LONG-TERM WATER SUPPLY STUDY

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DESIGN MEMORANDUM #3
CRYSTAL LAKE / LITTLE RIVER ALTERNATIVE

PREPARED FOR:

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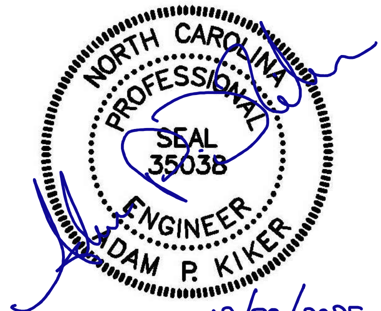

12/30/2025

ADAM P. KIKER, P.E.

MOORE COUNTY, NC

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1.0 EXECUTIVE SUMMARY

Moore County is considering utilizing Crystal Lake as a raw water supply and storage reservoir to serve its long-term water supply needs. This Design Memo #3 provides background details, calculations, expected scope, budgets, and schedules for a multi-phased approach to use Crystal Lake and the Little River as water supply sources.

Crystal Lake is located southwest of Vass in the unincorporated community of Lakeview. During tropical storm Chantal, the dam at Crystal Lake breached and will require a major capital investment to repair. The owners of Crystal Lake approached Moore County about a potential partnership to repair the dam, which opened discussions on the County potentially using the lake as a supply and storage reservoir for water supply purposes.

At normal pool elevation Crystal Lake is approximately 56 acres in size with an expected storage volume of between 80,000,000 and 100,000,000 gallons. The lake impounds Mill Creek with an approximately drainage area of 20 square miles. Mill Creek is part of the Little River watershed that drains eastern Moore County. Because of the old Fort Bragg raw water intake downstream on Little River, the entire Little River watershed upstream of the old Fort Bragg intake is already designated a Water Supply Watershed.

This alternative was not considered viable during the original preparation of Moore County's Long-Term Water Supply Study largely because (1) there is not sufficient yield directly from Mill Creek or Little River to satisfy the County's long-term needs without significant off-stream storage, and (2) obtaining ownership or control of a large body of water like Crystal Lake was not considered feasible.

A Crystal Lake alternative would be two-phased:

Phase 1 – Expected 2.0 MGD* capacity

1. Dredging of Crystal Lake, either by mechanical means or by floating barge, to maximize the storage volume
2. Repair the dam at Crystal Lake to current DEQ standards
3. Raw water intake and pump station on Crystal Lake
4. Raw water pipeline from Crystal Lake to the proposed treatment plant site
5. New 2.0-MGD water treatment plant
6. Finished water pipeline from the treatment plant to the County's existing transmission network

Phase 2 – Expansion from 2.0 to 5.5 MGD*

7. Raw water intake and pump station on the Little River near the Moore / Harnett County line
8. Raw water pipeline from the Little River to Crystal Lake
9. Water plant expansion from 2.0 MGD to 5.5 MGD*
10. Finished water pipeline extension

The exact capacity available from Phase 1 and Phase 2 would be determined during the conceptual design phase. Figures listed above are based on the best information obtained and calculated to date.* ***The available capacity of Phase 1 depends on the safe yield withdrawing water directly from Crystal Lake, and the safe yield is highly dependent on the required minimum release of the Dam Safety Permit.* *This value will not be determined until the Dam Safety Permit is issued.*

The capital cost of the Crystal Lake alternative is shown below in comparison to the two other alternatives considered viable at this time. The capital costs of all alternative are updated to reflect present-date cost estimates of each component so they can be compared to each other appropriately.

Table 1: Summary of Preliminary, Estimated Capital Costs

Alternative	Phase 1 Budget	Phase 2 Budget	TOTAL CAPITAL BUDGET
Drowning Creek	$39,078,000	$78,381,000	$117,459,000
Deep River, Carbonton	$132,044,000	$84,917,000	$216,961,000
Crystal Lake / Little River	$75,378,000	$100,496,000	$175,874,000

The chart below shows the expected annual cost of debt and system operation for each alternative listed above, normalized per 1,000 gallons of average daily water supplied from the new source.

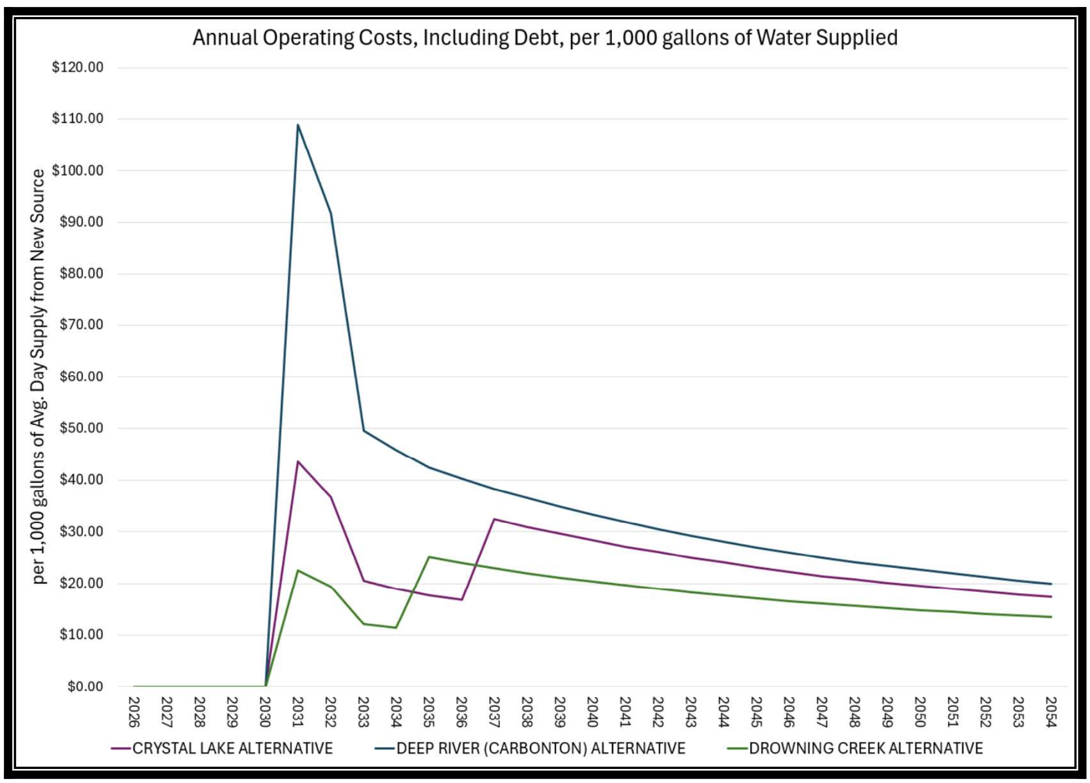

Figure 1: Annual Operating Costs, Including Debt, per 1,000 gallons of Water Supplied

2.0 TARGET FUTURE WATER SUPPLY CAPACITY

Design Memo #1 and #2 provided summaries of the project water supply capacity needs compared to the presently available sources. Moore County and Southern Pines are discussing their contractual relationship and the potential to extend the 1.0 MGD capacity offered to the County into the future.

The chart below shows how the County's supply would change over time based on implementation of the Crystal Lake alternative, with or without keeping the Southern Pines 1.0 MGD purchase arrangement. The target supply need is 6.0 MGD without Southern Pines continuing to sell 1.0 MGD; and 5.0 MGD if the relationship with Southern Pines is maintained.

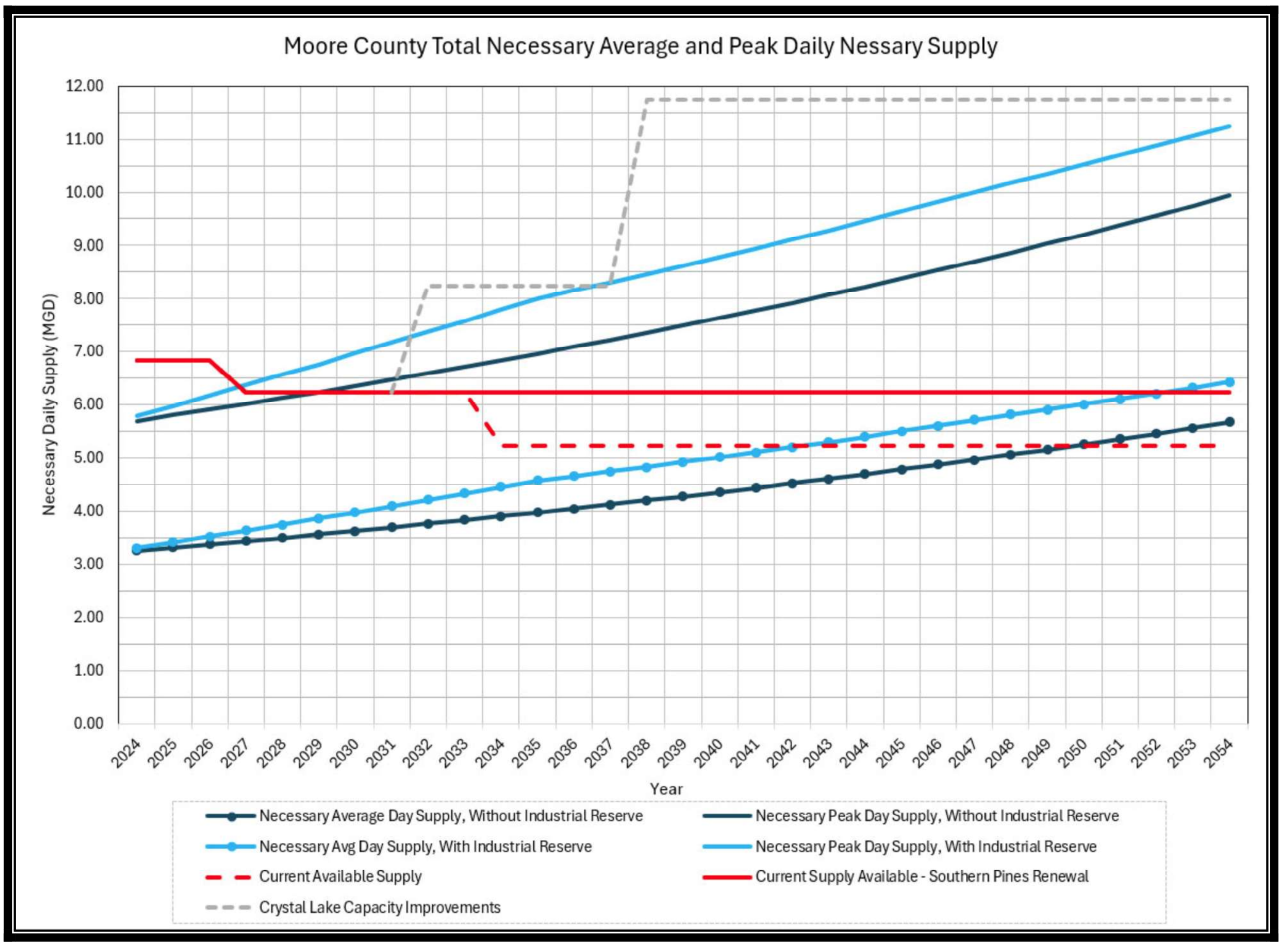

Figure 2: Projected Necessary Water Supply

3.0 CRYSTAL LAKE ALTERNATIVE DETAILS

3.1 Available Capacity from Crystal Lake Directly

To determine the available capacity at Crystal Lake, a numeric representation of the lake's inflow over time was established.

Located in the Southeastern region of Moore County, Crystal Lake has an approximate surface area of 56 acres, or 2,439,000 square feet. Assuming the lake has a uniform minimum depth of 4.5 feet, the volume of the lake was estimated to be approximately 82 million gallons of water. To produce a more conservative model, in this analysis the reservoir volume was rounded down to 80 million gallons. The drainage basin area of Crystal Lake was delineated to be 20 square miles using StreamStats, another USGS hosted web source, see Figure 3 below. Comparatively, the Manchester gage has a drainage basin area of 348 square miles.

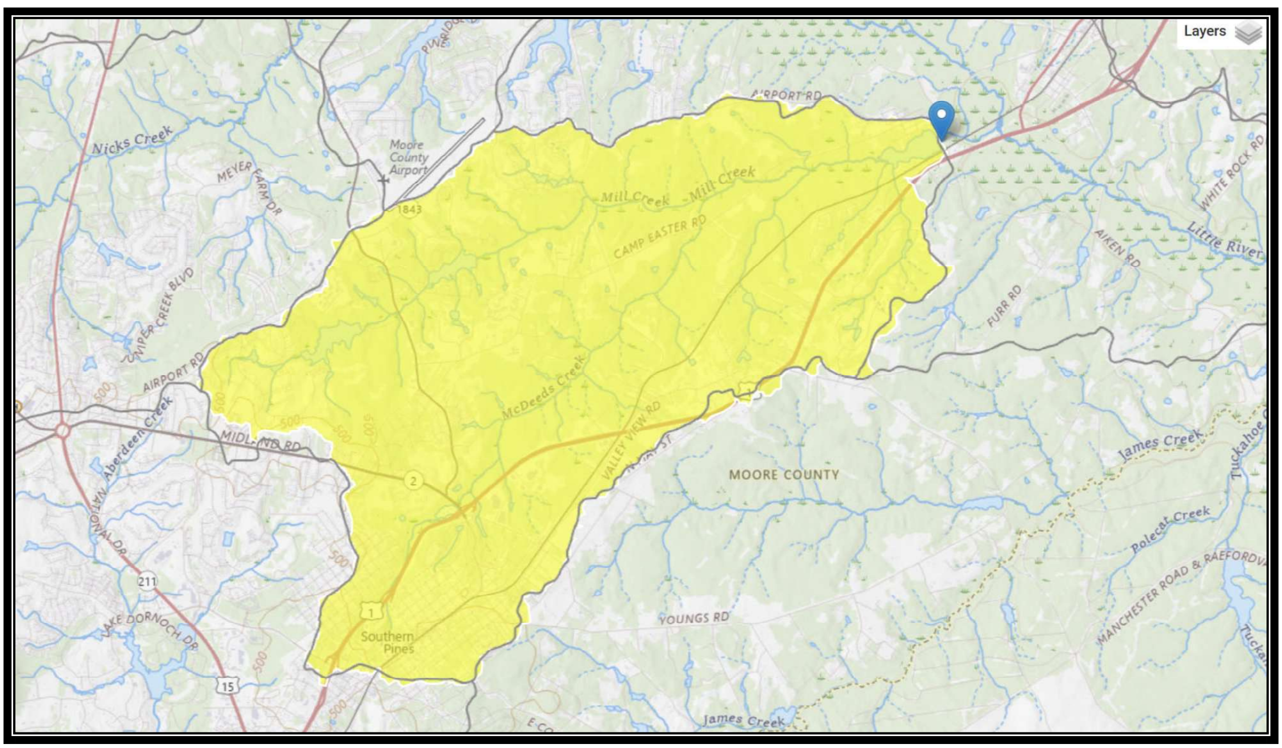

Figure 3: Crystal Lake Drainage Area

Historic stream flow data was collected from the "Little River at Manchester, NC" flow gage (aka Manchester gage) hosted by USGS as a starting point for model calibration. Data is available from December 1st, 1938, through September 29th, 1950, and was not available again at this gage station until July 1st, 2002. The gage station has since remained active with data available to present day. According to the USGS website the drainage area feeding the Manchester gage is 348 square miles. While not perfect, the data from 2002 through present date represents over 23 years of active flow data and captures the two most significant drought events in modern history. As such, this data is considered a satisfactory representation of the historical stream flow.

The Manchester gage is located downstream of Crystal Lake and its drainage basin area includes that of the lake. Therefore, this data can be used to approximate the daily stream volume feeding Crystal Lake by delineating the lake's drainage basin area and prorating flow based on drainage areas.

Little River has an additional stream flow gage located at the Morrison Bridge Road crossing (Mt Pleasant gage) with a drainage area of 152 square miles; however, this stream flow data is only available from October 2021 through present date and is not considered a large enough data set.

In order to stress-test the method of prorating the Manchester gage data to represent the Crystal Lake inflow for each day, the same method was used for the Mt Pleasant gage data, then the two prorated stream flows were plotted on top of each other for the time period between 2021 and 2025. The prorated flow data sets, representing the approximation of the Crystal Lake inflow, from the period of 2021 through present date correlate closely to each other. This further supports the use of this method to represent the Mill Creek stream inflow to Crystal Lake.

With a reasonable approximation of daily flow in Mill Creek at Crystal Lake, the safe yield calculation for the lake is performed as follows:

1. Start date of July 1, 2002 (Manchester gage data set start) with full volume of 80,000,000 gallons.
2. Subtract the desired safe yield volume, which would represent the water plant capacity.
   - A throttle is placed on the water plant withdrawal which would represent a water conservation measure implemented during a drought.
   - When the reservoir volume decreased below 70% full, the daily amount withdrawn is also decreased to 70% of the total, representing a mandatory water restriction.
3. Add the daily inflow volume into Crystal Lake from Mill Creek, calculated by prorating the Manchester flow gauge by drainage area.
   - To provide a more conservative approach, the inflow from Mill Creek is capped at the stream's calculated mean flow over the data period. This reduces the benefit in the calculation from major rainfall events following prolonged periods of no rain.
4. Subtract the estimated evaporative loss.
   - Evaporative loss is represented by a net inches of water lost each day times the surface area of the lake. For conservation purposes, the surface area of the lake is considered the full-pond area.
   - Net inches of water lost is the evaporation rate minus the average daily rainfall in inches.
   - These parameters vary based on season, and in general from November through May the result is a net positive with rainfall exceeding the

evaporation, on average. As such, the evaporative loss is set to zero for November through May of each year.
   - Evaporation losses are used for the months of June through October inclusive.
5. Subtract an estimated minimum release requirement for the Crystal Lake dam.
   - This is estimated using the Subchapter 02K rules, with the expected minimum release being 10% of the calculated safe yield of the reservoir if the minimum release is set to zero.

Running the above calculation for each day, the volume inside Crystal Lake is tracked day-by-day and plotted over a 23-year period. Item 2, the desired safe yield, is adjusted until the volume of the reservoir on any given day drops below a desired minimum volume. Figure 1 demonstrates the reservoir storage behavior using a safe yield of 2.0 MGD and a minimum release of 0.25 MGD.

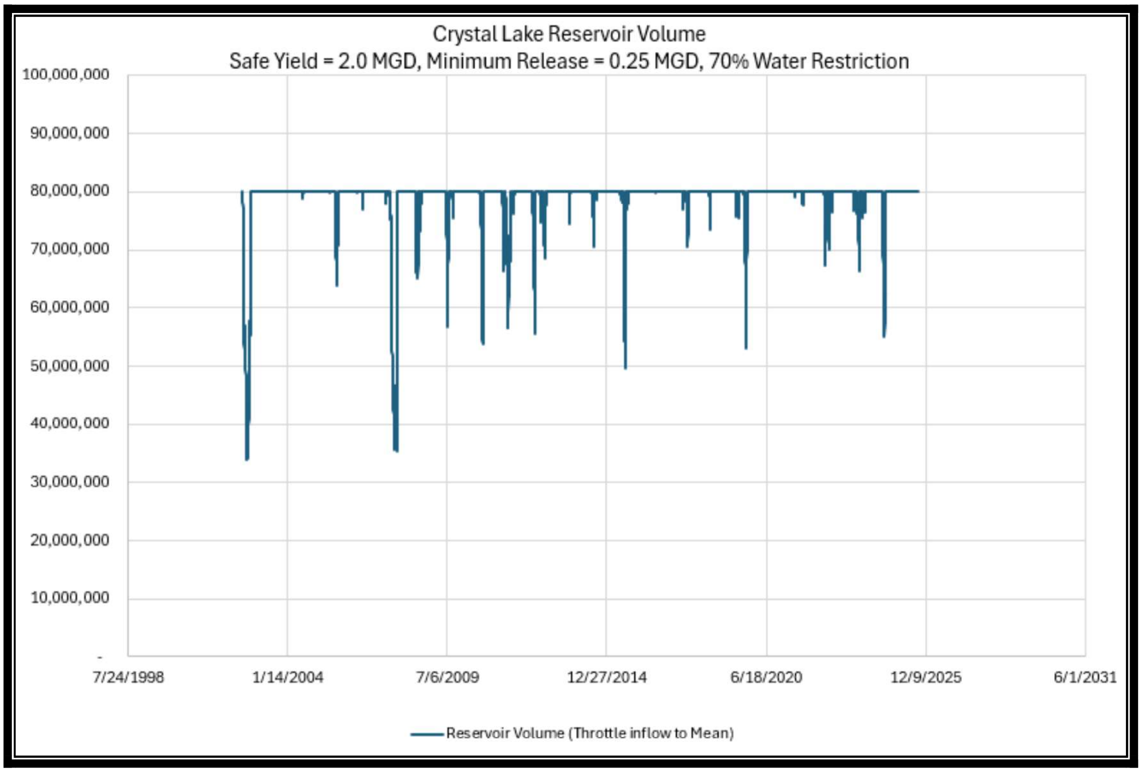

Figure 4: Crystal Lake Safe Yield Analysis

3.2 Available Capacity from a Little River Intake at Moore / Harnett County Line

To increase the available water supply to Crystal Lake, Phase 2 of this alternative would feature an intake on the Little River downstream, near the Moore County / Harnett County line. The target location is downstream of the confluents of Buffalo Creek and the Little River, where the drainage area is approximately 292 square miles or larger, see Figure 5:

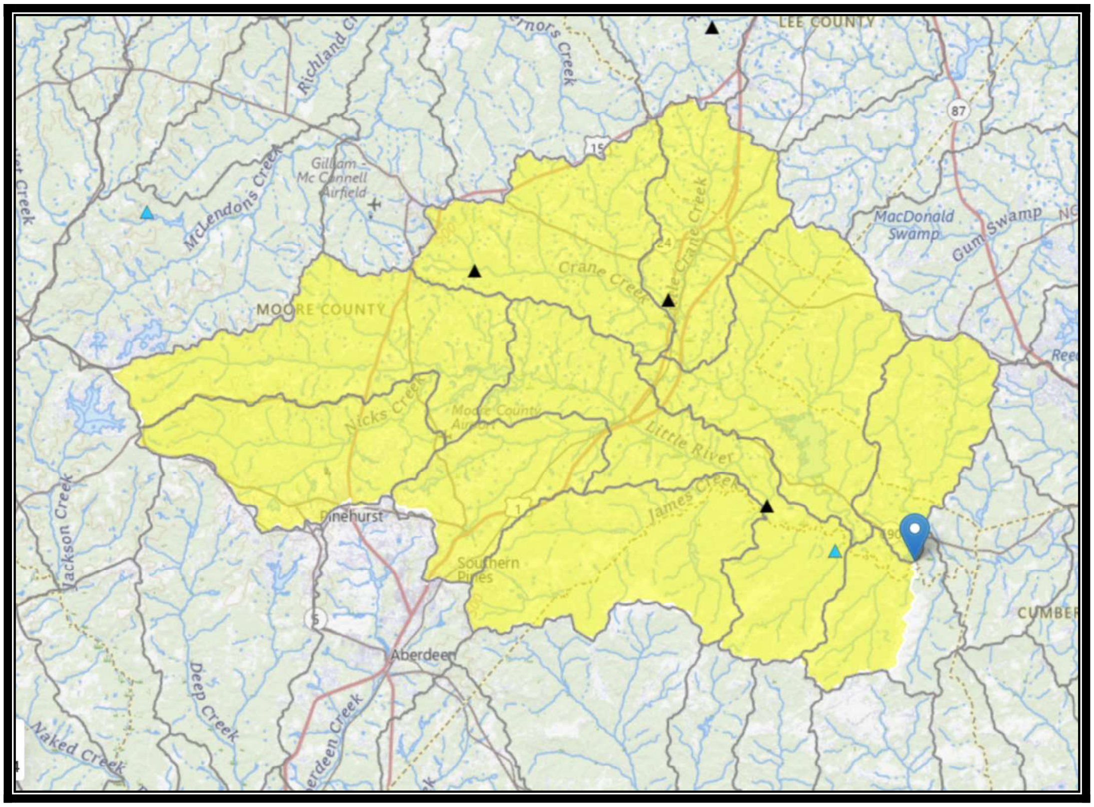

Figure 5: Little River Drainage Area

In early 2023, J. Curtis Weaver with the USGS provided a low-flow characteristic for the Little River near this location. The recommended 7Q10 yield for this location was 0.093 cubic feet per second per square mile of drainage area (cfsm). Applying this yield to the drainage area calculates a 7Q10 flow of 27.2 cfs, or 17.6 MGD. The acceptable safe yield from a run-of-the-river intake is 20% of the calculated 7Q10, which would be 3.53 MGD at this location.

The yield from the Little River would be pumped to Crystal Lake, making this volume additive to the safe yield of the lake by itself. As such, the ultimate capacity of Phases 1 and 2 combined is calculated as 2.0 + 3.53 = 5.5 MGD.

3.3 Crystal Lake Dam Repair

In July 2025 during Tropical Storm Chantal, the existing dam at Crystal Lake breached and was damaged beyond repair. Camp Easter Road, which crosses the lake dam, is closed and likely to remain closed until the dam is permanently repaired. The image below was taken in September of 2025:

Figure 6: Picture of Crystal Lake Dam, Sept. 2025

Before Crystal Lake is used for water supply or water storage purposes the dam needs to be repaired according to current NCDEQ standards, and a budget estimate for the capital cost of the repairs is included in the Phase 1 budget.

The dam repair is expected to consist of the following:

- Erosion control measures and a temporary stream diversion system to allow the removal of damaged or unusable portions as the dam as well as trees beyond the downstream allowable toe of the dam.
- Installation of a seepage cut-off wall and downstream seepage collection for the entire dam.
- Construction of a new concrete spillway system sufficient to meet high-hazard dam capacity requirements.
- Extension of the dam embankment slope to meet modern slope stability requirements and to accommodate future maintenance and mowing.
- Riprap wave protection along the upstream slope for shoreline stability and permanent ground cover along other areas.

3.4 Scope – Crystal Lake / Little River Alternative

The scope of the Crystal Lake / Little River alternative would be as follows:

Phase 1 – 2.0 MGD Capacity

- Dredging of Crystal Lake to increase its storage volume as much as possible. Dredging could be done by mechanical means or by barge, depending on permitting restrictions, and stable side-slopes would be left at the lake edge.
- Repairing the dam. The dam repair will follow proper Dam Safety requirements through DEQ such that the dam meets modern design standards.
- A raw water intake and pump station to draw water from Crystal Lake. The intake would be sized to support future expansion.
- Approximately 16,000 feet of 24" raw water pipeline from Crystal Lake to a treatment plant site to be determined.
- A new 2.0 MGD water treatment plant including an operations building, lab, and sludge handling facility. The budget includes granular activated carbon filters as an additional treatment mechanism to remove PFAS/PFOS.
- Approximately 13,000 feet of 24" finished water pipeline from the new treatment plant site to the existing County transmission main located at the intersection of Vass-Carthage Road and Heritage Farm Road. Hydraulic calculations indicate 2 MGD can be introduced to the system at this location using the existing 12" water lines as conveyance.

Phase 2 – Expansion to 5.5 MGD Capacity

- A raw water intake and pump station located on the Little River at a location downstream of Buffalo Creek.
- Approximately 68,000 feet of 24" raw water pipe from the Little River intake to Crystal Lake. Raw water from the Little River would be discharged into Crystal Lake for storage.
- Expansion of the water treatment plant from 2 MGD to 6 MGD, with the exact capacity to be determined based on further assessment.

3.5 Capital Cost – Crystal Lake

The table below provides a summary of the capital cost for both Phase 1 and Phase 2:

Table 2: Crystal Lake Alternative, Summary of Capital Costs

LITTLE RIVER/CRYSTAL LAKE, PHASE 1	
Dredging of Crystal Lake	$2,000,000
Crystal Lake Dam Repair	$5,200,000
Raw Water Intake/Pump Station on Crystal Lake	$5,500,000
Raw Water Pipeline from Crystal Lake to WTP	$8,563,000
New 2.0 MGD Water Treatment Plant	$33,875,000
Finished Water Pipeline	$5,844,000
Contingency, Engineering, and other soft costs	$14,396,000
TOTAL, PHASE 1	**$75,378,000**
LITTLE RIVER/CRYSTAL LAKE, PHASE 2	
Raw Water Intake/Pump Station on Little River	$7,500,000
Raw Water Pipeline from Little River to Crystal Lake	$27,872,000
Water Plant Expansion 2.0 to 6.0 MGD	$32,000,000
Finished Water Pipeline Extension	$15,000,000
Contingency, Engineering, and other soft costs	$18,124,000
TOTAL, PHASE 2	**$100,496,000**

3.6 Operational Cost – Crystal Lake

The annual cost of owning and operating the Crystal Lake alternative would consist of the following:

- Debt service payment for Phases 1 and 2
- Raw water pumping cost, both from Crystal Lake and from Little River
- Water treatment plant fixed costs (staffing, vehicles, IT, lab, capital outlay)
- Water treatment plant variable costs (energy, chemicals, sludge handling)

Detailed estimates for the annual cost of ownership and operation, year-by-year, is included in Appendix C.

The chart below shows the annual financial cost of ownership and operation for each year, for each viable alternative, normalized by a per 1,000 gallon basis of the anticipated average day demand from the new alternative for each year. This chart should be used solely for the comparison of one alternative to another on a financial basis, the values should not be used to set user rates or fees. Moore County should consult with their financial adviser to discuss how the selected alternative will affect water rates and fees.

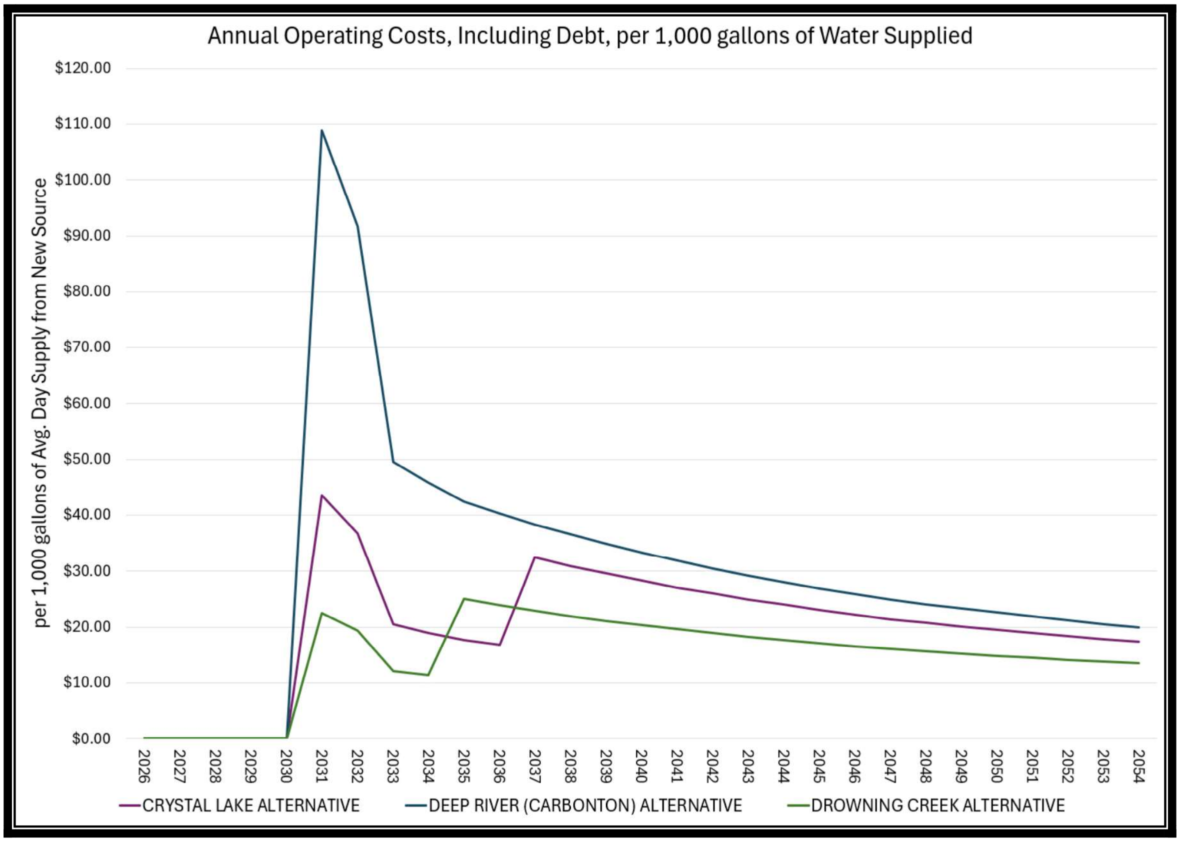

Figure 7: Annual Operating Costs, Including Debt, per 1,000 gallons of Water Supplied

3.4 Preliminary Timeline – Crystal Lake

Table 3 below provides a summary of the preliminary timeline for Phase 1.

Table 3: Preliminary Schedule, Crystal Lake Alternative Phase 1

Project Event / Milestone	Duration
Preliminary Engineering Report (10% design)	6 months
Environmental Permitting**	6 months
Preliminary Design	12 months
Final Design and Permitting	12 months
Construction Procurement	4 months
Construction	24 months
Commissioning	2 months
TOTAL	**60-66 months****

***Environmental Permitting can occur concurrently with Preliminary Design*

The repair of the dam and re-opening of the road can be structured as a separate and parallel project to the water supply project. The dam design and permitting would run concurrently with other design efforts, and dam construction could begin as soon as permitting requirements are fulfilled and funding is in place.

3.6 Miscellaneous – Crystal Lake

It is important to note that the available capacities from this alternative should still be considered preliminary and further vetting is necessary before formally committing to Crystal Lake as a long-term solution. Major factors that must be vetted further are:

- The required minimum release from the Crystal Lake dam. This will be determined during the Dam Safety permitting process, and the value directly impacts the available safe yield of the lake for water supply purposes.
- DEQ / Division of Water Resources will need to formally review and vet the method of calculating the safe yield from Crystal Lake by itself. LKC has had multiple conversations with DEQ/DWR staff about the methodology and thus far DWR staff has been supportive.

Both of the above items require design-level analyses to fully vet with regulatory agencies. The recommended next step for this alternative is engagement of a Preliminary Engineering Report on the Crystal Lake alternative. The PER would be considered a 10% design document and would provide all necessary calculations and submittals to regulatory agencies to give the County full confidence this alternative is worth implementing.

4.0 OTHER UPDATES

4.1 Session Law 2025-77, Elimination of Deep River as a River Basin

In 2025 the state legislature adopted Session Law 2025-77 (House Bill 694). Especially relevant to Moore County's water supply challenges, SL2025-77 eliminated the deep River as a designated River Basin. Rather, going forward, the Deep River is considered a sub-basin to the Cape Fear River. The result of this law is that any water transferred from the Deep River basin into the Cape Fear river basin, or vice-versa, will not be considered an interbasin transfer.

In previous Design Memoranda a major challenge with any alternative featuring the Deep River as a source was the necessity of an interbasin transfer certificate. IBT certificates are difficult and lengthy processes and not guaranteed to be issued.

5.0 ALTERNATIVE COMPARISON

There are several ways to compare one alternative to another, this report uses the same criteria as described in Design Memorandum #2, only comparing the Crystal Lake alternative to the Deep River, Carbonton and the Drowning Creek alternatives.

1. Initial capital cost: this represents the County's capital cost to place the project online (Phase 1 cost for phased alternatives). This is critical because any government entity has a finite ability to issue debt, and Moore County has other capital projects outside the water/sewer utility department that must also be addressed. It is also difficult to service debt for a project meant to satisfy 30 years of growth using the revenue capacity of the existing customer base.
2. Annual operating cost, including debt: this will vary from one alternative to another due to items like energy consumption, bulk purchase rates, and staffing requirements. It is a more direct representation of the relative impact to the rate payers of one alternative versus another.
3. Schedule: the ability to complete the project inside the timeframe necessary.
4. Long-term control over the resource and recurring costs: with this project being Moore County's primary water source long-term, it is important to understand the risk of cost escalations for things like bulk purchase rates.
5. Expandability: is the supply source robust enough to allow for future expansion in capacity.

5.1 Initial Capital Cost

Figure 8 below provides a graphical representation of the upfront capital cost of each alternative. For the alternatives with multiple phases, only the Phase 1 cost is represented:

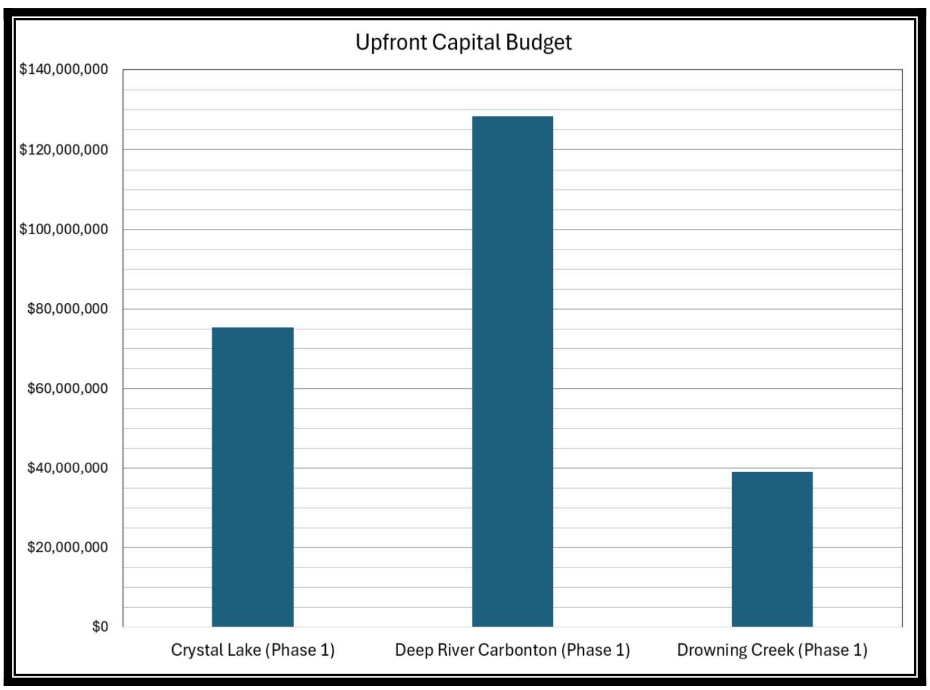

Figure 8: Initial Capital Cost Comparison

It is recommended that Moore County work with their financial consultant to discuss the process and feasibility for financing the project and how that would impact user rates over time.

5.2 Annual Operating Costs, Including Debt

Detailed calculations of the annual operating costs of the Crystal Lake alternative, including the calculated debt payment, are included in the appendices. **Figure 9** below plots each of the total cost, including debt payments, for each alternative. The values for the Deep River, Carbonton and Drowning Creek alternatives have been updated based on current construction estimates.

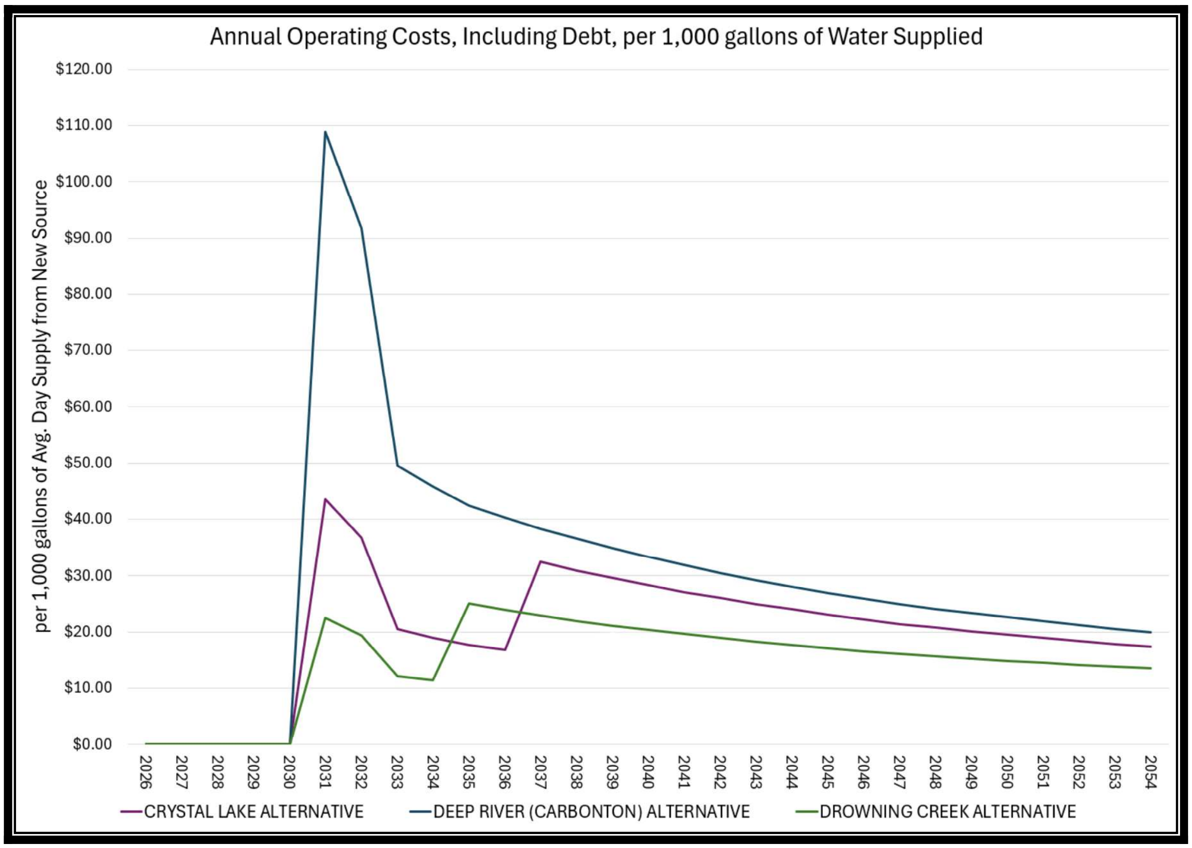

Figure 9: Annual Operating Costs, Including Debt, per 1,000 gallons

It is very important to note **Figure 9** is only intended to be a mechanism to compare each alternative to the others. The per 1,000 gallon figures should not be used to set user rates, Moore County should consult with a certified financial analyst to determine user rates.

Some key points from **Figure 9** are:

- The calculation assumes the project would be online starting in year 2031, and that is the year of the first debt payment. It is possible there would be interest payments associated with the financing before this time. The County's financial analyst should provide this information.

- Each line trends down over time because a portion of the annual costs (numerator) is fixed (debt, staffing, etc.), and the water supplied each year (denominator) is increasing.

5.3 Schedule

The Crystal Lake alternative can be completed on a similar time frame, or faster, than the other two viable alternatives. A detailed schedule for Crystal Lake, Phase 1 is provided in Section 3.

5.4 Long-Term Control of the Resource

The Crystal Lake / Little River alternative would be a County-owned and County-operated alternative. Operation of the asset and any financial impact to the County's rate payers would at the discretion of the County's leadership.

5.5 Expandability

This criterion considers the ability of the supply source to satisfy Moore County's needs beyond the 30-year planning horizon. Based on information available and analyzed during preparation of this report, LKC believes the Crystal Lake alternative can satisfy most or all of the County's 30-year water supply needs. Further vetting would be needed before this can be expressed with certainty.

Beyond the 30-year horizon, after the Crystal Lake Phases 1 and 2 projects are implemented, Crystal Lake can continue to be an asset supporting additional water supply capacity. Moore County could construct a raw water intake on the Deep River and a raw water pipeline to convey water from the Deep River to Crystal Lake for storage and treatment. As discussed in the Final Report submitted February 1, 2024, the Deep River could provide up to 6 MGD of raw water capacity above and beyond what Crystal Lake and the Little River provide.

Access to the Deep River would require a noticeable additional capital cost; however, it could allow Crystal Lake to provide as much as 12 MGD of safe yield, supporting Moore County's water supply needs well beyond the 30-year planning horizon.

6.0 RECOMMENDATIONS AND NEXT STEPS

After preparation of this Design Memo #3 and conceptual evaluation of a Crystal Lake / Little River alternative, it appears this alternative is an advisable method of satisfying the County's long-term water supply needs. It provides an alternative that would be wholly owned and operated by the County, that can satisfy the projected 30-year supply needs, at a noticeably lower Phase 1 capital cost estimate than the Deep River, Carbonton alternative. It is also located in close proximity to the areas in the County experiencing growth and future demands for water, namely the Town of Vass and surrounding East Moore Water District.

6.1 Financial Planning

During preparation of previous design memoranda, Moore County's utility financial consultant (Nelsnick Enterprises) prepared a Technical Memorandum summarizing the financial implications of the alternatives. It is recommended that Moore County update the memo based on the Crystal Lake / Little River alternative presented in this Design Memo #3 and begin planning for the financial implications of the alternative.

6.2 Preliminary Engineering Report (10% Design Document)

The recommended next step in the technical process is to begin a Preliminary Engineering Report focused on the Crystal Lake, Little River alternative. This should be considered a 10% design document and would cover some or all the following items:

- Recommended intake site on Crystal Lake.
- Recommended pipeline routing, any geographic barriers (railroads, highways, etc.) that could prove difficult to cross, and the areas where permanent and temporary easements will be needed to cross private property.
- Conceptual layout of the water treatment plant site to establish the necessary acreage for the site.
- Options for the location of the water treatment plant and the recommended parcels to be purchased.
- Water quality evaluation of Crystal Lake and the Little River with optional pilot testing of the proposed treatment equipment.
- Conceptual raw water intake design
    - Screen and intake size and configuration
    - Preliminary pump design and selection
    - Pump station sizing and layout
    - Site piping and valving
    - Site layout including access road and parking
- Conceptual water treatment plant design
    - Sizing for all processes and piping
    - Chemical feed sizing and layout
    - Operator's building conceptual floor plan and elevations
    - Site layout including access road, parking, and maintenance vehicle access
- Identification of environmental permitting process
    - Wetlands impacts and delineation, as needed

- Threatened and endangered species survey if necessary

6.3 Wetlands and Stream Impacts

The Preliminary Engineering Report described above would identify any potential impacts to jurisdictional wetlands and streams. It is recommended that the wetland delineation and impact permitting for the Phase 1 project begin immediately after those potential impacts are identified.

APPENDIX A

Map of Crystal Lake

Map of Crystal Lake

Appendix A

November 2025

0 550 1,100 Feet

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LEGEND

Parcel Line

LKC

APPENDIX B

Summary of Capital Cost Estimates

MOORE COUNTY PUBLIC UTILITIES
WATER SUPPLY MASTER PLAN
LITTLE RIVER/CRYSTAL LAKE ALTERNATIVE
SUMMARY OF CAPITAL COSTS

Phase 1: 2.0 MGD Capacity

Dredging of Crystal Lake		$2,000,000
Crystal Lake Dam Repair		$5,200,000
Raw Water Intake/Pump Station on Crystal Lake		$5,500,000
Raw Water Pipeline from Crystal Lake to WTP		$8,563,000
New 2.0 MGD Water Treatment Plant		$33,875,000
Finished Water Pipeline		$5,844,000
PHASE 1 CONSTRUCTION COST ESTIMATE		**$60,982,000**
Contingencies and Engineering (20%)		$12,196,000
Planning and Environmental		$250,000
Property and Easement Acquisition		$1,300,000
Treatment plant site	*$1,000,000*	
Easements for pipe lines	*$300,000*	
Legal Fees		$100,000
Permitting including R/R crossings		$50,000
Electrical Service to the Intake & WTP Site (budget)		$500,000
PHASE 1 PROJECT BUDGET:		**$75,378,000**

Phase 2: 2 to 6 MGD Capacity

Raw Water Intake/Pump Station on Little River		$7,500,000
Raw Water Pipeline from Little River to Crystal Lake		$27,872,000
Water Plant Expansion 2.0 to 6.0 MGD		$32,000,000
Finished Water Pipeline Extension		$15,000,000
CONSTRUCTION COST ESTIMATE		**$82,372,000**
Contingencies and Engineering (20%)		$16,474,000
Planning and Environmental		$350,000
Property and Easement Acquisition		$1,200,000
Intake site	*$400,000*	
Easements for pipe lines	*$800,000*	
Legal Fees		$50,000
Permitting		$50,000
PHASE 2 TOTAL PROJECT BUDGET:		**$100,496,000**

MOORE COUNTY PUBLIC UTILITIES

CRYSTAL LAKE ALTERNATIVE

2.0 MGD WATER TREATMENT PLANT (PHASE 1)

PRELIMINARY COST ESTIMATE

Site Work		**$3,300,000**
Clearing and mass grading	$600,000	
Plant piping, manholes, chemical injection vaults	$1,500,000	
Paving, curbs, gutters, and sidewalks	$400,000	
Drainage and stormwater management	$350,000	
Fencing	$250,000	
Landscaping	$200,000	
Flash Mix Basin		**$340,000**
Flash mixer and splitter box gates	$120,000	
Concrete for flash mix tank	$75,000	
Raw water flow controller	$25,000	
Bridge support for flash mixer	$15,000	
Miscellanous metals	$30,000	
Installation	$25,000	
Electrical	$50,000	
Flocculation/Sedimentation Basin and Sludge Removal		**$4,075,000**
Superpulsator with accessory equipment	$1,250,000	
Sludge removal system	$300,000	
Concrete	$1,500,000	
Piping	$250,000	
Metals	$200,000	
Installation	$350,000	
Coating systems	$75,000	
Electrical	$150,000	

MOORE COUNTY PUBLIC UTILITIES

CRYSTAL LAKE ALTERNATIVE

2.0 MGD WATER TREATMENT PLANT (PHASE 1)

PRELIMINARY COST ESTIMATE

Deep-bed Dual Media Filters		**$4,140,000**
Concrete	$550,000	
Filter room (occupied operations space)	$700,000	
Valves and in-building piping	$450,000	
Filter equipment	$1,100,000	
Filter piping and valves	$450,000	
Air blowers, piping, etc	$125,000	
Media	$50,000	
Installation	$400,000	
Coating systems	$90,000	
Miscellaneous Metals	$75,000	
Electrical	$150,000	
Granular Activated Carbon Filters		**$2,890,000**
Excavation	$40,000	
Concrete	$350,000	
Equipment - GAC filters and backwash system	$950,000	
Installation	$350,000	
Pre-engineered metal canopy	$500,000	
Filter piping and valves	$350,000	
Coating systems	$80,000	
Miscellaneous Metals	$120,000	
Electrical and controls	$150,000	
Two 0.5-MG Clearwells		**$2,300,000**
High Service Pump Station		**$2,470,000**
Excavation	$15,000	
Concrete	$120,000	
Equipment - pumps, motors, valves, controls	$750,000	
Installation	$175,000	
Pump station building	$850,000	
Internal Piping	$180,000	
Coating systems	$80,000	
Mechanical and plumbing	$90,000	
Electrical and controls	$210,000	

MOORE COUNTY PUBLIC UTILITIES
CRYSTAL LAKE ALTERNATIVE
2.0 MGD WATER TREATMENT PLANT (PHASE 1)
PRELIMINARY COST ESTIMATE

Chemical Feed Bulk Storage		**$1,435,000**
Concrete	$95,000	
Building with containment and removable walls	$750,000	
Bulk storage tanks and accessories	$200,000	
Mix and transfer pumps	$80,000	
Chemical feed piping	$180,000	
Installation and start-up	$50,000	
Electrical	$80,000	
Chemical Feed System		**$535,000**
Alum pumps with controls	$40,000	
Hypochlorite with controls	$40,000	
Caustic pumps with controls	$40,000	
Polymer pumps with controls	$40,000	
Chemical day tanks	$45,000	
Polymer wet/dry wetting system	$80,000	
Chemical feed piping	$120,000	
Installation and startup	$50,000	
Electrical	$80,000	

MOORE COUNTY PUBLIC UTILITIES

CRYSTAL LAKE ALTERNATIVE

2.0 MGD WATER TREATMENT PLANT (PHASE 1)

PRELIMINARY COST ESTIMATE

Operations Building and Laboratory		**$2,800,000**
Instrumentation, Analystical, and Metering		**$850,000**
Field instruments, analytical	$600,000	
Start-up	$100,000	
Installation/Electrical	$150,000	
Sludge Handling		**$2,780,000**
Sludge holding tank with mixer	$750,000	
Piping	$150,000	
Transfer pump station	$300,000	
Dewatering building	$600,000	
Dewatering equipment (press, polymer, screw conveyor)	$525,000	
Installation	$175,000	
Coating systems	$80,000	
Electrical, mechanical, plumbing	$200,000	
Electrical Construction		**$1,500,000**
General electrical construction	$1,200,000	
Generator and transfer switch	$300,000	
Plant SCADA System		**$300,000**
Contractor's Overhead & Profit (14.0%)		**$4,160,000**
Total Construction Estimate		**$33,875,000**

MOORE COUNTY

CRYSTAL LAKE ALTERNATIVE

24" RAW WATER LINE, CRYSTAL LAKE TO WTP SITE

PRELIMINARY COST ESTIMATE

Estimate covers a raw water pipe from the proposed intake location on Crystal Lake, downstream of Mill Creek, extending north along Vass-Carthage Rd to a proposed water treatment plant site.

	Item Description	Quantities	Units	Unit Cost	Extended Cost
1.	24" Class 250 DIP Water Main	12,300	LF	$275.00	$3,382,500.00
2.	24" Class 250 Restrained Joint DIP Water Main	2,000	LF	$350.00	$700,000.00
3.	36" Steel Casing Installed by Bore and Jack	300	LF	$2,600.00	$780,000.00
4.	24" RJDIP Installed by Directional Bore	1,200	LF	$1,800.00	$2,160,000.00
5.	Open Cut Blue Line Stream	4	LS	$125,000.00	$500,000.00
6.	Air Release Valve	10	EA	$12,000.00	$120,000.00
7.	24" Butterfly Valve with Concrete Collar	6	EA	$24,000.00	$144,000.00
8.	24" 90-Degree Bend	6	EA	$9,500.00	$57,000.00
9.	24" 45-Degree Bend	12	EA	$8,500.00	$102,000.00
10.	24" 22.5-Degree Bend	12	EA	$8,500.00	$102,000.00
11.	Blow-off Assembly	2	EA	$35,000.00	$70,000.00
12.	Rock Excavation	900	CY	$90.00	$81,000.00
13.	Select Backfill	1,000	CY	$35.00	$35,000.00
14.	Concrete Driveway Repair	300	SY	$75.00	$22,500.00
15.	Asphalt Replacement and Repair	500	SY	$65.00	$32,500.00
16.	Gravel Driveway Repair	100	TONS	$45.00	$4,500.00
17.	Pressure Testing	15,500	LF	$5.50	$85,250.00
18.	Erosion Control	15,500	LF	$2.00	$31,000.00
19.	Clearing and Grubbing	5	ACR	$20,000.00	$100,000.00
20.	Connection at termination point	1	LS	$30,000.00	$30,000.00
21.	Site Cleanup and Restoration	15,500	LF	$1.50	$23,250.00
				CONSTRUCTION ESTIMATE:	**$8,563,000**

MOORE COUNTY

CRYSTAL LAKE ALTERNATIVE

24" FINISHED WATER LINE, WTP TO SYSTEM

PRELIMINARY COST ESTIMATE

Estimate covers a finished water pipe from the proposed water treatment plant site, extending north along Vass-Carthage Rd, to an injection point site within the existing Moore County Water System.

	Item Description	Quantities	Units	Unit Cost	Extended Cost
1.	24" Class 250 DIP Water Main	12,100	LF	$275.00	$3,327,500.00
2.	24" Class 250 Restrained Joint DIP Water Main	1,000	LF	$350.00	$350,000.00
3.	36" Steel Casing Installed by Bore and Jack	200	LF	$2,600.00	$520,000.00
4.	24" RJDIP Installed by Directional Bore	300	LF	$1,800.00	$540,000.00
5.	Open Cut Blue Line Stream	2	LS	$125,000.00	$250,000.00
6.	Air Release Valve	9	EA	$12,000.00	$108,000.00
7.	24" Butterfly Valve with Concrete Collar	4	EA	$24,000.00	$96,000.00
8.	24" 90-Degree Bend	5	EA	$9,500.00	$47,500.00
9.	24" 45-Degree Bend	10	EA	$8,500.00	$85,000.00
10.	24" 22.5-Degree Bend	10	EA	$8,500.00	$85,000.00
11.	Blow-off Assembly	2	EA	$35,000.00	$70,000.00
12.	Rock Excavation	800	CY	$90.00	$72,000.00
13.	Select Backfill	900	CY	$35.00	$31,500.00
14.	Concrete Driveway Repair	300	SY	$75.00	$22,500.00
15.	Asphalt Replacement and Repair	300	SY	$65.00	$19,500.00
16.	Gravel Driveway Repair	200	TONS	$45.00	$9,000.00
17.	Pressure Testing	13,400	LF	$5.50	$73,700.00
18.	Erosion Control	13,400	LF	$2.00	$26,800.00
19.	Clearing and Grubbing	3	ACR	$20,000.00	$60,000.00
20.	Connection at termination point	1	LS	$30,000.00	$30,000.00
21.	Site Cleanup and Restoration	13,400	LF	$1.50	$20,100.00
				CONSTRUCTION ESTIMATE:	**$5,844,000**

MOORE COUNTY

CRYSTAL LAKE ALTERNATIVE

24" RAW WATER LINE, LITTLE RIVER TO CRYSTAL LAKE

PRELIMINARY COST ESTIMATE

Estimate covers a raw water pipe from the proposed intake location on the Little River, downstream of Crystal Lake, extending northwest along Aiken Rd to Crystal Lake, the proposed reservoir site.

	Item Description	Quantities	Units	Unit Cost	Extended Cost
1.	24" Class 250 DIP Water Main	64,500	LF	$275.00	$17,737,500.00
2.	24" Class 250 Restrained Joint DIP Water Main	2,000	LF	$350.00	$700,000.00
3.	36" Steel Casing Installed by Bore and Jack	1,100	LF	$2,600.00	$2,860,000.00
4.	24" RJDIP Installed by Directional Bore	1,600	LF	$1,800.00	$2,880,000.00
5.	Open Cut Blue Line Stream	4	LS	$125,000.00	$500,000.00
6.	Air Release Valve	15	EA	$12,000.00	$180,000.00
7.	24" Butterfly Valve with Concrete Collar	13	EA	$24,000.00	$312,000.00
8.	24" 90-Degree Bend	15	EA	$9,500.00	$142,500.00
9.	24" 45-Degree Bend	25	EA	$8,500.00	$212,500.00
10.	24" 22.5-Degree Bend	25	EA	$8,500.00	$212,500.00
11.	Blow-off Assembly	10	EA	$35,000.00	$350,000.00
12.	Rock Excavation	3,800	CY	$90.00	$342,000.00
13.	Select Backfill	3,000	CY	$35.00	$105,000.00
14.	Concrete Driveway Repair	2,000	SY	$75.00	$150,000.00
15.	Asphalt Replacement and Repair	4,000	SY	$65.00	$260,000.00
16.	Gravel Driveway Repair	1,000	TONS	$45.00	$45,000.00
17.	Pressure Testing	68,100	LF	$5.50	$374,550.00
18.	Erosion Control	68,100	LF	$2.00	$136,200.00
19.	Clearing and Grubbing	12	ACR	$20,000.00	$240,000.00
20.	Connection at termination point	1	LS	$30,000.00	$30,000.00
21.	Site Cleanup and Restoration	68,100	LF	$1.50	$102,150.00
				CONSTRUCTION ESTIMATE:	**$27,872,000**

APPENDIX C

Summary of Annual Financial Costs

MOORE COUNTY WATER SUPPLY

CRYSTAL LAKE ALTERNATIVE

		DEBT ANALYSIS - with coverage ratio			SYSTEM OPERATION ANALYSIS					
Year	Required Avg Day Supply (mgd) from New Source	Debt Payment - Phase 1	Debt Payment - Phase 2	Total Debt, per 1,000 gal Avg Day Supply	Raw Water Pumping Cost	Water Plant Fixed Cost	Water Plant Chemicals	Water Plant Sludge	Finished Water Pumping	Total Operation Costs, per 1,000 gal Avg Day Supply
2026	0.00	$0	$0		$0	$0	$0	$0	$0	
2027	0.00	$0	$0		$0	$0	$0	$0	$0	
2028	0.00	$0	$0		$0	$0	$0	$0	$0	
2029	0.00	$0	$0		$0	$0	$0	$0	$0	
2030	0.00	$0	$0		$0	$0	$0	$0	$0	
2031	0.61	$7,867,000	$0	$35.57	$9,000	$1,447,000	$66,100	$209,700	$35,000	$7.99
2032	0.72	$7,867,000	$0	$29.77	$10,000	$1,447,000	$78,900	$250,500	$42,000	$6.92
2033	1.34	$7,867,000	$0	$16.05	$30,190	$1,447,000	$146,400	$464,800	$78,000	$4.42
2034	1.46	$7,867,000	$0	$14.72	$38,341	$1,447,000	$159,600	$506,500	$85,000	$4.19
2035	1.58	$7,867,000	$0	$13.62	$46,400	$1,447,000	$172,600	$547,700	$92,000	$3.99
2036	1.67	$7,867,000	$0	$12.92	$51,717	$1,447,000	$181,800	$577,000	$97,000	$3.87
2037	1.75	$7,867,000	$10,489,000	$28.67	$57,123	$1,447,000	$191,200	$606,900	$102,000	$3.75
2038	1.84	$7,867,000	$10,489,000	$27.29	$62,621	$1,447,000	$200,900	$637,500	$107,000	$3.65
2039	1.93	$7,867,000	$10,489,000	$26.02	$69,213	$1,447,000	$210,700	$668,700	$113,000	$3.56
2040	2.02	$7,867,000	$10,489,000	$24.84	$74,901	$1,447,000	$220,700	$700,500	$118,000	$3.47
2041	2.12	$7,867,000	$10,489,000	$23.74	$80,686	$1,447,000	$231,000	$733,000	$123,000	$3.38
2042	2.21	$7,867,000	$10,489,000	$22.71	$87,572	$1,447,000	$241,400	$766,200	$129,000	$3.30
2043	2.31	$7,867,000	$10,489,000	$21.75	$93,561	$1,447,000	$252,100	$800,100	$135,000	$3.23
2044	2.41	$7,867,000	$10,489,000	$20.85	$99,654	$1,447,000	$263,000	$834,700	$141,000	$3.16
2045	2.51	$7,867,000	$10,489,000	$20.00	$106,856	$1,447,000	$274,100	$870,000	$146,000	$3.10
2046	2.62	$7,867,000	$10,489,000	$19.20	$113,167	$1,447,000	$285,500	$906,100	$153,000	$3.04
2047	2.73	$7,867,000	$10,489,000	$18.45	$120,592	$1,447,000	$297,100	$942,900	$159,000	$2.98
2048	2.82	$7,867,000	$10,489,000	$17.81	$126,626	$1,447,000	$307,900	$977,100	$164,000	$2.93
2049	2.92	$7,867,000	$10,489,000	$17.22	$133,546	$1,447,000	$318,400	$1,010,600	$170,000	$2.89
2050	3.02	$7,867,000	$10,489,000	$16.66	$139,571	$1,447,000	$329,200	$1,044,700	$176,000	$2.85
2051	3.12	$7,867,000	$10,489,000	$16.12	$146,705	$1,447,000	$340,100	$1,079,600	$182,000	$2.81
2052	3.22	$7,867,000	$10,489,000	$15.60	$152,948	$1,447,000	$351,400	$1,115,200	$188,000	$2.77
2053	3.33	$7,867,000	$10,489,000	$15.11	$159,305	$1,447,000	$362,800	$1,151,600	$194,000	$2.73
2054	3.44	$7,867,000	$10,489,000	$14.64	$166,777	$1,447,000	$374,500	$1,188,700	$200,000	$2.69

MOORE COUNTY PUBLIC UTILITIES
CRYSTAL LAKE ALTERNATIVE
PROPOSED WATER TREATMENT FACILITY
FIXED ANNUAL COSTS

1. Personnel (Salaries plus Benefits)			
a. Operators			
Chief Plant Operator	1	$90,000.00	
Class A	3	$225,000.00	
Class B	2	$120,000.00	
b. Mechanic	1	$60,000.00	
c. Lab Tech	1	$65,000.00	
d. Total Labor Cost			$560,000.00
2. Contract Services			
a. Professional services		$100,000.00	
b. Maintenance contracts		$80,000.00	
c. Equipment rental		$50,000.00	
d. Total Contract Services			$230,000.00
3. Repair Parts and Lubricants			
a. Water Treatment Plant		$150,000.00	
b. Total Repair Parts and Lubricants			$150,000.00
4. Vehicles			
a. Water Treatment Plant		$52,500.00	
b. Total Vehicles			$52,500.00
5. Office Supplies and Telephone			
a. Office equipment and supplies		$15,000.00	
b. Janitorial supplies		$2,500.00	
c. Uniforms		$20,000.00	
d. Telephone /Internet		$15,000.00	
e. Postage/Shipping		$4,000.00	
f. Dues, subscriptions, travel, etc.		$8,000.00	
g. Total Office Supplies and Telephone			$64,500.00
6. Laboratory Cost			
a. Laboratory supplies		$40,000.00	
b. Sub-contracted testing		$50,000.00	
c. Total Laboratory Cost			$90,000.00
7. Capital Outlay / Short-Lived Asset Reserve			
a. Short-Lived Asset Reserve		$300,000.00	
b. Total Short-Lived Asset Reserve			$300,000.00
TOTAL			**$1,447,000.00**
			per year, Fixed Costs

Crystal Lake Raw Water PS Energy Consumption		
Crystal Lake Intake Pumps		
Flow	1400	gpm
Head	80	ft
Pump Eff	80%	
Motor HP	35.35	HP
Use This	40	HP
	29.84	kW
Crystal Lake Intake Pumps		
Flow	4900	gpm
Head	300	ft
Pump Eff	80%	
Motor HP	464.02	HP
Use This	500	HP
	373	kW
Safe Yield	2	mgd
Peaking Factor	1.78	
ADD By Lake	1.12	mgd
$/kW-h	$ 0.11	
MAX Hours	20	

Year	Required Supply AVG (mgd)	Crystal Lake Intake Energy	Little River Intake Energy	Total Energy
2026	0.00	$0	$0	$0
2027	0.00	$0	$0	$0
2028	0.00	$0	$0	$0
2029	0.00	$0	$0	$0
2030	0.00	$0	$0	$0
2031	0.61	$9,000	$0	$9,000
2032	0.72	$10,000	$0	$10,000
2033	1.34	$19,000	$11,190	$30,190
2034	1.46	$21,000	$17,341	$38,341
2035	1.58	$23,000	$23,400	$46,400
2036	1.67	$24,000	$27,717	$51,717
2037	1.75	$25,000	$32,123	$57,123
2038	1.84	$26,000	$36,621	$62,621
2039	1.93	$28,000	$41,213	$69,213
2040	2.02	$29,000	$45,901	$74,901
2041	2.12	$30,000	$50,686	$80,686
2042	2.21	$32,000	$55,572	$87,572
2043	2.31	$33,000	$60,561	$93,561
2044	2.41	$34,000	$65,654	$99,654
2045	2.51	$36,000	$70,856	$106,856
2046	2.62	$37,000	$76,167	$113,167
2047	2.73	$39,000	$81,592	$120,592
2048	2.82	$40,000	$86,626	$126,626
2049	2.92	$42,000	$91,546	$133,546
2050	3.02	$43,000	$96,571	$139,571
2051	3.12	$45,000	$101,705	$146,705
2052	3.22	$46,000	$106,948	$152,948
2053	3.33	$47,000	$112,305	$159,305
2054	3.44	$49,000	$117,777	$166,777

Crystal Lake Alternative Finished Water PS Energy

Finished Water Pumps

Flow	3000	gpm
Head	350	ft
Pump Eff	80%	
Motor HP	331.44	HP
Use This	350	HP
	261.1	kW
$/kW-h	$ 0.11	
MAX Hours	24	

Year	Required Supply AVG (mgd)	Annual Energy Consumption Charge
2026	0.00	$0
2027	0.00	$0
2028	0.00	$0
2029	0.00	$0
2030	0.00	$0
2031	0.61	$35,000
2032	0.72	$42,000
2033	1.34	$78,000
2034	1.46	$85,000
2035	1.58	$92,000
2036	1.67	$97,000
2037	1.75	$102,000
2038	1.84	$107,000
2039	1.93	$113,000
2040	2.02	$118,000
2041	2.12	$123,000
2042	2.21	$129,000
2043	2.31	$135,000
2044	2.41	$141,000
2045	2.51	$146,000
2046	2.62	$153,000
2047	2.73	$159,000
2048	2.82	$164,000
2049	2.92	$170,000
2050	3.02	$176,000
2051	3.12	$182,000
2052	3.22	$188,000
2053	3.33	$194,000
2054	3.44	$200,000

APPENDIX D

Little River Low-Flow Characteristics

Outlook

Fwd: USGS response to DWR USGS Low Flows request # 2022-256 (dated 2023/02/06) for Little River Moore County...RE: [EXTERNAL] Low-flow request approval

From Jordan Caplanson-Torrens <Jordan@lkcengineering.com>
Date Mon 2/27/2023 7:05 PM
To Adam Kiker <adam@lkcengineering.com>
Cc Logan Parsons <logan@lkcengineering.com>

Hey Adam,

Here is the response to the low flow characteristics request for the location on the Little River.

I'll send over the others as they are sent to me.

Thanks,
Jordan Caplanson-Torrens EI

From: Weaver, John C <jcweaver@usgs.gov>
Sent: Monday, February 27, 2023 6:59 PM
To: Jordan Caplanson-Torrens <Jordan@lkcengineering.com>
Cc: adugna.kebede@ncdenr.gov <adugna.kebede@ncdenr.gov>; Montebello, Michael J <Michael.Montebello@ncdenr.gov>; Dowden, Doug <doug.dowden@ncdenr.gov>; Litzenberger, Kristin S <Kristin.Litzenberger@ncdenr.gov>; Denard, Derek <derek.denard@ncdenr.gov>; Albertin, Klaus P <klaus.albertin@ncdenr.gov>; Weaver, John C <jcweaver@usgs.gov>
Subject: USGS response to DWR USGS Low Flows request # 2022-256 (dated 2023/02/06) for Little River Moore County...RE: [EXTERNAL] Low-flow request approval

Mr. Caplanson-Torrens,

In response to your inquiry about the low-flow characteristics for the Little River along the boundary between Moore and Hoke Counties within the "eastern peninsula" just upstream from the boundary with Cumberland County in the general vicinity of Lobelia in eastern Moore County, the following information is provided:

A check of the low-flow files here at the USGS South Atlantic Water Science Center (SAWSC, Raleigh office) suggests a previous low-flow determination for the specific point of interest, identified by the lat/long coordinates (35.1740, -79.0983) provided via email dated 02/06/2023 from the DWR USGS Low Flows portal following your request submission. However, information pertaining to this previous determination could not be fully confirmed and is therefore not considered immediately available.

For the record: This is the fourth low-flow request received in recent months for a point of interest on the Little River in this part of the State. The USGS recently estimated low-flow characteristics for two downstream points of interest on the Little River in the vicinity of the Fort Bragg military reservation. The first point of interest was for the Little River adjacent a decommissioned water treatment facility located on the Fort Bragg military reservation in northwest Cumberland County (request # 2023-243, dated 10/30/2022). The second point of interest was for the lower Little River approximately 1,600 upstream from Elliot Bridge Road (NC Secondary Road 1607 for Cumberland County) along the boundary between Harnett and Cumberland Counties (request # 2023-245, dated 11/15/2022). The third point of interest was for the Little River immediately upstream from NC Highway 22 near Eastwood in east central Moore County (request # 2023-252, dated 12/09/2022).

No USGS discharge records are known to exist for the point of interest.

In the absence of site-specific discharge records sufficient for a low-flow analysis, estimates of low-flow characteristics at ungaged locations are determined by assessing a range in the low-flow yields (expressed as flow per square mile drainage area, or cfsm) at nearby sites where estimates have previously been determined.

A basin delineation completed using the online USGS StreamStats application for North Carolina (https://streamstats.usgs.gov/ss/) indicates the drainage area for the point of interest (StreamStats adjusted 35.17395, -79.09830 NAD83) is 301 sqmi, which confirms the drainage area submitted as part of the request information.

For streams in eastern Moore County, low-flow characteristics published by the USGS are provided in the following reports:

(1) The first is a statewide report completed in the early 1990's. It is USGS Water-Supply Paper 2403, "Low-flow characteristics of streams in North Carolina" (Giese and Mason, 1993). An online version of the report is available at http://pubs.usgs.gov/wsp/2403/report.pdf. The report provides the low-flow characteristics (based on data through 1988) via regional relations and at-site values for sites with drainage basins between 1 and 400 sqmi and not considered or known to be affected by regulation and/or diversions.

(2) The second is a basin-wide report for the Cape Fear River basin published in 2001. It is USGS Water-Resources Investigations Report 01-4094, "Low-flow characteristics and discharge profiles for selected streams in the Cape Fear River Basin, North Carolina, through 1998" (Weaver and Pope, 2001). An online version of the report is available through http://nc.water.usgs.gov/reports/wri014094/. The report provides the low-flow characteristics (based on data through 1998) for continuous-record gaging stations and partial-record sites within the Cape Fear River basin. The report also provides low-flow discharge profiles (7Q10, 30Q2, winter 7Q10, and 7Q2) for the Cape Fear River and selected tributaries within the basin.

(3) The third is a statewide report published in March 2015. It is USGS Scientific Investigations Report 2015-5001, "Low-flow characteristics and flow-duration statistics for selected USGS continuous-record streamgaging stations in North Carolina through 2012" (Weaver, 2015). The report is available online at http://pubs.usgs.gov/sir/2015/5001/. The report provides updated low-flow characteristics and flow-duration statistics for 266 active (as of 2012 water year) and discontinued streamgages across the state where a minimum of 10 climatic years discharge records were available for flow analyses.

Low-flow characteristics estimated for point of interest:

For the record: Discharge records for the Little River basin in eastern Moore County are somewhat limited. Further, visual inspection of the low-flow yields north of the river reflect little to no potentials for sustained base flows while low-flow yields south of the river reflect the much higher potentials for sustained base flows that is common in the Sand Hills region. When examined from a larger extent, the Little River appears to be very near the transition area from the soils and underlying geologic units of the eastern Piedmont/west central Coastal Plain to the Sand Hills region where low-flow yields are substantially higher.

For the record: The low-flow yields provided below include those utilized for a response to a recent low-flow request for the location on the Little River immediately upstream from NC Highway 22 near Eastwood in east central Moore County (request # 2023-252, dated 12/09/2022). The additional index site to the group below is for an actively operated USGS continuous-record streamgage located downstream on the Little River at Manchester (station id 02103000, NWIS drainage area = 348 sqmi, StreamStats-delineated drainage area = 345 sqmi, at East Manchester Road...NC Secondary Road 1451). Available data for this streamgage is described at https://waterdata.usgs.gov/nc/nwis/inventory/?site_no=02103000&agency_cd=USGS. Continuous records of discharge were initially collected from October 1938 to September 1950 and have more recently been collected since July 2002 after the station was re-activated. The low-flow yields for the downstream continuous-record streamgage are based on streamflow records analyzed as part of the responses to previous low-flow requests # 2023-243 and # 2023-245.

Inspection of the above reports indicates the presence of six (6) nearby selected USGS partial-record sites (4) and continuous-record streamgages (2) across central and southern Moore County and northwestern Cumberland County in the general vicinity of the point of interest where low-flow characteristics were published. Among these 6 index sites (including the additional downstream streamgage), the low-flow discharge yields for the indicated flow statistics are as follows:

Annual 7Q10 low-flow yields ==> from 0 to 0.34 cfsm (average about 0.13 cfsm, median about 0.093 cfsm) *(zero flow at 1 of 6 index sites)*
Annual 30Q2 low-flow yields ==> from 0.025 to 0.76 cfsm (average about 0.39 cfsm, median about 0.37 cfsm)
Winter 7Q10 low-flow yields ==> from 0.018 to 0.69 cfsm (average about 0.37 cfsm, median about 0.32 cfsm)
Annual 7Q2 low-flow yields ==> from 0.0031 to 0.62 cfsm (average about 0.28 cfsm, median about 0.24 cfsm)

Average annual discharge yields ==> from 1.1 to 1.7 cfsm (both average and median about 1.4 cfsm)

Application of the above range in yields to the drainage area (301 sqmi) for the point of interest results in the following estimated low-flow discharges:

Annual 7Q10 low-flow discharges ==> from 0 to 102 cfs (average about 39.1 cfs, median about 28 cfs)
Annual 30Q2 low-flow discharges ==> from 7.5 to 229 cfs (average about 117 cfs, median about 111 cfs)
Winter 7Q10 low-flow discharges ==> from 5.4 to 208 cfs (average about 111 cfs, median about 96.3 cfs)
Annual 7Q2 low-flow discharges ==> from 0.93 to 187 cfs (average about 84.3 cfs, median about 72.2 cfs)

Average annual discharge discharges ==> from 331 to 512 cfs (both average and median about 421 cfs)

Please note:

(1) The estimated flows are provided in units of cubic feet per second (cfs).

(2) The low-flow yields provided above are rounded to 2 significant figures. Estimated low-flow discharges less than 1 cfs are rounded to 2 significant figures. If between 1 and 100 cfs, then rounded to 1 decimal place; if greater than 100, then rounded to the nearest whole number (zero decimal places).

(3) The information provided in this message is based on a preliminary assessment and considered provisional, subject to revision pending collection of future data and further analyses.

These provisional streamflow statistics are provided via the DWR USGS Low Flows cooperative agreement between the USGS and the N.C. Department of Environmental Quality, Division of Water Resources.

Hope this information is helpful.

Thank you.

Curtis Weaver

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From: Albertin, Klaus P <klaus.albertin@ncdenr.gov>
Sent: Monday, February 6, 2023 12:01 PM
To: jordan@lkcengineering.com
Cc: Albertin, Klaus P <klaus.albertin@ncdenr.gov>; adugna.kebede@ncdenr.gov; Weaver, John C <jcweaver@usgs.gov>; Montebello, Michael J <Michael.Montebello@ncdenr.gov>; Dowden, Doug <doug.dowden@ncdenr.gov>; Litzenberger, Kristin S <Kristin.Litzenberger@ncdenr.gov>; Denard, Derek <derek.denard@ncdenr.gov>
Subject: [EXTERNAL] Low-flow request approval

Your request has been approved and will be forwarded to USGS. A response from USGS usually takes 7 - 10 business days.

Request Flow Statistic Approval

Request ID: 256

Requestor: Jordan

Requestor e-mail: jordan@lkcengineering.com

Requestor Phone: 9105237363

Local Government:

Public Water Supply:

Consultant:

Contact: Jordan Caplanson-Torrens

Reason: Water Supply Water Availability/Safe Yield

River/Stream: Littel River

Drainage Area (sq. mi.): 301

Latitude: 35.1740

Longitude: -79.0983

Other Information: The furthest east point of Little River that is still within the boundary of Moore County.

Statististics: ["7Q10","7Q10 - Winter","Average Annual"]

Approved by: Albertin, Klaus P