

36,000, the whole treaty allotment of second feet available, over 1,000,000 h.p. can be developed.

All of the excavated section of the canal will be in solid rock, with the exception of 1¼ miles of earth section running north from the Welland River and half a mile of earth section across the whirlpool ravine. These sections will be trapezoidal in shape, lined with rip-rap. The section at the whirlpool will also be faced with concrete.

Rock Section

The rock section is 48 feet wide at the bottom, with perpendicular sides, the average wetted section being 35 feet deep and lined with concrete. The velocity in the rock section will be about 6 feet per second when the plant is under maximum load. The earth overburden above the rock surface will be generally sloped 1½ to 1, but a flatter slope is provided for where local conditions require it.

The Commission has purchased a tract of land as a right-of-way which will be sufficient for all present and future needs. This right-of-way includes about 200 acres near St. David's which will be used as a dump for the disposal of excavated earth and rock.

At a point 2,200 feet distant from the gatehouse, the canal begins to widen into the forebay, the forebay gradually increasing in width to four hundred feet, which will be the approximate overall length of the gate house. The initial development provides for four steel penstocks each about 14 feet in diameter, 450 feet long; and one exciter penstock, about 5 feet diameter.

Provision is being made for the installation of four main generating units each of 50,000 h.p. capacity. Both the gate house and the power house are so designed that they may be extended whenever conditions warrant.

The surveys for the work were begun in 1914 and continued for nearly two years. During the year 1917 the construction plant was brought onto the job and assembled, and during the first part of 1918 the camps were completed.

The Three Largest Shovels Ever Built

The main equipment for the earth and rock excavation consists of the three largest electrically driven shovels ever built. They are of the revolving type, built by the Bucyrus Company, and are fitted with an 8-cubic-yard bucket for excavation in earth, and a 5-cubic-yard bucket for rock work. The boom on these shovels is about 90 feet long, and the dipper stick 58 feet. Either shovel can load dump-cars which stand on a track the level of which is 62 feet above the level of tracks on which the shovel stands. The shovel rests on two tracks (four rails) 30 feet centre to centre and is mounted on 16 wheels. The nominal horsepower of each of the two shovels is 715 h.p., upon a half-hour intermittent rating. Each shovel weighs over 300 tons, contains 75 tons of ballast, and has a capacity of 3,000 to 5,000 cubic yards per 10 hour day when handling earth.

There are also five other electrically-driven shovels at work, having dipper capacities ranging from ¾ cubic yards to 4½ cubic yards.

On the Welland River section of the canal, a Lidgerwood cable excavator is at work, fitted with a 3-cubic-yard Anderson-Evans clam. The cableway has an 80-foot head tower and 60-foot tail tower, and a

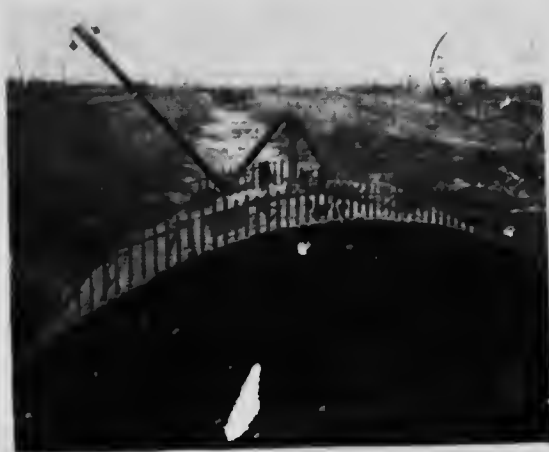
span of 1,000 feet. The excavated material is being dumped along the north bank of the river. The width of the Welland River at the water line averages about 300 feet.

The Commission has purchased one hundred and fifty 20-yard Western airdump cars, each of 80,000 pounds capacity; also seven 40-ton steam locomotives and twelve 50-ton electric locomotives. The steam locomotives are switchers purchased from the Pennsylvania Railroad. The electric locomotives were built by the National Steel Car Company, Limited, of Hamilton, Ontario, six of them being constructed with General Electric equipment and six with Westinghouse equipment. Two pile-drivers are at work on the river section. There are three 40-ton and two 15-ton Bay City locomotive cranes for general utility work.

15,000,000 Cubic Yards of Excavation

It is estimated that 9,000,000 cubic yards of earth and 4,000,000 cubic yards of rock must be removed from the excavated section; and from the river section, 2,000,000 cubic yards of material, mostly earth.

At the present time the material which is being



Centering for one of the concrete bridges over the Chippawa power canal

excavated from the Whirlpool sections is being used to fill the old Whirlpool gully, but the main dump, as already noted, will be at St. David's. A double-track railway line runs the full length of the canal from Montrose to the forebay, and a 2½ mile span connects the main line with the St. David's dump.

There will be various other branches of the railway constructed from time to time as needed. A railway will probably be built from the power house to connect with the Michigan Central at Queenston to bring in the machinery and to take out the materials excavated from the power house substructure.

The railroad lines are all electrified, the trolley wires being off-set on one side of the track, and carried in clamps devised by the Commission's line construction department. These clamps and the hangers which suspend them from the poles are all made up of standard material, and are so arranged that the temporary use of the material does not injure it.

Framed timber trestles are set alongside the dump and other temporary tracks to carry the trolley wire. These trestles are mounted on wheels or skids and can

Fig. 1. View of forebay taken from electric railway track which runs on the immediate crest of the bank above the proposed site of the power plant at Queenston—solid rock, showing about 25 feet in depth excavated. (a) View of forebay immediately following shot. (b) Looking up canal excavation from forebay. (c) View of rock section, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (d) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (e) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (f) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (g) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (h) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (i) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (j) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (k) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (l) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (m) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (n) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (o) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (p) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (q) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (r) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (s) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (t) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (u) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (v) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (w) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (x) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (y) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers. (z) Looking up canal excavation from forebay, showing the rock face, crushed in the rock face, and finally housing secondary crushers, and finally housing primary crushers.