MEMORANDUM

TO: Planning and Sustainability Commissioners, PSC Staff
FROM: Gary Oxman
DATE: April 6, 2015
SUBJECT: Framework and Standards for Considering Risk in Decision-Making

Fellow Commissioners

Following our March 17 PSC meeting, I volunteered to Chair Baugh to provide a framework to help us think about how to consider risk as we move ahead with decision-making about the Pembina proposal. I offered to do this because I have some background, experience and interest in risk perception and risk-based decision-making from my days at the health department.

Please consider this memo as background; it is not a decision-making protocol. I hope will help you in thinking and deciding about accepting risk. In preparing this memo, I relied primarily on two resources[1, 2].

The way I frame our task is that we (the PSC) are being asked to make a decision on behalf of the community about whether and how much risk to accept related to Pembina's proposed project.

Pembina's consultant (DNV-GL) has carried out a quantitative risk assessment (QRA). In essence, the results are a series of numbers and diagrams that describe the risks of the project (the hazards combined with their likelihood of occurring). An independent consultant to BPS has reviewed the QRA. The consultant found that there were a number of areas in which more detailed information and analytic rationale should be provided. The consultant also suggested improving the language of the report in a number of areas. Despite this, the consultant assessed the QRA as "…generally a thorough and realistic evaluation of the potential risks and consequences that can be expected due to the operation of the proposed terminal."

The QRA report takes the approach that since the risks fall within a set of numeric standards used by the UK, the PSC should see the risks as acceptable and approve the project.

I think there are three questions that we need to consider in our decision-making:
1. Should we incorporate factors other than the QRA into our decision making?
2. What is the role of the quantitative risk assessment (QRA)?
3. What statistical/numeric standards should we use to define acceptable levels of risk?

1. Should we incorporate factors other than QRA into our decision-making?

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[1] Reducing risks, protecting people, HSE's decision making process. www.hse.gov.uk/risk/theory/r2p2.pdf

[2] Schmidt, M: 2004. Investigating risk perception: a short introduction. http://www.markusschmidt.eu/pdf/Intro_risk_perception_Schmidt.pdf

The literature I reviewed on risk perception and risk decision-making makes it clear that inclusion of factors in addition to QRA results is both appropriate and unavoidable.

Risk Perception

All people's perceptions of risk - experts and laypeople alike - is based on factors in addition to numeric/statistical data. There are a number of factors that tend to either amplify or attenuate our
perception of risk. See Table 1 below.

Table 1: Psychological Factor Impacting Perception of Risk

Attenuate Perception of Risk		**Amplify Perception of Risk**
familiar		exotic
controlled by individual/self		controlled by others
natural		man-made
statistical - affects few		catastrophic - affects many
clear benefits		little or no benefit
risks and benefits fairly distributed		risks and benefits unfairly distributed
voluntary/chosen		imposed by others
information from trusted sources		information from untrusted sources
in the media		not in the media

Adapted from Schmidt

Each of us will unconsciously adjust our assessment of the risk of the project based on our individual observations related to the above factors. For example, if you believe that the community bears the risk but the benefits accrue to others, you are more likely to see the project as risky. In addition, multiple factors sometimes cluster together to affect our perception of risk - e.g., lack of control, catastrophic potential, and unfair distribution of risks and benefits can come together to more powerfully impact our perception of risk.

Also, while the above factors affect both laypeople and experts, their impact can be different. For example, to the experts that produced the QRA, the risk of gas leaks and their consequences (explosion and fires) are familiar, and likely perceived as controllable, and affecting few people. This leads the expert to assess the risk arising from gas leaks as low. Conversely, a layperson is likely to be unfamiliar with the risk of leaks, and see them as uncontrollable and potentially catastrophic. This leads the layperson judge the risk related to gas leaks as high.

Values and Culture

As discussed by Schmidt, both broad and sub-cultural belief systems impact perception and management of risk. Our "…socially constructed 'images' of the world…" impact how we see facts and events - e.g, what is dangerous, and how should we respond to dangerous situations or to changes in our world?

Values also enter into our perception and decision-making. An example is the different ways we see justice and fairness:

- Utilitarian justice: assuring the least risk or least unhappiness for all
- Libertarian justice: managing hazard consequences through voluntary market approaches (e.g., compensation for those most at risk)
- Egalitarian justice: allowing inequity in risk only if it is beneficial to the least advantaged people/groups

In 2001, the Health and Safety Executive, the UK's quasi-governmental body responsible for for workplace health and safety, published a document that explains how it goes about risk-based decision-making ("Reducing Risks, Protecting People" or R2P2). R2P2 is the source of the risk thresholds used in the Pembina QRA. In addition to noting and embracing the issues surrounding risk perception discussed above, R2P2 explicitly identifies value criteria that it includes in its decision-making process:

- "…an equity-based criterion, which starts with the premise that all individuals have unconditional rights to certain levels of protection." This criterion drives setting limits that represent the maximum level of risk that any individual can be exposed to regardless of individual or societal benefits
- "…a utility-based criterion…" which compares the marginal costs and benefits of actions to decrease risk. This criterion drives a monetized evaluation of the costs and benefits of risk prevention (for example the dollar value of lives saved compared to the dollar cost of the privative actions)
- "…a technology-based criterion which essentially reflects the idea that a satisfactory level of risk prevention is attained when 'state of the art' control measures (technological, managerial, organisational) are employed to control risks…."

2. What is the role of the QRA?

R2P2 embraces QRA as an important part of the risk decision-making process. It is a key component of Stage 2 in the six-stage risk decision process used by the HSE: 1) Deciding whether the issue is one for HSC/E, 2) Defining and characterising the issue, 3) Examining the options available and their merits, 4) Adopting decisions, 5) Implementing the decisions, and 6) Evaluating the effectiveness of action taken. However, R2P2 cautions:

"…properly used, the results of a risk assessment often provide an essential ingredient in reaching decisions on the management of hazards." Proposer use requires that:

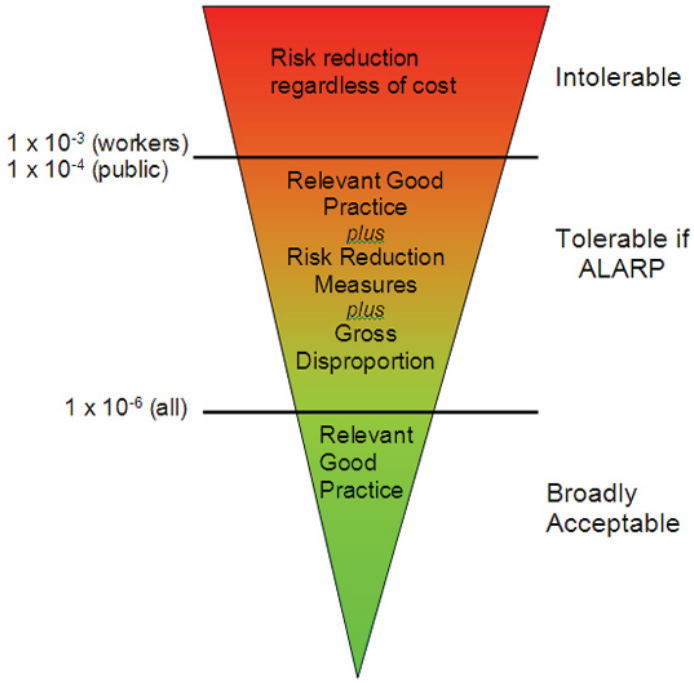
- "…the risk problem is properly framed;
- the nature and limitations of the risk assessment are clearly set out and understood; and
- the results of the risk assessment are used to *inform rather than to dictate decisions* and are only one of the many factors taken into account in reaching a decision." [emphasis added].

While strongly embracing QRA, R2P2 identifies criticisms of QRA:

1. It can underestimate the true impact of a problem overall; QRA is undertaken for a specific purpose and with a specific population in mind and can ignore risks to another population
2. It can be used or seen as being used to capriciously legitimize a decision
3. It can be misused to present a problem as being primarily one of risk and undermining the adoption of precautionary approaches
4. It is inadequate because it often reduces the characteristics of a complex issue into a single number; because of this, it is weak considering societal concerns

So the use of QRA is more complex than simply judging whether the results fall within an acceptable quantitative risk region. In addition, the HSE framework is part of a broader system for evaluating, managing and preventing risk. This framework explicitly utilizes a precautionary approach, particularly where this is unresolved uncertainty about risk.

3. What statistical/numeric standards should we use to define acceptable levels of risk?
The QRA cites and utilizes the risk regions and risk boundaries from the HSE. This is based on the tolerability of risk (TOR) framework:



Risk cannot be justified except in extraordinary circumstances*

Tolerable only if risk reduction is impracticable or its cost is grossly disproportionate to the improvement gained*

Necessary to maintain assurance that risk remains at this level*

Note: *1 x 10^{-4} (1 in 10,000) deaths for general public is "for members of the public who have a risk imposed on them "in the broader interests of society (R2P2 p. 48)*

* Source: http://www.industry-finder.com/machinery-directive/atex-directives.html

There are some key points when looking at these risk boundaries:

- These boundaries are part of a broad national health and safety framework that:
  - utilizes a cyclic systems approach with a well defined assessment, decision, implementation and ongoing evaluation components,
  - holds the creator of risk as primarily responsible for risk management,
  - extensively utilizes precautionary approaches,
  - is arguably impacted by UK cultural values that differ to some degree from those in the US
- R2P2 points out that actual experience data shows that there are fewer deaths than would allowed under the risk boundaries

Absent an alternate set of standards, the UK/HSE boundaries are probably reasonable to use as long as QRA is regarded as one of many factors considered in decision-making.