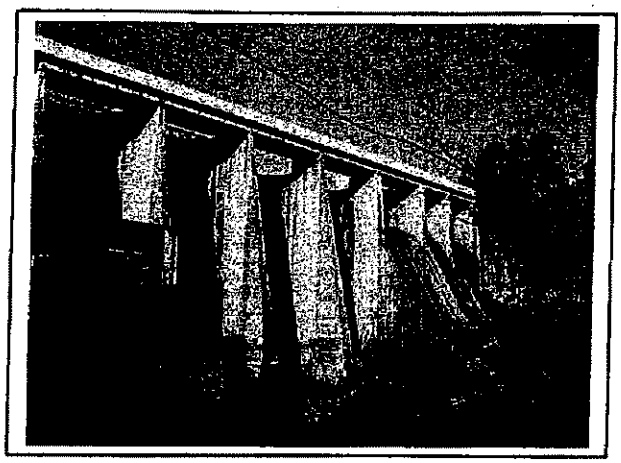
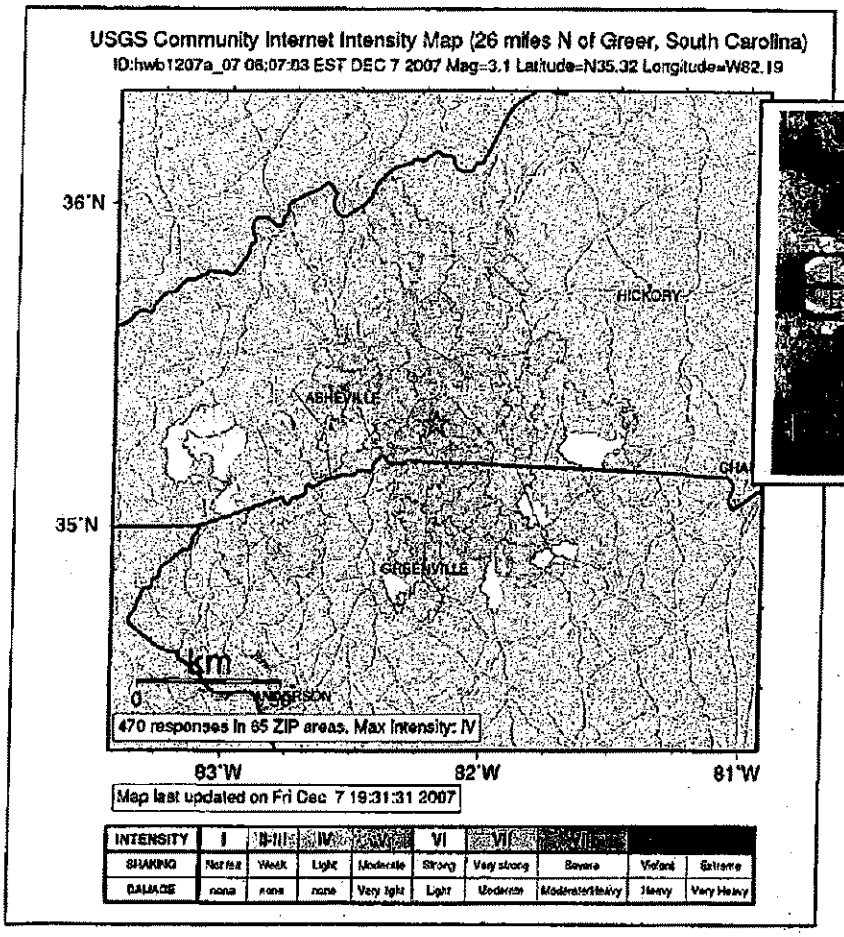
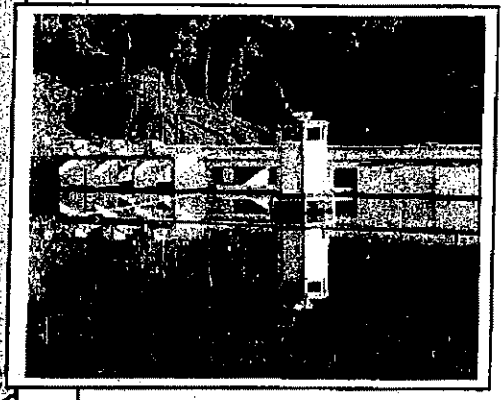
Devine Tarbell & Associates, Inc.
Consulting Engineers, Scientists, & Regulatory Specialists



Lake Lure Dam

Independent Consultant
Post Earthquake -
Dam Safety Inspection
December 2007





Prepared For:

Town of Lake Lure
North Carolina

Section 1 – INTRODUCTION

The Town of Lake Lure owns and operates the dam that impounds the Broad River to form Lake Lure. The dam includes an intake and penstock that supply water to a hydroelectric station located immediately downstream of the dam. Lake Lure Dam is a multiple-arch concrete configuration with ten arch bays and three ogee shaped gated (radial steel Taintor gates) gravity spillway bays. The circular arches have a central angle of 130 degrees and the upstream slope is 45 degrees (Creager, Justin and Hinds, 1945). The dam was constructed in 1925-1926 with no significant structural changes having been made since that time. Improvements have included individual gate hoist mechanisms and control upgrades for the powerhouse. A bridge deck carries local traffic (Buffalo Shoals Road) crossing along the dam axis.

The dam was reportedly designed by the engineering firm of Mees and Mees of Charlotte, North Carolina. This company is no longer in business. Dam construction was completed in September 1926 with the Lake being completely filled in 1927. At full pond, Lake Lure has a surface area of 720 acres with approximately 27 miles of shoreline. The hydroelectric facility began commercial operation in 1928, and is currently supplying power under contract to Duke Energy. The powerhouse contains two vertical shaft generating units (1200 and 2200 kilowatts) with Francis type turbines. The power station and dam are not regulated by the Federal Energy Regulatory Commission.

It is understood that the dam has performed well during its service life. Maintenance activities have been confined primarily to the powerhouse equipment, intake gate and spillway gates. No significant concrete structural modifications or repairs have reportedly been performed during the life of the structure.

The Lake Lure Dam falls under the dam safety regulatory oversight of the North Carolina Department of Environment and Natural Resources: Division of Land Resources – Land Quality Section (NCDENR). Representatives of the NCDENR Land Quality Section conduct periodic inspections of the dam. Personnel from that office inspected the dam on December 8th and again on December 21st. DTA staff participated in both state inspections at the request of Lake Lure personnel.

This report presents the observations, conclusions and recommendations made for the inspection which was conducted by Edwin C. Luttrell, P.E. of Devine Tarbell and Associates Inc. Mr. Luttrell had inspected the dam on October 18, 2006. These are supplemented by the observations of Dr. Alex Grenoble who, at the request of Town staff, participated in a site visit by NCDENR staff on December 21st. Conclusions are subject to the inevitable practical limitations on the scope of information that was available and the limitations of a visual examination of a structure of this type with limited points of access.

Section 2 – FIELD INSPECTION

An earthquake occurred at 6:07 a.m. on the morning of Friday, December 7, 2007, centered approximately nine miles south of Lake Lure. The event was small but was distinctly felt at the Lake Lure Dam site (details on the earthquake are provided in an Appendix to this report). Staff from the Town of Lake Lure inspected the dam and noted no obvious damage but did observe increased leakage at the arch immediately adjacent to the spillway gate bays (Photograph 1). The NCDENR was notified and they recommended lowering the lake and indicated they would send personnel to the site the next day. Lake Lure staff contacted Mr. Luttrell on Friday evening and asked him to come to the dam site as soon as possible. Mr. Luttrell arrived at Lake Lure at approximately 11:00 p.m. An inspection of the Lake Lure Dam was completed immediately by the Independent Consultant, Ed Luttrell, P.E. accompanied by William Grimes, Dam Superintendent and Ron Morgan, Lake Lure Fire and Emergency Management Coordinator. At the time of the inspection Lake Lure was at approximately normal full pond elevation. The lake is typically maintained in the top six to nine inches below full pond to support the strong recreation and homeowner associated with the lake.

Inspection was only possible using handheld lights and from the bridge deck and focused on the arch bay where the increased leakage had been noted. Mr. Grimes reported that no other damage or changed conditions had been observed when he had made an inspection during daylight hours. The increased leakage was observed along a horizontal line distributed around the arch and no structure damage (cracking, spalling, misalignment, displacement) was observed. The horizontal line where leakage was noted was eight to ten feet below the lake surface elevation. Mr. Grimes felt the leakage was more than he had previously observed at that location. As noted, the leakage was distributed along a horizontal line, in a series of small streams (no spray or pressurized flow). Mr. Grimes felt that the amount of flow had not changed during the day. Given the absence of any evidence of structural damage and the limited volume of observed incremental leakage, the immediate safety of the dam was felt not to be at risk. Mr. Luttrell concurred with continuing the NCDENR's recommendation to draw the lake down, but recommended not opening the spillway gates to a level that could cause vibration of other issues. Lake Lure staff were instructed to continue to monitor the dam throughout the night.

Mr. Luttrell returned to Lake Lure the next morning, December 8th to participate in an additional, more comprehensive inspection and to meet with NCDENR personnel from the Asheville regional office. A visual inspection of the dam was performed by walking the bridge deck, from the left (downstream) abutment and by accessing the downstream side of arch bays. The arch bays located to the left of the tailrace and powerhouse were accessed for close-up review by crossing a pipe bridge over the tailrace. The daylight conditions allowed for a more thorough inspection. Inspection observations are delineated below. Conditions as of the October 18, 2006 inspection were used as a point of reference. After discussion with the NCDENR personnel, they agreed that further drawdown was not required. NCDENR requested a copy of this inspection report.

Section 2 – FIELD INSPECTION

Bridge Deck

The bridge deck is in relatively good condition with some cracking of the concrete and weathering damage apparent. The bridge only sees moderate to light volumes of traffic and appears to be structurally sound. No changes or structural damage were noted as compared to the condition during the October 2006 inspection.

Radial Gates

The three steel frame radial gates were in good condition and reported to be fully operational. Maintenance, including new seals was performed in the mid 1980's. Each gate has a dedicated hoist with a single lift chain which connects/wye's to cables attached to each side of the base of the gate. Leakage was occurring, similar to conditions in October 2006, but was not excessive and seemed concentrated at the gate corner where the bottom and side seals intersect. This is a common location for some leakage to occur in this type gate.

Intake Structure

The intake to the hydroelectric station is a vertical concrete tower with a steel cylinder gate. The intake was observed from the bridge deck. No evidence of structural distress was observed. The cylinder gate is not normally operated and there was reportedly difficulty opening it the last time it was closed. The gate reportedly could be closed in an emergency.

Arch Bays

Arch bays were inspected by entering each bay from the downstream side. Similar to October 2006, minor leakage and efflorescence was observed at the lift lines (horizontal boundaries between successive concrete pours) and at the base of the arch. Reportedly, leakage does not vary significantly with seasonal changes in air and water temperature. Portions of the arch concrete continue to be obscured by vegetation. The arch bays located to the left of the powerhouse including the bay where the increased leakage was observed were accessed by traversing a pipe crossing the tailrace. There were no observed instances of structural distress such as severe cracking, deformation or misalignment. At a number of locations, spalled concrete is exposing steel that may be reinforcing steel as well as additional steel associated with supporting original formwork. The location of the increased leakage could be clearly observed (Photograph 2 & 3).

Buttresses

The buttresses were examined from accessible vantage points. No changes were observed when compared to the conditions during the October 2006 inspection.

Section 2 – FIELD INSPECTION

December 21, 2007 Inspection

During the week of December 17th, the Lake Lure Hydro operators noted an increase in flow at the newly installed monitoring point (*See recommendation No. 1 below*) from approximately 17 to 22 gpm. The NCDENR was contacted and an inspection/meeting was scheduled at the dam site for December 21st. DTA was contacted by Ron Morgan, Lake Lure Fire and Emergency Management Coordinator. Mr. Morgan ask that DTA be represented at the meeting. Mr. Luttrell was unavailable and Dr. Alex Grenoble of DTA agreed to attend the meeting.

Aside from the increase in measured leakage, conditions at the dam were observed to be unchanged from the inspections in early December. Two parameters were identified that may have influenced the leakage quantities, slightly higher lake levels (increased hydrostatic pressure on the dam face) and colder temperatures (results in contraction of the dam structural elements). All aspects of the situation were reviewed with the NCDENR staff and no additional action was proposed.

Section 3 – CONCLUSIONS & RECOMENDATIONS

The Lake Lure Dam continues to be generally in good condition based on visual inspection and evaluation as discussed in this report and in DTA's November 2006 report. The increase in leakage noted after the small earthquake does not appear to threaten the immediate integrity and safety of the dam. No items were noted that would suggest the safety of the structure has been compromised, or that immediate actions to assure project safety are required. No immediate repairs are necessary unless the leakage increases significantly or if other changed conditions are noted. Some leakage, near surface concrete deterioration and cracking was observed but these conditions do not appear to be materially worse than conditions described in previous inspection reports (DTA 2006, DE&S 1999) with the exception of the leakage increase discussed in this report.

The continued commitment to emergency preparedness by Town staff is commendable. It was prudent to react after the earthquake. Dams of this type have been found to be at risk during strong seismic loading along the axis (cross-valley) of the dam. Similar dams in the west have been modified to improve their resistance to damage in large earthquakes. Response was timely and thorough. The EAP is a valuable tool in situations such as the earthquake and immediate aftermath. It would be prudent to revise the inundation maps if development downstream has changed significantly since the maps were developed. The plan to convert to a GIS format is a good one.

RECOMMENDATIONS

1. Install a leakage monitoring point at the right downstream end of the arch bay where the increased leakage is occurring (Photograph 4). A small headwall can be built using hydraulic cement and a PVC pipe. Measurements can be made using a graduated bucket and stopwatch. Readings should be made at least weekly for three months and then monthly in the flows are stable.

Note: The measuring point has been installed by Town staff. Initial readings were 15-17 gallons per minute (gpm). The reading increased to approximately 22 gpm which triggered the additional inspection and meeting on December 21st.

2. As recommend in DTA's 2006 report, retain a dam safety engineering consultant to conduct a comprehensive structural inspection in 2008. This inspection should include close examination of all arch bays including those to the left (looking downstream) side of the powerhouse and areas currently obscured by vegetation. If concrete deterioration is determined to have advanced to an extent and depth to create structural concerns or if significant areas are present where reinforcing steel is exposed, concrete repairs should be considered at that time. If no progression in concrete condition is noted, similar independent consultant inspections from that point should be conducted at no less than five year intervals. The inspection results should include recommendations for any needed concrete repairs and technical specifications for the repairs including addressing the leakage first noted on

December 7th. Consideration should be given to augmenting the comprehensive visual inspection with an underwater inspection upstream using divers or an ROV (remote operated vehicle).

Any recommended repairs should be submitted to the NCDENR Land Quality Section as required by the North Carolina Dam Safety Law, for review and approval.

3. The NCDENR officials indicated that they plan to require that an assessment of seismic risk and stability be conducted.

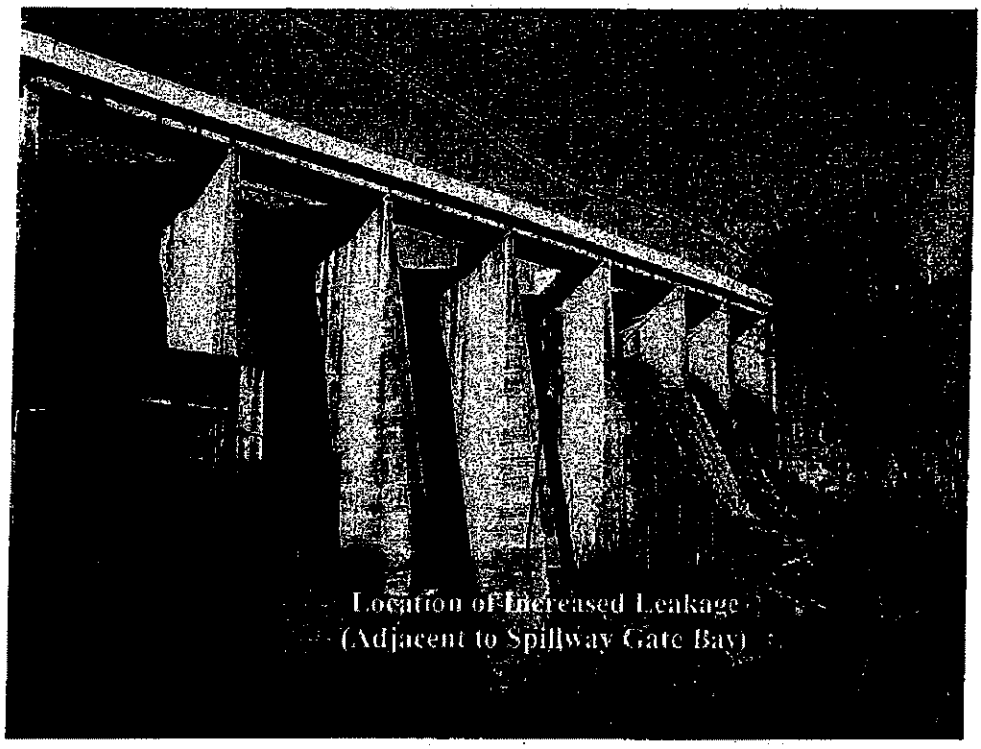
No current stability assessment or calculations are available. Given the age, condition and hazard classification (high) of the Lake Lure Dam, an up-to-date assessment of stability is appropriate. This will yield important data for reacting to situations such as the recent earthquake by providing a thorough understanding of what loading parameters, including extreme flood and seismic (earthquake), that the dam can safely withstand. Completing a stability assessment should include the following steps:

- Review all available drawings and reports in the Towns records.
- Literature search for published information about the dam.
- Determine accurate structure geometry.
- Assign strength properties. The concrete mix proportions are known.
- Verify foundation geology.
- Assess reinforcement and structural integrity of arch to buttress (pier) connection (integral or independent).
- Determine uplift distribution assumptions accounting for the influence of base slabs.
- Determine appropriate analysis load cases and loading including flood case (PMF) and earthquake loading case.
- Determine seismic analysis criteria (design basis ground motion).
- Define analysis methods to be utilized and establish acceptance criteria.
- Develop a stability model, gravity type analysis for the piers/buttresses and potentially a FEM model for cross valley seismic loading. Determine stresses in the arches. More complex analyses should not be utilized if more simplified and cost effective approaches are adequate to assess stability.
- Complete analyses and report on results.

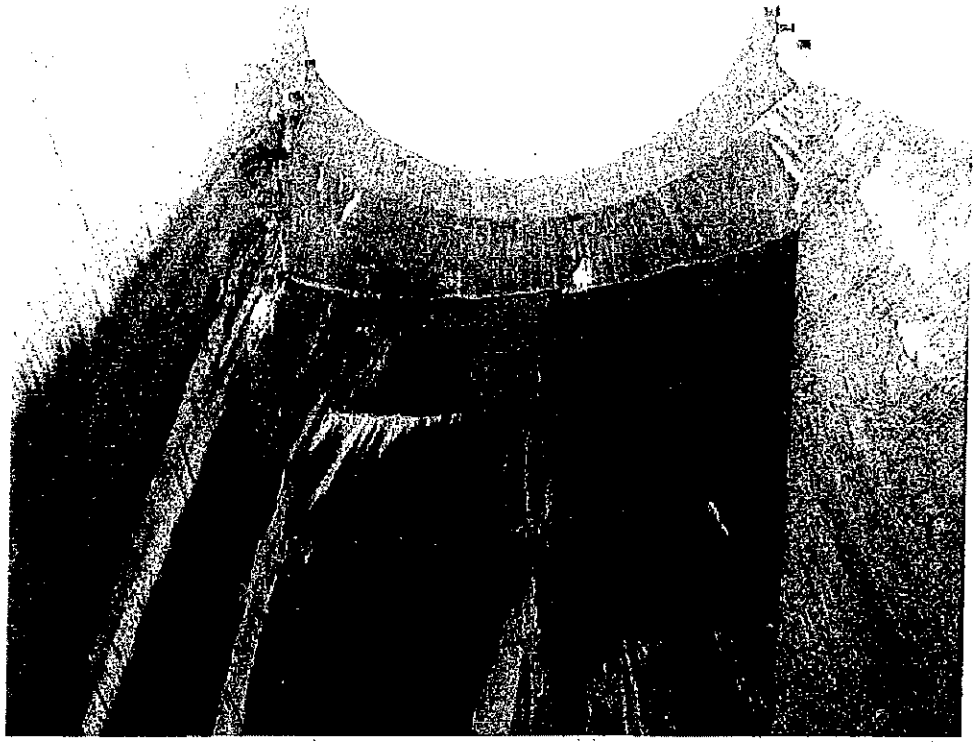
Section 4 - APPENDICES

- Photographs
- Earthquake Data

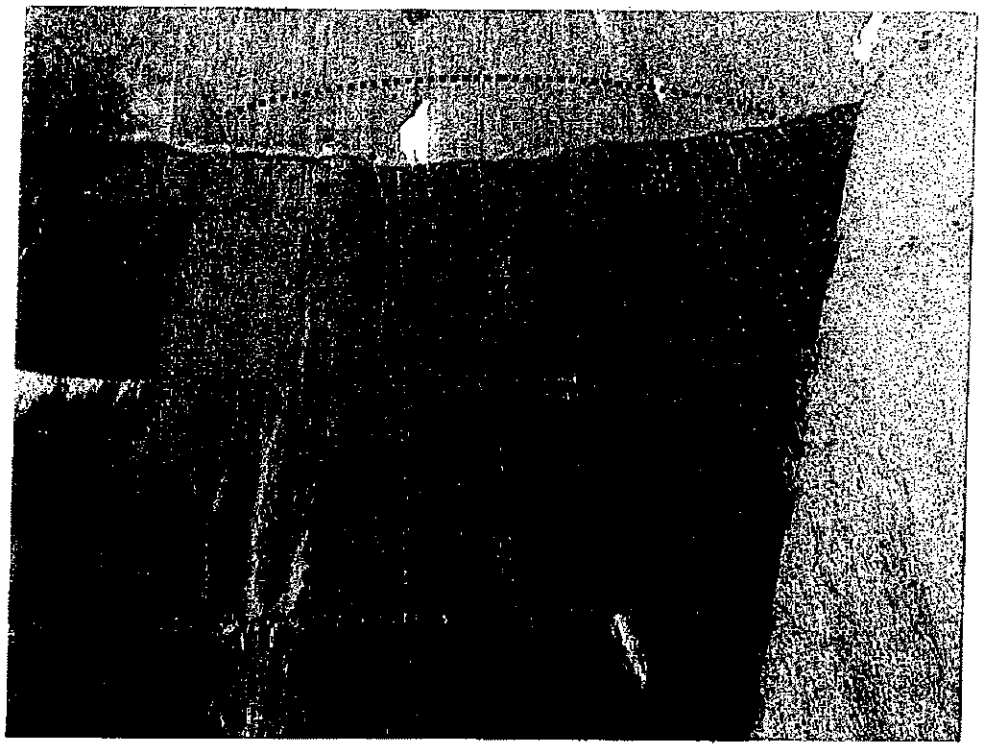
Photographs



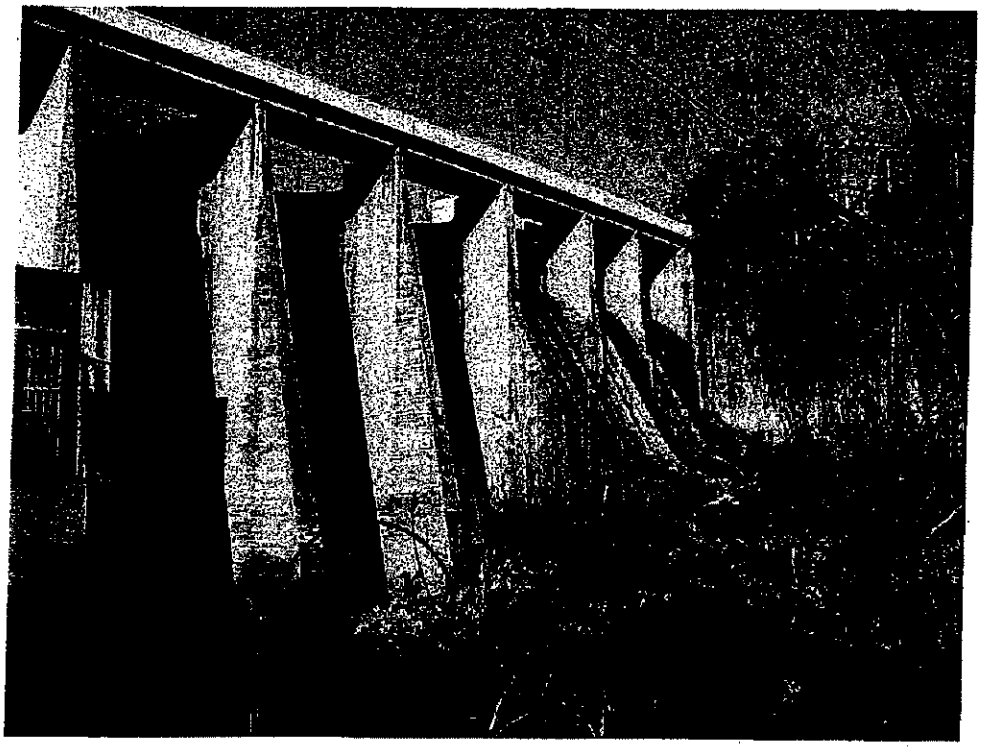
Photograph 1- View from Downstream



Photograph 2- Increased Leakage



Photograph 3- Increased Leakage at Horizontal Form/Lift Line

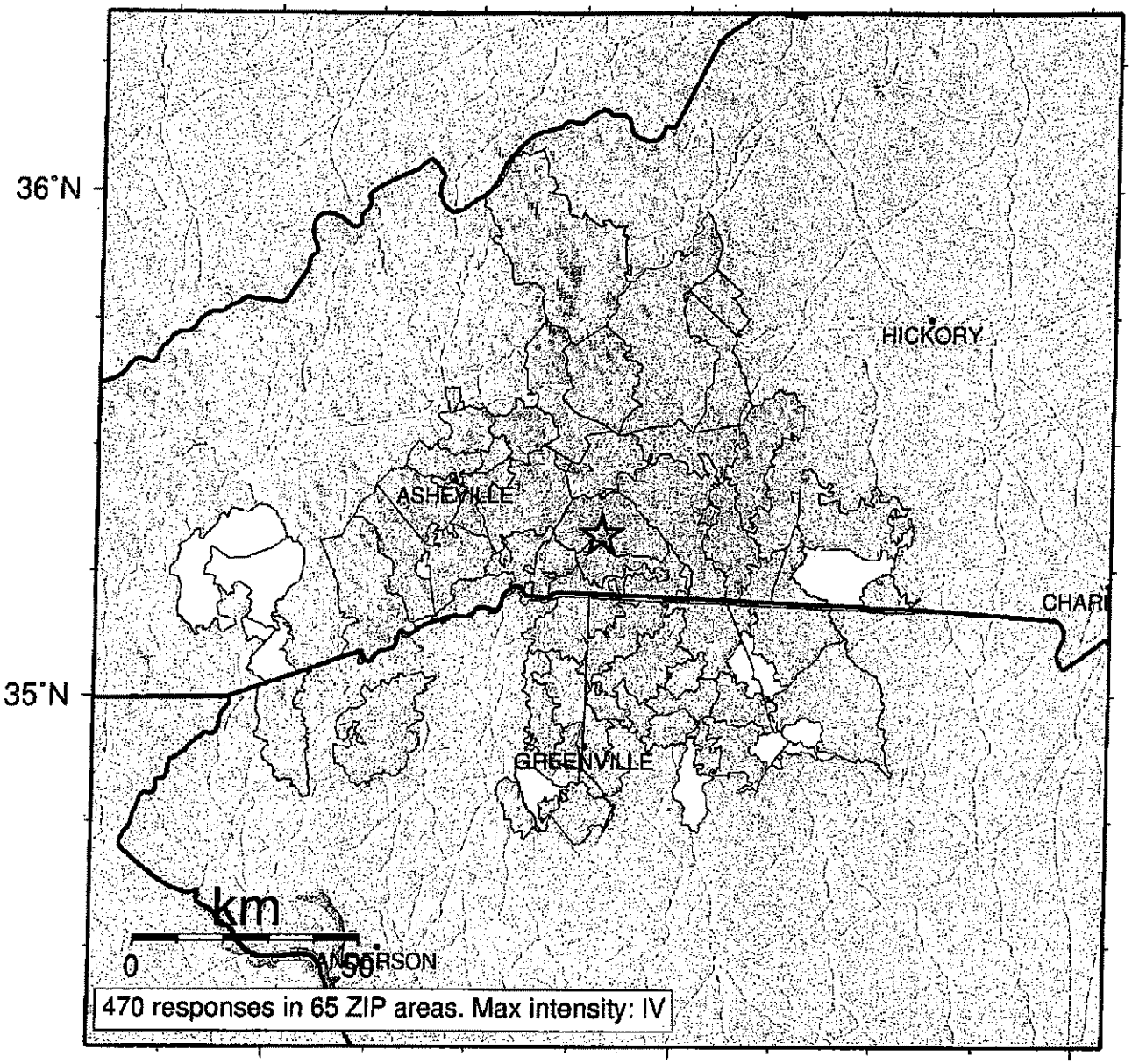


Photograph 4- Recommended Monitoring Location

Earthquake Data
(USGS)

USGS Community Internet Intensity Map (26 miles N of Greer, South Carolina)

ID:hwb1207a_07 06:07:03 EST DEC 7 2007 Mag=3.1 Latitude=N35.32 Longitude=W82.19



Map last updated on Fri Dec 7 19:31:31 2007

INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy

USGS science for a changing world

Earthquake Hazards Program

Magnitude 3.1 - NORTH CAROLINA

2007 December 07 11:07:03 UTC

Details Summary Maps Scientific & Technical Where can I find...?

Earthquake Details

Magnitude	**3.1**
Date-Time	**Friday, December 07, 2007 at 11:07:03 UTC** Friday, December 07, 2007 at 06:07:03 AM at epicenter Time of Earthquake in other Time Zones
Location	35.320°N, 82.190°W
Depth	8.1 km (5.0 miles)
Region	NORTH CAROLINA
Distances	8 km (5 miles) N (8°) from **Columbus, NC** 13 km (8 miles) NNE (20°) from **Tryon, NC** 14 km (9 miles) S (180°) from **Lake Lure, NC** 44 km (27 miles) SE (131°) from **Asheville, NC** 124 km (77 miles) W (276°) from **Charlotte, NC** 267 km (166 miles) NE (49°) from **Atlanta, GA**
Location Uncertainty	horizontal +/- 0.8 km (0.5 miles); depth +/- 0.9 km (0.6 miles)
Parameters	Nst= 22, Nph= 24, Dmin=8 km, Rmss=0.15 sec, Gp= 83°, M-type="Nuttli" surface wave magnitude (MLg), Version=D
Source	Southeast U.S. Seismic Network
Event ID	sehwb1207a

This event has been reviewed by a seismologist.

Did you feel it?

Report shaking and damage at your location. You can also view a map displaying accumulated data from your report and others.

Preliminary Earthquake Report
Southeast U.S. Seismic Network

U.S. Department of the Interior | U.S. Geological Survey
URL: http://earthquake.usgs.gov/eqcenter/recenteqsus/Quakes/sehwb1207a.php
Page Contact Information: Web Team
Page Last Modified: December 07, 2007 5:47:26 AM.

CONSULTING SERVICES AGREEMENT

THIS AGREEMENT is entered into effective as of December 28, 2007 by and between DEVINE TARBELL & ASSOCIATES, INC. ("DTA") and the Town of Lake Lure, NC ("Client").

ARTICLE 1 SCOPE

DTA shall perform the services (the "Services") described in the Scope of Work Section of the attached Appendix A.

ARTICLE 2 COMPENSATION

For performance of the Services, Client shall pay DTA the compensation specified in Appendix A, which is also attached hereto. This compensation shall be billed to Client at monthly intervals and shall be due and payable upon receipt of the bill. If for any reason Client fails to pay DTA in full within thirty (30) days from the date of a bill, Client shall pay DTA a late payment charge each month equal to one percent (1%) of any unpaid balance or the highest rate permitted by law, whichever is the lesser. If Client fails to pay DTA in full within sixty (60) days from receipt of a bill, DTA may suspend its performance of the Services until all outstanding bills have been paid in full by Client.

ARTICLE 3 REPRESENTATIVES

DTA will function in cooperation with and subject always to the direction and control of Client's authorized officers orignated representatives. DTA shall alsoignate a representative for the execution of the Services.

ARTICLE 4 RECORDS

For a period of one (1) year after completion of the Services, DTA will, if requested by Client, provide necessary supporting records for audit purposes.

ARTICLE 5 CONFIDENTIALITY

If either party discloses information which is clearly identified as proprietary or confidential in writing, the party receiving such information shall keep it in confidence and shall not furnish or otherwise disclose it to any third party during or after completion of the Services. Neither party shall be obligated to maintain the confidentiality of such information if:

(i) the information is independently developed by the receiving party without the utilization of the confidential or proprietary information;
(ii) the information is or becomes public knowledge without the fault of the receiving party;
(iii) the information is or becomes available to the receiving party from another source without any legal obligation to protect such information; or
(iv) the information is disclosed pursuant to a governmental or legal requirement.

ARTICLE 6 TERMINATION

Client may terminate this Agreement by giving ten (10) days' prior written notice to DTA, but such termination shall not relieve Client of its obligation to pay DTA for expenses incurred and Services performed up to the date of termination and all reasonable expenses which DTA incurs by reason of such termination.

ARTICLE 7 WARRANTY

DTA warrants that its services are performed, within the limits prescribed by client, with professional thoroughness and competence. There is no other warranty or representation, whether statutory, expressed or implied. The sole liability of DTA relating to defective services shall be limited to reperforming at DTA's expense any services performed by DTA which have failed to meet the above warranty, if such failure is promptly reported to DTA not later than 365 days following completion of the services. The foregoing remedy shall be client's sole remedy for any failure of DTA to comply with its warranty obligations.

ARTICLE 8 LIMITATION OF LIABILITY

DTA's total cumulative liability for claims of any kind whether based on contract, tort (including negligence and strict liability), under any warranty or otherwise, for any loss or damage relating to this agreement or the performance of the services, shall not exceed the compensation paid to DTA for the work, and client hereby releases DTA from any liability in excess of such amount. This monetary limitation shall survive the failure of any exclusive remedy.

DTA shall not be liable, whether based on contract, tort (including negligence and strict liability), under any warranty or otherwise relating to the services or this agreement, for any consequential, indirect, special, punitive or incidental loss or damage, any damage to or loss of any property or equipment, or any loss of use of property or equipment, and client hereby releases DTA from any liability for all such losses and damages.

All of the provisions of this agreement providing for limitation of or protection against liability of DTA shall also protect its directors, officers and employees, and affiliated entities of DTA and their directors, officers, employees, and affiliates, and shall apply regardless of the fault, negligence or strict liability of DTA, its directors, officers, employees, or affiliates.

Any cause of action or other claim relating to the services must be commenced within 365 days after completion (or termination) of the services.

The provisions of this article 8 shall apply notwithstanding any other provision of this agreement.

ARTICLE 9 INSURANCE

DTA shall provide and continue to maintain during the performance of this Agreement insurance coverage as follows:

Workers' Compensation insurance in compliance with statutory limits.	
Employers' liability with the following limits:	
Each Accident	$500,000
Each Person	$500,000
Policy Limit	$500,000
Umbrella Liability with the following limits:	
Each Occurrence and Aggregate	$5,000,000
Business Automobile Liability with the following limits:	
Combined Single Limit	$1,000,000
Commercial General Liability with the following limits:	
Each Occurrence	$1,000,000
General Aggregate	$2,000,000
Professional Liability Insurance with the following limits:	
Any One Claim	$2,000,000
Policy Aggregate	$2,000,000

ARTICLE 10 DELAYS

Neither party shall be considered in default in the performance of its obligations hereunder to the extent that the performance of any such obligation is prevented or delayed by any cause which is beyond the reasonable control of the affected party.

ARTICLE 11 MEDIATION

In an effort to resolve any conflicts that arise during the project or following the completion of the project, DTA and the Client agree that all disputes between them arising out of or relating to this Agreement shall be submitted to nonbinding mediation unless the parties mutually agree otherwise.

DTA and the Client further agree to include a similar mediation provision in all agreements with independent contractors and consultants retained for the project and to require all independent contractors and consultants also to

include a similar mediation provision in all agreements with subcontractors, subconsultants, suppliers or fabricators so retained, thereby providing for mediation as the primary method for dispute resolution between the parties to those agreements.

ARTICLE 12 NOTICES

Any notice related to this Agreement shall be in writing and shall be considered duly made if delivered to the other party at the following numbers and addresses:

DTA:	Devine Tarbell & Associates, Inc. 970 Baxter Boulevard Portland, Maine 04103	Client:	Town of Lake Lure, NC P. O. Box 255 Lake Lure, NC 28746
	ATTENTION: Edwin C. Luttrell		ATTENTION: H. M. "Chuck" Place, III
	Telephone: (704) 342-7377		Telephone: (828) 625-9983
	Telecopier: (704) 377-4185		Telecopier: (828) 625-8371

Either party may change its address or numbers for receiving notices by giving written notice of such change to the other party.

ARTICLE 13 SURVIVAL

The provisions of Articles 4, 5, 7, 8, 9, 11 and 13 of the Agreement shall survive the termination or cancellation of this Agreement and the completion of the Services performed hereunder and shall remain in effect.

ARTICLE 14 LAW

This Agreement shall be governed by and interpreted in accordance with the laws of the State of Maine, excluding its conflicts of law principles.

ARTICLE 15 INTEGRATION

These terms and conditions are intended by DTA and Client to constitute the final and complete statement of their agreement, and all prior proposals, communications and understandings relating to the subject matter of this Agreement are hereby superseded. No modification or amendment of this Agreement shall be effective unless the same is in writing and signed by both parties.

DEVINE TARBELL & ASSOCIATES, INC.	TOWN of LAKE LURE, NC
By: _____	By: _____
(typed) Edwin C. Luttrell	(typed) H. M. "Chuck" Place, III
Title: Vice President	Title: Town Manager

APPENDIX A
TO CONSULTING SERVICES AGREEMENT
BETWEEN
DEVINE TARBELL & ASSOCIATES, INC.
AND
TOWN of LAKE LURE, NC

I. Scope of Work

DTA shall perform the following Services for Client:

Complete an inspection of the Lake Lure Dam on December 21, 2007 Participate in a meeting with NCDENR – Land Quality Section staff to discuss the continued safety of the Lake Lure Dam following the December 7, 2007 earthquake event. Dr. Alex Grenoble, DTA dam safety Indpependent Consultant participated in the inspection and meeting. Observations from the inspection and meeting are noted in DTA's report documenting the post-earthquake inspections of December 7th and 8th.

The inspection and presence at the NCDENR meeting were requested by Ron Morgan, Lake Lure Fire and Emergency Management Coordinator following an observed increase in leakage at the monitoring point established following the earthquake.

II. Schedule

The visual inspection of the dam, the meeting with NCDENR staff and the written report are complete.

III. Information to be furnished by DTA

DTA shall provide the following information to Client in connection with the Services:

A written inspection report will be prepared and submitted. The report will document observations and findings from the visual inspection. Photographs and sketches will be included to assist in the documentation of observations and conclusions. Recommendations will be provided if it is determined that additional testing, evaluation or repairs are warranted.

Designated Representative is Edwin C. Luttrell

IV. Information to be furnished to DTA by Client

Client shall provide the following information to DTA in connection with the Services:

Any and all available drawing, previous inspection reports or other documentation useful to DTA's Inspector.

Designated Representative is H. M. "Chuck" Place, III

V. Compensation

Client shall pay DTA for the Services and all expenses as provided in the DTA Proposal for Independent Consultant Dam Safety Inspection dated September 1, 2006 and confirmed below:

Hourly Rates:

Independent Consultant	$158/hour
Staff Engineer	$130/hour
Administrative	$ 58/hour

The total charge shall not exceed $1,300.00 without written authorization from Client.

DAM SAFETY INSPECTION REPORT

NAME	COUNTY	NO.	INSPECTED BY	DATE
LAKE LURE	RUTH	003	CTK, JB	12/8/07

OWNER	ADDRESS	PHONE
TOWN OF LAKE LURE	POBOX 255 LAKE LURE, NC 28746	

TYPE DAM: ☐ Concrete gravity ☒ Concrete arch ☐ Other ☐ Embankment ☒ Concrete buttress ☐ Stone masonary

TYPE INSPECTION: ☐ Periodic ☐ Initial ☐ Followup ☐ Other

SITE CONDITIONS: ☒ Dry ☐ Wet ☐ Snowcover ☐ Other

HAZARD DESCRIPTION: 64/74

HAZARD CLASS: ☐ Intermediate (B) ☐ Low (A) ☒ High (C)

REMARKS: Emergency MGT called 12/7/07 6:00PM and reported INCREASE IN SEEPAGE AFTER EARTHQUAKE earlier in the day

ACTION: ☐ None ☐ Maintenance ☐ Monitoring ☐ Minor repair ☒ Engineering

RECOMMENDATIONS: ☐ Inspection letter ☐ Deficiency letter ☐ RE notice ☒ Engineering study ☐ Inspection by RE ☐ Inspection by DSE ☐ Dam safety order ☐ Enforcement ☐ Periodic reinspection ☐ Other reinspection

AREA	PROBLEMS	COMMENTS
UPSTREAM SLOPE / FACE	☐ 1.None ☐ 2.Trees ☐ 3.High bushes ☐ 4.Burrows ☐ 5.Wave erosion ☐ 6.Livestock damage ☐ 7.Slides ☐ 8.Depressions ☐ 9.Bulges ☐ 10.Sparse rip rap ☐ 11.Displaced rip rap ☐ 12.Cracks ☐ 13.Undermining ☐ 14.Holes ☐ 15.Spalling ☐ 16.Displaced joints ☐ 17.Deteriorated joints ☐ 18.Exposed reinforcement ☐ 19.Other	COVER: ☐ Vegetation ☐ Rip rap ☒ Concrete ☐ Asphalt ☐ Other UNable to MAKE INSpection of upstream surface
TOP OF DAM	☐ 1.None ☐ 2.Trees ☐ 3.High bushes ☐ 4.Burrows ☐ 5.Ruts ☐ 6.Livestock damage ☐ 7.Depressions ☐ 8.Unlevel ☐ 9.Misalignment ☐ 10.Has overtopped ☐ 11.Cracks ☐ 12.Spalling ☐ 13.Deteriorated joints ☐ 14.Displaced joints ☐ 15.Exposed reinforcement ☐ 16.Other	COVER: ☐ Vegetation ☐ Gravel ☒ Concrete ☐ Asphalt ☐ Other No visible misalignment IN the ROAD SURFACE AND WALLS were observed. There is some CRACKING & WEATHERING of the concrete surfaces.
DOWNSTREAM SLOPE / FACE	☐ 1.None ☐ 2.Trees ☐ 3.High bushes ☐ 4.Burrows ☐ 5.Erosion ☐ 6.Livestock damage ☐ 7.Slides ☐ 8.Depressions ☐ 9.Bulges ☒ 10.Wetness ☒ 11.Seepage ☐ 12.Boils ☐ 13.Cracks ☐ 14.Holes ☒ 15.Spalling ☐ 16.Displaced joints ☐ 17.Deteriorated joints ☒ 18.Exposed reinforcement ☐ 19.Other	COVER: ☐ Vegetation ☐ Rip rap ☐ Concrete ☐ Other CARETAKER STATED INCREASE IN SEEPAGE AT BAY #10 From the right Abutment. SEEPAGE IS IN horizontal construction joint. There is slight SEEPAGE & wetness IN ALL the bays AT the SAME elevation. Concrete spalling APPARENT IN most of the bays. AT BAY #7 behind the powerhouse SEEPAGE is lower on the dam & needs monitoring.
TOE CONTACT	☐ 1.None ☐ 2.Trees ☐ 3.High bushes ☐ 4.Burrows ☐ 5.Erosion ☐ 6.Livestock damage ☐ 7.Slides ☐ 8.Depressions ☐ 9.Bulges ☒ 10.Wetness ☒ 11.Seepage ☐ 12.Boils ☐ 13.Cracks ☐ 14.Holes ☐ 15.Spalling ☐ 16.Displaced joints ☐ 17.Deteriorated joints ☐ 18.Exposed reinforcement ☐ 19.Undermining ☐ 20.Other	COVER: ☐ Vegetation ☐ Rip rap ☒ Concrete ☒ Other BEDROCK SEEPAGE & wetness occuring IN all bays.

DAM INSPECTION

Name of Dam: LAKE LURE DAM RUTHE 003 County: RUTHERFORD

COMMENTS: CONTACTS ON SITE: ① ED LUTTRELL (DTA) DEVINE TARBELL ASSOC
704-400-4494
② RON MORGAN (ENG. MANAGEMENT GOV.)
3. ROGER Hollifield (UFD)

① INCREASE SEEPAGE AT THE #10 BAY } Short term
② Prepare Report
③ INSTALL monitoring, update EAP
④ Seismic study, } Long Term
⑤ Concrete repairs
⑥ Monitor seepage behind powerhouse
⑦ Provide better access to inspect bays on the left side of the Powerhouse

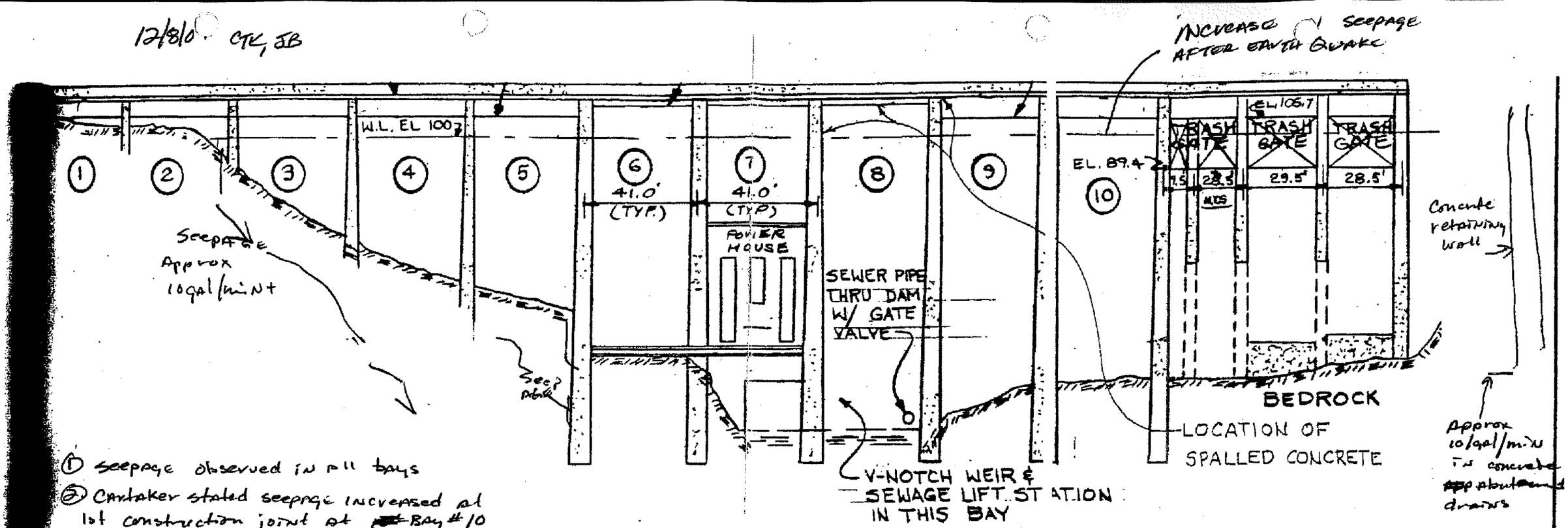
Date: 12/8/07 Inspected by: CTK, J.B.

INVENTORY UPDATE

Change in Ownership / / yes / / no Inventory No.: _____

OTHER: _____

12/8/10 CTK, JB



DOWNSTREAM ELEVATION

NOT TO SCALE

① Seepage observed in all bays

② Caretaker stated seepage increased at 1st construction joint at ~~Bay~~ Bay #10

③ Spalling & concrete deterioration occurring on all the concrete arches.

④ Abutments appear to be in good condition

⑤ NO vertical cracks observed in any of the bays

⑥ SEEPAGE behind powerhouse at bay #7 needs to be monitored.

N.C. DEPT. OF NAT. RES. & COMM. DEV.	
MAIN	LAKE LURE DAM RUTHERFORD COUNTY, N.C.
DOWNSTREAM ELEVATION	
DRAWN BY ICH	DATE 6-12-81
DWG NO. 1909-7-7	FIG. 2

GENE
FILE
RUTHE-003

TOWN OF LAKE LURE
Office of the Town Manager

Incorporated 1927

February 15, 2007

Janet Boyer, P.E.
Regional Engineer
Land Quality Section, NCDENR
2090 US Hwy 70
Swannanoa, NC 28778-7034

re: Lake Lure Dam - Rutherford County

Dear Janet:

Enclosed is the dam inspection report by Devine, Tarbell & Associates, Inc. performed at our request in response to your letter dated June 30, 2006. I am pleased to say that the inspector, Ed Luttrell, P.E., found no critical problems with our dam structure.

According to Mr. Luttrell, "The Lake Lure Dam was determined to be generally in good condition based on visual inspection and evaluation as discussed in this report. The dam is generally well maintained by the Town staff. No items were noted that would suggest the safety of the structure has been compromised, or that immediate actions to assure project safety are required. Some leakage, near surface concrete deterioration and cracking was observed but theses conditions do not appear to be substantially worse than conditions described in previous inspection reports (DE&S 1999)."

He also states that, "The emergency action plan (EAP) is appropriate given the consequences of a dam failure. The commitment to emergency preparedness by Town staff is commendable. The EAP should be kept updated with current communication information. It would be prudent to revise the inundation maps if development downstream has changed significantly since the maps were developed."

The report concludes with four recommendations regarding minor maintenance and record keeping and states that another inspection should be conducted in two years to check the condition of the facility and, if there is no further deterioration of the concrete surfaces, at five year intervals thereafter.

I trust this report meets your requirements. Rest assured, we will comply with Mr. Luttrell's recommendations. Please let me know if we need to do anything more.

Sincerely,

H. M. Place III
Town Manager

xc: Mayor and Town Council (info)
Ed Luttrell, P.E., DTA, Inc.
William Grimes, Director of Utilities
Mary Flack, Town Clerk
File - Utilities - Dam
S:\HYDRO\Dam inspection report - letter to NCDENR.wpd

Received
FEB 16 2007
Land Quality Section
Asheville

P. O. Box 255, Lake Lure, NC 28746 ❖ Phone 828-625-9983 Ext 101, Fax 828-625-8371