevention Plan specified in the EIR designed to prevent runoff from reaching ocean; no recreational exposure expected
soil particles	semi-quantitative	soil data (limited) and mitigation in EIR	review existing soil data and issues (lead) around site contamination	a Remedial Action Plan proposed in the EIR requires additional soil sampling to fill data gaps; removal of soils exceeding applicable guidelines and a Fugitive Dust Control Plan are required
Upset scenarios				
crude oil spill	semi-quantitative	probability of oil spill and mitigation in EIR, health literature	evaluate probability of oil spill (0.07%) from EIR, mitigation effectiveness and related health literature	an independent 3rd party audit of equipment and additional upset scenario risk reduction measures are discussed in the EIR; rapid containment and cleanup of any crude oil spills required to minimize exposure

Table 3. Assessment details for identified health determinants – cont.

Health determinant	Assessment	Evidence/Data	Assessment approach	Mitigation measure (from the EIR)
Upset scenarios – cont.				
well blowout	semi-quantitative	probability of well blowout calculated from EIR, blowout records and health literature	evaluate probability of blowout during various the phases and effects from anticipated event (fear) vs. actual event (injury/fatality)	an independent 3rd party audit of equipment and additional upset scenario risk reduction measures are discussed in the EIR; although a well blowout is an extremely rare event (drilling the phase: 1 in 323 years; non-drilling the phase: 1 in 604 127 years), no mitigation measure can completely eliminate the possibility
Noise and light				
noise emissions	quantitative	noise data from EIR and health literature	compare noise levels from different phases of the project with established health-based noise guidelines (WHO night noise) and typical suburban/urban noise levels	noise mitigation measures in the EIR include noise barriers and various engineering controls to lower noise from operations; additionally, noise from construction will only be permitted during daytime hours
light emissions	semi-quantitative	information on light sources from EIR and health literature	evaluate additional light sources and potential for impacts on sleep cycles using available health literature	light mitigation measures in the EIR include downcast lighting, a perimeter barrier and shielding of 3 sides of the drill rig will minimize any additional sources of light in the area; however, for safety reasons there will be lighting at the sight during nighttime hours
Traffic				
traffic safety	semi-quantitative	traffic impact analysis from EIR	analyze traffic impact analysis from a health and safety perspective using relevant literature	traffic mitigation measures include: road improvements, a truck traffic safety program, a pedestrian protection plan, traffic restrictions (specified routes and restricted hours), and safety measures, including signage, flagmen, pavement markings, barricades, and lights
perceived traffic hazard	qualitative	health literature	evaluate potential impacts from perceived traffic hazard using available literature	traffic mitigation measures may also reduce perceived hazards, especially those that restrict truck travel routes and provide additional signage and safety measures for protection of pedestrians and cyclists

Table 3. Assessment details for identified health determinants – cont.

Health determinant	Assessment	Evidence/Data	Assessment approach	Mitigation measure (from the EIR)
Community livability				
property values	semi-quantitative	property value analysis from the CBA	review property value analysis, case studies of similar projects, and health literature on impacts	none: the CBA determined that property values could be impacted from 0–10% in the vicinity of the project
access to recreational resources and green space	qualitative	stakeholder feedback and social/health literature	review community feedback, City data on parks and recreation spaces and social/health literature	provision of a "Tidelands Fund" and "General Fund" where project revenue can be allocated to improving green spaces and beach areas and other community resources
aesthetics and visual resources	qualitative	visual simulations of key observation points from the EIR	review and compare changes in the visual landscape from project simulations, including community concerns and social/health literature	mitigation for visual impacts includes: building structures must be complementary to the character, scale, and quality of the surrounding environment; material used for the drill rig must be "sky-colored" to blend in; and the site must contain vegetation and landscaping to improve aesthetics
education funding	quantitative	information provided in the CBA	review of educational funding provision along with education and health literature	a portion of project revenues will go to the Hermosa Beach School District to provide educational funding throughout the life of the project (30–35 years)
social cohesion	qualitative	stakeholder feedback and social/health literature	review of community feedback from stakeholder engagement initiatives and social/health literature	none: individual disputes can arise from differing opinions, which can be distressing to some community members
political involvement	qualitative	social/health literature	review of community feedback from stakeholder engagement initiatives and social/health literature	none: the residents of Hermosa each have the unique opportunity to decide whether the project can proceed; this type of community control is linked to self-efficacy and overall well-being

NO_2 – nitrogen dioxide; PM – particulate matter; TAC – toxic air contaminants; H_2S – hydrogen sulfide.
EIR – Environmental Impact Report; WHO – World Health Organization; AAQS – Ambient Air Quality Standards; US EPA – United States Environmental Protection Agency; NAAQS – National Ambient Air Quality Standards; CBA – Cost Benefit Analysis.

RESULTS

The results of the HIA are summarized in the Table 4. The discussion outlining the key aspects of the assessment and results have been provided in the sections below. For additional information, the full report may be found on the Hermosa Beach website.

Table 4. Health Impact Assessment (HIA) summary of results

Health determinant	Potential health outcome	Geographic extent	Vulnerable populations	Magnitude	Adaptability	Likelihood	Post-mitigation health effect
Air quality							
NO_2 emissions	respiratory irritation and airway constriction	localized	children; elderly; pre-existing conditions	low	high	unlikely	no substantial effect
PM emissions	morbidity (e.g., cardio-pulmonary effects) and mortality	localized	children; elderly; pre-existing conditions	low	high	unlikely	no substantial effect
TAC emissions	varies for the TACs; includes acute effects, chronic non-carcinogenic and carcinogenic effects	localized	children; elderly; pre-existing conditions	low	high	unlikely	no substantial effect
odor emissions	headache, eye nose and throat irritation, cough and nasal congestion	localized	odor sensitive individuals	medium	low	possible	negative
Water and soil							
surface water	acute health symptoms including eye and skin irritation	localized	beach users	medium	medium	unlikely	no substantial effect
soil particles	soil particles can contain chemicals posing varying degrees of human health risk depending on concentration and exposure	localized	children	unknown	unknown	unlikely	no substantial effect
Upset scenarios							
crude oil spill	acute health symptoms including headaches, eye/skin irritation, respiratory conditions, anxiety, and depression	localized	people in immediate vicinity	medium	medium	unlikely	no substantial effect
well blowout	injuries and/or fatalities and psychological effects including stress	localized	people in immediate vicinity	high	low	unlikely	negative
Noise and lighting							
noise emissions	annoyance, stress, sleep disturbance and hypertension and cognitive impairment at very high sound pressure levels	Phase 1–4: localized (project site and truck/pipeline routes)	residents and schoolchildren in proximity to pipeline route	Phase 1, 2, 3a, 4: low; Phase 3b: medium	Phase 1, 2, 3a, 4: high; Phase 3b: medium	Phase 1, 2, 3a, 4: possible; Phase 3b: probable	Phase 1, 2, 3a, 4: no substantial effect; Phase 3b: negative

Table 4. Health Impact Assessment (HIA) summary of results – cont.

Health determinant	Potential health outcome	Geographic extent	Vulnerable populations	Magnitude	Adaptability	Likelihood	Post-mitigation health effect
Noise and lighting – cont.							
light emissions	annoyance, stress and possible disturbance of typical sleep cycles	localized	people with a direct line-of-site of the lit side of electric drill rig at night	low	high	unlikely	no substantial effect
Traffic							
traffic safety	potential increase in number of pedestrian, bicycle or other injuries	localized	pedestrians and cyclists (children and the elderly)	high	medium	unlikely	no substantial effect
perceived traffic hazards	decrease in active transportation resulting in less physical activity	localized	pedestrians and cyclists (children)	medium	medium	unlikely	no substantial effect
Community livability							
property values	potential increase in stress and anxiety	localized	property owners	medium	medium	possible	negative
access to recreational resources and green space	change in physical activity levels, which can lead to other health issues	community	none	medium	high	possible	positive
aesthetics and visual resources	annoyance and stress from negative perceptions and anxiety over project aesthetics	community	none	medium	medium	possible	negative
education funding	increased resources and funding for education can indirectly lead to a more positive health status	community	school children	medium	high	probable	positive
social cohesion	potential increase in stress	community	none	low	medium	possible	no substantial effect
political involvement	increase in self-efficacy and positive impacts on health and well-being over communities ability to vote	community	voters	medium	high	possible	positive

Abbreviations as in Table 2.

DISCUSSION

Baseline health assessment

The City of Hermosa Beach, as defined by the 2010 Census, has the population of 19 506, including 52.7% male and 47.3% female residents. Age is an important factor in determining vulnerability to certain environmental exposures. According to the census data for Hermosa, approximately 25% of the population may be considered to be more vulnerable based on age (9% over the age of 65 and 16% under 18 years). This is lower than the percentage of Los Angeles County residents considered to be vulnerable to environmental exposures based on age (35%) [17].

Education, income, and housing are all considered to be key social determinants of health. Social and economic factors constitute the single largest predictor of health outcomes as compared to clinical health care, health behavior, and the physical environment [18]. Nearly 70% of Hermosa residents have obtained a bachelor's degree or higher as compared to < 30% in greater LA County. Average household income in Hermosa Beach is almost double as that of LA County (102 000 dollars vs. 56 000 dollars). Less than 4% of Hermosa residents live in poverty as compared to 16.3% of LA County residents.

Based on the LA County Cancer Registry, the recorded number of cancer cases in the City of Hermosa from 2000 to 2010 was within or below the expected numbers, based on age-, race- and sex-adjusted incidence rates for Los Angeles County, for most cancers. Exceptions include melanoma and breast cancer, which both have a higher number of cases than expected.

Hermosa Beach appears to have a favorable mortality profile, according to all-cause mortality, heart disease, and cancer, as compared to LA County [6]. The unadjusted all-cause mortality rate in Hermosa (40.5 deaths per 10 000 people) is lower than the all-cause mortality rate in LA County (56.9 deaths per 10 000 people). Hermosa mortality rates are also lower for cardiovascular disease (9.2 vs. 15.8) and cancer (9 vs. 13.9).

A Gallup-Healthways Well Being survey of 1332 Hermosa, Manhattan and Redondo residents conducted in 2010 found that the overall well-being rate for local residents was higher than the California average rate and above the top tier of other cities. More than 90% of local residents said they had access to health care, health insurance and enough money for food, shelter and other basic needs. Two-thirds were found to be "thriving." However, the survey also found that 46% of the Beach Cities residents felt stressed for most of the day – the number that ranked them 176th out of 188 communities surveyed [19].

Overall, the baseline health assessment has found that Hermosa Beach is a relatively young community that is highly educated, has above average income levels, and a higher sense of well-being than other California residents. Overall, demographic indicators show that Hermosa Beach is not highly vulnerable to negative health outcomes traditionally associated with poverty, unemployment, and low educational attainment.

Air quality

The potential for air emissions from construction and operation of the project to affect air quality in Hermosa Beach was evaluated using the emissions inventory produced as a part of the EIR [16]. The air pollutants carried forward for assessment in the HIA included nitrogen dioxide (NO_2), particulate matter (PM), toxic air contaminants (TAC), and hydrogen sulfide (H_2S) and other odorous compounds.

Nitrogen dioxide has the potential to produce a range of respiratory effects depending on the concentration in air (e.g., eye, nose and throat irritation, inflammation of lung tissue) [20,21]. For the HIA, the max 1-h and annual average NO_2 air concentrations were calculated (background plus project) and found to be below the WHO air quality health guidelines, indicating that adverse health effects were not expected to result from either short-term or long-term exposure [22]. Additionally, there were no exceedances of California's Ambient Air Quality Standards (AAQS), or the US EPA National Ambient Air Quality Standards (NAAQS) for NO_2 [20,23,24]. Therefore, it was concluded that exposure to NO_2 from the proposed project (post-mitigation) was expected to have "no substantial effect" on community health.

Particulate matter (PM) is a widespread air pollutant composed of a mixture of solid and liquid particles, and its effects on health are well documented. Particles with a diameter of ≤ 10 μm are referred to as PM_{10}, and particles with a diameter of ≤ 2.5 μm are known as $PM_{2.5}$. Exposure, particularly to the smaller $PM_{2.5}$ particles, is associated with increased respiratory and cardiovascular disease and mortality [25,26]. The max 1-h and max annual average $PM_{2.5}$ air concentrations were added to baseline concentration in LA County and resulted in exceedances of the WHO air quality guidelines [22]. However, when background levels from South Coastal LA County (assumed to better represent Hermosa Beach air quality) were used, the project was below the California annual AAQS and US EPA NAAQS [27,28].

The assessment concluded that any exceedances of the WHO air quality guidelines were based on existing background levels in the area and the project was not expected to have a material impact on existing $PM_{2.5}$ related health risks. For example, the annual average $PM_{2.5}$ air concentration across the community was 10.1–12.5 μg/m^3, with the project contributing an additional 0.6 μg/m^3 to the air-shed. This increase in $PM_{2.5}$ would not be measurable across the project area. While it was concluded that there was no substantial effect from post-mitigation exposure to $PM_{2.5}$ from the project, existing ambient levels of $PM_{2.5}$ in the area were already in the range, at which increased mortality had been observed in large urban centers.

Toxic air contaminants (TAC) may be used to describe a wide array of chemicals, including volatile organic compounds (VOC), polycyclic aromatic hydrocarbons (PAH), hydrogen sulfide (H_2S), inorganic elements (e.g., metals) and particulate emissions from diesel exhaust. Considering that there are many different types of groups of the TAC, the potential health effects associated with these compounds are accordingly diverse and may range from short-term sensory irritation to long-term one, that may turn into irreversible effects such as cancer [29].

The nature and extent of the various toxic responses depend largely on the magnitude and duration of the exposures. Without any mitigation, project emissions of certain TAC would pose a potential risk to human health; however, given the implementation of the measures proposed in the EIR, the risk estimates are below thresholds of significance for both cancer and non-cancer endpoints, including chemical mixtures. Therefore, the proposed project is not expected to have a substantial effect on community health.

Odor may result from the release of compounds, such as H_2S during various drilling and production processes or upset scenarios. The most commonly reported symptoms arising from odor exposure are headaches, nasal congestion, eye, nose, and throat irritation, hoarseness, sore throat, cough, chest tightness, and shortness of breath, among others [30]. The presence of odor has also been reported to interfere with people's daily activities, use of property, social interactions, and quality of life as well as to cause fear and anxiety over chronic disease and property values [31–35].

Adverse health outcomes associated with odor are related to the frequency, duration, concentration, and the individuals' level of sensitivity. Hydrogen sulfide is a common odor associated with oil and gas production and it has a relatively low odor threshold. The H_2S odor threshold (i.e., the lowest concentration perceivable by human smell) is highly variable within the human population and may be detected at concentrations as low as a 1/2 of a part per billion (0.5 ppb) [36]. Although mitigation measures proposed in the EIR would reduce the frequency of odor releases, they have still been identified as "significant and unavoidable" in the EIR because of the close proximity of residences and businesses to the project site. For these reasons, the HIA has identified the post-mitigation health effect as negative near the project site.

Water and soil quality

The assessment of water and soil quality has evaluated the potential health impacts of discharge of wastewater and surface water runoff during construction and operations; and deposition of windblown soil particulates to off-site surface soil.

If uncontrolled, project-related chemicals in stormwater runoff could be detrimental to the environment and human health. Swimming or recreating in the ocean near stormwater outflows is associated with increasing acute health symptoms, such as eye and skin irritation due to contact with polluted stormwater runoff [37]. During rain, contaminants and debris that enter the storm drain system could flow into the nearby Santa Monica Bay which is already listed as an "impaired water body" for "contact" recreation. During the Phase 2 and 4, drilling operations, surface runoff at the project site would be contained with walls and berms and pumped into the water processing system for injection into the oil reservoir [16]; therefore, preventing negative impact to surface water quality and potential health effects during operations.

Without mitigation, construction-related contaminants and debris flowing into storm drains connected to the Pacific Ocean could result in the impact to water quality and increasing acute health outcomes during the Phases 1 and 3 of the proposed project. However, the EIR mitigation measures will reduce the possibility of construction-related impacts through the requirement of a Storm Water Pollution Prevention Plan [16]. Overall, due to the EIR mitigation measures to control runoff during all project the phases, there is no substantial effect on health, arising from surface water.

Soil under the project site contains contaminants related to its former use as a landfill. While the property is currently paved over, preventing exposure, so future construction activities could release particulate emissions during trenching, grading, and other earth-moving activities. The primary contaminant of concern is lead; however, baseline data is limited and the property is not yet well characterized with respect to the level and extent of existing contamination [16]. Additional surface soil data is required in order to fully assess the potential for a health hazard. The EIR addresses this data gap by requiring soil sampling during the Phase 1 grading, and removal of soil from the site if contamination is in exceedance of regulatory thresholds. Implementation of the EIR remedial action plan to remove contaminated soil and mitigation measures to reduce fugitive dust emissions will reduce the possibility of hazardous soil particulate emissions during project-related activities. Therefore, soil particulates are not expected to pose a substantial effect to human health.

Upset conditions

The HIA has considered the potential health impacts of 2 upset conditions that are not covered under typical operational scenarios – an oil spill into the ocean and a well blowout. Potential human health impact that could result from exposure to an oil spill includes headaches, eye/skin irritation, respiratory conditions, anxiety, and depression [38,39]. In the unlikely event of a spill (0.07% chance of an oil spill to the ocean), the proponent would be required to contain and clean-up any crude oil in the environment; therefore, irreversible or chronic health outcomes would not occur and no substantial effect on human health is expected.

A well blowout could result in serious injuries and/or fatalities in the vicinity of the project site. A well blowout is a very low probability event, predicted to occur once in 323 years during drilling and once in 604 127 years during non-drilling periods if the wells are pressurized [16].

The fear of a blowout accident could result in moderate impacts to human health due to elevated levels of stress and anxiety. Since a well blowout could have severe health consequences, and the possibility of an upset scenario occurring cannot be completely avoided through mitigation, the post-mitigation health effect is classified as negative.

Noise and light emissions

The potential for noise and light emissions to have an impact on human health as arising from various the phases of the project has been assessed in the HIA. Although both noise and light are useful components of everyday life, they are highly subjective emissions that may be perceived differently by different individuals [40,41].

Noise is ubiquitous in suburban/urban and commercial areas. The most common effect of exposure to environmental noise is annoyance, although more severe effects may be observed at higher sound levels. Noise-related annoyance, typically described as a feeling of displeasure evoked by a noise, has been extensively linked to a variety of common noise sources such as rail, road, and air traffic [42–44]. Although annoyance is considered to be the least severe potential impact of community noise exposure [44,45], it has been hypothesized that sufficiently high levels of noise-related annoyance could lead to negative emotional responses (e.g., anger, disappointment, depression, or anxiety) and psychosocial symptoms (e.g., tiredness, stomach discomfort and stress) [44,46–50]. Since the project-related activities predicted to produce the highest noise levels have been only permitted during daytime hours, nighttime impact of noise is not a primary concern in the current HIA.

The impact of project-related noise emissions on the local community, particularly residents located around the project site and along the pipeline and truck routes is negative without the use of mitigation measures; however, the EIR has identified a variety of mitigation techniques to reduce the potential impact of noise on the surrounding community including a 35-foot acoustical barrier around the project site [16]. Based on the current HIA, no substantial effect on human health is expected to result from project activities in the Phases 1, 2, 3a (site construction) and 4. There is some potential for negative health effects arising from high levels of noise associated with the pipeline construction (the Phase 3b); however, this is expected to be short-term in duration (approx. 1 week per location) and is limited to daytime hours.

The invention and widespread use of artificial light, especially at night, has become a necessity in many areas of the world to enhance commerce, promote social activity, and increase public safety [51]. Despite the fact that the use of artificial light is a widespread consequence of industrial and economic development, it may have unintended negative consequences, especially when it becomes inefficient, annoying and unnecessary [52,53]. The major health concern related to excessive "light-at-night" is disruption of sleep and biological circadian rhythms which influence melatonin production and promote overall health [51,54,55].

To ensure visibility, the site security and worker safety, artificial lighting would have to be installed as a part of the project [16]. The majority of the on-site lighting would be shielded and downcast to reduce glare. Additionally, the site would have a 35-foot acoustical barrier to eliminate light spill beyond the site boundary in most cases. Therefore, light emissions are not expected to have a substantial effect on community health. The one exception to this is the presence of lighting on the electric drill rig, which extends up to 26.5 m. Therefore, residents who have a line-of-sight view of the exposed side of the electric drill rig from their bedroom window(s) may be disproportionately impacted.

Traffic

The traffic assessment has focused on the potential impacts that the project may have on traffic safety and the effect that the perceived decrease in pedestrian safety could have on active transportation (i.e., walking, biking).

Vehicular traffic is a well-known potential safety hazard. Traffic safety hazards are associated with a number of factors, including a vehicle volume, vehicle type, road infrastructure, driving behavior, and population density. Increase in traffic volume is associated with higher risk of injury and death due to vehicle-vehicle, vehicle-pedestrian, and vehicle-bicycle collisions [56–58].

Currently, fatalities resulting from motor vehicle collisions are very rare in the pedestrian and bike-friendly City of Hermosa Beach. Based on the results of a traffic impact analysis, the EIR has indicated that project-related traffic will not have a significant impact on local traffic congestion [16]. However, the introduction of truck traffic on roads not accustomed to large trucks could represent a safety hazard to bicyclists and pedestrians. Consequently, the EIR has recommended additional mitigation, including increased crossing guard presence near the project site, installation of warning signs and lights, limiting truck size, and reconfiguring roadways. Therefore, based on implementation of these safety measures, traffic safety is not predicted to have a substantial health impact on the community.

Findings from the literature suggest that perception of safety is an important mediator of the relationship between traffic safety and active transportation, or walking/bicycle trips [59,60]. Perceived risk of injury may discourage walking and bicycling, which may directly impact health by decreasing physical activity levels [61]. Parental perception of safety is especially important for rates of walking and biking among children [62]. Since the project site is adjacent to a "safe walk to school" route within the community, there is a possibility that perceived traffic hazards could result in decreased active transportation in that area. However, the extent of the impact is limited to a small area and community members should be able to adapt by seeking alternative routes for walking and biking. Thus the HIA has determined that there is no substantial health effect resulting from perceived traffic hazards and active transportation.

Community livability

Community livability defines elements that make it desirable to live in a particular place, and may include environmental, social and economic aspects. Local residents have voiced certain concerns regarding different aspects of community livability that could be affected by project activities. The following health determinants related to community livability have been identified and assessed: property values; access to recreational resources and green space; aesthetics and visual resources; education funding; social cohesion; and political involvement.

Commercial and industrial developments have the potential to impact local property values [63]. The complexities around property value fluctuations make it difficult to accurately evaluate the potential impact arising from 1 project. The cost-benefit analysis has concluded that property values within Hermosa Beach could be impacted by 0–10%; and it has suggested that any decrease in property values is likely to be localized [64,65]. Any perceived or actual decrease has the potential to moderately increase stress and anxiety among Hermosa Beach residents, which could lead to a negative effect on human health.

Access to recreational areas and green space is an important community resource and may be a key component of overall health and well-being [66–68]. Beach residents are considered to be very active due to their proximity to the beach, access to parks and availability of recreation and fitness facilities. Since the project would not be removing any existing green space in the community and project revenue could be used to enhance green space and recreational resources it is anticipated that there would be a positive effect on community health.

Aesthetic value is a complex concept that is highly subjective. There is a high degree of individual variability when it comes to the visual impact and/or aesthetic value of an object or agplace and how this affects health and well-being [69–71]. The presence of the electric and work-over drill rigs during the Phase 2 and 4 of the project could negatively impact well-being by diminishing the aesthetic appeal of the community landscape. This could potentially lead to increased stress and anxiety; thus, the post-mitigation health effect is classified as negative. However, aesthetic and visual changes are not anticipated to have chronic effects on health.

Educational funding may provide improvements in some of the key indicators of socioeconomic status (i.e., occupation and income) and has been described as a cost-effective method of increasing health and well-being [72]. In the cost-benefit analysis it has been estimated that the school district would receive net revenues of approximately 1.2–3.2 million dollars, over the 35 year life of the project [64]. Hermosa Beach has one of the top school districts in the U.S. and the modest increase in annual funding (4–9%) that will be provided to the schools as a result of revenue from oil production is expected to have a positive effect on health now and in the future.

Social cohesion is a complex concept that is difficult to measure and is related to the interactions among community members [73,74]. Some local residents have voiced concerns about the situation causing a division in the community – those in favor of oil development versus those opposed it. As an indicator of health, social cohesion is linked to the idea of "quality of life" which is associated with certain aspects of health and well-being [74–76]. Hermosa Beach residents experience higher levels of well-being than most California cities [19]. Although it is not expected that all residents will experience a reduction in social cohesion due to differences of opinion, some individuals may. For those residents, this could result in increased stress; however, social cohesion is not considered to have a substantial effect on overall community health.

Active involvement in local politics is associated with increased self-efficacy and may have positive impact on health and well-being [74,77,78]. Hermosa Beach residents have the unique opportunity to decide whether the proposed project can go ahead by voting on whether to allow oil drilling within the City. This opportunity extends to all adult members of the community, although only a subset of the population is actively involved in politics and is more likely to benefit from the positive impact on health.

Recommendations

The following recommendations have been made based on the findings of the HIA (Table 5). Where a potential negative health effect has been identified or additional measures have been deemed appropriate, these recommendations have been suggested to reduce any impact and facilitate public comfort and well-being throughout construction and operation of the project.

Monitoring and evaluation

The following monitoring recommendations have been made based on the findings of the HIA:

- The Community Liaison Committee – consideration should be given to forming a Community Liaison Committee if the project is approved, and prior to commencement of construction activities. The committee would serve as the vehicle, through which citizens could voice active concerns about project-related activities with the intention of working collaboratively with the proponent to find ways of addressing any issues.
- The Follow-up Community Health Assessment – analysis of health statistics by means of susceptible subpopulation status could identify whether some groups are disproportionately impacted by the project operations. An update to the baseline health study could be completed 5 years after the project becomes operational.
- The Quality of Life Health Survey – a quality of life health survey could be used as a tool to establish current baseline conditions, and to monitor whether health status changes during the project.

Although not being a component of all the HIAs, the evaluation step may demonstrate the effectiveness of the HIA in the planning process by showing what the assessment

Table 5. Health Impact Assessment (HIA) recommendations

Health determinant	Additional recommended measure
Odor emissions	if frequent reports of odor occur, additional study and/or periodic monitoring of odor may be warranted
Well blowout	incorporate well blowout scenario into the City of Hermosa emergency preparedness plan
Noise emissions	in anticipation of potential elevated noise levels from pipeline construction activities (the Phase 3b) it is recommended that local residents be provided with written notification of impending work including the dates and times of activities that may produce excessive noise
Light emissions	although the magnitude is "low" for the majority of residents, it could be higher for those individuals with a bedroom window in the direct line-of-sight of the exposed side of the electric drill rig that will be lit at night; it is recommended that these individuals be provided with black-out blinds or curtains to eliminate any potential impact to typical sleep patterns
Property values	to reduce any potential stress or anxiety that local property owners may experience as a result of the proposed project, the proponent could consider having a property value analysis conducted prior to construction, during construction and one year into operations; this analysis would need to take into consideration local, regional and national fluctuations in property values and compare and contrast the data against potential changes in the value of properties located near the proposed project; this would help to ensure that any observed fluctuations on property values remain within expected levels and consistent with other similar communities; additionally, the proponent could consider stabilizing "proven" impacts to property values, perhaps through an arbitrator process

has actually achieved. An internal evaluation of the overall approach and effectiveness of the HIA is to be conducted by the authors, including both a process evaluation and an impact evaluation [79]. The process evaluation is intended to provide lessons on how and why the HIA has been successful and where the process could be improved, whereas the impact evaluation considers whether and how well the HIA has fulfilled its intended purpose.

CONCLUSIONS

There is no simple answer to the potential impact that the project will have on the health of Hermosa Beach residents since different aspects of the project would impact the community in different ways. The authors acknowledge that 1 limitation of the HIA is that the assessment is based on population health and not on single individuals, although vulnerable populations have been considered. There is a number of aspects of the project that may positively influence health (e.g., increased education funding, ability to enhance green space), and at the same time there have been potential negative effects identified (e.g., odor, blowouts, property values). With the exception of upset conditions, the negative health outcomes have been largely nuisance-related (e.g., odor, aesthetics) without irreversible health impacts. The majority of the health determinants, that had been examined, have revealed that the project would have no substantial effect on the health of the community.

Overall, based on the proposed mitigation measures in the EIR and additional recommendations provided in the HIA, the authors conclude that the project will have no substantial effect on community health in Hermosa Beach. This conclusion has been reached using the developed transparent methodology and matrix and the authors acknowledge that what may constitute "no substantial effect" to some stakeholders may not be socially acceptable to others. This methodology and explanation have proven valuable at the follow-up at community meetings. While some stakeholders may not have agreed with the outcome or the label of "no substantial effect" they have been appreciative that they could clearly follow how the authors have reached this conclusion.

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