

# RECLAMATION

*Managing Water in the West*

U.S. Department of the Interior  
Bureau of Reclamation

## Arrowrock Dam: Idaho's Eighth Wonder of the World

**Kelsey Doncaster:** So, I'm Kelsey Doncaster, I'm the historian for the Columbia-Cascades Area Office of the Bureau of Reclamation in Yakima. So I'm not here from the Snake River, but they have asked me to come down. And I really am excited to be here to present to you folks about Arrowrock Dam, Idaho's 8th wonder of the world. As mentioned, I am a fifth generation Washingtonian. My mother would talk about Grand Coulee Dam was the 8th wonder of the world. But before Grand Coulee, there was Arrowrock. And you could not have Grand Coulee without Arrowrock Dam.

So we're going to learn tonight about the wonderful and amazing and magnificent structure built by reclamation from 1911 to 1915. And I like this post card because it shows a little lady there, it shows you how big the dam is and it says it's the highest dam in the world, and largest dam in the world. Boise, Idaho. I thought that was very unique and a neat way to advertise such a wonderful structure. So Arrowrock Dam facts, it was the tallest concrete gravity-arch dam in the world when completed in 1915 until 1932. It's built from July 1911 to November 1915. And as the largest number of islands of any reclamation service dam, some folks here from Idaho Power, I don't know about your system, don't know if that's true but I know for reclamation that is true. It was the first reclamation service dam that required 20 ensign valves, at its peak, a 1059 people were employed in the construction of the dam.

Reclamation service created its own town called Arrowrock, where as many as 4300 people lived there during the height of construction. Interestingly enough, this dam is actually in two counties. Boise and Elmore County split it right down in the middle. That was very interesting because a lot of times there were dams associated in one spot or the other. It's been cut in two. It was built by the Reclamation Service under a forced account which means, that the agency couldn't find people who could afford to or have the capital or the knowledge to know how to build such a structure. So the government was forced to do it themselves. In its construction, those working set a world record for concrete placed in a month. 45,700 cubic yards in April 1914 and it would be the next month was 51,490 cubic yards. The dam is composed of 613,330 cubic yards of sand concrete when it was completed in 1915. It is one of only two reclamation service dams built of sand concrete in the United States. The crest of the dam is approximately 1150 feet long which winds to be 223 feet wide at the bottom. In 1935 to 1937, it was increased in height to 353 and a half feet as part of the work's progress initiation project. And we'll talk a little bit more about that especially we have time is why there was a WPA project on the dam and it has to do with some of the

revolutionary style of construction that was done back in the day. So, the dam is built to serve the Boise project.

Here is a map of the Boise Project, we see here, I'll try to walk up a little bit. So here's Arrowrock dam over here, and it brought water and regulate it, so it irrigated the whole project with 397,000 acres here all the way from Boise to Nyssa. This project helped turned the Boise Valley from desert and make it bloom with agriculture. Other two divisions, in it the Arrowrock and the Payette Division, and the one is Arrowrock of course gets the water from Arrowrock dam. Payette also gets some additional stuff in that water from Arrowrock dam. So, the dam was built and located at a certain spot called Arrowrock. And this was a real mystery. I worked with some of our regional people to discuss how this came about and where this location was. And I found this photograph in the National Archives. We're going to see many photographs today from the National Archives.

This shows Arrowrock in 1912. So the story goes that this is called Arrowrock because you're showing Indians would fire their arrows into the rock. It was target practice. I don't know if that's true or not. Idaho State Historical Society has interesting interview done of a gentleman who was a wagon driver who discusses that, because it's a wagon road, they went up to Canyon to Twin Springs. Another story was at Idaho State Historical Society, they have someone found an Arrowhead inside the dam, but then they lost it. Don't know if that's true. But I do think it's true is that there a geological formation that is somewhat in the shape of an arrow. And so, it may have been something that they thought, that's why they call it Arrowrock because it looks like the shape of an arrow. The other interesting thing which you can't see here, I will move on then. There is a sphere, it looks like inside it, I don't know if that's really there or not.

This is the valley before it was flooded. This was taken in 1912. It's looking downstream at the dam site. Arrowrock was chosen over a location called Hell's Gate, which is three miles upstream, as it would take less excavation to bedrock to do that. But this shows you what that looks like. Here we are in 1910, it shows the dam location, diamond drill barge, getting ready to drill holes down to bedrock, to go where the dam is. You can see the trail here of the wagon road, you know, winds its way along here. It went from Boise to Twin Springs. And this was a really unique spot that they thought they could build this dam. So they have these diamond drill barges that they used to get out to the bedrock, you think about how that work was of a gentleman there, no fall protection, this was 1910, safety and relative, still had safety, mind you. But it was not what we think of today. And here this is hot, sweaty work here on the river and across the way, you see the diversion, whenever you're up, the diversion tunnel for the dam. So the diversion tunnel was hand out, was broken out by hand tools and by--we're going to see here drills in that time and that was done for way to reroute the river. Idaho City Historical Society put a poster of a river that ran through it. Well that's what they did. They forced river out of the way, so they can clear out the bedrock and they drilled this tunnel to push the river through. They built a cofferdam up to help dry out and we'll do work for where the dam would be executed out. So picture taking here on October 30th, 1911, think of what you want to do in October, be stuck in a cavern. So then, what this was working on, here we have them high up on the hill, 400 feet up, and breaking out rock and blasting for the spillway. This is before the railroad came. This is work that was done primarily by hand until larger machinery could come up from the railroad.

And you can see, here we come with the Boise and Arrowrock railroad. So, the agency needed to have a railroad because that's how you are going to be able to get supplies. It's still the most efficient way to ship large volumes of material from one place to the other. And the agency had a problem. The dam was built 22 miles from Boise, but there was no railroad that went 22 miles from Boise. So they had to build the Boise and Arrowrock, government-owned, standard gauge, common carrier railroad. That was built from May 28th, 1911 to November 15th 1911, and it was 17 miles long. Railroad operated daily except Sunday by mixed train passenger service, beginning on December 7th, 1911 to August 2nd, 1915. The Boise and Arrowrock had three steam locomotives, two passenger cars, two box cars, one caboose, 14 flat cars and 26 gondola cars. The railroad transported 13,966,264 tons of freight for the dam. So over 13 million. Plus, it also transported 60,314 tons of non-reclamation service freight. So they also would, because a common carrier, someone needed to move their livestock, or need a stove, or--and something else they would also bring it up for them. Special excursion trains left Boise every Sunday at 3 'o'clock for Arrowrock dam. There were 89,603 excursions who took these trains on the Boise and Arrowrock to see the world's tallest dam under construction. So here's an example of a mixed train and also when the snafus was, the lettering was mixed up, the reclamation service purchases equipment, had some lettered and organized, or we should say, all Boise and Arrowrock and they labeled it United States reclamation service. But the government was efficient. They didn't renumber, didn't repaint things, they just left it that way and ran it as it is. And here is a train in 1913 in [inaudible] next station. But the railroad was designed to bring heavy freight up. And so this slide here shows the dumping of materials into storage vans. And I want to point out that there's an Oregon short line which was the Union Pacific gondola here. So you know, they had 26 gondolas that didn't have enough. That means they had to buy more or lease more and bring the [inaudible] from, down by Boise diversion dam and other locations, to help build the dam, besides what they did to all of the spillway and in the bedrock. It's a very unique operation, something that you don't see today. But these are the Sunday excursions that I talked about.

There's a great image that I found. This was not at the National Archives. It's actually onearchives.org, but it shows the greater Boise excursion to Arrowrock dam. Everyone's dressed, like myself in a Sunday finest, coming up to see this wonderful magnificent thing that they are creating on the Boise River. And I thought it was a big deal, you know. It was something people were really proud of, they want to be a part of and what you guys have learned about today. So the railway brought up large machinery. Here we see the Atlantic steam shovel 70 tons, that was brought up by rail, we see western rail scrappers, little narrow gauge dump cars and arrow gauge saddle tank steam locomotive. These were needed to help do large scale excavation for the dam. And you couldn't bring this up without the railroad because that's a lot of heavy machinery that couldn't come up on its own, by freight or wagon or otherwise.

And it's something that you think about, you know, what was life like for this people that came to a place that was 22 miles from Boise. It wasn't something that was known to be a metropolis. It's a place that wasn't that much, out on its own in the environment. And so here we see they're out--In 1912, they started an excavation in the Boise river bed. There's a drag lining machine [inaudible] skips for cableways. They'll be lifted up and they take that material and they crush it, to use it for the concrete mixture they are building at the dam. It really gives you a sense of the work

environment. It's dusty, it's dirty, it's wet. We see all the water here. And so they had equipment-- stays in certain locations to make use of--most efficient use in the material and the location where it was at, one of which here we see on the spillway. Again, we talk about safety, notice that lovely eight-ton boulder there, people are under. So they were blasting rock out of the spillway. And they had the steam shovel now located up on the spillway, taking out large, eight-ton boulders and other things to move that and make it the spillway that it is today.

So here we are in 1912. This is on June 15th. We still see the Boise River running in its normal course. We start to see some of the river being diverted into the diversion tunnel. This will change, shortly you will see what it was going to shift to being--for having a cofferdam and then they're going to start holding back the river and forcing it through that tunnel to make Arrowrock Dam. I really like these photographs because they're taken from a certain point. Walter Lubkin picked the same spot many times to photograph. And so you can see their progress overtime. This is in 1912.

Again, this is on October 15th. This is the upper cofferdam in place. And you know we don't think it is today, but a hundred years ago, they were very, very ingenuous. They're very thrifty, not that we aren't are today, we have microcomputers and other things, but you have to realize, they had to work with what they had, and I talked about the 70-ton Atlantic steam shovel was there in the bed of the river. And then they have it on a spillway, well how do you get it up there? Well, they disassembled it into pieces and hauled it up by a cable way to the spillway up there. And that was really interesting that they weren't afraid to disassemble a steam shovel and then back up on the spillway, put it all back together again and work it there. Also very interesting to note as historian, when I found some of the records and things that just says, we moved the steam shovel from the riverbed to the spillway, well how did they do that? I found this photograph, I was like well, how the hell did they do it? Here we are in 1913, same spot, shows 8000 second feet of river, going to through the diversion tunnel. And we can see now that the cofferdam is in place. They're just trying to build up here where they've got the sliding gauge right here, of the dam, there's going to be 25 [inaudible] so this is just the first five. Now, you're starting to see, we got the cofferdam here and the river is forced that way.

Here we go again, now it's getting taller. And this date, it is September 15th, 1913. And then they kept building the dam. They're still working the spillway at the same time. And it is followed by another photograph taken in 1914, that will show us the upper cofferdam has been removed. They build cofferdams, to people who don't understand, to hold back the river or the water so they could pool it up. But here, they've removed it and now we see all the water pooling up down here. Well the dam, but it was finished at that level so they could do that. And it's always amazing, if you noticed the snow on the ground, they operated year round. And they didn't take time off for the winter. They did have Sunday off though. I found they didn't work at Sunday at all. But the trains from Boise always come up on Sunday, so kind of a mixed message there.

So here we see the view in September 1914. This is the view of it. Now, the dam is getting higher and higher. They're placing more forms. They're using the cable way. We see the town down below. Everybody starts to see the dam take shape, to what it's going to be today. To do all this, so they have to not only place the concrete but then they had to form the concrete. And they would form it in different fashions with rebar, the technology needed to build the structure and to support

the dam. And so here we see that rebar in the forms for the concrete that's sluice outlets, these big cylinders here. And you see all the faults work. Imagine all this wood that was involved in the building of this dam. They had so much wood. I'll tell you where they got it later on. Here we see the sluice gates installed.

And we're looking upstream, this is on September 15th 1913, so you can see them then you get an idea of the scale of this project. Three little men, here's the sluice gate; and you can see the delivery system, the [inaudible] cable way concrete delivery system. So they would build these in sections and each layer will go up farther and farther and farther. And when they drive in, here we see it again, now they've covered over that section we just saw where the sluice gates were, and they're building farther and farther and farther up in the dam, getting the second hyphen [phonetic] in, getting it dry and then going in and build another one. So, as this progressed, and then they had to do something different with the machine that they had and locations they moved it up moved it around. And as I mentioned, here is a line steam shovel again. OK, so now they finished excavating the spillway, how did they get it down? Because they needed to use it out by Boise diversion dam, the big gravel pit. Well this time, instead of disassembling it, they decided it would just work its way down on the railroad tracks and a switch back down this canyon, which is pretty crazy if you've even been there because it's a lot of loose material, that's not very strong bedrock. I thought that was really amazing that they have enough gumption if you all just get the men out, we'll just build a railroad track and we'll just inch it down the hillside to go to Boise diversion dam.

But again, same thing, very much you know, brute force ingenuity, something I found as I mentioned, we moved it to Boise diversion dam. That's all I found, didn't say how or why, and what was the whole process involved in doing such a thing. We're going to see another slide next coming up. We're going to be looking upstream at Arrowrock in 1914 to show what the dam would look like.

So we see it starting to go up like this, it's moving farther and farther as we go. Again, more and more solid wall of concrete in the canyon. And I like these photographs getting taken on the same location, show how the dam is progressing and the different features that were used to build it and around it and how the landscape has blended into the dam. It's really, you know, do you think--but these are also, here's the end of the spillway, looking up stream and you see all the reinforcing steel. This is in October 6th, 1914. And you know, these are all classified negatives, for the most part, I found it at College Park National Archives. And we lugged all this stuff up by camera, you know, they put a big piece of glass in. They're 8 by 10, get it shot and make it roll.

So here we are on October 30th--August 30th, 1915, this shows the dam nearly complete. And we're seeing one of the features we know today, if you happened to be there or go by. There is a truss bridge and there's the dam. There's--one of the features here is this lovely log way or log shoot, that they built. This is very interesting, at 637 feet long, portion of it is still there today. Don't know if it was ever used. When they started building this dam in 1911, a lot of logs were rafted down the Boise River. But by 1915, they came out mostly by railroad, later on, by truck and so on and so forth. So, the agency spent the time, I don't know what the whole story was behind that to build it, and then they didn't use it.

Here is the dam in August 30th, 1915 nearly complete. Ready to go and starting to be used, you see the ensign valves open. They're on the lower level. And getting an idea of the water that

comes out of this, we're going to see a series of photographs of the spillway here. So here it is closed. This is showing it--showing you the spillway is 402 feet long and has six drum gates. It's a boomerang shape. It's not a flat or a straight angled spillway, that's the boomerang. And we'll see that it's slowly trying to open up, so these are a series of gates. And these gates will open each one independently. And they help release water on the dam, and people will ask, what's a spillway for? Anyone knows what a spillway is for? That's designed to release water, so it doesn't over top the dam. So they have a problem. They've got too much water, and then they want to release some water. We want to maybe release it out through [inaudible], they can't quite do so they're going to push out over the spillway, they're going to spill that water out. But for the most part with the reclamation service and today's United States Bureau of Reclamation, they didn't ever really use those, they want to keep all that water. So you can't see a lot of spillways in use. Here we see it dumping 6,000 cfs right there, so that's a lot of water.

So we do know it was used sometimes but it wasn't used a whole lot. But they're really magnificently designed, something that you would even appreciate especially if you were downstream. So, here we are in June 1917 Arrowrock dam had been completed for the cost of \$4,796,488 and 82 cents. It was 2 million--it's not \$2--\$2 million under budget. Do you have an idea what that cost is today? Historians like to look it up, in 2014. This dam would cost \$110 million and change. So we also see different features here on the dam as I mentioned and we have the truss bridge and we have the spillway, we have the dam here, we have a crane on the dam, we have the log way which may or may have never been used. Here is the little dry chain to pick it up and the chain of the logs and we have the caretaker's house. And today there still is a caretaker at Arrowrock dam. It's a very important installation to have someone who's there 24 hours a day always on call. So, as I wanted to talk about some of the details, I have limited time. Too many images and too much information. I did want to talk about this crane. This is a 7-ton crane which was taken in 1917 here, used for operation maintenance of the valves and the gates. An interesting thing about Arrowrock is that it has the valves on the outside going this way. And so we would have this crane, and they would usually come down to the back side of the dam. And it would come down so it could operate on these valves and do maintenance in all the needed requirement. So it was a little bit interesting to operate and to maintain because of the location. So again, I found this picture here, this gentleman. He gets hoisted 100 feet down to work on these. So you know, it was definitely not for the faint hearted if you had to work there. And I really thought that that was a real unusual photograph. We haven't found many of these and I found this one, showing the gentleman being lowered for operation and maintenance purposes on the ensign valves.

So next we're going to talk about the Arrowrock dam town side. This is in 1912. As I mentioned, some may heard it on the radio. The United States Reclamation Service had to build a town because there was no town there. They had to have housing for all the employees. This was a big deal because you had to have people who were there at the dam, they couldn't leave. They had to work. And so they built this whole complex we see here. We see a hospital, bunk houses, dormitories, US post office, cottages, guest house, general store, ice plant, soda fountain, meat market, bakery, public bath, a 70 horse table, engine house, turn table for the Boise and Arrowrock locomotors, warehouses, cement testing facility. Lumber finishing mill because they bought in lumber up stream but it was rough cut they had to finish it there. There's a sewer, there is a water system. There was a volunteer fire department. There was even a soda fountain in the general

store. And they actually did quite well with that. It served the general population and area because, I think they also did well because no alcohol was allowed in camp. If you are caught with alcohol, you are reprimanded and fired. So they do not keep people around and they're also really strong and kind of make sure this was a sanitary facility. There's a lot of concern with infectious diseases. You know, people being adequately cared for--You know, this is an era in 1915. We think of it as commonplace today. But they had electricity. They had running water. They had indoor toilets, you know. In that time people had to go to the outhouse. Maybe people here in Boise proper had some of that but certainly in the outskirts, you're [inaudible] things of this sort. So, to get this town built, they had to have lumber. It's an all wooden town, and so they have this location on Cottonwood Creek 13 miles upstream of Boise of Arrowrock dam. So it was 35 miles from Boise. And this, saw mill cut all the lumber for the town. Until that came with all the lumber, people lived tents we see here. They do have the warehouse done, they have the stable done. But the interesting thing on this caption from 1911, stated there have been--this is before the fire. So you see the importance of having a volunteer fire department because they're 20 miles from Boise and if it is wooden town and it burns down, you don't have anything to do or anywhere to go. So you see it being developed here in August 10th, 1911.

And we see the town progressing, a series of slides now through 1911 and 1912, the town will grow. They developed it in certain stages. Some, they built what they could before the railroad came. This is part of the railroad so everything was bought in by wagon or the lumber was bought down the Boise River or by wagon from there from Cottonwood Creek. And it was all--something that you think but was a lot of effort, a lot of work to have to be just freighted up and to pay the [inaudible] to bring it all the way 20 miles from Boise. So it wasn't a minor event. They started to build more and more of the town. They built the associated structures. They built the complexes first. I think, I thought it was interesting as here it is in December 12th, 1911. And I see it's snowing and you know, it's snowed up here. There's ice on the river and by now, the bunk houses for the single men have been built across the river, that seemed to be built later, I'm not quite sure why.

The interesting thing about the housing is that each housing often had a varying scale of price, based on design or layout. So, the dormitories for mechanics and foremen cost them \$2 dollar a month. The dormitories for skilled laborers was a dollar 50 a month. Engineers and office personnel, their cost of their dormitory was four to five dollar per month and that depended on each design and layout of them some are more fancy than others, some are more crude than others. And I think it's interesting to see how the cottages were done. These were the most expensive. These were \$10 to \$16 per month. There were 14 of these. They were the most expensive housing. They're used for married men. And they were kind of, I think probably you would say the tour of homes, the show piece for the Arrowrock camp. It is really a neat little complex and interesting to see how the camp was divided up and developed over time. Certainly those who lived in the cottages, they had a screen then porch. They had, you know, more privacy, they had, here is a flower garden. So it was really, you know, a little paradise in there, it was somewhat wilderness. I mean, it's still very rugged out there today. It's something that was very much peacefully made into a spot that people enjoyed; as a garden you see there. There are some fruit trees. And so every good engineered work or logging company or other natural resources extraction really lives on its food. So here we see the kitchen and the mess crew with a large mess and this is taken in 1912. So look at all these men here, look their pots and pans and all things, there was a dishwasher here which again not a big thing today, but hey, 100 years ago,

dishwasher, that was a big deal, was automatically run, wasn't the person having the wine or clean the dishes, they made so much food there, it's amazing to think how much was used in 1914. They used 431 pounds of mutton, 27,488 pounds of beef, 56,703 pounds of pork and one whole refrigerated car--just the meat would have been over 30,000 pounds of meat. And, you know, they were very thrifty because again you're 22 miles from Boise. They used everything. So you know, they didn't make anything go waste. They made sausage. They made bacon. They made head cheese and they made pickles, pickled pig's feet.

So here we see the man at the mess hall. This is laborer's mess hall. This could hold 600 men at a time. So there's a side--so in the tables that were 4.5 to 5 feet in diameter and they're all crowded in here and you see some coffee on the wall and see the cups in the plates. I love these photograph because they give us an insight upon this construction that maybe isn't in the written record but shows us visually. I was in Twin Falls and someone noticed something very interesting on this picture because here is the engineer's mess hall. The engineers have their own mess hall. It fed 36 people, not 600. And after August 1st in 1913, they had their own cook and female waitress. So prior to August 1913, food was brought over from that laborer's mess. Someone at Twin Falls, knows last night, I thought it's very interesting. The men in this photograph if you noticed except for two, don't have any facial hair but all the men in the laborer's mess hall have a mustache or they have a beard. But the one place where everyone went to that could participate in no matter whether they were engineers or they were the common laborer is the Arrowrock club. The Arrowrock clubhouse and we see here, it was available to all employees from eight in the morning till ten at night. Arrowrock Club, it was furnished with various [inaudible] district brands of the YMCA and provided pool tables, piano, victrola, movies for 10 cents, checkers chess sets. One of the neat things is you see who was involved and actually people could have access to everything being [inaudible] Idaho free lib--Idaho free traveling library provided books. So hey, go Idaho, free traveling library.

They provided books, magazines and newspapers. They had a steward to help with letters. And the banks would come up twice a week to help cash checks and do other needed financial things. So, it was really the hub of the camp. Besides, they're having entertainment, you would have need for hospitals or cuts or cares or bruises. And so here, we see the general ward on April 18th in 1912 that treated 145 patients with various illnesses and 201 patients with accidents in 1914. Each year, they keep track a records of how many people they have to see what they were caught or what was involved with. Here, we see the office and exam room. Looks a little scary today? But hey, 1915, that was the cutting-edge modern medicine and they had everything painted white and they made sure things were clean and sterile because they wanted everyone to be healthy. They really did. And the camp prided itself in cleanliness and did not have any labor troubles at that time. I thought it was interesting because, you know, some men lived in the camp, there are also some men who lived in the dormitories at the most inexpensive and sparsely furnished ones. And they had to go to work every day via suspension bridge. So, you seem crossing there in the camp. So here, we see the camp on January 1st, 1912. A little boy here with some Idaho Statesman, I presume, and a dog and here's a train that came up and it's winter because they operate year round and the quote on the glass plate negative was, "Sagebrush to civilization in six months". So, six months, why there wasn't anything there.

And here is the town of Arrowrock that had its own post office and postmark stamp. And as a historian, I'm always curious about different aspects when we talk about, you know, the buildings and what was said or what happened but also about people. So, we have who's involvement because this dam wasn't built up by machines but it was built by people. And here, we see a photograph of engineers for Arrowrock Dam and a gentleman on the bucket. This is the first bucket of concrete placed in the dam in 1912, one yard bucket. That is Frances Crowe and we have Charles Paul, this gentleman right here. He was the construction engineer for the project. And so here, here's office staff. And I got some great shot. It shows all the accountants, clerk, also timekeepers, pay masters, et cetera, in 1911, wearing a suit, looking fine, got the tie. And, you know, that was one portion of this because they helped control what was coming in and out and make things work. But these were the people who really worked hard in the dam. These are the laborers, you know, and we also got table rolls, old shirt, you know, that's a rough thimble work. These are the drillers working on the spillway. You know, laborers were paid \$2.40 to \$2.50 a day which was the lowest wage there at the dam construction. Now, give me idea what is that cost today. That means you're making \$56 to \$58 a day. Here we see, a gentleman also working on the spillway but is now is now, it's blasted out. They're using burly drills and they're injecting the spillway with these drills, you can see men in motion there. The highest paying job was not this, was actually for the dragline operator which you got \$5 a day. So, everyone has a sliding scale how much they were paid. But, you know, this dam was built, even though with modern technology, with the brute muscle of men. And we see this here because here we see gentlemen clearing rock that's been blasted in the bedrock for the dam. And so, even though, they had all these machines here, these men are out with picks and shovels and they're picking up the pieces of rock and putting them in these 8 by 8 skips to be lifted away. There's a lot of hand labor in there. Other jobs in the camp were blacksmith, cooks, carpenters, cableway, powder men, riggers and even a gentleman called the flunky.

So, as I mentioned, technology for the dam, we had Boise Diversion Dam which is built prior to Arrowrock and a powerhouse built on there. We see here in 1912. And they built a powerhouse because even though we have had hand labor, we have these other things, we had to have electricity power to do this to operate this dam 24 hours a day in this construction in certain parts of the season. So, they built a powerhouse at Boise Diversion Dam, they hydroelectric power, brought it up via transmission line here to Arrowrock Camp. And then, it was transformed and it went to the houses, it went to the plants, whatever you see here, they're using inside the diversion tunnel. They didn't have a candle with a wick in it. They actually had lights. And so, it was a lot easier to work with having all that electrical power. When, you know, very much new inventions still at that time, in 1914, in 1912, in 11 and 15.

This is a great picture. I love this photo. This shows that actually working at night. So they were at times three shifts. And so, they would have the dam lit up at light and they were continually placing concrete, building it higher and higher. And shows you that they had to have the electricity in order to keep the dam construction moving or they would be stymied by that. And so, electricity was very important in building of the Arrowrock Dam. It wasn't the first time that was used for but certainly, very much in a large, large scale. So, one of the interesting things was this cable way system. So, they devised a system to--string a series of cables across the dam with towers. And here, we see it in 1915. We see a tower over here. There's a linger wood tower system here. And it goes across and there are two here. This is 100-foot tower here and they're 260-foot there. And

you see it would bring material out from the bottom, the bedrock in this portion, and then they double here in this hopper and they crush that rock and they would put it in the concrete mixing production for the dam. They were very much focused on trying to be thrifty with this project. We would think of today, they were just being economical. They re-used a lot of materials that were raw to make this--to finish dam.

So here, we see this two-yard gravel bucket. Imagine how huge it is. You got Manny fits gladly in it. I want to think I would want to rest in there but it's definitely a large piece of machinery. And so, these cableways would take this and pick it up, bring it high up on to the hillside where this hopper was located and then they would dump that material into it and crush it and screen it. And then, they would try to make a concrete out of it. So this carrier was used from many different things. We see it here, they're using just rudimentary with a grab bucket in getting out the material, bringing it up and deposit it. But also was used as a way to ferry things across the dam site. So here, we see, here's a narrow-gauge locomotive being carried across. So again, same thing like with the 7-ton Atlantic steam shovel, they took it apart and they do what they could. Stuck it out around cables and strung it all across the canyon here. That was very ingenious that they were very thoughtful and they really want to make sure they had good use of the equipment they had. These are taken on April 2nd, 1915. It shows 8 foot by 8 foot skips. These are getting to ready to dump the load of concrete.

So, not only that we have the gravel bucket bringing material up and deposit it, then later on, we have it bringing up concrete. And one of the main things with the first things with these dam and they made it the 8th wonder of the world, was use of the Crowe concrete distribution system. So, Frank Crowe, Francis, his name, his official name devised a system to be used on a cableway to help deliver concrete to the dam. And we see here being started with a small floor pour. We have the two components right here and here. And this had never been done before. This technique was used later in dams such as Hoover and elsewhere. But it never been done so that comes in on a conveying bucket, it was an automatic dump we see here. And then it goes into a swivel hopper. And so, they could put that batch in. They could three yards of concrete in it. Bring in the hopper then they could pour it out here on the dam. Gentleman earlier on asked me about if they had used a wheelbarrow, if someone had a wheelbarrow. And this one here is if that was when you use some of them. I'm not really sure because they have this system where they could deliver the concrete in the sections in this occasion. It doesn't mean they didn't used a wheelbarrow somewhere else in the dam's construction. But it's only here, they were using this because this is very efficient. They use this system for two 8-hour shifts 6 days a week. And we see here the second section of the dam under construction and being poured, so very much somewhat we still live today a very much a wet muddy mess of the concrete. And it's being poured in all kinds of directions to get the right amount.

So, the real unusual thing on this dam is it specified the use of Ensign valves. O.H. Ensign devised a way to use reservoir pressure to have a horizontal plunger or needle that moves forward and backward to open or close. And this was something that was a new technology. And it had been tried before in several other reclamation dams and had kind of worked OK but it had been retrofitted or in someday was specified for something that was brand new. And Arrowrock required 20 of these. And I thought it was very interesting because I was so--how did you get these things installed in a dam? Because these as you can tell are not small. Well, they brought in a railroad

car. Interesting is they brought them in, just like we saw with the Atlantic steam shovel and narrow gauge locomotive. And then they had to disassemble them. So, just disassemble, one here is a disassembling of 58 inch ensign valve prior to insulation.

This is on December 18th, 1914. So, they brought it in and they took it all apart and labeled it. In here you could see, they start taking apart and used the cableway system to bring it up over the dam onto the other side. So here, we see the--here, we see the [inaudible], the face of the dam, looking on the south side, we can see a 7-ton piston going up the cableway. I always think, you know, look at the amount of ingenuity and fearlessness that they do some of these things. Here's a base ring going across the canyon. It's going to be installed in the dam. Imagine, that 7 tons. And then, it was transferred from the cableway to a car which then go to the deck to be lowered and placed. And that's what we see here. Now, they've swung it all the way across the valley. And they put it down here on this little car. There are gauge rails and then they'll take it to a deck which is then going to put it down on the other side of the dam. And you again look at all the lumber. I mean, they had the [inaudible] cricket cut all that, cut all the trees and make it work. So here we see, it being lowered the piston in the trash rock structure on the backside. So, it was a quiet and event, just to get this installed, they had had to it 20 times, they had 20 of these. Bring it up and bring it down and put in place then assemble all down there.

So here on this view from August 3rd in 1915, we see them in place. You see two more, that are left to be finished. So, it was more what the dam would look like nearly when it was done. And these valves were very efficient. They did not need to have any electric power, they're operated by hand, they're open or were lever or they're open, they were shot in one mark. So you see, they're fully open or closed. And here we see a 9,000 CFS coming out over the dam. Here's upper and lower valves being opened.

Now, we're going to talk a little about sand concrete. That was this dam was built of. This was the first one to build that way. And you see the missed from the dam. So, I'm going to talk a little bit what that caused later on the dams lifelong longevity. So, we see the sand cement plant here. And the sand cement was something that they devised, recommend sort of testing concrete and its uses. And they discovered that Portland cement was very, very heavy. So for you to ship all the way up from Boise even though it's 20 miles away, it's extremely heavy, it cost a lot of money. They felt, "Hey we could take this material, we can pulverize and make it small and we can combine with some Portland cement. We can get a mixture. We get a blend." And this blend will turn out to be a strong as pure Portland concrete. And so, they were able to save over \$250,000 back in the day by doing the sand concrete mixture and making the material from the riverbed and spillway that they've blast out or moved. Do you have an idea how much money that is today, I mean \$250,000 still wasn't seems changed. But back in that era, in 1915, that'll be \$6 million. So, that was quite a cost savings. And so, when they mixed in the sand concrete plant, we saw there, then they went and took it to the concrete mixing plant. They have a 3-cubic yard electric dump cars and mixers and a trolley system.

So the dam was completed somewhat on October 4th 1915. Actually, it wasn't completed until November that year but they have 4,000 people come up from Boise so here's a special train, all passenger cars. They came up as I mentioned in my teaser for this event. Governor Alexander awarded as one of the Greatest Engineering Achievements of Mankind. The other thing is that

they let people mill around. They give them barbecue, meat and vegetables and grains from the Boise project lands that were served by this dam. So everyone got a free meal. When people milled around, they did certain things and they wanted to make sure people were safe. One of the things was--is they do not want anyone going down the 6,037 foot long log way. Well

[ Laughter ]

It's a hundred years ago. But people still the same back then as we were now. People went down that and they got stuck. And so, one of the reclamation service employees was caught saying, "We nailed up that entrance to keeping fool such as you out."

[ Laughter ]

So as I mentioned, the dam was dedicated on October 4th 1915. But actually, it wasn't completed until November. Then you can see enough photograph that that the globe wasn't on the light fixture. Dam is still there today. Go up and see it. Take a look at it. I have my cousin here. She-- [inaudible] in the audience. But she's actually been in. So it's a great structure. It's really cool. It's something you can see and be a part of today. You can't go on it due to security reasons today but you can certainly drive by and see it. So, I'm going to finish here. And you see, people in Idaho were so proud of it. They even have [inaudible] labels made with Arrowrock brand. Anyone have any questions? Yes?

**Audience:** So how much longer will it last?

**Kelsey Doncaster:** Well, it's very, very strong. Now, the sand concrete as I mentioned was a great mixture and did really well in fact. But unlike Elephant Butte Dam which is the other dam build by Reclamation Service in New Mexico. That missed from the ensign valve. You don't want to cause that dam to get eroded over time. And it really got pitted within 20 years, they have to rephase the whole dam with Portland concrete, strict concrete. But it's still very sound today. Even though the other portion of the dam is sand concrete, it's still as strong as it was when it was built. They made sure that they had different types of check systems in it and guards and gutters. They help break the water out. And so, it's not going anywhere. I can see it here, Christian's here but it's not--the press is gone. In 1985, someone asked the dam tender, "What would happen if we had a cataclysmic, you know, 500-year flood, would it wipe out the dam? He said, "No. It would just go over." Yes sir.

[ Inaudible Remark ]

**Kelsey Doncaster:** Right. So then, during the summer time, they had three shifts. And so, they would have a shift, for example, you know, do you have an idea of the time for the kitchen, they would breakfast at 4:15, that's for the first shift. And then, they have their last breakfast at 6:00 for the graveyard shift. So they would have three shifts working on the summer. Then on the winter time, it just kind of back to one or two. And they may have focused on different areas of the dam at that time to work on [inaudible] the concrete. They had assembled some of the mechanical components within the dam at that time.

**Audience:** What happened to the little city?

**Kelsey Doncaster:** Little city. Lasted there for several years. Everyone, of course, moved out. The agency in 1941, you could see in some maps, there was some buildings, the office building was still there. But most of it was raised. And again, I'm from Yakima, I'm not a native Boisean person, Idahoan. So someone may say, "Well, I've got a house that was shipped down there," may be the idea but that's a long way to ship out. I believe of what I found is that they raised most but they actually made it a park. And so, it's all gone today. But, as I told this [inaudible] archeologist, there's lots of archeology there because it had a sewer system and had a water system and all these components. So it may be wiped off from what we can see in the ground but it doesn't mean below ground, there are some things there.

**Audience:** So you have mentioned the raising the [inaudible].

**Kelsey Doncaster:** Yes.

**Audience:** What is the purpose of that location? [Inaudible]

**Kelsey Doncaster:** Yes.

--future,

Yes.

[ Inaudible Remark ]

**Kelsey Doncaster:** Yes, yes. That I can't comment on because I don't who [inaudible] on that. But all I can say is they raise it back then to get more water storage. You know, they were able to raise it at 5 feet and get and then, and even if it sound like a lot, that's where the whole area the reservoir pulls. So, that's a lot of acre-feet water. And that's why they raised it back then. You know, they built the dam. They thought it would be enough but then they realized, "Well, we got to have another dam. We're going to build Anderson Ranch Dam from 1941-1950. So--

**Audience:** Does anybody die on this project?

**Kelsey Doncaster:** You know, that's interesting thing. Someone asked about that. There was article in the Idaho Statesman recently, I don't know if you folks saw that. They said that 12 people had died because of that. Actually, when I researched and do the work for the Historic American Engineering record, I never found much indication of that. Now, it doesn't mean it didn't happen. It doesn't mean, the agency didn't have to note that although think they would. I found some in 1958, they had a gentleman working in Oregon on a--embankment dam and he rolled his dump truck and died. So that was in the records. So I'm not sure. So then, there were people who were injured, if they have ever seen a broken arm or loss of finger or, you know, a foot, things like that. But not that I can say they verify, I'm not saying that what Idaho Statesman said wasn't correct but certainly it's something I couldn't find when I did Historic American Engineering record. I wanted to make sure that it was accurate and complete. No, I couldn't verify, I didn't put it in.

We only have one more question so everybody else--

[ Inaudible Remark ]

**Kelsey Doncaster:** Yes.

**Audience:** So, I saw that they have a big--

**Kelsey Doncaster:** Yes.

**Audience:** Whatever you call those.

**Kelsey Doncaster:** Yes.

[ Inaudible Remark ]

**Audience:** So then, what is that connected to [inaudible].

**Kelsey Doncaster:** Yes, in blasting, they put holes and they put anchors on the walls and actually, because Lucky Peak reservoir now comes up to the bottom of Arrowrock Dam. But when it got down, Christian's back here who's on the camera. She actually was there doing some [inaudible] for the heir and discovered that some of those pedestals were still there. And so, even though those towers are gone, there are the pedestals still on the same spot. OK, let's see. Who has been patient? Who's--gentleman with the glasses? You. Yes.

**Audience:** When did the actual planning for this dam start?

**Kelsey Doncaster:** It actually started, oh gosh. It started quite a few years before. They actually want to build the dam first, but they couldn't get funding for that. They said, why don't you build the Boise diversion dam and build the New York Canal and the Deer Flat Embankment, and so on the so forth, first, before you get to do that. But certainly, they started construction in 1911 of May and started planning it in 1909, pretty consistently drawing up plans and informational on that. OK. Let's see gentlemen?

**Audience:** How long did it take to dig that diversion tunnel? Do you know the figure?

**Kelsey Doncaster:** You know--Just an off the cuff response would be I think it took about six months or less. It wasn't very long. You know, they had drills, so they could do it a lot faster than doing by hand. But that was the first thing they had to do to help reroute the river around there. Gentleman behind you?

**Audience:** Yeah, was structural concrete, it has to be vibrated, once it's poured to get the air pockets out of it? Did they have a device like that?

**Kelsey Doncaster:** Back then, no. So again, you're testing grounds. And we're building up farther and farther on dam construction we knew with the trial load method and dam design certainly, you know, and later dams, they have that type of thing to help vibrate that. But you know, they were learning as they went. There were four dams built before this for reclamation service and several of those are just masonry dams like Roosevelt dam in Arizona, Shoshone Dam in Wyoming. And so, you didn't have the development that you do today, and some of that [inaudible] technology.

**Audience:** What was the maximum size of the aggregate?

**Kelsey Doncaster:** Oh gosh. They try to get it fairly small. That's a figure I can't remember here, but I could talk to you later about it from the information I've pulled here. But it was fairly small. They didn't try to get, you know, a big aggregate. Yeah, yeah. And they were very much working on that. They tested it in places there and also in San Francisco what size of the aggregate that works the best for this mixture and--

**Audience:** So did you talk about the electricity where it was [inaudible], that cluttered diversion dam?

**Kelsey Doncaster:** It was generally the Boise diversion dam. Our house is there today.

**Audience:** And do they light all the houses and just like a dishwasher [inaudible]?

**Kelsey Doncaster:** Yup, yup. Yeah, so we had electricity and you had indoor plumbing. And you have steam heat. OK. Lady in the red.

**Audience:** Was that the same frame [inaudible] that worked on the Hoover Dam?

**Kelsey Doncaster:** That's correct.

**Audience:** I thought so. And they learned a lot from this day, aren't they?

**Kelsey Doncaster:** Correct, yeah. I didn't see enough, you know, it's just outside Idaho. But the Arrowrock, you know, Boise's dam is the world's tallest dam to Owyhee dam on the BR project. And that incorporated some of these new things you are learning and each time they built another dam, they did something different. I know this worked and that didn't work. So just always learning from that. This gentleman over here.

**Audience:** My grandfather's brother was one person who did that [inaudible] dam, however it's my understanding that in engineering, articles all over the world, at times, there would be people marveling at how a, very, very few people died building it and b, very, very, few people if any died from disease in the camp. That was just a miracle.

**Kelsey Doncaster:** Yeah. And they worked really hard on that. And you find records, you're seeing how you know, someone came down to somebody because they had--I showed pictures of a hospital and also had an isolation hospital. And they did it just from what that gentleman was saying. Someone came down and suddenly they put them in isolation. They made sure sure it didn't spread amongst the 1400 people there were living there. OK. Who is next?

[ Inaudible Question ]

**Kelsey Doncaster:** No, that's United States reclamation information service.

[ Inaudible Remarks ]

[ Inaudible Question ]

**Kelsey Doncaster:** Yes, yup. All the Arrowrock system for the Boise project had been built out for the Arrowrock division at that time. The one thing added after Arrowrock was the Anderson Ranch dam. So they actually had built out the irrigation canals, Deer Flat Embankment, the lateral

systems to irrigate the valley. Now, there is a Payette Division which came later with the Black Canyon Diversion dam and Deadwood dam, how they irrigate that part of the whole Boise project. But the Arrowrock division, it was ready to go as soon as they turned the water on from the dam.

**Audience:** So how was the Lucky Peak better?

**Kelsey Doncaster:** Lucky Peak is an army corps of engineers which is not United States reclamation service. And what I was told, it was built for flood control. And that's why they built it. It did work as flood control but it was built primarily to store water. I mean, it did work as both things, but they built Lucky Peak for flood control.

So again, I'm not a native Idahoan and so I can't tell a whole story on that but I know that there's been a lot of concern over the years of the flooding in the Boise River and what they can do to retire that and keep that river in check.

**Audience:** I don't understand the sand concrete, could you explain that again?

**Kelsey Doncaster:** So, sand concrete is a portion, and I don't have my notes in front of me on that, but what they did is they took a portion of Portland cement, and so you can just trade Portland cement then they combine it with pulverized granite or other type of aggregate material that was ground to be very, very small. They're going to be very fine sieve that was sorted over time and ground down to be just a fine mixture. And so then they combined it together. So they mix it together and plant. So they were, like you would take flour and salt, you mix the two together.

[ Inaudible Remark ]

**Kelsey Doncaster:** Yeah, it was an economic thing and at that time, if I--hey this is great you know, we can do this. We can combine this, we can save all this money and they did it there and they were building Elephant Butte Dam in about the same time in New Mexico. But those are the only two ever built because they discover surely thereafter that that really wasn't that good of an idea. Yeah.

**Audience:** So, is it the State of Idaho that helped build the dam or was it all federal money?

**Kelsey Doncaster:** All federal money. Yeah it was that over almost 5 million dollars.

[ Inaudible Question ]

**Kelsey Doncaster:** Well, they taper some of the cost. And that's more of an accounting information. It's very interesting how some of those things work. United States reclamation service was started in 1902 and helped develop the arid West and would build irrigation systems and they're going to build these out and then they would have irrigations at the same time, [inaudible] would help come and take over and do operations management systems and start paying that back, OK?

But that doesn't mean necessarily that they got it completely. For example, where I'm from in the Yakima Valley, there's a Tieton irrigation to [inaudible] irrigation district. And that district in 1947 was the first in the nation to pay off all of their construction cost. But, we still own the system. So even though they paid us off, the federal government still owns the irrigation system. And I know

that there was money spent back to pay for the cost of Arrowrock Dam by the Nampa and Meridian, and all the other irrigation districts in the area. But it also was part of when the Boise project was transferred over for operation and maintenance by these various irrigation districts and energies. This was retained by the federal government. So the United States government still owns Arrowrock dam. Anyone else?

**Audience:** Just curious where they [inaudible]?

**Kelsey Doncaster:** Boise was always a regional headquarters like it is today, for the reclamation service for the Pacific Northwest region which is Oregon, Washington and Western Montana. As to workers, you know, they advertise your people to come work on the dam, I wish I knew more. But I think they came from different parts throughout the country. They had a very solid labor force as the gentleman mentions, they didn't have problems with disease, you know, they had good food. And so they kind of had a very solid force, it didn't change a whole lot. You know, you see other projects for example, some private [inaudible] they be hiring people every other week. There are so many people left here and there. And wish I could tell you more, but I believe that they all came from probably around the general area, we're in the western US. But these people also may have not had a lot of education because I found references where the steward helped them write letters to family back east. Yes sir.

**Audience:** Yeah, the construction engineer Charles Hall. He was from Holden, Massachusetts and his younger brother worked on the dam as well and wrote a novel about the gullies, so Arrowrock dam is just called Lather Rock which is a strange name for it. You know, [inaudible] 1929 is a very readable novel, so short novels less than 200 pages long. I loaned it to a friend of mine who's a dedicated fly fisherman, went over to Sun Valley. And he started reading it and instead of going down and fly fishing, he stayed in the hotel all day reading the book. I know it's fascinating but--It's out of print. But the name of it is Arrowrock remain Leather Rock, if anyone, it's very readable, novel and it's factual. About the events, so they're going to change its name, and so on but the events that are part described in the novel or things that actually happened [inaudible].

**Audience:** Well, I think MK did work on the data that we started in 1912, the [inaudible] neighbors and I know Harry worked throughout the day.

**Kelsey Doncaster:** No, now I was only built by the reclamation service. They didn't contract out with anybody. It was built from 1911, to 1915. [inaudible] many other dams on things and the reclamation service would contract that out, but not Arrowrock. It was all done in-house. Yes?

**Audience:** Is there a Power Plant there?

**Kelsey Doncaster:** There is today. There's a 15,000 kilowatt plant done by the Boise boarder control. And that little plant is there at the bottom. Interestingly enough, when they built the dam, they actually had designed it and two spots of the tubes coming out from the ensign valves to be wider for hydroelectric power generation. But they never built that. Thank you,

Thank you.

Thank you all for coming.