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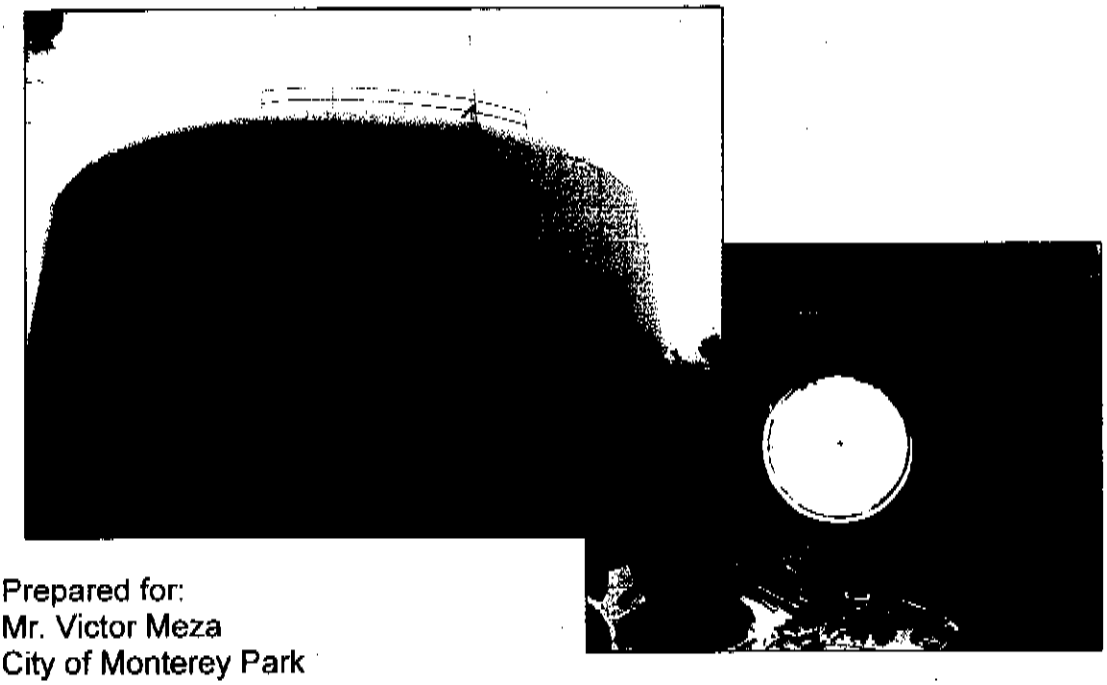
Final Report
Maintenance Inspection

Sombrero 1.5MG Water Storage Reservoir
City of Monterey Park



Prepared for:
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Prepared by:
CSI Services, Inc.

Pat Sweeney
Project Manager

August 2, 2010

Introduction

The City of Monterey Park authorized CSI Services, Inc. (CSI) to conduct a maintenance inspection on the Sombrero Reservoir located in Monterey Park, CA. The reservoir is the only tank on site and has also been identified as Reservoir No. 7. The focus of this maintenance dive inspection was to evaluate the tank coatings and develop recommendations for maintenance activities.

Coatings maintenance recommendations have been made in accordance with the applicable requirements of American Water Works Association's Standard (AWWA) D102 "Coating Steel Water Storage Tanks," AWWA Standard M42 "Steel Water Storage Tanks, and CSI's experience with evaluating hundreds of water storage facilities. A photo summary and narrated DVD video are also included to document the condition of the tank.

The field-work was completed on Wednesday, July 7, 2010 by a two man team comprised of Mr. Emilio Smith and Mr. Damian Hackett. The exterior shell observations were made mostly from grade level, while the exterior of the roof was examined close-up. The interior inspection was carried out with the tank water level at approximately twenty-four feet using special underwater diving equipment and techniques. Mr. Smith was the lead diver and Mr. Hackett was the dive tender throughout the inspection. Mr. Pat Sweeney, Project Manager, reviewed the results of the field data and prepared recommendations for maintenance work. Mr. Sweeney is a certified SSPC and NACE inspector, an SSPC Certified Protective Coating Specialist, and has evaluated hundreds of water storage tanks.

Summary

With respect to corrosion, the exterior paint system is in overall good condition with some minor negligible rust spots and heavier corrosion on the edges of appurtenances. The paint system is thin, heavily chalked with satisfactory adhesion. The chalking on at least the roof has resulted in a very thin film that is reaching a point where its will no longer provide the required barrier protection. Although laboratory analysis was not a part of this work scope, it is suspected that with the age of the tank that the exterior paint film contains heavy metals (i.e. Pb, Cr, or Cd). The paint system should be encapsulated to extend the life of the existing system and defer the removal of the probable heavy metal laden films. Based on the above, it is recommended that the exterior surfaces be reevaluated for possible spot repair and overcoat within the next 3 to 5 years.

The interior lining is in fair to good condition with isolated areas with advanced corrosion developing. Coating breaks are primarily located on roof flanges, the third course of the shell, and at pipe connections. The areas below the highest common water level have red rust and a relatively small amount of white calcareous deposits. It is suspected that the

cathodic protection (CP) system is either off or not operating efficiently. It was also noted that the internal uncoated ladder is stainless steel and is directly connected to the tank shell. This has likely resulted in the more advanced corrosion in areas closest to the ladder and caused the CP system to operate inefficiently. It was noted that some of the roof rafters shifted years ago. It is recommended that the proper and efficient operation of the CP system be verified. Assuming that the CP system can be adjusted to provide proper protection of the steel, the driving force for any lining work in the tank will be the condition of the roof coatings. It is further recommended that within the next 3 to 5 years that underwater repairs be completed to the spots with the most advanced corrosion. It would also be wise to complete a cleaning of the sediment on both the shell and tank bottom. It is projected that the roof will require relining in 5 to 7 to prevent any widespread significant corrosion development, and that this will be the be the driving force for relining the tank. A few minor non-coating related items were also noted for work.

Background

The Sombrero Reservoir Tank is welded steel above grade cylindrical structure. The tank is approximately 140 feet in diameter by 32 feet high, providing a nominal capacity of approximately 1.5MG. No documentation was provided to CSI as part of this assignment, but it is projected that the tank was build in the early 1980's. The tank is located adjacent to Sombrero Road, and specifically the tank is located at GPS coordinates 34.05901 and -118.14841.

The tank shell has four courses connected to a pitched roof by a knuckle radius. The roof plates are supported internally by rafters, knuckle bracing, and a center column. The overflow consists of an interior pipe that exits the lower course. There is one center roof vent. The tank has two shell manways, one being a flush clean-out. There is one interior ladder that leads to the single roof access hatch. The ladder is stainless steel. The tank piping has flexible couplings and enters the tank through the first course. There is a cathodic protection (CP) system installed, which includes CP hand-holes throughout the roof. There is no external CP system is in place. The tank does not have an exterior ladder, and rests on a concrete ring wall with no anchoring. The tank site itself has been asphalted.

Although a few piping connections were found to have what appears to be underwater applied epoxy patches, it is believed that the tank coatings are the original and that no significant coating maintenance activities have taken place. All of the interior steel tank surfaces are coated with a bitumastic lining. The interior steel surfaces above the second course; including the roof, shell, support members, and appurtenances are coated with a bitumastic cut-back solution (Supertank). The lowest two courses and floor have a hot-mop coal-tar enamel bitumastic lining. The exterior paint system on the roof, shell, hand rail

assembly and appurtenances are painted with what appears to be an alkyd enamel paint system.

Field Evaluation

The purpose of this survey was to assess the conditions of the existing coatings and recommend remedial work where applicable. The evaluation mainly involved visual observations. Photographs and video was taken to document the field inspections. A photo summary and narrated DVD is included with this narrative report.

For survey purposes, the tank evaluation has been segmented areas: exterior roof structure, exterior shell, interior roof structure, interior shell, and interior floor. The various appurtenances within each of these areas have also been evaluated. A rating system has been developed to quantify the condition of the various tank areas. Each of the rating criteria is found in the Attachments (Charts 1 through 6).

The condition of the coating systems was rated as being poor, fair, good, or excellent (Chart 1). The extent of any rust defects identified within each of the areas were generally determined using guidelines set forth in ASTM D610 "Standard Test Method for Evaluating the Degree of Rusting of Painted Steel Surfaces" (Chart 2). Where applicable, the characteristic or stage of corrosion was determined according to CSI Corrosion Grade criteria (Chart 3). The degree of chalking was determined in accordance with ASTM D4214 "Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint Films," Test Method D659, Method C (Chart 4). Coating adhesion was assessed in accordance with ASTM D3359 "Standard Test Method for Evaluating Adhesion by Tape Test, modified Method A or ASTM D6677 "Standard Test Method for Evaluating Adhesion by Knife" (Chart 5). Any blistering that may have been present was rated in accordance with ASTM D714 "Standard Test Method for Evaluating the Degree of Blistering in Paints" (Chart 6). The result of the evaluation follows:

Exterior

Close-up visual observations of the coating was limited to the first (lowest) shell course, upper shell areas adjacent to the roof, and the roof. The exterior paint on the roof is in good condition with heavy chalking (ASTM D4214, No. 6) and isolated patches of light and dark rust spots (CSI Corrosion Grades 1 and 2). The majority of the rust on the roof was primary on appurtenance edges and in a few isolated areas. There was also some sporadic peeling of the topcoat from a red primer. Peeling areas were commonly at depressions in the roof plates or adjacent to roof drains that have a tendency to clog and pond water. The amount of corrosion on the roof was rated to be less than 0.1 percent of the roof surface (ASTM D610, 8). Although dark rust is present in many areas, no pitting or significant metal loss is associated with any of these areas. The paint dry film thickness on the exterior was measured to range between 5 and 9 mils and film adhesion was found to

be satisfactory (ASTM D3359, 4A). It was noted that the center vent screening is loose is not secured.

The exterior paint on the shell is in good condition with heavy chalking (ASTM D 4214, No. 6). Areas damaged by mechanical means (i.e. dings and scrapes) are minimal, and there are both light and dark rust spots (CSI Corrosion Grades 1 and 2) present in isolated areas (ASTM D610, <9). The majority of all corrosion or coating defects were located on the edges of appurtenances or areas what were recently disturbed by mechanical work and along the bottom two feet of the structure (chine). The paint dry film thickness on the exterior was measured to range between 2 and 6 mils and film adhesion was found to be satisfactory (ASTM D3359, 4A). The drain pipes from the exterior roof were found to have peeling paint from an intact galvanizing with only minor corrosion. It was noted that the overflow pipe does not have a screen air-gap.

Interior

The water level at the time of the survey was at approximately twenty-four feet, and close-up visual observations were made to all areas below the waterline. With a few exceptions, the coating on the roof is in good condition. The few exceptions include some dark corrosion (CSI Corrosion Grade 2) adjacent to rafters that were found to have shifted a few inches, light and dark rust in isolated areas, and rust staining from the unsealed plate lap seams. The dark rust was primarily found on the flanges to roof rafters and at the knuckle bracing. The total amount of rust on the roof was rated to be less than approximately 0.3 percent of the total surface area (ASTM D610, 7).

The coating on the shell was found to be in overall fair condition. The lining exhibits coating checking and cracking in many isolated areas. The vast majority of all coating breaks were located within the transitional areas between the hot-mop enamel and the Supertank Solution. The upper portion of the shell in the areas above the common water level was found to have both light and dark rust spots (CSI Corrosion Grades 1 and 2). The coating breaks below the common water level often have white calcareous deposits, but the amount of white deposits is typically much less than red rust in the same areas. The lower chine was found to have a few random isolated dark rust spots. The amount of red rust on the shell was rated to have a rust grade of less than 1 percent of its total surface (ASTM D610, 6). Isolated patches of blistering were noted in each quadrant of the shell (ASTM D714, No. 2 medium) some of which extended to a bare substrate. It should also be noted that sandy sediment has accumulated on the much of the lowest two courses.

Although the majority of the floor coating was not visually accessible, observations noted that its level of corrosion in spot area of the tank bottom was minor. The floor was mostly obscured by as much as approximately 2 inches of sandy sediment. No indication of significant lining defects is suspected on the floor. It was also noted that a rusting drill bit was stuck in the floor lining.

All of the various appurtenances within the tank were found to be in generally fair condition with dark rust and white calcareous deposits common to many pipe connections and pipe bracing. The hatch had some minor light and dark rust. The ladder is comprised of stainless steel.

Discussion

With respect to corrosion, the exterior paint system is in good condition. The paint is heavily chalked with satisfactory adhesion. Paint sample analysis was not a part of this assignment, but it presumed that all films contain heavy metals. The main defect on the exterior paint is in the form of chalking. Chalking occurs as a film's binder degrades in ultraviolet light, which leaves behind the film's pigment in the form of unbound chalk. Although there is only a relatively minor amount of corrosion on the tank, the thin chalky film will, at some point, not provide enough of barrier protection from atmospheric moisture.

Generally speaking, there are four possible approaches to maintenance painting. The coatings can be either completely removed and replaced (repainted), spot repaired, spot repaired and overcoated, or simply overcoated. In evaluating the condition of a coating to determine the best painting approach there are a number of different factors to consider. The first set of factors includes the determination of the coating's ability to withstand the added stress of an additional coat(s). Attributes impacting this decision include film thickness and adhesion. If the paint film is too thick or has poor adhesion, the tension from the curing stresses and/or weight of the additional paint can cause the existing system to disbond. The second set of factors to consider when determining what painting approach to take is the amount of surface area requiring repair, the overall difficulty in providing access to the structure, and whether the coating system contains heavy metals (i.e. lead, cadmium, and chromium). The final factor is the condition of the substrate.

When considering whether a spot repair approach is a viable option, a good rule of thumb is that spot repair, with or without overcoat, makes sense with up to 10 percent of the surface area requiring repairs. With more than 10% in disrepair, making spot repairs and overcoating becomes a diminishing return. With 10 percent rusting, overcoating may be an option if the adhesion is better than fair. If there is more than 10 percent rusting and the substrate is free of mill scale, overcoating may be considered an option if the adhesion is excellent. Once the amount of surface area in need of repair exceeds this range, the cost of cleaning and coating the individual rust spots approaches (or exceeds) the total cost of removal and replacement.

The exterior paint system is presumed to contain heavy metals. As a result, the focus of any future exterior paint work should be to spot repair and overcoat the tank (i.e. lead encapsulation) before the existing coating system degrades to a level where wholesale paint replacement is required. Any work disturbing the heavy metal bearing film will require

that the workers and environment are properly protected. At this time, the only reason to paint the exterior would be for aesthetic purposes. Based on the above, it is recommended that the exterior surfaces be reevaluated for possible spot repair and overcoat within the next 3 to 5 years. It was also noted that the drip edge that runs the circumference of the roof has a tendency to collect and pond atmospheric water, and it is that the drains be periodically cleaned to removed any accumulated debris that would clog the drains. The paint at these areas was not designed for immersion.

Overall, the interior lining is in fair to good condition with isolated areas with advanced corrosion developing. Coating breaks are primarily located on roof flanges, the third course of the shell, and at pipe connections. It was noted that some of the roof rafters have shifted exposing a few inches of a "paint shadow". These strips of exposed metal have dark rust and this indicates that the rafters shifted, probably from a seismic event. The dark rust at these areas indicates that the condition is not a recent development. Patches of broken blisters was also common to the third course. Although there is wide spread blistering and coating breaks, many of these areas have a relatively small amount of white calcareous deposits and red rust. The calcareous deposits are a bi-product of the impressed current cathodic protection (CP) system protecting the immersed areas of the steel from metal loss. There was no significant corrosion in the form of metal loss. The third course is believed to have the most advanced lining degradation since it is in area that tends to face the most severe stress from constant wetting and drying cycles associated with the highest afternoon heat and fluctuations in water levels.

However, although the CP has prevented the development of corrosion in the areas of the steel below the highest water level (HWL), it provides no protection to the roof or upper areas of the shell, each of which is starting to show more advanced corrosion. It should also be noted that there is a considerable amount of red rust below the HWL and this indicates that the CP system has not been properly protecting the exposed steel. It is not clear if the CP is off, but it clearly has at least been operating inefficiently. It should be noted that the internal uncoated ladder is stainless steel and is directly connected to the tank shell. This has likely resulted in the more advanced corrosion in areas closest to its connection and caused the CP system to operate inefficiently. Essentially, the CP system has been spending considerable, unbalanced effort to properly protect the bare ladder. The significant darker rust below the HWL may be attributed to holidays in the adjacent coating and to the difference in galvanic potentials of the ladder and tank shell's two dissimilar "directly connected" metals. This inefficient operation of the CP may have also resulted in the thinner lining in the upper courses to blister.

It is recommended that the proper and efficient operation of the CP system be verified. Assuming that the CP system can be adjusted to provide proper protection of the steel, the driving force for any lining work in the tank will be the condition of the roof coatings. It is recommended that within the next 3 to 5 years that underwater repairs be completed to the spots with the most advanced corrosion. It would also be wise to complete a cleaning of

the sediment on both the shell and tank bottom. It is projected that the roof will require relining in 5 to 7 to prevent any widespread significant corrosion development, and that this will be the be the driving force for relining the entire tank.

A few non-coatings related items were noted. The overflow pipe does not have a screen-air gap and the center vent screening is loose. Each of these conditions can result in a sanitary concern.

Recommended Work

It is recommended that the tank be placed back on a 3 to 5 years maintenance inspection schedule, and that the following activities be completed:

Exterior

1) Repair/reattach the center roof vent screening.

2) Install a screen to the outlet end of the overflow pipe.

3) Complete periodic operational inspections to assure that the roof drains to not become clogged with leaves and other debris.

Interior

1) At the next inspection, plan to complete underwater repairs to the areas with the most significant corrosion below the water line.

2) Consider cleaning out the sediment from the shell and tank bottom of the tank.

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	Emilio Smith		

Water Tank Dive Inspection Report

Tank Owner/Client: City of Monterey Park	**Dive Supervisor:** Emilio Smith
Client Contact: Victor Meza	**Lead Diver:** Emilio Smith
Tank Name: Sombrero Reservoir	**Dive Tender:** Damian Hackett
Date of Last Inspection:	

Scope of Work	Maintenance Dive ☒	Warranty Dive ☐	Cleaning ☐	Patch Repairs ☒	UT Readings ☐	Sampling ☐

Site

Item	[redacted]	[redacted]	[redacted]
GPS Coordinates	☒	☐	34.05901 / -118.14841
Cross Street			Sombrero
Tank Location			only tank on site
Perimeter Fencing	☒	☐	satisfactory
Site secured on arrival	☒	☐	
Nearest Structures	☒	☐	Pump House
Overhead Power Lines	☐	☒	
Antenna on Tank			Yes
Surrounding Site	☐	☐	paved
Impact potential	☒	☐	tree
	☐	☐	No Data Plate

Structural

Item	[redacted]	[redacted]	Data
Capacity	1.5MG	Number of Roof Vents	one center
Diameter	appx 140	Roof Vent Design	round hooded
Height	32	Center Roof Vent Size	24"
Erection Year		Roof vent sealed	Yes - screened
Contract No.		Roof Rail System	yes
Tank Substrate	welded steel	Roof Rail Satisfactory	Yes, 42" high, 2 midrails, 4 inch
Tank Profile	on grade	Rail Location	other
Tank Geometry	cylindrical	Ext Roof Access	none present
Number of Courses	four	Exterior Vandal Deterrent	
Height of Each Course	8 feet	Ext Ladder Sat	none
Roof Design	pitched roof with knuckle	Ext Ladder Fall Prevent	none
Roof Structure	rafters	Roof Tie-Off Present	no
Column Design	pipe	Tank Piping	common inlet/outlet
Upper Center Column	dollar plate	Inlet Diameter	12"
Column Base Design	free plate with stabilizing c	Outlet Diameter	
Structural Connections	welded	Flexible Pipe Coupling	present
No. Shell Manways	two	Overflow Pipe Diameter	12"
Type of Manways	round	Overflow Exterior Design	poorly screened with air gap
Manway Cover Design	bolt circle with hinge	Overflow Interior Design	pipe lower course exit
Diameter of Manways	36"	Drain location	flush clean-out
No. Roof Hatches	one- center	Tank Foundation	concrete ringwall with no anch
Hatch Design	steel hinged	CP System	interior impressed current
Size of Roof Hatch	48"x36"	Water Level Indicator	telemetry