COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"To Enrich Lives Through Effective and Caring Service"

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IN REPLY PLEASE
REFER TO FILE: WR-5
A3570

March 31, 2011

TO: Each Supervisor

FROM: Gail Farber
Director of Public Works

BOARD MOTION OF MARCH 1, 2011, AGENDA ITEM 60-C
DEVIL'S GATE DAM AND RESERVOIR POSTFIRE SEDIMENT REMOVAL SHORT-TERM SOLUTION REPORT FOR SEDIMENT ACCUMULATION ALONG THE FACE OF THE DAM

In response to your Board's motion, Public Works has prepared the attached report. The report contains our findings and recommendations for short-term measures that can be implemented to reduce the impact of sediment accumulation along the face of Devil's Gate Dam. We will return to your Board for approval of emergency contracting authority and force account authority to implement the interim measures in the report.

We will be contacting your offices shortly to schedule individual briefings of the report. In the interim, if you have any questions, please call me or your staff may contact Diego Cadena, Deputy Director, at (626) 458-4008.

AF:abc
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Attach.

cc: Chief Executive Office (Rita Robinson)
County Counsel
Executive Office

DEVIL'S GATE DAM AND RESERVOIR POSTFIRE SEDIMENT REMOVAL

SHORT-TERM SOLUTION REPORT FOR SEDIMENT ACCUMULATION ALONG THE FACE OF THE DAM

March 2011

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DEVIL'S GATE DAM AND RESERVOIR POSTFIRE SEDIMENT REMOVAL INTERIM OPERATIONAL AND MAINTENANCE PLAN

1. EXECUTIVE SUMMARY

Located in the City of Pasadena, Devil's Gate Dam and Reservoir serves as a critical component of the Los Angeles County Flood Control District's (District) infrastructure, providing flood protection to the Cities of Pasadena, South Pasadena, and Los Angeles, as well as the 110 Freeway, and numerous recreational facilities along the Arroyo Seco, including the Rose Bowl and Brookside Park.

Following the devastating 2009 Station Fire, storms during the 2009-10 storm season deposited 1,000,000 CY of sediment into Devil's Gate Reservoir. For comparison, that one-year volume is ten times the total amount deposited in the reservoir during the previous 16 years (since its last cleanout in 1994).

This sudden sediment accumulation buried one of the dam's outlet gates and now threatens to block the other outlets and spillway ports. Additionally, the sediment has reduced the reservoir's volume, and it no longer has capacity to safely contain another major debris event.

Likely impacts include the inability to utilize the dam's outlet valves to make flood control releases or to lower the reservoir in response to a dam safety concern. Additionally, there is a risk of significant flooding and debris flows below the dam. These impacts and risks will only be mitigated by removing the sediment within the reservoir.

In an effort to minimize the anticipated impacts until the sediment is removed, we have developed a Risk Reduction Plan that includes an interim operating plan, physical dam modifications, and a Flood Hazard Warning and Contingency Plan. These measures will require a $960,000 capital outlay as well as an annual maintenance expenditure of up to $1,250,000 depending on the severity of each storm season.

It is critical to note that these interim risk reduction measures are only being implemented until the sediment is removed from the reservoir following the completion and certification of an Environmental Impact Report (EIR) by the Board of Supervisors. If the facility experiences another debris event of the same or larger magnitude encountered during the 2009-10 storm season, the interim measures will not suffice and our ability to control releases from the dam will be lost, thereby placing downstream communities at additional risk of debris flows and flooding.

2. CONDITION ASSESSMENT

2.1 Watershed Condition

Devil's Gate Dam and Reservoir, located in the City of Pasadena, is a part of the Arroyo Seco Watershed. The facility impounds flows from the Arroyo Seco, which serves as a major tributary to the Los Angeles River. Devil's Gate Dam was the first of several dams to be built by the District for the purpose of flood control and water conservation and was completed in 1920. The reservoir is operated primarily for flood and debris control to provide flood protection to several communities including the Cities of Pasadena, South Pasadena, and Los Angeles; numerous recreation areas including the Rose Bowl; the 110 Freeway; and several bridges.

Devil's Gate Reservoir, lying south of the San Gabriel Mountains, is subject to a highly erosive watershed. Approximately 20,416 acres (39.1 square miles) of both residential and undeveloped land drain into Devil's Gate Reservoir. The reservoir covers approximately 120 acres (0.18 square miles).

In 1993, the City of Pasadena established the Hahamongna Watershed Park and incorporated Devil's Gate Reservoir within the Hahamongna Park's boundaries. Recreational uses in the park include hiking, bicycling, horseback riding, picnicking, and disc golf. These recreational uses will be impacted as additional debris accumulates in the reservoir.

The Station Fire burned over 162,000 acres in the Angeles National Forest in the fall of 2009. Approximately 68 percent of the watershed (nearly 100 percent of the undeveloped watershed) tributary to Devil's Gate Reservoir was burned. On average, a watershed requires five years to recover from a wildfire, thus the dam and reservoir are expected to be impacted from the affects of the Station Fire for several more storm seasons. During this time, increased sediment production is expected from the denuded ground surface.

2.2 Dam Condition

Following the 1971 Sylmar Earthquake, heightened safety concerns and better understanding of seismic behavior prompted new investigations and analysis of District dams, including Devil's Gate Dam. In response to findings from these studies, in 1978 the State Department of Water Resources Division of Safety of Dams (DSOD) officially imposed an operational restriction preventing the holding of water at Devil's Gate Dam due to concerns with the dam's ability to withstand a major earthquake. In 1997, the District completed a construction project that seismically rehabilitated Devil's Gate Dam. The rehabilitation project also enlarged the spillway to safely pass the Probable Maximum Flood, the required level of flood protection, without overtopping the dam. After project completion, the DSOD restriction was removed restoring the dam and reservoir

to its full operational capacity, thus providing its potential for water conservation.

Devil's Gate Dam and Reservoir attenuates peak storm runoff, and impounds sediment and debris during storm events to prevent high flow rates from overwhelming the downstream system. Outflow from Devil's Gate Dam is controlled by three outlet corridors; a sluice gate, the outlet valve, and the outlet tunnel gates (Figure 1). The outlet valve and tunnel gates are used to make controlled releases when the reservoir has impounded storm water. The sluice gate is used to drain the reservoir after storm flows recede, or due to an emergency condition.

During small storms and the early stages of larger storms, the sluice gate is left open so that the storm flow along with its accompanying sediment passes through the dam. During larger storm events when more flow enters the reservoir than exits through the sluice gate, stormwater and sediment begin to accumulate at the dam face. When that occurs, the sluice gate is closed so that a pond develops in the reservoir. This pond, referred to as a buffer pool, prevents more sediment from accumulating at the face of the dam. As sediment-laden storm flows from the watershed enter the reservoir and reach the buffer pool, they slow down and the sediment settles to the bottom of the pool away from the dam. As the storm continues, water is released from the outlet valves and tunnel gates at a rate that maintains the buffer pool.

If the rate of storm inflow exceeds the capacity of the outlet valves and tunnel gates, the reservoir will continue to rise until it reaches the spillway ports (ungated openings below the main spillway). During major storm events, the reservoir may continue to rise even higher and flow will go over the main spillway.

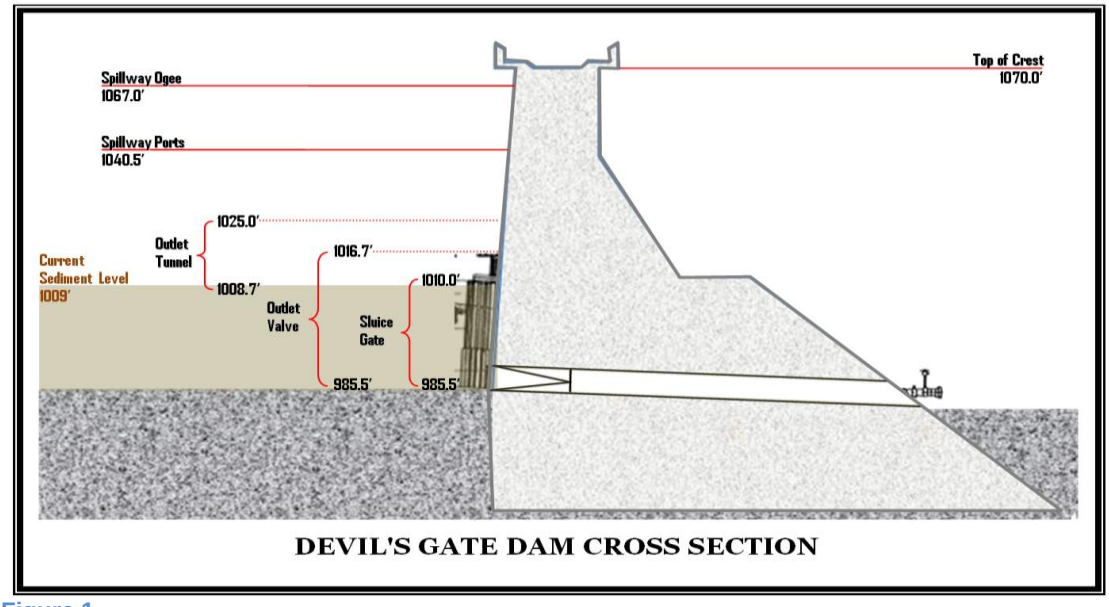


Figure 1

This operation of Devil's Gate Dam prevents debris loads from building up on the face of the dam and reduces the amount of debris that is trapped in the reservoir. The reservoir area is periodically surveyed to verify sufficient capacity is available to hold the debris produced by a 50-year storm event over an entirely burned watershed, estimated to be 1,671,000 CY.

Despite these operational efforts, the constant inflow of debris during storm events requires that we periodically plan projects to remove sediment. The most recent cleanout of Devil's Gate Reservoir occurred in 1994 when 190,000 CY of sediment were removed. Since the cleanout in 1994 and prior to the 2009-10 storm season, there had been an insignificant amount of sediment build up in the reservoir. In 2006 and 2009, 14,000 CY and 3,800 CY, respectively, of sediment were removed from around the outlet works of Devil's Gate Dam. During the 2009-10 storm season, rain falling on the denuded watershed burned during the Station Fire resulted in 1,000,000 CY of sediment being washed into the reservoir.

As a result of this sudden sediment accumulation, the reservoir storage capacity has been significantly reduced (See Attachments A-1 and A-2). Additionally, the outlet valve is plugged and inoperable. During the March 4, 2011, storm, we attempted to utilize the sluice gate during storm operations, but it quickly became partially plugged and we could not close it until maintenance crews cleaned the trashrack around the sluice gate (See Attachments A-3 and A-4). The top of the sluice gate trashrack is at elevation 1,010 feet. When debris exceeds this level, the trashrack will plug and the sluice gate will be inoperable. The operability of the sluice gate is crucial as it is the only outlet that has the ability to drain the reservoir for maintenance, inspection, and emergencies. The outlet tunnel invert is at elevation 1,007 feet behind a trashrack. The top of this trashrack is at elevation 1,025 feet. When sediment reaches this elevation, the gates will be inoperable. The current sediment elevation is at 1,010 feet and could inundate the sluice gate during the next storm. Additionally, the recent 2010 DSOD inspection report recommends the silt and sediment buildup in the reservoir be removed.

3. RISK ASSESSMENT

The sediment accumulation poses several consequences for Devil's Gate Dam and Reservoir. The ability to operate the dam by keeping the outlet works functional is critical to controlling storm flows to minimize the risk of downstream flooding. However, the greater concern is the loss of flood water and sediment storage capacity in the reservoir. Not only will storm flows reach the spillway faster, but the uncontrolled storm flows that will pass over the spillway will become increasingly more sediment laden and frequent as the reservoir continues to fill and lose capacity. There is a potential for the spillway ports to plug, which would force all flows over the ogee spillway at higher flow rates. Downstream channel capacity was designed with the assumption that most of the sediment would deposit in Devil's Gate Reservoir before the storm flows are discharged downstream. The larger

sediment load in the storm flows leaving Devil's Gate Reservoir will severely impact the capacity of our downstream flood control channel. The combination of losing capacity to sedimentation in the reservoir and the inability to properly operate any of the dam's outlet works affects the facility's capability for flood and debris control. The channel, which protects property from flood damage downstream of the dam, was not designed to handle heavy sediment flows from the watershed above the dam. Consequently, the following locations shown on Figure 2 will potentially be inundated with storm flows and debris during large storm events:

AREA 1:
- Portions of Brookside Golf Course

AREA 2:
- Lower Arroyo Park at Colorado Boulevard, west of Westbridge Place, and west of California Boulevard

AREA 3:
- Adjacent residents at Busch Garden Drive and Busch Garden Court
- Adjacent stables north of San Pascual Avenue
- San Pascual (Arroyo) Park and Stoney Drive at the 110 Freeway

AREA 4:
- 110 Freeway and adjacent property at York Boulevard/Pasadena Avenue
- 110 Freeway and adjacent property south of Marmion Way
- 110 Freeway at Metro Gold Line Crossing
- 110 Freeway, freeway onramp, and adjacent park near South Avenue 60

AREA 5:
- 110 Freeway near Via Marisol
- 110 Freeway and adjacent residents near South Avenue 52/Griffith Avenue

AREA 6:
- 110 Freeway and east of Sycamore Park Drive

In the unlikely event of a dam safety emergency, the outlets would be required to safely drain the dam. If all the outlets become inoperable, emergency dewatering of the reservoir would be impossible. Figure 3 illustrates the inundation area, which would potentially be flooded if the dam were to fail before being dewatered.

4. RISK REDUCTION PLAN

Until the sediment is removed from the reservoir, following the completion and certification by the Board of Supervisors of an Environmental Impact Report (EIR), the dam's three outlet corridors and the spillway ports have a high potential to be completely covered with sediment, which would damage the valves and eliminate our ability to control outflow from the dam. Reducing the risk of damage to the dam's outlet corridors and spillway ports can be accomplished through a change in the operation of the dam and by constructing several physical modifications to the dam. In addition, a Flood Hazard Warning and Contingency Plan will be developed due to the increased flood hazard downstream.

4.1 Interim Operational Plan

Due to the operational impacts from the current and increasing sediment levels in the reservoir, it is necessary to deviate from the standard operating plan until the sediment is removed. The interim plan is intended to reduce additional sediment accumulation near the face of the dam by establishing a buffer pool of water in the reservoir and maintaining it throughout the storm season. This will encourage sediment inflows to settle out in the upper end of the reservoir as it reaches the buffer pool. The depth of the buffer pool will be increased periodically as sediment continues to accumulate.

The outlet tunnel gates will release water once the buffer pool elevation is exceeded. As the reservoir elevation reaches 1,040.5 feet (the lower spillway elevation), the outlet gates will be closed. As inflow recedes, the reservoir will be drawn down by releasing stormwater from the outlet tunnel gates to reestablish the buffer pool elevation. At the end of the storm season the reservoir will be drained using the sluice gate, if the gate is operable. If not operable, the reservoir would need to be drained using portable pumps. Prior to the next storm season, the sluice gate will be closed to prevent debris and material from plugging the gate, and the reservoir will again be allowed to fill to the elevation of the buffer pool. With diminishing storage capacity in the reservoir, even mild storms have the potential to fill the reservoir to spillway at which point all gates will be closed.

4.2 Physical Dam Modifications

In addition to the Interim Operational Plan of Devil's Gate Dam and Reservoir, the following interim measures will be implemented while the District is progressing toward obtaining an EIR certification for a sediment removal project at this location. These measures will reduce the risk of damage to the dam and will be confined to the boundary shown on Attachment A-5. Sediment removal within Devil's Gate Reservoir must be completed to avoid damage to critical flood control components of Devil's Gate Dam and to reduce the risk of flooding to downstream communities.

4.2.a Measures (Force Account Work)

1. Regrade the access road from the left abutment of the dam down to the sluice gate area in front of the dam. This measure will provide maintenance crews access to the reservoir invert area in front of the dam to perform required maintenance activities. The estimated cost is $30,000.

2. Replace the existing wooden boom logs (wood plank and frame – See Attachment A-6) that are deployed upstream of the dam to trap floating debris. The wooden logs are more than 50 years old and

many are now dilapidated. In addition, the wood logs become very heavy and extremely difficult to handle when water-logged. This measure will replace the wooden logs with modern foam/plastic boom logs that are equipped with a short chain "skirt" hanging below the water surface in order to retain the floating debris more efficiently. The estimated cost is $40,000.

3. Install new sets of anchor points on the banks of the reservoir to allow safe and flexible anchoring of the boom logs (See Attachment A-7). This measure will allow the boom to be adjusted up and down with the changing water surface elevations as the reservoir is being operated. The estimated cost is $60,000.

4. Clear an estimated 25,000 CY of sediment from an area approximately 100 feet upstream of the dam to minimize clogging and/or other impacts to dam operations prior to each storm season and haul the material to Scholl landfill at an estimated annual cost for labor, equipment, and dump fees of $750,000 ($30 per CY). This amount is the estimated volume expected to migrate to the face of the dam even though a buffer pool will be maintained. It will be removed without impacting existing willow trees by positioning a crane on the crest of the dam to "clamshell" wet debris and sediment accumulation from in front of the sluice gate when the reservoir is drained at the end of each storm season. This would result in approximately 150 to 200 truck trips per day for four weeks, which is not expected to disrupt traffic in the area. Removal of the initial 25,000 CY is critical to the completion of all remaining measures. The limits of sediment removal are shown on Attachment A-5.

4.2.b Measures (Emergency Contract Work)

1. Modify the existing sluice gate trashrack to reduce the bar opening width and help to keep large debris from breaching the protection of the trashrack. This measure is aimed to reduce damage and/or interference with the sluice gate's operation. The estimated cost is $100,000.

2. Extend the existing sluice gate trashrack by approximately 32 feet up to the spillway port holes at an elevation of 1,040.5 feet. This measure is aimed to alleviate a potential scenario where the sluice gate trashrack becomes completely clogged by debris or sediment, and the District has no other means to drain the reservoir. The estimated cost is $500,000.

3. Install 200 feet of new catwalk on the upstream face of the spillway approximately 10 feet above the top elevation of the spillway port

holes. This measure will provide maintenance crews safe access to the port holes during high flows. This will enable crews to dislodge tree trunks and other large debris that may be caught at the port holes thereby impeding the flow capacity of the spillway. The estimated cost is $60,000.

4. Modify the Altadena west storm drain that discharges into the east bank of the reservoir just upstream of the dam. The Altadena west system is a major flood control drain for the residential and commercial area to the east of the Devil's Gate Dam. The current sediment level in the reservoir is already higher than the top of the existing drain outlet. The proposed outlet will guarantee the continued operation of the drain, should the sediment continue to build up in the reservoir in the succeeding storm seasons. The estimated cost is $80,000.

5. Replace approximately 100 feet of damaged ladder system on the upstream face of Devil's Gate Dam. The existing ladder provides the only access to the sluice gate trashrack for clearing of debris that are clogging the trashrack or interfering with the operation of the sluice gate. Several components of the ladder system were damaged by recent debris inundation and pose a safety hazard for the crews performing the maintenance activities. The proposed stairs will replace the vertical ladders to provide maintenance crews safe access to the trashracks to dislodge tree trunks and other large debris that may be caught in the trashracks thereby impeding the flow to the valves and gates. The estimated cost is $90,000.

Based on the booming operations in 2009 and 2010, an additional $500,000 is estimated to be incurred for hauling and dumping of trash and organic material at the landfill each season.

Applicable DSOD and regulatory agency permits will be required for interim measures. Following Board review, we will consult other agency experts to solicit suggestions for any possible additional interim implementation measures.

4.3 Cost Summary

Project/Measure	Estimated Cost
Using Public Works Forces (Force Account)	
Re-grade access road to Dam's sluice gate	$30,000
Replace boom logs	$40,000
Install new boom log anchors	$60,000
Remove sediment from face of dam	$750,000
Total Using Public Works Forces	***$880,000***
Emergency Contracts	
Modify trash rack bars on Dam's sluice gate	$100,000
Extend height of trash rack on Dam's sluice gate	$500,000
Install additional catwalk on Dam's spillway	$60,000
Modify the Altadena West Storm Drain	$80,000
Replace ladder system on Dam's upstream face	$90,000
Total Emergency Contracts	***$830,000***
Total Interim Modifications and Safety Measures	***$1,710,000***

4.4 Flood Hazard Warning and Contingency Plan

In order for agencies and residents to properly prepare for and respond to flooding risks and potential emergencies associated with Devil's Gate Dam, until the reservoir cleanout is complete, two emergency plans, as discussed below, will be developed prior to the 2011-12 storm season. The first plan will be used to notify agencies and residents in response to potential flooding along the Arroyo Seco Channel due to high debris flows. The second will be used to notify agencies in response to a dam safety emergency that could lead to failure of the dam.

4.5 High Debris Flow Emergency Plan

The locations shown in Figure 2 will be monitored by channel observers during storms when the channel reaches 2/3 full. A notification list will be developed with affected agencies and residents for road closures and evacuations when warranted.

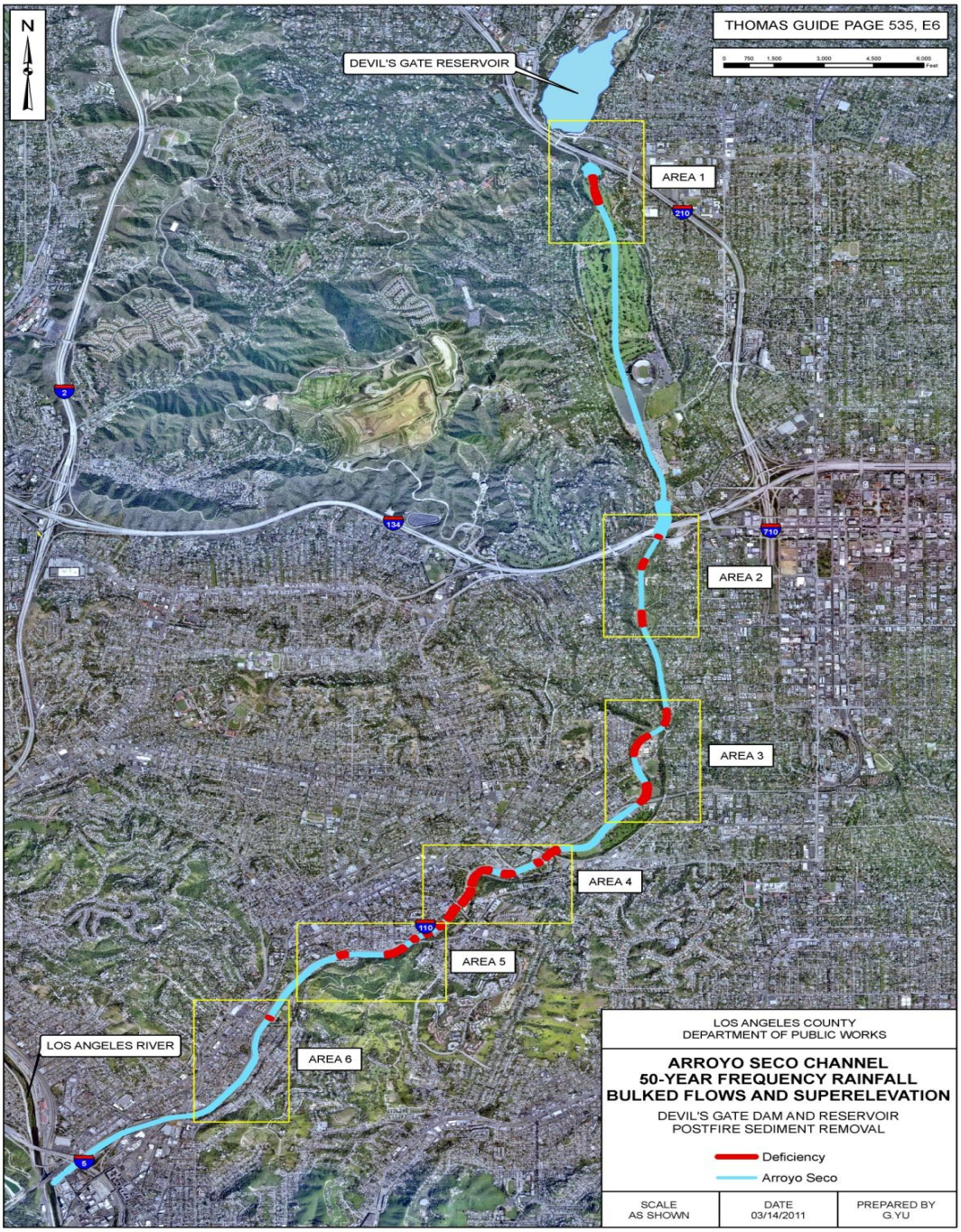


Figure 2 Arroyo Seco Overtopping Locations

4.6 Dam Failure Emergency Plan

Figure 3 illustrates the inundation area that would be flooded in the unlikely event of a dam failure. A current list exists for notifying emergency responders of imminent or actual dam failure. The list will be updated, and we will meet with emergency responders to clarify notification protocols and to encourage them to develop road closure and evacuation plans.

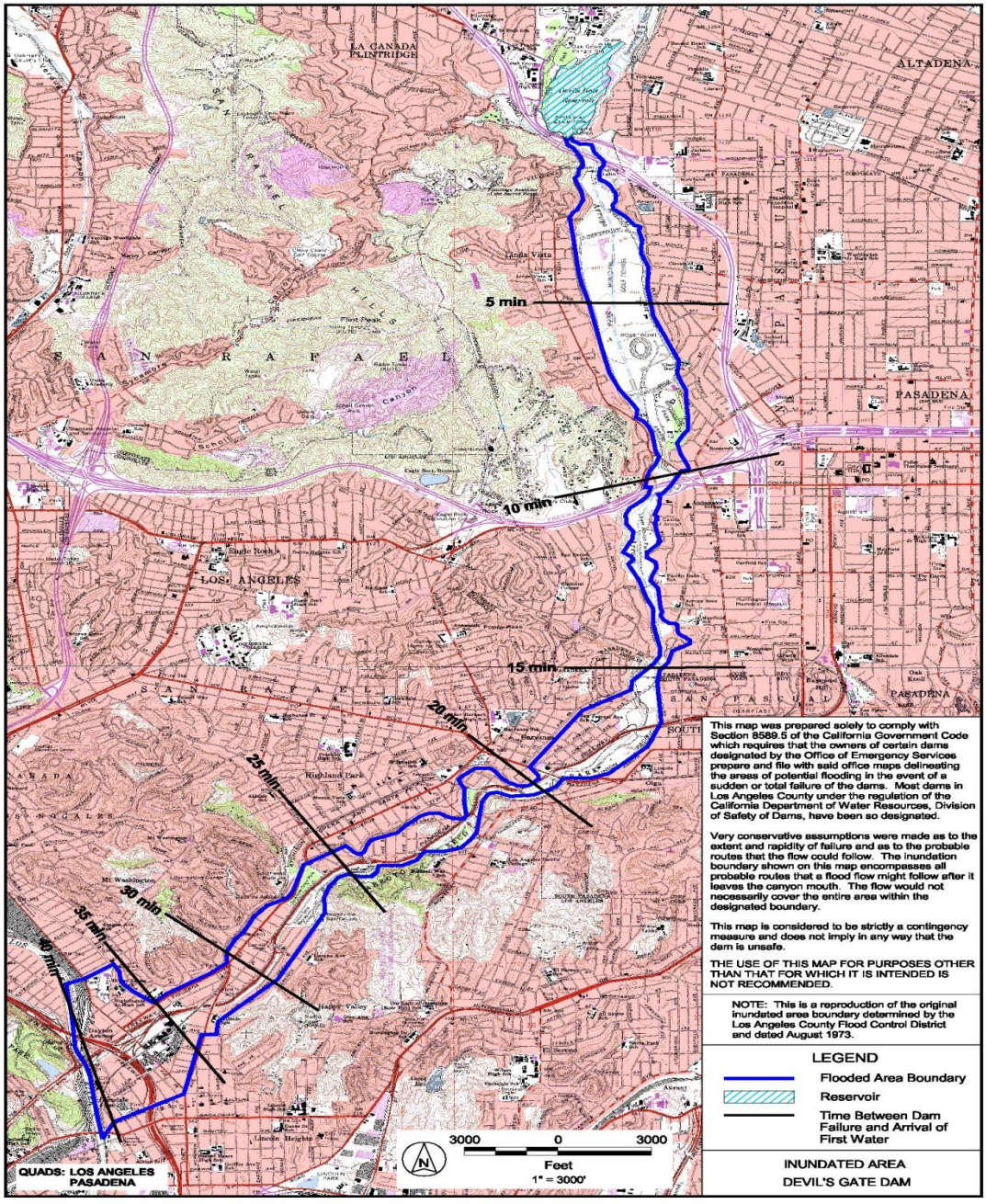


Figure 3 Arroyo Seco Dam Failure Inundated Area

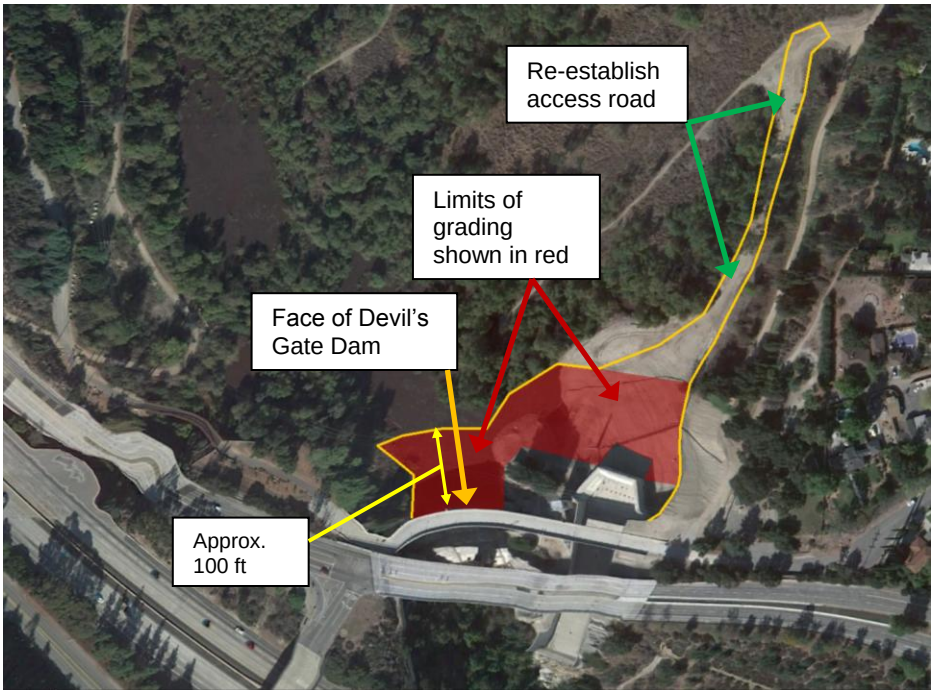
ATTACHMENTS
A-1 THROUGH A-7

A-1 Pre-Station Fire

A-2 Post-Station Fire 02/08/10

A-3 Intake Structures Cleared Pre-Station Fire 08/05/09

A-4 Sediment Threatening Sluice Gate Post-Station Fire 03/10/11



A-5 Boundary limits for interim measures
No vegetation will be removed

A-6 Wooden Boom Logs **03/10/11**

A-7 Plastic Booms **02/10/10**

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