



**Regular Council**

**Tuesday, February 14, 2017**

Place: Council Chambers  
Richmond City Hall

Present: Mayor Malcolm D. Brodie  
Councillor Chak Au  
Councillor Derek Dang  
Councillor Carol Day  
Councillor Ken Johnston  
Councillor Alexa Loo  
Councillor Bill McNulty  
Councillor Linda McPhail  
Councillor Harold Steves

Corporate Officer – David Weber

Call to Order: Mayor Brodie called the meeting to order at 7:00 p.m.

RES NO. ITEM

**MINUTES**

- R17/3-1 1. It was moved and seconded  
*That:*
- (1) *the minutes of the Regular Council meeting held on January 23, 2017, be adopted as circulated; and*
  - (2) *the Metro Vancouver 'Board in Brief' dated January 27, 2017, be received for information.*

**CARRIED**



**Regular Council**  
**Tuesday, February 14, 2017**

COMMITTEE OF THE WHOLE

- R17/3-2      2.    It was moved and seconded  
*That Council resolve into Committee of the Whole to hear delegations on agenda items (7:05 p.m.).*

**CARRIED**

3.    Delegation from the floor on an Agenda item.

Bylaw No. 9663 - Consolidated 5 Year Financial Plan (2017-2021)

Don Flintoff, 6071 Dover Road, commented on correspondence he received from the City in response to a number of questions he had submitted, related to information included in the 2017-2021 Consolidated 5 Year Financial Plan. He suggested that the accuracy of some of the information in the report required further clarification, before being released to the public. Mr. Flintoff requested that Council delay consideration of Bylaw No. 9663 pending its further review. In response to questions, Mr. Flintoff suggested the City consider the District of West Vancouver's public communication process, which includes open houses.

- R17/3-3      4.    It was moved and seconded  
*That Committee rise and report (7:13 p.m.).*

**CARRIED**

CONSENT AGENDA

- R17/3-4      5.    It was moved and seconded  
*That Items No. 6 through No. 18, with the removal of Item No. 9 be adopted by general consent.*

**CARRIED**



**Regular Council**  
**Tuesday, February 14, 2017**

6. **COMMITTEE MINUTES**

*That the minutes of:*

- (1) *the Parks, Recreation and Cultural Services Committee meeting held on January 24, 2017;*
  - (2) *the General Purposes Committee meeting held on February 6, 2017;*
  - (3) *the Finance Committee meeting held on February 6, 2017; and*
  - (4) *the Planning Committee meeting held on February 7, 2017;*
- be received for information.*

**ADOPTED ON CONSENT**

7. **2017 HEALTH, SOCIAL AND SAFETY GRANTS**

(File Ref. No. 03-1085-01) (REDMS No. 5254911 v. 2, 5136190, 5279189, 5284099, 5277653, 5278153, 5277674, 5277755, 5277715, 5278007, 5277655, 5277986, 5278042, 5277677, 5277695, 5277679, 5277684, 5278156, 5277651, 5277842, 5277761, 5277864, 5277991, 5277983, 5277656, 5277685, 5278159, 5278025, 5277683, 5278067, 5278154, 5277682, 5277658, 5277773, 5278155, 5277654, 5278152, 5277982)

*That, as per the report from the General Manager of Community Services, dated January 11, 2017:*

- (1) *Health, Social and Safety Services Grants be awarded for the recommended amounts, and cheques disbursed for a total of \$586,095;*
- (2) *The following applicants be approved for the first year of a three-year funding cycle, based on Council approval of each subsequent year of funding, for:*
  - (a) *Big Brothers of Greater Vancouver; and*
  - (b) *Big Sisters of BC Lower Mainland; and*
- (3) *The following applicants be approved for the second year of a three-year funding cycle, based on Council approval of each subsequent year of funding, for:*
  - (a) *Community Mental Wellness Association of Canada*
  - (b) *Heart of Richmond AIDS Society*



**Regular Council**  
**Tuesday, February 14, 2017**

- (c) *Richmond Mental Health Consumer and Friends Society*
- (d) *Richmond Society for Community Living*
- (e) *Richmond Women's Resource Centre; and*
- (4) *The following applicants be approved for the third year of a three-year funding cycle:*
  - (a) *Chimo Community Services*
  - (b) *Family Services of Greater Vancouver*
  - (c) *Pathways Clubhouse*
  - (d) *Richmond Addiction Services Society*
  - (e) *Richmond Family Place Society*
  - (f) *Richmond Multicultural Community Services*
  - (g) *Richmond Youth Service Agency; and*
  - (h) *Volunteer Richmond Information Services Society.*

**ADOPTED ON CONSENT**

**8. 2017 CHILD CARE GRANTS**

(File Ref. No. 03-1085-01) (REDMS No. 5281754 v. 1A, 3955623, 4731429, 5273751, 5287644, 5316921, 5316920, 5316924, 5316923, 5316922, 5316925)

- (1) *That, as outlined in the report from the General Manager of Community Services, dated January 10, 2017, the Child Care Capital Grants be awarded for the recommended amounts, and cheques be disbursed for a total of \$8,536.62; and*
- (2) *That, as outlined in the report from the General Manager of Community Services, dated January 10, 2017, the Child Care Professional and Program Development Grants be awarded for the recommended amounts, and cheques be disbursed for a total of \$10,000.*

**ADOPTED ON CONSENT**



**Regular Council**  
**Tuesday, February 14, 2017**

9. **2017 PARKS, RECREATION AND COMMUNITY EVENTS GRANTS**  
(File Ref. No. 03-1085-01) (REDMS No. 5223432 v. 6, 5229427, 5203163, 5283821, 5278187, 5278188, 5278178, 5278172, 5278176, 5278167, 5278177, 5278170, 5278164, 5278163, 5278166, 5278171, 5278189, 5278191)

Please see Page 8 for action on this matter.

10. **2017 ARTS AND CULTURE GRANT PROGRAM**  
(File Ref. No. 03-1085-01) (REDMS No. 5280279, 4891049, 5264256, 4891045, 5283821, 5277604, 5277612, 5277632, 5277621, 5277630, 5276801, 5277628, 5276774, 5277633, 5277614, 5277617, 5277643, 5277614, 5277617, 5277643, 5272963, 5277618, 5277622, 5277619, 5277623, 5277636, 5277639, 5277625, 5277641, 5277637)

*That the 2017 Arts and Culture Grants be awarded for the recommended amounts and cheques disbursed for a total of \$109,754, as outlined in the report from the Director, Arts, Culture and Heritage Services, dated January 10, 2017.*

**ADOPTED ON CONSENT**

11. **REVENUE ANTICIPATION BORROWING (2017) BYLAW NO. 9674**  
(File Ref. No. 12-8060-20-009674) (REDMS No. 5280973 v. 2, 5280990)
- (1) *That Revenue Anticipation Borrowing (2017) Bylaw No. 9674 be introduced and given first, second and third readings; and*
- (2) *That staff be directed to notify Council if credit facilities are utilized.*

**ADOPTED ON CONSENT**

12. **DEVELOPMENT COST CHARGES IMPOSITION BYLAW NO. 9499**  
(File Ref. No. 12-8060-20-009499) (REDMS No. 4757567 v. 11, 4661434, 4757567, 5280191, 2729228, 5299838, 5295576, 5304615)

*That Development Cost Charges (DCC) Imposition Bylaw No. 9499 be introduced and given first, second and third readings.*

**ADOPTED ON CONSENT**



**Regular Council**  
**Tuesday, February 14, 2017**

**13. RICHMOND SENIORS ADVISORY COMMITTEE 2016 ANNUAL REPORT AND 2017 WORK PROGRAM**

(File Ref. No. 07-3400-01, 01-0100-30-SADV1-01) (REDMS No. 5290445, 5290454, 5257462)

*That the staff report titled, "Richmond Seniors Advisory Committee 2016 Annual Report and 2017 Work Program", dated January 14, 2017, from the General Manager, Community Services, be approved.*

**ADOPTED ON CONSENT**

**14. CHILD CARE DEVELOPMENT ADVISORY COMMITTEE 2016 ANNUAL REPORT AND 2017 WORK PROGRAM**

(File Ref. No. 07-3070-01, 01-0100-30-CCDE1-01) (REDMS No. 5285393)

*That the Child Care Development Advisory Committee's 2016 Annual Report and 2017 Work Program, as outlined in the staff report titled, "Child Care Development Advisory Committee 2016 Annual Report and 2017 Work Program," from the General Manager, Community Services, be approved.*

**ADOPTED ON CONSENT**

**15. APPLICATION BY AJIT THALIWAL AND RAMAN KOONER FOR REZONING AT 9320 DIXON AVENUE FROM "SINGLE DETACHED (RS1/B)" TO "SINGLE DETACHED (RS2/K)"**

(File Ref. No. 12-8060-20-009624; RZ 16-735119) (REDMS No. 5161511, 4573372, 5176053)

*That Richmond Zoning Bylaw 8500, Amendment Bylaw 9624, for the rezoning of 9320 Dixon Avenue from "Single Detached (RS1/B)" to "Single Detached (RS2/K)", be introduced and given first reading.*

**ADOPTED ON CONSENT**

**16. APPLICATION BY 1002397 BC LTD. FOR REZONING AT 9851, 9891/9911 STEVESTON HIGHWAY AND 10931 SOUTHGATE ROAD FROM SINGLE DETACHED (RS1/E) TO LOW DENSITY TOWNHOUSES (RTL4)**

(File Ref. No. 12-8060-20-009659; RZ 10-552879) (REDMS No. 5243375, 5243365)

*That Richmond Zoning Bylaw 8500, Amendment Bylaw 9659, for the rezoning of 9851, 9891/9911 Steveston Highway and 10931 Southgate Road from the "Single Detached (RS1/E)" zone to the "Low Density Townhouses (RTL4)" zone, be introduced and given first reading.*

**ADOPTED ON CONSENT**



Regular Council  
Tuesday, February 14, 2017

- 17. **APPLICATION BY WESTMARK DEVELOPMENTS LTD. FOR REZONING AT 7140/7160 MARRINGTON ROAD FROM TWO-UNIT DWELLINGS (RD1) TO SINGLE DETACHED (RS2/B)**  
(File Ref. No. 12-8060-20-009668; RZ 16-741244) (REDMS No. 5257121, 1081048, 5262680)

*That Richmond Zoning Bylaw 8500, Amendment Bylaw 9668, for the rezoning of 7140/7160 Marrington Road from “Two-Unit Dwellings (RD1)” to “Single Detached (RS2/B)”, be introduced and given first reading.*

**ADOPTED ON CONSENT**

- 18. **APPLICATION BY SANSAAR INVESTMENTS LTD. FOR REZONING AT 11660/11680 MONTEGO STREET FROM TWO-UNIT DWELLINGS (RD1) TO SINGLE DETACHED (RS2/C)**  
(File Ref. No. 12-8060-20-009673; RZ 16-741547) (REDMS No. 5256478, 280602, 5283946)

*That Richmond Zoning Bylaw 8500, Amendment Bylaw 9673, for the rezoning of 11660/11680 Montego Street from “Two-Unit Dwellings (RD1)” to “Single Detached (RS2/C)”, be introduced and given first reading.*

**ADOPTED ON CONSENT**

\*\*\*\*\*

CONSIDERATION OF MATTERS REMOVED FROM THE  
CONSENT AGENDA

\*\*\*\*\*

In accordance with Section 100 of the *Community Charter*, Councillor Alexa Loo declared a potential conflict of interest with respect to Item No. 9, given her appointment as a Director for Kidsport – Richmond Chapter and left the meeting at 7:54 p.m.



**Regular Council**  
**Tuesday, February 14, 2017**

9. **2017 PARKS, RECREATION AND COMMUNITY EVENTS GRANTS**  
(File Ref. No. 03-1085-01) (REDMS No. 5223432 v. 6, 5229427, 5203163, 5283821, 5278187, 5278188, 5278178, 5278172, 5278176, 5278167, 5278177, 5278170, 5278164, 5278163, 5278166, 5278171, 5278189, 5278191)

R17/3-5

It was moved and seconded

- (1) *That Parks, Recreation and Community Events Grants be allocated and cheques disbursed for a total of \$103,250 as identified in Attachment 1 of the staff report titled "2017 Parks, Recreation and Community Events Grants," dated January 11, 2017, from the Senior Manager, Recreation and Sport Services;*
- (a) *with an additional \$500 added to the cheques for the Richmond City Centre Community Association and the Richmond Fitness and Wellness Association; and*
- (b) *an additional \$1,758 added to the cheque for Kidsport – Richmond Chapter;*
- (2) *That Sea Island Community Association not be approved for a three-year funding cycle, but be approved for consideration as a minor grant application; and*
- (3) *That Steveston Community Society – Richmond Summer Project be approved for the third year of a three-year funding cycle.*

**CARRIED**

Councillor Alexa Loo returned to the meeting at 7:56 p.m.

**PUBLIC ANNOUNCEMENTS**

Mayor Brodie announced the release of resolutions, associated report and memorandum from the October 11, 2016 Regular Closed Council meeting and the November 7, 2016 Special Closed meeting relating to the transfer of assets from the City of Richmond to the Lulu Island Energy Company.





Regular Council  
Tuesday, February 14, 2017

NEW BUSINESS

18A. **GEORGE MASSEY TUNNEL**

(File Ref. No. 10-6350-06-02)

Councillor Steves distributed materials related to the George Massey Tunnel (attached to and forming part of these Minutes as Schedule 1).

R17/3-6

It was moved and seconded

*Whereas the Massey Tunnel was built in a liquefaction zone, and*

*Whereas drilling for natural gas in 1901 and 1932 brought up sand, mud and water from depths of 700, 800 and 1,000 feet, and*

*Whereas a tunnel was built instead of a bridge because "it was almost impossible to find firm foundation for one lofty enough to provide clearance for the ocean going freighters that frequent the river route," and*

*Whereas test drills have been made at the Massey Tunnel site,*

*Richmond Council requests through Freedom of Information: drill tests, reports, recommendations, plans, correspondence, emails etc. on the depth to bedrock, soil stability, feasibility and types of foundations to be considered for a new bridge, resulting bridge stability, earthquake risk and costs of construction, and*

*Further, as the bridge is designed for public transit and the CNR line across Richmond has previously been listed for sale, Richmond requests any feasibility studies, costs, reports or correspondence on the feasibility of ground level or elevated rail rapid transit across the new bridge and any similar materials on using the existing tunnel or an added tube for LRT.*

**CARRIED**

BYLAWS FOR ADOPTION

R17/3-7

It was moved and seconded

*That the following bylaws be adopted:*

*Business Licence Bylaw 7360, Amendment Bylaw No. 9632*



**Regular Council**  
**Tuesday, February 14, 2017**

*DCC Reserve Fund Expenditure (4000 May Drive) Bylaw No. 9643*  
*Consolidated 5 Year Financial Plan (2017-2021) Bylaw No. 9663*  
*Richmond Zoning Bylaw No. 8500, Amendment Bylaw No. 9569*  
*Richmond Zoning Bylaw No. 8500, Amendment Bylaw No. 9608*  
*Richmond Zoning Bylaw No. 8500, Amendment Bylaw No. 9614*

**CARRIED**

**DEVELOPMENT PERMIT PANEL**

R17/3-8

19. It was moved and seconded

- (1) *That the minutes of the Development Permit Panel meeting held on January 25, 2017, and the Chair's report for the Development Permit Panel meetings held on October 12, 2016, October 26, 2016, January 11, 2017 and January 25, 2017, be received for information;*
- (2) *That the recommendations of the Panel to authorize the issuance of:*
  - (a) *a Development Permit (DP 15-709934) for the property at 4991 No. 5 Road; and*
  - (b) *a Development Variance Permit (DV 16-733949) for the property at 9580 Williams Road (Formerly 9580 and 9600 Williams Road and 10140 Gower Street) and 10060 Gower Street;**be endorsed, and the Permits so issued; and*
- (3) *That the changes to the design be deemed to be in General Compliance with the Development Permit (DP 11-564405) issued for the property at portions of 10111, 10197 and 10199 River Drive (formerly portions of 10111 and 10199 River Drive).*

**CARRIED**

Council extended appreciation to City road crews for their commendable road maintenance work during the recent snowstorms.



**Regular Council**  
**Tuesday, February 14, 2017**

**ADJOURNMENT**

R17/3-9

It was moved and seconded  
*That the meeting adjourn (8:17 p.m.).*

**CARRIED**

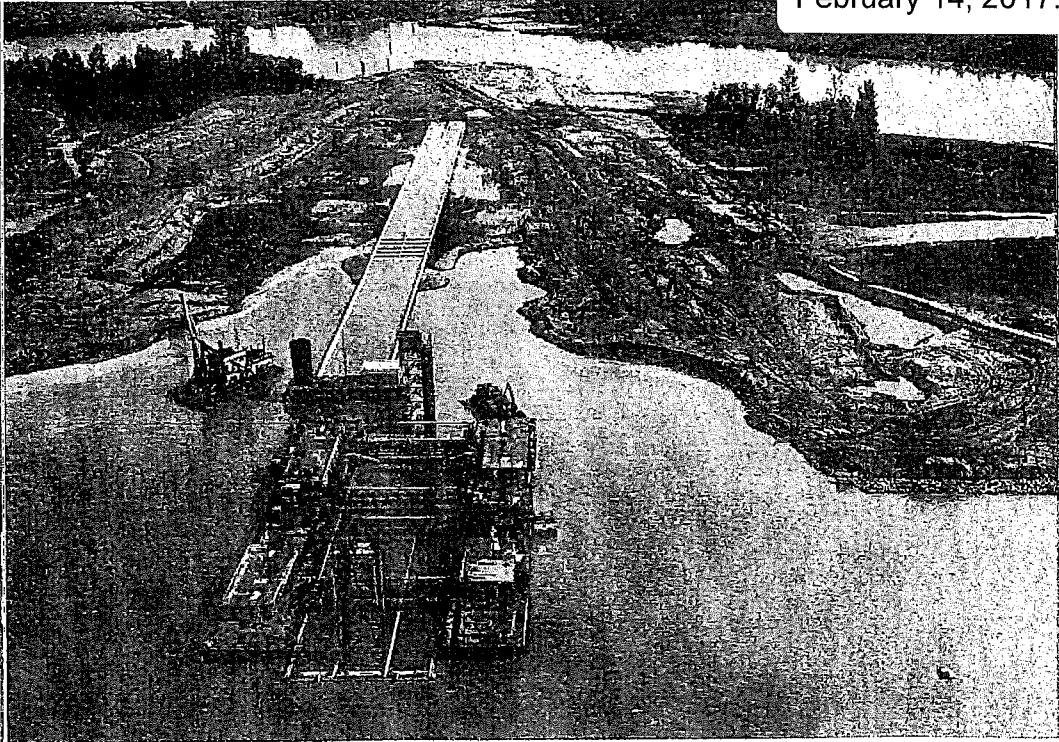
Certified a true and correct copy of the  
Minutes of the Regular meeting of the  
Council of the City of Richmond held on  
Tuesday, February 14, 2017.

---

Mayor (Malcolm D. Brodie)

---

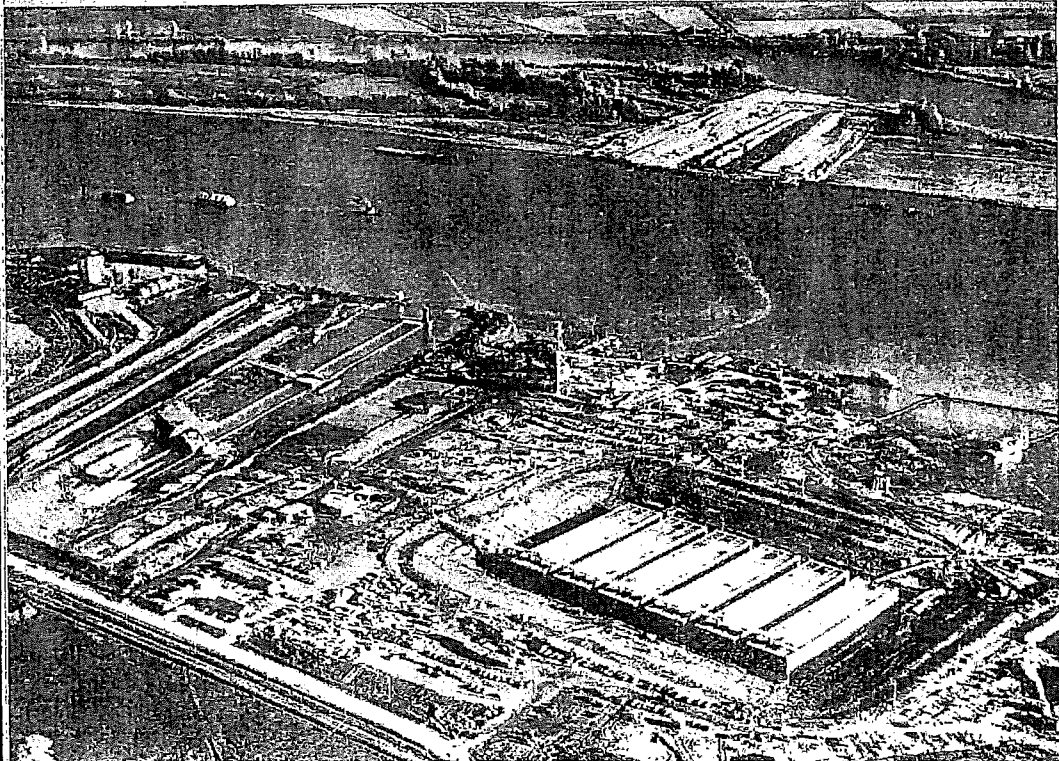
Corporate Officer (David Weber)

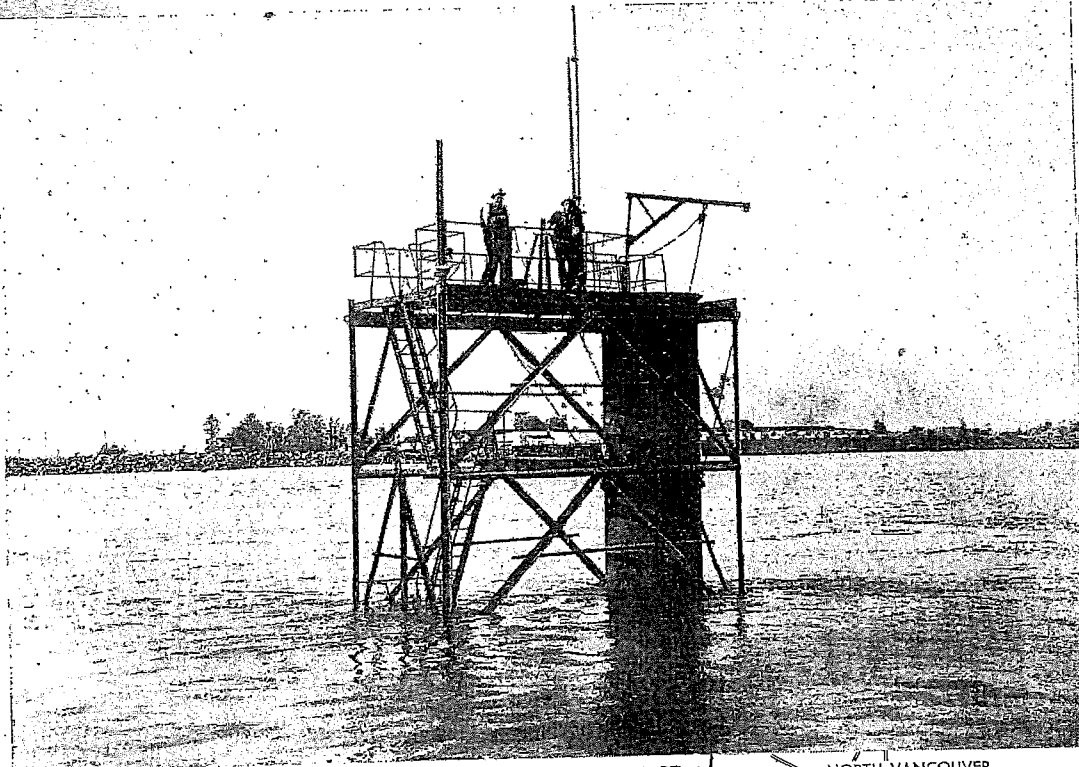


Four steel scows ease a prefab section of the tunnel into position for sinking—six inches per second

## A Prefab Tunnel Conquers a Tough River

Six sections of tunnel (lower right) were prefabricated in 40-foot drydock; then floated to positions





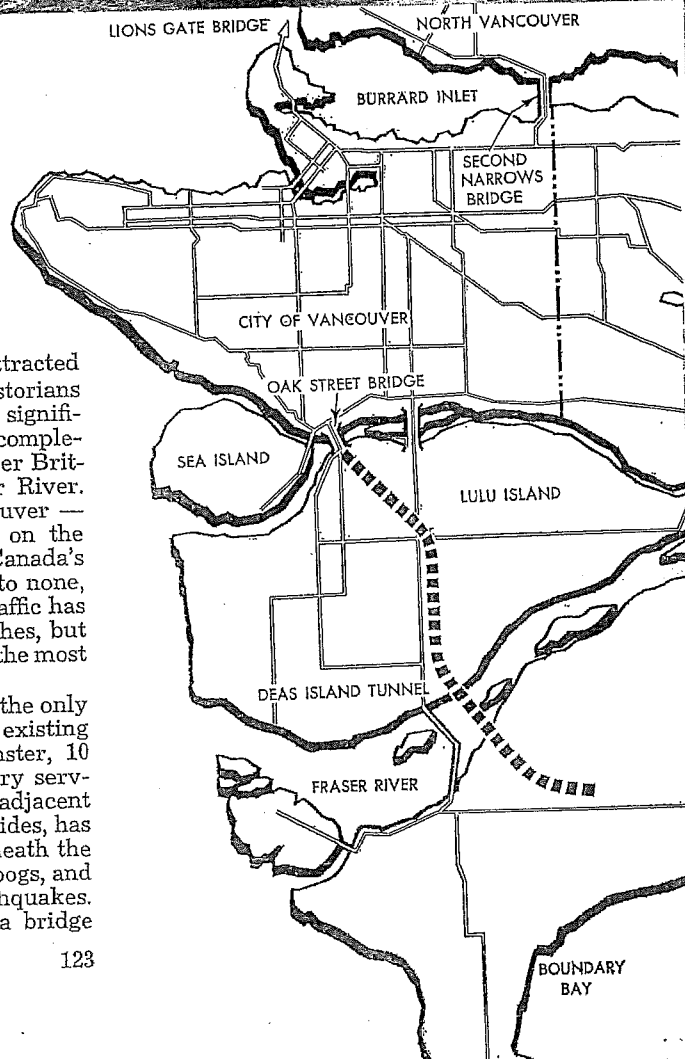
Shafts 70 feet high were fitted to the sections before sinking. Right, dotted lines show main traffic route via tunnel

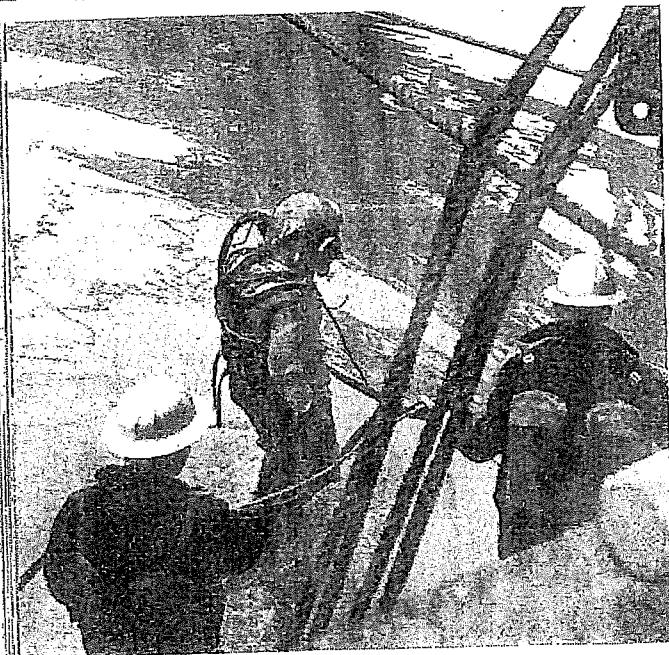
By Carson Kerr

THE BIG RIPPLE ROCK blast attracted more attention, but future historians will probably attach much more significance to the comparatively quiet completion of the Deas Island Tunnel under British Columbia's treacherous Fraser River. The scenic surroundings of Vancouver — mountains north and east, ocean on the west and river to the south—give Canada's third largest city a setting second to none, but also complicate access to it. Traffic has demanded more southerly approaches, but the scenic features have presented the most problems.

For years, experts have felt that the only possible supplement to the one existing highway bridge at New Westminster, 10 miles up-river, was additional ferry service. At any feasible crossing point adjacent to the city the Fraser is subject to tides, has constantly shifting sand dunes beneath the surface, is bordered by large peat bogs, and frequently feels the force of earthquakes.

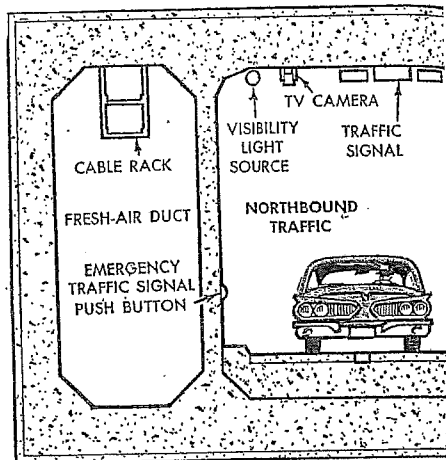
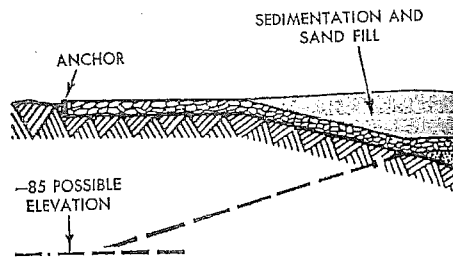
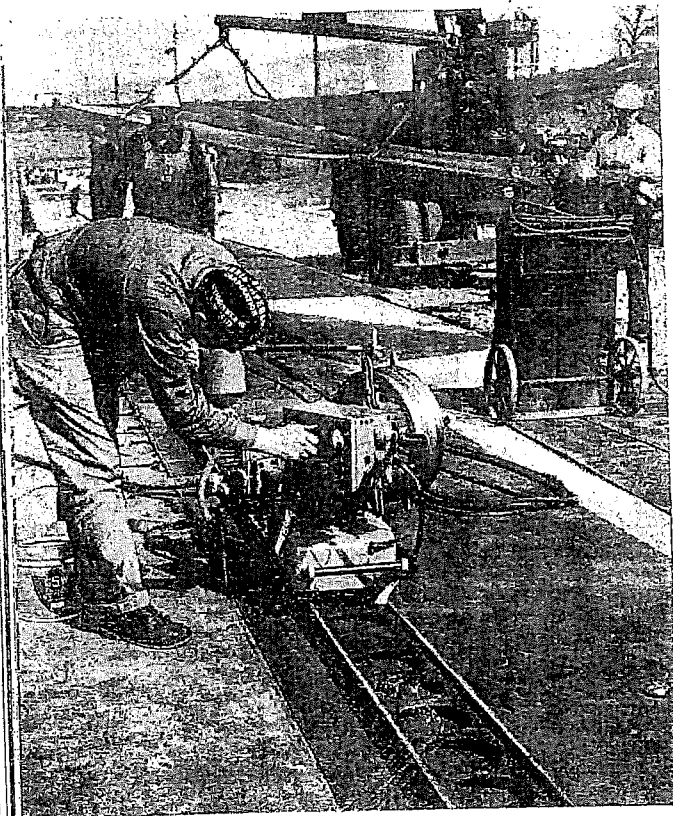
After decades of deliberation, a bridge





Divers played important part in helping position the sections had been ruled out, for two reasons: It was almost impossible to find firm foundation for one lofty enough to provide clearance for the ocean-going freighters that frequent the river route; also, a high bridge would create a hazard to aircraft using Vancouver Airport on nearby Sea Island. A solution to the problems was finally found in going under, instead of over, the river. But it was by no means a simple one. History was made last year with a unique prefabricated tunnel, first of its kind in

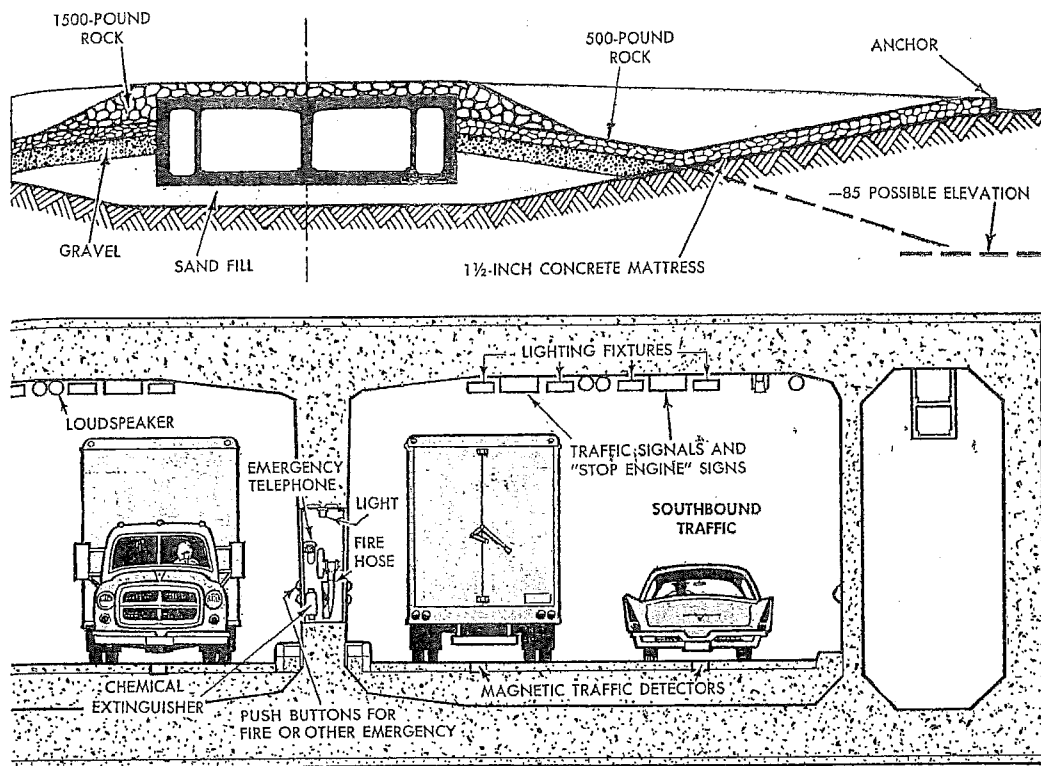
Strips of bituminous material are sealed for waterproof cover



North America and second in the world, and the mighty Fraser met its match in the combined engineering and construction skills of man.

The tunnel was one of the most complex construction jobs ever undertaken, according to project manager Ole H. Bentzen. A Danish engineer, Bentzen represents the Foundation of Canada Engineering Corporation, which shared credit for the project with Christiani & Neilsen of Canada, designers of the famous Maas Tunnel under Rotterdam Harbor.

"The Fraser River is under the double influence of tides and mountain freshets," Ole observes. "The flow varies from 12 feet per second to almost-still water. Work had to be done at extreme low tide and when velocity dropped below two feet per second. We were limited to a period from the beginning of winter to mid-April, because at any other time the river was unmanageable. Most of the critical work was done 'blind,' in heavy rain, high winds or dense fog. The river was so muddy that contractors had to rely on instru-



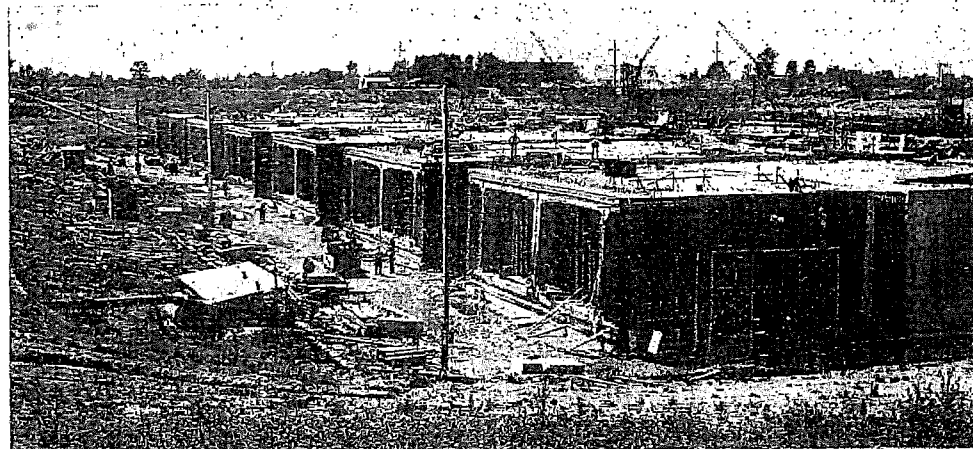
ments and the verbal reports of divers. We'd hoped to achieve accuracy within one quarter of an inch; we actually made it plus or minus one eighth. Before the last section was sealed in place, I'd almost worn out my knuckles knocking on wood."

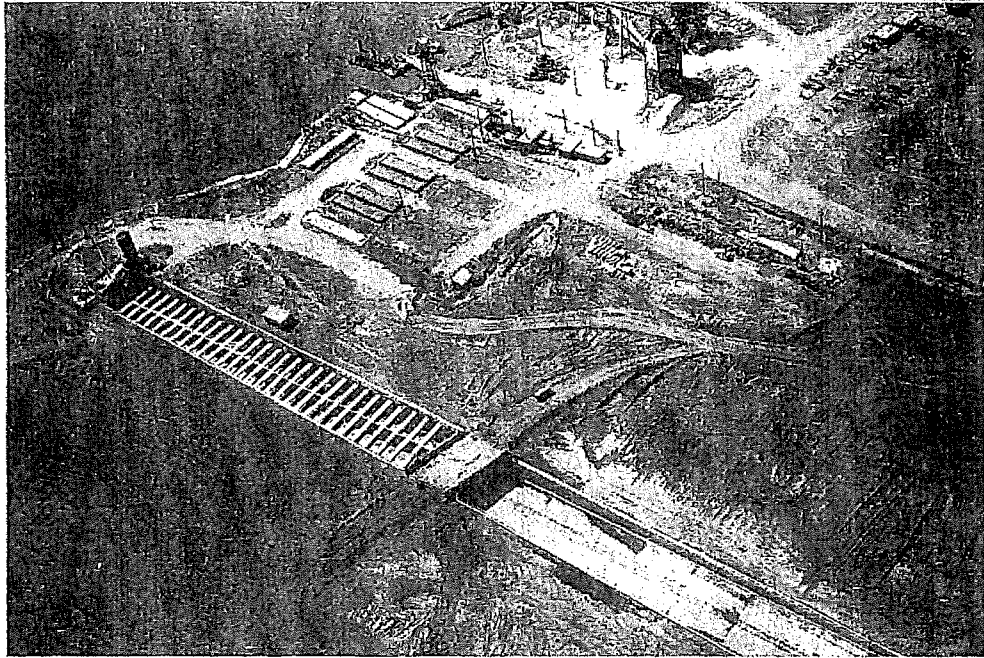
Crossing only a short distance from where the river pours into the Pacific, the new tunnel is 25 miles from the Canada-U.S. border, and is linked to Highway 99 to the south and the Trans-Canada High-

way to the east. It connects Lulu Island (from which two bridges lead to Vancouver) with the mainland, and cuts across the end of Deas Island, after which it has been named. Together with its approaches, it is 8000 feet in length with 2100 feet of tunnel. The two 24-foot roadway tubes are 60 feet beneath the surface at the lowest point, allowing navigable water with a depth of more than 40 feet above.

Although it was patterned after the Maas

Concrete sections nearing completion in drydock; each is 344 feet long, 24 feet high and weighs 18,500 tons





Sun screens over approach prepare drivers' eyes for dimmer interior; dark stack is from ventilation building

Tunnel, the Deas Island Tunnel is of vastly improved design and has many modern features usually associated only with free-ways of the future. The maximum flow of 7000 cars per hour is controlled by attendants aided by a maze of safety systems, including magnetic traffic detectors in the roadbed, loudspeakers every 50 feet, and 14 TV cameras placed at strategic points. Emergency telephones are located at 177-foot intervals; there's a sprinkler for every 120 square feet of interior surface, and a number of emergency traffic-signal and fire-alarm push buttons.

Long, troughlike approaches, rather than a continuation of the tunnel, were originally designed mainly to simplify ventilation, but they also make possible one of the more important traffic safeguards. Each has a system of huge sun screens that cause a gradual transition in light intensity from exterior to interior. These serve a double purpose in that they prevent re-entry of vitiated air.

Ventilation buildings at each end are independently founded on slabs and almost completely below ground level; soil pressure around them is the same as that under the approaches. Power for ventilation is provided in both buildings, but each can handle the full load. There is also an emergency storage-battery unit. Variable-speed fans are controlled by time clocks set to suit the traffic pattern, but can be overridden automatically by

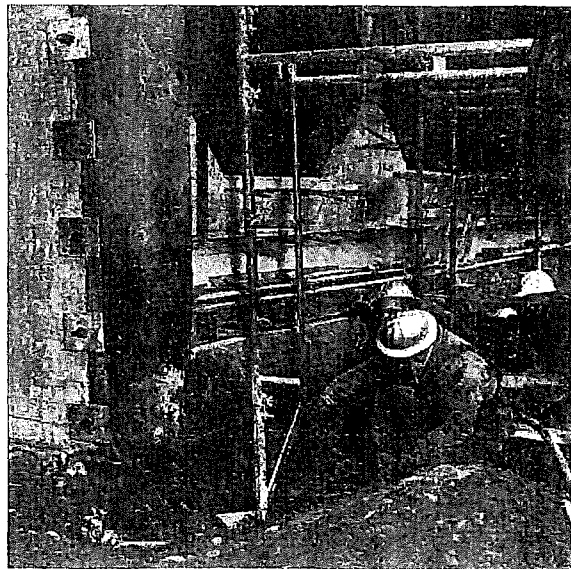
carbon-monoxide meters, visibility meters or the fire-alarm system. The fans can also be operated manually.

Throughout the tunnel there are STOP ENGINE signs, which will flash on when the amount of oxygen in the air begins to drop toward the danger point. Abnormal conditions with any degree of frequency are not anticipated, because tests have shown that the ventilation system will normally renew tunnel air every two minutes.

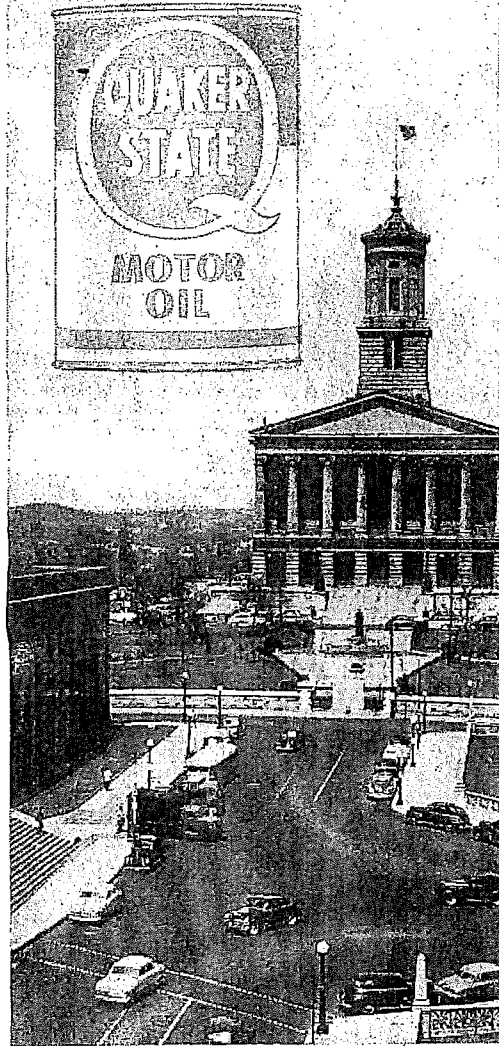
The prefabricated underpass was

(Continued to page 226)

Workman inspects rubber pneumatic seal at the end of section







VICTORY PARK AND CAPITOL BUILDING, NASHVILLE, TENN.

On tour or around town, drive with Quaker State, the oil that cuts engine wear, prevents engine breakdown. Fortified with anti-wear detergent additives, this pure Pennsylvania oil stops rusting and corrosion, eliminates sludge, carbon deposits and damaging acid action. Result: moving parts work smoothly and friction-free under all driving conditions! Next oil change, insist on Quaker State.

QUAKER STATE OIL REFINING CORPORATION, OIL CITY, PA.

Member Penn. Grade Crude Oil Assn.

1859—100th Anniversary of Drake Oil Well —1959  
and Founding of the Petroleum Industry

## A Prefab Tunnel Conquers A Tough River

(Continued from page 126)

constructed ashore in sections. Instead of tunneling under the river bed, a 40-foot-deep trench was sucked out and the sections were then floated into position, sunk, and sealed together on top of a padding of gravel. The first step in connecting them was the linking of a huge hook-and-eye arrangement. In the past, tunnels have been circular, because of the erroneous belief that they were easier and cheaper to build that way, but the Deas Island Tunnel was built on the square.

"The height of a circular cross section is governed by the width required to accommodate the necessary roadway," Ole Bentzen explains. "Whereas, that of a rectangular cross section depends solely on the vertical clearance required for the traffic lanes. Also, for the same navigable depth, a circular tunnel must be carried deeper, which means longer and deeper approaches and, therefore, greater cost."

Construction, which was started in March of 1957 and was completed late last year, cost \$16,600,000. It involved the use of \$2,000,000 worth of equipment, 100,000 cubic yards of concrete and 12,000 tons of steel. Excavation and backfill totaled 2,500,000 cubic yards. As many as 800 men were employed at one time, but the crew averaged between four and five hundred. Not the least significant record established was that of safety, which resulted from the wearing of lifejackets as well as hard hats by all workmen on or near the water, plus weekly safety meetings throughout the term of the project. Although 90 percent of the work was dangerous, there was never any serious time loss and no loss of life.

This fact is brought into sharp focus when contrasted with the record of another B.C. construction job, of similar magnitude, the \$16,000,000 Second Narrows Bridge, an intercity link connecting Vancouver with its main suburb, North Vancouver, across Burrard Inlet. This structure and approaches, with a total length of almost two miles, was originally scheduled to be completed about the same time as the tunnel, but was tragically delayed last June. Two 70-foot sections of the mile-long bridge gave way, workers fell 200 feet to the water and 22 men were killed.

The Deas Island Tunnel probably set a new record for attracting sight-seers, since as many as 10,000 local citizens and tourists served as sidewalk superintendents on week ends. The first act of the big show

(Continued to page 228)

was the construction of the elements by Narod, Dawson & Hall. Scene 1 was a huge excavation, 684 by 933 feet, 20 feet below the surface of the Fraser and separated from it by an earthen dike. This open cut was used as a drydock during the building of reinforced-concrete sections, each 344 feet long and 24 feet high, weighing 18,500 tons. When they were completed, it was converted to a graving dock by simply breaking through the dike. The flooded sections were then pumped out so they could be floated to the outfitting jetty where their waterproofing, a combination of built-up bituminous and light-steel mantles, was checked by an automatic leak-testing system. Each section was then fitted with a 70-foot stack supporting a shaft with a 6-foot manhole, to allow access after sinking.

#### Foolproof System Necessary

One of the problems was to keep the sections watertight while workmen went inside to break away temporary bulkheads and finish off the joins with concrete. The sealing system used in constructing the Maas Tunnel had been far from satisfactory, and there was no intention of undertaking the Deas Island job unless a foolproof system could be devised. Company after company turned it down, but Gutta Percha & Rubber Ltd. of Canada tackled it.

Months of exhaustive experimenting led to the development of huge rubber pneumatic seals, resembling colossal inner tubes, each 80 feet long, 26 feet high and 30 inches thick. Designed to withstand pressures up to 4000 tons, these were installed at the ends of five of the tunnel sections. The air space was filled with water and the section was sunk and moved into position near the previously positioned one. Water was then pumped out, the sections were pushed together and the seals kept workmen perfectly safe while permanent joins were secured. While the rubber will deteriorate in about 18 months, this will have no adverse effect, because all joins will have hardened.

Besides, the tunnel is well-encased by concrete "mattresses," timber lagging, sand jetting and backfilling, so that neither ocean nor river action will disturb it. Also, it should easily withstand the most severe earthquake shocks to be expected in the area. Each section is anchored in place by four 37-ton concrete blocks, interconnected in pairs with 12-inch steel pipe, and secured by cable suspension. The whole tunnel is tied to several 3100-pound Dutch anchors (looking like inverted umbrellas, with 7-foot flukes that open when a pin is pulled after they have been placed 30 feet beneath

the bed of the river) and three 7000-pound Navy anchors.

The "sinking fleet" was made up of 14 equipment carriers. Key vessel was a "floating rig" formed from four steel scows, which was used to ease the sections to location and maneuver them into position above a predetermined center line. The rig was hooked up to a complicated system of winches and land and river anchors, and movement was controlled inch by inch as engineers eyed instruments that measured river velocity, tide elevation and the stress on every cable. Typical of the extreme caution with which the sinking operations were carried out is the fact that the top recommended speed of movement was six inches per second, but the first element was moved only 12 inches per hour.

"Anything to do with the Fraser presents problems," Fred Knez, one of the project managers points out. "It's a most difficult body of water. More than anything else, the project required patience. It took three hours just to move one of the sections into the floating rig, seven more to arrange the winches and anchors preparatory to sinking. From outfitting jetty to final position, the first section kept us busy for almost 14 hours."

The actual placing operations were commanded by K.P. Kitchen, a Kiewit riverman of 50 years' experience. While four divers described underwater progress every foot of the way, Kitchen issued instructions by radio from a control room aboard the floating rig—calling for a cable to be clinched here, a pump to be started or stopped there, a jack to be operated somewhere else.

Serving over 3,000,000 residents of the Lower Fraser Valley and 650,000 in Vancouver, the tunnel was built for the Department of Highways and will be operated by the Toll Authority. Maintenance and operation are estimated at \$50,000 annually, and the toll will be 25 cents. Its effect has already been felt on Vancouver Island, where tourist trade is of great importance.

It's more than possible that the success of the tunnel will eventually lead to a similar but much more ambitious project—an underwater passage linking Vancouver Island to the mainland. In any case, the amazingly accurate engineering and almost faultless design of the Deas Island Tunnel have added to the wonders of the modern world. \* \* \*

---

☐ Floating on water that is more than 2000 feet deep, Ross Ice Shelf in the Antarctic is about 1000 feet thick and about as large as France.