

**Recommended Structural and Environmental Guidelines for  
Tethered Habitable Structures on  
Grand Lake O' The Cherokees**

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## **1.0 Introduction**

Grand Lake O' The Cherokees was created in 1940 with completion of the Pensacola Dam. Grand Lake is a 46,500-acre multi-use reservoir in northeast Oklahoma and is managed by the Grand River Dam Authority (GRDA), a state agency established in 1935 as a conservation and reclamation district for the waters of the Grand River and its tributaries. Pensacola Dam and Grand Lake were originally justified as hydroelectric power generating facilities. Over the years, the beneficial uses have grown to include: i) Public and Private Water Supply, ii) Fish and Wildlife Propagation (Warm Water Aquatic Communities), iii) Recreation (Primary Body Contact) and iv) Class I Irrigation.

Grand Lake is one of the premier lakes in the central U.S. Midwest and is considered by many to be the crown jewel of the northeastern Oklahoma region. Its waters are ideal for boating, skiing, fishing, swimming and sailing. The lake lies in a southwest to northeast direction, which makes it particularly popular with sailboat enthusiasts wishing to take advantage of the prevailing wind. Grand Lake is consistently ranked among the top lakes for bass fishing in the region and is also a haven for migratory waterfowl and other wildlife. With 667 miles of shoreline meandering through the foothills of the Ozark Mountains, everything from lakeside communities to secluded coves and lakeside resorts can be found along its shore (Grand River Dam Authority, 2014)

The increased popularity of Grand Lake has resulted in increased boat traffic and a demand for docking facilities. Most of the permanent docking facilities are at least partially covered, usually with some type of metal roof structure. Prior to 2007, some slip owners constructed elevated housing facilities to entertain guests and/or retreat to during inclement weather. These "habitable structures" were constructed without notifying GRDA or the Federal Energy Regulatory Commission (FERC). The lack of structural design standards resulted in construction of a variety of different types of structures. Severe weather events, including high winds and winter ice storms, have resulted in structural damage to some of these docking facilities (e.g., KTUL, 2011). In 2007, GRDA placed a moratorium on new habitable structures. GRDA will not issue approvals for construction of new habitable structures until minimum structural design standards

are in place. Existing facilities may be required to meet the new minimum standards.

These habitable structures are frequently plumbed for water, which also means they generate wastewater that must be properly handled and disposed. Given their close proximity, these wastewater holding, conveyance, and disposal systems represent a possible water quality threat to Grand Lake if not designed, constructed and operated properly.

Because Grand Lake is a hydroelectric facility, it is regulated by FERC. After reviewing the Shoreline Management Plan submitted by GRDA, FERC specifically noted concerns about the increasing numbers and locations of habitable structures on Grand Lake. Concerns were raised about possible structural impacts to the habitable structures from wind, waves and ice. Finally, FERC noted that the metal building structures commonly used at these facilities may have adverse impacts on aesthetics.

Given this history, GRDA proposed a study regarding an evaluation of the environmental and structural integrity of habitable structures. The proposed objectives for this study were:

- a) Recommend minimum design standards to leak/spill proof wastewater holding, conveyance, and disposal systems for single/multiple habitable structures;
- b) Recommend minimum design standards for both covered boat docks and the elevated habitable structures within the covered docks;
- c) Develop guidelines for improving the aesthetic quality of these facilities.

The work tasks needed to achieve the stated objectives are as follows:

- a. Survey other lakes regarding design standards for wastewater facilities;
- b. Identify available wastewater treatment technologies for single/multiple habitable structures;
- c. Identify techniques for leak/spill proofing wastewater holding, conveyance, and disposal systems;
- d. Propose minimum design standards for leak/spill proofing wastewater holding, conveyance, and disposal systems;
- e. Survey other lakes regarding structural design standards for docking facilities;

- f. Identify structural requirements for both the covered boat docks and the elevated habitable structures within the covered docks;
- g. Propose minimum design standards for wastewater facilities and structural design; and
- h. Develop general guidelines for aesthetics based on existing information from other sources.

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## 2.0 Definitions

**"Certified installer"** means a person in the business of installing or constructing on-site sewage treatment systems who has been certified by the DEQ to inspect and approve his/her own installations.

**"Certified contractor"** means a person in the business of constructing floating residential structures who has been certified by GRDA and meets the following minimum standards: possesses a valid GRDA permit prior to commencing construction on any structure in Grand Lake; provides proof of commercial liability insurance of not less than \$1,000,000 with GRDA listed as additionally insured; provides proof of worker's compensation insurance and employer's liability insurance with limits of no less than \$500,000, and as provided by state law; passes an initial certification inspection and random inspections thereafter.

**"Dead loads"** consist of the weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating, and air-conditioning systems.

**"Engineer"** means a person who, by reason of special knowledge and use of the mathematical, physical, and engineering sciences and the principles and methods of engineering analysis and design, acquired by engineering education and engineering experience, is qualified, after meeting the requirements of Section 475.1 et seq. of the State of Oklahoma Statutes Regulating the Practice of Engineering and Land Surveying and the regulations issued by the State Board of Registration for Professional Engineers and Land Surveyors (the Board) pursuant thereto, to engage in the practice of engineering.

**"Floating habitable structure"** means a floating structure intended to be used as a temporary or permanent domicile by one or more persons and may contain all or part of the following: cooking, eating, living, and sanitary facilities. The definition includes a floating home, residence

or domicile.

**"Lift station"** means a short-term storage reservoir, containing an automatically controlled pump that pumps sewage to a higher elevation for treatment.

**"Live loads"** are those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load, or dead load.

**"Professional engineer"** means a person who has been duly licensed as a professional engineer as provided in Section 475.1 et seq. of the State of Oklahoma Statutes Regulating the Practice of Engineering and Land Surveying and the regulations issued by the Board pursuant thereto.

**"Sewage"** means wastewater that generally originates as human waste from certain activities including using toilet facilities, washing, bathing, preparing foods and washing laundry, excluding industrial wastewater.

### **3.0 Guidelines for Sanitary Facilities in Tethered Floating Habitable Structures on Grand Lake O' The Cherokees**

#### **Toilets**

All floating habitable structures shall have an incinerating or flushable toilet for human waste as long as black water is dumped into a sealed grinder pump. Toilets must meet all current DEQ regulations.

#### **Pump Tank/Lift Stations**

All floating habitable structures will have a sealed grinder pump tank/lift station system to collect all sewage generated within the habitable structure. The sealed grinder pump tank/lift station must meet the following criteria:

- 1) have minimum liquid storage capacity of thirty-five (35) gallons;
- 2) must be a sealed commercially manufactured tank installed and operated to prevent sewage from leaking out of the tank;
- 3) installed in a temperature controlled environment or winterized annually;
- 4) connected to a DEQ certified "on-land" septic tank wastewater treatment and disposal system or a municipal sewer system
- 5) installed by an Oklahoma Licensed Plumbing Contractor;
- 6) meet current DEQ regulations.

DEQ regulations regarding septic tank systems and certified installers can be found in: Title 252, Department of Environmental Quality, "Chapter 641. Individual and Small Public On-Site Sewage Treatment Systems" July, 2012 or at this link (<https://www.deq.ok.gov/wp-content/uploads/deqmainresources/641.pdf>)

#### **Pump Controls**

The pump controls shall be set as follows:

- 1) The following control settings apply to lift stations:
  - (a) Alarm. There shall be an alarm set to activate and alert the owner/operator if the pump tank fails.
- 2) meet all current DEQ regulations.

## **Wastewater Conveyance System**

The wastewater conveyance system must meet the following criteria:

- (1) A polyethelene pipe with a minimum diameter of 1 ¼" ASTM#D3035 All pipe sections must be fused together utilizing a fused transition fitting must contain a check valve above the pump
- (2) for vertical bluffs must have structural pipe support systems (e.g., hangers or posts) every 10 feet;
  - (a) intermediate supports shall be provided to polyethelene pipe runs to maintain shape and resist all imposed loads from internal fluids and external effects
- (3) any exposed polyethelene pipe shall be buried a minimum of 16" below the surface or be winterized annually;
- (4) installed by an Oklahoma Licensed Plumbing Contractor;
- (5) all current DEQ regulations.

## **Cleanouts**

For all pipe located upstream of a septic tank, a two-way cleanout or two-way cleanout assembly shall be installed:

- (1) within five feet (5') from the end of the discharge line from pump in a gravity flow system

Nothing in this paragraph shall require the installation of more than one (1) two-way cleanout or two-way cleanout assembly per one-hundred-foot (100') section of straight pipe. For purposes of this paragraph, straight pipe is pipe that does not have any change of direction of more than forty-five degrees. Cleanout assemblies must also:

- (2) be installed by an Oklahoma Licensed Plumbing Contractor;
- (3) meet all current DEQ regulations.

## **4.0 Structural and Aesthetic Guidelines for Tethered Floating Habitable Structures on Grand Lake O' The Cherokees**

### **Submittals**

All construction or modifications of floating habitable structures shall have the plans, drawings, and applications submitted to GRDA by a Certified Contractor. These plans and drawings shall be signed and sealed by a Professional Engineer licensed in the State of Oklahoma and experienced in the design of floating habitable structures.

### **Governing Design Codes**

The design, fabrication, erection, and construction of all structural components shall be in accordance with the following standards and specifications, latest editions:

- 1) Structural Steel: American Institute for Steel Construction (AISC) Specification for Structural Steel Buildings (AISC 360).
- 2) Cold-Formed Steel: American Iron and Steel Institute (AISI) North American Specification for the Design of Cold-Formed Steel Structural Members.
- 3) Concrete: American Concrete Institute (ACI) Building Code Requirements for Structural Concrete and Commentary (318).
- 4) Wood: National Design Specification (NDS) for Wood Construction.
- 5) Aluminum: Aluminum Association (AA) Specification for Aluminum Structures.

### **General Design Requirements**

All structures shall be designed for the dead, live, and environmental loads in accordance with all applicable building codes and the minimum requirements stated within this specification. In addition, the following general design requirements shall be satisfied:

- (1) Overall Stability: Flotation and anchorage for the structure shall ensure a minimum safety factor against overturning of 2.0 under the action of dead load, unsymmetrical live load, and environmental loading (wind and/or snow and ice).

- (2) Anchorage: The structure shall be securely fastened to the shoreline and lake bed in such a manner as to minimize any disturbance to the existing shoreline and inhibit significant shifting of position during storm events. Anchorage shall also adequately protect the structure and any moored watercraft from passing boat wakes.
- (3) Stabilizers or Underwater Braces: Stabilizers or underwater braces are recommended between boat dock fingers with the size determined based on the width between the dock fingers and the depth determined based on the draft of the watercraft to be stored in the boat dock.
- (4) Flotation: Flotation shall be provided under all areas of the substructure covering 25 square feet or greater of water surface and shall be sufficient to support the minimum design loads and dead load of the structure.
- (5) Minimum Freeboard: Under dead load, the distance from the top of the water to the bottom of the structural frame shall be a minimum of 12 in. Under dead load, live load, and environmental load, the distance from the top of the water to the bottom of the structural frame shall be a minimum of 6 in.
- (6) Approach Bridges and Walkways: Connection of the approach bridges and walkways to the floating structure and shoreline shall accommodate all necessary vertical and horizontal movement due to changes in the lake water level and the effects of wind loads and wave action.

### **Minimum Design Loads**

All structures shall be designed for the dead, live, and environmental loads in accordance with all applicable building codes as well as the following minimum requirements:

- (1) Dead Loads: The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such

as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating, and air-conditioning systems.

(2) Live Loads:

- a. Decks, floors, approach bridges, and walkways: A uniformly distributed load of 50 pounds per square foot (psf) or a single concentrated load of 400 pounds on any 2 square foot (sq. ft.) area. These two loads need not occur simultaneously.
- b. Roof: A uniformly distributed load of 20 psf unless the roof is used as a deck, in which case the loads shall be as indicated in (2)a above.

(3) Wind Loads:

- a. A uniformly distributed load of 20 psf acting from any horizontal direction on the projected area of the structure including any potential docked watercraft.
- b. In lieu of the above minimum loading, the engineer may perform a detailed wind load analysis in accordance with ASCE 7: Minimum Design Loads for Buildings and Other Structures, latest edition.

(4) Snow/Ice Loads:

- a. Uniformly distributed load of 15 psf on all exposed surfaces (i.e., roof, deck, walkways, etc.), which need not be taken simultaneously with the minimum roof live load.
- b. Drifting and unbalanced snow loads shall be based on provisions within ASCE 7: Minimum Design Loads for Buildings and Other Structures, latest edition.

(5) Wave Loading: Floating structures shall be designed to endure the wave action of their proposed location and, at a minimum, be able to withstand a minimum of one-foot-high wave action. A specific site may warrant a larger wave loading as determined by a licensed professional engineer.

(6) Railings: All handrail and guardrail systems shall be designed to resist the following loads:

- a. A single concentrated load of 200 lb. applied in any direction at any point on the handrail or top rail to produce the maximum load effect on the element being considered and to transfer this load through the supports to the structure.
- b. A distributed load of 50 lb./ft. applied in any direction along the handrail or top rail. This load need not be assumed to act concurrently with the single concentrated load specified in (6)a.

### **Materials and Aesthetics**

All construction materials shall meet the following minimum requirements:

- (1) Roof Construction: All roofs shall be gabled or mono-sloped and constructed with steel or aluminum panels that are either plated, galvanized, powder coated, or painted to provide adequate corrosion resistance. All roof framing shall be of 1-1/4 in. or greater ID standard pipe, structural steel, or structural aluminum tubing and spaced not more than 2 ft.-0 in. center-to-center. Purlins shall be not less than 1 in. ID standard pipe, structural steel, or structural aluminum tubing and spaced not more than 2 ft.-0 in. center-to-center.
- (2) Wall Construction: All exterior walls shall be constructed with steel or aluminum panels that are either plated, galvanized, powder coated, or painted to provide adequate corrosion resistance. All wall framing shall be of 1-1/4 in. or greater ID standard pipe, structural steel, or structural aluminum tubing and spaced not more than 2 ft.-0 in. center-to-center.
- (3) Floor and Deck Construction: All flooring or decking shall be constructed with wood, metal, or concrete, but for wood decking, minimum requirements consist of 1 in. nominal rough, 2 in. x 6 in. S4S, or 3/4 in. marine plywood, with all wood material located above the waterline and treated with a preservative.
- (4) Framing: Materials shall be not less than 2 in. ID standard pipe, structural steel, or structural aluminum tubing.
- (5) Flotation Construction: All flotation shall be extruded polystyrene, polyethylene, or expanded polystyrene encased within a protective covering that is warranted by

the manufacturer for eight (8) years or more against cracking, peeling, sloughing, and deterioration from ultraviolet rays. Flotation material shall have a water absorption of less than 3.0 pcf at 7 days when tested by “The Hunt Absorption Test.” The flotation must also retain its resiliency against ice and bumps by watercraft. Flotation shall be positively attached to the supporting structure with minimum 3/8 in. diameter plated bolts, 0.120 in. thick fender washers, and lock nuts and in a manner to allow ease of replacement if necessary.

- (6) Metal Deck: Steel or aluminum metal floor decking shall be minimum 22 gauge, 2 in. deep sections that are either plated, galvanized, powder coated, or painted to provide adequate corrosion resistance. Steel or aluminum metal roof decking shall be minimum 22 gauge, 7/8 in. deep sections that are either plated, galvanized, powder coated, or painted to provide adequate corrosion resistance.
- (7) Structural Steel Coatings: All structural steel members shall be stainless steel, galvanized, or have a patented enamel and/or anodized aluminum finish.
- (8) The use of alternative construction materials (ie, plywood decking, asphalt shingles, etc) associated with roof and wall construction, an Oklahoma Licensed Engineer must certify the structural integrity of alternative materials and will meet the minimum design loads outlined in section 4.0 above.

## References

Grand River Dam Authority, Web, 2014. <<http://www.grda.com/lake-management/grand-lake-o-the-cherokees/>>.

<http://www.ktul.com/story/14694189/possible-tornado-causes-damage-at-grand-lake>, *Posted: May 22, 2011 7:57 PM CDT*