

page of this paper, the pile driver going first, then the construction of the trestle work on which to lay the railway track for the transportation of the rock and matting. The wood work is expected to last only during the construction of the jetty. It will soon decay and disappear, but the rocks and sand reef will remain to confine the flow of the river to the desired channel. The government has a valuable plant at the mouth of the Columbia and ordinary prudence demands that the work be completed before that plant becomes useless. An appropriation of \$700,000 from the present session of congress is asked by the engineers. A very distinct benefit to the channel on the bar is already shown, so the work is no longer of the nature of an experiment.

The next matter requiring the attention of the government is the improvement at the cascades. The river channel there is very rocky and the fall is so great that no boat can stem the current. Occasionally during the high water season steam boats descend the rapids, but it is always recognized as a hazardous feat which only very unusual circumstances warrant undertaking. The principal difficulty is at what is known as the upper cascade, that being the uppermost and by far the most turbulent rapid in a stretch of some four and a half miles of rocky channel. The project for overcoming the obstacle to continuous navigation presented by the cascades contemplates the improvement of the channel below the upper cascade by the removal of boulders from the stream and jutting rocks from the banks so as to give a navigable channel. The fall at the upper cascade is to be overcome by the construction of a canal 3,000 feet in length to cut off a point of land around which the river flows and falls in a broken, surging torrent. The canal, in its present stage, forms the subject of the illustration in the center of this paper, the view being taken from the lower or western end. The removal of rocks from the river channel has been accomplished so now efforts may be concentrated on the canal. A force of 175 men is now engaged there, excavating and laying masonry. About 1,000 feet of the canal is practically completed; that is, the excavation is done, the masonry laid and the rip-rap work finished for that distance, though the construction of locks has barely been begun. The solid masonry extends from the bottom to a height of thirty feet and the rip-raping to a height of about 100 feet. The distance between the gates in the canal will be 500 feet and the fall to be overcome is between fifteen and twenty-four feet, according to the stage of the river. The difference between the extremes of high and low water is forty-five feet at the foot of the canal and fifty-four feet at the head, so it will readily be seen that it is no small engineering job to build a canal that will work successfully at different stages of water. The improvement

now in progress is calculated to render passage possible at any stage up to twenty feet above the low water mark. It is only during a few weeks, at most, in early summer that the water is above the twenty-foot mark.

The work at the cascade canal was begun by a private company but was not then prosecuted with vigor. The lack of means prevented the treatment that would have been desirable. The government took hold of the enterprise in 1879, and there have since been expended in the work about \$1,500,000, and it is estimated that as much more will be required to complete the enterprise. The dilatory methods of congress in making appropriations may make a greater expenditure necessary before boats can be locked around the upper cascade. Granite from Spokane Falls is being employed in constructing the locks. A system of water works has been constructed by which all the water necessary for domestic or mechanical purposes is supplied by gravity from a reservoir in the mountains near. A number of buildings for the accommodation of men and stock are included in the government's plant. Half a million dollars a year could be profitably expended on the enterprise, and if the amount were furnished two or three years would suffice for rendering the canal serviceable. The work is now in a condition that will admit of its being pushed to an early completion if the government will but provide the money.

Now that the canal at the cascades is well under way means are being devised for circumventing the greater obstruction farther up the river, without which little benefit can be realized from the cascades canal. At the Dalles the impediment to navigation is much greater than at the cascades and requires improvements of much greater magnitude. From Celilo rapids, above the city of The Dalles, for a distance of about thirteen miles down the river, the channel has numerous rocks and currents too rapid for navigation, owing to the vast volume of water being forced between rocky walls of an average distance apart of only 250 feet. For short distances between these obstructions the stream is navigable, but the impediments are so near together as to render advisable a general scheme for avoiding them all in the same calculation. Estimates for the construction of a canal to flank Celilo rapids and to blast the channel below so as to make it passable for boats are that about \$14,000,000 would be necessary for the job. The extraordinary variations in the height of the water and the unprecedented size of gates, etc., necessary for an enterprise of such huge dimensions, bring into the problem too many uncertain elements to make any accurate calculation of the work or its results possible. With the present system of making appropriations in vogue the work on such a vast enterprise would be well nigh perpetual and the