

Geomembrane Floating Covers and Liners

for Potable-Water Reservoirs

M25

Fourth Edition



American Water Works
Association



Documents

Document Sharing Hub

Geomembrane Floating Covers and Liners for Potable Water Reservoirs

Fourth Edition



**American Water Works
Association**

Manual of Water Supply Practices—M25, Fourth Edition

Geomembrane Floating Covers and Liners for Potable Water Reservoirs

Copyright © 2023 American Water Works Association

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including scanning, recording, or any information or retrieval system. Reproduction and commercial use of this material is prohibited, except with written permission from the publisher.

Disclaimer

The authors, contributors, editors, and publisher do not assume responsibility for the validity of the content or any consequences of their use. In no event will AWWA be liable for direct, indirect, special, incidental, or consequential damages arising out of the use of information presented in this book. In particular, AWWA will not be responsible for any costs, including, but not limited to, those incurred as a result of lost revenue. In no event shall AWWA's liability exceed the amount paid for the purchase of this book.

Senior Editorial Manager – Book Products: Melissa Valentine
Senior Manuals Specialist: Molly Beach
Manager – Publishing Operations: Gillian Wink
Copyright and Permissions Manager: Peggy Tyler
Technical Editor: Dianne Beirne
Cover Composition: Michael Labruyere
Production: Innodata

Library of Congress Cataloging-in-Publication Data

Names: American Water Works Association.

Title: M25 - geomembrane floating covers and liners for potable water reservoirs / by American Water Works Association.

Other titles: Flexible-membrane covers and linings for potable water reservoirs | Geomembrane floating covers and liners for potable water reservoirs

Description: Fourth edition. | Denver, CO : American Water Works Association, [2023] | Revised edition of: Flexible-membrane covers and linings for potable water reservoirs, 3rd ed. Denver, CO : American Water Works Association, [2000]. | Includes bibliographical references and index. | Summary: "This manual is a technical reference guide for designing, installing, operating, and maintaining geomembrane liners and floating covers for potable water storage reservoirs"-- Provided by publisher.

Identifiers: LCCN 2023032037 (print) | LCCN 2023032038 (ebook) | ISBN 9781647171438 (paperback) | ISBN 9781613006740 (adobe pdf)

Subjects: LCSH: Reservoirs--Linings--Handbooks, manuals, etc. | Membranes (Technology)--Handbooks, manuals, etc.

Classification: LCC TD395 .F59 2023 (print) | LCC TD395 (ebook) | DDC 628.1--dc23/eng/20230821

LC record available at <https://lcn.loc.gov/2023032037>

LC ebook record available at <https://lcn.loc.gov/2023032038>

Printed in the United States of America

ISBN 978-1-64717-143-8

eISBN 978-1-61300-674-0



All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including scanning, recording, or any information or retrieval system. Reproduction and commercial use of this material is prohibited, except with written permission from the publisher. Please send any requests or questions to permissions@awwa.org.



**American Water Works
Association**

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235-3098
303.794.7711
awwa.org

Contents

List of Figures, v

Acknowledgments, vii

Chapter 1	Introduction	1
	Purpose and Scope, 1	
	Description of Facilities, 1	
	Advantages and Disadvantages, 2	
	Permeation, 2	
	Definitions, 3	
	Survey of Existing Facilities, 6	
Chapter 2	Design and Installation of Geomembrane Floating Covers	7
	Floating Cover Design, 7	
	Floating Cover Installation, 23	
Chapter 3	Operation, Inspection, and Maintenance Guidelines for Geomembrane Floating Covers	27
	General, 27	
	Operation, 28	
	Inspection, 30	
	Maintenance, 32	
Chapter 4	Design and Installation of Geomembrane Liners	35
	Liner Design, 35	
	Liner Installation, 43	
Chapter 5	Operation, Inspection, and Maintenance Guidelines for Geomembrane Liners	47
	General, 47	
	Operation, 47	
	Inspection, 49	
	Maintenance, 50	

Bibliography, 53

Index, 55

List of AWWA Manuals, 59

This page intentionally blank.

Figures



- 1-1 Cross sections of a typical weighted-sump floating-cover system, shown full and empty, 4
- 1-2 Mechanically tensioned floating cover, 6
- 2-1 Floating cover and geomembrane liner installed in 1998 on 525-mil-gal potable water reservoir in Monterey Park, Calif., 8
- 2-2 Floating cover and geomembrane liner installed in 2017 on 360-mil-gal potable water reservoir in Rolling Hills Estates, Calif., 8
- 2-3 Floating cover and geomembrane liner installed in 2001 on 275-mil-gal potable water reservoir in Mission Viejo, Calif., 9
- 2-4 Floating cover installed in 2014 on 83-mil-gal potable water reservoir in Eagle Rock, Calif., 9
- 2-5 Floating cover installed in 2004 on 30-mil-gal potable water reservoir in Reno, Nev., 10
- 2-6 Floating cover installed in 2019 on 139-mil-gal potable water reservoir (Upper Stone Canyon Reservoir) in Los Angeles, Calif., 10
- 2-7 Floating cover installed on 67-mil-gal potable water reservoir (Lower Franklin Canyon Reservoir) in Los Angeles, Calif., 11
- 2-8 Floating cover access hatch, 15
- 2-9 Floating cover air vent, 15
- 2-10 Floating cover vacuum vent, 16
- 2-11 Floating cover rainwater collection trough, 17
- 2-12 Floating cover inverted tee rainwater removal system, 17
- 2-13 Floating cover perforated can rainwater removal system, 18
- 2-14 Floating cover inflation for inspection (reservoir empty), 19
- 2-15 Wedge welder seaming, 24
- 2-16 Hot air welder seaming, 25
- 2-17 Hot air hand seaming, 25
- 3-1 Floating cover cleaning, 32

This page intentionally blank.

Acknowledgments



This manual was prepared by the AWWA Standards Committee on Geomembrane Floating Covers and Geomembrane Liners for Potable Water Storage. The membership of the committee at the time it approved this manual was:

Douglas A. Hilts, *Chair*

General Interest Members

D.H. Gerber, Gerber Consulting, Carmel, Calif.
P.F. Greiner, NSF International, Ann Arbor, Mich.
D.A. Hilts, Hilts Consulting Group Inc., Yorba Linda, Calif.
D. Mason (*liaison, nonvoting*), Standards Council Liaison, O&M Enterprises, Holden, Mo.
C.W. Neal II, Broken Arrow, Okla.
P.J. Olson (*liaison, nonvoting*), Standards Engineer Liaison, AWWA, Denver, Colo.
I.D. Peggs, I-Corp International Inc., Lake Worth, Fla.
W.A. Way, Consulting Engineer, Johnstown, Colo.

Producer Members

S. Falk, Conterra, Inc., El Cajon, Calif.
D.J. McCullough, Colorado Lining International Inc., Mission Viejo, Calif.
W.D. Shehane, Seaman Corporation, Wooster, Ohio
C. Taylor, Carlisle SynTec Inc., White Salmon, Wash.

User Members

T.P. Campbell, Metropolitan Water District of Southern California, Los Angeles, Calif.
D.G. Miller, Manchester Water Works, Manchester, N.H.
J.T. Otoshi, Los Angeles Water & Power, Los Angeles, Calif.

This page intentionally blank.

Chapter **1**

Introduction

PURPOSE AND SCOPE

This manual is intended to serve as a technical reference guide for designing, installing, operating, and maintaining geomembrane liners and floating covers for potable water storage reservoirs. Source information was gathered by reviewing and collecting the experience of designers, manufacturers, and owners of geomembrane products available to the water industry.

This manual is not intended to be a design handbook or the equivalent of an AWWA standard. Rather, it should serve as a technical reference document to be used in conjunction with ANSI/AWWA D130, Geomembrane Materials for Potable Water Applications. The purpose of this manual is to recommend minimum design criteria and minimum operations and maintenance procedures for potable water reservoir floating covers and liners. Site-specific conditions should be evaluated by a qualified professional engineer and the recommendations adjusted accordingly to provide a comparable performance level.

Information in this manual may not apply to all types of installations or materials. In applying specific recommendations, the user must assume responsibility for accommodating a specific set of conditions.

DESCRIPTION OF FACILITIES

Geomembrane liners and floating covers can be incorporated into many types of water-storage facilities, both new construction and rehabilitated structures. Some examples of facilities include:

- **An earthen reservoir for storage of untreated or raw water.** A geomembrane liner used in this type of installation is normally intended to minimize water losses due to seepage and prevent the introduction of any contaminants that may exist

in the underlying soil. In arid regions, a geomembrane floating cover might be installed to reduce water loss due to evaporation as well.

- **An earthen reservoir for storage of potable water.** Such a facility might be located at a water treatment plant or within a distribution system. Normally, the structure would incorporate both a liner and a floating cover to reduce water losses and to protect the treated water from contamination.
- **A storage facility that has developed an excessive leakage condition.** This type of structure might be constructed of steel, concrete, or another material, or it might be asphalt-lined. Normally, a geomembrane liner would be installed without a floating cover to reduce leakage and protect the stored water from outside contamination.
- **An uncovered storage facility requiring protection from contamination.** A geomembrane floating cover can quite often be used to meet these requirements. Many large, open reservoirs have been covered in this manner.

ADVANTAGES AND DISADVANTAGES

The principal advantages of geomembrane liners and floating covers are:

- prevention of airborne and groundwater contamination,
- prevention of evaporation and seepage losses,
- reduction of algal growth,
- reduction of disinfection chemical demand,
- low capital cost, and
- superior seismic performance compared to more traditional structural applications.

The principal disadvantages of geomembrane liners and floating covers are:

- susceptibility to damage by ice action and vandalism,
- floating covers having shorter life expectancy than rigid covers, and
- the need for regularly scheduled maintenance to inspect the geomembrane material and system integrity, remove surface water and debris, and make repairs.

PERMEATION

Selection of materials is critical for water-storage facilities and distribution piping in locations where the reservoir materials and/or pipe will likely be exposed to significant concentrations of pollutants composed of low-molecular-weight petroleum products or organic solvents and their vapors. Research has documented a potential for such compounds to permeate through plastic pipe materials such as polyethylene, polybutylene, polyvinyl chloride (PVC), and asbestos cement and through elastomers such as those used in jointing gaskets and packing glands. If a reservoir must be located in, or a water pipe must pass through, an area subject to such contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, reservoir geomembranes, and similar appurtenances before selecting materials for use in that area.

DEFINITIONS

For the purpose of this manual, definitions are provided as follows. For additional definitions, the reader may reference ASTM D4439, Standard Terminology for Geosynthetics.

Access features: Access hatches/pathways and/or perimeter access vaults incorporated into a floating cover to allow access by personnel under the floating cover while it is floating or inflated.

Air vents: Air vents are provided to release entrained air that enters the reservoir with the water and subsequently accumulates beneath the floating cover. Air vents are also used to prevent formation of vacuum in areas where water exits the reservoir (e.g., outlets, overflow drains). Air vents can have a negative effect on wind resistance of floating covers, so their use should be minimized. Air vents are used on geomembrane liners to prevent uplift due to gas accumulation or air pushed ahead of rising groundwater levels.

Appurtenances: Ancillary items that are installed on or under the geomembrane liner or floating cover to permit their proper operation or function.

Bridging: Unsupported geomembrane material spanning between areas of support.

Closed-cell float: (See Floats)

Coating: A film built up through successive applications of an appropriate dispersion or solution system to achieve a specific dry-film thickness. Generally, coatings are applied to steel tanks for the purpose of protecting the steel against corrosion.

Contractor: The party under contract with the owner to furnish a completed geomembrane floating cover or liner.

Cut-and-fill reservoir: A water-holding facility constructed by excavating a central portion and, normally, forming the excavated earth as fill material into an embankment that increases the capacity of the reservoir while avoiding costs of disposal for the excavated material.

Earthen reservoir: (See Cut-and-fill reservoir)

Engineer: The party responsible for the technical design and preparation of design drawings and technical specifications for the geomembrane liner and/or floating cover.

Fabricator: The party that joins rollstock strips of geomembrane material into large panels in a fabrication plant for delivery to the jobsite for installation. The fabricator may also shop fabricate liner and/or floating cover accessory components.

Flexible baffles: Vertical curtains of geomembrane material, usually the same material as the geomembrane floating cover, typically extending from the water surface to the reservoir floor. Flexible baffles may be attached to the reservoir floating cover; rigid cover when present; or structurally supported by some other independent system. Flexible baffles direct the flow of water throughout the area of the reservoir to lengthen the contact/residence time of disinfected water.

Floating cell: An area of floating cover bounded by surface water collection troughs.

Floating cover: A continuous, flexible, tensioned, impervious, and weather-resistant geomembrane material that floats on the surface of a water reservoir to function as a floating cover system (see Figure 1-1). Air-supported floating cover systems, bladder tanks, and nontensioned floating covers are not discussed in this manual. (Nontensioned floating covers are no longer considered state-of-the-art technology.)

Floats: Closed-cell, semi-rigid foam members, usually encased in the same type of geomembrane material as the floating cover and permanently joined to it. Floats are usually required for stabilization, to facilitate surface water removal, to frame access and other hatches, and to provide buoyancy.

Geomembrane: Any of several continuous, flexible, and impermeable geomembranes, usually ranging in thickness between 0.036 in. (0.91 mm) and 0.060 in. (1.52 mm), which may be fabricated into large panels for final assembly in the field.

The geomembrane may be nonreinforced or scrim-reinforced, depending on the physical requirements of the application. Three types of geomembrane materials are generally used: plastic (thermoplastic); cured elastomer; and uncured elastomer (thermoplastic elastomer).

Geomembrane floating cover: (See Floating cover)

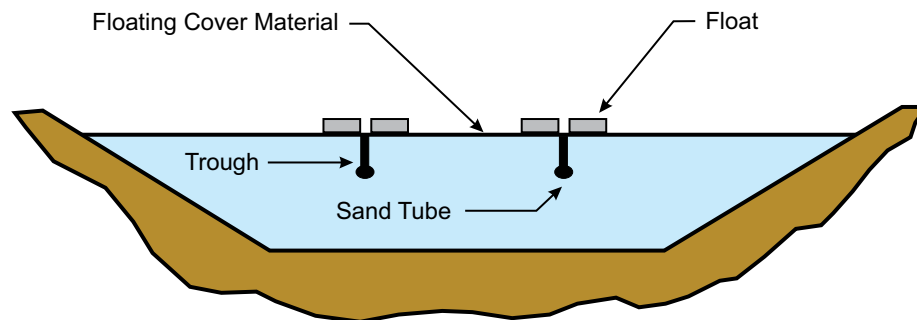
Geomembrane manufacturer: The party that produces a flexible geomembrane rollstock material, which is used to create geomembrane panels and other liner and/or floating cover accessories.

Geotextile: A permeable synthetic fabric, typically nonwoven, used in reservoirs to protect a geomembrane liner from damage due to rough or uneven surfaces.

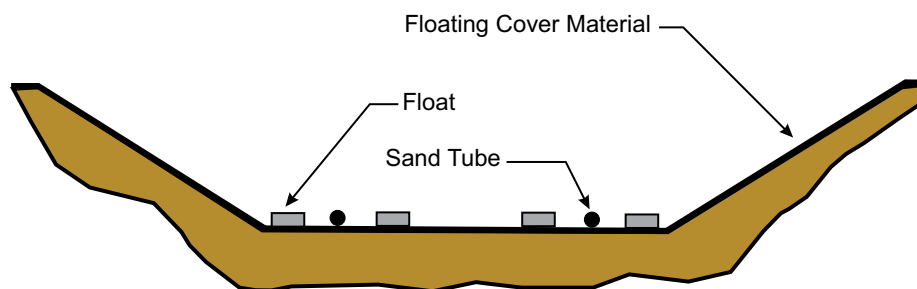
Grillage: A framework installed under the floating cover to protect the floating cover under certain reservoir operating conditions. Grillage is commonly a three-dimensional framework installed over structures or openings in the reservoir floor or slopes that the floating cover must be supported on in dewatered or low operating conditions.

High operating level (HOL): The maximum water surface elevation at which the reservoir is commonly operated.

Inflation features: Specific design features that allow a floating cover to be conveniently, safely, and temporarily inflated and accessed for reservoir inspection, cleaning, and maintenance. Inflation should be performed when the reservoir is empty.



(a) Schematic of weight-tensioned floating cover with full reservoir (not to scale)



Source: Metropolitan Water District of Southern California

(b) Schematic of weight-tensioned floating cover with empty reservoir (not to scale)

Figure 1-1 Cross sections of a typical weighted-sump floating-cover system, shown full and empty

Inspector: The party responsible for performing inspection tasks associated with the manufacturing, shop fabrication, and/or field installation of a geomembrane liner and/or floating cover.

Installer (installation contractor): The party that installs the geomembrane liner and/or floating cover in the field.

Liner: A reservoir component designed to prevent leakage of water or infiltration of contaminants into the contained water. This component may be of geomembrane material, steel, reinforced concrete, asphalt, compacted earth, or a combination of these materials. Some designs integrate geomembrane liner functions with the structural members of the reservoir, such as concrete walls and slabs, or asphalt liners.

Low operating level (LOL): The minimum water surface elevation at which the reservoir is commonly operated.

Normal operating level (NOL): The water surface elevation or range at which the reservoir is operated under normal conditions.

Owner: The party contracting for the installation of the floating cover or liner and also responsible for the ongoing operation and maintenance of the reservoir, liner, and floating cover.

Panel: The product of the assembly of two or more rollstock strips of flexible-geomembrane material cut and assembled by the fabricator using factory-seaming techniques to form a portion of a geomembrane liner or floating cover ready for field assembly by the installer.

Project documents: Project specifications and project drawings prepared by a licensed professional engineer and tailored to describe unique project-specific requirements. Project specifications typically include text and technical drawings.

Purchaser: The party that purchases any materials or work to be performed.

Reinforcement: (*See Scrim*)

Repair float: A float, unattached to the cover, used to temporarily elevate a portion of floating cover geomembrane material above the water surface to make repairs.

Reservoir: A pond, lake, basin, or other water impoundment facility, either naturally formed or man-made, which is used for storage, regulation, and control of water. (*See also Tank*)

Rollstock: Rolls of flexible geomembrane material, as produced by the manufacturer, usually in widths of 5–15 ft.

Scrim: Reinforcing material or fabric encapsulated within the flexible geomembrane rollstock material.

Scrim edge: The edge of the reinforcing material encased in a geomembrane.

Substrate: The soil, concrete, asphalt, or other surface that is below and supports the geomembrane liner.

Sump: (*See Surface water collection trough*)

Supplier: (*See Fabricator; Geomembrane manufacturer*)

Surface water collection trough: A portion of a weight-tensioned floating cover where reservoir geometry determines placement of excess material that distributes itself automatically and uniformly into a fold or sump configuration that collects and conveys surface water to the surface water removal system.

Surface water removal system: A series of components that is responsible for the removal of surface water from on top of the floating cover. The surface water removal system typically consists of pumps or gravity drains.

Tank: A reservoir created in whole by constructing an engineered structure in which water or other liquids are stored. Ponds and lakes, naturally or artificially constructed, are not classified as tanks (*see also Reservoir*). Several general construction materials are: steel, reinforced concrete, prestressed concrete, wood, fiberglass-reinforced plastic, and combinations of these materials.



Source: Courtesy of Layfield USA

Figure 1-2 Mechanically tensioned floating cover

Tensioning features: Floating covers are often fitted with flexible weights or other devices for maintaining floating cover tension. These features impart a discrete, low-level tension to the floating cover geomembrane that stabilizes the floating cover system and provides for improved surface water runoff and personnel access (Figure 1-2).

SURVEY OF EXISTING FACILITIES

Surveys of existing storage facilities were conducted in 1979 and 1994 to develop technical information and performance records of various types of geomembrane materials and designs. A questionnaire was developed and sent to known owners of tanks and reservoirs using geomembrane liners or floating covers. Results of the survey were incorporated into the content of this manual. Additional background information is available in published periodicals and technical journals. A limited bibliography is provided at the end of this manual.

Chapter **2**

Design and Installation of Geomembrane Floating Covers

FLOATING COVER DESIGN

The water industry began using floating covers made of butyl rubber or ethylene propylene diene monomer (EPDM) synthetic rubber (and less commonly polyvinyl chloride [PVC]) during the mid-1960s. Since then, improvements in design, materials, and operating procedures have resulted in hundreds of successful floating cover installations throughout the world. Most of these installations are in the United States and Canada, and most have been constructed using reinforced geomembranes. Each geomembrane material has unique physical characteristics and requires special methods of construction and repair. These characteristics should be thoroughly evaluated before the geomembrane product is specified. Figures 2-1 through 2-7 illustrate several installations.

There are two basic types of floating covers: weight-tensioned and mechanically tensioned.

- Weight-tensioned floating covers are created with a series of weights and floats strategically located on the top of the floating cover. The weights serve to keep the floating cover material taut and take up excess material as the floating cover rises with the water surface. The fold or trough created by the weights serves as the surface water collection trough, which conveys surface water to the surface water removal system. The surface water removal system is located within the surface water collection troughs.



Source: Metropolitan Water District of Southern California

Figure 2-1 Floating cover and geomembrane liner installed in 1998 on 525-mil-gal potable water reservoir in Monterey Park, Calif.



Source: Metropolitan Water District of Southern California

Figure 2-2 Floating cover and geomembrane liner installed in 2017 on 360-mil-gal potable water reservoir in Rolling Hills Estates, Calif.



Source: Hilts Consulting Group

Figure 2-3 Floating cover and geomembrane liner installed in 2001 on 275-mil-gal potable water reservoir in Mission Viejo, Calif.



Source: Los Angeles Department of Water and Power

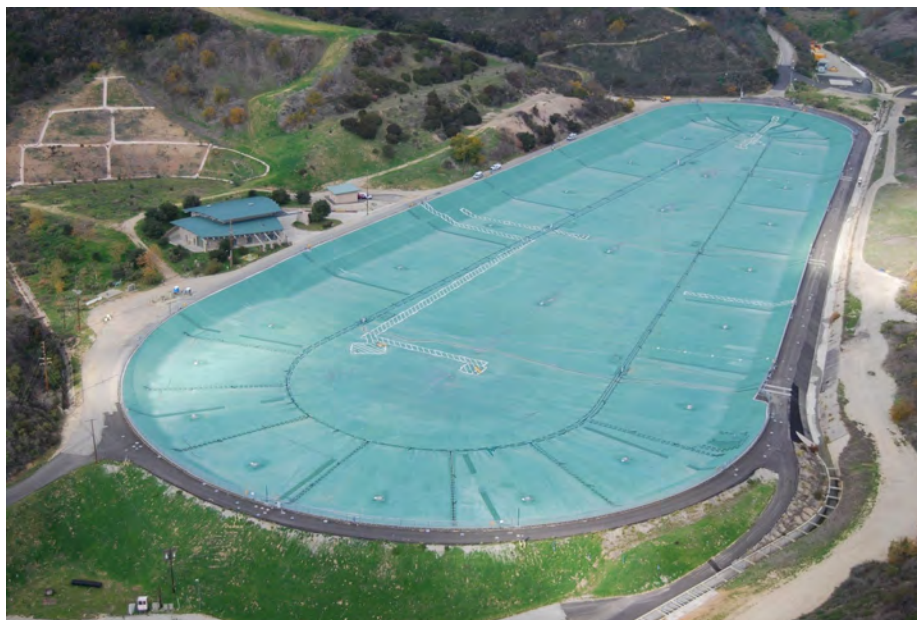
Figure 2-4 Floating cover installed in 2014 on 83-mil-gal potable water reservoir in Eagle Rock, Calif.

- Mechanically tensioned floating covers are created with a series of tower weights or tensioning springs located at the top of the slope around the reservoir perimeter. The tower weights or springs impart tension into the floating cover material to keep the floating cover taut. The excess material created as the floating cover rises is taken up by forming a fold at the top of the slope. The surface water removal system is located in the center portion of the floating cover. Some floating cover designs may be patented, requiring appropriate licenses.



Source: Hilt Consulting Group

Figure 2-5 Floating cover installed in 2004 on 30-mil-gal potable water reservoir in Reno, Nev.



Source: Los Angeles Department of Water and Power

Figure 2-6 Floating cover installed in 2019 on 139-mil-gal potable water reservoir (Upper Stone Canyon Reservoir) in Los Angeles, Calif.

General Areas of Concern

The areas of concern that an owner must recognize are described in the following paragraphs.

Engineer qualifications. The drawings and specifications for a floating cover system should be prepared by a licensed engineer having specialized knowledge and experience in the design and operation of geomembrane floating cover systems.



Source: Los Angeles Department of Water and Power

Figure 2-7 Floating cover installed on 67-mil-gal potable water reservoir (Lower Franklin Canyon Reservoir) in Los Angeles, Calif.

Design drawings should include:

- floating cover surface area,
- overflow elevation,
- high operating level,
- normal operating range,
- low operating level,
- reservoir capacity,
- inlet and outlet flow capacities,
- floating cover material (type, thickness, color, reinforcing, etc.),
- seaming procedures,
- float layout,
- surface water removal system,
- hatches,
- air vents,
- perimeter attachment,
- penetrations, and
- other miscellaneous support material(s).

Design calculations should, at a minimum, address floating cover tension, entire floating cover buoyancy, hatch buoyancy, air vent buoyancy, and surface water removal systems.

Economic consideration (budget limitation). Floating covers compare favorably with other reservoir-covering alternatives in economic analysis based on initial construction cost. However, a life-cycle total cost comparison should consider expenses for periodic

replacement and regularly scheduled maintenance, inspection, and repair over a time period consistent with the design life assumptions.

Operations and maintenance methods and equipment. Once a floating cover system is installed, access for maintenance and inspection to the interior of the reservoir must involve special precautions to keep the floating cover supported off the floor while workers are inside. Otherwise, provisions must be made for maintenance and inspection entry through floating cover access hatches while the reservoir is full.

Jurisdictional and regulatory agency requirements for types of floating cover materials. The floating cover material, chemical fusion agents, adhesives, and similar items should be suitable for contact with potable water. Materials should not contain any ingredients that, when dissolved in water, would exceed applicable water quality standards or add objectionable tastes or odors. Floating cover system materials should be checked to verify that they are approved by appropriate regulatory agencies and meet the requirements of ANSI/AWWA D130.

Degree of reliability desired. If the reservoir is a critical component of the water system, extensive out-of-service time for repairs and maintenance may not be acceptable. In such a case, a floating cover material with a proven record of satisfactory performance should be selected. In addition, the reservoir could be designed as a dual basin, so that one half can be taken out of service independently while the other half remains in use. Alternatively, a bypass system can be provided to facilitate the reservoir being taken out of service.

Environmental Considerations

Site selection. The floating-cover design and layout should take into account the prevailing wind conditions at the site. Stabilizing floats and mechanical-tensioning devices should be positioned to minimize the effects of wind on the floating cover. Other special design features may be necessary to provide wind resistance. They should be considered where appropriate.

Reservoir side slopes should ideally be no steeper than 2 units horizontal to 1 unit vertical. Reservoirs with steeper side slopes should have special provisions to increase worker safety during construction and required maintenance and inspection activities.

Internal reservoir surfaces should be smooth, flat, and uniform. To the maximum extent possible, all inlet facilities, outlet facilities, overflows, and other structures within the reservoir should be flush with or below the plane of the reservoir liner. Grillages, grating, and other standoff structures should be low profile. Reservoir side slopes should be straight and uniform. Internal corners greater than 180 degrees should be avoided wherever possible.

On-site emergency power provisions with an automatic switchover should be considered to provide power to all surface water removal pumps and other vital equipment.

Other site considerations include bypass piping for the ability to isolate the reservoir without disrupting water delivery; presence of groundwater; and clearances from sewage facilities. The engineer should consult applicable state waterworks standards for regulatory requirements.

Security. Reservoirs may incorporate perimeter berms or other screening mechanisms to prevent visual observation of the floating cover from the surrounding terrain. Other security issues to consider include screening vegetation; nearby trees; debris; and animals.

The security fence should be placed far enough away from the floating cover to discourage rock throwing or other types of vandalism. The security fence should also be designed to prevent intrusion by animals that might damage the floating cover. Increased security measures, such as an intrusion alarm, video surveillance, or patrol personnel, may