### Stockpiling of Aggregates

Aggregates will be stockpiled using a loader. They will be stacked in a way that minimises any segregation to the piles. We successfully used this method on the Tongue River Dam in Montana, which had aggregate much softer than what we will see on the Muskrat Falls project. Should we find that the rock breaks down to the point of putting our combined gradation out of the specified gradation limits, we will switch to stockpiling with a stacking conveyor.

### Quality Control of Aggregate Production

All aggregate used in the RCC and conventional concrete will be tested onsite to verify conformance to the Specification requirements. An important note is that the combined gradation of the aggregate is the ultimate conformance measure. Strict testing and compliance at the split levels are the only way to guarantee conformance of the combined.

### Quality Control

We expect that Nalcor will provide quality control sampling of the process aggregates on a daily basis for both shifts while in operation. In addition, setup sampling for plant shakeout will require more samples to ensure the plant is set up properly.

### ROLLER-COMPACTED CONCRETE (RCC)

This section describes our general approach to Roller-Compacted Concrete (RCC). In general, our approach is to minimise interruptions in the placement of RCC. We have looked at placing the RCC in two ways to prevent extended downtime while forms are jumped. Ultimately, we determined that the slope layer method is preferred over the conventional horizontal lifts.

### RCC Production

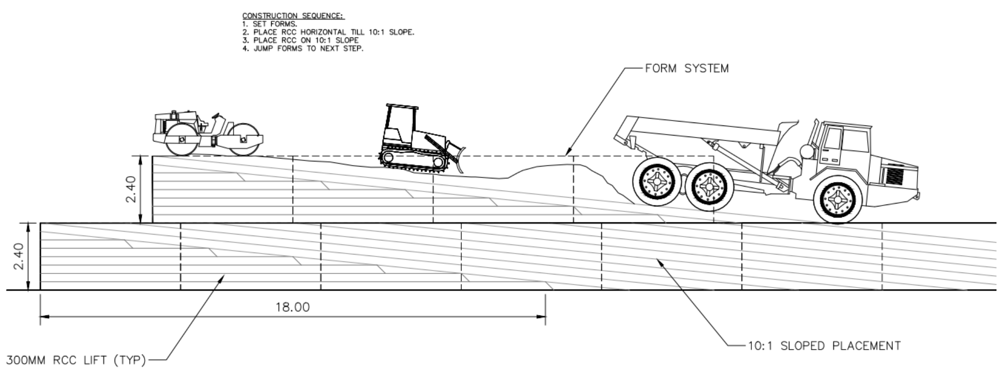
We currently complete the RCC construction in 140 days, with a winter break between November 1, 2016, and May 2017. The average production is approximately 85 $m^3$/hour. Currently, we do not meet Nalcor's interim milestone dates; however, we do meet the finish date.

### Horizontal Lifts

The formwork on this RCC section will drive the production. If we place RCC in a conventional way, we will have significant delays when the RCC crew finishes the top of one step while waiting for the form crew to jump the forms. You can either build the RCC Riverside Cofferdam in monoliths bottom up at each contraction joint, or you can incorporate a slope layer method. We have chosen to utilize the slope layer method on this project to minimise the impacts the formwork will have on the project.

### Slope Layer

The slope layer method is widely used in China and Australia. This method will ensure that the formwork is caught up as close as possible to the RCC placement, essentially taking it off the critical path. The slope layer method also minimises the use of admixtures in the mix, minimizing form pressure and joint cleaning. The overall RCC produced is a much higher quality when placed in mass blocks.




### Mix Design

Nalcor and the Engineer provided a base mix design for this project:

- MPa = 15 to 17
- Nominal Maximum Aggregate Site = 40 mm
- Cement Type I = 60 - 85 kg/m³ (We used 80 kg/m³ in our estimate)
- Flyash = 110 – 160 kg/m³ (We used 100 kg/m³ in our estimate)
- Water = Variable – To be established with more lab testing and trial placement
- Admixtures = WRA = to be determined
- AEA = to be determined
- Aggregates = 4 pile mix

RCC mixes for the project will be determined once sufficient data are available from crushing and screening trials. Barnard-Pennecon J.V. is familiar with the trial mix procedure. For the Muskrat Falls project, we will need to start with the crushing equipment and its effectiveness in crushing the rock. We have discussed our approach to crushing in the previous section.


Nalcor has defined characteristics of the mix design in Specification Section 03 37 23 RCC. Barnard-Pennecon J.V. would request to be involved with the final grading determinations for ease of workability and compaction efforts during the mix design process.

### Trial Placement

The Specifications state that a trial placement will be performed with at least 600 m³ roughly 30 days prior to full RCC production. The trial placement will provide training for our crews and will allow Nalcor to evaluate the top RCC mixes from the Laboratory Mix program and any subsequent Onsite Mix Program. The purpose of the trial RCC placement is to develop the following:

- Effectiveness of the equipment, construction materials and process of the delivery method.
- Effectiveness of the equipment, construction materials (i.e., formwork) and process of the placement method.
- Training of the workers regarding the importance of safety, timing and quality of work required during the RCC placement.
- Training of the quality control and inspection personnel as to safety, timing and quality of their work during the RCC placement.
- Developing expectations for and from Nalcor and SLI on specific work practices to satisfy the design.
- Expectations on facing finished looks, not only for the workforce, for but Nalcor and SLI.

Following the setup and shake-out of the crushing plant, aggregate will be produced to the gradation bands stated earlier.

Following a consistent run period, producing approximately 3,000-5,000 tonnes of each aggregate, an onsite trial batch program could be run by Nalcor and SLI with Barnard-Pennecon J.V.'s selected materials. This is normally done to optimize the mix with the materials planned for use prior to the Trial Placement.

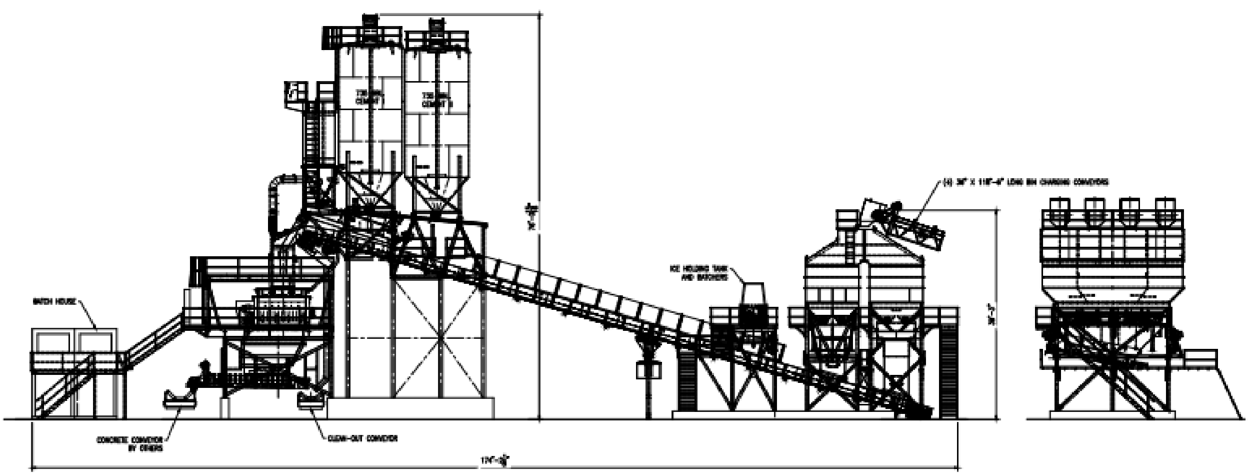
Provided Nalcor is happy with the results from the lab trials, the top five or so mixes would be tested in the field. The Trial Placement would be made using the full-sized equipment envisioned during full production. We have planned for a two-day trial placement period.

We plan to utilise the following equipment:

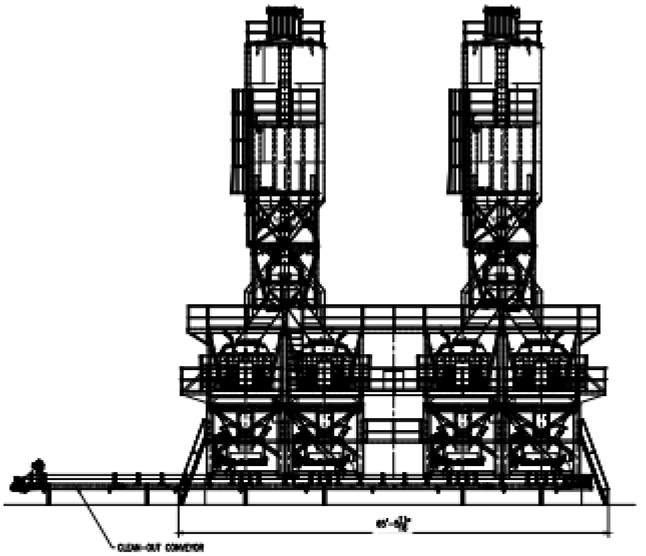
- CAT D-5 spreading dozer
- CAT 563CS roller
- 40-tonne articulated haul trucks
- Con-e-co Dual Mix Plant with Twin-shaft Compulsory Mixers
- CAT 980 loader to feed the plant
- Gang formwork
- Small vibrator double-drum roller
- Wacker packers
- GERCC mixer and hand-held concrete vibrators
- Waterstop demonstration
- Curing equipment

## Mixing Plants

We will utilise two Con-e-co weigh batch plants with four separate Liebherr or Simoma compulsory mixers. These plants provide the most accurate and thoroughly mixed RCC. We are currently utilizing one plant similar to this on our Gilboa Dam Reconstruction Project in New York State.




**Con-e-co Plant Profile**




**Con-e-co Front View**

**Single Plant – Dual Mix Capability at Barnard's Gilboa Dam Project, New York**

### Aggregate Handling

When loading aggregate out of stockpiles into the RCC mixing plant surge bin, we anticipate using four aggregate bins to handle the required four-pile mix.

Aggregate will be individually or cumulatively weighed. Cement and flyash will also be weighed separately before entering each mixer. Mixer times will be determined from the mixer performance testing; however, we expect a mix time of approximately 30 seconds. Computer monitors and individual weigh tickets will be generated for each mixed product. The plant will automatically reject and record mixes that exceed the mix tolerance requirements.

### Cement Handling

Cement will be stored in either vertical silos or horizontal silos meeting the four-day storage requirements of the Specifications. We have allowed for rapid unloading capabilities so that cement trucks can achieve quick unloading times. We expect to unload trucks in 15 minutes with our system.

Currently, we have two options for supply of Cement and Flyash.


**Plant Control Room at Gilboa Dam – Command Alkon Controls System**

### Temperature Control

The control of temperature could become critical during the summer months. To maintain the cool temperatures, we will rely on several techniques and methods.

**Winter Stockpiling:** We have allocated time in the cold winter months to rehandle the coarse and fine aggregates. This will consist of moving the entire stockpile and generating a new pile. This allows for opening the existing pile and allowing cold air and moisture to enter the piles. Re-building these piles will maintain a cold stockpile for later use. We will utilise thermo-couplers in the pile to help us monitor the internal temperature. We believe we will be able to get -15°C benefit with this process.

**Wet belt at Saluda Dam, South Carolina**

**Wet belt:** We are considering using either a wet belt or dry flake ice as an additional cooling method. Wet belts use near freezing water to spray and cool the aggregates. A final rinse screen will be utilised to remove any excess water off the material prior to entering the plant. One problem with using wet belts is that we cannot run all of the coarse aggregate on the wet belt because of the sizing required by the Specifications. This means the wet belts will become less effective.

**Flake Ice:** Although a higher initial investment, the flake ice plants provide for a smaller footprint and lower operating costs overall. We would look to have the storage and plant capacity to run 200 m³/hour using flake ice directly added to the aggregates before entering the mixer.

During hot summer months, the RCC production will need to be slowed, mainly because of the cooling systems needed to maintain a cool RCC temperature. We may need to shift RCC production to only a night shift if daytime temperatures are too hot.

### Delivery of RCC to the Cofferdam

Barnard-Pennecon J.V. has experience with multiple delivery methods for RCC. It is not uncommon on a project that has a long crest to employ multiple placement methods.

For the Muskrat Falls North Dam, Barnard-Pennecon J.V. will have two methods of placement available. The first will include a 30-inch-wide conveyor from the RCC plant in Area A to the south end of the North Dam, where a telescoping conveyor will be used to load trucks on the placement. This system is sized to take the maximum available production from the RCC plants, which is approximately 300 $m^3$/hour.

The secondary option will be to utilise a truck-loading gob hopper at the RCC plant, trucking the RCC to the upstream side of the North Dam in CAT 740 Ejector trucks, dumping it into a surge-crete hopper, and feeding a conveyor placer that fills trucks on the dam surface.

It is likely both methods maybe utilised at the same time to maximize production in multiple areas of the North Dam.

### Plant Area

We have looked at many areas on the site to establish our RCC and CVC plants. The only area that makes sense to us is Area A & B. The primary reason is that this area is above the high water mark of El 39.0; we would not have time to remove all of the equipment in time if everything were located in Area G & F. Work Area G & F would be better if Nalcor could provide some schedule relief on when the water-up period begins.

Other works areas, such as Area J, are too small to accommodate the RCC/CVC Plants and their required cooling equipment and stockpiles. Plus, many of these areas are already utilised by Astaldi. Any remaining area in this location will be used for laydown for formwork, rebar and crane erection.

### Conveyor Layout

We will utilise multiple runs of 30-inch conveyors to deliver the RCC from the plant location to a point of placement at the dam. Our conveyors will be covered and protected from the weather to allow as much placement time in adverse weather conditions as possible.

By using Area A & B as our plant area, an overhead conveyor can be used to cross the existing access road to Work Area C1. All other conveyors will be laid along the ground as much as possible. Across the spillway area, we will run the conveyor on our temporary bridge, cutting the bridge to one-lane traffic.

The placement of RCC to the lift surface will consist of multiple methods discussed above because of the location of each placement and the flexibility needed to maintain the project schedule. Each method is described below, based on our past experience from other RCC projects.

## A13 Attachment 1
Execution Plan

### All-Conveyor System
This method uses a Putzmeister TB-600 or similar conveyor placer at the end of a conveyor string to deliver RCC directly to the lift surface. The placer evenly distributes the RCC in windrows which prevents segregation of the mix.

### Conveyor to Trucks
This method uses a string of conveyors from the RCC plants to the placement where RCC is loaded into trucks. Trucks make the final delivery to the placement for each lift. The method of loading the trucks can range from a swinging conveyor to a gob hopper on the lift surface.

**Gob Hopper on the Lift at Cotters Dam, NSW Australia**

### Trucks to Conveyor
This method consists of using haul trucks to take the RCC from the RCC Plants and deliver it to a Surge-crete or Augermax where it is fed onto a conveyor that delivers the RCC directly to the lift surface or to another haul truck on the lift.

# A13 Attachment 1
Execution Plan


**A gob hopper loads a haul truck from the RCC plant at the Saluda Dam Project**

## Foundation Preparation

The existing foundation surface is very irregular. We anticipate that it will be shaped as contemplated in the Specifications. A minimum work area of 1800 m² is required before we can utilize RCC.

## Levelling Concrete to Dam Foundations

Prior to full production RCC placement, it will be necessary to provide a platform onto which the RCC can be placed. We anticipate that significant rock shaping and levelling/dental concrete will be required to meet the minimum area requirements to start RCC.

Often when large areas of levelling concrete are required on an abutment, the placements are formed. Levelling is typically required to fix holes or faults along an abutment. In this case, the Engineer may require a staged approach where lifts and placement rates are dictated to avoid generating excess heat in the block. It is important to get this work done prior to RCC so it does not influence the placement schedule or project schedule. No bid item has been included for levelling concrete, and, therefore, we added an item in anticipation of separate payment for this work.

# A13 Attachment 1
Execution Plan

**Levelling concrete on the left abutment at San Vicente Dam**

## Dental Concrete Placement
We anticipate performing this work in isolated spots, as directed by the Engineer. We have planned for a small placement crew and concrete placed by pump or crane and bucket.

**Dental concrete crew on the San Vicente Dam**

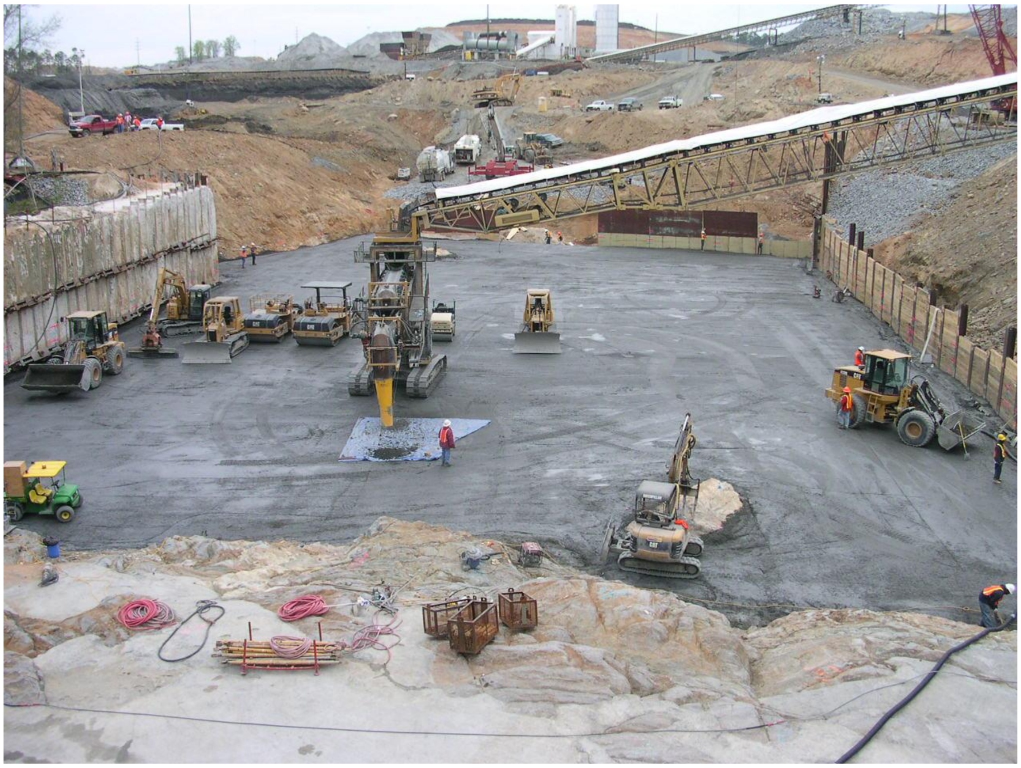
### RCC Placement and Compaction

This section describes the RCC placement means and methods. All of these practices will be demonstrated at the trial placement and adjusted according to preferences of Nalcor and SLI.

### Preparation Prior to Placement

Prior to placement, the lift surface will be air blown or light pressure-washed. Depending on the lift joint maturity, the surface will receive a bedding mix layer. This bedding mix layer is anticipated to be a grout mixture, the same as used for the GERCC water-stop detail.

Prior to starting, all equipment will be tested and cleaned. Dry material from the plant, conveyors, etc. will be collected and removed from the lift surface.



**A crew uses a tarp to collect dry RCC as they prepare the lift surface for treatment**

### Spreading

The RCC will be spread evenly to ensure a 300-mm thick compacted layer by use of a Caterpillar D5-sized tracked dozer. These will be equipped with a laser level to keep the blade parallel to the previous layer and at the correct elevation and by using paint marks on the formwork. This method is the same for the slope layer method, except that the lift will be sloped between a 10:1 or 20:1 angled surface.

The D5 will also be equipped with a power angle and tilt (PAT) blade to enable detailed placement and handling in tight locations. The RCC will be spread in a series of lanes, probably 6m to 8m wide, working from side to side on the sloped placement.

# A13 Attachment 1
Execution Plan

**Spreading RCC with a Cat D5 dozer at North Fork Hughes River Dam. The laser detector is mounted on the blade for grade control.**

In order for the RCC to commence uninterrupted, the Quality Control staff on the project need the resources to accurately and rapidly perform the quality control testing. There are two streams of quality testing on the RCC that will occur throughout placement operations.

One stream of the testing procedure identifies the quantities of cement and flyash being fed into the mix. As the material is batched and placed, the in situ compaction level is verified by nuclear densometers and strength by hot curing at one and seven days with cold curing tests at 7, 14, 28, 56, 180 and 365 days. The Hot 1d (one day) tests give a reasonable indication of the Cold 7d (7 day) while the Hot 7d give an indication of the Cold 28d (28 day). The Hot 1d are our first line of defense against low strengths from a strength perspective alone.

Our second stream of QA checking involves looking at the material properties, which will verify that the mix is performing as intended and that all components have been properly combined. This stream verifies that the correct gradings have been used in the mix and then that the vebe time and density are correct. The mix is subjected to the human eye and feel; this is a very important step. It is absolutely certain that if the vebe time is varying without adequate explanation or that the vebe density is incorrect or that the mix “looks wrong,” then something has been incorrectly dosed into the mix. Over time, an experienced crew and placement supervisor will notice differences in the mix and shut the operation down until the mix has been replaced and the problem is identified.

This testing redundancy is vital to ensuring the repeatability of each lot and layer and the entire structure.

We have teamed with Kleinfelder on this project, which will provide the RCC Specialist(s) and additional technicians working at the RCC, CVC and Aggregate plants.

### Joints between Layers

Three levels of joint treatment are proposed for the RCC:

1. **A fresh (or hot) joint:** The surface of all hot joints should be lightly cleaned prior to the placement of the next layer to remove all loose materials or other foreign matter. This is often done with light blowing or vacuuming with a vacuum truck. We believe that many of the slope layers will have this type of joint between lifts – the best quality.

2. **A prepared (or warm) joint**: The surface of all warm joints should be lightly washed with low-volume, low-pressure washers. This washes the surface and provides for enough pressure to move loose material across the lift. Water and loose debris are pushed off the dam face or picked up by vacuum. We only anticipate this at the end of each placing shift, prior to the next day shift if we exceed 16 hours. *Following preparation, the entire surface receives a bedding mix layer*. The bedding mix is placed just ahead of the next RCC lift. Bedding is easily spread by hand and tractor-mounted squeegee.

3. **A cold joint:** The surfaces of all cold joints should be treated to expose the surface aggregates. A planned joint may be treated early by either brooming or low-pressure washing. An un-planned joint should be treated with diligent cleaning using high-pressure washing equipment. After treatment, the joint should be lightly washed and cleaned by vacuum. The entire lift is covered with bedding mix just prior to the next RCC lift. With the slope layer placement, we anticipate preparing a small section of green cutting on a daily basis between each major step.

Typical joint preparation of warm joints

Typical surface of a treated cold joint

Bedding mix placement on the top lifts at Saluda Dam

### Contraction Joints in the RCC

Contraction joints through the RCC will be formed by vibrating steel crack initiators along a specified line in the RCC. We have successfully used vibrated fabric as well. The distance between control joints on the Riverside RCC Cofferdam are spaced farther than we typically see; however, joints are easy to add if required.

Typical waterstop and rear drain detail surrounded by either conventional concrete or grout-enriched RCC

The contraction joints through the dam will be sealed in a way similar to that proven on a significant number of RCC dams constructed to date.

Grout and RCC (GERCC) will be place around the waterstop, which will be installed adjacent to the upstream facing element. A pipe drain can be easily installed as well downstream of the waterstop and used to grout if substantial leaks in the joint develop. All of these components will be incorporated within a fixed template to maintain their alignment throughout the RCC placement operation. Following RCC compaction and well before any initial set, the template will be removed to ensure the induced joint maintains its correct alignment with the waterstop.

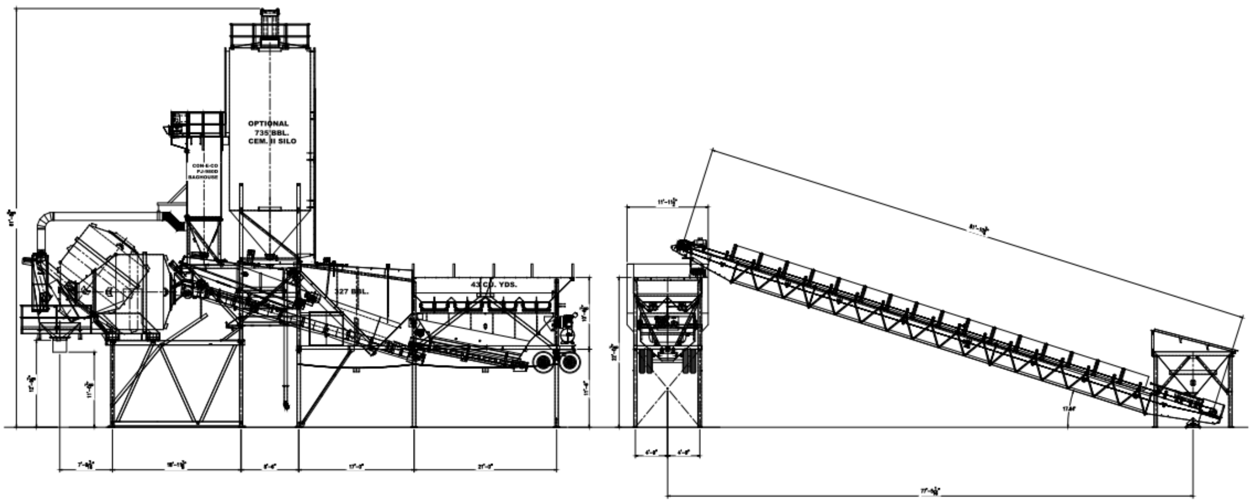
### Curing

Water curing will be used for all RCC and adjacent steps. For the placement area, water curing using water trucks will be combined with curing by hand-held hose-pipe and misting or a combination of all three. Curing will start almost immediately after the concrete has been roller-compacted. The surface of a well-designed high-cementitious content RCC is impermeable as soon as it is roller-compacted. Curing will be continued until just before placement of the next layer of RCC. Excess water will be removed by vacuum truck or compressed air.

**Proper curing of an RCC lift surface.**

## CVC PLANT

Like the RCC Plant, we will set up a CVC plant for the onsite concrete production.




**Proposed CVC plant shown here with Tilt; however, priced with Twin-Shaft Compulsory Mixer**

The CVC plant will be located next to the RCC plants to take advantage of common utilities, work crews and cement/flyash storage facilities.

### Temperature Control

The primary sources for cooling will be chilled water, dry-flake ice, and winter-stockpiled sands and aggregates. We have allowed for these costs in our bid.

### Cement/Flyash

Currently we have two options for supply of Cement and Flyash for the project.

### Quality Control

Quality Control at the CVC plant will be provided by Nalcor with testing in its onsite lab.

## A13 Attachment 1
Execution Plan

**Ogee Crest placed over RCC at the North Fork Hughes River Dam**

**Ogee with Flip Bucket placed at the Crest of the Blue Lake Dam in Alaska, August 2014**

## SOUTH DAM

### Schedule

We plan to start this work in the first year, to balance our equipment fleet. We also have the ability to get this work out of the way, so we can focus on the South Dam later in the project schedule. It also provides material for the C-1 Access Road. We will use the excavated foundation material as the base of the access road.

### Zone Fill Emankment

The zones identied are big enough for many methods of placement. We will likely utilise the large fleet of CAT 775s for the rock and CAT 740s for the filters and till placement. Till will be stockpiled for the South Dam area similar to the cofferdam work using on-road trucks from the designated borrow area.

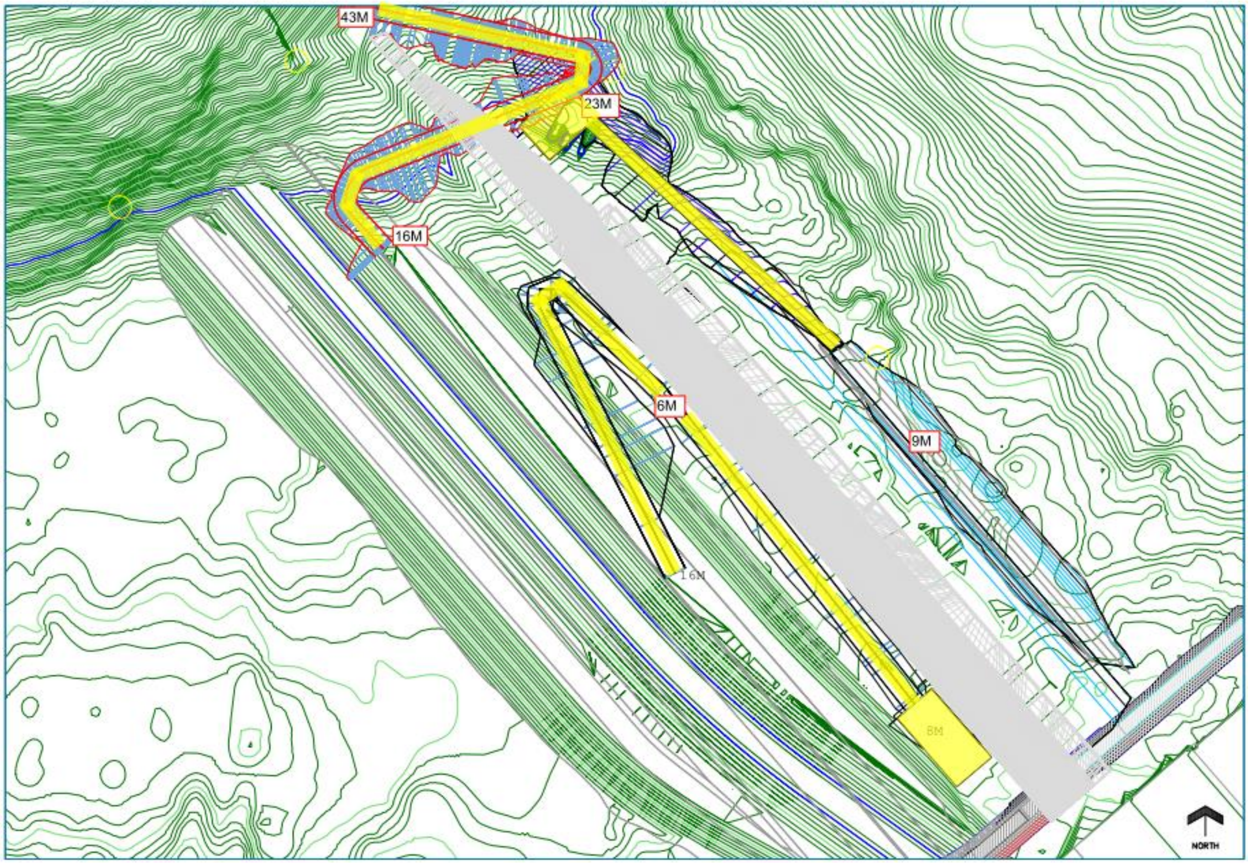

**Multi-zone placement at Saluda Dam**

## CRANE LAYOUT

Aside from the setup crane needed for erecting plants and equipment, our project will be supported with two crawler cranes located for the North Dam work. At 275-tonne crawler will be located upstream of the dam. This is equivalent to a Manitowoc 999. It will have the capacity to pick a truck off the RCC lift surface.

A second crane will be located downstream of the dam. This crane will be sized for a 230-tonne, similar to a Manitowoc 888. It will likely have a luffing jib, to provide reach to the far left abutment for picking downstream forms.

Crane pads have been designed both upstream and downstream of the North Dam, and we have assumed that these can be left in place.




**Crane Access Pads and Ramps, Upstream and Downstream of the North Dam**

## SITE LAYOUT

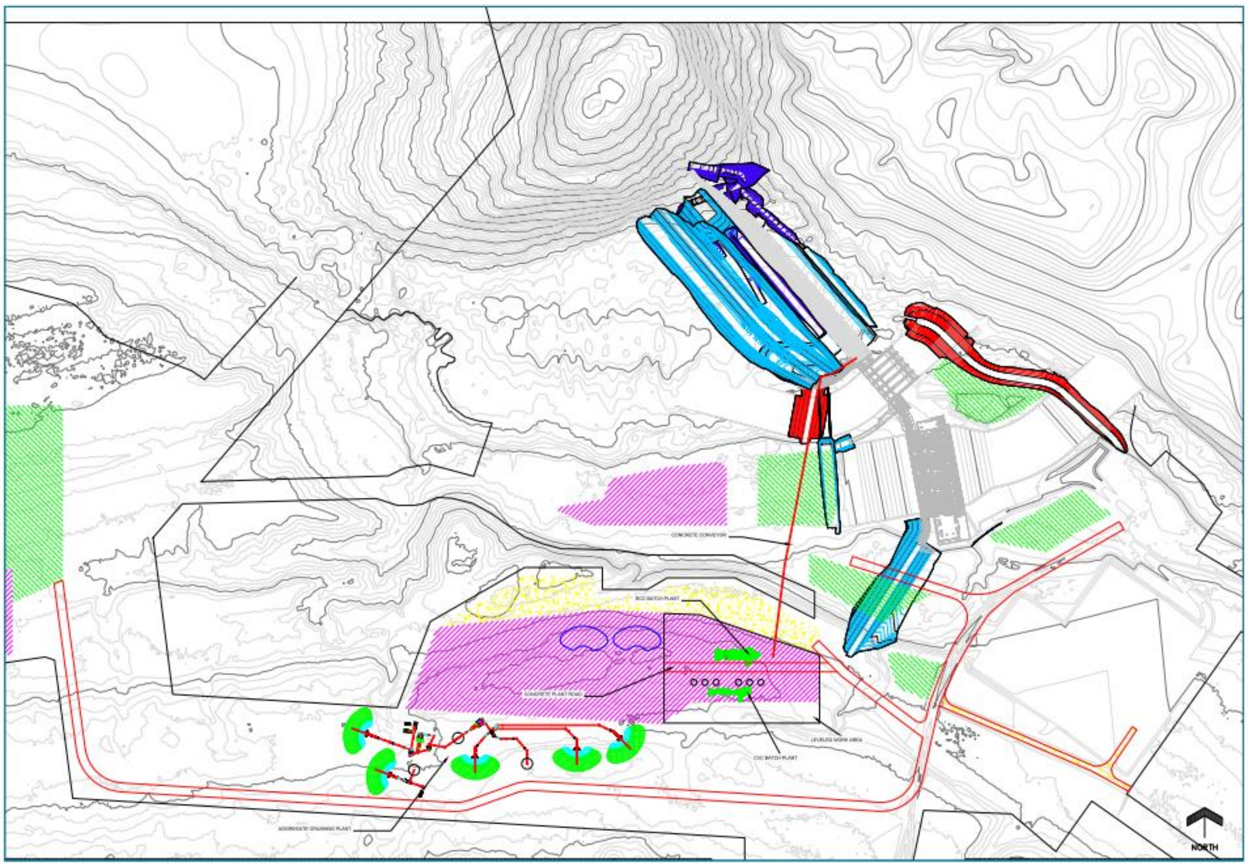
As stated above, we plan to utilise Work Area A & B as our main staging and work area. We will also utilise the powerline right-of-way for stockpiling aggregates. We will use Work Area J for form and materials staging. Work Areas G & F will be utilised temporarily until the water is elevated. We will use other Work Areas as allowed by the RFP. Contractor's Facilities

### MECHANIC & WORK SHOPS

We will be installing one large fabric structure to house work on equipment during the winter months. The structure will be well lit and heated and able to accommodate two 70-ton Rock Trucks with dimensions of 25.4m wide x 31.7m long. Doors will be bi-fold with dimensions of 18.2m wide x 6.1m high.

### MISCELLANEOUS OFFICES AND SHACKS

We will ensure that multiple work offices, break shacks and a lunch shack will be available onsite for work crews to take breaks, hold pre- and post-work meetings, and provide equipment storage.




**Proposed Site Layout and Access**