

Teamwork Makes the Dream Work on the Bois d'Arc Lake Program

Adam Payne, Greg Bradley, and Fain Butler

The Bois d'Arc Lake dam and reservoir project in north Texas has been under construction for several years and is fast approaching substantial completion.



Key Takeaways

Construction of Bois d'Arc Lake, a US\$1.6 billion program in north Texas, required a strategic approach to quality control, quality assurance, field management, and inspection.

Using a five-package construction approach, the North Texas Municipal Water District has been able to break down the reservoir construction program into manageable projects.

While the construction program has been largely successful, lessons learned include establishing quality assurance processes early and determining document control processes.

Developing Bois d'Arc Lake, Texas' first major reservoir in 30 years, has been a massive undertaking for the North Texas Municipal Water District (NTMWD). The US\$1.6 billion program was divided up into five distinct construction packages, four of which are being delivered using the construction manager at risk (CMAR) procurement method. The fifth package contract used a full-service provider (FSP) for environmental mitigation. The construction package breakdown was as follows:

- CMAR 1 (Archer Western)—construction of a dam, clearing of the reservoir site, and construction of a terminal storage reservoir at the treatment plant site
- CMAR 3 (Garney)—construction of the Leonard Water Treatment Plant, the high-service and

raw water pump stations, and the dam maintenance facility

- CMAR 4 (Austin Bridge and Road)—construction of Farm-to-Market (FM) Road 897, Fannin County roads, recreational boat ramps, and a lake operations center
- CMAR 5 (Garney)—construction of a raw water pipeline between the reservoir and Leonard Water Treatment Plant and a treated water pipeline between Leonard and McKinney, Texas
- FSP (Resource Environmental Solutions)—environmental mitigation in Riverby, Texas; in the upper mitigation site east of Bonham, Texas; and at additional mitigation sites around the reservoir

The magnitude of the program required each project to have a proactive plan for quality control (QC) and quality assurance (QA). NTMWD's strategies to maintain consistent quality on a complex program—including organizational configurations, tools to assist with management, and best practices for field representation and inspection—were vital from the start of the program construction efforts.

The US Army Corps of Engineers (USACE) 404 permit was received on Feb. 2, 2018, and construction activities on all components of the program have started. Program completion and treated water production is scheduled for summer 2022. The program components span 70 miles from the northeast corner of Fannin County on the Red River to just northeast of McKinney, Texas. Figure 1 shows a rough layout of project locations.

Current Status

The dam and reservoir project (CMAR 1 construction package) has been going strong for several years and is fast approaching substantial completion (i.e., sufficiently completed to a point that it can be used for its intended purpose). The construction notice to proceed was issued in April 2018, and the work on the major components is nearing completion, including

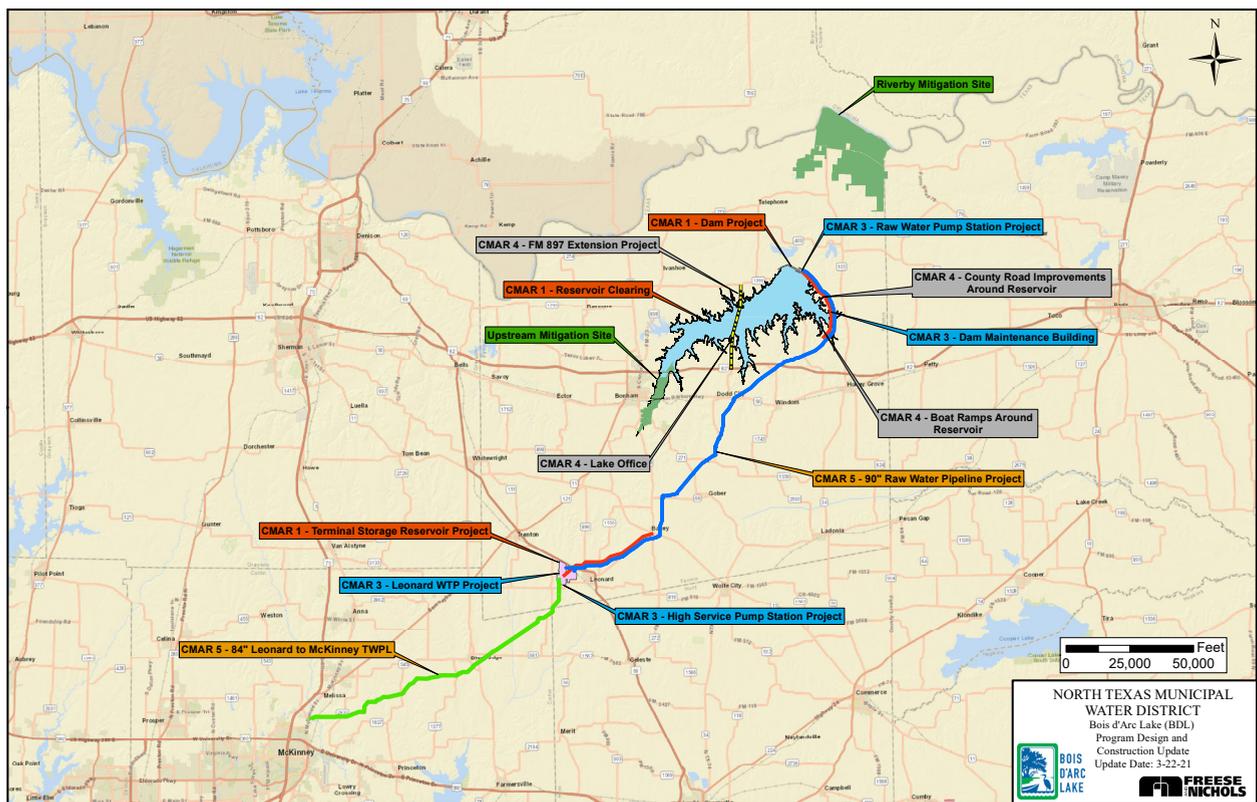
- the 90-foot-tall, 2-mile-long earthen embankment;
- the embankment's internal drainage system;
- soil cement facing on the upstream face of the embankment;
- the 110-foot-tall raw water intake structure; and
- twin 78-inch intake conduits and the uncontrolled labyrinth weir service spillway.

As of June 2021, approximately 4.9 million yd³ of fill (out of the 5 million yd³ total for the project) had been placed. Construction of a 60- to 70-foot-deep soil bentonite slurry trench is complete; this will provide an impermeable structure below the dam to prevent piping.



As part of the environmental mitigation project, crew members plant 2,000–3,000 bare-root tree saplings per day (per person) by hand; they will plant approximately five million trees during the construction program. © 2021 Resource Environmental Solutions. Printed with permission.

Program Overview Map



CMAR—construction manager at risk, FM—Farm-to-Market Road, TWPL—treated water pipeline, WTP—water treatment plant

Figure 1

Clearing the reservoir upstream of the dam in the lake footprint is also complete. Multiple debris piles consisting of cabled down timber, concrete pipes, and concrete debris were left in deeper areas of the reservoir to provide habitat for fish. On April 14, 2021, the dam construction progressed to a point at which the intake gates were closed and official impoundment started. Work to complete the dam’s embankment, soil cement facing, labyrinth weir spillway, and other noncritical activities (fencing, roadways, paving, etc.) will continue on-site while the lake fills. Substantial completion is expected later in 2021.

The 404 permit for the reservoir includes the requirement for environmental mitigation at three separate sites—Riverby Ranch, the upper mitigation site along the Bois d’Arc Creek east of the town of Bonham, Texas, and a smaller section of grasslands

The magnitude of the program required each project to have a proactive plan for quality control and quality assurance.

(FSP construction package). The combined footprint of these areas totals more than 17,000 acres. Mitigation is focused specifically on construction and enhancement of forested wetlands, riparian zones, upland forests, emergent wetlands, and grasslands. During planting seasons, crew members plant 2,000–3,000 bare-root tree saplings per day (per person) by hand and will ultimately plant approximately



The construction of the raw water pump station, which is about the size of one American football field, is well underway, and operation is expected in early fall 2021.



The construction program must also address the transportation issues caused by the new reservoir, so the project included about 6 miles of state highway construction and upgraded nine county road bridge crossings.

five million trees throughout the three- to four-year construction period. Contractors worked year round on stream rehabilitation for the first two years of construction and completed almost 70 miles of new or rehabilitated streams. Major construction work is expected to be complete in 2022 or 2023 with monitoring and maintenance continuing for up to 20 years. USACE will work with Resource Environmental Solutions, the NTMWD and Freese and Nichols Inc. (FNI) to periodically review progress at the mitigation sites until the restoration is complete.

With such a high volume of work for the Bois d’Arc Lake program occurring in a relatively short amount of time, setting targets for quality in several areas was critical.

The raw water impounded and pumped from the Bois d’Arc Lake will make its way to Leonard, Texas, where the North Texas Municipal Water District’s new Leonard Water Treatment Plant is being constructed (CMAR 3 construction package). The plant’s first phase will be able to treat a maximum of 70 mgd, and

at buildout after four phases of construction, the plant will be rated at 280 mgd. The Leonard Water Treatment Plant will use ozone disinfection and biologically active filtration. As of June 2021, it was a little more than 80% complete, but substantial completion is expected in winter 2021 or in early 2022. Final completion is expected to occur in summer 2022.

The 210-mil-gal terminal storage reservoir was constructed on the north end of the Leonard Water Treatment Plant site. The raw water from Bois d’Arc Lake will be pumped here for storage before treatment. The reservoir is poly-lined and protected by a layer of soil cement. A second 210-mil-gal reservoir will be constructed adjacent to the first during the second phase of work on the Leonard Water Treatment Plant. The terminal storage reservoir was one of the last projects to begin, but it progressed quickly and reached substantial completion by December 2020. Some instrumentation and mixing equipment will need to be installed, so final completion is planned for summer 2021.

Construction of the raw water pump station at the Bois d’Arc Lake site calls for 90 mgd during the first phase and 236 mgd in total at completion. The pump room is the size of an American football field and is four stories deep; it is split into two sections to provide system redundancy. Operation of the pump station is planned to begin in early fall 2021.

One of the last major projects to get started was the high-service pump station, which is under construction on the west end of the Leonard Water Treatment Plant. It also will be built to operate at a 90-mgd



The construction project included about 35 miles of 90-inch raw water pipeline. Testing of the raw water pipeline began in June 2021.



The Leonard Water Treatment Plant is presently under construction, and the plant's first phase will be able to treat 70 mgd; the plant will ultimately be rated at 280 mgd.

capacity during the first phase. In subsequent expansions of the facility, a second pump station will be constructed to support the south plant. The two pump stations together will be able to pump 330 mgd of treated water. This project is expected to be operational in early 2022.

In addition to the water resource, transmission, and treatment efforts undertaken by NTMWD, the program must also address the transportation issues caused by the new reservoir. NTMWD worked with its consultants, the Texas Department of Transportation (TxDOT), and Fannin County officials on the construction,

rehabilitation, and closure of several state and county roads. About 6 miles of state highway (FM 897)—from US 82 north to FM 1396—were constructed, including 1.3 miles of bridge over the new lake (CMAR 4 construction package). Nine county road sites were upgraded to pass floodwaters after the dam is completed, and now both the FM 897 and county road projects are complete, and TxDOT and Fannin County have assumed control of their respective roadways.

To convey the raw and treated water collected by the Bois d'Arc Lake program, NTMWD contracted with five designers and its CMARs to construct 35 miles of 90-inch raw water pipeline and 25 miles of 84-inch treated water pipeline (CMAR 5 construction package). Both pipelines will be constructed using cement-mortar-lined coated steel pipe. Testing of the raw water pipeline started in June 2021, while the treated water pipeline construction began in the spring of 2020 and is well underway. A major component of construction on the treated water pipeline was the half-mile-long tunnel under the East Fork of the Trinity River; that tunneling effort was completed in early 2021. All pipelines are expected to be in service ahead of operation of the water treatment facilities.

The last components to begin construction for the Bois d'Arc Lake program were the lake facilities. NTMWD's Lake Operations Center, which began construction in late summer 2019, will serve as the district's operational facilities for the reservoir and will include offices, a private marina, a private boat ramp, warehouse buildings, and a bunkhouse for



With a planned capacity of 210 mil gal, the terminal storage reservoir was constructed on the north end of the Leonard Water Treatment Plant site.

emergency operations. In addition, a dam maintenance building is being constructed to house and maintain various equipment needed to operate the reservoir. NTMWD’s agreement with Fannin County included three public boat ramp facilities; these are spread out across the eastern half of the reservoir, which was cleared for recreation.

The program has been successful because it has a “deep bench” of partners that can be on call given short notice.

Quality Setup

With such a high volume of work for the Bois d’Arc Lake program occurring in a relatively short amount of time, setting targets for quality in several areas was critical. Following the typical NTMWD project approach, the program’s CMARs are responsible for quality control staff and dedicated construction

materials testing facilities to conduct all tests required by the construction documents. FNI is serving as the program manager and program construction manager for the projects. NTMWD, FNI, and other inspection firm partners collaborated on QA, construction management, and inspection. A program-level QA laboratory is located on-site at several project locations to provide additional testing and oversight as needed. For a program of this size, the amount of staff assigned to its QA activities is substantial; at its peak, approximately 45 program management, construction management and inspection staff were on-site, consisting of NTMWD staff, the program construction management team, and subconsultants (Figure 2).

As an example of the program’s QA activities, the organizational chart for the dam and raw water pump station site’s construction management and inspection staff is shown in Figure 3. As a result of the round-the-clock work hours and seven-day work-week, the amount of staff required to cover these projects is more than 10 full-time individuals—this group includes a mix of staff from NTMWD, the program construction management team, and the design engineer.

The Bois d’Arc Lake program had several approaches to QC and QA that worked well for a program of this size, and the following concepts were key to success:

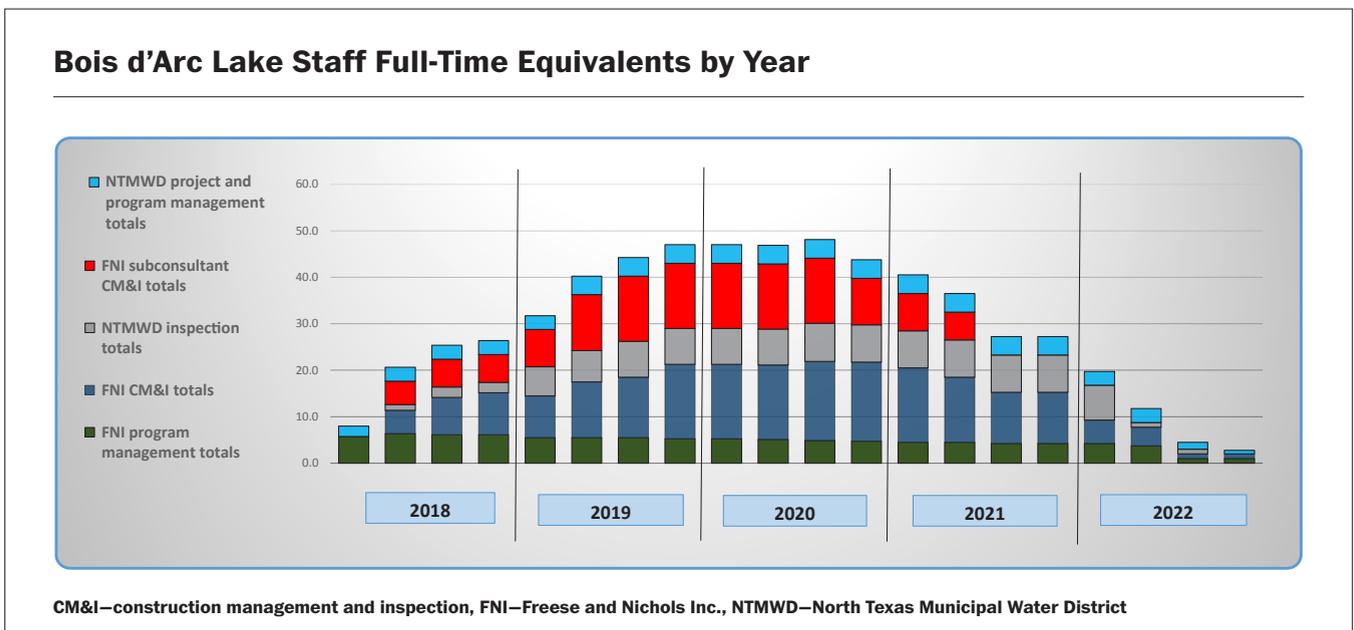
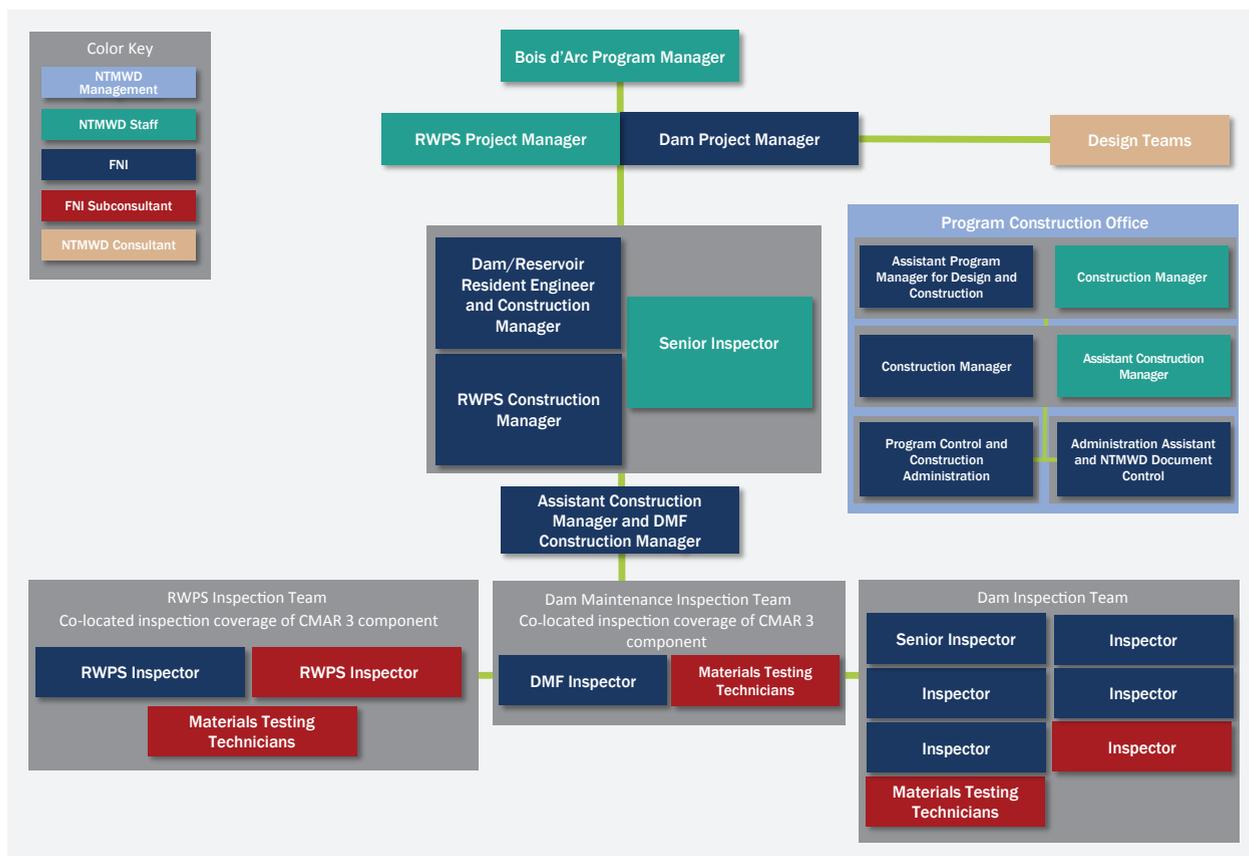


Figure 2

Dam, Dam Maintenance Facility, and Raw Water Pump Station Quality Assurance Setup



CMAR—construction manager at risk, DMF—dam maintenance facility, FNI—Freese and Nichols Inc., NTMWD—North Texas Municipal Water District, RWPS—raw water pump station

Figure 3

- **Develop and implement plans early.** The current plan for quality coverage on all the Bois d'Arc Lake program job sites continues to evolve and is currently on its 38th revision, but planning began between the program construction manager and NTMWD as early as 2016.
- **Collaborate and study previous examples.** Early meetings between NTMWD and the program construction manager used lessons learned from past projects of similar scale to develop the current plan's foundation and identified additional areas that needed resources.
- **Contract year to year to adjust for changes.** The program set up contracts to run year to year

with new authorizations each January to increase the team's flexibility, allowing easier response to contractor changes or staffing changes without risk of overallocation of funds.

- **Include contingency hours/positions.** Without flexibility, plans can fall apart when conditions change, contractor schedules shift, and/or if individuals leave, so the program included buckets of contingency hours and full contingency positions for each phase.
- **Standardize processes.** While across-the-board standardization may not be possible across a variety of project types with different contracts, the program established uniform processes, forms, document

control standards, and regular reporting requirements to ensure consistency throughout the project.

In addition, the program has been successful because it has a “deep bench” of partners that can be on call given short notice. Because of the size of the staff needed to support the QA efforts, it’s helpful to have partners that understand the plan and appreciate the flexibility needed to respond quickly.

Lessons Learned

While the program has been largely successful, there are areas where the program could have benefited from changes or from incorporating different practices.

Establish QA Laboratory at the Start

Laboratory support should be ready early enough to assist with full program quality plan and QC plan review from contractors/CMARs. In our case, the program’s QA laboratory has been a great asset throughout construction on all the program’s projects; however, establishing the laboratory earlier to assist with review items like CMAR QC laboratory proposals and QC plans would have been beneficial. While they were in place to review the plan submittals at the beginning of construction, earlier coordination between the CMAR QC and program QA laboratories would have been worthwhile.

Meet Early With QC and QA Representatives

Initial construction efforts presented a few hurdles for the on-site QC and QA laboratory representatives. Although they were developed ahead of time, equipment calibration, reporting procedures, and communication protocol could have been fine-tuned with a stakeholder meeting or workshop. It’s recommended to work through communications, documentation, and testing procedures as early as possible with QC and QA representatives.

Develop Document Naming Conventions

A document naming convention was developed before construction began on the first projects. However, because of the variety of projects and their complexity, the convention didn’t work for every project component. For example, the bid package setup for CMAR 3 is much more complex than CMAR 1 and required some naming convention changes to account for that complexity. Better naming conventions and bid package setups within each CMAR would have streamlined the document control processes once construction started.

Project Success

Successful construction of Bois d’Arc Lake, the first major reservoir constructed in Texas in 30 years, has taken hard work and collaboration on QC, QA, field management, and inspection. At the time this was written, NTMWD had begun impounding or capturing what will someday be a 16,641-acre lake. This major project will bring additional water supplies for the growing population that NTMWD serves, and construction of this \$1.6 billion project has benefited across the development program from effective teamwork among the participating stakeholders, including NTMWD, FNI and its subconsultants, and design engineers. ●

Acknowledgment

Special thanks to the QA team that worked in the field providing oversight on the program’s projects. The dedication and teamwork demonstrated by the field staff from NTMWD, FNI, Kleinfelder, Lamb-Star Engineering, Foster CM Group, Plus Six Engineering, TEC Consulting, CAS Consulting & Services, RHSI Engineering, CRCM, Accurate Inspections, and Criado and Associates were key to the success of the projects.

About the Authors



Adam Payne is a program construction manager at Freese and Nichols Inc., Dallas, Texas; ap@freese.com.

Greg Bradley is a construction manager at the North Texas Municipal Water District, Wylie, Texas.

Fain Butler was the assistant construction manager at the North Texas Municipal Water District, Wylie, Texas, at the time this article was written.

<https://doi.org/10.1002/awwa.1763>

AWWA Resources

- The Art of Getting Yelled At: Construction Outreach Done Right. Otis EP, Rossetto S. 2019. *Journal AWWA*. 111:8:75. <https://doi.org/10.1002/awwa.1346>
- Benchmarking Water and Wastewater Construction Projects Delivered by Design-Bid-Build. Andary EG. 2020. *Journal AWWA*. 112:7:66. <https://doi.org/10.1002/awwa.1538>
- Dynamic Reservoir Operations Support Sustainable Water Management. Rivera M, Nebiker S, Wright B. 2016. *Opflow*. 42:3:12. <https://doi.org/10.5991/OPF.2016.42.0012>

These resources have been supplied by *Journal AWWA* staff. For information on these and other AWWA resources, visit www.awwa.org.