

equipment has not been advanced far enough to be certain it will work in the geological structures underground in the District and therefore it is not being considered.

The CHAIRMAN. Dr. Hibbard, I do not wish to interrupt your train of thought, but as you have been discussing this, I have thought of the enormous amount of money we are spending in connection with our nuclear testing program underground. Maybe you can relate, to the extent you can in open session, what contribution has occurred from the work that has been done in this area? Certainly there has been a substantial amount of research and coordination that takes place between the Interior Department and the Atomic Energy Commission.

Dr. HIBBARD. There has been major fallout from these. We work very closely with the Atomic Energy Commission. In fact, the Atomic Energy Commission is one of the nine agencies we are working together with on this matter.

The CHAIRMAN. I hope you will explain it at the proper time. I think it is a very important point. If you want to elaborate on it now, it will be fine.

Dr. HIBBARD. As part of our program, we hope to get access to one of their large boring machines in Nevada. This is one of the ways we believe we can speed our development because certainly this equipment has been built as the result of Atomic Energy Commission contract, Bureau of Reclamation contract. We think this is a starting point of our research program. We are working very closely together.

To continue, we believe, with appropriate research and development program as mentioned, instead of ending up in the range of 750 feet per week, we can probably develop equipment that will permit speeds in the range of 1,750 per week. This will make a tremendous difference in the cost of tunneling and thus the use of the tunnels. Either we can do the same amount of tunneling with less money or, in my opinion, I think tunneling will be much more accepted and we can spend the same amount of money for much greater amount of tunneling.

I think one of the most exciting areas today is Montreal where they have put in a new subway, where they have an underground complex which illustrates this trend away from moving skyward toward moving underground. In Montreal you not only drive underground and park to take the subway but there are stores, restaurants and hotels.

To summarize briefly, the concept of advanced tunneling systems, the equipment we have today is simply the borer or cutter. I say simply because when a tunnel is bored with a 36-foot diameter machine, it goes forward 1 foot and produces 36 cubic yards of muck to dispose of. This is about 90 tons. When the equipment is advancing 10 to 20 feet an hour there is a tremendous requirement for removing material, and a brand new system is required. Here it is in concept on this next chart (p. 46). It looks like a vacuum cleaner, but it is continuous removal.

Secondly, when the equipment moves this fast a whole new concept of ground stability is required. Here again, in concept a liner slides in place as the machine moves forward and maintains the cut.

Thirdly, you must be able to cut whatever rock, whatever material is in the path. There are mountains with both soft and hard rock. The borer must be able to cut both so we believe there will be new designs of cutting tools. In addition, when we move this fast under-