

**THE CHOICE OF ALTERNATIVES IN THE
REPLACEMENT OF THE LION'S GATE BRIDGE**

by

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ABSTRACT

For sixty years the Lion's Gate Bridge has served as an important transportation link between Vancouver and its North Shore suburbs. Everyday some 70,000 vehicles cross the First Narrows of Burrard Inlet over the bridge. The high frequency of usage of the bridge by cars, trucks and buses, and constant exposure to rain, winds and snow in the winter have cumulatively contributed to the bridge's rapid deterioration. Concern has been raised by the public, the government, and transportation professionals as to how much longer the Lion's Gate Bridge can tolerate the heavy traffic and withstand this daily wear and tear of its surface. A 1995 bridge structural study predicted the bridge would be safe until 1999, but beyond that date it must be replaced or rehabilitated. To address the bridge's structural problems the province entertained bids and proposals from which a list of possible replacement options emerged. For this study, eight alternatives were whittled down from twenty-one proposals and were selected for evaluation. These include: 1) repair and maintain the bridge (do-nothing option), 2) rehabilitate and widen the bridge with three wider lanes, 3) modify the bridge to four lanes, 4) a new four-lane bridge, 5) a new five or six-lane bridge, 6) a four-lane bored tunnel, 7) a Brockton Point tunnel, and 8) a mid-harbour tunnel (as a third crossing).

The purpose of this study is to evaluate the choice of alternatives to replace the Lion's Gate Bridge and to determine which option is perceived by several public and private respondent groups to be the most favoured to deal with the bridge problem. Eight criteria, which have often been used in urban transportation project evaluation, were selected to evaluate the alternatives. They were: i) Technical Feasibility, ii) Economic Feasibility, iii) Financial Feasibility, iv) Social Feasibility, v) Political Feasibility, vi) Spatial Impact, vii) Environmental Impact, and viii) Aesthetic Impact.

The research comprised a review of Lion's Gate Bridge reports, public meeting proceedings, comments submitted to the Public Information Centre during the Choices Public Involvement Forum, and thirteen case study interviews with eight public and five private stakeholders. Nonparametric statistical analysis, which entails the use of Spearman's rank correlation coefficient and Kendall's coefficient of concordance, was employed to ascertain the degree of agreement and disagreement among the eight public and five private groups in their perception of their favoured choice as the most preferred option for the replacement of the Lion's Gate Bridge.

The results from the Choices Forum indicated that a four-lane crossing on the present alignment was the most acceptable option to the public and politicians. However, the

government's decision to charge tolls on an improved crossing was not unanimously endorsed for implementation by the local municipalities.

The statistical analysis of the case study interviews shows a strong degree of agreement among the public respondents in expressing their preference for a modified four-lane bridge as their favoured choice. This preference appears to be guided by the province's financial constraints, namely, a contribution of only \$70 million of taxpayers' money to the project. In contrast with the perception by the public group respondents, one discerns a strong degree of agreement among the private respondents in their perception favouring the choice of a new four-lane bridge. It is significant to note that when the eight public and five private respondent groups were combined, the most preferred choice that emerged was a new four-lane bridge, while the second choice is a modified four-lane bridge. Despite the perceived advantages of the new or modified four-lane bridge options, both groups feel a three-lane rehabilitation has equal political support. Consequently, the recent announcement made by the provincial government in favour of the rehabilitated bridge was not a surprise.

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CHAPTER I

FRAMEWORK OF ANALYSIS

Statement of the Problem

The Lion's Gate Bridge, a vital transportation link between downtown Vancouver and its North Shore suburbs, is expected to carry vehicular traffic safely until 1999 when it must be upgraded or replaced.¹ Since 1938, millions of cars, vans, trucks and bikes have used the three-lane bridge for commuting, tourist, shopping and delivery purposes. The bridge provides an important spatial linkage for people and goods movement in Greater Vancouver and to tourist destinations beyond.

Traffic levels often exceed the bridge's capacity, especially during the morning and evening rush hours when there are serious congestion problems. Future population growth on the North Shore will likely result in demand for increased bridge capacity (Consulting engineer, Personal communication).

Expensive on-going maintenance is necessary to keep up with the bridge's rapid deterioration. Rust, rain, salt and 70,000 vehicles per day threaten the structural integrity of some important bridge elements. There are serious concerns over the bridge's capability of handling heavy traffic and of withstanding a possible earthquake.

The Lion's Gate Bridge is an icon in Vancouver. People from across Canada and beyond see the bridge as a symbol of the city, much like San Francisco's Golden Gate Bridge. Vancouverites also appreciate the importance of this heritage structure that has served the region for over fifty years.

A number of concerns about the Lion's Gate Crossing have been expressed by the public. How long will the bridge last? How do the communities directly impacted feel about the traffic congestion and structural problems? What proposals have been suggested to deal with the problems posed by a deteriorating and inadequate bridge to handle growing traffic demand?

Concerns have been expressed not only by the public but also by the government, urban planners and transport engineers. Consequently, the provincial government has authorized the Ministry of Transportation and Highways to find an acceptable replacement for the Lion's Gate Bridge.

¹ The bridge is deemed safe until 1999. This is not an absolute date for the completion of a new or improved structure but is an approximation of the bridge's remaining life span.

Public involvement in choosing an acceptable alternative to replace the bridge has been initiated by N.D. Lea Consultants on behalf of the government. Bids and proposals, e.g. for a bridge or tunnel, have been invited to entertain the choice of a suitable replacement. A number of debate and hearing sessions² were sponsored and held by the Ministry. Out of some twenty-one proposals submitted for consideration, nine were short-listed to deal with the bridge problem, as shown in Figure 1. The nine are:

1. Repair and maintain the existing bridge (referred to as the do-nothing option).
2. Rehabilitate and widen the existing bridge.
3. Modify the existing bridge to four or more lanes.
4. Construct a new four-lane bridge on the existing alignment.
5. Construct a new five or six-lane bridge on the existing alignment.
6. Construct a bored tunnel along the existing corridor
7. Construct a four-lane bored tunnel to Capilano Road.
8. Construct an immersed tube/cut-and-cover tunnel on zoo alignment.
9. Construct an immersed tube tunnel on Brockton Point alignment.

Questions may be raised as to what kind of perceptions various groups and interested people have in regards to the replacement of the bridge. What is the range of choice presented? What factors are associated with each choice of alternative? What similarities and differences are there in the choice of an acceptable replacement? These are the questions explored in this thesis.

Objectives of the Study

The purpose of the study is to evaluate the choice of alternatives to replace the Lion's Gate Bridge and to determine which among the range of alternatives submitted for consideration is perceived by several public and private respondents as the favoured or likely alternative to deal with the Lion's Gate Bridge problem.

Framework of the Study

The framework of the study covers some past studies of the Lion's Gate Bridge, the debate over a bridge or a tunnel, the Choices Forum, the long and short lists of proposals, the latest options under consideration and the criteria of choice.

² Four stakeholder roundtables, four open houses, a proponents' showcase and several information update sessions have been held. The locations and dates of these meetings are listed in the Works Cited section.

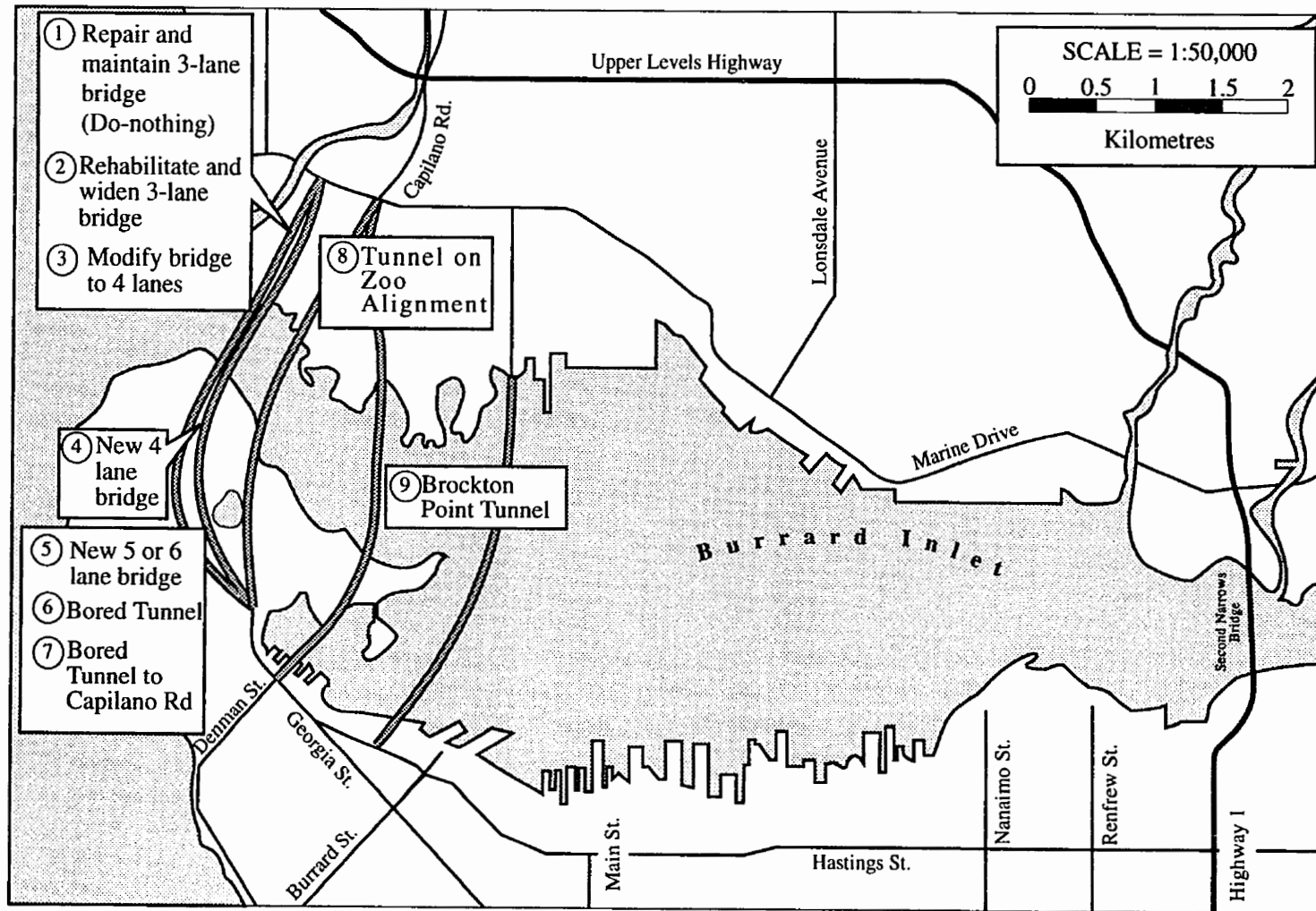


Figure 1. Map of Short-Listed Alternatives.

Some Past Studies of the Lion's Gate Bridge

Since it was built and the first cars passed over the First Narrows in 1938 there has been considerable interest in the Lion's Gate Bridge. Talk of the bridge's replacement made media headlines in 1993 after a large chunk of concrete broke off and fell onto the Stanley Park Seawall, nearly hitting a pedestrian (*Vancouver Sun* September 15, 1993). This incident prompted the examination of several routes and options to repair or replace the aging structure.

Aside from the current alignment across the First Narrows and through Stanley Park, other possible routes included: i) an alignment through the First Narrows just to the east of the present one; ii) the Brockton Point alignment through Coal Harbour; iii) the middle of Vancouver Harbour, and iv) an improved crossing on the Second Narrows alignment.

The options on the table at that time in 1993 comprised six bridge and three tunnel schemes, as shown in Figure 2. Of the bridge proposals, the do-nothing option, modified three-lane bridge (with wider lanes), modified four-lane bridge, new four-lane bridge, and new five or six-lane bridge followed the present route. The sixth bridge option involved widening the Second Narrows Bridge and eliminating traffic on Lion's Gate. One tunnel design followed the Zoo Road in Stanley Park and crossed Burrard Inlet just to the east of the bridge. The tunnel would then link traffic with either the present Lion's Gate system on the North Shore or with the Upper Levels Highway. The Brockton Point tunnel avoided Stanley Park entirely and linked downtown Vancouver with Eastern North Vancouver. The mid-harbour tunnel also surfaced in Eastern North Vancouver, but instead of taking traffic downtown it swung eastward to Main Street or Clark Drive in East Vancouver.

From these schemes, the decision-makers did not arrive at a solution for the Lion's Gate Bridge problem. In addition, no decision was reached on whether to build a bridge or tunnel. This led to a number of alternative proposals submitted by the public and a lot of concern over the outcome of the Lion's Gate Bridge project.

The Lion's Gate Bridge Debate: Bridge or Tunnel?

The government has studied two alternatives to link downtown with the North Shore: by bridge and by tunnel. A 1993 report indicated that the public was evenly split on the issue (*The Vancouver Sun*, September 15, 1993). Tunnel proponents argue that moving heavy traffic underground is the best solution, environmentally. It eliminates surface traffic through the heart

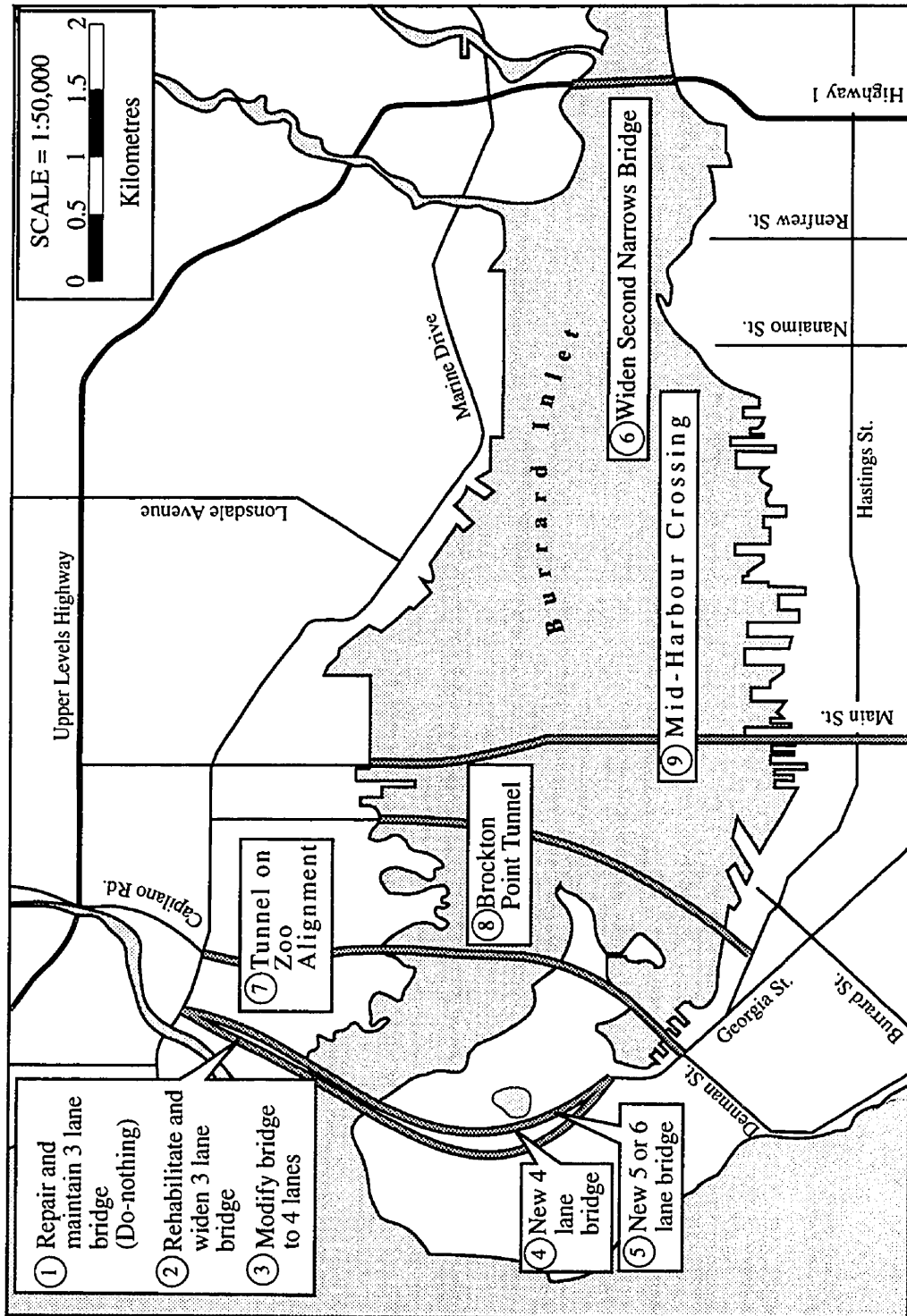


Figure 2. Map of Proposed Routes and Corridors.

of Stanley Park, and the noise and emissions that accompany that traffic. A tunnel would eliminate visual intrusions of a multi-lane road through the park and improve it aesthetically. A tunnel would also ensure that the aesthetics of Vancouver Harbour are not intruded upon by additional bridges and may lead to the preservation of Lion's Gate as a landmark for pedestrian and cyclist use. It is argued that maintaining and operating a tunnel is easier because the road surface is not directly subjected to rain, snow and salt. Although a tunnel is much more expensive in terms of capital cost, those who support it feel that saving the environmental integrity of Stanley Park is worth the extra cost.

Bridge proponents, on the other hand, feel that it is unreasonable for people to give up the beautiful drive through the park for a concrete tunnel. A bridge is perceived as being a much cheaper and more reliable crossing to build, in terms of unknowns during the construction process. The amount of environmental damage incurred in Stanley Park is not seen as enough to justify the extra cost of a tunnel. One of the main arguments for bridge supporters is the preservation of the Lion's Gate Bridge's symbolic value.

The following sections briefly describe the types of bridges and tunnels under investigation.

Bridges

Currently, two types of bridges are being considered for the Lion's Gate Bridge rehabilitation or replacement. The first is a suspension bridge, like the present structure as shown in Figure 3. Suspension bridges are made up of two or more towers with large cables draped over the tops of the towers. From these main cables hang smaller vertical cables that hold the driving deck. The main cables are anchored in the ground at both ends of the bridge.

The second type of bridge, a newer technology called cable-stayed, is illustrated in Figure 4. Like the suspension bridge, there are two towers. The main difference is that the cables radiate directly from the towers to the driving deck. This eliminates the need to anchor large cables into the ground and allows for a deck as wide as desired, by increasing the angle between the towers and the cables. A suspension bridge deck is restricted to the width between the tower and cables.

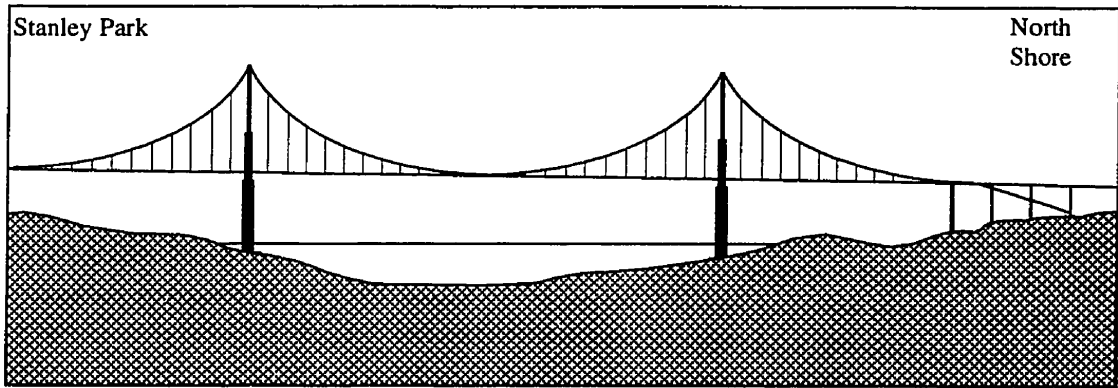


Figure 3. Current Suspension Bridge.

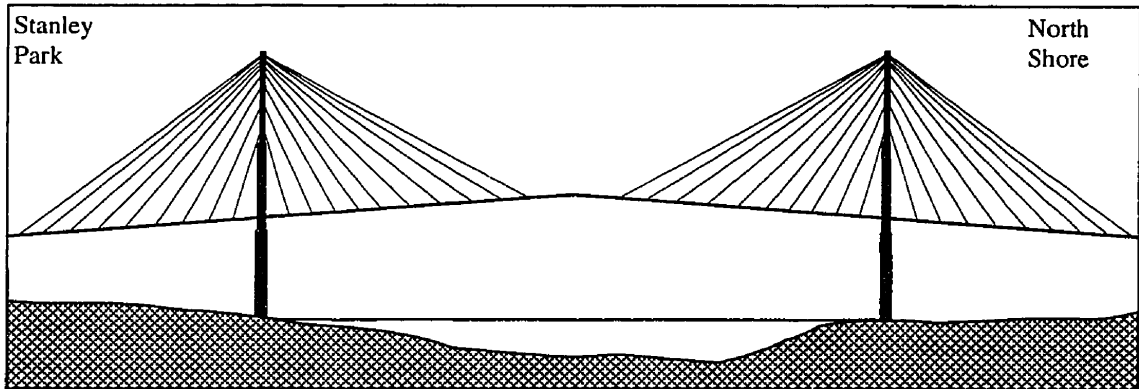


Figure 4. Cable-Stayed Bridge.

Tunnels

As with bridges, there are two types of tunnels that can be used to cross the First Narrows. The first is a bored or mined tunnel, as shown in Figure 5. A circular boring machine digs a hole underground and under the sea bed of Burrard Inlet. A concrete liner is then placed around the sides of the hole and is fitted with a driving surface, lighting and ventilation systems.

The alternative type of tunnel is cut-and-cover and immersed tube technology, shown in Figures 6 and 7. This involves cutting an open trench through Stanley Park and on the bottom of Burrard Inlet, then placing a pre-cast concrete tube in the trench and covering it up for protection.

The debate over whether to build a bridge or tunnel to replace the Lion's Gate bridge, along with growing public concern led to an extensive process of public consultation to help find a suitable replacement for the bridge.

Choices Forum: The Lion's Gate Bridge Public Involvement Process

In 1993, the provincial government began its public consultation process. This involved informing the public about the project and gathering feedback at a number of stakeholder roundtables, open houses, debate sessions and a proponents' showcase. The meetings began with presentations from technical experts about the possible routes and alternatives under consideration, followed by question periods. Panels made up of representatives from stakeholder groups and technical experts answered questions from the public. Interested people could also submit their opinions on paper at the meetings or by mail to the Lion's Gate Bridge Public Information Center, which was located in Denman Place Mall until early in 1997. In total more than 1000 submissions were received.

During the Choices Forum, a number of key players had a role in the planning and decision-making process. These included: The Ministry of Transportation and Highways, several consultants, two technical support groups, public stakeholder groups and Lower Mainland citizens.

The Players

The Ministry of Transportation and Highways is responsible for the maintenance and operation of the Lion's Gate Bridge, as well as the decision-making for the rehabilitation or replacement of the bridge. To try and solve the problem facing the crossing, the government initiated the search for alternatives, undertook the evaluation of those alternatives and launched the public process to help determine the preferred solution.

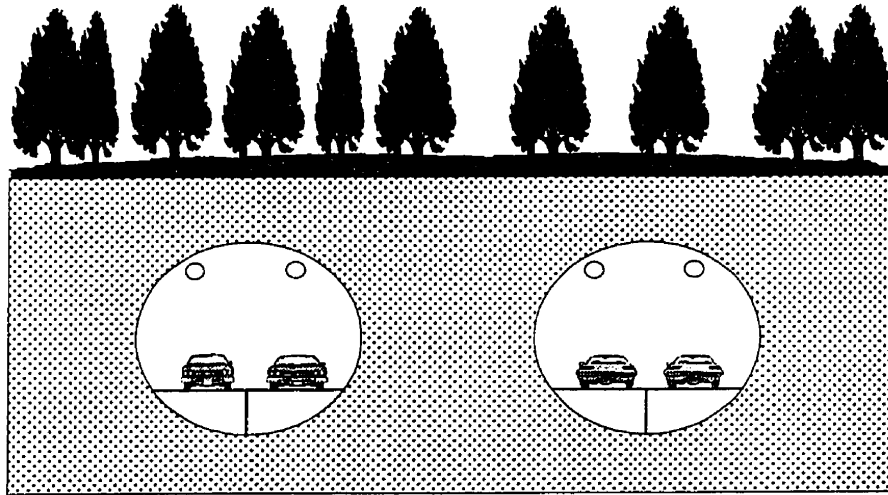


Figure 5. Bored Tunnel.

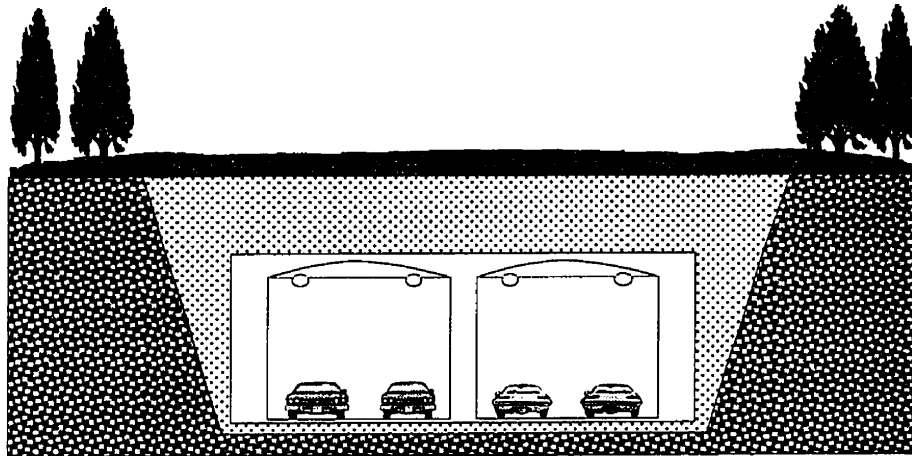


Figure 6. Cut-and-Cover Tunnel.

Burrard Inlet

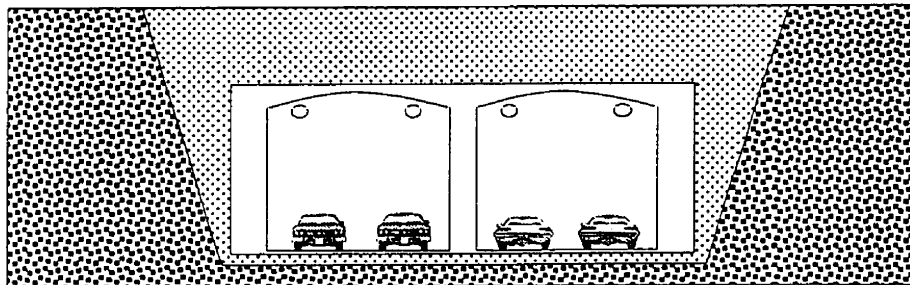


Figure 7. Immersed Tube Tunnel.

N.D. Lea Consultants managed the Lion's Gate project on behalf of the government. The firm investigated some of the transportation planning requirements; namely, a vehicular lane study and the constructability and costs of the proposed alternatives. Representatives from N.D. Lea gave presentations at the public meetings, for local agencies who were interested in the project and for local municipalities. Other consulting firms conducted studies on various transportation and environmental aspects of the project under N.D. Lea. At the end of the process, N.D. Lea submitted a report to the Ministry with three options recommended for further consideration. These recommendations were never disclosed to the public.

Several other consulting firms worked on the bridge project on behalf of the government. Dome FCB Advertising managed the Choices Forum, contacted panel members for each stakeholder meeting, arranged the times and locations for the meetings and advertised them in the local media. Dome also managed the Public Information Center in Denman Place Mall, in Vancouver's West End. All technical reports were on display at the office for public viewing and staff was on hand to answer questions. In early 1997, the British Columbia Transportation Financing Authority took over the Information Center.

Buckland and Taylor, a local engineering firm, inspects the bridge and reports on its structural condition to the Ministry. They published reports of the physical state of Lion's Gate Bridge in 1993 and 1995, in which the end of the bridge's safe life was estimated to be 1999. They have made recommendations as to what parts of the bridge are in safe condition and what must be replaced.

Acres International Limited completed the first of several environmental studies for the Choices Forum. The study, titled *Environmental and Social Overview of Lions Gate Crossing Options*, was completed in November, 1993. The environmental and social benefits and drawbacks of the proposed solutions were identified and recommendations for further study were made.

Two technical committees were set up in 1993 to assist in the Choices Forum. These included:

- Community Focus Group - Chaired by Arthur Griffiths, Former Vancouver Canucks owner. This committee was comprised of twenty volunteer representatives from community groups and organizations whose role was to discuss issues and submit a recommendation from a community perspective.
- Agency Liaison Committee - Chaired by Peter Hyslop, President of N.D. Lea Consultants. The purpose of this committee was to create a link between government and industry. Representatives from various agencies attended meetings to provide feedback on technical

and environmental issues on the bridge rehabilitation plan, and to keep each agency up-to-date on the project.

The players involved in the Choices Forum were responsible for evaluating the design proposals submitted for consideration. As part of the process, the public was invited to submit possible solutions to the Lion's Gate Bridge problem.

The Proposals Submitted

At a Proponents' Showcase held in 1994 at Robson Square in downtown Vancouver, eight engineering firms and twelve individuals representing public groups, companies or themselves presented a total of twenty-one proposals. The twenty-one schemes included: eleven bridge designs, five tunnel plans, two rail transit proposals, two recommendations for improved ferry service and one suggestion for a gondola under the bridge. The schemes were not limited to the present alignment, with many using routes through the middle of Vancouver harbour. Further, some of the schemes were not for an automobile crossing, but instead proposed improved public transit as a means of moving people. Since it was not feasible to evaluate all of the proposals presented at Robson Square, many had to be dropped from the list of options under consideration. All proposals that focused on transit and not automobiles were eliminated from the list because they were deemed unfeasible. This meant that improved ferry service and rail service to the North Shore would not be considered in the project. Only three options along corridors other than the current one made the short list. It should be noted that of these three options, two follow the same south shore alignment but use different routes on the North Shore, while the third is completely east of the present Lion's Gate system in Vancouver and on the North Shore.

The Range of Choice to Replace the Lion's Gate Bridge

From the twenty-one unsolicited proposals submitted, nine were short-listed by the province for further study. However, the zoo alignment tunnel, and the tunnel to Capilano Road were dropped from consideration because the respective proponents felt they had no chance of being selected. Consequently, these two options were not used in this study. However, eight proposals have been selected for consideration, as shown in Figure 8. Each proposal is followed by a brief description.

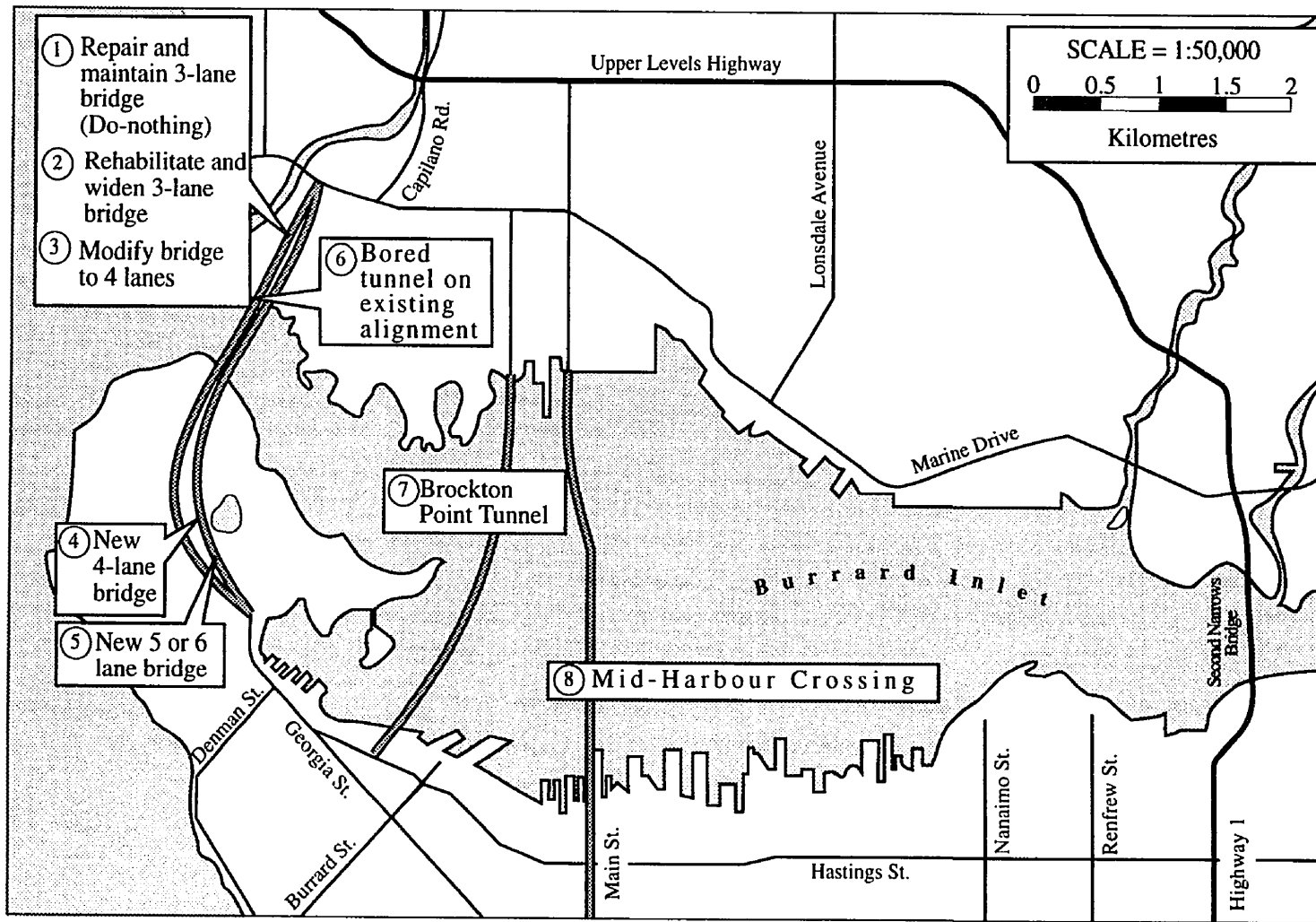


Figure 8. The Range of Choice to Replace the Lion's Gate Bridge.

1) Repair and maintain the existing bridge or Do-nothing option³

This option involves on-going bridge maintenance and replacement of some parts of the bridge. This can only be done for about five years when large parts of the bridge will need to be replaced. Some night time closures of the bridge will be necessary and the Stanley Park causeway will undergo routine maintenance. This option will cost between one and two million dollars per year (N.D. Lea Consultants 1995).

2) Rehabilitate and widen the existing three-lane bridge

With this option, the bridge driving deck will be replaced with a wider one and the Stanley Park causeway will be widened. Between forty and fifty night time closures will be required to replace the deck. The towers, cable bent and cable posts will undergo maintenance. This option will cost approximately eighty-three million dollars for bridge rehabilitation and \$2.7 million for the causeway (N.D. Lea Consultants 1995).

3) Modify the existing bridge to four or more lanes

In this option the existing suspension cables will be replaced with cable stays or new suspension cables; the stiffening trusses and deck will be replaced and the towers will be strengthened and heightened. If five or six lanes are required, a second deck will be added. Rebuilding major portions of the bridge and retaining traffic during the day may be difficult. Night time closures will be necessary to replace the bridge deck. The Stanley Park causeway can be widened, replaced with a depressed roadway with landscaped bridge(s) or replaced with a cut-and-cover tunnel. The costs of this bridge option are \$110 million for a four-lane cable-stayed (\$137 million for a four-lane suspension bridge), \$170 million for a five-lane double deck and \$186 million for a six-lane double deck bridge. The causeway options cost \$6 million for the widened road, \$22.7 million for the depressed road and \$167 million for the cut-and-cover tunnel (N.D. Lea Consultants 1995).

4) Construct a new four-lane bridge on the existing alignment

With this option a new-four lane bridge will be constructed just to the east of the existing bridge and will likely be a cable-stayed bridge (a new suspension bridge would cost about \$25 million more than a new cable-stayed bridge). This option will have little to no impact on traffic. The Stanley Park causeway can be widened at-surface, widened at-surface route with a short tunnel before the bridge, a combination of cut-and-cover and bored tunnels at the park entrances

³ "Repair and maintain bridge" and the "do-nothing" option are used interchangeably throughout the thesis.

connected by a depressed road and landscaped bridge(s), two bored tunnels through the park or a cut-and-cover tunnel on the existing alignment. Tunnels surfacing at Lost Lagoon will require dewatering of 30 to 50 percent of the lagoon during tunnel portal construction. Traffic on West Georgia between Denman and Lost Lagoon will be rerouted through Devonian Harbour Park to build ramps to the tunnel portals. A new four-lane cable-stayed bridge will cost \$118 million. A widened at-surface causeway will cost \$13.2 million, widened at-surface with a short tunnel at north end will cost \$67 million, a depressed causeway with bored tunnels at either end will cost \$297 million (landscaped bridge will cost \$6 million), a depressed causeway with cut-and-cover and bored tunnels at each end will cost \$192 million (landscaped bridge will cost \$6 million), two bored tunnels will cost \$207 million and a cut-and-cover tunnel will cost \$171.5 million (N.D. Lea Consultants 1995).

5) Construct a new five or six-lane bridge

A new five or six-lane bridge on the existing alignment will be located just east of the existing bridge and will likely be a cable-stayed bridge (a new suspension bridge will cost \$25 million more). This will have little or no impact on traffic. The Stanley Park causeway options, the same as for the previous option, include a widened at-surface route, at-surface with short tunnel, combination of bored and cut-and-cover tunnels connected by a depressed road and landscaped bridge(s), two bored tunnels through the park and a cut-and-cover tunnel through the park. The costs for this option are \$130 to \$135 million for the bridge, \$19.8 million for a widened at-surface route, \$350 million for depressed road with bored tunnels, \$288 million for depressed road with bored and cut-and-cover tunnels (\$6 million for a landscaped bridge), \$207 million for two bored tunnels (\$6.7 million for additional transit lanes) and \$257 million for a cut-and-cover tunnel (N.D. Lea Consultants 1995).

6) Construct a four-lane bored tunnel along existing corridor

This option includes two two-lane tunnels from West Georgia Street to Marine Drive in North Vancouver. The Lion's Gate Bridge could be retained for cyclists and emergency vehicles. As with the previous two options, this one calls for the dewatering of 30 to 50 percent of Lost Lagoon during tunnel portal construction. Two 12 meter diameter ventilation shafts will be required in Stanley Park. Loose gravel under Burrard Inlet will require a tunnel boring machine designed to handle these conditions. The cost of a bored tunnel is \$308 million, a new connection to Marine Drive will cost \$5.2 million, rehabilitating the Lion's Gate Bridge will cost \$40 million

and property acquisitions on Indian Reserve no. 5 will be \$30 million (N.D. Lea Consultants 1995).

7) Construct an immersed tube tunnel on Brockton Point alignment

This option is an updated version of a third crossing proposal from the 1970's (Swan Wooster-CBA 1970). It includes a peninsula from the foot of Bute and Jervis Streets to Deadman's Island. Access to downtown streets will be on Bute and Jervis with downtown bypass tunnels leading to Nelson and Smithe Streets. An immersed tube tunnel will pass to the east of Stanley Park and connect with a three level interchange on the North Shore that will distribute traffic onto Pemberton Avenue, Welsh Street and the Low Level Road, as shown in Figure 9. The Lion's Gate Bridge could be kept for cyclists and emergency vehicles. Marine shipping will be disrupted while putting the tube in place. Traffic in downtown Vancouver will also be disrupted during work on tunnels and utility repairs. The costs of the project are \$700 million for the tunnel (with bypass tunnels and connections), \$100 million for a connection to Upper Levels Highway and \$40 million for rehabilitating the Lion's Gate Bridge (N.D. Lea Consultants 1995).

8) Mid-Harbour Tunnel (As a third crossing)

No formal studies have been done on this option, but there are several interested parties, including some North Shore politicians and Vancouver business people. It is generally proposed that a tunnel (either immersed tube or bored) would connect the Main Street area in East Vancouver with the middle of North Vancouver, and would include some rapid transit component. The costs of doing this are projected to be approximately \$1 billion. No decision has been made as to the details of the project, but a crossing at First Narrows is assumed to be part of it.

This list constitutes the range of choice or alternatives for the Lion's Gate Bridge replacement for this study. Since April 1997, the B.C. government has presented the public with an even shorter list of options from which a choice will be made.

The Short List of Four Options

After the end of the Choices Forum, the provincial government narrowed the list of possible solutions to a few schemes that follow the present alignment. The announcement called for proposals from the private sector for a four-lane crossing, with two lanes in each direction,

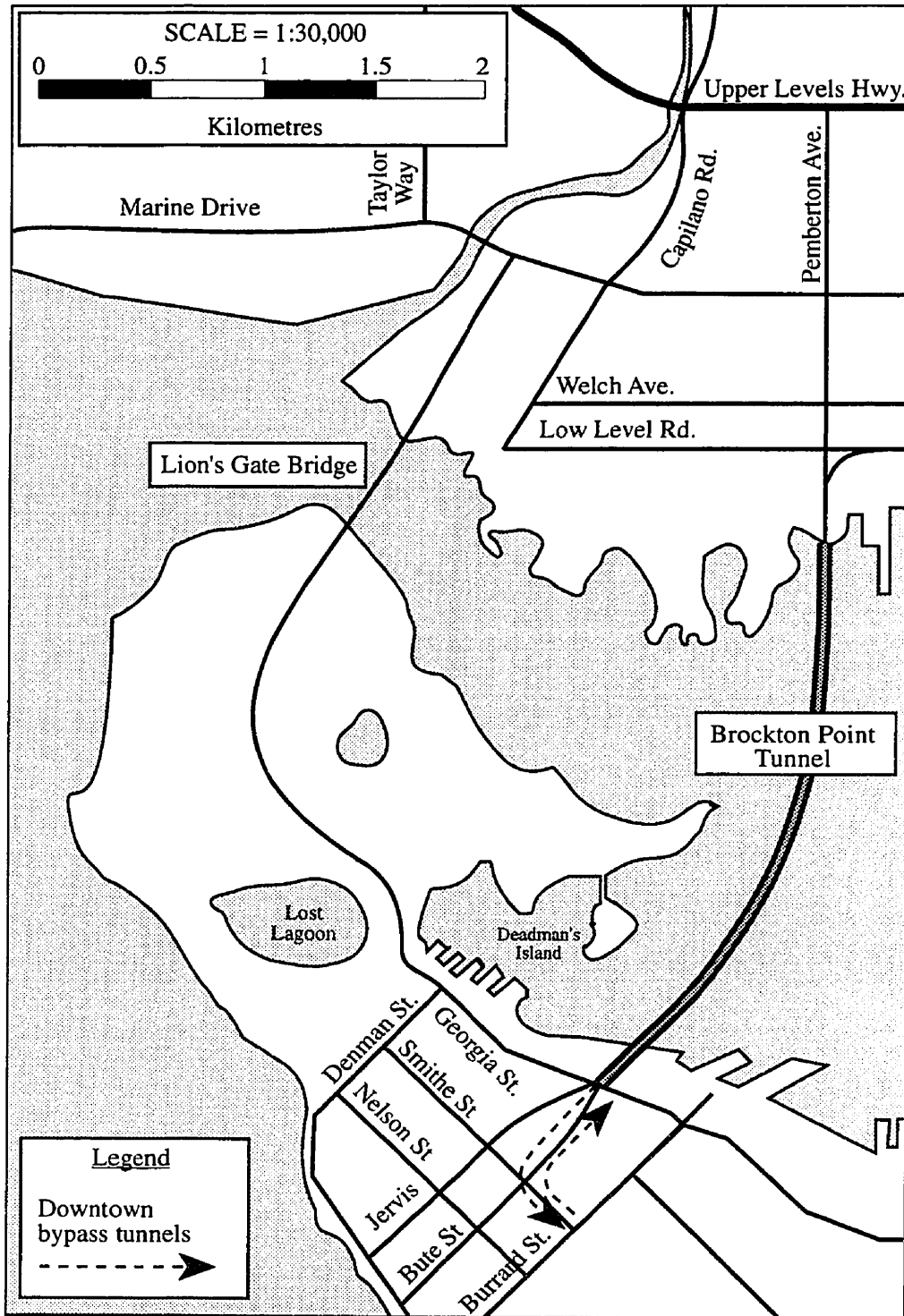


Figure 9. Brockton Point Tunnel Street Connections.

that would reduce or eliminate surface traffic through Stanley Park, produce “no net detrimental effect” on the park and “reduce traffic impacts on the West End” (*Vancouver Sun*, April 19, 1997). The government expected a four-lane crossing to improve transit’s ability to attract commuters with better queue jumper facilities, reduce congestion, improve safety on the bridge and allow enhanced emergency vehicle access to the bridge (*Vancouver Sun*, April 19, 1997). The announcement limited the potential solutions to the following list:

1. Rehabilitate the existing bridge with three lanes.
2. Modify the existing bridge to four lanes with a tunnel (at least two lanes) under Stanley Park.
3. A new four-lane bridge with a tunnel (at least two lanes) under Stanley Park.
4. A four-lane tunnel from Georgia Street to the North Shore.

The province committed \$70 million to the project (the cost of rehabilitating the bridge with three lanes). Any private consortium that wanted to build a crossing costing more than \$70 million would have to finance the balance with tolls.

The Criteria of Choice

To evaluate the choice of alternatives to replace the Lion’s Gate Bridge and to determine which option is perceived as the favoured or likely alternative to deal with the problem, eight criteria that affect the choice process in urban transportation are investigated. For purposes of study, a decision-making framework is modified after Gilbert White’s “choice of use framework” (White 1961), which has been widely used in resource management (Wong 1968). This perception schema has been adapted to suit the urban transportation choice process. Five feasibility and three impact criteria are used for evaluation. These are:

1. Perception of technical feasibility
2. Perception of economic feasibility
3. Perception of financial feasibility
4. Perception of social feasibility
5. Perception of political feasibility
6. Perception of spatial impact
7. Perception of environmental impact
8. Perception of aesthetic impact

Each criterion is now defined:

- Perception of technical feasibility deals with the awareness that people have of the technical performance and capability of the proposed alternatives. What are the technological capabilities of a rehabilitated bridge to withstand daily traffic capacity? How will traffic flow and safety improve on the bridge?

- Perception of economic feasibility is concerned with the gains and losses of each alternative. What are the benefits and costs of each alternative? How do these gains and losses of each alternative compare among the others?
- Perception of financial feasibility deals with the availability of funds, the cost effectiveness, rate of repayment and the cost sharing arrangements. Why are there funds available for one alternative while there is little or none for other alternatives? How long will it take to repay? What type of cost-sharing arrangement is there to ensure equity?
- Perception of social feasibility looks at the awareness of public feedback and support. What is the perception of social desirability of the options?
- Perception of political feasibility addresses the awareness of the political, input feedback and support. What type of feedback has been received from technocrats and bureaucrats? Will they back a group's preferred option?
- Perception of environmental impact is concerned with the awareness which various groups have of the effects of noise generation and air pollution in Stanley Park and the surrounding areas stemming from the choice of different options.
- Spatial impact refers to the increase in traffic flow caused by the choice of an alternative to the West End and surrounding areas. What linkage impact do the proposed alternatives have on the traffic flow in Vancouver, North and West Vancouver, Stanley Park, the Second Narrows Bridge, and the adjacent areas?
- Perception of aesthetic impact deals with the awareness of the potential impacts which a chosen alternative will have on the visual scenery and appearance of the Lion's Gate Bridge and its surrounding landscape.

An examination of these criteria affecting choice will hopefully enhance understanding of the choice process in urban transportation and might provide insights useful for future urban transport policy formulation.

Organization of the Study

This study is organized into six chapters. While Chapter I provides the overall framework of the study, Chapter II presents the research design and discusses how the study started, the preparations in formulating the research, the selection of subjects for interview, the interview structure, and problems confronted and limitations of the study. Chapter III takes an in-depth look at the Choices Forum public involvement program. Chapter IV, which comprises the main part of the study, examines selected case study interviews to gain insight into the choice process. Chapter V provides a comparison of public and private preferences. Finally, Chapter VI summarizes the

major findings and conclusions, points out the implications of the study, and suggests areas for further research.

CHAPTER II

RESEARCH DESIGN

The methodology of this study involved two types of investigations. The first entailed a review of literature, tapes and videos on urban transportation planning and the Lion's Gate Bridge. The second was based on thirteen interviews with stakeholder groups, private consultants and politicians.

The rest of the chapter covers how the study started, the preparations in formulating the research, the selection of subjects for interview, the interviews, the use of the decision matrix, and some problems and limitations of the study.

How the Study Started

The study started in 1996 when the researcher was introduced to the project by his senior supervisor who mentioned the Choices Forum public meetings. Choices had been in progress for three years, with no decision on a bridge replacement in sight.

My initial interest in urban transportation was in public transit, as opposed to highways for automobiles. I wanted to examine the increasing amount of residential high-rise development around some Skytrain stations in the Lower Mainland. However, when I told my senior supervisor about my interest he suggested that I should consider taking up the Lion's Gate Bridge replacement as my thesis topic. The suggestion was appealing as the bridge problem has generated a great deal of public interest and is a high profile government project. Because of its timeliness and prominence, I decided to choose the Lion's Gate Bridge project for my master's thesis.

There are several reasons why the Lion's Gate Bridge project is a good choice for my research. First, there is an abundance of data on this important topic, which has not been analyzed for any in-depth research study. After years of public input a wealth of information had accumulated. A long list of technical reports, summaries of more than 1000 written submissions from the public, tapes of public meetings, videos and extensive media reports were all available for the research. Second, few transportation projects in the Lower Mainland have received the kind of attention this sixty-year-old bridge has. The bridge's importance in Vancouver is one of the primary reasons for undertaking the study. Third, the Lion's Gate Bridge is an important link in the local transportation system. One only has to look at the volume of traffic the bridge carries for evidence of this. The narrow three-lane bridge carries more vehicles on a daily basis than the

eight-lane Granville Street Bridge and the six-lane Burrard Street Bridge (Urban Systems 1995). Not only is the bridge a link for North Shore residents commuting to downtown Vancouver, it is heavily used by Vancouver residents to access recreation activities on the North Shore, the Horseshoe Bay ferry terminal and Whistler.

Preparations in Formulating the Research

The preparations in formulating this research included a review of Lion's Gate Bridge literature, and a review of public meeting proceedings and public comment summaries.

Lion's Gate Bridge Studies

Several Lion's Gate Bridge reports and studies were investigated prior to the preparation for the interviews. These studies are summarized under four sub-headings: Structural Studies, Geotechnical Studies, Transportation Studies, and Social and Environmental Studies.

Structural Studies

A 1995 *Bridge Condition Survey* (Buckland and Taylor 1995a) assessed the Lion's Gate Bridge's capacity to carry heavy traffic and withstand deterioration. It concluded that the towers, cables and stiffening trusses were in acceptable condition, but the bridge deck and sidewalks were deteriorating rapidly and would require expensive maintenance or replacement in the near future. Also in 1995, a *Seismic Assessment* (Buckland and Taylor 1995b) study concluded that in the event of an earthquake, the north viaduct would be at risk of significant damage, while the current suspension span would require only minor upgrades to ensure its safety. These seismic upgrades were determined to be the highest priorities for bridge repairs right now (Buckland and Taylor 1995c), although the cost of bridge deck repairs will increase quickly in the coming years (Buckland and Taylor 1996).

In order to determine the technical feasibility of several private proposals submitted for consideration, bridge and tunnel expert panels were formed to evaluate the options. The *Bridge Rehabilitation Options Report* (Bridge Expert Panel 1994) found the proposals to rehabilitate the bridge with three, four, or five or six-lanes to be technically feasible, while the 'do-nothing' option is only feasible until 1999. Despite being technically feasible, the rehabilitation options have some problems. For example, required nighttime closures, automobile and marine traffic disruptions, and public risk from overhead construction make new bridge options more feasible.

The tunnel proposals, which make use of tunnel boring, cut-and-cover, and immersed tube technology along the present alignment, the zoo alignment, and the Brockton Point

alignment respectively, were determined to be feasible in the *Tunnel Options Report* (Tunnel Expert Panel 1994). The expert panel concluded that one advantage of a bored tunnel over cut-and-cover is the minimal impacts in Stanley Park.

From all of the technically feasible options, N.D. Lea Consultants investigated the *Constructability and Cost Estimates of Long List of Choices* (1995). The report looks at the infrastructure and right-of-way costs, and the constructability risks of the province's list of options (see the options presented on page 2 in Chapter I). A summary table (N.D. Lea Consultants 1995, p. 6-1) presents the estimated costs for each alternative. The new four, or five or six-lane bridge options are determined to have the least risk and have costs that depend largely on the amount of tunneling required in Stanley Park. The Inlet tunnel options are generally more expensive with higher risks, whereas the rehabilitated bridge options are less expensive with higher risks than a new bridge.

An important consideration for any of the tunnel options is the ventilation of automobile exhaust. Consequently, a consultant was retained on behalf of the government to review the *Ventilation Requirements for Tunnel Options* (Keen Engineering 1995). Their report describes the different ventilation options available and concludes that the most economical technology is longitudinal ventilation, which makes use of jet fans to move exhaust in the direction of traffic flow. Since this technology does not necessitate separate ventilation tunnels like the alternative ventilation technologies, capital costs are minimized. Finally, due to the length of the tunnels (just over 3 km), two 10 m high mid-tunnel ventilation stacks in Stanley Park will be necessary.

Geotechnical Studies

Along with the technical studies, four geotechnical reports were conducted to identify the soil conditions in Stanley Park, North Shore, and Lost Lagoon. The Stanley Park causeway report (Ministry of Transportation and Highways 1994d) concluded that the proposed tunnel options are feasible from a geotechnical standpoint but that much more investigation is necessary before construction begins.

North Shore approach tunnels may have problems with high water pressure, water coming into the tunnel during excavation, and large boulders (Ministry of Transportation and Highways 1995b). Even though no bedrock through which to tunnel was found around the North Shore bridge approach, the Ministry is not concerned about ground liquefaction during an earthquake. The study also concludes that a rehabilitated bridge approach will require some upgrades given the sandy soils in the area.

Finally, soft soils were found under Lost Lagoon, which might cause tunneling problems

and may require tunnel portals to be moved further from the Lagoon (Ministry of Transportation and Highways 1995c).

Transportation Studies

After West End and downtown groups expressed considerable concern about the potential traffic impacts of the Lion's Gate Bridge replacement options, the province commissioned a *South Shore Traffic Impact Study* (Urban Systems 1995). One of the study's findings is that traffic on the bridge and approaches are at or near capacity during the morning and evening peak hours. It was also found that the majority of traffic using local West End Streets originates or is destined in the West End. Further, most bridge traffic uses the Georgia-Pender corridor, although this number varies between 65% to 85% depending on the time of day, and day of the week. However, this pattern does not change during the year. These conclusions are contrary to concerns expressed by West End groups who perceive bridge traffic in their neighborhood to be a major problem. Looking to future conditions in 2001, the study predicts little change in current traffic patterns, given West End traffic calming measures. Further, the capacity of intersections on bridge approaches is expected to limit traffic increases on any three, four or five-lane crossing options.

A study on the *Vehicular Laning Alternatives for Rehabilitated and Parallel Bridge Options* (N.D. Lea Consultants 1994) concluded that instead of an HOV or exclusive bus lane on the bridge, improvements should be made to queue jump facilities on bridge approaches. The study also found that the wider five or six-lane crossing options will have considerably larger impacts on Stanley Park than a four-lane crossing.

Similar conclusions on the necessity of an exclusive bus lane on Lion's Gate Bridge were made in a *North Shore Transit Options* report (BC Transit 1994). The study found that given present transit volumes across Burrard Inlet, a bus-based system is more cost-effective than a rail connection, or improved ferry service. Because of the need to transfer from a bus to a train or ferry, the trip time savings with either mode are deemed to be negligible, and insufficient to attract many new transit patrons. Overall, BC Transit prefers improvements to the queue jump facilities on bridge approaches to an exclusive bus lane or rail or ferry modes. Still, further study of the possibility of improved ferry service was deemed desirable.

In 1995, BC Transit and Sandwell Inc. completed a study of potential *North Shore Marine Connections* for an improved ferry transit system. From nine potential routes three were selected for examination. These were:

1. Ambleside to Waterfront Station

2. Capilano to Waterfront Station
3. Seymour River to Waterfront Station

The six other routes were eliminated from consideration, primarily because of low ridership potential or lack of trip time savings.

The study concluded that the Ambleside to Waterfront Station route is the most feasible, followed by Capilano to Waterfront Station and the Seymour River to Waterfront Station route. Despite this study, it does not appear that improved ferry service will be implemented in the near future.

Social and Environmental Studies

The Acres Report (1993) marked the beginning of the social and environmental impact investigation of the Lion's Gate Bridge replacement options. The strengths and weaknesses of nine options (shown in Figure 2 in Chapter one of this study) are listed in the report, and some environmentally sensitive areas are pointed out, namely Stanley Park, Coal Harbour, Capilano Indian Reserve No. 5, and M^c Kay Creek. The study concludes that a solution on the present alignment will have the fewest social and environmental impacts, and that a Stanley Park tunnel will minimize environmental impacts.

After the Acres Report was completed, eight specific environmental studies were done to satisfy the requirements of the Canadian Environmental Assessment Act (CEAA). These included studies on *Air Quality* (B.H. Levelton and Associates 1995), *Archeological and Heritage Resources* (Ministry of Transportation and Highways 1995a), *Fisheries and Aquatic Resources* (Coast River Environmental Services 1995), *Noise Impacts* (Wakefield Acoustics 1995), *Soils and Drainage* (Talisman Land Resource Consultants 1995a), *Vegetation Resources* (Talisman Land Resource Consultants 1995b), *Wildlife Resources* (Robertson, Ian and Bekhuys, Timothy 1995), and *Socio-Economic Resources* (Harvey Research and Talisman Land Resource Consultants 1995).

A summary report of the eight environmental studies titled *Comparative Environmental Assessment of Lion's Gate Crossing Options Related to Stanley Park and First Narrows* (Ministry of Transportation and Highways 1995a) highlights the major conclusions. First, as in the Acres Report, the present Lion's Gate corridor is preferred as it poses the fewest social and environmental impacts on surrounding areas. The least impact option is a rehabilitated three-lane bridge, with a modified four-lane bridge only slightly worse. The study dismisses a Brockton Point tunnel environmentally because it has serious noise, socio-economic, and aquatic impacts. The zoo alignment tunnel is also not recommended for further study as it poses negative

archeological, noise, socio-economic, aquatic and wildlife impacts. In terms of Stanley Park, a bored tunnel or surface causeway are preferred over a cut-and-cover tunnel or a depressed roadway.

Further investigation was made into the noise and air pollution, and social impacts of crossing options in Vancouver's West End. The first of these, the *Socio-Community Analysis of Vancouver's West End* (Economic Planning Group 1996) concludes that there is a split among West End residents as to whether a new bridge or tunnel is preferred, but it is quite clear that a rehabilitated bridge is not desirable. Further, a surface Stanley Park causeway appears to be preferred over a tunnel. The study also revealed that there is some public concern over safety, air quality, and pedestrian, bicycle and park access.

The *West End Region Air Quality Evaluation* (B.H. Levelton and Associates 1996) concludes that current West End air quality is in adherence with provincial standards. The study's consultant feels that even with traffic increases, air quality will not worsen, as the number of fuel efficient vehicles increases.

Finally, the *South Shore Traffic Noise Study* (Wakefield Acoustics 1996) concludes that although noise levels along major West End streets exceed acceptable levels, people living inside the West End do not experience excessive noise. The report goes on to predict little change in noise levels along major streets or elsewhere in the West End due to an expanded Lion's Gate Bridge.

Public Meetings and Comments

During the Choices Forum several public meetings were held to gather feedback from interested groups and people. During March and April of 1994 four Open Houses were held in Vancouver and on the North Shore to provide information to the public (Lion's Gate Crossing Public Involvement Program *Open House* March 15, 17, 21, and 21, 1994). In May of 1994 a Proponents' Showcase was held to entertain bridge replacement proposals (Lion's Gate Crossing Public Involvement Program *Proponents' Showcase* May 25, 1994). During June of the same year four Stakeholder Roundtables provided Vancouver and North Shore groups and residents the opportunity to offer input (Lion's Gate Crossing Public Involvement Program *Stakeholder Roundtable* June 1, 8, 16, and 22, 1994). Next, five drop-in meetings were held in areas that are not immediately impacted by the bridge project (Lion's Gate Crossing Public Involvement Program *Drop-In Information Meeting* July 26, 27, 28, and August 4, and 5, 1994).

The Open Houses, Proponents' Showcase, and Stakeholder Roundtables were recorded on audio tape and are available to the public (the five drop-in meetings were not recorded on

tape). Each meeting was reviewed twice and the main points and themes from each were summarized. Since these summaries are covered in the next chapter, they will not be elaborated upon here. Comments from the public that were submitted at the drop-in meetings and a summary of comments that were mailed to the Public Information Office were also reviewed and are summarized in the next chapter.

Selection of Subjects for Interview

After reviewing the Lion's Gate Bridge reports and listening to the tapes of the public meetings, a list of potential interview subjects was made. The list comprised the public stakeholder groups who attended the Choices Forum meetings, the Community Focus Group, the business associations who participated in the public process, the North Shore municipalities, the City of Vancouver, the Greater Vancouver Regional District, the Squamish Nation, the provincial government, the engineering firms who submitted proposals, and the consulting firm in charge of the Lion's Gate Bridge project, N.D. Lea Consultants. This diverse list of groups was chosen for several reasons. First, each group participated in the public involvement process and all have a stake in the outcome. For this reason it was hoped they would oblige in giving time for an interview. Second, from their involvement in the process it was assumed the groups had a good knowledge of the issues surrounding the bridge project and could offer helpful insights on the choice process. Third, all of the groups play a role in the decision-making process leading to the bridge replacement, and finally, the groups on the list come from a broad range of backgrounds and interests that would give the study good representation. Contact numbers for the public groups were found in the phone book or in the Vancouver Public Library's "Community Group Directory", which is located on the library's computer catalogue. Contacts for the private groups were found in the technical reports or in the phone book.

The number of interview subjects used in the study depended on who agreed to grant time for an interview and who would answer the interview questions. Each group was contacted by telephone and was faxed a letter that outlined the research if they agreed to a meeting. In total, thirteen case subjects were used in the study. Eight of these were public respondents and five were private respondents. To differentiate between public and private groups, each is briefly defined. Public groups are those that are accessible to, or represent the whole community. For example, the Friends of Stanley Park is a public stakeholder group that anyone can join, while the municipal government of the District of North Vancouver is a group of elected officials who represent the interests of that community. Conversely, private groups represent their own interests. They are not accessible to and are not representative of the community. An example of a

private group is an engineering consulting firm or a self-employed business. In this study the public group comprises respondents from: the British Columbia Transportation Financing Authority (BCTFA), the Vancouver Parks Board, the Friends of Stanley Park, the Lower Capilano Steering Committee, the City of Vancouver, the District of North Vancouver, the City of North Vancouver, and a respondent from the District of West Vancouver. The private group is made up of four consulting firms who are part of the consortiums that are submitting proposals for the bridge replacement project, in addition to a transportation engineer who has worked on the Lion's Gate project for many years. These firms cannot be named for confidentiality reasons, but it can be noted that among the private respondents four transportation engineers and one transportation planner were interviewed.

The Interviews

The interviews consisted of two parts. Part one involved semi-standardized interviews (Burton and Cherry 1970) which were designed to elicit qualitative responses from the interviewees. The interview structure comprised eight sections, one for each of the criteria of choice investigated in the study. These sections are: Technical Feasibility, Economic Feasibility, Financial Feasibility, Social Feasibility, Political Feasibility, Spatial Impact, Environmental Impact, and Aesthetic Impact, as described in Chapter I. The questions asked in the interviews were intended to explore the respondents' perceptions of the alternatives to replace the Lion's Gate Bridge in relation to each of the criteria of choice. The questions were not necessarily worded the same way, nor did they follow the same order in each interview. In this approach, the same topics were covered in the interviews, while allowing follow-up questions on the various sections as they came up during the discussion. This also permitted more in-depth questions on particular issues in which a respondent had considerable knowledge. A short summary of the sections covered in the interviews is now given. In addition, a copy of the interview structure is provided in the Appendix.

To gain insight on each respondent's perception of technical feasibility, questions focused on the performance and capability of the preferred type of bridge or tunnel design, how the alternatives would help improve traffic flow on the bridge and Stanley Park causeway, and how they would improve traffic, pedestrian and cyclist safety. Questions regarding economic feasibility focused on the perceived gains and losses, or the pros and cons of the preferred alternative and how these compared with the other options. In terms of financial feasibility, the questions dealt with the cost-effectiveness of the alternatives, how long the preferred option is expected to take to repay, and the type of cost-sharing arrangement that will ensure equity. To

determine the perceptions of social feasibility the respondents were questioned on the type of public feedback they had received, and how socially desirable they perceived the options to be. Similarly, questions regarding the political feedback and acceptability of the proposed alternatives were asked to determine the perceived political feasibility of the options. Questions about the perceived traffic impacts on the North Shore, Vancouver, Second Narrows Bridge, and other adjacent areas were directed to the respondents to ascertain their views on the spatial impacts of the various alternatives. In order to assess the perceptions of environmental impacts, questions focused on the affect on air and noise pollution in Stanley Park and surrounding areas. Finally, questions were asked about the perceived aesthetic impacts on the Lion's Gate Bridge and its surrounding landscape.

Part two of the interviews is focused on the use of a decision matrix developed to aid in the evaluation of alternatives based on the criteria of choice. A copy of the matrix used in the interviews is presented in the Appendix.

Use of the Decision Matrix

The structural framework of analysis in this research design makes use of a decision matrix, which is an adaptation of Hill's decision matrix (Hill 1979) and a modification of White's choice of use schema (White 1961) that is widely used in resource decision making (Wong 1968). The matrix comprises eight alternatives under consideration, and eight selected criteria against which the alternatives are evaluated. The eight alternatives, which were narrowed from twenty-one proposals, are:

- | | |
|---|--|
| 1. Repair and maintain existing bridge | 5. New five or six-lane bridge |
| 2. Rehabilitate and widen three-lane bridge | 6. Four-lane bored tunnel on existing corridor |
| 3. Modify bridge to four lanes | 7. Brockton Point tunnel |
| 4. New four-lane bridge | 8. Mid-harbour tunnel |

The eight criteria used to evaluate the choice of alternatives are:

- | | |
|--------------------------|--------------------------|
| 1. Technical Feasibility | 5. Political Feasibility |
| 2. Economic Feasibility | 6. Spatial Impact |
| 3. Financial Feasibility | 7. Environmental Impact |
| 4. Social Feasibility | 8. Aesthetic Impact |

These criteria have already been defined earlier in Chapter one. They have been selected as they are often used in the decision making of project evaluation.

In using these criteria to evaluate the choice of alternatives, the criteria are ordered in importance by preference, and weighting factors are calculated for each, as follows:

Criteria	Order	Weighting Factor
Technical Feasibility	8	$8/36=0.22$
Economic Feasibility	7	$7/36=0.19$
Financial Feasibility	6	$6/36=0.17$
Social Feasibility	5	$5/36=0.14$
Political Feasibility	4	$4/36=0.11$
Spatial Impact	3	$3/36=0.08$
Environmental Impact	2	$2/36=0.06$
Aesthetic Impact	1	$1/36=0.03$
Total	36	$36/36=1.00$

The order of importance of these criteria is based on knowledge of the problem, awareness of the situation, and what one felt should be given the highest priority in consideration. Since technical performance is of utmost importance in a bridge replacement project, technical feasibility is given the highest rating and a score of 8. Economic, financial, social, and political feasibility are generally given secondary preference and hence are rated 7, 6, 5, and 4 respectively. The tertiary and more subjective criteria, namely, spatial, environmental, and aesthetic impacts are given scores of 3, 2, and 1 respectively.

It is possible sometimes that there may be situations where two or more criteria are felt to be of equal importance. For example, economic and financial feasibility may be of equal importance, or social and political feasibility are the same in importance. In such cases, the criteria are ordered in importance and given scores, as shown below:

Criteria	Order	Weighting Factor
Technical Feasibility	6	$6/30=0.20$
Economic Feasibility	5	$5/30=0.17$
Financial Feasibility	5	$5/30=0.17$
Social Feasibility	4	$4/30=0.13$
Political Feasibility	4	$4/30=0.13$
Spatial Impact	3	$3/30=0.10$
Environmental Impact	2	$2/30=0.07$
Aesthetic Impact	1	$1/30=0.03$
Total	30	$30/30=1.00$

We turn next to the consideration of the range of alternatives with respect to the selected criteria. In evaluating which among the eight alternatives is judged most preferred or the one that

should be chosen, we assign rating factor values to each alternative in terms of each selected criterion. These rating factor values are given a score of 10 for each criterion, ranging from 10 to 1 (highest to lowest). The respondent is asked to rate an alternative by giving it a score value in terms of the ten point criterion score. Table 1 shows how the alternatives are scored or rated by a hypothetical respondent with respect to technical feasibility. A rating factor value of 10 for the modified four-lane bridge shows that it is considered the most technically feasible, while a score of 1 given to the mid-harbour tunnel indicates that it is the least preferred from a technical point of view. Table 2 shows hypothetically how a respondent has rated or scored each alternative in terms of each criterion on the 10 point scale. One notices that if a respondent feels that a criterion merits the same importance for all the alternatives, the same rating factor value is given under that criterion. For example, under social feasibility, a rating factor value of 8 is given for all alternatives.

Table 1. Decision Matrix

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	3(RF) RF*WF								
Rehab 3-lane bridge	8								
Modified 4-lane bridge	10								
New 4-lane bridge	9								
New 5/6-lane bridge	6								
4-lane bored Tunnel	4								
Brockton Point tunnel	3								
Mid-Harbour tunnel	1								

The final step in the use of the decision matrix involves the calculation of weighted coefficients for each alternative vis-à-vis each criterion. The process calls for calculating the product of the rating factor value (RF) with its corresponding weighting factor (WF) to arrive at a weighted coefficient for each alternative against each criterion. The weighted coefficients are obtained by multiplying the rating factor values (RF), (scores at the upper left corner of each

square cell) with each of the weighting factors (WF) (under the criteria in the decision matrix). The product of RF and WF is recorded in the lower right corner of each cell. All the weighted coefficients for each alternative are summed horizontally and totaled under the 'Sum' column. Table 3 shows a hypothetical completed matrix and the summed weighted coefficients of each alternative. One notes that the alternative that receives the highest weighted sum is the modified four-lane bridge. Its score of 8.75 means that a respondent places an 87.5% level of confidence in his/her judgment for the choice of a modified four-lane bridge, assuming a score of 10 means 100% if one prefers percentages. A close second choice that has an 87.4% level of confidence is a new four-lane bridge. The alternative least preferred is the mid-harbour tunnel which has a weighted score of 32.6% level of confidence.

Table 2. Completed Decision Matrix

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	3	2	5	8	1	1	1	9	
Rehab 3-lane bridge	8	4	7	8	5	5	1	10	
Modified 4-lane bridge	10	7	10	8	8	10	8	8	
New 4-lane bridge	9	9	9	8	8	10	8	8	
New 5/6-lane bridge	6	10	8	8	6	3	5	7	
4-lane bored Tunnel	4	8	6	8	5	10	9	6	
Brockton Point tunnel	3	2	1	8	1	2	9	5	
Mid-Harbour tunnel	1	4	1	8	1	2	9	6	

The use of a decision matrix to evaluate the choice of alternatives to replace the Lion's Gate Bridge has a number of advantages. First, it shows how a respondent perceives the range of choice in relation to the criteria affecting choice, and how preferences of alternatives may be rated and prioritized in the choice process. Second, using a combination of rating factor values and weighting factors, enables one to overcome the problem of tied alternatives. They also reveal which combination of weighted coefficients has the greatest impact in influencing the selection of the optimal alternative. Third, the decision matrix provides not only insights into the choice

process, but also supports a decision by giving the rationale behind each expressed judgment or choice.

This structural framework of analysis will be used as the basis for evaluating the choice process in decision making by both public and private groups regarding the choice of alternatives to replace the Lion's Gate Bridge in Chapters four and five.

Table 3. Completed Decision Matrix with Summed Scores

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	3 0.66	2 0.38	5 0.85	8 1.12	1 0.11	1 0.08	1 0.06	9 0.27	3.53
Rehab 3-lane bridge	8 1.76	4 0.76	7 1.19	8 1.12	5 0.55	5 0.40	1 0.06	10 0.30	6.14
Modified 4-lane bridge	10 2.20	7 1.33	10 1.70	8 1.12	8 0.88	10 0.80	8 0.48	8 0.24	8.75
New 4-lane bridge	9 1.98	9 1.71	9 1.53	8 1.12	8 0.88	10 0.80	8 0.48	8 0.24	8.74
New 5/6-lane bridge	6 1.32	10 1.90	8 1.36	8 1.12	6 0.66	3 0.24	5 0.30	7 0.21	7.11
4-lane Bored Tunnel	4 0.88	8 1.52	6 1.02	8 1.12	5 0.55	10 0.80	9 0.54	6 0.18	6.61
Brockton Point tunnel	3 0.66	2 0.38	1 0.17	8 1.12	1 0.11	2 0.16	9 0.54	5 0.15	3.29
Mid-Harbour tunnel	1 0.22	4 0.76	1 0.17	8 1.12	1 0.11	2 0.16	9 0.54	6 0.18	3.26

Problems and Limitations of the Study

It is important to note the problems encountered during the research and some limitations of the study at the outset. First, finding people who were willing to give time for an interview and who would answer the interview questions posed some problems. Several respondents declined to give time for an interview or refused to complete the interview due to time constraints or because they could not answer the questions. Second, given the sensitive and controversial nature of the Lion's Gate Bridge project certain people were unable or unwilling to speak freely in giving opinions for the study. Third, some private consulting firms were reluctant to be interviewed as they are in the process of making proposals for the bridge replacement contract and did not want to divulge any information. Consequently, the small number of interview subjects was determined by the respondents' cooperation. Fourth, the study faced the constant change of the alternatives

under consideration to replace the bridge. The ongoing uncertainty throughout the process as to which options were favoured was illustrated by the fact that several proposals were added and deleted from the government's list of preferred options. Although a short list of options was finalized in 1996, the government continued to entertain new proposals until April of 1997.

Despite these problems and limitations, the study managed to establish a practical range of alternatives and use a set of selected criteria to evaluate the choice process expressed by both public and private stakeholders over which among the options offered was preferred for the Lion's Gate Bridge.

To provide a brief account of the public involvement process on the Lion's Gate Bridge replacement we proceed to the next chapter, which examines the Choices Forum.

CHAPTER III

CHOICES AND PUBLIC INVOLVEMENT ON THE LION'S GATE BRIDGE REPLACEMENT

This chapter describes the Ministry of Transportation and Highways' Choices Public Involvement Forum for the Lion's Gate Bridge replacement from its inception to the government's decision. This description provides a background framework for explaining how public input contributed to the process of determining public preferences, narrowing the list of replacement options to nine, and an eventual decision on the fate of the Lion's Gate Bridge.

The chapter comprises three sections, one for each phase of the Choices Forum. Section one deals with the initial stage of the process and discusses what it accomplished and how it led into phase two. Section two deals with phase two, during which much of the public input for the Choices Forum was gained at nine public meetings and several mall displays. This section investigates the public input that was used to help reach a decision. Section three looks at how concerns and opinions that were expressed during the first two phases were addressed with a series of impact studies, information up-date sessions and a Community Focus Group report.

The end of phase three marked the completion of the Choices Forum. As a result of this three-year program, the Ministry compiled a package of information from which two or three options were presented to the government and recommended for further public and technical consideration pending a decision (Consulting engineer, Personal communication 1997).

Phase I – Provide Information

In July of 1993, the provincial government began a process of educating the public about the problems facing the Lion's Gate Bridge and some of the ideas being considered to replace it. A bridge condition report had recently concluded that the crossing would soon require some major structural improvements to ensure public safety (Buckland & Taylor 1993). The growing concern over the bridge's physical state led the Greater Vancouver Regional District to recommend that the Ministry of Transportation and Highways "... re-examine a broader range of alternatives for dealing with the Lion's Gate Bridge at that time" (Consulting engineer, Personal communication 1997). This range of options included ferry systems, rapid transit, and automobile crossings at First Narrows, Second Narrows and various alignments in between (BCTFA respondent, Personal communication 1997). Although the government publicly stated that everything was on the table, it was evident from the outset that the preferred option would not

vary from the present traffic patterns in Vancouver and on the North Shore, in addition to providing some enhanced facilities for transit, high occupancy vehicles, and cyclists and pedestrians. It would also be consistent with the policies set out in *Transport 2021* (*Vancouver Sun*, September 15, 1993).

As part of this phase, the public information center was opened in Vancouver's West End and four committees were formed by the Ministry, namely, the Community Focus Group, the Agency Liaison Committee, the Technical Support Group, and the Environmental Affairs sub-committee. These committees were briefed and provided with technical information by engineering consultants from N.D. Lea Consultants.

The local media gave the project a lot of attention at the time. This was highlighted by a four-page feature in the *Vancouver Sun* (September 15, 1993) which provided an excellent overview of the problem, the process and the options to help people make an informed decision. The nine options being considered which included private proposals and some from the Ministry of Transportation and Highways were:

1. Repair and maintain the bridge or the Do-nothing option
2. Rehabilitated bridge with three wider lanes
3. Modified bridge with four lanes
4. New four-lane bridge
5. New five or six-lane bridge
6. Brockton Point Crossing
7. Cut-and-cover tunnel on zoo alignment
8. Mid-Harbour crossing
9. Widen Second Narrows Bridge

Engineers from N.D. Lea gave presentations to more than twenty-four groups and agencies that requested information. Displays were set up in local shopping malls, municipal halls and at BCAA offices. To initiate the evaluation of alternatives Acres International published an option assessment report. This report provided the preliminary means of educating the public and was distributed to most local libraries around Vancouver.

Acres Report

In November of 1993, Acres completed an *Environmental and Social Overview of Lions Gate Crossing Options*. This report looked at the potential social, environmental and transportation impacts of various crossing alternatives in Vancouver, on the North Shore and in Stanley Park at an overview level. The environmental, social and transportation objectives were broken down into eleven categories. These were:

Environmental

1. Minimize park impacts
2. Enhance park entrance and aesthetics
3. Preserve foreshore habitats

Social

4. Minimize community disruptions
5. Minimize residential and commercial displacement
6. Improve pedestrian and cycle safety
7. Retain heritage value of bridge

Transportation

8. Retain current traffic patterns
9. Improve transit opportunities
10. Meet regional transport needs
11. Preserve Port operations (Acres 1993).

Although the report made no recommendations for a preferred alternative, it pointed out that the present alignment will create the fewest negative social and environmental impacts, tunneling under Stanley Park will have fewer environmental impacts than a surface causeway, and a dedicated transit lane will achieve *Transport 2021* objectives (Acres 1993).

Included in this report was a summary table that indicates whether or not the options achieve each of the eleven objectives with "yes" or a blank placed in each cell (Acres 1993, table 3.1). The crossing option that meets the most objectives is a new five-lane bridge (It achieved nine of the eleven objectives). Five of the options tied for second place by achieving seven objectives each, a modified four-lane bridge achieved six objectives and the Brockton Point and Mid-Harbour schemes finished last, each achieving five objectives. The Brockton Point scheme made it to the government's short list of nine while the Mid-Harbour plan and a widened Second Narrows Bridge were both eliminated. Both of these plans that were eliminated performed the poorest in terms of the transportation objectives but fared quite well in the other categories. Does this mean that transportation objectives are the most important? Since a weighting system was not used for the objectives it is impossible to rank the options. Nor is it evident to what degree the options achieve each objective. In fact, one of the study's recommendations is that weighted evaluation criteria be developed to assess the options (Acres 1993).

The Acres report gives some indication of how the alternatives perform, but feedback gathered from the public sheds some more light on the process leading to the final list of nine options. First, the city of Vancouver provided some important guidance to the Choices Forum.

City of Vancouver Conditions

During phase one, Vancouver City Council addressed the Lion's Gate Bridge Project at a March 31, 1994 meeting. The result was not a recommended solution, but a list of conditions for the Ministry to consider when making a decision. First, the city wanted the Ministry to:

Formalize a public process to review and discuss, with City Council, the Park Board and Vancouver residents, the Lions Gate crossing options, including public transit, ferry and rail options, prior to a final decision and to incorporate this feedback in their evaluation process (City of Vancouver 1994).

Regarding the crossing alternatives, council requested that the following options be excluded from the process:

1. Any options east of Brockton Point,
2. Any options that require a lot of filling in of Burrard Inlet,
3. Any options that provide additional peak direction capacity into downtown Vancouver for single occupant vehicles,
4. Any options that create negative impacts in Stanley Park and the West End (and that present impacts should be reduced), and
5. Any options that include tunnel portals that will result in disruptions to neighborhoods, the downtown core and the waterfront area.

The city of Vancouver also wants any option to provide crucial improvements to cycling, pedestrian and transit facilities, that a portion of toll revenues be dedicated to improving Stanley Park, and that the process be accessible to people who speak languages other than English (City of Vancouver 1994).

These conditions obviously eliminate the Mid-Harbour and Second Narrows crossings from consideration, and impose the necessity of a dedicated transit lane(s) on any five or six-lane options. Conditions four and five imply that a tunnel under Stanley Park is desirable but tunnel portals must not be disruptive. Although the idea of the Brockton Point alignment is not discounted, the island that is part of the proposed scheme is not acceptable to the city. An examination of the final list of options later in this chapter indicates that these conditions played an important role in the decision-making process.

The first phase of the Choices Forum ended with a series of four Open Houses held during March and April of 1994. Two meetings were held on the North Shore and two in Vancouver to initiate public debate and gather feedback on the options.

Open Houses

Each Open House began with presentations from engineering consultants about the problems facing the Lion's Gate Bridge. These were followed by comments from some members of the Community Focus Group and questions from the audience.

The public discussion and debate at the Open Houses followed a typical pattern, with a strong focus on how to improve our transportation system's ability to move people instead of cars. People were concerned that more cars using the Lion's Gate Bridge would cause neighborhood disruption in downtown Vancouver and that a crossing further east might cause disruption in North Shore neighborhoods. A common sentiment expressed by West End participants in particular was that the government was trying to solve the wrong problem. Despite the bridge's obvious structural defects, they felt that a much larger problem had to be dealt with, which should not include simply building a new wider and faster bridge with more than three lanes for automobiles. Many people concluded that rail or ferry transit between downtown Vancouver and the North Shore was the answer to improving congestion and pollution problems in neighborhoods around the bridge and in Stanley Park. Others recognized that the high cost of rail transit, a relatively small and spatially dispersed North Shore population, future low growth policies and rail transit priorities further east in Burnaby and Coquitlam make it unlikely that this mode of transport will be feasible in the near future.

Concern was also expressed over using the First Narrows corridor. Would traffic be better served on a different alignment? Some people felt that moving traffic out of Stanley Park and the West End would solve some of the community impact problems, while others thought that this might lead to serious negative impacts on current traffic patterns in Vancouver and on the North Shore.

After eight months of work, phase one of Choices was complete. Throughout this phase people were more interested in discussing broader issues such as cost, transit, Stanley Park and regional transportation rather than the best replacement option. Many people who expressed concerns at the Open House meetings were troubled because they felt that the government was pursuing alternatives for an improved automobile crossing and not seriously considering other options. There was also concern that the province was not adequately addressing potential community impacts, Stanley Park impacts and how the Lion's Gate Bridge should fit into the broader transportation system in Vancouver. All of this public feedback helped to focus the debate for the next stage of the process.

Phase II – Focus Debate and Hear Concerns

The first phase of Choices left little doubt that reaching a consensus on a preferred alternative or type of crossing would not be easy. In addition, members of the West End Traffic Committee criticized the process from the beginning, claiming that it was too narrow in focus and did not provide an opportunity for the public to participate in defining the problem. In order to entertain a wider range of choices and let interested people pitch their ideas for a solution, phase two was kicked off with a Proponents' Showcase at Robson Square in downtown Vancouver so the public could listen to all crossing proponents, debate the issues and ask questions.

Proponents' Showcase

The Proponents' Showcase began with a presentation from Jackie Pement, the former Minister of Transportation and Highways. The Minister outlined what had been learned during the Forum's first phase, namely, that people prefer solutions that improve public transit rather than accommodating single occupant vehicles, and stated that the second phase would continue with public education and stakeholder forums to help find a solution for the whole community. The Minister's speech was followed by an update on the bridge's current condition and problems from a representative of the engineering consulting group in charge of the project.

The rest of the meeting consisted of three segments. The first two segments entailed bridge and tunnel proposals from eight private engineering firms. The bridge schemes included four plans to upgrade the bridge and increase the number of lanes. One of the plans included a twin suspension bridge alongside a rehabilitated Lion's Gate Bridge. The others involved upgrading the present structure and increasing its capacity to either five or six lanes, with one or two transit lanes (Ministry of Transportation and Highways 1994a). The tunnel schemes comprised five plans on various alignments, four of which included six lanes (four general-purpose traffic lanes and two transit lanes, and one with provision for rail transit), and one for a four-lane tunnel.

The third segment was reserved for public proposals from individuals and some from companies. The focus of these schemes was more on people moving systems with improved public transit and providing more opportunities and incentives for people to leave their cars at home. These included several plans for rail transit, two ferry proposals and an idea for a gondola across the bridge.

Questions arose about how well the proposals would perform during a large earthquake and about funding alternatives for the more expensive options. Aside from these issues, the public feedback and line of questioning that followed the private group presentations tended to focus on

how the schemes would help to provide better transit service. Although the five and six-lane options included transit lanes, some people feared that these lanes would be turned over to general purpose traffic during off-peak hours, leading to much more capacity for single occupant vehicles and creating havoc on surrounding traffic patterns. Once again, the debate was directed away from what to do with the Lion's Gate Bridge, and towards a broader look at the transportation system (Lion's Gate Crossing Public Involvement Program *Proponents' Showcase* May 25, 1994).

To conclude the meeting, the Minister pointed out that the government was in fact looking at all the options, including improved transit and pedestrian access to the bridge. She realized that an open process was needed and that more public input was required to help reach a short list and a decision. To this end, the Minister announced that a series of stakeholder roundtables would be held in Vancouver and on the North Shore.

Stakeholder Roundtables

During June of 1994, four stakeholder roundtables were held (two in Vancouver, one in West Vancouver and one in North Vancouver) to gather more public input on the crossing options. Given the results of previous public meetings, there appeared to be no groundwork laid for reaching a consensus on what should be done as the public seemed uninterested in discussing bridge and tunnel options.

Each meeting began with an up-date on the bridge's physical state from a representative of Buckland and Taylor, the structural engineering firm in charge of monitoring the bridge's condition. Next, representatives from the Ministry presented the various bridge and tunnel schemes under consideration and a sample of the costs of some options. Following this was an overview of the Choices Forum and the criteria used to narrow the options presented at the Proponents' Showcase. These included:

1) Crossing and Approaches Meet Basic Transportation Function

- Compatible with existing north and south shore traffic systems.
- Compatible with *Transport 2021* strategy ("four or five lane bridge with reversible bus lane).
- Consistent with direction of *Going Places* and *South Coast Transportation System Plan*.

2) Crossing and Approaches Meet Community Values

- Provides net environmental gain for Stanley Park.
- Minimizes commercial and residential property impacts.
- Has potential for negotiated settlement with First Nations.

- Minimizes impact on Port of Vancouver operations.

3) Crossing and Approaches Risks are Manageable

- Reasonable potential for public acceptance.
- Reasonable possibility for satisfying Federal Environmental Review.
- Reasonable potential for successful land and Stanley Park negotiations.
- Constructability and cost uncertainty not too high. (Ministry of Transportation and Highways 1996)

4) Cost

- Must provide value for money (Lion's Gate Crossing Public Involvement Program *Stakeholder Roundtable* June 1, 1994).

Following the government presentations, the eight panel members briefly outlined their positions. These positions were often hotly debated amongst the panel members, and the audience as well. Briefly, the groups' positions were:

1) *Lower Capilano Steering Committee*- The group represents 9000 people in North Vancouver that are affected by the crossing project. The group is aware of the structural problems afflicting the bridge and feels that they must be fixed now. However, they do think that a better transit system is needed to help reduce single occupant vehicle traffic throughout the region.

2) *The West End Traffic Committee*- The West End group has been consistent in criticizing the Choices process. They feel that the public should have had more input from the beginning to properly state the problem and set acceptable limits for community, environmental and economic impacts. Along with regional air quality and livability in their neighborhood, the group is concerned that only automobile solutions are being seriously considered in the Choices process. They prefer funding priority to be given to public transit, that Stanley Park be protected, that neighborhoods be preserved and that the bridge be retained for cyclists and pedestrians.

3) *The Downtown Vancouver Association*- Representing downtown business interests, this groups feels that traffic into Vancouver's core should not increase, that the solution should be part of the regional transportation system and that the mid-harbour alignment should be used instead of First Narrows to better serve regional transportation. The group feels that a mid-harbour crossing that allows traffic to bypass downtown and has a rapid transit component, along with the retention of Lion's Gate Bridge is the best long term solution.

4) *Cycling BC*- The cycling group is bothered by the unsafe cycling and pedestrian facilities on the bridge. They see this as a deterrent to more people cycling across Lion's Gate. If a

tunnel is built, the group wants the bridge retained for cyclists and pedestrians. If a new or refurbished bridge is chosen they want wider and safer lanes.

5) *The Friends of Stanley Park*- This group wants nothing less than to eliminate at-surface automobile traffic through Stanley Park. They feel that building the causeway in the park was a terrible mistake that must be corrected. Although they realize that the financial costs of 'rescuing' the park are high, they deem those costs to be justifiable.

6) *BC Transit Bus Driver*- This participant uses the bridge several times daily and finds the safety conditions quite troubling. The main safety problems he perceives are: excessive speed on the bridge, narrow lanes, high and uneven curbs, poor drainage, proximity of the roadway to sidewalks, large vehicles using the middle lane, sharp curves at approaches, motorists running red lights and insufficient law enforcement on the bridge.

7) *Resident of Ambleside (West Vancouver)*- The current traffic levels on the bridge and in surrounding neighborhoods are perceived to be excessive and more automobile capacity on the bridge is not desirable. He prefers better transit as a means of discouraging automobile use, which can be accommodated on a three-lane bridge with a four-lane Stanley Park causeway. Present levels of demand do not justify rapid transit but he believes it will be necessary in the future.

8) *Two 'typical' North Shore commuters*- Both commuters use their car to get to and from work in downtown Vancouver and both feel that the present transit system is not fast or reliable enough to convince them to use it. They feel that until a much better transit system is in place, few North Shore commuters will be willing to abandon their cars.

The debate at the first two roundtable meetings clearly highlighted the different opinions amongst the stakeholder groups. As expected, the West End group stated strong opposition to crossing options that accommodate automobiles and felt that little attention was given to environmental and social costs. The heavy traffic that threatens their neighborhood is perceived to only get worse with a wider bridge or tunnel. There was little sympathy or tolerance for North Shore commuters who use their neighborhood as a downtown bypass to reach other destinations in the city. They strongly believe that people should rely more on transit than cars, and that transit solutions should be the focus of the Lion's Gate replacement project. Consequently, they want the government scrap the current process and start over by letting the public have input from the beginning, in formulating the statement of the problem.

Some of the North Shore participants objected because there are presently no good transit alternatives to the automobile. They find transit too unreliable and inefficient to switch from their cars. In fact all stakeholders agreed that transit should be a priority instead of increased

automobile capacity. The focus of debate tended to be that most North Shore commuters are unwilling to switch to transit until a better system is in place.

Questions from the audience stressed the public's preference for improved transit over increased car capacity. Both the North Shore and Vancouver meetings resulted in more discussion on broader transportation issues, including transit, than on the Lion's Gate Bridge options. People seemed quite aware of the negative consequences of providing ever increasing automobile capacity, citing pollution problems in Los Angeles as an example. There seemed to be general agreement that the best way to avoid these mistakes in Vancouver is to pursue transit options.

At the third roundtable, there was continued emphasis on transit, both from the stakeholders and the public. However, at this meeting, there was considerable discussion on preventing negative impacts in Stanley Park, getting on with the decision-making before further deterioration occurs on the bridge, and potential negative impacts on the North Shore.

By the final roundtable meeting, it was clear there would be no unanimity on an option or alignment. Because of the nature of the meetings, with opinions being so far apart on many issues, and the exclusion of rail or ferry transit options for consideration, consensus was highly unlikely. The West End group once again denounced the whole process for its lack of meaningful public input and narrow range of options. Another stakeholder made the point that the focus of the process should be on the bridge, since it is nearing the end of its service life.

To conclude this series of public debate sessions, the panel members were asked to comment on the issues where they felt a consensus had been reached. There was no agreement on bridges or tunnels, the desired number of lanes or a preferred alignment. This is undoubtedly because the debate lacked sufficient discussion about these issues and the options under consideration, as other issues dominated every meeting. In the end, consensus was only reached on improving the transit system, that the alternative should be a part of the regional transportation system and that Stanley Park must be protected (Ministry of Transportation and Highways 1994a).

Conclusion

After four open houses, a proponents' showcase and four stakeholder roundtables some valuable insights into public choice had been gained. Aside from the strong support for transit, people were clearly unwilling to accept options that would:

- significantly increase automobile capacity (especially for single occupant vehicles),
- damage Stanley Park or,
- disrupt neighborhoods.

Some participants were convinced that the government had already made a decision to build a wider bridge and that concerns about social and environmental impacts were not going to be addressed. This fear was likely fueled by the fact that some of the engineers involved openly supported a new five or six-lane cable-stayed bridge and that the options under consideration had not changed to include rail or improved ferry transit, even though they were clearly desirable. In order to address the public's concerns, the government embarked upon a series of social and environmental studies to evaluate the options. In addition, BC Transit conducted feasibility studies for rail, ferry and bus transit options between Vancouver and the North Shore.

Up to this point the public meetings for the Choices Forum had only been held in areas near the Lion's Gate Bridge. In order to gather feedback from people in other areas who are not directly impacted by the crossing decision but still have an interest in the outcome, five information drop-in display meetings were held in Vancouver and on the North Shore¹ (Ministry of Transportation and Highways 1994c). During the summer of 1994, these displays were set up close to major routes that lead to the bridge.

Drop-In Information Displays

Each drop-in center was open from 2pm to 8pm, with representatives from the Ministry of Transportation and Highways, N.D. Lea Consultants, Buckland and Taylor, and the manager of the public information center on hand to answer questions. Information was available on the Choices Forum and some of the private proposals, and there were comment sheets for people to fill out and submit at the meeting or to mail-in later. To advertise the times and locations of each meeting, ads were placed in local newspapers and invitations were dropped in mailboxes near the meeting locations.

Although some of the displays had large turnouts, the number of comment sheets submitted at the meetings was somewhat small. Most people chose to fill in the comment sheets later and mailed or faxed them to the information office. Due to small numbers it is not possible to make general conclusions from these comments. In addition, because of the open-ended nature of the responses on the comment sheets, they are not in a form that allows statistical analysis. The comment sheets provided space for people to express concerns and preferences, but not necessarily for any specific option. For example, one of the categories used in the summaries was "Unspecified tunnel (4 or more lanes)" (Ministry of Transportation and highways 1994c). This category obviously includes all four, five and six-lane tunnels on any number of alignments,

¹ The dates and locations of these meetings are listed in the Works Cited section.

some of which are private proposals, which have separate categories of their own. Due to these problems, only a qualitative analysis is possible. This section will discuss some interesting findings by examining the patterns of comments from the drop-in displays, and will end with a discussion of a tabulation of 660 comments that were submitted to the Lion's Gate Public Information Center.

Findings from Drop-In Centers

An examination of the comment sheets from the drop-in centers yields some interesting findings. First, one notices a difference from the previous meetings that were held in areas adjacent to the bridge, namely, the comments focused less on transit than at the open houses and stakeholder roundtables. Although there was considerable support for improving transit, with designated lanes or a rail link to the North Shore, other issues received equal attention.

Protecting Stanley Park from further damage was a major public concern. Reducing current levels of air and noise pollution in the park by replacing the causeway with a tunnel was generally seen as desirable. Some respondents pointed out that we need to consider the long term impacts of a surface causeway through Stanley Park and not just financial costs. Most people were aware that building a park tunnel would dramatically increase the cost of the project. Although some felt this extra cost was unjustifiable, others thought a park tunnel was the only sensible solution. Overall, it was apparent that people felt the park should be an important factor in the decision-making process.

Despite the small number of comments, it appeared that tolls were more acceptable to respondents at the Vancouver meetings than on the North Shore. Many of those who favoured tolls realized that in order to get an improved crossing or one that will protect Stanley Park, tolls will be necessary. Although more people opposed tolls than favoured them on the North Shore, there is some indication that they would be more socially feasible if tolls were charged on all bridges in Greater Vancouver.

It is impossible to determine which proposal was most preferred, or even whether a bridge or a tunnel was preferred because the comments were so open-ended, with most responses falling into the "New bridge (4 or more-lanes)", or the "Unspecified tunnel (4 or more-lanes)" categories. Overall, there was nearly equal support for bridges and tunnels, but it appears that the people at these meetings want to see some improvement on the crossing with at least four lanes. Despite their drawbacks, the drop-in centers provided some indication of how the public feels about the bridge project.

Tabulation of Public Concerns Received at Public Information Center

In order to gain a better understanding of public choice it is useful to also examine the comments submitted by 660 people to the Lion's Gate Public Information Center between July, 1993 and June, 1994. Although the individual comment sheets that were filled out were not available, a tabulation of the results was done. These should be helpful in providing some insights into choice. Of the 660 submitted sheets, seventy-seven requested information or could not be categorized as favouring any particular option.

After looking at the numbers, it is obvious that no clear consensus emerges for any one option. Nor is there any indication as to whether a bridge or tunnel is preferred. Most comments were focused on the plan for a new bridge or "unspecified tunnel" as opposed to specific options submitted by private proponents. A new four or more lane-bridge and a four or more-lane tunnel were each favoured by approximately 120 people. This was not new news as even in 1993, the government was aware of the 50-50 split between bridges and tunnels (*Vancouver Sun*, September 15, 1993). In addition some 150 people expressed interest in retaining the present bridge for cyclists and pedestrians. Judging from the comments submitted at the Drop-in centers, it may be fair to assume that many of these people also favoured a tunnel.

These results make it difficult to determine which alignment and type of alternative is preferred, because of the broadness of the comments. Even the "rehabilitated bridge" option, which was favoured by seventy-four people, is not specific about number of lanes. The only private proposal that received any real support was the Bentzen scheme². The comments from the drop-in centers indicated that most people who favoured this scheme thought that it was the best option financially, because it would be financed by selling real estate on an island built with tunnel spoil, leaving no debt and no tolls. Some people also felt that the additional land on the island was badly needed in downtown Vancouver (Ministry of Transportation and Highways 1994b).

Of the one hundred people who commented on tolls, nearly seventy approved of tolls, and another thirteen approved if the tolls were two dollars or less. Only fifteen people who submitted comments were opposed to a user pay system on the bridge. This may provide some limited insight into the social feasibility of tolls on the Lion's Gate Bridge, but one can not help but wonder how representative these respondents are and how often they use the bridge. If most of them do not use the bridge regularly and would not be repeatedly taking the financial hit from

² It should be pointed out that the Brockton Point alignment (the alignment which the Bentzen scheme follows) also received a fair amount of support.

a toll, there is probably little reason to oppose them. Obviously few people would want their tax dollars to pay for something they will rarely use. Additionally, it was apparent from the open houses and stakeholder roundtables that many people would only favour tolls if they were charged on all other crossings in the Lower Mainland. The tabulated responses lack this information and make the usefulness of these data on the acceptability of tolls questionable.

As for transit, slightly more than one hundred people indicated a desire for better transit. Just over half of these responses were in favour of rapid transit. The rest preferred a dedicated transit lane.

It appears from the responses that most people want some improvement to Stanley Park either by removing traffic, tunneling in the park or not widening the causeway. This is consistent with the feedback received from other meetings. The public seems unwilling to accept an option that will cause harm to or damage the park. Whether or not the majority will be willing to pay for it is not clear from these data.

The Short List of Nine Options

As anyone who has followed the Lion's Gate Bridge project knows, the list of alternatives under consideration has changed throughout the Choices Forum. The original list, discussed in chapter one and the first section of this chapter, evolved into the government's short list of nine alternatives. The list includes:

1. Repair and maintain or the Do-nothing option
2. Rehabilitated three-lane bridge
3. Modified four-lane bridge
4. New four-lane bridge
5. New five or six-lane bridge (with one or two transit lanes)
6. Bored tunnel along the existing alignment
7. Bored tunnel to Capilano Road
8. Cut-and-cover/immersed tube tunnel on the zoo alignment
9. Immersed tube tunnel on the Brockton Point alignment (Ministry of transportation and Highways 1996).

Several factors led to the creation of this list. First, in addition to the criteria used to reduce the number of options, a provincial representative notes that the feedback gathered from the open houses and stakeholder roundtables played a major role in narrowing the alternatives and reaching a decision (BCTFA respondent, Personal communication 1997). A lot of people have questioned this because transit options received overwhelming support but were dropped from consideration quite early in the process. However, the exclusion of rail and ferry transit is explained by a *North Shore Transit Options Report* conducted by BC Transit (1994). The study

concludes that high costs, present and future ridership, little travel time savings and modest North Shore population growth make both ferry and rail transit options to the North Shore unfeasible. The only transit improvement BC Transit feels is worth pursuing is an enhanced bus service that can be accommodated on a four, five or six-lane crossing (BC Transit 1994). Although the options do not reflect the public's desire for transit, the list addresses a few of the major concerns from the meetings, namely that Stanley Park be protected and no significant increase in single occupant vehicle capacity.

Additional input came from the bridge and tunnel expert review panels who evaluated the technical feasibility of the private proposals. In fact, it was made clear from the beginning that any option would have to be proven technically feasible before it would get consideration from politicians (Consulting engineer, Personal communication 1997). This appears to have eliminated ideas from people with no engineering background or with no access to such expertise who submitted proposals. The reports concluded that aside from some technical issues to be addressed, the private submissions were viable (Bridge Expert Review Panel 1994; Tunnel Expert Review Panel 1994).

Finally, the city of Vancouver appears to have provided some of the most crucial input to narrowing the list of alternatives. According to a 1996 Vancouver City Council Administrative Report, all of the city's conditions that were submitted to the Ministry in 1993³ had been implemented in the Choices Forum (General Manager of Engineering Services 1996), meaning the elimination of Mid-Harbour and Second Narrows options.

After examining the two lists, one will notice that the only changes from the original list are that the Mid-Harbour and Second Narrows options were eliminated and that two bored tunnel options near the existing alignment were added. This is perhaps because the lengthy attack waged against both the original list (for not including transit options) and the process (for not seeking public input from the outset) lacked enough strength to change either during the public meetings.

With its short list of nine options in hand, the government set out to address some of the questions raised during phase two and evaluate the alternatives with a series of studies which would lead to a shorter list of options and an eventual decision.

Phase III – Address Concerns with Results of Studies

The services of several consulting firms was called upon to investigate the potential impacts of the nine options. Although many of the studies address public concerns expressed

³ See page 37 for City Council conditions.

during the previous phase, the breadth of the environmental portion is intended to satisfy the requirements of the Canadian Environmental Assessment Act (CEAA) (Ministry of Transportation and Highways 1995b). These include studies on:

Environmental

- Air Quality
- Noise
- Vegetation
- Aquatic
- Wildlife
- Socio-Economic
- Soils and Drainage
- Archeological and Heritage

Technical

- South Shore Traffic Impact Study
- Ventilation Requirements for Tunnel Options
- Vehicular Laning Alternatives
- Constructability and Costs of Options
- Lion's Gate Bridge Condition Survey
- Lion's Gate Bridge Seismic Assessment
- North Shore Marine Connections

The studies were made available for public viewing at the Lion's Gate Crossing information center, at local libraries and at six public information update sessions held in November of 1995.

Information Up-Date Sessions

In order to keep people up-to-date on the project and to gather feedback on the study results, six meetings were held on the North Shore and in Vancouver. The format of the information update meetings was much like that of the Open Houses. The public could study the material throughout the day and watch the *Choice of Crossings* video, which outlined the process leading to a decision (McIntyre & Mustel 1994). Even with representatives from the Ministry of Transportation and Highways, N.D. Lea Consultants and two information officers present to answer questions, turnouts were smaller than anticipated and there was little media attention given to the meetings or study results.

Four meetings were held in Vancouver and two on the North Shore. As might be expected, the comments and questions expressed at the meetings reflected local concerns. For example, the West End meeting was dominated by criticism of the South Shore Traffic Impact

Study for alleged inaccuracies in the reported West End traffic volumes, and cyclists expressed concerns about how they would be accommodated on a new or enhanced crossing. Finally, a Stanley Park tunnel received quite a bit of support because of positive park impacts (Corporate Strategies 1995).

The two North Shore meetings focused on how the options would affect traffic on local bridge approaches (especially on Taylor Way and Capilano Road) and how the bridge would be connected with the Upper Levels Highway. Like at the Vancouver meetings, a Stanley Park tunnel received a lot of support on the North Shore. Many North Shore residents who came to the meeting wanting extra crossing capacity changed their minds after hearing how it would negatively impact downtown Vancouver (Corporate Strategies 1995).

The other three meetings were held in areas of Vancouver that are not particularly close to the bridge. These sessions tended to draw smaller crowds and generally had a different focus. Many people felt that the decision-making process had dragged on too long and that a choice must be made now. Also, the bridge's heritage value seemed to be more important to people in areas further from the bridge. Like at the other meetings, there was some agreement that a tunnel should replace the Stanley Park causeway (Corporate Strategies 1995).

The Information update sessions did not provide a clear picture of what option people wanted; for example a bridge or tunnel. They did, however, highlight some key public concerns that helped in the decision-making process. For example, throughout the meetings it was obvious that Stanley Park was of chief importance. Most people felt that the park must be protected in some way, regardless of the cost. With so much concern over the park, one might conclude that a park tunnel was the most socially desirable idea. Although no agreement was reached on a specific option, it appears that the idea of a four-lane crossing on the present alignment with the possibility of a transit lane generated the most support (Corporate Strategies 1995).

Toward the end of phase three the Community Focus Group submitted a report to the Ministry outlining its recommendations for a crossing solution. A brief summary of the contents of the report follows.

Community Focus Group Report

This twenty-member group represented a broad range of community interests from Vancouver and the North Shore whose mandate was:

1. To provide a cross section of community perspectives on the issues related to the Lions Gate crossing replacement process;
2. To help define and provide feedback on the range of realistic alternatives available for the crossing;

3. To assist in identifying specific community concerns associated with each of these alternatives, and
4. To suggest appropriate means of securing additional community input to the planning and development process. (Ministry of Transportation and Highways 1993)

The Community Focus Group met seven times. The members reviewed all relevant material that was available to the public and heard presentations from specialists from technical, environmental, traffic, transit, proponent and community input backgrounds (Griffiths 1995). Their recommendations were based on consideration for transportation, environmental and social needs, outlined in the *Transport 2021*, *Going Places* and *Livable Region Strategy* reports and from the members' input and experiences from the first two phases of the Choices Forum. When the group's process began, they created a list of fifteen community priorities to evaluate the alternatives that would help reach a conclusion. These were:

- Meets basic transportation system needs
- Serves current traffic patterns
- Opportunity for enhanced public transit
- Provides Stanley Park enhancements (net benefit)
- Minimizes environmental impact
- Expands opportunities for cyclists
- Meets needs of pedestrians
- Improvement provides value for money (worth toll rate)
- Minimizes disruption of established neighborhoods
- Meets regional transportation policy
- Can be built in an appropriate time frame
- Minimum risk (cost/construction/time for approval)
- Private sector investment opportunities
- Improves capacity for passenger cars
- Built without significant disruption of traffic flow (Griffiths 1995, app. 1)

After two rounds of voting, the group made its recommendations. First, the Brockton Point and rehabilitated four-lane crossings were eliminated from further consideration in a 1993 vote due to negative impacts. Subsequently, during the group's 1995 vote nearly all members agreed that the present alignment was the best. In addition, the vote excluded the Brockton Point and Capilano corridors because of "... cost, community and environmental impacts and reaffirmed previous conclusions that any corridors further to the east do not serve basic transportation system needs and traffic patterns" (Griffiths 1995). As one member put it, alignments further east of the present one drag traffic across both the North Shore and East Vancouver where congestion problems already exist; hence this only creates new dilemmas (Community group representative, Personal communication 1997). As for a crossing, their preferred option is a new four-lane bridge with a transit/HOV lane. A new four-lane bridge was

second. The report notes that despite consultant studies that dismiss the need for a dedicated transit lane on the crossing at this time, some members were not convinced that future transit requirements could be served on a four-lane crossing, therefore they included the extra lane (Griffiths 1995). Finally, although the group's preferred option in Stanley Park is an at-surface route, several members do support a tunneled causeway or a combination of a surface and tunneled scheme through the park (Griffiths 1995).

The report concludes by pointing out that the extensive membership input offered five points to be considered in the decision making, that may not be captured in the recommendations. These include an increasing need to address bridge safety, the desire to procure net benefits for Stanley Park, the possibility to provide the First Nations with a share of the revenues from any public/private partnership, provide better facilities for cyclists and pedestrians, and to consider the future transportation requirements across First Narrows and the rest of the region (Griffiths 1995). These points also reflect some of the concerns from the stakeholder roundtables.

One of the Community Focus Group's mandates was to suggest ways to obtain additional community input to help in the decision-making process. The only reference in the report to this was one sentence stating that the group hoped that the feedback already gathered would "... provide a documented file that will expedite any regulatory reviews" (Griffiths 1995). One would assume this means that the membership felt no further public input was required for an informed decision to be made. Consequently, the government has sponsored no public input meetings since phase three concluded, shortly after the release of the Community Focus Group report. However, public consultation continues with one on one meetings between representatives from government and forty to fifty stakeholder groups. It is hoped that this approach will yield better input about community concerns than large public meetings where both sides might not be as open to good discussion (BCTFA respondent, Personal communication 1997).

The Government's Decision

The Choices Forum ended in 1995. A lot of public input was gathered, several technical studies were completed and a short list report from the engineering consultants managing the project was submitted to the Ministry. Together this information formed a package that was used to make decision that would be put to the government (Consulting engineer, Personal communication 1997). Although this decision was supposed to have been announced in 1995, it was delayed several times. After the 1996 British Columbia election, the NDP government revealed that instead of an expected budget surplus there was a hefty deficit on provincial books. This led to a capital-spending freeze that delayed the construction of many projects, including the

Lion's Gate Bridge. Since construction was delayed the decision was also put on hold. By early 1997 the province loosened the tight reigns on capital spending but the necessity to limit large expenditures remained. In an effort to pursue badly needed infrastructure improvements, while not contributing to the debt, the provincial government began venturing into public-private partnerships in order to share costs. The Lion's Gate Bridge became one of these projects in April, 1997 when the province announced it would contribute a maximum of seventy million dollars of taxpayers' money to the project, which would finance an enhanced three-lane bridge. Any additional improvements would have to be paid for with private sector money. These costs would then be recovered with a toll on the crossing. In a news release the Minister of Transportation and Highways, Lois Boone, stated she was seeking bids for a crossing that met the following conditions:

- The new crossing is to follow the existing First Narrows alignment from Marine Drive in North Vancouver to Georgia Street in Vancouver.
- Four lanes of traffic, two northbound and two southbound, but with surface traffic through Stanley Park reduced or eliminated.
- No net detrimental effect on Stanley Park.
- A plan to reduce traffic impacts on the West End
- The province will invest up to \$70 million over five years, which is the same amount as would be spent on a three-lane rehabilitation.
- Additional costs are to be financed from tolling revenues. (BCTFA 1997a)

This clearly shows the government's commitment to improve the Lion's Gate Bridge but not to pay for it. Was this a good decision? Public reaction has been less than favourable, especially from North Shore municipalities who do not want their residents singled out to pay a toll. The provincial government has stated that it would pursue the three-lane rehabilitation option if local governments do not reach a consensus on the more expensive alternative, but amid strong opposition from municipalities the province appeared ready to proceed with the four-lane option.

This chapter concludes with a discussion of the government's announcement in the context of the Choices Forum and 'post-Choices' data that were collected.

Discussion

There has been no shortage of critics of the Choices Forum that led to the Lion's Gate Bridge decision. As one Vancouver politician put it, many people feel that, "... if the process had just been properly conducted, it would have come to a proper resolution. Since it didn't, let's go back and criticize the process that got people to that point, to that point of view" (Vancouver politician, Personal communication 1997). He also suggests that people would be equally dissatisfied if no process had been conducted and the same result was reached. Some people have

argued that the process was not responsive to public desires, because it did not include transit options, or that a new bridge was in the cards from the beginning. Although these statements might be true, an examination of the material presented here clearly shows that a great deal of public input was sought and that the government's decision, at least in part, is not that bad.

A four-lane crossing on the present alignment with a Stanley Park tunnel, although not everyone's preference, appeared to be quite socially feasible after Choices. The Acres and Community Focus Group reports both concluded that the present alignment was the best, while no alignment was agreed upon at the public meetings. From the Open Houses and Stakeholder Roundtables it was clear that some groups would find a wider bridge unacceptable (Five and six-lane options were especially unacceptable) and that Stanley Park should be protected with a tunnel or alignment outside of park. On the other hand, the comment sheets submitted indicate a desire for an improved crossing with at least four lanes, as do the Acres and Community Focus Group reports. Even the conditions set out by the city of Vancouver suggest that they find the four-lane crossing/park tunnel combo acceptable.

Early in the process, a distrust developed between some public groups and the government over the fact that rail and improved ferry transit options would not be part of the solution. Underlying this conflict was the fact that the government was attempting to solve a structural problem on the bridge when a lot of other people wanted to solve broader transportation problems, such as single occupant vehicle use by providing a better transit options like rail or expanded ferry service. The public desire in Vancouver to reduce reliance on the automobile is not unique to this project. The *City Plan* process and *Clouds of Change* (City of Vancouver 1990) report both point to a growing public determination to consider broad transportation issues such as improving the region's transit system, reducing automobile use and improving air quality. Nonetheless, building a Skytrain extension or improving the ferry system were not objectives of the Lion's Gate project. However, maintaining consistency with *Transport 2021*, *Going Places* and local municipal plans was cited time and again as an important guide to reach a decision. None of these reports and plans indicate that rapid transit or ferries are needed to serve North Shore transit needs in the short or long term. The *Going Places* report only points out the need to implement "HOV and bus priority measures into any replacement or refurbishment of the Lions Gate Bridge" (British Columbia Transportation Financing Authority 1995). *Transport 2021* findings suggest that more single occupant vehicle capacity is not needed across Lion's Gate Bridge, and that a four-lane crossing or five lanes with one for transit is preferred (Ministry of Transportation and Highways 1993). The government decision is certainly consistent with *Transport 2021* recommendations but does not include the transit lane endorsed in *Going Places*.

Further, regional growth plans predict relatively slow growth on the North Shore (GVRD 1996) and local plans do not encourage or provide for population densities required for rail transit. Given these circumstances, transit options other than a bus-based system were doomed from the start.

Overall, the public input from the Choices Forum suggests that a four-lane crossing and a Stanley Park tunnel are quite acceptable. Still, there has been a lot of public and political backlash to the announcement because a toll will be charged on the crossing. Tolls on the Lion's Gate Bridge are not new. From the time the bridge opened in 1938 until it was paid for in 1963 tolls were collected. Tolls have also been discussed for this project since Choices began in 1993, and it was not until the announcement was made that local municipalities voiced such strong opposition to a tolled facility. To respond to the relentless objections to tolls, the government has cited a public opinion survey about the project that was conducted just before the decision was announced.

Viewpoints Research interviewed fifteen hundred Lower Mainland residents by telephone during January and February, 1997. People were asked several questions regarding the Lion's Gate Bridge replacement, including how they felt about tolls. One of the key findings from the survey was that seventy-two percent of respondents favoured tolls to pay for the crossing. In addition, sixty-four percent of North Shore residents were found to prefer tolls (BCTFA 1997b). Although the government feels that these numbers suggest that most people do not oppose tolls on the crossing, a closer examination casts some doubt on how the data have been interpreted.

After scrutinizing the poll results one notices that only eight percent of the interviewees use the bridge "everyday" or "a few times a week" (BCTFA 1997b, 11). All others (Ninety-two percent of respondents) claimed they use the bridge, at most, a few times a month. Can these people be considered regular users? Out of the sample, some sixty-two percent are not bridge users at all and a large portion of the rest really do not use the bridge all that often and thus would not have to pay \$1000 per year in tolls that an everyday user would, assuming a two dollar toll (BCTFA 1997b).

The results show that sixty-four percent of North Shore respondents favour tolls over other financing options like increased taxes. But, some sixty percent of these respondents use the bridge, at most, a few times a month, meaning that less than half of the North Shore residents polled in this survey use the bridge everyday or even a few times a week (BCTFA 1997b). Knowing this, one can probably conclude that those who do not use Lion's Gate Bridge a lot, even on the North Shore, prefer tolls to pay for its replacement instead of more taxes from their pockets.

In response to this opinion survey, the North Vancouver Chamber of Commerce conducted a poll of Lion's Gate Bridge users to see how they felt about tolls. The results of the nine hundred questionnaires that were handed out to motorists on the bridge are quite different from the results of the government's poll with eighty-seven percent of respondents being opposed to having to pay a toll on the Lion's Gate Bridge (*Vancouver Sun*, November 13, 1997).

This divergence in opinion polls may not come as a surprise. People who will not use the crossing a lot have no reason to oppose tolls and every reason to support them. Who would want to pay for something they got little use out of? On the other hand, people who use the bridge frequently are more apt to oppose tolls. They argue that no other crossing in the region is tolled so neither should Lion's Gate Bridge (North Shore politician, Personal communication 1997).

The government's announced preference for a four-lane bridge is both good and bad, depending on one's perspective. For the traveling public, a four-lane bridge with a park tunnel may well be the most acceptable crossing option, while for North Shore commuters, a toll may be the most unacceptable financing option. The decision-making process leading to the Lion's Gate replacement has been lengthy and often frustrating for those involved. In 1993, stakeholder groups, consultants and public participants were herded into public meetings to help find a suitable solution. Everyone knew then that the bridge was in bad shape and needed to be dealt with immediately. Now, some five years later, the bridge's two concave arches and three narrow lanes still hover over Burrard Inlet.

To probe deeper into the decision making process, the next chapter presents an in-depth examination of the case study interviews of the perception and choice of alternatives by public and private groups.

CHAPTER IV

PERCEPTION AND CHOICE OF ALTERNATIVES BY PUBLIC AND PRIVATE GROUPS ON THE REPLACEMENT OF THE LION'S GATE BRIDGE

This chapter examines the role which perception and choice of alternatives plays in the consideration of the range of alternatives to replace the Lion's Gate Bridge by both public and private groups. The discussion is organized in two parts. Part one, which comprises the public groups, is made up of case interviews with respondents from eight groups. Part two, which focuses on the private groups, covers the case interviews with respondents from five private consulting firms. Together the two groups make up thirteen case studies to provide insight into the choice process¹.

Public Group Case Studies

The eight case studies that make up the public group are:

1. British Columbia Transportation Financing Authority (BCTFA)
2. Vancouver Parks Board
3. Friends of Stanley Park
4. Lower Capilano Steering Committee
5. City of Vancouver
6. District of North Vancouver
7. City of North Vancouver
8. District of West Vancouver

Case One - BCTFA Respondent

The British Columbia Transportation Financing Authority (BCTFA) is a Crown Corporation that was formed in 1993 with the purpose "to plan, acquire, construct, improve or cause to be constructed or improved transportation infrastructure throughout British Columbia and to do such other things as the Lieutenant Governor in Council may authorize" (BCTFA Web page, 1998). On the Lion's Gate Bridge project, the BCTFA is responsible for finding innovative financing solutions and is presently working with public and private groups in order to find a suitable bridge replacement.

As shown in Table 4, the interviewee's preferred alternative is a modified four-lane bridge, but it emerges as only slightly more favorable than a new four-lane bridge. Although he perceives both options to be quite technically feasible he thinks that a new bridge built from

¹ The "Repair and Maintain bridge" alternative in the decision matrices is referred to as the "do-nothing" option in the discussion.

scratch will perform better with standard width lanes. However, he perceives the five or six-lane bridge, and a mid-harbour crossing to be even better technically than the four-lane options. He dismisses the bored tunnel and Brockton Point tunnel as unfeasible technically, and thinks that rehabilitating the bridge to three lanes does nothing for current safety problems. Further, just maintaining the current bridge is no longer a viable option given its structural condition.

In his opinion, both four-lane bridge alternatives are equal in terms of gains and losses, but they are not the best. He perceives more gains with a five or six-lane bridge, such as faster travel times in both the peak and non-peak directions. Even if there are benefits to building the tunnel options, their extremely high costs make him skeptical of their economic feasibility. For example, although a four-lane bored tunnel on the current alignment has similar benefits to the four-lane bridge options, its costs make it unfeasible

Table 4. Completed Matrix by BCTFA Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	1 0.22	1 0.19	1 0.17	4 0.56	3 0.33	5 0.40	6 0.36	5 0.15	2.38
Rehab 3-lane bridge	2 0.44	2 0.38	5 0.85	6 0.84	6 0.66	5 0.40	6 0.36	5 0.15	4.08
Modified 4-lane bridge	6 1.32	6 1.14	8 1.36	8 1.12	5 0.55	8 0.64	8 0.48	7 0.21	6.82
New 4-lane bridge	8 1.76	6 1.14	5 0.85	7 0.98	5 0.55	8 0.64	7 0.42	10 0.30	6.64
New 5/6-lane bridge	10 2.20	8 1.52	8 1.36	1 0.14	1 0.11	3 0.24	3 0.18	10 0.30	6.05
4-lane Bored Tunnel	5 1.10	3 0.57	2 0.34	5 0.70	5 0.55	8 0.64	3 0.18	5 0.15	4.23
Brockton Point tunnel	5 1.10	3 0.57	1 0.17	1 0.14	1 0.11	4 0.32	2 0.12	5 0.15	2.68
Mid-Harbour tunnel	10 2.20	2 0.38	1 0.17	1 0.14	1 0.11	1 0.08	1 0.06	5 0.15	3.29

economically. The other tunnels cost even more, making them equally or less feasible in his opinion. He sees little benefit in keeping three lanes on the bridge because it will not improve travel times or safety that much with the retention of the reversible lane.

Even with the required funds available from the province, he does not perceive the three-lane rehabilitation option to be as financially feasible as a modified four-lane, or a new five or

six-lane bridge, as it does not improve the bridge's transportation component.. He thinks the latter two are more cost-effective, and they can be paid for through tolls, but he does not judge a new four-lane bridge to be as financially feasible. As well, the expensive tunnel options are constrained by high costs, and a lack of government funding to complete them.

He does not think a toll will sway public opinion much against the four-lane bridge options. He is aware that some people want to see the suspension design remain and will resent a user-pay system, but he still thinks the public prefers an improved four-lane crossing over a no toll three-lane bridge. However, he dismisses the five or six-lane option because West End residents do not want capacity to increase that much. Although he thinks the bored tunnel falls in the middle range of social feasibility, he has seen no evidence that the other tunnel options will get any public support.

Even though the province prefers a four-lane bridge he does not perceive it to be the most politically feasible. He thinks that North Shore municipal support of a no toll option makes the basic three-lane rehabilitation slightly more feasible; but he rates the 'do-nothing' option as unfeasible, because some improvement is expected to make the bridge safe. However, he points out that if tolls were going to be charged on every crossing in the region, they would be acceptable on Lion's Gate Bridge. He also thinks a four-lane bored tunnel will receive average political backing. Although he is aware that a mid-harbour crossing is receiving a lot of political support right now, he thinks that once we know more about the impacts it will have on surrounding areas it will be completely unacceptable to politicians. He also finds a Brockton Point tunnel to be unfeasible politically.

In terms of impacts on traffic around the bridge, he is most pleased with the four-lane options, and perceives no differences in their impacts. He thinks an extra non-peak direction lane will reduce queues and congestion along Georgia and Denman Streets in the West End. Although he is not concerned about induced trips as a result of smoother traffic flow, he states that some trips might switch from off-peak to peak periods. Also, he is unaware of how much traffic will divert to the Second Narrows Bridge because of a toll, as the study to determine this amount is incomplete. He rates the three-lane options in the middle because they cause no change, but a five or six-lane bridge will increase peak-direction capacity and could create more congestion downtown and on the North Shore, so he rates it quite low. He also dismisses the Brockton Point and mid-harbour tunnels because he thinks they will create major problems on Vancouver and North Shore street systems.

He perceives the modified four-lane bridge to provide the most improvements to air and noise pollution by reducing stop and go, and idling traffic, and with some tunneling in Stanley Park. He does not see much difference in the impact between a modified and a new four-lane bridge, but he rates the three-lane options slightly lower because they change nothing. Because the five or six-lane bridge will increase traffic, and probably air and noise pollution, he thinks it has no merit environmentally. Even though the tunnel options rid Stanley Park of noise impacts, the concentrated emissions from vents make them the worst options for the environment in his view.

Like most people, he is aware of the public's attachment to the Lion's Gate Bridge, but he thinks that both new bridge options will look even better, followed by a modified bridge. It is not clear whether these options will be cable-stayed, but this scenario seems more likely than a new suspension design. He does not perceive really good or bad aesthetic impacts from the three-lane bridge or from the tunnel options, even if they maintain current views.

Despite the aesthetic appeal of the new four, or five or six-lane bridges, although it is marginally less feasible technically than a new bridge, a modified four-lane bridge is perceived to be more financially and socially feasible.

Case Two - Vancouver Parks Board

Table 5 shows that this Parks Board representative prefers a crossing with four lanes; with a bored tunnel receiving a slightly higher score than the four-lane bridges. Based on his knowledge of tunnels, he thinks the bored tunnel will perform well technically. He believes it will be just as good as a new four-lane bridge, and slightly better than a modified bridge. Although he thinks a three-lane rehabilitation can be done, and is better than doing nothing, he hesitates to rate it high technically because it does not address the reversible lane. He dismisses the Brockton Point and mid-harbour tunnels but states that the technical problems associated with tunneling under Burrard Inlet can be worked around.

He perceives the rehabilitation and four-lane bridge options to be equally economically feasible. The four-lane bored tunnel is expected to have similar travel time savings and safety benefits to a four-lane bridge, but it will cost more. He perceives fewer benefits in pursuing the five or six-lane bridge or 'do-nothing' options, and thinks the other tunnel options cost too much to be economically feasible.

His perception of financial feasibility is similar, with the rehabilitation and four-lane bridge options rated equal, followed by a four-lane bored tunnel. He rates the rehabilitation

option high because the funds are available to do it, and he thinks the four-lane bridge options (with some Stanley Park tunneling) are the most cost-effective and can be repaid with tolls. He perceives the 'do-nothing' and five or six-lane bridge to be less cost-effective, and although he likes the idea of a mid-harbour tunnel for other reasons, he is aware that the tolls required to pay for it would be too high.

Table 5. Completed Matrix by Vancouver Parks Board Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	2 0.44	5 0.95	5 0.85	2 0.28	2 0.22	5 0.40	8 0.48	9 0.27	3.89
Rehab 3-lane bridge	5 1.10	8 1.52	8 1.36	7 0.98	5 0.55	5 0.40	8 0.48	9 0.27	6.66
Modified 4-lane bridge	6 1.32	8 1.52	8 1.36	6 0.84	7 0.77	5 0.40	7 0.42	8 0.24	6.87
New 4-lane bridge	7 1.54	8 1.52	8 1.36	5 0.70	6 0.66	5 0.40	7 0.42	4 0.12	6.72
New 5/6-lane bridge	4 0.88	5 0.95	5 0.85	3 0.42	7 0.77	3 0.24	4 0.24	4 0.12	4.47
4-lane Bored Tunnel	7 1.54	7 1.33	6 1.02	9 1.26	8 0.88	5 0.40	9 0.54	9 0.27	7.24
Brockton Point tunnel	4 0.88	2 0.38	1 0.17	3 0.42	5 0.55	2 0.16	2 0.12	4 0.12	2.80
Mid-Harbour tunnel	4 0.88	2 0.38	1 0.17	9 1.26	7 0.77	9 0.72	8 0.48	9 0.27	4.93

He thinks a bored tunnel is the most socially desirable option because it ensures the entire park causeway will be underground. He also perceives a third crossing at mid-harbour to be as acceptable. Since a three-lane rehab avoids tolls he rates it quite high, and thinks the public prefers it to either of the four-lane bridges. The five or six-lane bridge may have public support but he knows communities around the bridge oppose it, making it unfeasible. After the lengthy public process, the 'do-nothing' option is not acceptable to anyone, nor does he think a Brockton Point tunnel will get public support because of the Coal Harbour island.

He perceives most politicians to be in favour of a bored tunnel, but he thinks a modified four-lane bridge or a five or six-lane bridge will get nearly the same level of political support. He also rates the mid-harbour tunnel high but believes it will never be built because it lacks political support in Vancouver. A new four-lane bridge is thought to be only slightly less feasible, but he

perceives the three-lane rehab as a "crazy political position to take" (Personal communication, 1997). Finally, he does not anticipate any political support for the Brockton Point tunnel because it will disrupt waterfront developments.

The only option he thinks will have positive impacts on traffic around the bridge is a third crossing at mid-harbour because it bypasses downtown Vancouver and reduces traffic through the park and West End. He rates all of the three and four-lane crossings in the middle range of spatial impacts, even though he thinks the four-lane crossings will improve non-peak direction flow. On the other hand, he does not like the potential impacts of a Brockton Point tunnel or the increased traffic coming off of a five or six-lane bridge.

In his view, a bored tunnel offers the most environmental improvements by reducing air pollution with an emission filtering system, and eliminating noise impacts in Stanley Park. He prefers maintaining current pollution levels on the three-lane bridges to building a modified or new four-lane bridge, because he thinks they will end up with only some tunneling under the park, and more traffic along the surface portions. He also expects positive environmental impacts from a mid-harbour crossing, but dismisses the five or six-lane bridge and the Brockton Point tunnel.

He likes the look of the Lion's Gate Bridge and so he favours the aesthetic impacts of the options that will keep the suspension design. Hence, the three-lane bridges, the bored tunnel, and mid-harbour tunnel are all favoured aesthetically. He also thinks that if it is done well, a modified four-lane bridge can look good, but he is not as impressed with the appearance of the new four, or five or six-lane bridge options. Finally, he dismisses the Brockton Point tunnel because of its island.

Although a bored tunnel costs more to build than both four-lane bridges, he feels the public and politicians favour the tunnel solution. This option may not solve the transportation problem, but it will benefit Stanley Park, and help preserve the icon of Burrard Inlet. These factors lead him to rate the bored tunnel slightly higher than both the modified or new four-lane bridge options on the existing alignment.

Case Three - Friends of Stanley Park

The Friends of Stanley Park is a stakeholder group that has been involved with the Lion's Gate Bridge project from the beginning. As their name indicates, the group is in the business of looking out for the interests of Stanley Park. The group is not pleased with the current traffic conditions in the park, and wants to see improvements.

After considering the choice of alternatives, this respondent favours either a new or modified four-lane bridge, which he assumes will be accompanied by a Stanley Park tunnel, as shown in Table 6. He sees no difference in the technical feasibility of the two options, and judges them to be as feasible as a bored tunnel. He is not terribly impressed with the technical feasibility of any of the options, but he rates these three the best. He dismisses the bridge rehab, 'do-nothing', and five or six-lane bridge options as unfeasible and he is concerned that tunnels at Brockton Point and mid-harbour will have problems connecting with local street systems and will cause traffic flow problems on the crossings themselves.

He judges the 'do-nothing' and bridge rehab options to be the best economically, as they cost very little. He does not completely reject the four-lane bridges, but at the same time he is uncertain whether travel time savings and safety benefits will outweigh the costs. As the costs of the other options increase, he thinks their economic feasibility decreases. He perceives little benefit in the five or six-lane bridge, and thinks the risks of a bored tunnel make it unfeasible economically. He also dislikes the Brockton Point and mid-harbour tunnels because they will require a lot of money for major infrastructure improvements.

Table 6. Completed Matrix by Friends of Stanley Park Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	2 0.44	8 1.52	10 1.70	7 0.98	8 0.88	3 0.24	3 0.18	10 0.30	6.24
Rehab 3-lane bridge	3 0.66	7 1.33	8 1.36	7 0.98	8 0.88	3 0.24	3 0.18	10 0.30	5.93
Modified 4-lane bridge	6 1.32	6 1.14	6 1.02	8 1.12	8 0.88	5 0.40	8 0.48	7 0.21	6.57
New 4-lane Bridge	6 1.32	6 1.14	6 1.02	8 1.12	8 0.88	5 0.40	8 0.48	7 0.21	6.57
New 5/6-lane bridge	1 0.22	5 0.95	5 0.85	1 0.14	1 0.11	1 0.08	1 0.06	8 0.24	2.65
4-lane Bored Tunnel	6 1.32	4 0.76	4 0.68	7 0.98	7 0.77	5 0.40	8 0.48	10 0.30	5.69
Brockton Point tunnel	2 0.44	2 0.38	1 0.17	1 0.14	1 0.11	2 0.16	9 0.54	7 0.21	2.15
Mid-Harbour tunnel	1 0.22	1 0.19	1 0.17	1 0.14	1 0.11	1 0.08	1 0.06	8 0.24	1.21

He rates the financial feasibility of the options similar to their economic feasibility. The inexpensive three-lane options are thought to be the most feasible because the funding is available, while the billion dollar tunnels are judged unfeasible and unappealing to investors. He perceives the four-lane bridge and park tunnel combination options, and a five or six-lane bridge to be somewhere in the middle, but he does not think any of them are all that financially attractive.

Because Stanley Park is so important to Vancouverites, he thinks both four-lane bridges with a Stanley Park tunnel are the most socially desirable options that people are willing to pay a toll to use. He perceives a bored tunnel and the three-lane options (with no tolls) to be slightly less acceptable, but still thinks they have a fair degree of public support. He thinks that a five or six-lane bridge, and the Brockton Point and mid-harbour tunnels will all meet too much public opposition in impacted areas to be feasible.

He is aware of the North Shore political backlash to a tolled Lion's Gate Bridge replacement. For this reason he judges the three-lane options to be just as politically feasible as the four-lane bridge options, which, with a park tunnel, avoid political problems in Stanley Park. Further, he thinks a bored tunnel is also quite politically acceptable because it avoids land acquisition problems on the North Shore. He does not think, however, that a five or six-lane bridge, or the Brockton Point and mid-harbour tunnels will get much political support.

He anticipates few positive impacts on traffic around the bridge with any option, but he does think the four-lane schemes are the best for the West End and North Shore, because the extra non-peak direction lane will reduce queues in the one-lane direction. Because the three-lane options maintain current traffic conditions, he rates them lower, but not as low as the five or six-lane bridge, which will increase traffic volumes; and the mid-harbour tunnel, which will drag traffic across North Vancouver and the downtown east side.

The four-lane bridges and park tunnel, the bored tunnel, and the Brockton Point tunnel all ensure that car traffic will not travel at-surface through Stanley Park. With the interests of the park in mind, he perceives these schemes to be the best environmentally. In fact, he rates all the other options near the bottom, as they will not improve present air and noise pollution in the park, or they will make it worse in other areas.

He knows the bridge's appearance is important to many Vancouverites, but he also thinks people are willing to see it change. Still, he supposes the three-lane options, and the bored tunnel will have the best aesthetic impacts. He thinks all the options can look quite good, but

notes that the Brockton Point island, and the new connecting roadways associated with a mid-harbour tunnel take a little away from their appeal.

One notes from the rating factors in Table 6 that this respondent sees no difference between the modified and new four-lane bridges. He feels that they perform equally in terms of each criterion and has no preference for one over the other.

Case Four - Lower Capilano Steering Committee

This North Shore public stakeholder group comprises 9000 residents in North Vancouver. They have also been involved in the Lion's Gate Bridge project from the outset, with a representative attending the Choices meetings throughout 1994.

This group representative prefers a modified four-lane bridge, as shown in Table 7. He deems the bridge's substructure to be in good condition, and thinks that modifying the bridge to four lanes is the best option technically, along with a mid-harbour tunnel. In fact, he perceives most of the options to be quite technically feasible except for the 'do-nothing' option, which he thinks has no merit, and the bored tunnel, which he expects will have problems in the loose sands under Burrard Inlet.

Table 7. Completed Matrix by Lower Capilano Steering Committee Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1 0.22	2 0.38	10 1.70	2 0.28	2 0.22	2 0.16	10 0.60	10 0.30	3.86
Rehab 3-lane bridge	9 1.98	9 1.71	9 1.53	9 1.26	8 0.88	7 0.56	10 0.60	10 0.30	8.82
Modified 4-lane bridge	10 2.20	10 1.90	8 1.36	10 1.40	7 0.77	9 0.72	10 0.60	10 0.30	9.25
New 4-lane bridge	9 1.98	4 0.76	6 1.02	9 1.26	7 0.77	9 0.72	6 0.36	8 0.24	7.11
New 5/6-lane bridge	9 1.98	3 0.57	3 0.51	9 1.26	5 0.55	5 0.40	5 0.30	8 0.24	5.81
4-lane Bored Tunnel	2 0.44	2 0.38	2 0.34	8 1.12	5 0.55	8 0.64	4 0.24	9 0.27	3.98
Brockton Point tunnel	8 1.76	2 0.38	2 0.34	8 1.12	2 0.22	8 0.64	2 0.12	9 0.27	4.85
Mid-Harbour tunnel	10 2.20	7 1.33	6 1.02	8 1.12	5 0.55	8 0.64	8 0.48	9 0.27	7.61

He perceives the rehab and modified bridge alternatives to be the most economically feasible, as they deliver the most benefits for the cost. In his opinion only a new-four lane bridge will have a Stanley Park tunnel, but he does not perceive enough benefits to justify the extra costs of doing this. With higher costs and fewer benefits, he rates the five or six-lane bridge even lower. He knows that the tunnel options cost more than the bridge schemes, and with the exception of the mid-harbour tunnel, he does not think the benefits will even come close to the costs to build them.

Although he dislikes the 'do-nothing' option, he thinks the funds are available to maintain it for now. He also perceives the bridge rehab to be quite financially feasible, as the province is obligated to pay for it. He is aware that a modified four-lane bridge will cost more, but he thinks it is nearly as financially feasible and can be built without a toll. Because he thinks a new four-lane bridge will have a tunnel, he judges it to be less cost-effective and unaffordable, much like a mid-harbour tunnel. He is convinced that the five or six-lane bridge is much less cost-effective than a four-lane bridge, and that the bored and Brockton Point tunnels are not at all feasible because they cost too much.

He deems all of the options, except doing nothing, are acceptable to the public. He thinks a modified four-lane bridge is slightly more desirable, but he sees little difference between it and the others. He does, however, think that North Shore residents will be a bit happier with a bridge rather than a tunnel.

He does not have the same feelings about political feasibility. Because of North Shore opposition to tolls, he thinks the bridge rehab is narrowly more feasible than either of the four-lane bridges, even though he is aware that they have considerable political backing. As the scores indicate, he does not think the other schemes will gain the same degree of support, although he explains that a third crossing at mid-harbour will be more politically feasible in the future.

In his view the modified and new four-lane bridge options will have the best impacts on surrounding traffic. He thinks either option can be set up with three peak direction lanes and one non-peak lane, or two lanes each way. He is aware that the tunnel options can also have positive spatial impacts but they may also cause disruption at the portals, so he rates them lower than the four-lane bridges. Although he dismisses the 'do-nothing' option, he does not mind the bridge rehab. However, he thinks the extra capacity on a five or six-lane bridge will have negative traffic impacts.

The modified four-lane bridge and the three-lane bridge options are expected to provide the most environmental improvements. He likes three lanes because it changes nothing, and

although four lanes increases traffic capacity, non-peak direction traffic will flow more smoothly and reduce emissions. He also likes the mid-harbour tunnel idea, but not the other tunnel options (this includes a new four-lane bridge with a park tunnel) on account of the ventilation stacks spewing vehicle exhaust in Stanley Park and residential areas.

He has no qualms with any of the options aesthetically and thinks they will all look good. The only negative aesthetic impacts he mentions are with a cable-stayed bridge design, tunnel ventilation stacks in Stanley Park, and the loss of part of Lost Lagoon.

He clearly perceives the modified four-lane bridge option to be superior to the others. He thinks it performs well in relation to all the criteria, and although he perceives the rehab option to be more feasible financially and politically, he has no real problem in choosing the modified four-lane bridge.

Case Five - City of Vancouver

The City of Vancouver is a major player in the Lion's Gate Bridge project, and without an official position from city council, there are certain options that do not meet the city's criteria set out in 1994². Although there is city support for a three-lane rehabilitated bridge, there is also support for a four-lane bridge. Since city council had not taken an official position on the bridge project at the time of the interview, it is not clear whether this respondent's views reflect those of the city.

As shown in Table 8, the interviewee from the city prefers either a new or modified four-lane bridge. He feels that both of these bridges, the bored tunnel, and a five or six-lane bridge are all quite technically feasible and will improve bridge safety, with the latter being the best in terms of traffic flow. He rates the mid-harbour tunnel slightly lower and dismisses the Brockton Point tunnel because it will run into problems on the South Shore. He also rejects the three-lane options, which will only marginally improve safety at best.

He perceives little difference in the gains and losses between all of the four-lane options, and the five or six-lane bridge, although he rates the wider crossing slightly higher. He also thinks the mid-harbour tunnel is economically feasible, but he sees little benefit in doing nothing, or spending \$70 million on the rehab option. He rates the Brockton Point tunnel in the middle, because he thinks traffic from the island will impose some costs on downtown traffic.

With funding already available, he deems the three-lane rehab to be the most financially feasible. However, he indicates that the modified four-lane bridge is just as feasible, and is likely

² The city's criteria were discussed in the previous chapter. See page 37.

the most cost-effective option. As the cost of the options goes up, he feels their financial feasibility goes down. He thinks the tunnel options cost much more and are “not even in the picture” (Personal communication, 1997). He feels the new four, and five or six-lane bridges are more feasible than the tunnels, but are not as cost-effective as a modified four-lane bridge, which makes use of structurally sound parts of the existing crossing.

This respondent thinks that the public wants a four-lane bridge, but they do not want to pay for it. Hence, he rates the rehabilitated (no toll) and modified bridges equally acceptable to the public, and more desirable than the other options. Further, he thinks that a new four-lane bridge and a bored tunnel are only slightly less acceptable, but he does not anticipate that any other option will receive public support.

Table 8. Completed Matrix by City Vancouver Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1 0.22	2 0.38	1 0.17	3 0.42	1 0.11	5 0.40	7 0.42	10 0.30	2.42
Rehab 3-lane bridge	3 0.66	3 0.57	8 1.36	6 0.84	7 0.77	6 0.48	8 0.48	10 0.30	5.46
Modified 4-lane bridge	8 1.76	8 1.52	8 1.36	6 0.84	5 0.55	8 0.64	4 0.24	7 0.21	7.12
New 4-lane Bridge	9 1.98	8 1.52	7 1.19	5 0.70	6 0.66	8 0.64	5 0.30	9 0.27	7.26
New 5/6-lane bridge	10 2.20	9 1.71	5 0.85	3 0.42	1 0.11	3 0.24	2 0.12	9 0.27	5.92
4-lane Bored Tunnel	8 1.76	8 1.52	6 1.02	5 0.70	4 0.44	8 0.64	6 0.36	8 0.24	6.68
Brockton Point tunnel	3 0.66	5 0.95	2 0.34	2 0.28	1 0.11	2 0.16	8 0.48	4 0.12	3.10
Mid-Harbour tunnel	6 1.32	7 1.33	2 0.34	1 0.14	1 0.11	8 0.64	10 0.60	10 0.30	4.78

He perceives the most political support to be behind the bridge rehab because it avoids tolls. He thinks that Vancouver city council is somewhat concerned about the capacity increase on a four-lane crossing but he still feels there is some political support for the four-lane bridges. However, he perceives no support for the ‘do-nothing’, five or six-lane bridge, Brockton Point, or mid-harbour tunnels because they all have too many impacts.

He is aware of potential problems with rehabilitating or modifying the present bridge that may cause negative spatial impacts. These include traffic diversion due to the toll (on a four-lane bridge), and traffic disruption during the construction process. Although he feels the disruption problem is a significant factor in the decision-making process, he rates the modified and the new four-lane bridges the same in terms of spatial impacts, along with a bored tunnel. He thinks the mid-harbour tunnel can tie into downtown corridors to distribute traffic, but it will also have some negative impacts. He dislikes three lanes, as it fails to improve non-peak direction congestion, and dismisses the five or six-lane bridge and Brockton Point tunnel because they will have adverse impacts.

He does not think the four-lane, and five or six-lane bridge options will help environmentally, with no improvement to air and noise pollution. But, he rates the three-lane options much higher because they do not increase capacity or pollution. He is also pleased with the tunnel options because they allow emissions to be screened and vented high enough to avoid major impacts. This is especially the case with the mid-harbour and Brockton Point tunnels, which will reduce or eliminate traffic in Stanley Park, whereas the bored tunnel will have to vent emissions in the park.

Aesthetically, he favours the options that maintain the current bridge. He is aware of the emotional attachment many people have to the bridge, but he also points out that almost any crossing would look good there, given the beautiful setting. The only option he really dislikes aesthetically is the Brockton Point tunnel because of its Coal Harbour island.

Clearly, two options emerge as preferable to this interviewee. He likes both four-lane bridge options (a new bridge slightly more) because they provide a desirable transportation component at a reasonable price. However, he does not like their environmental impacts, and he is unsure whether they are as politically feasible as a three-lane bridge rehabilitation, given tolls.

Case Six - District of North Vancouver

This North Shore municipality is one of the major stakeholders in the project. The Lion's Gate Bridge is an important link between the district and the city of Vancouver. As traffic volumes attest, many North Vancouver residents rely on Lion's Gate Bridge to get to and from work, and recreation activities in Vancouver. Needless to say, the outcome of the project is of great interest to all three North Shore municipalities.

This representative from the district is overwhelmingly in favour of a rehabilitated three-lane bridge, as shown in Table 9. He would also like to see, in the future, a third crossing at

mid-harbour with a rapid transit component. He admits that the four-lane bridge options are the most technically feasible, as they improve safety and traffic flow, as well as a mid-harbour tunnel. He also rates the rehab option high, but dismisses the 'do-nothing' option as unfeasible, along with the five or six-lane bridge which may have traffic flow problems as volumes increase on surrounding streets. In addition, he feels the bored tunnel and Brockton Point tunnel will run into problems with loose sands under Burrard Inlet.

He perceives a mid-harbour tunnel to be the most economically feasible, as it provides several benefits to users. Although he prefers a rehab option overall, he thinks it has fewer gains than both four-lane bridges. He rejects the 'do-nothing' option, and sees little benefit in building

Table 9. Completed Matrix by District of North Vancouver Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	1	1	1	1	1	7	1	3	1.54
Rehab 3-lane bridge	9	7	10	10	10	10	4	10	8.85
Modified 4-lane bridge	10	8	7	8	3	3	4	4	6.96
New 4-lane bridge	10	8	5	6	2	3	4	2	6.17
New 5/6-lane bridge	1	4	3	1	1	1	1	1	1.91
4-lane Bored Tunnel	3	5	3	2	1	5	5	4	3.33
Brockton Point tunnel	5	6	2	2	2	10	8	7	4.57
Mid-Harbour tunnel	10	10	2	10	10	10	10	7	8.55

a wider five or six-lane bridge that will only increase congestion. Further, he does not perceive enough benefits from an expensive bored tunnel or a Brockton Point tunnel to justify the costs.

Like many other people, he thinks the most financially feasible option is to rehab the bridge because the money is available, tolls are not needed, and some safety improvements will be made. He perceives the modified four-lane bridge to be more cost-effective than three lanes in terms of improving the transportation component, but dislikes the fact that it will be tolled. In addition, a new four-lane bridge will cost more, making it less cost-effective. Again, he dismisses

the 'do-nothing' option, and is skeptical of the feasibility of the other options, partly because the prices have changed so dramatically throughout the process. Hence, he rates the expensive tunnel solutions, and the new five or six-lane bridge options quite low.

Based on the public feedback he has received, he perceives the no toll rehabilitated bridge, and a mid-harbour tunnel to be the most socially desirable options. However, he is aware of considerable public support for a modified four-lane bridge, and to a lesser degree for a new four-lane bridge. Despite the public desire for some additional capacity, he thinks a five or six-lane bridge is unacceptable. He points out that after the lengthy public process, people will demand some bridge improvements, which renders the 'do-nothing' option unfeasible. He also believes the public does not want either the bored tunnel or the Brockton Point tunnel.

The implementation of a toll on any crossing costing more than \$70 million has a major effect on his perception of political feasibility. With a toll, he thinks the only feasible option right now is the bridge rehab. He also thinks a third crossing at mid-harbour will gain considerable political support in the future. As for the other alternatives, he finds them all completely unfeasible because Lion's Gate Bridge users would be singled out to pay a toll, which he believes is inequitable. However, he points out that there is provincial support for four lanes, even among North Shore MLA's, and that without a toll, he thinks that the four-lane crossings would receive much more political support.

One of his main concerns about a toll is the amount of traffic that will divert to Second Narrows Bridge, causing traffic chaos on the North Shore. He is aware of existing problems at Second Narrows, which he feels will only worsen with a tolled Lion's Gate Bridge. For this reason, he rates the three-lane rehab high, as well as the 'do-nothing' option. He also likes the Brockton Point and mid-harbour tunnels because they will distribute regional traffic more effectively. He does not like the four-lane bridge and bored tunnel alternatives because of traffic diversion, and thinks the five or six-lane bridge will have even worse impacts.

He is not pleased with current pollution problems in and around the park, and he does not think the three or four-lane bridge options will improve things, even with some tunneling along the causeway. He also thinks that increased traffic volumes on a five or six-lane bridge will only make things worse. While he likes the Brockton Point and mid-harbour tunnels because they reduce or eliminate impacts in the park, he is concerned that concentrated exhaust vented from a bored tunnel on the current alignment will not improve conditions that much.

He likes the look of the Lion's Gate Bridge and thinks that preserving the suspension design has some merit. He favours rehabilitating the bridge, but thinks that the 'do-nothing'

option is only feasible in the short term, so he rates it low. His scores indicate that he is not terribly impressed with how most of the other options will look, with the exceptions being the mid-harbour tunnel and Brockton Point tunnel. But, he points out that even if these options allow retention of the bridge, they will have other impacts on the North Shore landscape, and in Coal Harbour with a Brockton Point island. Although a bored tunnel will likely result in retention of the bridge for cyclists and pedestrians, he still rates it low.

It is obvious that this respondent's choice of alternatives is guided by the threat of a toll. The fact that Lion's Gate Bridge users will be singled out to pay for an improved crossing, and the potential for serious traffic congestion on the North Shore from people avoiding the tolled bridge lead him to favour a three-lane rehabilitated bridge for now.

Case Seven - City of North Vancouver

As a North Shore municipality, the city of North Vancouver has a stake in the replacement of the Lion's Gate Bridge. However, the respondent feels that the city is not as directly impacted as the districts of North and West Vancouver because it is further from the bridge.

Table 10. City of North Vancouver Respondent.

Criteria Weighting Factors	Criteria								Sum
	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1 0.22	2 0.38	10 1.70	1 0.14	1 0.11	1 0.08	8 0.48	10 0.30	3.41
Rehab 3-lane bridge	10 2.20	5 0.95	10 1.70	7 0.98	7 0.77	2 0.16	9 0.54	10 0.30	7.60
Modified 4-lane bridge	8 1.76	5 0.95	8 1.36	7 0.98	9 0.99	4 0.32	9 0.54	9 0.27	7.17
New 4-lane bridge	10 2.20	5 0.95	8 1.36	8 1.12	9 0.99	6 0.48	9 0.54	8 0.24	7.88
New 5/6-lane bridge	9 1.98	5 0.95	5 0.85	3 0.42	6 0.66	2 0.16	8 0.48	6 0.18	5.68
4-lane Bored Tunnel	10 2.20	5 0.95	5 0.85	7 0.98	8 0.88	6 0.48	10 0.60	10 0.30	7.24
Brockton Point tunnel	8 1.76	5 0.95	7 1.19	6 0.84	6 0.66	6 0.48	10 0.60	8 0.24	6.72
Mid-Harbour tunnel	8 1.76	5 0.95	8 1.36	6 0.84	6 0.66	6 0.48	10 0.60	10 0.30	6.95

One notices in Table 10 that a new four-lane bridge receives the highest score. Despite this, the interviewee's preferred option is a rehabilitated three-lane bridge; and he would like to see a third crossing in the future. He perceives few technical problems with all but the 'do-nothing' option, which he feels is no longer feasible. He rates the bridge rehab, new four-lane bridge, and a bored tunnel as the best options technically, but there is little perceived difference between these and the modified four-lane bridge, new five or six-lane bridge, and the other tunnel alternatives.

His perception of economic feasibility is quite different than that of the other respondents. He thinks the 'do-nothing' option has no benefit and is only a short term solution. As for the other options, he rates their economic feasibility to be equal. He does not think that any of the options will deliver benefits that really outweigh their costs, as he rates each option in the middle of the range.

He does, however, perceive the 'do-nothing' and bridge rehab options to be more financially feasible than the others, with provincial money available, and the absence of tolls. He thinks the new and modified four-lane bridge options are slightly less, but still quite feasible, as is a future mid-harbour tunnel. He rates the feasibility of a new five or six-lane bridge, and a bored tunnel to be average, while the Brockton Point tunnel is better, with the island real estate to help pay for it.

He is aware of several options that are acceptable to the public. Although he rates the bridge rehab, the modified and new four-lane bridges, and a bored tunnel almost equally feasible, he thinks the public will want more than one extra lane if they have to pay a toll. He finds the 'do-nothing' option unacceptable because people expect something to be done, and he dismisses a five or six-lane bridge because it provides too much capacity.

In terms of political feasibility, he is aware that the four-lane bridge options have important political backing from the province so he rates them high. He thinks a four-lane bored tunnel is also feasible, followed by the bridge rehab, which has considerable support from the North Shore municipalities. Again, because something must be done on the bridge, he thinks the 'do-nothing' alternative is unacceptable. With few politicians endorsing a five or six-lane bridge, a Brockton Point tunnel, or a mid-harbour tunnel, he perceives them to be much less politically feasible.

He does not think any of the options will have particularly good impacts on traffic, but he distinguishes the new four-lane bridge and all of the tunnel options as being slightly better than the other alternatives. He likes the fact that they avoid disruption during construction of a

rehab or modified bridge, and will improve non-peak direction traffic in adjacent areas. While four lanes appears to be acceptable, he dislikes the capacity and expected congestion increase with a five or six-lane bridge.

He has few concerns over air and noise impacts in the park and surrounding areas with any of the options. He thinks that maintaining three lanes will cause no increase, and the four-lane bridge options may allow smoother traffic flow, thus reducing emissions and noise from idling vehicles. Further, he believes the tunnel options will be a bit better in reducing pollution by screening emissions and eliminating noise in the park.

Preserving the look of the bridge has some importance, and he is aware of its heritage value. Consequently, his favorite options aesthetically are the three-lane options, the bored tunnel and the mid-harbour tunnel. He rates both four-lane bridges slightly lower because he anticipates they will have a different appearance than the current suspension design, and he dislikes the Brockton Point island's negative visual impact on Coal Harbour.

Although the final scores do not show it, the interviewee prefers a three-lane rehabilitated bridge, despite its failure to improve non-peak direction traffic in adjacent areas. He explains that if a four-lane crossing is built now, there will be no chance for a third crossing at mid-harbour, which he thinks is a better long term transportation solution.

Case Eight - District of West Vancouver

This respondent from West Vancouver prefers a mid-harbour tunnel. However, he knows this is not affordable right now, and that the provincial government will not support it. After considering the choice of alternatives, Table 11 shows that a modified four-lane bridge receives the highest score.

He perceives no difference in the technical feasibility of any of the options, and thinks they can all be easily built.

He expects a modified four-lane bridge to perform the best in terms of gains and losses, followed closely by a bridge rehab. He perceives several benefits with a mid-harbour crossing, but he rates it a bit less economically feasible, probably due to higher costs. He also thinks a new four-lane bridge is economically feasible, but he dismisses the 'do-nothing' option because it has no benefits, and the tunnel options (except mid-harbour) because they cost far too much. He judges the five or six-lane bridge the same, as he perceives it to have fewer benefits than a four-lane bridge.

In his view, the new and modified four-lane bridge options are the most cost-effective and financially feasible. He thinks the three-lane options are a waste of money, while he perceives the five or six-lane bridge, the bored tunnel, and the Brockton Point and mid-harbour tunnels as unaffordable and not financially feasible right now due to a lack of funds.

Despite the imposition of a toll, he thinks the four-lane bridge options are the most acceptable to the public. Based on his knowledge, he believes people find the three-lane solutions unacceptable, and that the public perceives a five or six-lane bridge, a bored tunnel, and a Brockton Point tunnel to be absurd. He does, however, feel that a mid-harbour tunnel will get a lot of support from the public.

Table 11. Completed Matrix by District of West Vancouver Respondent.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	10 2.20	4 0.76	1 0.17	1 0.14	5 0.55	4 0.32	3 0.18	7 0.21	4.53
Rehab 3-lane bridge	10 2.20	9 1.71	1 0.17	3 0.42	6 0.66	4 0.32	3 0.18	7 0.21	5.87
Modified 4-lane bridge	10 2.20	10 1.90	7 1.19	9 1.26	8 0.88	6 0.48	3 0.18	6 0.18	8.27
New 4-lane bridge	10 2.20	7 1.33	7 1.19	9 1.26	8 0.88	6 0.48	3 0.18	6 0.18	7.70
New 5/6-lane bridge	10 2.20	4 0.76	4 0.68	1 0.14	1 0.11	1 0.08	1 0.06	1 0.03	4.06
4-lane Bored Tunnel	10 2.20	4 0.76	4 0.68	1 0.14	1 0.11	6 0.48	9 0.54	9 0.27	5.18
Brockton Point tunnel	10 2.20	4 0.76	4 0.68	2 0.28	1 0.11	7 0.56	9 0.54	9 0.27	5.40
Mid-Harbour tunnel	10 2.20	8 1.52	4 0.68	8 1.12	9 0.99	8 0.64	9 0.54	9 0.27	7.96

Although he knows the province will not back a mid-harbour crossing right now, he thinks it is the most politically feasible solution. He feels it will get support from other political sources, and that spending a billion dollars on the project is quite justifiable. He also rates the four-lane bridges high because of provincial support, but he does not expect the same degree of support for the 'do-nothing' or bridge rehab options. He also thinks politicians will completely disregard the five or six-lane bridge, bored tunnel and Brockton Point tunnel.

One the main reasons he likes a mid-harbour tunnel is that it takes North Shore, Whistler, and truck traffic around downtown Vancouver and distributes it throughout the city more effectively than options on the current alignment. He perceives similar spatial impacts with a Brockton Point tunnel; and he points out that the four-lane bridge and tunnel options can have positive impacts on adjacent traffic by reducing counterflow congestion. He rejects the three-lane options, because they improve nothing, as well as a five or six-lane bridge because it will create more congestion in adjacent areas.

The only options he thinks will have benefits to air and noise pollution are the tunnels. He also feels that tunneling under the park with the bridge options will help conditions, but he is not certain this will happen. Therefore, he rates the three and four-lane bridge alternatives quite low in terms of environmental impacts, but not as low as a five or six-lane bridge.

He thinks that any option that changes the suspension design of Lion's Gate Bridge will be controversial for years, however, he does not know if the public will accept a new suspension bridge if it costs \$30 million extra dollars over a cable-stayed design. He rates the three-lane options slightly lower than the tunnels, aesthetically, although they will all maintain the look of the bridge. He is unsure whether the four-lane bridges will be suspension or cable-stayed, but thinks they will have more pleasing impacts than a wider five or six-lane bridge.

From the interview it is apparent that this respondent would like to see a mid-harbour tunnel, even if it means only a bridge rehab for now. However, he knows that the funds are simply not available for this ideal scheme, with the provincial government nearly bankrupt. Given this, he thinks it is only fair that the province add a fourth lane to the crossing, despite a lack of environmental benefits and compromised improvements to traffic flow between Vancouver and the North Shore. So, his assessment of the alternatives shows a preference for a modified four-lane bridge.

Summary of Public Group Perceptions

Because of the concern over safety on the Lion's Gate Bridge, technical feasibility plays an important role in the choice process. Both the modified and new four-lane bridges are perceived to perform well technically. Both provide wider lanes, will lead to fewer accidents, and improve non-peak direction traffic flow on the bridge. However, a new four-lane bridge will also make use of new materials and will avoid night time closures needed to modify the bridge to four lanes. Opinions regarding the technical feasibility of the three-lane rehab option are mixed, as the

reversible lane operation will remain. There is also some apprehension about tunneling under Burrard Inlet because of the unknowns involved.

Among the long list of Lion's Gate Bridge reports, a comprehensive economic analysis is strangely missing. Regardless, the gains and losses of the various options have certainly played a role in the choice process. Most respondents perceive the new and modified four-lane bridges to have the most gains to bridge users and Stanley Park, while costing less than the tunnel options. In addition, although rehabilitating the bridge with three-lanes costs less than any crossing with four or more lanes, it lacks the user benefits of an additional lane.

A crucial consideration in any public project is the availability of funding. All respondents in the study are aware of the \$70 million government contribution and the need for tolls to cover additional costs. Given these circumstances, the less expensive options are perceived to be the most financially feasible. One respondent explicitly states that "The province is going to be uncomfortable with anything in the \$300 to \$400 million range because even the tolling system they're talking about is probably not going to handle it" (Transportation engineer, Personal communication, 1997). Most other respondents agree, and consequently, the five or six-lane bridge and the tunnel options are all perceived to be unfeasible financially.

There is little agreement as to who should pay for the bridge replacement. North Shore respondents feel that a toll exclusively on Lion's Gate Bridge is inequitable and think the province must pay since the bridge is a provincial crossing. Most others are quite comfortable with a user-pay system for an improved crossing, and more than one respondent believes that tax dollars should not be used to subsidize car-oriented facilities. North Shore opposition notwithstanding, tolls will likely be charged on any four-lane crossing.

Despite a lack of agreement regarding which option is most preferred by the public, there is some consensus that the four-lane bridge and bored tunnel options are the most socially feasible. Several respondents point to the government's public opinion poll results as evidence that most people will not mind paying a toll to ensure improvements to Stanley Park while limiting increases in traffic capacity. However, there is also a strong feeling that the public does not want a tolled crossing and prefers the bridge rehab option; but that without tolls there would be overwhelming public support for a four-lane crossing. Further, a North Shore politician states that even though the public will expect more than one additional lane if they have to pay a toll, public opposition to a five or six-lane bridge from the West End precludes it from serious consideration.

Since the government announcement last year, there has been no shortage of political commentary on the bridge replacement project in the Vancouver media. From the data in this study, it is clear that three options emerge as being particularly politically feasible. The three-lane bridge rehab, the modified four-lane bridge and a new four-lane bridge are perceived by most respondents to be equally acceptable to politicians. Support for the rehab option comes from the North Shore municipalities who oppose tolls exclusively on the Lion's Gate Bridge, while the province and Vancouver Parks Board both support a four-lane crossing.

Perceptions of spatial impacts of the alternatives on areas adjacent to the Lion's Gate Bridge vary depending on who one talks to. For example, there is great concern on the North Shore that any tolled crossing will lead to traffic diversion to the Second Narrows Bridge, creating more problems on already congested North Shore transportation routes. Although this impact is acknowledged by all respondents, it is generally not perceived to be bad enough to avoid building a four-lane crossing. Maintaining three lanes is not perceived to have any real impact on surrounding areas, while a five or six-lane crossing is expected to lead to undesirable traffic increases in surrounding areas. The spatial impact in downtown Vancouver of putting the population of the West End on an island in Coal Harbour is a big reason why the Brockton Point tunnel is perceived to be unacceptable. However, most respondents like the idea of a mid-harbour tunnel that bypasses downtown as a long term transportation solution.

One of the biggest environmental concerns in Stanley Park is noise pollution from causeway traffic. This problem, coupled with air quality considerations around the bridge and throughout the region are perceived to be best addressed with the tunnel solutions, although there is some concern that emissions concentrated at tunnel portals will aggravate pollution problems. The exception to this is the traffic generated by the Brockton Point island into downtown, which makes it less desirable than the other tunnel options. The respondents perceive little difference in environmental impact between the three and four-lane bridge options, but a five or six-lane bridge is dismissed because of the anticipated increase in traffic volume and accompanying pollution.

The provincial government is conducting seminars to determine how the look of the Lion's Gate Bridge should be incorporated into the decision-making process. Although the public respondents in this study all have some affection for the bridge's appearance, it did not seem to play a crucial role in the choice process. Most respondents feel that a cable-stayed bridge will look just as good as the present suspension bridge, as one respondent put it, "Maybe you could put any bridge in there because the setting is so wonderful" (Transportation engineer, Personal

communication, 1997). Further, a new or modified four-lane cable stayed bridge and park tunnel are expected to lead to some aesthetic improvements in Stanley Park.

Private Group Case Studies

This section looks at the five private group case studies, as follows:

1. Urban transportation planner
2. Urban Transportation Engineer
3. Urban Transportation Engineer
4. Urban Transportation Engineer
5. Urban Transportation Engineer

Of this group, four are from the consortiums that are currently bidding for the bridge replacement project, and one is an urban transportation engineer who has years of experience with the bridge.

Case One - Urban Transportation Planner

This urban transportation planner has been involved with the Lion's Gate Bridge process for several years and is currently part of a consortium bidding for the bridge replacement.

This interviewee prefers both a modified and new four-lane bridge and perceives virtually no difference between the two, as shown in Table 12. He thinks the four-lane bridges

Table 12. Completed Matrix by Urban Transportation Planner.

Criteria <i>Weighting Factors</i>	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1 0.22	5 0.95	7 1.19	6 0.84	6 0.66	5 0.40	6 0.36	10 0.30	4.92
Rehab 3-lane bridge	1 0.22	5 0.95	6 1.02	8 1.12	6 0.66	5 0.40	6 0.36	10 0.30	5.03
Modified 4-lane bridge	10 2.20	10 1.90	4 0.68	4 0.56	8 0.88	10 0.80	10 0.60	8 0.24	7.86
New 4-lane bridge	10 2.20	10 1.90	4 0.68	4 0.56	8 0.88	10 0.80	10 0.60	8 0.24	7.86
New 5/6-lane bridge	1 0.22	1 0.19	3 0.51	3 0.42	3 0.33	2 0.16	8 0.48	4 0.12	2.43
4-lane Bored Tunnel	10 2.20	10 1.90	2 0.34	3 0.42	3 0.33	10 0.80	10 0.60	8 0.24	6.83
Brockton Point tunnel	5 1.10	5 0.95	1 0.17	2 0.28	2 0.22	2 0.16	8 0.48	8 0.24	3.60
Mid-Harbour tunnel	5 1.10	5 0.95	1 0.17	3 0.42	3 0.33	2 0.16	8 0.48	8 0.24	3.85

and the bored tunnel are the best technically as they improve bridge traffic flow in the non-peak direction. He rates the Brockton Point and mid-harbour tunnels to be feasible, although they may have technical problems; and he dismisses the 'do-nothing' and bridge rehab options because they offer few improvements.

He perceives the most gains and fewest losses to users from the four-lane options, while the 'do-nothing' and bridge rehab have little benefit and poor rates of return on investment. He does not reject the Brockton Point and mid-harbour tunnels, but he is not convinced their benefits will match their billion dollar costs. The worst option economically in his opinion is a five or six-lane bridge, which may have benefits, but is still not perceived to be feasible.

He is aware that the funds are available to rehabilitate the bridge, and he knows the province will continue to pay for bridge maintenance, so he rates these options to be the most financially feasible. Like many other interviewees, he thinks that the more expensive alternatives are the least feasible financially, and this is reflected in his judgment of the options. He is even unsure whether or not the four-lane bridge options will be financially feasible.

Because of tolls, he thinks the bridge rehab is the most socially feasible choice. In fact, he even thinks the 'do-nothing' option is more acceptable than any tolled bridge or tunnel. Despite public and North Shore municipality desire for a no toll crossing, he believes that both the modified and new four-lane bridges are the most politically feasible. He explains that because the bridge is a provincial structure, the province's preference for four-lanes will win in the end. However, he does not expect the five or six-lane bridge, or any of the tunnel options to get much backing from the public or politicians.

He anticipates the best traffic impacts in areas around the bridge from the four-lane bridge and tunnel options with an extra non-peak direction lane. But, with no change to current conditions, he rates the three-lane options in the middle. Finally, he dismisses the five or six lane bridge, and the Brockton Point and mid-harbour tunnels as having negative impacts.

Aside from the three-lane bridge alternatives, which maintain the status quo, he thinks all of the options will provide some improvements to air and noise pollution. The four-lane bridges will have some tunneling in Stanley Park, and will reduce non-peak direction queues, while a bored tunnel will eliminate the surface causeway. Further, the five or six-lane bridge, Brockton Point and mid-harbour tunnels may reduce Stanley Park impacts but might also cause problems elsewhere.

His awareness of the bridge's iconic value leads him to rate the three-lane options as the best aesthetically. He has no problems with the other bridge and tunnel options and thinks they

will be pleasing to the eye, except for the five or six-lane bridge, as he is uncertain how good a larger bridge like this will look.

Despite some doubt about the financial and social feasibility of the modified and new four-lane bridge alternatives, he perceives them to be the best. He thinks they are both technically viable options with several user and environmental benefits that have the necessary provincial government support to be chosen.

Case Two - Urban Transportation Consultant

Although not part of a consortium in the bridge replacement competition, this interviewee has been involved with the bridge project for years, and is very knowledgeable of the problem and the options under consideration.

His preferred option is a new four-lane bridge, as shown in Table 13. He thinks it is the best technically, as it uses new material, provides slightly wider and safer lanes than a modified four-lane bridge, and avoids the unknowns of tunneling under Burrard Inlet associated with a bored tunnel. He thinks that doing nothing and rehabilitating the bridge fail to improve safety. He also dismisses the five or six-lane bridge, Brockton Point and mid-harbour crossings.

Table 13. Completed Matrix by Urban Transportation Engineer.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	2 0.44	2 0.38	9 1.53	5 0.70	6 0.66	5 0.40	3 0.18	9 0.27	4.56
Rehab 3-lane bridge	4 0.88	3 0.57	5 0.85	7 0.98	7 0.77	5 0.40	3 0.18	7 0.21	4.84
Modified 4-lane bridge	8 1.76	7 1.33	7 1.19	7 0.98	7 0.77	7 0.56	6 0.36	7 0.21	7.16
New 4-lane bridge	9 1.98	7 1.33	9 1.53	8 1.12	6 0.66	7 0.56	6 0.36	9 0.27	7.81
New 5/6-lane bridge	4 0.88	7 1.33	4 0.68	5 0.70	3 0.33	3 0.24	3 0.18	5 0.15	4.49
4-lane Bored Tunnel	8 1.76	7 1.33	3 0.51	3 0.42	2 0.22	7 0.56	7 0.42	7 0.21	5.43
Brockton Point tunnel	5 1.10	2 0.38	2 0.34	6 0.84	1 0.11	2 0.16	7 0.42	3 0.09	3.44
Mid-Harbour tunnel	3 0.66	1 0.19	1 0.17	3 0.42	1 0.11	1 0.16	7 0.42	3 0.09	2.14

He perceives the modified and new four-lane bridges, a new five or six-lane bridge, and a bored tunnel to perform equally well in terms of gains and losses. They will each improve travel time savings and safety, which will benefit bridge users. He sees little benefit in the three-lane options and thinks the Brockton Point and mid-harbour tunnels cost far more than any benefits they would provide.

He thinks a new four-lane bridge, and the 'do-nothing' option are the most financially feasible. He feels building a new four-lane bridge is more cost-effective than using the aging structure on a modified bridge, and has a more desirable transportation component than a five or six-lane bridge. Further, although the province will pay for a bridge rehab, he does not think it is a cost-effective option. On the other hand, he does not believe the funds are available to build the Brockton Point or mid-harbour tunnels, nor can a reasonable toll cover the costs.

He is aware that public opinion on the replacement options is quite mixed. On balance he perceives a new four-lane bridge to be the most socially feasible, but only slightly more than a bridge rehab or modified four-lane bridge. Even with a toll, he thinks people prefer an extra non-peak direction lane to reduce congestion. Both the 'do-nothing', and the five or six-lane bridge are thought to be less desirable, while he perceives very little public support for the bored tunnel or mid-harbour tunnel. He is aware of some public support for the Brockton Point tunnel because it was promoted as free to taxpayers, but he still thinks the bridge options are more acceptable.

Because of tolls, he feels the bridge rehab will get a lot of political support, but he also feels the modified bridge will get the same support. He expects the 'do-nothing' and new four-lane bridge alternatives to be only marginally less feasible, while politicians will reject five or six lanes because it increases peak direction capacity. He perceives the bored tunnel, and both Brockton Point and mid-harbour tunnels to be unfeasible. In his view, politicians are unwilling to make the necessary infrastructure investments for the latter two.

He thinks both four-lane bridges and the bored tunnel on the current alignment will provide the most improvements to traffic around Lion's Gate Bridge. The extra lane will eliminate queues in the non-peak direction and on weekends at both ends of the bridge. He rates the three-lane options in the middle because they change nothing, but the five or six-lane bridge may lead to increased congestion in downtown Vancouver with more peak direction capacity. He also suspects the Brockton Point and mid-harbour tunnels will adversely impact traffic on both sides of the inlet without major street network improvements.

He is aware of the potential improvements to air and noise pollution with the tunnel options, and he rates them the highest in terms of environmental impacts. If the ventilation stacks

are built high enough, he expects emissions will dissipate immediately. In addition, noise in Stanley Park will be eliminated. With some tunneling under Stanley Park with both four-lane bridge options he knows there will be environmental improvements, but he still rates them slightly lower than the tunnels. However, he dislikes the five or six-lane bridge and the three-lane options.

He appreciates the bridge's suspension design and thinks that leaving it alone is the best aesthetically, while rehabilitating or modifying it will have some visual impact. He is convinced that a new four-lane bridge can look very good, but that a five or six-lane bridge may not. As well, a bored tunnel allows retention of the bridge, but will leave big footprints at the portals. He dismisses both the Brockton Point tunnel because of the island, and the mid-harbour tunnel because of visual intrusions of new street networks on the landscape.

Although the Lion's Gate Bridge has to be replaced because of technical problems, he sees this as an opportunity to 'normalize' the bridge with four lanes. This is why he prefers a new four-lane bridge over the other alternatives. Although a modified bridge is not dismissed, a new bridge is perceived to be a slightly safer, more cost-effective, and socially desirable option that will likely look better.

Case Three - Urban Transportation Engineer

This respondent works for an engineering consulting firm that has been involved with the project for quite some time. The respondent has also been involved and is well aware of the problems and complex issues around choosing a suitable replacement for the Lion's Gate Bridge.

Table 14 shows that the interviewee favours either a modified or new four-lane bridge. He perceives all of the options to be technically feasible, but thinks that the four-lane bridge and bored tunnel options on the current alignment are better than the rest. He has little concern over a five or six-lane bridge or the Brockton Point tunnel, while the bridge rehab and mid-harbour crossing might be slightly trickier to build. He also deems the 'do-nothing' option somewhat unfeasible.

He figures the modified and new four-lane bridges with a Stanley Park tunnel are the most economically feasible solutions. They offer more gains in terms of safety and travel time savings than the three-lane options, and cost much less than the Brockton Point and mid-harbour tunnels. He also feels they have more benefits and fewer costs than a five or six-lane bridge, and will cost less than a bored tunnel.

Of the range of choice, he perceives all but two options to be nearly equal in terms of financial feasibility. He sees little difference between any of the three-lane, four-lane, and five or six-lane options. He is aware of the availability of government funds for the three-lane options, and he believes that coming up with money for the more expensive bridge and tunnel alternatives is not a problem for big consortiums. However, he does not think the billion dollar Brockton Point and mid-harbour tunnels are nearly as cost-effective and he dismisses them financially.

Although public acceptance for a bored tunnel was slow in coming, he feels the desire to protect Stanley Park has led public opinion to favour a bored tunnel or a four-lane bridge (new or

Table 14. Completed Matrix by Urban Transportation Engineer.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
	Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03
Repair and maintain bridge	5 1.10	6 1.14	9 1.53	5 0.70	9 0.99	6 0.48	4 0.24	4 0.12	6.30
Rehab 3-lane bridge	6 1.32	6 1.14	9 1.53	5 0.70	9 0.99	6 0.48	4 0.24	4 0.12	6.52
Modified 4-lane bridge	8 1.76	9 1.71	9 1.53	8 1.12	8 0.88	9 0.72	8 0.48	8 0.24	8.44
New 4-lane bridge	8 1.76	9 1.71	9 1.53	8 1.12	8 0.88	9 0.72	8 0.48	8 0.24	8.44
New 5/6-lane bridge	7 1.54	6 1.14	8 1.36	3 0.42	1 0.11	2 0.16	2 0.12	5 0.15	5.00
4-lane Bored Tunnel	8 1.76	5 0.95	8 1.36	9 1.26	8 0.88	8 0.64	10 0.60	9 0.27	7.72
Brockton Point tunnel	7 1.54	3 0.57	3 0.51	1 0.14	1 0.11	2 0.16	1 0.06	1 0.03	3.12
Mid-Harbour tunnel	5 1.10	1 0.19	1 0.17	2 0.28	2 0.22	4 0.32	1 0.06	8 0.24	2.58

modified) and park tunnel combination. He thinks people want more than just three lanes, but five or six-lanes will not be acceptable. Given the perceived negative impacts of a Brockton Point or mid-harbour tunnel, he thinks the public has no desire for either one.

He is aware of the municipal opposition to tolls on the North Shore, which leads him to rate the three-lane options as the most politically feasible. However, he thinks they are only a bit more feasible than a modified or new four-lane bridge, or a bored tunnel, which have more provincial support. Like the public, he does not think any politicians will back a five or six-lane

bridge, and they will reject the Brockton Point and mid-harbour tunnels because of big impacts on surrounding areas.

Because of an extra non-peak direction lane that will help eliminate queues along Georgia and Denman, he favours both four-lane bridge and the bored tunnel options in terms of spatial impacts. But, he dismisses a five or six-lane bridge because it will lead to more peak direction capacity and congestion in surrounding areas. He also dislikes the three-lane options because they do not improve traffic conditions, and he expects really negative impacts on surrounding traffic with the Brockton Point and mid-harbour tunnels.

He thinks the bored tunnel has the best environmental impacts because it will screen automobile emissions with electrostatic precipitators to remove particulate, dust, and perhaps odors, in addition to removing noise from the park. He expects similar improvements from both four-lane bridge and park tunnel combination options. He rates all the other alternatives much lower, as they will either provide no improvements (three-lane options), or will create more pollution problems (five or six-lane bridge). He perceives the Brockton Point and mid-harbour tunnels will have the worst impacts on air and noise pollution by introducing more traffic in already congested areas.

Unlike most respondents, he is not stuck on preserving the look of the Lion's Gate Bridge, although it can be part of the bored tunnel proposal. Consequently, he rates the 'do-nothing' and bridge rehab options low in terms of aesthetics. He thinks the modified and new four-lane bridge options, and the bored tunnel are better and will allow the causeway to revert back to the park. He also finds the mid-harbour tunnel acceptable aesthetically, but rejects the five or six-lane bridge and Brockton Point tunnel because of the island.

This respondent clearly favours the four-lane bridge options, and the bored tunnel more than the other alternatives. He feels both four-lane bridge options perform equally well in terms of all the criteria, and neither have any serious shortcomings. Although he does not mind the bored tunnel overall, he perceives it to be less economically feasible than the bridges.

Case Four - Urban Transportation Engineer

This interviewee has also been involved with the Lion's Gate Bridge for years and is well aware of the bridge problem. His firm is also part of a consortium bidding for the replacement project.

Table 15 indicates that a five or six-lane bridge receives a slightly higher score than a new four-lane bridge. He thinks both are among the most technically feasible options, while a

modified bridge is only slightly inferior. He feels the Brockton Point tunnel is quite straightforward to build and is technically better than the rest. He has some concerns over boring a tunnel underneath Burrard Inlet, so he dismisses the bored tunnel, and the mid-harbour tunnel, which he thinks would use the same technology. He also rejects the 'do-nothing' and bridge rehab options as they fail to improve bridge safety.

Table 15. Completed Matrix by Urban Transportation Engineer.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1 0.22	2 0.38	1 0.17	1 0.14	1 0.11	5 0.40	3 0.18	1 0.03	1.63
Rehab 3-lane bridge	3 0.66	5 0.95	3 0.51	3 0.42	5 0.55	5 0.40	3 0.18	8 0.24	3.91
Modified 4-lane bridge	7 1.54	7 1.33	7 1.19	6 0.84	7 0.77	3 0.24	7 0.42	5 0.15	6.48
New 4-lane bridge	8 1.76	8 1.52	7 1.19	6 0.84	7 0.77	3 0.24	7 0.42	3 0.09	6.83
New 5/6-lane bridge	8 1.76	8 1.52	8 1.36	8 1.12	5 0.55	3 0.24	7 0.42	3 0.09	7.06
4-lane Bored Tunnel	4 0.88	5 0.95	5 0.85	5 0.70	3 0.33	3 0.24	3 0.18	8 0.24	4.37
Brockton Point tunnel	9 1.98	7 1.33	6 1.02	8 1.12	1 0.11	5 0.40	3 0.18	8 0.24	6.38
Mid-Harbour tunnel	5 1.10	5 0.95	3 0.51	7 0.98	1 0.11	5 0.40	3 0.18	8 0.24	4.47

He perceives the new four, and five or six-lane bridges to be best in terms of gains and losses, but only marginally better than a modified bridge and Brockton Point tunnel. All of these options provide trip time savings and safety benefits, while the Brockton Point scheme has the island to help cover its higher costs. He rates the bored tunnel, mid-harbour tunnel, and bridge rehab in the middle range of economic feasibility, while he sees little benefit in doing nothing because, as he puts it, the bridge will likely fall down.

Even though the funds are available, he rates the three-lane options financially unfeasible because they are not cost-effective and will prove to be a waste of money if another government wants to improve the crossing in a few years. Meanwhile, both of the four-lane, and the five or six-lane bridges are perceived to be much better because they improve the transportation component. As for the tunnel options, he thinks the Brockton Point scheme is quite expensive,

but is less risky, and hence more cost-effective and feasible than the bored tunnel and mid-harbour options.

His perception of social feasibility is somewhat divergent from most respondents. He agrees that the public wants more than three lanes, and he is aware of the strong opposition to five or six-lanes among some West End residents. However, he believes most people prefer this wider bridge option. He also thinks most people would back the Bentzen scheme, and to lesser degree, the mid-harbour tunnel. While he feels there is public support for both four-lane bridges, the bored tunnel is not seen as desirable.

Despite a lot of silent public support for five or six-lanes, he thinks Vancouver politicians will oppose it because of increases in peak direction capacity. On the other hand, the modified and new four-lane bridges have provincial support, and he thinks the city may also back them. While he perceives no political support for the 'do-nothing' option, or the tunnel solutions (because of negative impacts at the portals), he is aware of some North Shore municipal support for the bridge rehab because it avoids tolls.

He does not think any of the options will have really good impacts on traffic around the bridge. He is concerned about the 'do-nothing' option falling down, while the bridge rehab will cause disruption during construction. He has even more serious concerns about the bridge and tunnel options along the current corridor that include a toll, because of traffic diversion to the crowded Second Narrows Bridge. This is why he rates all tolled options along the First Narrows corridor so low in terms of spatial impacts. Finally, he thinks people may be more willing to pay a toll on the Brockton Point and mid-harbour tunnels, so he rates them in the middle.

He thinks both four, and five or six-lane bridge schemes will have positive impacts on air and noise pollution, especially with some tunneling in Stanley Park. However, he rates both three-lane options much lower because they provide no improvements. He also thinks the three tunnel options are equally bad because they surface in residential areas, and will emit a lot of pollution, in addition to adding pollution to other parts of downtown and the North Shore.

He fears there will be significant tree loss and negative aesthetic impacts in Stanley Park with the new four, and five or six-lane bridges. In order to connect these bridges with the current alignment a large swath of trees will have to be cut down. Although a modified bridge avoids these problems, it will not look as good as the present bridge. Therefore, he rates the bridge rehab, and the tunnel options equal in terms of aesthetic impacts, as they all maintain the suspension bridge design.

The assigned rating factors show that despite some negative aesthetic impacts, and problems with traffic diverting to Second Narrows Bridge the interviewee perceives the four, and five or six-lane bridge options to be quite good. Although the five or six-lane bridge ends up with a slightly higher score, he perceives little difference between it and either of the four-lane bridges in relation to most of the criteria.

Case Five - Urban Transportation Engineer

This interviewee's firm has teamed up with several engineering and construction companies to form another of the interested consortiums. He has several years of experience dealing with the causeway and bridge, and offers interesting insights into the choice process.

As shown in Table 16, he prefers a new four-lane bridge much more than the other choices. He thinks a new four-lane bridge will perform the best technically, followed closely by a new five or six-lane bridge, or a Brockton Point tunnel. He hesitates to rate the bored tunnel and mid-harbour crossing as high, but he still thinks they are technically much better than the rehab and modified bridges, which use the existing structure instead of all new components.

Table 16. Completed Matrix by Urban Transportation Engineer.

Criteria Weighting Factors	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impact	Environmental	Aesthetic Impact	Sum
Options	0.22	0.19	0.17	0.14	0.11	0.08	0.06	0.03	1.00
Repair and maintain bridge	1	1	1	1	1	1	1	1	1.00
Rehab 3-lane bridge	3	3	10	2	8	2	2	8	4.61
Modified 4-lane bridge	2	4	9	5	5	3	3	3	4.49
New 4-lane bridge	10	5	8	9	7	9	5	7	7.77
New 5/6-lane bridge	8	3	7	4	3	5	3	5	5.14
4-lane Bored Tunnel	7	3	6	6	5	7	7	7	5.71
Brockton Point tunnel	8	6	5	2	2	7	7	3	5.32
Mid-Harbour tunnel	6	7	4	8	3	6	8	5	5.89

Even though he prefers a new four-lane bridge he thinks it has fewer benefits than the Brockton Point and mid-harbour tunnels, which allow traffic to bypass downtown Vancouver. The bored tunnel and new five or six-lane bridge are not perceived to have more benefits than their costs, and although the bridge rehab and 'do-nothing' option have small costs, they provide no real benefits. He also dismisses the modified four-lane bridge because its construction risks and potential costs make it less economically feasible.

He knows the province has the money to rehab the bridge, making it the most financially feasible choice but he rejects the 'do-nothing' option because it is not cost-effective. Since a modified four-lane bridge reportedly costs a little less than a new four-lane bridge, he rates it as slightly more financially feasible. In his view, as the costs of these options go up, financial feasibility goes down. The five or six-lane bridge and bored tunnel may be feasible, but he does not think the funds are available to build either the billion dollar Brockton Point or mid-harbour tunnels, nor can they be paid for with tolls.

He finds it difficult to judge the general public's preference, but based on his knowledge he does not think people will be satisfied with three lanes, nor do they want capacity increased to five or six lanes. Thus, he perceives the perfect balance to be four lanes. However, he perceives a new four-lane bridge to be the most desirable because a modified four-lane bridge will create disruption during construction, and a bored tunnel is more expensive. He suspects the mid-harbour tunnel will also receive a lot of public support, but not the Brockton Point tunnel because nobody wants an island in Coal Harbour.

A new four-lane bridge is expected to get considerable political support, but the threat of a toll makes the bridge rehab slightly more politically feasible. He is aware of provincial support for a modified four-lane bridge, but he thinks overall it lacks enough political backing to be chosen. He also perceives a bored tunnel to lack sufficient support. Finally, no politicians are anticipated to accept the 'do-nothing' option, and he thinks Vancouver politicians oppose a five or six-lane bridge.

With an extra non-peak direction lane to eliminate queues in the West End and North Shore, and no increase in peak direction capacity, he perceives a new four-lane bridge to have the best impacts on traffic, despite some diversion to the Second Narrows Bridge. He thinks a bored tunnel will have similar impacts, but he rates it slightly lower. In addition, the Brockton Point and mid-harbour tunnels will take traffic around downtown and the West End to relieve congestion. He is less satisfied with a five or six-lane bridge, although he feels the street system can handle the extra traffic. He dismisses the modified four-lane bridge because it will cause a lot

of disruption during construction, and he rejects the three-lane options because they improve nothing.

He is aware that the tunnel options can help reduce air and noise pollution, especially in Stanley Park, so he rates all the tunnel schemes quite high in terms of environmental impacts. However, even with some tunneling in the park he knows that both four-lane bridge options will increase traffic and pollution impacts along surface portions of the causeway. A five or six-lane bridge is also rated low, but is not perceived to be as bad as maintaining current conditions with three lanes.

After consulting with an architect, he concludes that maintaining the current suspension design is the most aesthetically pleasing option, but he rejects the 'do-nothing' option. He also rates the bored tunnel high because the bridge will likely remain, and the causeway can be returned to the park. He does not think a modified cable-stayed bridge will look as good as either the new four, or the five or six-lane bridge (likely cable-stayed), but points out that the bridge design has yet to be chosen. He also dislikes the Brockton Point island, and the potential visual impacts of a mid-harbour tunnel.

Despite potentially high costs (which hinges on how much of the park causeway is tunneled), and few improvements to air and noise pollution in the park, he thinks a new four-lane cable-stayed bridge is the best because it performs well technically, and provides enough non-peak direction traffic improvements to gain sufficient public and political support for implementation.

Summary of Private Group Perceptions

The private group respondents are all well aware of the technical problems that plague the bridge. One private consultant states that, "There have already been floor beam failures and cracks have gone right through the floorbeams" (Engineering consultant, Personal communication, 1998). There is an overwhelming belief in the group that the bridge must be fixed now before it has to be closed to traffic. This is an urgent problem that worries the respondents more than trying to solve broader transportation problems. Among the alternatives, rehabilitating the bridge is not perceived to be as good technically as modifying it to four lanes or building a new bridge. With the exception of the mid-harbour scheme, the tunnel options are perceived to be quite technically feasible, although both tunnel technologies are perceived to have some problems.

Like the public group, the private group respondents perceive some important benefits from the modified and new four-lane bridge options that do not come from a rehabilitated three-lane bridge or a five or six-lane bridge. The gains from the four-lane bridges appear to have a considerable impact on the choice process; and while a four-lane bored tunnel has similar benefits, it is perceived to be less economically feasible due to higher costs. After considering the gains and losses, the respondents deem the Brockton Point and mid-harbour tunnels to be unfeasible economically.

Because of high costs and limited government funding, there is some doubt as to whether a user pay system can cover the costs of building any of the tunnel proposals. Consequently, the most expensive options are deemed financially unfeasible. On the other hand, the modified and new four-lane bridge options are favoured as they are perceived to be the most cost-effective, and it is believed both can be paid for with a reasonable toll. The three-lane rehab is not seen to be as cost-effective as the four-lane bridge options because some respondents believe it is a waste of money as it will likely be replaced in a few years anyway. In addition, a five or six-lane bridge is not perceived to be as cost-effective because it provides an undesirable transportation component.

There is some consensus among the respondents that after years of public input most people want more than a rehabilitated three-lane bridge. While either a modified or new four-lane bridge are perceived to be quite acceptable, the respondents also feel that the public will accept some of the other alternatives. For example, one respondent feels there is a silent majority of people on the North Shore and in the West End who prefer a five or six-lane bridge, while another respondent is convinced that throughout the Choices Forum the public came to desire the four-lane bored tunnel. There is also some feeling that the public will accept a mid-harbour tunnel. It appears that among the eight criteria, the private respondents agree the least on what the public wants for a bridge replacement.

Only three options emerge as being perceived as politically feasible by the private group. The respondents recognize that there is North Shore municipal support for the three-lane rehab option, and they feel it is as feasible politically as the modified or new four-lane bridges. The latter two are known to have provincial support, and one respondent feels that since Lion's Gate is a provincial bridge the province's preference for a four-lane bridge is more politically feasible. The other options are not anticipated to get much political backing, as they increase capacity too much (five or six-lane bridge), or they will cause too much disruption in adjacent areas (the tunnel options).

Eliminating queues in the one-lane direction along Georgia Street and Marine Drive is a key spatial impact that leads the respondents to favour a modified or new four-lane bridge. However, one interviewee is concerned that any tolled crossing will divert motorists to Second Narrows Bridge and will create traffic chaos on the North Shore. Another respondent feels that this will be more of a problem on weekends when people value their time less and do not mind travelling the extra distance than during weekday peak periods.

Although a couple of respondents like the fact that a Brockton Point or mid-harbour tunnel will allow traffic to bypass downtown, these options are still perceived to create problems wherever they surface. This is even more of a concern with the additional traffic from a Brockton Point island.

After considering the environmental impacts of the alternatives, there is some agreement that a modified or new four-lane bridge and the tunnel options will have positive impacts. However, there is some discrepancy in the perceptions of the merits of these options. For example, while the bridge options will provide improvements to Stanley Park and surrounding areas, some respondents are concerned about concentrated emissions from tunnel portals, especially in the residential West End. Another respondent argues that tunnel ventilation methods allow these emissions to be filtered before they are discharged. Meanwhile, the three-lane rehab option is dismissed as it does nothing to improve current environmental conditions. Further, although a five or six-lane bridge is perceived to have quite good environmental impacts by a couple of respondents, the others feel it will only worsen existing problems.

The respondents are all aware of the symbolic importance the Lion's Gate Bridge carries on its tired shoulders. Given this, the three-lane bridge rehab option is perceived to be one the best alternatives in terms of aesthetic impacts. Nonetheless, perceptions of aesthetic impacts are quite subjective, which is evident in the stated preferences for different bridge designs. Although the present bridge looks good, there is a feeling that a cable-stayed bridge will look just as good if not better. Consequently, the modified and new four-lane bridge options are popular with the respondents. There is also some concern over aesthetic impacts in Stanley Park, namely with the additional space needed at the park entrance for a five or six-lane bridge, and with the potential loss of some of Lost Lagoon for tunnel portals. However, it is felt that the loss of Lost Lagoon may be offset by the portion of the park that is regained by putting the causeway underground.

We turn next to the comparison of public and private preferences in the choice of alternatives in the following chapter.

CHAPTER V

COMPARISON OF PUBLIC AND PRIVATE PREFERENCES

While in the previous chapter an in-depth case interview was conducted for eight public groups and five private consulting firms to gain insight into the choice process, in this chapter attention is now turned to the statistical analysis of the behavioral pattern displayed by both groups with respect to their expression of preferences in the choice of an alternative to replace the Lion's Gate Bridge. Questions may be raised as to what kinds of preferential choice patterns are displayed by the public and private group perception data matrices. What alternatives are perceived to be more preferable? What similarities and differences are depicted by the two types of perception data matrices? What kinds of rank correlations can one discern between pairs of respondents in each group and between groups? To what extent is the concordance and discordance within a group and between the groups discernible? What observations can one infer from the statistical evaluation of the statistical comparison of public versus private preferences in the choice of an alternative to replace the Lion's Gate Bridge? These are the questions to which answers will be sought in this chapter.

Two non-parametric statistics are employed in the analysis of the perception data matrices. They are Spearman's rank correlation coefficient, rho or r_s and Kendall's coefficient of concordance, W (Siegel 1956). Spearman's rank correlation analysis is used to show how strong the rank correlation is between pairs of respondents in their ranking of preferences among a range of alternatives in a group or between a group of decision makers. Kendall's coefficient of concordance is employed to show how strong the degree of concordance is among the respondents of a group in their judgment of the choice of alternatives.

This chapter is organized in three parts. Part one is directed at the portrayal and presentation of an 8 * 8 rank ordered public group matrix. Part two is a depiction and appraisal of an 8 * 5 rank ordered private group matrix. Part three presents a comparison of the rank correlations and coefficients of concordance between the public and private groups.

Matrix of Public Group Ranks

Table 17 shows a matrix of public group ranks as expressed by the eight respondents for the range of eight alternatives. Among the eight public groups, four of the respondents rated and ranked the modified bridge alternative as their highest or first preference. These respondents are

those from the British Columbia Transportation Financing Authority, the Friends of Stanley Park, the Lower Capilano Steering Committee, and the District of West Vancouver. Three respondents (from the Friends of Stanley Park, the City of North Vancouver, and the City of Vancouver) rate a new four-lane bridge number one while the District of North Vancouver rates the rehabilitated bridge as number one. It is clear that the modified four-lane bridge is the favoured choice of the public group and the new four-lane bridge is the second choice, while the least preferred option is to repair and maintain the bridge.

Table 17. Matrix of Public Group Ranks

Alternatives	BCTFA	VPB	FSP	LCSC	Van	NVD	WVD	NVC	Sum	Rank
Repair (Do-nothing)	8	7	2	8	8	8	7	8	57	8
Rehab	5	4	3	2	5	1	4	2	27	3
Modify	1	2	1	1	2	3	1	4	15	1
New 4	2	3	1	4	1	4	3	1	19	2
New 5/6	3	6	5	5	4	7	8	7	46	6
Bored Tu	4	1	4	7	3	6	6	3	35	4
Brockton	7	8	6	6	7	5	5	6	51	7
Mid-Harb	6	5	7	3	6	2	2	5	37	5

Note: **BCTFA**=British Columbia Transportation Financing Authority; **VPB**=Vancouver Parks Board; **FSP**=Friends of Stanley Park; **LCSC**=Lower Capilano Steering Committee; **Van**=City of Vancouver; **NVD**=District of North Vancouver; **NVC**=City of North Vancouver; **WVD**=District of West Vancouver.

In order to determine whether there is any similarity or difference in the expression of preferences by the eight public group respondents, a Spearman rank correlation analysis is performed on the matrix of public group ranks. Spearman rank correlation analysis is commonly used to ascertain the level of association between two ordinal-scaled variables, in this case two sets of ranks (Dickey and Watts 1978). The calculated rank correlation coefficient ranges from -1 to 1, where -1 indicates that the ranks are ordered inversely, and 1 indicates that the ranks are ordered identically. To test the significance of the coefficients, a table of critical values of rho was used. The rank correlation results are shown in Table 18.

A striking feature in Table 18 is the significant rank correlation between the British Columbia Transportation Financing Authority and the City of Vancouver respondents. Its Spearman rho of 0.952 between the two respondents' rank is significant at the 0.01 level. Both respondents perceive the same ranks for the 'do-nothing', Brockton Point, mid-harbour tunnel

and rehabilitation options (See Figure 10). Their ranking preference between the modified and new four-lane bridges differs only by one rank unit.

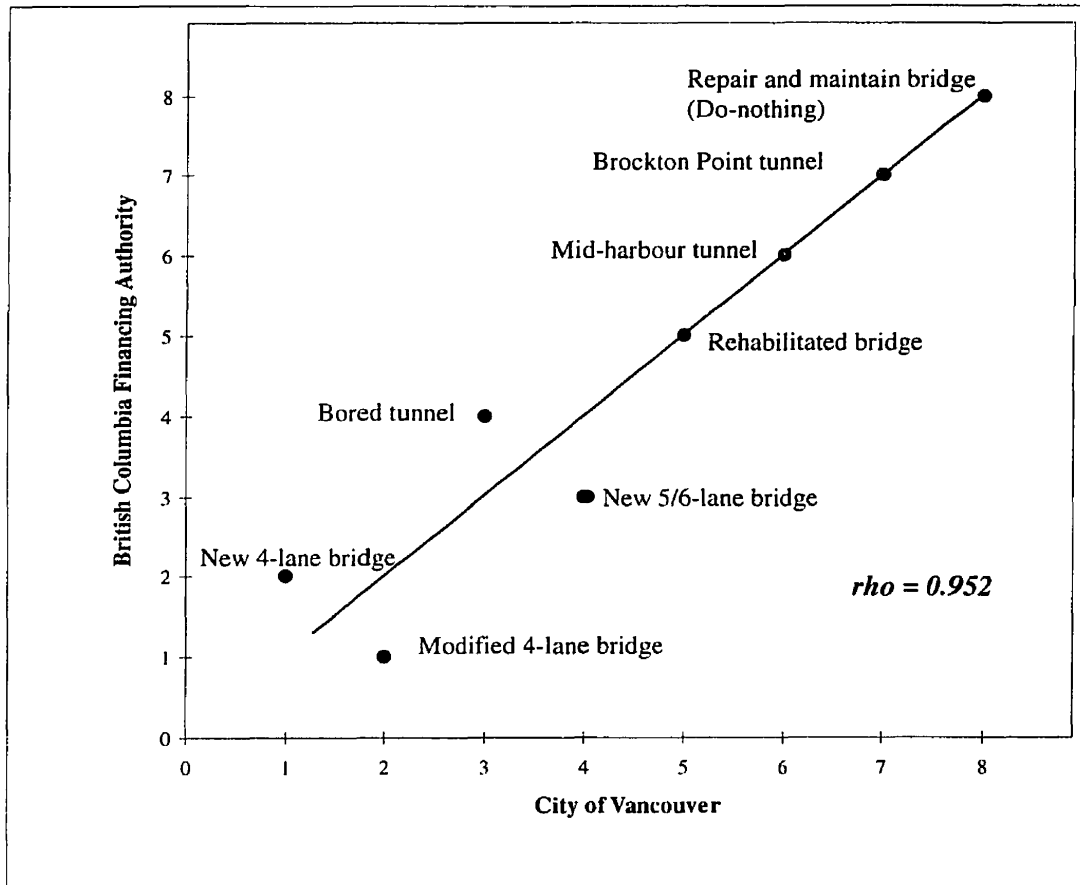


Figure 10. Relationship between British Columbia Transportation Financing Authority and City of Vancouver ranks.

There is also a strong rank correlation between the British Columbia Transportation Financing Authority and the Vancouver Parks Board respondents. The Spearman rho of 0.714 is significant at the 0.05 level. Despite this high degree of agreement, the respondents rank their first choice differently. The Parks Board respondent ranks the four-lane bored tunnel number one, and the modified four-lane bridge number two, while the British Columbia Transportation Financing Authority respondent ranks the modified bridge number one. This difference is probably due to the Parks Board respondent's concern that if a four-lane bridge is built, the entire causeway will not be underground.

Although the rank correlation coefficients of the British Columbia Transportation Financing Authority with the Friends of Stanley Park, the Lower Capilano Steering Committee, and the City of North Vancouver are above 0.500, they are not significant. The Transportation Financing Authority's rank correlations with the District of North Vancouver and West Vancouver are even weaker, as they disagree over whether a mid-harbour tunnel should be built.

Table 18. Spearman Rank Correlation Matrix for Public Group

	<i>BCTFA</i>	<i>VPB</i>	<i>FSP</i>	<i>LCSC</i>	<i>Van</i>	<i>NVD</i>	<i>NVC</i>	<i>WVD</i>
BCTFA	1.000							
VPB	0.714	1.000						
FSP	0.512	0.440	1.000					
LCSC	0.571	0.381	0.179	1.000				
Van	0.952	0.810	0.536	0.452	1.000			
NVD	0.238	0.333	-0.060	0.857	0.238	1.000		
NVC	0.548	0.738	0.369	0.500	0.714	0.643	1.000	
WVD	0.381	0.429	0.226	0.786	0.381	0.810	0.548	1.000

The Vancouver Parks Board is strongly correlated with the City of Vancouver (0.810) and the City of North Vancouver (0.738). The three respondents' ranks bear a similarity in their placement of the 'do-nothing' option and the Brockton Point tunnel near the bottom, and the four-lane bridge and bored tunnel options near the top.

The Friends of Stanley Park has some degree of agreement with the British Columbia Transportation Financing Authority (0.512), and the City of Vancouver (0.536) but the rank correlations are not very strong. Although the preference ranks of all three groups show that they would like to see either a new or a modified four-lane bridge replacement, there is less similarity with the rest of the alternatives.

The Lower Capilano Steering Committee has strong correlations with the Districts of North and West Vancouver, with Spearman rhos of 0.857 and 0.786 respectively. Its association with the City of North Vancouver is slightly weaker, with a rho of 0.500. The only North Shore municipality with which the City of Vancouver has a strong correlation is the City of North Vancouver, with a rho of 0.714. An examination of the ranks in Table 17 shows both respondents perceive the same ranks for the 'do-nothing', new four-lane bridge, and bored tunnel, while only one rank unit separates their placement of Brockton Point and mid-harbour tunnels. However,

among the three North Shore municipalities, there is a strong degree of agreement in their judgment of the alternatives to replace the bridge. This is evident in the rank correlation coefficients between the District of North Vancouver, the City of North Vancouver, and West Vancouver shown in Table 18. This agreement may be partly explained by the municipalities' desire for a third crossing at mid-harbour, their displeasure with the 'do-nothing' alternative, and the support from the City and District of North Vancouver respondents for the rehabilitation option.

Given this high intercorrelation of the rhos among the eight respondents from the public groups, one might ask how much concordance is there among the respondents within the public group. To determine the level of association between more than two sets of ranks, Kendall's coefficient of concordance (W) is performed. Unlike Spearman rank correlation analysis which compares two sets of ranks at a time, Kendall's coefficient of concordance determines the association between all eight public group respondents. The value of W ranges from 0 to 1. If all ranks are the same, $W = 1$. The closer W approaches to 1, the more similar are the ranks, whereas the closer W is to 0, the more variation there is in the ranks. A chi-square test is performed to test the significance of W. The result of the concordance analysis yielded a W of 0.587. A chi-square test of W shows that the calculated chi-square value of 32.896 with seven degrees of freedom is highly significant at the 0.001 level. This means that there is very strong evidence to reject the null hypothesis and accept the alternative hypothesis, which supports the strong concordance of the eight public respondents in the population. The highly significant W suggests that the modified four-lane bridge is the preferred public choice.

Matrix of Private Group Ranks

Table 19 presents the matrix of private group ranks in terms of five respondents from five private consulting firms. Among the five private respondents one notices a strong similarity in ranking preference displayed by the first three case respondents. All three respondents concur that a new four-lane bridge is the best choice as a bridge replacement. The strongest agreement in the preference ranks is exhibited between cases 2 and 3 where seven of their rank preferences for alternatives are identical (Figure 11). Case 3 shows a tie with rank one for both a modified and new four-lane bridge alternatives. Strong agreement also exists between cases 1 and 3, and with the exception of the rankings for the new five or six-lane bridge and the mid-harbour tunnel options, their rankings in Table 19 are identical. Among the first three cases, rehabilitating the

bridge is seen as a more preferable choice than a five or six-lane bridge or either the Brockton Point or mid-harbour tunnels.

Table 19. Matrix of Private Group Ranks.

Alternatives	Case 1	Case 2	Case 3	Case 4	Case 5	Sum	Rank
Repair (Do-nothing)	5	5	5	8	8	31	8
Rehab	4	4	4	7	6	25	4
Modify	1	2	1	3	7	14	2
New 4-lane	1	1	1	2	1	6	1
New 5/6-lane	8	6	6	1	5	26	5
Bored tunnel	3	3	3	6	3	18	3
Brockton Pt	7	7	7	4	4	29	6
Mid-Harbour	6	8	8	5	2	29	6

A striking feature from the private group ranks in Table 19 is the discrepancy in ranks of the alternatives in cases 4 and 5. Whereas in cases 1,2 and 3, the 'do-nothing' and bridge rehabilitation options are ranked in the middle, in cases 4 and 5 the former are ranked near the bottom. Conversely, while in cases 4 and 5, the Brockton Point and mid-harbour tunnels occupy a middle ranking, in the first three cases, they are ranked at the bottom. Despite the dissimilarity in ranking displayed by the respondents of cases 4 and 5, to a large extent the respondents in the private group rank the new and modified four-lane bridge options as their first and second choices to replace Lion's Gate Bridge.

Among the five private cases, the strongest similarity in the relationship as portrayed by Spearman's rho, are the rank correlations between Case 2 and Case 3 (0.988), Case 1 and Case 2 (0.887), and Case 1 and Case 3 (0.905). The first three cases all have Spearman rhos significant at the 0.01 level, as shown in Table 20.

A concordance analysis of the five private cases yields a W of 0.514. Its calculated chi-square value of 18.000 shows that the W is significant at the 0.02 level with seven degrees of freedom. The lower W and chi-square in the private group matrix of ranks is due to the divergence in ranking by Cases 4 and 5. The higher W and chi square in the public group is due to the higher degree of agreement among the public respondents.

One thing is evident from the rank correlations and concordance analysis of both the public and private group matrices. Whereas the public group ranks for the modified and new

four-lane bridge options as their number one and two preferences, the private group prefers a brand new four-lane bridge over a modified four-lane bridge as their choice to replace Lion's Gate Bridge.

Table 20. Spearman Rank Correlation Matrix for Private Group

	<i>Case 1</i>	<i>Case 2</i>	<i>Case 3</i>	<i>Case 4</i>	<i>Case 5</i>
Case 1	1.000				
Case 2	0.893	1.000			
Case 3	0.905	0.988	1.000		
Case 4	-0.083	0.143	0.107	1.000	
Case 5	0.012	0.000	-0.131	0.381	1.000

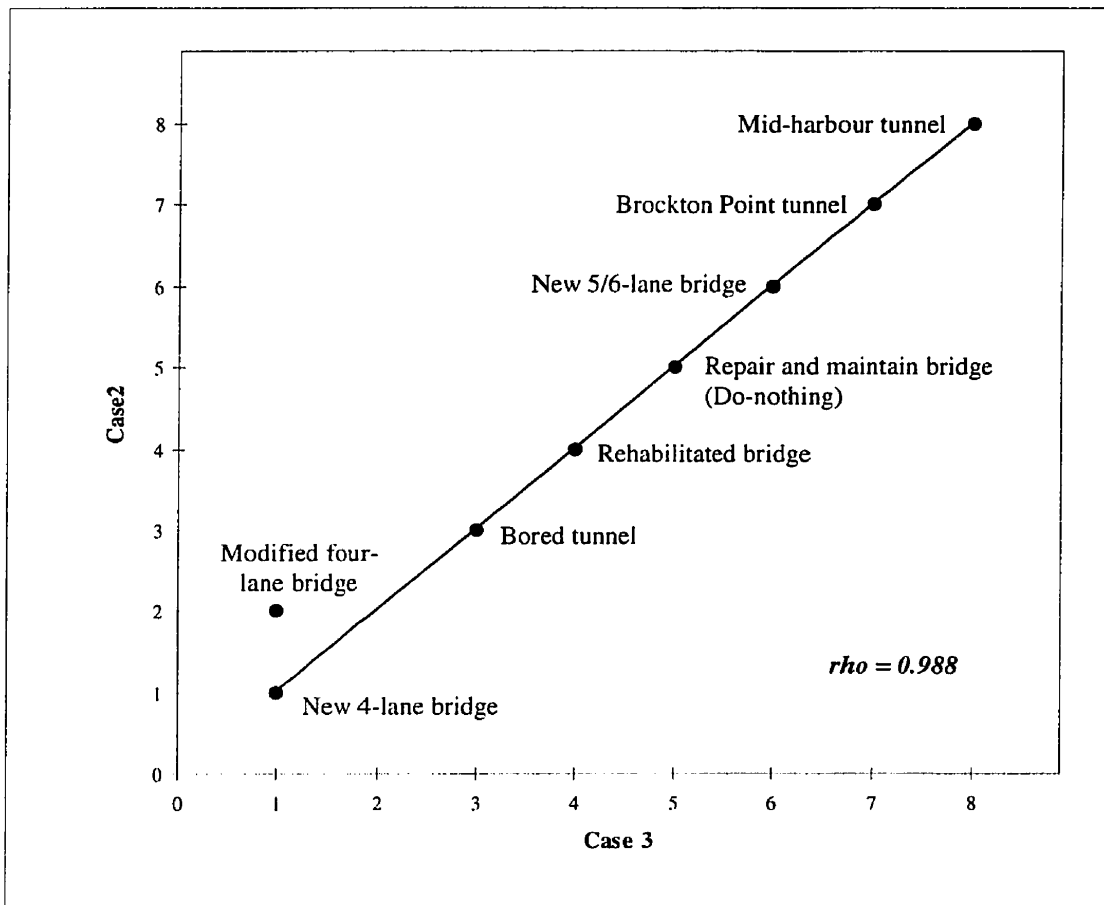


Figure 11. Relationship between Case 2 and Case 3 ranks.

Comparison of Public and Private Preference

Given the similarities and agreement among the respondents in both the public and private groups in the expression of preferences in the choice of alternatives, one might ask:

1. How strong is the concordance between the public and private groups? Or what is the *W* between the eight public and five private groups?
2. How do the *Ws* of the public and private groups compare with the rank correlation coefficients of the two groups?
3. What variability can one discern in the *Ws* between the four Vancouver public groups versus the four North Shore public groups? Similarly, how do the *Ws* of the three convergent private cases compare with that of the two divergent cases?
4. How does the *W* of thirteen public and private groups compare with that of eight public groups and five private groups?
5. What conclusions can one infer from this statistical analysis of public and private preferences with respect to decision making in providing a replacement for the Lion's Gate Bridge?

Table 21 presents a summary of the concordance analysis and rank correlations of the eight public and five private groups. The coefficient of concordance, *W*, for the eight public groups is 0.587, and for the five private groups is 0.514. The *W* for the combination of both public and private groups is 0.512. It is important to note that as the sample size of the group gets larger, the value of the *W* becomes smaller while the calculated chi-square value gets bigger. Despite this variation, the calculated chi-square values of the *Ws* are all highly significant. This shows that there is a very high degree of concordance displayed by the respondents of the public and private groups in their judgment of finding an alternative to replace the Lion's Gate Bridge.

When one compares the preferences of the respondents in the ranking of alternatives between the public and private groups (See Tables 17 and 19, and Figure 12), one notes that the public group prefers the modified bridge option as their premier choice, while the private group casts their favoured choice on the new four-lane bridge. This preference may not be surprising since the public group tends to stay more within the government's financial constraints, while the private group is more flexible in expressing their choice preference.

Table 21. Summary of Concordance Analysis and Rank Correlations

CONCORDANCE ANALYSIS	W	χ^2	SIGNIFICANCE LEVEL
8 Public Groups	0.587	32.896	0.001
4 Vancouver Groups	0.781	21.875	0.01
4 North Shore Groups	0.768	21.500	0.01
5 Private Groups	0.514	18.000	0.02
3 Convergent Cases	1.047	22.000	0.01
2 Divergent Cases	0.690	9.667	0.30
13 Public and Private Groups	0.512	46.603	0.001
RANK CORRELATIONS	rho	SIGNIFICANCE LEVEL	
8 Public Groups vs. 5 Private Groups	0.917	0.01	
8 Public Groups vs. 13 Public and Private Groups	0.976	0.01	
5 Private Groups vs. 13 Public and Private Groups	0.941	0.01	

One striking feature that emerges from this comparison is that when the two groups are combined into an 8 * 13 matrix of group ranks (Table 22), the alternative that shows up first in ranking preference is the new four-lane bridge. A concordance analysis of this matrix yielded not only an important W of 0.512 but also a highly significant calculated chi-square value of 46.603. The latter is significant beyond the 0.001 level with seven degrees of freedom. This means that the degree of concordance among the thirteen respondents is so strong in favour of a new four-lane bridge that the possibility that this concordance occurred by chance is less than one in a thousand. This strong concordance is consistent with the Spearman rank correlations between the eight public versus five private respondents, the eight public respondents versus all thirteen respondents, and the five private respondents versus all thirteen respondents, which yield rank correlation coefficients of 0.917, 0.976 and 0.941 respectively, as shown in Table 21.

Interesting features of Table 21 are the results of breaking the public and private groups into sub-groups. For example, one might separate the eight public groups into those based in Vancouver, namely, the British Columbia Transportation Financing Authority, the Vancouver Parks Board, the Friends of Stanley Park, and the City of Vancouver; and those based on the North Shore, namely, the Lower Capilano Steering Committee, the District of North Vancouver,

Table 22. Matrix of Public and Private Groups Ranks

Alternatives	BCTFA	VPB	FSP	LCSC	Van	NVD	NVC	WVD	Case 1	Case 2	Case 3	Case 4	Case 5	Sum	Rank
Repair bridge (Do-nothing)	8	7	3	8	8	8	8	7	5	5	5	8	8	88	8
Rehabilitate bridge	5	4	4	2	5	1	2	4	4	4	4	7	6	52	3
Modify bridge	1	2	1	1	2	3	4	1	1	2	1	3	7	29	2
New 4-lane bridge	2	3	1	4	1	4	1	3	1	1	1	2	1	25	1
New 5/6-lane bridge	3	6	6	5	4	7	7	8	8	6	6	1	5	72	6
4-lane bored tunnel	4	1	5	7	3	6	3	6	3	3	3	6	3	53	4
Brockton Point tunnel	7	8	7	6	7	5	6	5	7	7	7	4	4	80	7
Mid-harbour tunnel	6	5	8	3	6	2	5	2	6	8	8	5	2	66	5

the City of North Vancouver, and the District of West Vancouver. For the five private groups, one can group the convergent cases, Cases 1, 2, and 3, and the divergent cases viz. Cases 3 and 4.

Table 21 shows that the *W*s for the Vancouver sub-group (0.781), and for the North Shore sub-group (0.768) are considerably larger than the *W* of the public group as a whole (0.587). Similarly, the values of the *W*s for the three convergent private cases (1.047), and the two divergent cases (0.690) are higher than the *W* for the entire private group (0.514). The higher concordance values among the four sub-groups are due to the greater homogeneity in the rankings of alternatives.

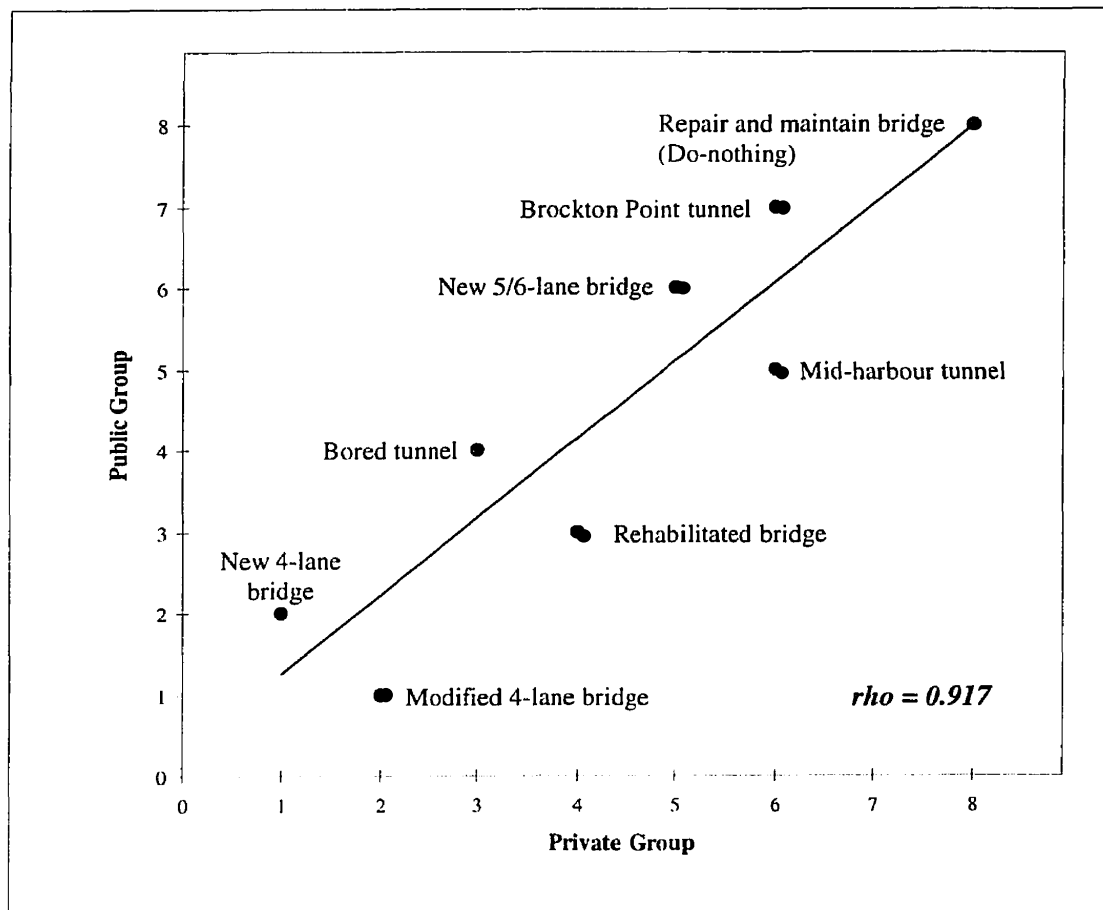


Figure 12. Relationship between Public and Private group ranks.

Summary

The comparison of public and private preferences shows that both the public and private groups recognize the pros and cons of a new and modified four-lane bridge. Both groups are

aware of the support for the four-lane bridges and the three-lane bridge rehabilitation, and many of the people spoken to feel that the political decision could go for a three or a four-lane bridge.

When one looks at the whole picture and considers the 8*13 matrix (Table 22), one sees that the new four-lane bridge emerges as the favoured choice, followed by a modified four-lane bridge. The respondents' least preferred alternative is to repair and maintain the bridge.

CHAPTER VI

FINDINGS, CONCLUSIONS AND IMPLICATIONS

Having presented the case study interviews and the comparison of public and private preferences, we come now to the final chapter. This chapter synthesizes the research findings, discusses the implications of the research, and suggests topics for further work. The findings from this study hopefully will provide some insights for understanding the choice process by showing which alternative is most preferred, and which option best replaces the Lion's Gate Bridge.

This chapter is organized into four parts. Part one focuses on the major findings from the Choices Forum. Part two highlights the findings from the case study interviews with the public and private groups. Part three deals with the implications of the study. Part four concludes with some suggestions for further research.

Choices Forum

The major findings from the Choices Forum that led to the government's preference for a four-lane bridge on the present alignment and a Stanley Park tunnel are:

1. Despite the lack of closure and consensus on a suitable solution from the Open Houses, Stakeholder Roundtables, and Information Up-date meetings, three main points emerged from these meetings. The first point was a consensus that Stanley Park must be protected. The stakeholders with the interests of Stanley Park at heart recognized that the government would never tunnel under the park if they chose to maintain three lanes. Hence, the only way the park would be 'saved' from the effects of automobiles (with a tunneled causeway) was by building a wider crossing. To secure the tunneled causeway option, there had to be support for a wider crossing. During the public meetings it became apparent that a lot of Vancouver and North Shore motorists were not satisfied with the narrow three-lane Lion's Gate Bridge and wanted to see improvements. The second point was that many Vancouver residents did not want to see traffic capacity (and hence traffic volume) on the crossing significantly increased. The public opposition to a crossing with more capacity came primarily from West End groups who feared their neighborhood would suffer from more traffic on Lion's Gate Bridge. This, coupled with some North Shore objection to a wider crossing helped seal the fate of a five or six-lane bridge or tunnel as nothing more than an idea on paper. The third point was that many people in the West End and North Shore did not want surrounding neighborhoods to be disrupted by increases in automobile traffic from the Lion's Gate

Bridge. While this ruled out a five or six-lane bridge, a four-lane crossing that did not increase peak direction capacity seemed reasonable.

2. While the public meetings failed to identify a preferred alignment, the present alignment was deemed preferable in the Acres, Community Focus Group, and *Transport 2021* reports. Further, the City of Vancouver was unwilling to accept any crossing east of Brockton Point, while people on the North Shore did not want disruptions to neighborhoods or the local street network with any crossing. This left the well-established current alignment being preferred over any other corridor.
3. In the face of constant public demands for an improved transit link between Vancouver and the North Shore, it was obvious that the province had little interest in pursuing this type of solution. A *North Shore Transit Options Report* (BC Transit 1994) identified a lack of North Shore transit patrons, transit priorities elsewhere in the Lower Mainland, and high costs as factors precluding major improvements to transit connections across Burrard Inlet. The transit issue dominated much of the debate at the public meetings and seemed to be a barrier in pinpointing which among the government's list of bridge replacement options was preferred by the public. In fact, the lack of transit options under consideration led to some degree of public distrust of the province's intentions and hampered any opportunity to gain public consensus on a favoured alternative.
4. Throughout the Choices Forum, local municipalities gave no indication that they would reject a four-lane crossing and Stanley Park tunnel. For example, the conditions set out by the City of Vancouver did not rule out a four-lane crossing, as long as it operates with two lanes in each direction. In addition, there was no evidence of North Shore municipal resistance to four lanes. This is probably because it was not known that tolls would be included until after the government announcement.
5. The preference for a four-lane bridge or tunnel remained unclear after the Choices Forum. The public meetings revealed no consensus on any option, while the opinions expressed on the comment sheets submitted by interested people revealed a split in preferences. Further, a 1997 public opinion poll reaffirmed the split in preference between a bridge and tunnel.
6. There were conflicting views on the feasibility of tolls. A government public opinion poll conducted after the completion of Choices showed that tolls were acceptable to the majority of Lower Mainland residents. Another poll of bridge users showed the majority opposed tolls.

Given these findings, one might conclude that the government's initial preference to proceed with a four-lane crossing was the most acceptable option to the public and politicians.

However, not everyone was pleased with the choice due to the lack of consensus among the stakeholders involved. On the other hand, there was a vocal group of West End residents who did not want to see capacity on the Lion's Gate Bridge increased. Rather they preferred to see better transit options. There were people and engineering firms who wanted to add more lanes to the bridge to alleviate traffic congestion. Between these divergent opinions were several people who did not support a big increase in traffic capacity on the bridge, but who were content with a four-lane crossing. Further, there were Stanley Park interest groups who would not accept any alternative that might harm the park. By adding one lane, the province addressed some of the non-peak direction traffic concerns, made a commitment to improve the condition of Stanley Park, and adhered to the City of Vancouver's condition for no additional peak direction capacity.

One might also conclude that the decision to charge tolls on any improved crossing was not proven to be sufficiently socially or politically feasible for implementation according to a government opinion poll. Although the North Shore municipalities showed no objection to a four-lane crossing throughout the Choices Forum, they were unaware that tolls would be included. Toll had been discussed during the Choices Forum as a distinct possibility to finance a bridge replacement solution, but the municipalities were surprised by the announcement and claim that they had not been consulted adequately beforehand. If tolls are unacceptable to the North Shore municipalities the government will have to opt for a three-lane rehabilitated bridge. This is what the government has recently decided.

The Case Study Interviews

The major findings from the thirteen selected case study interviews are:

1. The public group prefers for their first choice a modified four-lane bridge to replace the Lion's Gate Bridge, while the second choice is a new four-lane bridge. The criteria that have the strongest impact in influencing the choice for a modified four-lane bridge are economic, financial, and social feasibility.

The public respondents perceive several pros and cons of adding a lane to the Lion's Gate Bridge, namely, reducing one-lane direction queues in Vancouver and on the North Shore, improving motorist, pedestrian and cyclist safety, and improvements to Stanley Park. However, there is some concern on the North Shore that despite the additional capacity on a four-lane bridge, a tolled Lion's Gate Bridge will likely make people use the free Second Narrows Bridge more.

The province's meager \$70 million financial contribution to the Lion's Gate Bridge replacement leads several public decision makers to dismiss the more expensive alternatives

in order to avoid hefty tolls. The prospect of a large toll to cover the costs of an expensive tunnel crossing is perceived to be unpopular and unfair to motorists, especially given the immense cost of the Vancouver Island Highway that is being paid with taxpayers' dollars. One respondent explicitly states that any option costing more than \$300 to \$400 million will be impossible to pay for with only a two-dollar toll on the crossing.

The public group recognizes that people expect some bridge improvements after such a lengthy public process. However, they also realize that the public will not accept a crossing with five or six lanes. Given this, a modified four-lane bridge is perceived to be more socially feasible than any other option.

2. Unlike the public group, the private group shows a preference for a new four-lane bridge. This preference is most influenced by the strong impact of technical, economic, and social feasibility.

The private respondents perceive a new bridge to be a technically superior crossing to a modified four-lane bridge. There is concern among some of the group members that the structural problems on the Lion's Gate Bridge might be difficult to overcome by simply modifying it. They feel that meeting current design and safety standards can be more easily accomplished by starting from scratch on a new bridge. This would also avoid having to work with parts of the bridge that are currently in acceptable condition, but might deteriorate beyond repair in a few years.

Like the public group, the private group also recognizes several pros and cons of a four-lane bridge. However, the private group perceives a new four-lane bridge to be more economically feasible than a modified one.

The private group respondents feel that the public prefers a four-lane bridge as a replacement alternative. While there is a split in opinions on this issue among the public respondents, there is a general consensus in the private group that most people want a four-lane bridge. However, both groups feel that the political decision for a three-lane rehabilitation, a modified four-lane bridge or new four-lane bridge could go in favour of any of these three alternatives.

It is evident that the preferred choice of alternatives by the public and private respondents in this study comes down to a modified or a new four-lane bridge. One might hasten to add that while the public group prefers a modified bridge as their primary choice, their second preference is a new four-lane bridge. Likewise, the private group's primary preference for a new four-lane bridge is complemented by a modified bridge as a secondary preference.

3. When the preferences of the public and private groups are combined (see Table 22), we

discern immediately that a new four-lane bridge emerges as the favoured choice, followed by a modified four-lane bridge as a secondary choice. The concordance among the public and private respondents in expressing their preference is so strong that not one in a thousand could this agreement have occurred by chance.

Implications for Urban Transportation Planning

The findings and conclusions from this study have some implications for urban transportation planning on the Lion's Gate Bridge project and for future bridge replacement projects in the province.

First, the research conclusions are important in that they contribute to our understanding of the public and private choice processes leading to a possible solution to the Lion's Gate Bridge problem. By examining the groups' perceptions of the replacement alternatives based on the eight selected criteria, we have gained insights into how the groups reach their decisions, and which criteria have the strongest influence in making choice. The in-depth interviews with key stakeholders, in conjunction with public meetings and forums, have not only provided insight for a better understanding of decision making, but also have helped us make better suggestions for policy formulation.

Second, in light of the controversial nature of the Lion's Gate Bridge replacement, achieving consensus among stakeholders on the problem is impossible, let alone the effort for successful public input into the choice process. The fact that the public meetings during the Choices Forum failed to reach a consensus on a suitable bridge replacement or even the best alignment is not surprising, given the gap between the stakeholder group and government perceptions of the problem. Despite constant reminders from the consultants in charge of the Forum that the province only intended to address the bridge's structural problems, distrust and animosity grew to the point where meetings erupted into shouting matches. If the province had sat down with representatives from the stakeholder groups before the public meetings to discuss its goals and objectives pertaining to the Lion's Gate Bridge replacement, much of the misunderstanding could have been avoided. Informing the groups of the reasons why broader transportation problems could not be incorporated into this project in the presence of two or three hundred frustrated people at a public meeting proved to be a hollow effort. A better approach might be to hold small meetings, as the government is currently doing, to listen to concerns and try to reach agreement on contentious issues, such as the bridge problem statement. This would probably be more productive in resolving which alternative is most appropriate in dealing with the problem.

Third, the options under consideration should reflect the problem under consideration. At the Proponents' Showcase for the Lion's Gate project, several transit options were advanced for the government's consideration. If the government's goal is to fix the bridge's structural problems, why did the province entertain transit solutions? Leaving the table open to any and all ideas and proposals only confused the stakeholder groups and prohibited agreement on a suitable bridge replacement.

Finally, the study has shown that risks and errors arise if stakeholders are not consulted before a decision is made. For example, the North Shore municipalities claim that they were not consulted about the Lion's Gate Bridge replacement decision and thus were very surprised when they heard the government announcement. Even though the analysis shows that there is a strong concordance among the groups in their preference of alternatives, there is disagreement between the North Shore municipality respondents and the British Columbia Transportation Financing Authority respondent on the social feasibility of tolls. This disagreement has led to some strong North Shore objection to the province's plan to put a toll exclusively on the Lion's Gate Bridge. However, most of the respondents in this study perceive a three-lane bridge rehab to be just as politically feasible as a four-lane bridge. Nevertheless, given the time and money spent on the Choices Forum, one could end up with the same thing one started with: a three-lane bridge. This has some implications for future urban transportation planning in British Columbia. As the provincial government is increasingly implementing user pay schemes as a means of reducing debt, it is important that we determine how acceptable these schemes are. Otherwise, we are only wasting our tax dollars the Lion's Gate Bridge project has shown.

Suggestions for Further Study

This study has been accomplished not without problems. Throughout the course of the investigation in the research, the author was faced with numerous problems. Among these were the sample size issue, the difficulty in getting responsible decision makers associated with the project to give time for interviews, the reluctance of some respondents to speak freely when asked questions, and the constant change in the list of options under consideration. Despite these constraints, the study has yielded some tentative findings and conclusions, which provide interesting insights that might be useful for future urban transportation project policy formulation. Due to the small sample size of the public and private groups, it is quite evident that the conclusions that emerge from the study can only be tentative and incomplete.

To complement this study, further work is needed in at least some of the following areas:

1. Have a more representative sample of important interviewees, viz., key decision makers

involved in the project. However, this can only be achieved if there is cooperation from potential respondents to give time for interviews, and in answering interview questions. Unless key decision makers involved in a study like the Lion's Gate Bridge replacement are accessible to the interviewer, any suggestions for policy formulation are unlikely to have any weight.

2. Sharpen the decision matrix by converting the feasibility and impact criteria into a series of indices by means of a scale. For example, for technical feasibility, one might create a technical feasibility index and scale it as follows:

-1 means the alternative is not feasible or unacceptable.

0 means project feasibility is neutral.

1 means project feasibility is acceptable and gainful.

For economic, financial, social, and political feasibility indices, the same scale values might be applied. In the case of spatial, environmental, and aesthetic impacts one might refer the scale notations to imply the following:

-1 means the impact is negative.

0 means the impact is neutral

1 means the impact is positive.

Through the use of a three-point scale in the form of a series of feasibility and impact indices, one can thus improve and sharpen the judgmental rating of preferences in the choice process for effective decision making in project evaluation. Such a depiction of the evaluative criteria no doubt enhances the judgmental value of the decision matrix and provides better insights of the choice process than the use of merely qualitative factors in decision making studies.

Using an index like this would allow one to attach a qualitative statement to each of the rating factors assigned by the respondents, and would give some good insights into the choice of alternatives.

3. Improve public awareness about the issues affecting decision making in choosing a bridge replacement. Although the respondents in this study are quite knowledgeable about the major issues surrounding the bridge project, the general public should have more summary information about the problems for better-informed judgments. The public information office in the West End did a good public relations job by providing people with several technical studies, but most of the reports did not have enough social and economic information for a curious citizen to make careful judgment. Collected articles like the *Vancouver Sun's* four-

page information package (September 15, 1993) were a good start to inform people about the Lion's Gate Bridge project. However, more of such efforts are needed.

4. Examine the feasibility of establishing a bridge or tunnel authority to operate and maintain the Lion's Gate Bridge. A bridge or tunnel authority to raise funds to finance the crossing, collect tolls and manage toll revenue to pay for the bridge replacement solution is essential. Unless money can be raised through some kind of authority, there will always be opposition to the use of tolls whenever the issue is mentioned.
5. Investigate the pros and cons of a bridge versus tunnel regarding flexibility of incorporating future transit improvements to the North Shore. As noted throughout this study, connecting Vancouver and the North Shore with rapid transit was a major concern for the public participants in the Choices Forum. Even if the desired rapid transit connection will not be built in the next ten or twenty years, one should look at how the current choice of alternatives to replace the Lion's Gate Bridge will accommodate future transit improvements, such as exclusive bus lanes, or rail connections.
6. Further research could make use of criteria other than the eight used in this study to evaluate the alternatives to replace the Lion's Gate Bridge. For example, the importance of native lands right of way, territorial integrity of Stanley Park, ecological disruption of the environment, obstruction of Port of Vancouver, and accessibility to downtown.
7. Do a bridge versus tunnel evaluation to see which one would better fit the visionary plan in the future development and growth of Greater Vancouver. How well do the alternatives fit into the *Transport 2021*, *Going Places*, and *Livable Region Strategy* plans? How compatible are the options with local municipal growth plans? Which option provides the best transportation function? What type of option is most compatible with community values? How would a toll on the Lion's Gate Bridge, or on all crossings in Greater Vancouver impact the future of British Columbia's tourism industry, which is becoming increasingly important to the provincial economy? How would each of the options impact future economic development in the Lower Mainland? These are some possible questions that could be explored in future investigations for a replacement of the Lion's Gate Bridge.

APPENDIX

Interview Structure

1) Technical Feasibility

- Technical performance of bridge or tunnel design.
- Impact on traffic flow efficiency?
- Improvements to traffic safety for cars?
- Cyclists?
- Pedestrians?

2) Economic Feasibility

- Benefit-cost analysis done?
- Gains and Losses, or pros and cons?
- How do these compare among each other?

3) Financial Feasibility

- Cost-effectiveness of options?
- How do they compare among each other?
- How long to repay?
- Preferred cost-sharing arrangement?
- Does this ensure equity?

4) Social Feasibility

- Any public feedback or approval?
- Social desirability of options?

5) Political Feasibility

- Any political feedback or approval? From whom?
- Political acceptability of options?
- What will politicians support?

6) Spatial Impact

- Any traffic impacts on surrounding areas?
- Downtown Vancouver?
- West End?
- North Shore?
- Second Narrows?
- Other areas?

7) Environmental Impact

- Any impacts on noise generation in Stanley Park?
- West End?
- Downtown
- North Shore?
- Other areas?
- Impacts on air pollution in Stanley Park?
- West End ?
- Downtown?

- North Shore?
- Other areas?

8) Aesthetic Impact

- Any impacts on the bridge's appearance ?
- Impacts on the bridge as an icon or heritage structure?
- Any aesthetic impacts on the surrounding landscape?

Decision Matrix
Lion's Gate Bridge Replacement

Introduction

Hello, my name is Mike Belyea. I am a graduate student in the Department of Geography at Simon Fraser University and am writing a masters thesis on decision-making in the choice of alternatives to replace the Lion's Gate Bridge. As part of my research I need to know how people express preferences in the choice process. To do this I have to conduct some field interviews with a number of people and interest groups who are concerned with the bridge problem. The information you provide me will be strictly confidential and you will not be named in the study. This information is crucial to my research in evaluating the choice process and in making suggestions for a suitable replacement for the Lion's Gate Bridge. Your cooperation for my research is greatly appreciated.

The information that I need in evaluating the choice process requires your judgment in rating the influence which each of eight criteria has on your preference for the choice of alternatives to replace the Lion's Gate Bridge. In rating the influence which each criterion has on your preference for an alternative, a performance scale of 1 to 10 (based on eight criteria) where 10 is highest and 1 is the lowest score, is used. For your information, the eight criteria which are deemed to have an influence on the choice process are:

1. Technical Feasibility - This criterion deals with the technical capability and performance of the alternative, and how it affects traffic flow efficiency and traffic safety on the crossing.
2. Economic Feasibility - This criterion is concerned with the economic benefits and costs, or gains and losses of the alternative.
3. Financial Feasibility - This criterion deals with the cost-effectiveness of the alternative, the rate of repayment, cost-sharing arrangement and the availability of funds to carry out the project.
4. Social Feasibility - This criterion deals with public support and social desirability of the alternative.
5. Political Feasibility - This criterion is concerned with the degree of support and consensus which the politicians and elected representatives give to the alternative.

6. Spatial Impacts - This criterion deals with the impacts on traffic which the alternative has in areas near or adjacent to the bridge and Stanley Park.

7. Environmental Impacts - This criterion deals with the impacts that an alternative will have on the air and noise pollution generated by it in Stanley Park and around Burrard Inlet.

8. Aesthetic Impacts - This criterion is concerned with the visual impacts that the alternative will have on the bridge and surrounding landscape.

The short-listed alternatives that have been presented for public feedback are:

1. Repair and maintain the existing bridge - Involves on-going maintenance for about 5 years, when more intensive rehabilitation will be required. Annual costs currently exceed \$2 million.

2. Rehabilitate and widen the bridge with three wider lanes - Requires widening lanes by replacing the driving deck and cantilevering the sidewalks on the outside of the bridge. The towers and cables will undergo maintenance. This will result in the need for night time bridge closures. The cost is now estimated to be \$ 70 million.

3. Modify the bridge to four lanes - The cables and driving deck will be replaced and the towers will be strengthened and heightened. Night time closures will be necessary. Costs are between \$100 and \$300 million.

4. New four-lane bridge - A cable-stayed bridge located just to the east of the present bridge will be built. Costs are between \$135 and \$420 million.

5. New five or six-lane bridge - Like the new four-lane bridge, a cable-stayed bridge will be built just to the east of the present bridge. Costs run between \$150 and \$490 million.

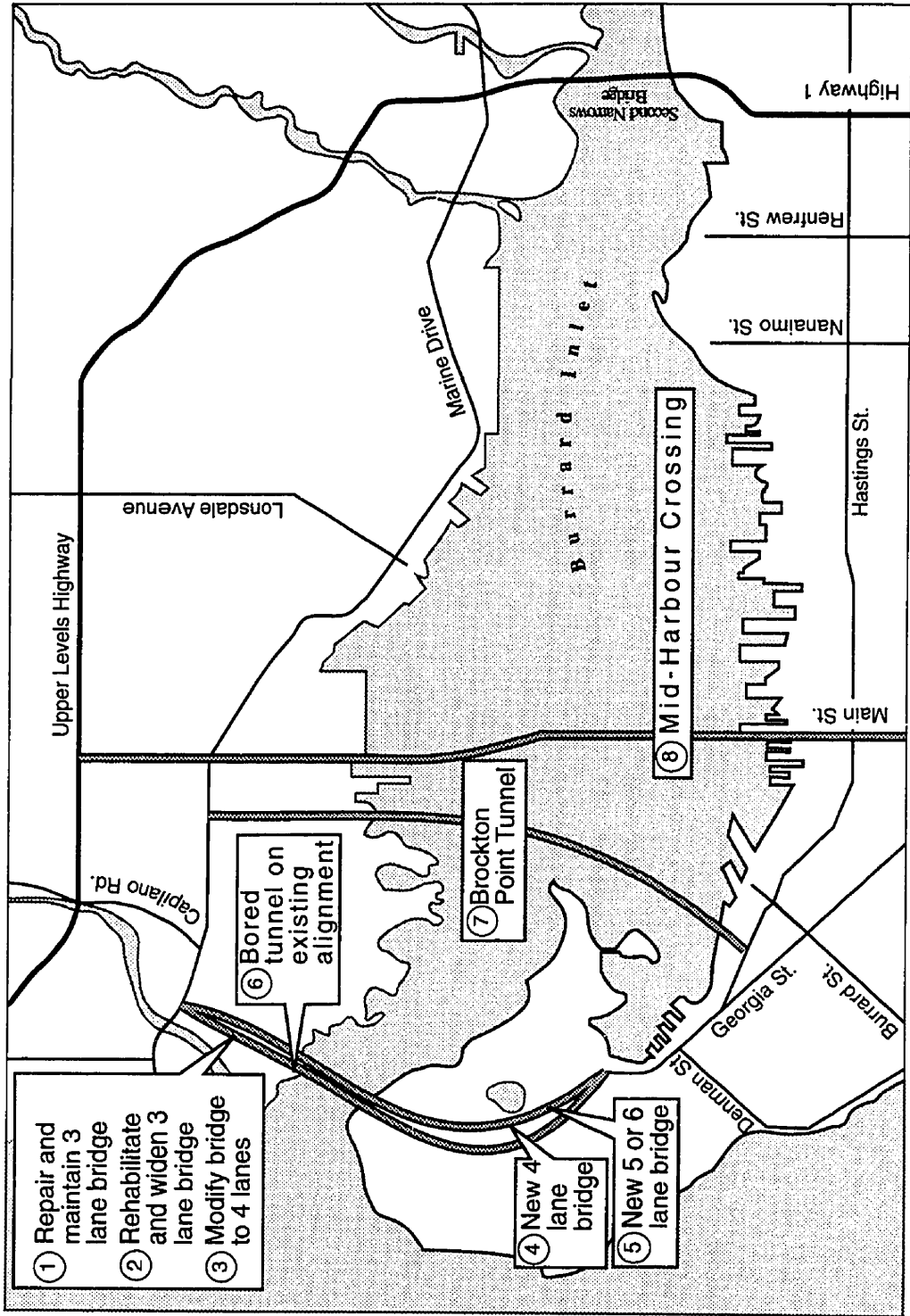
6. Bored tunnel on the existing alignment - Two two-lane tunnels, with ventilation shafts in Stanley Park, will follow the same route as the present causeway and bridge. Between 30 and 50% of Lost Lagoon will be dewatered for the South Shore tunnel portal. The cost is approximately \$350 million.

7. Immersed tube tunnel on Brockton Point alignment - A tunnel from the foot of Bute and Jervis Streets passes under Burrard Inlet and connects with a three-level interchange on the North Shore. Downtown by-pass tunnels will take traffic to Nelson and Smithe Streets. Land on a proposed island in Coal Harbour, to be built with the spoil from tunnel construction, is hoped to be sold to developers in order to offset the \$1 billion price tag.

8. Mid-Harbour Crossing - This involves a tunnel that connects the Main Street area in East Vancouver near the Via Rail station with the BC Rail station on the North Shore, by crossing under the middle of Vancouver Harbour. The cost is around \$1 billion.

Based on these eight criteria and eight short-listed alternatives, a matrix is drawn for you to fill in your judgment scores.

Map of Alternatives



Selected Criteria	Technical Feasibility	Economic Feasibility	Financial Feasibility	Social Feasibility	Political Feasibility	Spatial Impacts	Environmental Impacts	Aesthetic Impacts	Sum
Proposed Alternatives									
Repair and maintain existing bridge									
Rehabilitate and widen bridge with 3 wider lanes									
Modify existing bridge to 4 lanes									
New 4-lane bridge on existing alignment									
New 5 or 6-lane bridge on existing alignment									
4-lane Bored tunnel on existing alignment									
Brockton Point tunnel									
Mid-Harbour Crossing (As a 3rd Crossing)									

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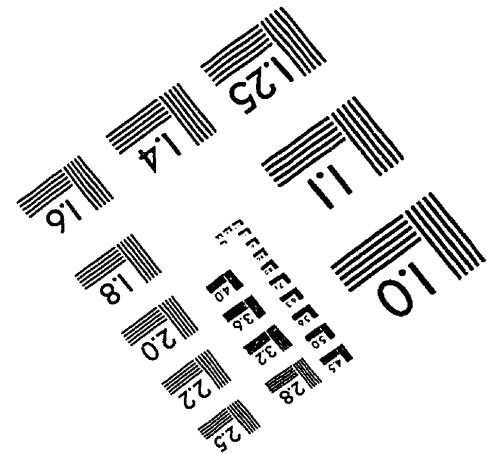
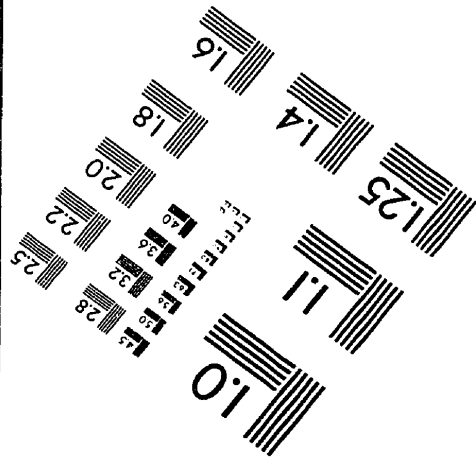
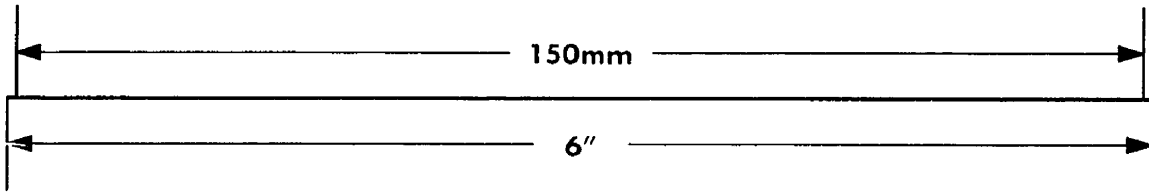
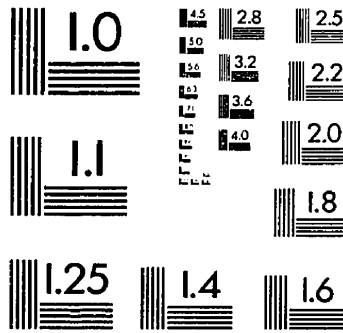
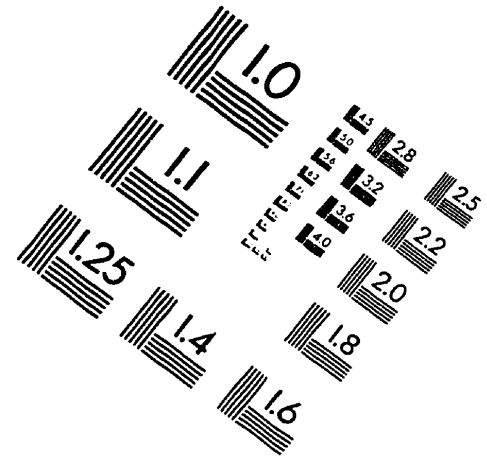
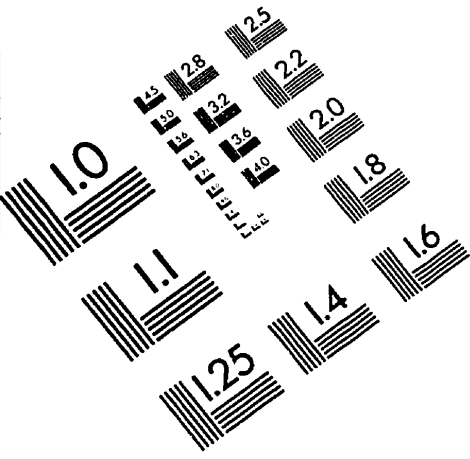
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IMAGE EVALUATION TEST TARGET (QA-3)



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