TASK II: Research & Analysis
WATER RESOURCES REPORT

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SILVER LAKE RESERVOIR COMPLEX
MASTER PLAN PROJECT

September 13, 2019
CONTENTS

1 Introduction to the Site ........................................................................................................ 2
  SLRC Existing Site Features .............................................................................................. 2
  Brief Historic Overview .................................................................................................... 7
  Current Use and Operations ............................................................................................ 11
  Planned Future Operations ............................................................................................... 12

2 Goals .................................................................................................................................. 14
  Goal 1: Manage the SLRC as Open Reservoirs of Non-Potable Water ......................... 14
  Goal 2: Preserve DWP System Operations and Future Projects ................................... 14
  Goal 3: Strive for Water Quality Objectives Consistent With Potential Designated Beneficial Uses ................................................................. 14

3 Opportunities and Constraints ..................................................................................... 21
  Reservoir Refilling ........................................................................................................... 21
  Shoreline Improvements ................................................................................................. 22
  Recreational Structure Additions or Improvements ....................................................... 23
  Wetlands ........................................................................................................................... 23

4 Potential Funding Sources ............................................................................................ 25
  Grants for Water Resources ........................................................................................... 25
  Grants for Urban Greening ............................................................................................... 25
  Grants for Park Improvements ........................................................................................ 25
  Grants for Pedestrian or Bicycle Improvements ........................................................... 25
  Other Grants ..................................................................................................................... 26
  Loans ................................................................................................................................ 26

5 References ...................................................................................................................... 27
1 INTRODUCTION TO THE SITE

The Silver Lake Reservoir Complex (SLRC) is composed of Silver Lake Reservoir, Ivanhoe Reservoir, and the land immediately adjacent to both reservoirs. The SLRC is located about four miles northwest of downtown Los Angeles and bounded by West Silver Lake Drive to the west, Tesla Avenue to the north, Armstrong Avenue to the northeast, Silver Lake Boulevard to the east and southeast, and Van Pelt Place to the south. The roughly 127-acre property is owned by the Los Angeles Department of Water and Power (DWP) and includes reservoirs, dams, buildings, water and stormwater infrastructure, access roads, and public recreational facilities (BOE, 2018).

The following subsections introduce the site as a whole and provide a brief description of existing water resources features within the SLRC and a brief historic overview of the SLRC.

SLRC Existing Site Features

Besides the two reservoirs, the SLRC contains various geographic, utility, and structural components. These are shown in Figure 1-1, divided into DWP operational features in red text and community/recreational features in turquoise text.

![Figure 1-1 SLRC Existing Site Features](image-url)
DWP Operational Features

The following sections introduce the DWP operational features from Figure 1-1 starting at the south end of the SLRC and proceeding northward.

![Silver Lake Dam](image1)

**Figure 1-2  Silver Lake Dam (Bing Maps)**

**Silver Lake Dam** is a compacted earth dam with an interior gravel drain. The original dam was demolished and replaced with the existing dam in 1976, when construction crews placed 719,300 cubic yards of compacted earth to a height of 41.5 feet above the bottom of the reservoir. The dam stretches from Silver Lake Boulevard to West Silver Lake Drive, a length of 915 feet, and the dam has a width of 30 feet at the top (DWP, 1976). The interior 3 to 1 slopes of the dam, like the rest of the reservoir, are covered with a layer of asphalt. The exterior 2.5 to 1 slopes are landscaped with short grasses.

![Silver Lake Outlet Tower](image2)

**Figure 1-3  Silver Lake Outlet Tower**

The **Silver Lake Outlet Tower** was also constructed in 1976 on the west side of the reservoir approximately 150 feet north of the toe of the dam. The outlet tower is accessible from the shore by a 79-foot-long footbridge (DWP, 1976). The tower was constructed with three 54" butterfly valves to control the reservoir outflow into the water distribution system when the reservoirs were in service. The existence and operability of the butterfly valves is currently undetermined since Silver Lake Reservoir was removed from service.
The **Overflow Spillway** is on the west side of Silver Lake Reservoir and has an overflow elevation of 454 feet (NGVD29). The spillway connects to a 36-inch storm drain pipe that tunnels under the ridge to the west of Silver Lake Reservoir and discharges to a Los Angeles County Flood Control District (LACFCD) storm drain. The spillway has a capacity of conveying 74 cubic feet per second during a probable maximum precipitation storm (DWP, 1973).

The **Auxiliary Spillway** is on the east side of Silver Lake Reservoir and has an overflow elevation of approximately 455.5 feet (NGVD29). The auxiliary spillway flows occupies the same space as Silver Lake Meadow. The auxiliary spillway has a capacity of conveying 130 cubic feet per second (DWP, 1973).
**DWP Facilities** northeast of Silver Lake Reservoir include several buildings, structures, utility features, access roads, and landscaped areas. The area is and will continue to be used by DWP for maintenance operations. DWP will be constructing new office space in this area in the near future. A gatewell structure in this area is currently used during refilling operations at the SLRC and could be used for future recirculation operations as well.

A **Regulator Station** northwest of Silver Lake Reservoir regulates pressure in the potable water system. The regulator station was constructed in 2014 at the same time as the new 66-inch bypass waterline that disconnected Silver Lake Reservoir from the potable water system. Near the regulator station is another gatewell structure that will potentially be modified and reused for the future water recirculation project.
Figure 1-8  Ivanhoe Spillway

_Ivanhoe Spillway_ separates Ivanhoe Reservoir from Silver Lake Reservoir. When the water elevation in Ivanhoe Reservoir is at or above 451 feet (NGVD29), water spills into Silver Lake Reservoir. A 10-foot-wide concrete bridge spans the spillway.

Figure 1-9  Ivanhoe Inlet Tower

The _Ivanhoe Inlet Tower_ lies atop a waterline valve that allows water to refill Ivanhoe Reservoir. During recirculation operations in the future, the recirculated pumped water from Silver Lake Reservoir may enter Ivanhoe Reservoir through the Ivanhoe inlet tower. Ivanhoe inlet tower is only one point of water refill.
Ivanhoe Dam, sometimes called Ivanhoe North Dam to distinguish it from the Ivanhoe South Dam that separates Ivanhoe Reservoir from Silver Lake Reservoir, was first constructed in 1906 when Ivanhoe Reservoir was constructed. Additional compacted earth fill was added in 1952, and the elevation was raised so that the dam crest was 14 feet above the toe of the dam on Tesla Street and 25 feet above the floor of Ivanhoe Reservoir. Ivanhoe Dam has a crest width of about 14 feet, and its interior slopes, like the slopes around the rest of Ivanhoe Reservoir, are covered with colored concrete.

**Brief Historic Overview**

Silver Lake Reservoir was designed by William Mulholland and placed into service as an agricultural reservoir in 1907.
In 1920 the dam was raised 5 feet and modifications were made to allow the reservoir to be used as a potable water supply for the City of Los Angeles.

Ivanhoe Reservoir was designed as a potable water supply when it was put into service in 1906. Ivanhoe Reservoir originally had a wooden roof until it was taken down in 1938.
Substantial improvements were made in the early 1950s to enlarge Silver Lake Reservoir by steepening the side slopes from 3:1 to 2:1 and paving them. Much of the excess excavated material was used to fill in a portion of Silver Lake Reservoir that has now become the Meadow. The project also involved the installation of a 60-inch bypass line under Silver Lake Reservoir.

Silver Lake Dam was completely removed and reconstructed in the 1970s due to seismic concerns. The east end of the new dam was angled slightly north of the original location, resulting in a reduced surface area of 3%. The outlet tower was demolished and replaced with a new structure, and a new 72-inch bypass pipe extended through the new dam to connect the 1951 bypass to the new point of connection in what is today the Grassy Patch.
By 2010, new drinking water standards introduced complications to operating Silver Lake Reservoir as a potable water supply. DWP was forced to remove Silver Lake Reservoir from service. Between 2008 and 2017, Ivanhoe Reservoir continued to be used for potable water. DWP installed plastic shade balls to comply with State Water Resources Control Board (SWRCB) drinking water standards to control the formation of bromate (DWR). The shade balls were removed in 2017.

Both Silver Lake Reservoir and Ivanhoe Reservoirs were drained in 2015 so that a new 66-inch bypass pipeline could be installed. The pipeline fully disconnected the reservoirs from the potable water system, and permanent blocks were installed that completely isolated the reservoirs from the upstream potable water system. The reservoirs were refilled in 2017.
Current Use and Operations

Silver Lake Reservoir and Ivanhoe Reservoir are no longer used for potable water. Instead the two reservoirs are currently used as an aesthetic neighborhood feature that plays a major role in defining the neighborhood characteristic. Although the reservoirs are no longer used for potable water, DWP will continue to occupy roughly 10% of the site for current and future operations of their water distribution system. Both reservoirs combined hold approximately 2,200 acre-feet (ac-ft) of water below the lip of the spillway between Ivanhoe Reservoir and Silver Lake Reservoir. The elevation of this lip is approximately 451 feet (NGVD29).

A neighborhood survey from 2016 found that “keeping water in the lake” enjoyed the support of 96% of the Silver Lake community (Silver Lake Reservoirs Conservancy, 2017).

Refilling Operations

The water level in both reservoirs drops from five to seven feet every year due to evaporation and seepage. DWP must pump approximately 460 to 585 acre-feet of water into both reservoirs every year to account for water lost due to evaporation and seepage (Black & Veatch, 2017). The historic operable range of water surface elevations within the SLRC is between 440 and 451 feet, and DWP is currently committed to keeping the water level at a minimum above 440 feet (DWP, 2013).

After being drained for the construction of the 66-inch bypass line, refilling of the Silver Lake Reservoir with potable water began in April 2017. However, the reservoir was topped off with treated groundwater from Pollock Well #3 starting in October 2018 into 2019 (DWP, 2018).

Pollock Well #3 is a groundwater well located at DWP’s Ripple Street Yard northwest of the SLRC. Work was done in 2017 to rehabilitate the well with a new pump, motor, and well treatment system. DWP constructed a pipeline to connect the well to the Ivanhoe Tunnel, which feeds the SLRC from the northeast. The solution enabled Silver Lake Reservoir to be refilled with local groundwater sources that have no impact on the drinking water supply (DWP, 2017). The current policy going forward at this time will be for DWP to continue using treated groundwater from the Pollock Well field.

Water quality at the Pollock Well field is part of the San Fernando Groundwater Basin, and it is impacted by contamination plumes from hexavalent chromium and from volatile organic compounds (VOCs) such as trichloroethylene (TCE) and perchloroethylene (PCE) (DWP, 2018b). In 2017, the Regional Board granted a Waste Discharge Permit that allowed groundwater from Pollock Well #3 to be discharged to the SLRC as long as it was first treated by a granular activated carbon system prior to discharge into the SLRC (Regional Board, 2017).

Firefighting Operations

The SLRC is currently used as a source of water for firefighting operations. Under an agreement with DWP, both the City and County of Los Angeles Fire Departments may use reservoir water storage for firefighting purposes, and both departments have used the water in the past. Minimum water level requirements need to be maintained for emergency firefighting operations.

Existing Water Quality

Existing water quality within the SLRC is generally very good. This is due in part to the limited size of the tributary watershed. The predominant source of water since 2017 has been a mix of potable water and non-potable treated groundwater, with very little stormwater. The only stormwater that can currently enter the SLRC comes from
precipitation that falls on the SLRC. Stormwater tends to have more impaired water quality than treated potable water or treated groundwater because as it moves over the surface of the land it picks up sediments and pollutants from the ground surface.

Recent water quality samples, as shown in Figure 1-, depict a slow steady increase in chlorophyll-a concentrations that abated somewhat after the most recent top-off.

![Figure 1-18 Chlorophyll and Reservoir Elevation in Silver Lake Reservoir](image)

Existing water within the SLRC is likely not impaired and likely meets the existing water quality objectives (discussed further in Section 2).

**Planned Future Operations**

The SLRC is currently owned and operated by DWP. The DWP has planned certain activities to help maintain and operate the SLRC as non-potable open reservoirs of clean water. DWP will continue to maintain DWP facility areas as shown on the DWP land use map for water system operational requirements. Future operation and maintenance of the Master Plan study area, outside dedicated DWP facilities areas, will be developed through the Master Plan process.

*Proposed DWP Aeration Project*

An aeration project has been proposed by DWP to reduce algae development and minimize potential odors related to anaerobic conditions in the reservoirs (DWP, 2018).

The aeration project will install new air pumps inside the existing chlorination building east of Silver Lake Reservoir within the DWP facilities area. New piping underneath the existing access road on the east side of both Silver Lake Reservoir and Ivanhoe Reservoir will be constructed. The air pumps will pump air into ten small tubes (seven in Silver Lake and three in Ivanhoe) that convey air bubbles to diffusers placed in the middle of each lake. Draining of the reservoirs will not be required to complete the project.

*Proposed DWP Recirculation Project*

A recirculation project has been proposed by DWP with the goal of reducing algae development and minimizing potential odors related to anaerobic conditions in the reservoirs (DWP, 2018).

The recirculation project will modify the original 60-inch bypass line constructed in 1951 to recirculate water from the south end of Silver Lake Reservoir back to the north end of
Ivanhoe Reservoir. The project will allow for more thorough mixing and de-stratification, which will reduce algae development in the lake (DWP, 2018).

**Proposed DWP Stormwater Capture Project**
The DWP has signed a Memorandum of Agreement with the City of Los Angeles Bureau of Engineering (BOE) and the City of Los Angeles Bureau of Sanitation and Environment (LASAN) to pursue the design of a stormwater capture project. The project would capture and treat stormwater from the surrounding neighborhood and use it to deliver up to 159 acre-feet of stormwater on average per year to the SLRC (DWP, 2018). This is about 38% of the annual total needed to keep the water surface at the operable water level of 440 to 451 feet. This project is slated to begin construction no earlier than summer of 2021.

As previously discussed, the location of the reservoir complex at the upstream end of Ivanhoe Canyon means the natural drainage area is quite small, about 240 acres. However, not even all of the small natural drainage area can be captured. Catch basins to the north of Ivanhoe Dam, for example, have a surface elevation below the water level in the SLRC. Although it will provide a new source of refill water, the stormwater capture project alone cannot satisfy the evaporation and seepage losses from the SLRC, and another source of refill water will need to be used in conjunction with the stormwater capture project.
2 GOALS

The Silver Lake Master Plan of 2000 listed four goals related to water quality in the SLRC (Mia Lehrer and Associates). The water quality goals related to DWP operations and potential future storage and treatment facilities. However, the transition from reservoirs of potable drinking water to non-potable water requires an updated set of goals to conform to the current and future use of the SLRC. These goals are listed below.

1. Manage the SLRC as open reservoirs of non-potable water
2. Preserve DWP system operations and future projects
3. Strive for water quality objectives consistent with potential designated beneficial uses

Goal 1: Manage the SLRC as Open Reservoirs of Non-Potable Water

The SLRC Master Plan will present many opportunities to reshape the SLRC, but all options must start with the reservoir being maintained as an open above-ground reservoir full of non-potable water. There are at least three reasons that this goal must be implemented: the historic designation of Silver Lake Reservoir, fire protection, and neighborhood aesthetics.

The Silver Lake and Ivanhoe Reservoirs were designated as Los Angeles City Historic Cultural Monument #422 in 1989. The designation does not prevent alteration of the SLRC, but it does introduce an opportunity for the Cultural Heritage Commission to review any potential changes to the SLRC, and substantial changes to the aesthetic characteristics of the SLRC would likely not be permitted.

The SLRC is also currently used for firefighting purposes. Under an agreement with DWP, both the City and County of Los Angeles Fire Departments may use reservoir water storage for firefighting purposes, and both departments have used the water. If development were to substantially reduce the surface area of the open bodies of water, it would be more difficult for the fire departments to protect life and property.

Finally, keeping open water in the SLRC is enormously popular in the neighborhood. A neighborhood survey from 2016 found that “keeping water in the lake” enjoyed the support of 96% of the Silver Lake neighborhood community (Silver Lake Reservoirs Conservancy, 2017). Draining a substantial portion of Silver Lake Reservoir for development would be devastating for the community.

Goal 2: Preserve DWP System Operations and Future Projects

The SLRC Master Plan envisions physical changes to the SLRC that may impact the current geometric and topographic form of the reservoirs. However the SLRC will continue to be owned by DWP, and any alterations to the SLRC will need to preserve the ability of DWP to operate and maintain the reservoirs. DWP is responsible for reservoir safety, the infrastructure, and the operational features and areas described in Figure 1-1. Future management and maintenance of the SLRC should be addressed in the Master Plan.

Goal 3: Strive for Water Quality Objectives Consistent With Potential Designated Beneficial Uses

The Los Angeles Regional Water Quality Control Board (Regional Board) has the responsibility of establishing water quality objectives for surface water bodies within the
region. The Los Angeles Basin Plan (Basin Plan) bases these water quality objectives on the designated beneficial uses of water bodies.

Currently Designated Beneficial Uses
The 2019 Basin Plan update has designated the same beneficial uses for both Ivanhoe Reservoir and Silver Lake Reservoir. The designated beneficial uses are as follows:

- **MUN**: Existing beneficial use, but may be considered for exemption at a later date
- **IND**: Existing beneficial use
- **PROC**: Existing beneficial use
- **WARM**: Potential beneficial use
- **WILD**: Existing beneficial use
- **REC-1**: Potential beneficial use, but public access restricted by LACDPW
- **REC-2**: Existing beneficial use

The definitions of these beneficial uses are from the Basin Plan as follows.

**MUN: Municipal and Domestic Supply**
Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

**IND: Industrial Service Supply**
Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

**PROC: Industrial Process Supply**
Uses of water for industrial activities that depend primarily on water quality.

**WARM: Warm Freshwater Habitat**
Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

**WILD: Wildlife Habitat**
Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g. mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

**REC-1: Water Contact Recreation**
Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, waterskiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

**REC-2: Non-contact Water Recreation**
Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Potential Future Designated Beneficial Uses
Development of the SLRC may change the water function of all or a portion of the SLRC, and thus it may necessitate a change in the beneficial use designation of the water resources within the SLRC. Changing the beneficial use designation of a water body is a public process that takes several years, and it may or may not be necessary depending on the changes to the SLRC. This subsection lists reasonable expectations of beneficial uses that may be attainable by the SLRC depending on various development scenarios.
MUN - The State Water Board adopted a policy in May 1988 that states that all surface waters and groundwater in the State of California are considered suitable or potentially suitable for municipal or domestic water supply and should be designated with the MUN beneficial use with certain exceptions. Hence most surface waters are designated with either a potential or an existing MUN beneficial use, and it is reasonable to expect that the SLRC will continue to be designated with a MUN beneficial use in the future.

IND – Because the IND beneficial use cites fire protection as a use, and since the SLRC will continue to be used as a source of water for firefighting activities, it is reasonable to expect that the SLRC will continue to be designated with an IND beneficial use in the future.

PROC – Most open bodies of water have the PROC designation, and it is reasonable to expect that the SLRC will continue to have the PROC beneficial use in the future.

WARM – Water attracts wildlife of all forms, from mammals and birds to benthic invertebrates. Almost every body of water within the Regional Board’s jurisdiction is designated with the WARM beneficial use in existing, potential, or intermittent form. It is reasonable to expect that the SLRC’s potential WARM beneficial use will be converted to an existing WARM beneficial use in the future since the potable water status of the SLRC has changed.

WILD – As with the WARM designation, the WILD beneficial use is a designated beneficial use of almost every body of water within the Regional Board’s jurisdiction. It is reasonable to expect that the SLRC will continue to be designated with a WILD beneficial use in the future.

REC-1 – The SLRC currently is designated as having a potential REC-1 beneficial use. However, the beneficial use designation is limited by the fact that under existing conditions, public access to the water is prevented by fencing. Most plans for the future of the SLRC include scenarios where the public will come into contact with water from Silver Lake Reservoir and/or Ivanhoe Reservoir either through swimming or through other incidental contact such as boating and fishing. It is reasonable to expect that the SLRC’s potential REC-1 beneficial use, which is currently limited by the fencing, will be converted to an existing REC1 beneficial use under future development.

REC-2 – The SLRC currently has a REC-2 existing beneficial use, and it is reasonable to expect that the SLRC will continue to have a REC-2 beneficial use in the future.

SPWN – The SLRC does not currently have a beneficial use designated for spawning, reproduction, and/or early development of fish. However, certain ideas for development of the SLRC involve the creation of habitat conducive to fish spawning and development. Therefore it may be reasonable to include the SPWN beneficial use as a potential beneficial use for the SLRC in the future.

WET – The SLRC does not currently have a beneficial use designated for wetland habitat, which is defined in part as uses of water that support wetland ecosystems, including preservation or enhancement of wetland functions which enhance water quality, such as providing flood and erosion control, and filtration and purification of naturally occurring contaminants (Basin Plan). However, several ideas for development of the SLRC involve the creation of wetland habitat, either as a water quality enhancement, a habitat enhancement, or both. Therefore it may be reasonable to include the WET beneficial use as a potential beneficial use for the SLRC in the future.

Table 2-1 presents a summary of the existing and potential future designated beneficial uses of Silver Lake Reservoir and Ivanhoe Reservoir.
### Table 2-1  Current and Potential Future Designated Beneficial Uses

<table>
<thead>
<tr>
<th>Silver Lake Reservoir and Ivanhoe Reservoir</th>
<th>MUN</th>
<th>IND</th>
<th>PROC</th>
<th>WARM</th>
<th>WILD</th>
<th>REC-1</th>
<th>REC-2</th>
<th>SPWN</th>
<th>WETb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Designated Beneficial Uses (from Basin Plan)</td>
<td>E*</td>
<td>E</td>
<td>E</td>
<td>P</td>
<td>E</td>
<td>Pk</td>
<td>E</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potential Future Designated Beneficial Uses</td>
<td>E*</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>E</td>
<td>P</td>
<td>P</td>
</tr>
</tbody>
</table>

E: Existing beneficial use  
P: Potential beneficial use  
E and P shall be protected as required.  
*: Asterisked MUN designations are designated under SB 88-63 and RB 89-03. Some designations may be considered for exemption at a later date.  
b: Waterbodies designated as WET may have wetlands habitat associated with only a portion of the waterbody. Any regulatory section would require a detailed analysis of the area.  
k: Public access to reservoir and its surrounding watershed is prohibited by Los Angeles County Department of Public Works

### Water Quality Objectives

Water quality objectives are identified in Chapter 3 of the Basin Plan and relate to designated beneficial uses. Not every category of water quality objectives applies to the SLRC. The Regional Objectives for Inland Surface Waters and the Regional Narrative Objectives for Wetlands will guide the water quality objectives for the SLRC. These regional objective categories are listed in Table 2-2, along with the determining characteristic by which they apply to the SLRC. The highlighted rows indicate water quality objectives that could change given a change in the designated beneficial uses of Silver Lake Reservoir and/or Ivanhoe Reservoir.

### Table 2-2 Regional Water Quality Objectives Applicable to SLRC

<table>
<thead>
<tr>
<th>Water quality objective (WQO) category</th>
<th>Water body characteristic or designated beneficial use by which WQO category applies to SLRC</th>
<th>Narrative WQO or Numerical WQO?</th>
<th>Applies to SLRC under existing designated beneficial uses?</th>
<th>Applies to SLRC under potential future designated beneficial uses?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>Freshwater, not COLD or MIGR, not RARE</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Bacteria, Coliform</td>
<td>Freshwater, REC-1, REC-2</td>
<td>Numeric</td>
<td>Yes, for REC-2 beneficial use</td>
<td>Yes, for REC-1 beneficial use</td>
</tr>
<tr>
<td>Bioaccumulation</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD₅)</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Water quality objective (WQO) category</td>
<td>Water body characteristic or designated beneficial use by which WQO category applies to SLRC</td>
<td>Narrative WQO or Numerical WQO?</td>
<td>Applies to SLRC under existing designated beneficial uses?</td>
<td>Applies to SLRC under potential future designated beneficial uses?</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>--------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td>Biostimulatory Substances</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chemical Constituents</td>
<td>MUN</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Chlorine, Total Residual</td>
<td>Surface water</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Color</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Exotic Vegetation</td>
<td>Stream courses</td>
<td>Narrative</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Floating Material</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Methylene Blue Activated Substances (MBAS)</td>
<td>Surface water</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Mineral Quality</td>
<td>MUN, PROC, WARM, SPWN</td>
<td>Numeric (guidelines only)</td>
<td>Yes</td>
<td>Yes, but a potentially more strict chloride WQO is possible for a SPWN beneficial use</td>
</tr>
<tr>
<td>Nitrogen (Nitrate, Nitrite)</td>
<td>MUN</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oxygen, Dissolved (DO)</td>
<td>WARM</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Pesticides</td>
<td>MUN</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>pH</td>
<td>Surface water, not a bay or estuary</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Polychlorinated Biphenyls (PCBs)</td>
<td>Freshwater</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Water quality objective (WQO) category</td>
<td>Water body characteristic or designated beneficial use by which WQO category applies to SLRC</td>
<td>Narrative WQO or Numerical WQO?</td>
<td>Applies to SLRC under existing designated beneficial uses?</td>
<td>Applies to SLRC under potential future designated beneficial uses?</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Priority Pollutants (California Toxics Rule)</td>
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<td>Radioactive Substances</td>
<td>MUN</td>
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<td>Solids, Suspended, or Settleable Materials</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Taste and Odor</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Temperature</td>
<td>WARM</td>
<td>Numeric</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Toxicity</td>
<td>Surface water</td>
<td>Narrative</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Surface water</td>
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<td>Yes, if wetlands are incorporated</td>
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<tr>
<td>Wetlands – Habitat</td>
<td>WET</td>
<td>Narrative</td>
<td>No</td>
<td>Yes, if wetlands are incorporated</td>
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</table>

**Water Quality Monitoring**

Water quality standards within Silver Lake Reservoir and Ivanhoe Reservoir will need to be evaluated during development of the site. Depending on the nature of the development (for example if public access is no longer restricted, if swimming is allowed, or if wetlands are constructed), the designated beneficial uses of the SLRC may change, which will trigger more stringent water quality standards.

Currently neither Silver Lake Reservoir nor Ivanhoe Reservoir has designated water quality impairments. DWP has been monitoring the site since the 2017 refill for certain characteristics including chlorophyll, pH, temperature, turbidity, and others. Water quality monitoring is generally not a Regional Board requirement unless an impairment to the water body has been demonstrated. Changes in the REC-1 beneficial use would likely require a monitoring regime for bacteria. This has been the case with other reservoirs converted to recreational usage, such as at Hansen Dam Recreation Center and Puddingstone Reservoir.
Total Maximum Daily Load Discussion

Silver Lake Reservoir and Ivanhoe Reservoir are isolated water bodies that under normal operating conditions are tributary to neither the Los Angeles River nor to Ballona Creek. The SLRC is not officially within the boundaries of either the Upper Los Angeles River Enhanced Watershed Management Program (EWMP) or the Ballona Creek EWMP (see Figure 2-1). However, there is a possibility that the SLRC could be considered within the Ballona Creek watershed in the future and become subject to Ballona Creek Total Maximum Daily Load (TMDL) requirements.

Ballona Creek is included on the Clean Water Act Section 303(d) list of impaired waterbodies and has several TMDLs that address trash, bacteria, metals, estuary toxic pollutants, wetlands sediment and exotic vegetation. Many of these TMDLs identify compliance measures related to dry- and wet-weather flow in Ballona Creek. The Ballona Creek Trash TMDL requires point source discharges into Ballona Creek to comply with the TMDL by installing full trash capture systems. A full capture system is any device that traps all particles greater than 5 millimeters and has a design treatment capacity equal to the peak flow rate from a one-year, one-hour storm on the tributary drainage area. If the SLRC were to become subject to the Ballona Creek Trash TMDL, it would need to be shown that no outflow from the system during a one-year one-hour storm would contain particles greater than 5 millimeters. However, under normal operating conditions, the elevation of the water within the reservoir is set several feet below the spillway elevation, which is the lowest elevation at which discharges from the reservoir complex occur. Therefore, even if the SLRC were to fall under the jurisdiction of the Ballona Creek Trash TMDL, it is likely that the SLRC would be able to comply with the TMDL compliance measures without any physical modification to the spillway or outflow pipe, with the caveat that this is all subject to the discretion of the Regional Board.
3 OPPORTUNITIES AND CONSTRAINTS

The purpose of the SLRC Master Plan is to explore the potential long term uses and physical changes within the SLRC that will benefit the community, the City, and the environment. There are opportunities to drastically change the characteristics of the SLRC while improving the quality of life for both humans and wildlife in the surrounding neighborhood and the City as a whole. Each opportunity comes with a set of constraints that should be met to conform to various overlapping regulations and goals. This section presents research into these opportunities and constraints related to water issues.

Reservoir Refilling
Existing DWP operations policy is to continue using treated groundwater from Pollock Well #3 as reservoir refill water, which will be supplemented with treated stormwater from the future stormwater capture project. The next two sections explore other potential non-potable sources of refill water, Los Angeles River water and recycled water.

Los Angeles River Water
The Los Angeles River is about half a mile northeast of Ivanhoe Reservoir and adjacent to DWP’s Ripple Street Yard. Los Angeles River water could be used in the future to refill the SLRC. The pipeline that currently delivers water from Pollock Well #3 is the same pipe that could ultimately also deliver water from the river (DWP, 2016). The required refill rate is about 1,350 gallons per minute, or 3 cubic feet per second (cfs), and streamflow data from the river at Los Angeles County’s streamflow gauge at the Arroyo Seco confluence over the last five years has shown that the average monthly flow rate in the river for the minimum month was 41 cfs, almost 14 times the required rate (LACDPW).

If Los Angeles River water were to be used instead of groundwater to periodically refill the SLRC, the project would require certain new infrastructure within the Los Angeles River channel. A new diversion structure would be required within the channel, as well as a pump to get the water from the bottom of the channel to the existing pipes at Ripple Yard.

The new physical infrastructure within the Los Angeles River would present several permitting challenges, including the need to get US Army Corps of Engineers (USACE) Section 408 Permits, Section 401 and 404 permits, a California Department of Fish and Wildlife Section 1602 permit, and a LACFCD flood construction permit. The permitting process tends to take several years, in particular the USACE Section 408 permit, and thus the project would be held up for a substantial amount of time before implementation could occur.

The use of Los Angeles River water for refill water at the SLRC could also present water quality challenges. The diversion would likely be set to only take in a portion of the Los Angeles River dry-weather flows rather than stormwater flows. Dry-weather flows in the Los Angeles River are composed of the effluent from water reclamation plants, in particular from the Los Angeles Glendale Water Reclamation Plant (LAGWRP), the Donald C. Tillman Water Reclamation Plant (DCTWRP), and from the Burbank Water Reclamation Plant (BWRP). Overall effluent from water reclamation plants is very clean, but this water tends to be high in nutrients, and usage of this water in the SLRC would lead to an increase in chlorophyll and algae if no additional treatment processes were used.

Recycled Water
Recycled water could be used rather than groundwater as a source of non-potable water to refill the SLRC. The DWP could install piping from the existing recycled water facilities in Griffith Park a mile and a half away (DWP, 2016). The source of this recycled water is the LAGWRP, the same plant that discharges treated wastewater to the Los Angeles River upstream of any potential diversion discussed in the previous section. The 2015 Urban
Water Management Plan (UWMP) set a goal to supply 75,000 acre-feet of recycled water per year by 2040 (DWP, 2015). Additionally, Mayor Eric Garcetti announced in February 2019 a plan to recycle 100% of the City’s wastewater by 2035 (Boxall). Using recycled water to refill the SLRC would help achieve this goal.

Currently, all the recycled water from the LAGWRP has been allocated to various uses, so a restructuring of the uses would be necessary for use in the SLRC. If recycled water were to be used instead of groundwater to periodically refill the SLRC, the project would require certain new infrastructure. Specifically, the project would require a new pipeline stretching to the SLRC from existing recycled water pipelines in area of Griffith Park. This new pipeline could be as long as 1.5 miles, an expensive new undertaking. Additional infrastructure would also need to be constructed, such as pump stations and tanks and possibly a new pressure regulator station. The recycled water pipeline extension project would present challenges such as right-of-way acquisition, utility relocation, and construction traffic management. Recycled water would also present some of the same water quality challenges as using Los Angeles River dry-weather flows. Despite the fact that recycled water is very clean, elevated levels of nutrients may lead to an increase in chlorophyll and algae in the SLRC without additional treatment processes being present.

**Comparison with the Existing Process**

Additional complexities are involved with using Los Angeles River water and recycled water that exceed what is detailed here. The complexities involve not just technical and engineering challenges, but also water quality, permitting, and other challenges.

The water from the Pollock well field, after treatment through granular activated carbon, has higher water quality than the water from the Los Angeles River or from recycled water. Continuing to use the treated groundwater as a source of refill water would also be the least time consuming and the least expensive alternative, and it is a solution that is already in place.

**Shoreline Improvements**

Part of the goal of the SLRC Master Plan is to evaluate many development alternatives. Many of the alternatives involve improvement of access to Silver Lake Reservoir and Ivanhoe Reservoir. Proposed development alternatives will likely include alternatives that remove a portion of the protective fencing that currently surrounds the SLRC and physical improvements to the shorelines for portions of the reservoirs. From a water quality perspective, these improvements would result in a change in status of the beneficial use of the two water bodies. Specifically, by allowing the public to access to the reservoirs, this introduces the potential for bodily contact with the water, and would convert the current potential REC-1 beneficial use into a future existing REC-1 beneficial use. The water quality objective for bacteria would thus become more stringent.

Some concepts for shoreline improvements include the removal of the existing asphalt and concrete banks of the reservoirs and re-grading the slopes with a gentler grade. Removing the impervious paving on the banks of Silver Lake and Ivanhoe Reservoirs was found to have the support of 78% of neighborhood residents in 2016 (Silver Lake Reservoirs Conservancy). This was also a stated goal of the three community organizations invested in the future of the SLRC (Silver Lake Forward, Silver Lake Now, Silver Lake Reservoirs Conservancy), according to a joint statement released in 2016 (Silver Lake Coalition).

Shoreline improvements have their own set of constraints from the perspective of water use beyond water quality challenges. Any design of shoreline improvements would need to consider California Division of Safety and Dams (DSOD) development requirements in the areas of the SLRC where the DSOD has jurisdiction. Some of the DSOD constraints include restrictions on the types of vegetation allowed on the land designated as a dam. Trees,
deep-rooted plants, and dense vegetation are not allowed on dams and within certain DSOD areas. DSOD approval is required for any plantings on slopes or bank naturalization.

The goal of preserving DWP system operations also presents certain challenges to any shoreline improvements. DWP will require continued access to all necessary facilities, including those located along the perimeter of both reservoirs and the existing access ramps. Additionally, the future aeration and recirculation projects will add new infrastructure to the SLRC, and this infrastructure must be protected. Aeration tubes and manifolds will be located on or near the slopes and will require hard surfaces to lay down piping and tubes.

**Recreational Structure Additions or Improvements**

The SLRC Master Plan may present concepts that call for the placement of additional structures onsite. Some of those concepts may call for structures or other improvements to land that is currently within a FEMA designated floodplain.

Both Silver Lake Reservoir and Ivanhoe Reservoir are in FEMA Flood Zone AE to the current extents of the normal pool elevation. The FEMA Flood Zone AE designation means that a portion of the SLRC is within a special flood hazard zone, which is a category that places restrictions on the type of construction that can occur within the zone. If structures are proposed on filled land within the existing boundaries of the flood zone, there may be limitations to the type of development that can occur there.

**Wetlands**

Several plans for Silver Lake Reservoir over the years have introduced the concept of providing constructed wetlands around the periphery of Silver Lake Reservoir for stormwater quality improvements (Soderstrom, et al., Jao). The natural bioremediation processes present in the wetland plants and soils help filter out contaminants in water.

Constructed wetlands are permanently wet facilities with inlet and outlet structures, a forebay, and a permanent pool with aquatic plants. Constructed wetlands are a treatment control BMP as described in the LACDPW LID Standards Manual (2014). The permanent pool can either contain a large uniformly shallow pool, or contain several pools with varying depths not to exceed about 5 feet. The aquatic plants within constructed wetlands enhance pollutant removal through consumption of harmful nutrients and bacteria. Typically constructed wetlands are used in situations with permanent inflows and outflows rather than in lacustrine environments with no inflows or outflows.

From a water quality perspective, the inclusion of wetlands is most beneficial when it is used in situations where there is a consistent source of polluted influent flows. For the four sources of external water discussed in this report as potentially or currently being used for reservoir refill, one of them is from sources that has already been treated (treated groundwater from Pollock Well #3) and one is from a source that is not a consistent flow (the DWP stormwater capture project). Constructed wetlands would be useful therefore from a water quality perspective through the continuous recirculation of water from within the SLRC itself or to remove nutrients from recycled water or from the Los Angeles River sources of water.

Certain design concepts will feature activities that increase bodily contact with water, perhaps from shoreline access to new recreational features on the water or through swimming facilities. It is reasonable to expect that the concentration of bacteria in the water will increase under such a design scenario while at the same time necessitating water quality objectives that become more stringent regarding bacteria concentrations. Under such a design concept, recirculation of water through a constructed wetlands area, perhaps in combination with other treatment BMPs, would be an effective treatment process.

A challenge to constructed wetlands is the large footprint required for the treatment BMP to be effective. The SLRC is very large, but most of the area is currently composed of surface
water at very deep depths. The inclusion of constructed wetlands will require some of this existing water surface area to be filled in. This may trigger other issues regarding the DSOD jurisdictional area and DWP operations areas. Other water quality constraints to shallow water include the fact that shallow water tends to have warmer water and more algae growth than deep water, though dissolved oxygen tends to be better than in deep water.

Additionally, the current inflow structure at Ivanhoe Reservoir introduces water to the system at an elevation several feet below the surface of the reservoir. Any inflow to a constructed wetlands system would need to enter the wetlands near the water surface, which would mean modifying the existing inlet structure, building a new inflow structure, or building a berm or weir surrounding the inlet structure to force refill water to the surface.

Additional concerns regarding the development of constructed wetlands would be aesthetic, odor, and vector related. Constructed wetlands introduce habitat and food for wildlife, and they attract mosquitoes, which plays an important role as a food source for wildlife. Constructed wetlands may also increase odors in the neighborhood as organic material decomposes. Nearby residents may not approve of the conversion of previously open water areas to reedy plant areas from an aesthetic perspective.
4 POTENTIAL FUNDING SOURCES

This is a list of grants and loans that have been used in the past for similar projects. These may or may not be available for SLRCMP projects depending on timing of the project, availability of grant funds, and final design of the project.

Grants for Water Resources

- Los Angeles County Measure W funding
- California Department of Parks and Recreation – Proposition 68 Parks and Water Bond
- California Department of Water Resources (DWR) – Integrated Regional Water Management Grants via Proposition 1 (project must be included in an IRWM Plan).
- California DWR – Urban Streams Restoration Program (including removing concrete from embankments)
- California SWRCB – Stormwater Grant Program (Proposition 1) (project must be included in a stormwater resource plan).
- California Water Commission – Water Storage Investment Program
- U.S. Environmental Protection Agency – Urban Waters Small Grants
- California SWRCB – Water Recycling Fund Program (for recycled water)
- National Fish and Wildlife Foundation – Five Star & Urban Waters Restoration Grant Program.
- U.S. Bureau of Reclamation – Drought Resiliency Projects
- U.S. Bureau of Reclamation – Cooperative Watershed Management Program

Grants for Urban Greening

- National Fish and Wildlife Foundation – Environmental Solutions for Communities Grant Program.
- Surdna Foundation Grant
- California Climate Investments – Urban Greening Program
- California Department of Parks and Recreation – Habitat Conservation Fund (for wetlands)
- National Fish and Wildlife Foundation – Five Star & Urban Waters Restoration Grant Program.
- California Wildlife Conservation Board – Habitat Restoration Grant

Grants for Park Improvements

- California Department of Parks and Recreation – Proposition 68 Parks and Water Bond
- California Natural Resources Agency – California River Parkways Grant Program
- National Endowment for the Arts – Our Town Grants
- California Climate Investments – Urban Greening Program
- California Department of Parks and Recreation – Land and Water Conservation Fund (for outdoor recreation)
- California Department of Parks and Recreation – Outdoor Environmental Educational Facilities
- California Natural Resources Agency – Environmental Enhancement and Mitigation Program (for urban forestry)
- National Parks Service – Land & Water Conservation Fund (for recreational facilities)

Grants for Pedestrian or Bicycle Improvements

- California Department of Parks and Recreation – Recreational Trails Program
- Los Angeles County Metropolitan Transit Authority (Metro) Access and Mobility Grants.
- California Department of Parks and Recreation – Land and Water Conservation Fund (for outdoor recreation)
- California Transportation Commission – Active Transportation Program
- Federal Transit Administration (FTA) – Enhanced Mobility of Seniors and Individuals with Disabilities
- FTA – Flexible Funding Program: Surface Transportation Block Grant
- People for Bikes – Community Grant Program
- Rails to Trails Conservancy – Doppelt Family Trail Development Fund
- Federal Highway Administration – Recreational Trails Program

**Other Grants**

- U.S. Department of Housing and Urban Development Community Development Block Grants
- California Department of Parks and Recreation – Outdoor Environmental Educational Facilities
- California DWR – Water-Energy Grant Program (if it can be proven that the project will reduce greenhouse gas emissions and reduce water and energy use)

**Loans**

- California SWRCB – Clean Water State Revolving Fund
- California SWRCB – Loan Forgiveness for Green Projects
- California Infrastructure and Economic Development Bank – Infrastructure State Revolving Fund
- The Conservation Fund – Conservation Loans (for trails, parks, and habitat restoration)
5 REFERENCES


City of Los Angeles Department of Public Works Bureau of Engineering (BOE). 2018. “Los Angeles Department of Water and Power Silver Lake Reservoir Complex Master Plan RFP.”


City of Los Angeles Department of Water and Power (DWP). 2013. Addendum to the Final Environmental Impact Report: Silver Lake Reservoir Complex Storage Replacement Project. SCH # 2003081133


City of Los Angeles Department of Water and Power (DWP). 2019. “Silver Lake & Ivanhoe Reservoirs: Aerial Exhibit”.


Silver Lake Reservoirs Conservancy. [http://www.silverlakereservoirs.org/historic-gallery](http://www.silverlakereservoirs.org/historic-gallery)