Draft

ARUNDO DONAX MANAGEMENT – SACRAMENTO RIVER

Aquatic Pesticide Application Plan (APAP)

Prepared for:
California Department of Water Resources

September 2021
(Revised November 2021)

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ARUNDO DONAX MANAGEMENT – SACRAMENTO RIVER

Aquatic Pesticide Application Plan (APAP)

Introduction

On May 10, 2021, Governor Gavin Newsom of California declared a State of Emergency in 41 counties due to severe drought conditions. Under the proclamation, it states that: "the Department of Water Resources shall take actions, if necessary, to implement plans that address potential Delta salinity issues. Such actions may include, among other things, the installation and removal of, Emergency Drought Salinity Barriers at locations within the Sacramento-San Joaquin Delta." The California Department of Water Resources (DWR) has determined that a salinity barrier is needed in response to the current drought conditions in the Sacramento-San Joaquin Delta (Delta). The 2021 Emergency Drought Salinity Barrier Project in the West False River is a temporary rock barrier to reduce the intrusion of high salinity water into the central and south Delta. The Incidental Take Permit (ITP) for the project specifies that DWR shall develop and implement an Invasive Species Management and Monitoring Plan to manage non-native vegetation on 1.85 acres of sandbar locations for two years. The goal of the plan is to expose sandbars in shallow water habitat to increase habitat for smelt egg deposition. It was determined that the application of aquatic herbicides would be needed to control the non-native vegetation. This requires coverage under the Statewide General National Pollutant Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (General Permit). Section VII(C) of the General Permit requires that Dischargers develop an Aquatic Pesticides Application Plan (APAP). The APAP, along with the notice of intent (NOI), is provided to the State Water Board as part of DWR's application for coverage under the General Permit.

Description of the Water System

The Sacramento River is the largest river in California, flowing south more than 300 miles from Mount Shasta, starting at river mile (RM) 302, to Suisun Bay, ending at RM 0. Along this route it drains an area of 62,000 km^2. Prior to flowing into Suisun Bay in upper San Francisco Bay, the Sacramento River meets the north-flowing San Joaquin River forming the Sacramento-San Joaquin Delta (Delta). Spreading east from the confluence of the Sacramento and San Joaquin rivers, the Delta is comprised of 700 miles of sloughs and waterways surrounding more than 60 islands that serves as habitat for fish, birds, and other wildlife. The lower Sacramento River constitutes the area between the confluence of the

Sacramento River with Steamboat Slough and the Prospect Slough/Cache River complex at RM 14, and the confluence with the San Joaquin River at RM 0.

The lower Sacramento River and the Delta are impacted by the establishment of numerous invasive animal and plant species. In particular, invasions of non-native plant species are a primary concern of natural resource managers. Growth of non-native, invasive floating and submersed aquatic vegetation such as Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), respectively, are widely recognized as problematic in the Delta (Boyer and Sutula 2015). In addition to these non-native aquatic plants, the riparian zone of the Delta is impacted by large stands the non-native *Arundo donax* (Arundo). This bamboo-like perennial grass lines both banks of the lower Sacramento River, and the sloughs of the Delta, growing up to 25 feet tall. Establishment of Arundo stands occurs at the expense of native riparian plants, such as the common tule (*Schoenoplectus acutus*) which has historically dominated the Delta (Atwater 1980). Once established, Arundo reduces shading of the stream habitat, thereby increasing water temperatures, and decreases plant and animal diversity by displacing native species typically associated with riparian habitats.

The establishment of Arundo in the Delta is a wide-spread problem and local natural resource agencies have formed the Arundo Control and Restoration Program in order to remove Arundo from Delta waterways and restore native vegetation. This collaboration, which includes DWR, the Delta Conservancy, Solano Resource Conservation District, California Department of Fish and Wildlife (CDFW), US Fish and Wildlife Service (USFWS), and local landowners, is focused on restoring riparian habitats along Lindsey Slough, the Cache Creek Complex, and the lower Sacramento River.

Description of the Treatment Area

The treatment area for the current project is approximately 2 miles southwest (downstream) from the community of Rio Vista, CA. The treatment area is a long and narrow riparian zone located along the west bank of the lower Sacramento River, between RM 3 and 11 (Figure 1). This area is across from Decker Island and Sherman Island. Decker Island is carved out from the larger Sherman Island by a horse-shoe shaped meander of the lower Sacramento River (Figure 1). Vegetation along the east bank of the lower Sacramento River (on Decker Island) is dominated by grassland, agricultural land, and riparian scrubs or shrub including willow thickets. The west bank is dominated by grasslands and Arundo stands (SFEI-ASC 2014). Inland from the riparian zone, the west bank and upland area are primarily urban whereas the east bank is agricultural.

Within the area of interest, the Sacramento River is up to 3,000 feet wide and 40 feet deep. This is substantially wider and deeper than the channel above RM 14 and results in the river slowing down when it enters this region. The residence time of the water in this portion of the lower Sacramento River is influenced by a semi-diurnal tide, causing the water to travel back-and-forth with the ebb and flood tidal cycle several times before exiting into Suisun Bay.

SOURCE: Esri, 2021; DWR, 2021; ESA, 2021.

Mitigation: West False River Emergency Drought Salinity Barrier Project

Figure 1
Arundo donax Treatment Location

ESA

Description of the Target Species

Arundo donax (family Poaceae), also known as giant reed or Arundo, is a Class B pest in California. Class B pests are of known economic or environmental detriment and, if present in the state, is of limited distribution (CDFA 2021). Arundo is a perennial grass with hollow cane stems that grows up to 25 feet tall. It spreads vegetatively from horizontal roots (rhizomes) below the soil forming dense stands that can measure several meters across. Seed production is not a factor in its spread in California as seeds are not viable. It has green leaves similar to the leaves of corn, up to two feet in length, and it has a plume-like flowerhead. It grows along the edge of waterways as it prefers moist growing conditions. It spreads rapidly through fragmentation of both its stems and rhizomes which travel via water and mud to re-establish in new locations. Sprouting of new shoots from rhizomes (and stems) with a node is most common in spring and biomass accumulation is fastest during warm months when rates of growth can reach 4 inches per day (Cal IPC 2020). When colonizing a location, Arundo will quickly out-compete the native flora due to its fast growth rate enabling it to monopolize sources of water and nutrients. Owing to its high rates of growth and transpiration, Arundo will use three times as much water as native grasses, impacting hydrology and reducing freshwater availability where the stands develop (USDA 2014).

Intended Products

Aquatic Herbicides and Adjuvants

Applications of herbicides will be by trained personnel according to product label instructions and will be consistent with best management practices (BMPs), and local, State, and Federal regulations. The application method may vary in order to suit the target weed and site conditions. All applications will be “targeted” through the use of a back pack or hand-held power sprayer. No broadcast methods will be used (such as aerial spraying). Given that the Arundo treatment site, is located in a riparian area, applications could occur from the shoreline if access is sufficient or by boat from the river side. An Aquatic Pesticide Application Log (APAL) will be maintained to record aquatic herbicide applications and site conditions. The APAL will allow DWR and the Water Board to investigate any exceedance of receiving water limitations or receiving water monitoring triggers. A blank APAL is included as Appendix A.

Imazapyr ((*RS*)-2-(4-Methyl-5-oxo-4-propan-2-yl-1*H*-imidazol-2-yl)pyridine-3-carboxylic acid): is a systemic herbicide labeled for application to emergent leaves of aquatic plants. Imazapyr is absorbed by the leaves and roots and moves rapidly through the plant. It accumulates in the meristem region (active growth region) of the plant. In plants, imazapyr disrupts protein synthesis. Common brand names of imazapyr that are formulated for aquatic vegetation include “Habitat” “Arsenal”, and “Polaris AC”. Imazapyr is commonly used in conjunction with an adjuvant that is labeled for aquatic use. Imazapyr is broken down via microbial degradation in terrestrial soils. The three major metabolites of imazapyr are pyridine hydroxyl-carboxylic acid, pyridine dicarboxylic acid,

and nicotinic acid (Niacin, or Vitamin B3). The average soil half-life for imazapyr is highly variable, 25 to 141 days (Tu et al. 2001).

Glyphosate (*N*-(phosphonomethyl)glycine): is also a systemic herbicide labeled for application to emergent leaves of aquatic plants. Glyphosate is absorbed through foliage, and minimally through roots, and transported to growing points. It is effective in actively growing plants only through the inhibition of the plant enzyme EPSP (5-enolpyruvylshikimate-3-phosphate synthase) involved in the synthesis of the aromatic amino acids tyrosine, tryptophan, and phenylalanine. Common brand names of glyphosate that are formulated for aquatic vegetation include “Aquamaster” and “Rodeo”. Similar to Imazapyr, glyphosate is commonly used in conjunction with an adjuvant that is labeled for aquatic use. Glyphosate breaks down in water via microbial degradation. The primary metabolites of glyphosate are aminomethylposphonic acid (AMPA) and glyoxylic acid, both of which further degrade into carbon dioxide. It binds readily with soil or suspended organic particles, effectively inactivating its herbicidal properties. The average soil half-life for glyphosate is 47 days (Tu et al. 2001).

The nonionic surfactant, “Competitor”, and the drift and deposition control agent, “Crosshair”, are proposed for use with the tank mix to increase leaf absorption and decrease drift, respectively. Treatments will occur during low tide.

Factors Influencing Product Selection

Because growth of Arundo is so robust, and because it spreads via fragmentation of its stems and roots, it is difficult to eradicate and control. As a result, herbicides are commonly used as a control method in conjunction with other integrated approaches (USDA 2014). The herbicides glyphosate and imazapyr proposed here for the use in managing Arundo are approved for use in riparian habitats by the State Water Resources Control Board (SWRCB 2013) and the US Environmental Protection Agency (USEPA). The glyphosate formulation intended for this treatment is under the brand name “Aquamaster” (USEPA 2009a) and the imazapyr formulation under the brand name “Habitat” (USEPA 2009b). Minimizing the quantity of herbicides required for control can be accomplished by applying the herbicides within the ideal time frame of the target species growth cycle, resulting in fewer herbicide applications required and reducing the total amount of herbicide used. Decision to use and selection of appropriate herbicide(s), their rate of application, timing of application relative to weed growth stage, and other factors will be based on the recommendation of a California Department of Pesticide Regulation (CDPR) - licensed Pest Control Adviser (PCA). The PCA considers a variety of control options that may include mechanical and/or cultural techniques that alone or in combination with an aquatic herbicide are the most efficacious and protective of the environment.

Gates or Control Structures

No gates or control structures are within or adjacent to the treatment area.

Statement on Short-term or Seasonal Exceptions

The Discharger does not intend to use acrolein or copper to control Arundo, therefore an exception to the "Policy for Implementation of Toxic Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California" (Policy) section 5.3 is not applicable.

Monitoring and Reporting Program

The Monitoring and Reporting Program (MRP) will comply with the general monitoring provisions set forth in Attachment C of the 2013 General Permit and constructed to address two key questions:

> **Question 1:** Does the residual algaecides and aquatic herbicides discharge cause an exceedance of receiving water limitations?
>
> **Question 2:** Does the discharge of residual algaecides and aquatic herbicides, including active ingredients, inert ingredients, and degradation byproducts, in any combination cause or contribute to an exceedance of the "no toxics in toxic amount" narrative toxicity objective?

The MRP in Attachment C of this General Permit establishes monitoring and reporting requirements to implement federal and state requirements. The goals of the MRP are to:

1. Identify and characterize algaecide or aquatic herbicide application projects conducted by the Discharger;
2. Determine compliance with the receiving water limitations and other requirements specified in this General Permit;
3. Measure and improve the effectiveness of the APAP;
4. Support the development, implementation, and effectiveness of BMPs;
5. Assess the chemical, physical, and biological impacts on receiving waters resulting from algaecide or aquatic herbicide applications;
6. Assess the overall health and evaluate long-term trends in receiving water quality;
7. Demonstrate that water quality of the receiving waters following completion of resource or weed management projects are equivalent to pre-application conditions; and
8. Ensure that projects that are monitored are representative of all algaecide or aquatic herbicide and application methods used by the Discharger.

General Monitoring

Samples and measurements will be representative of the monitored discharge. All laboratory analyses will be conducted at a laboratory certified for such analysis by the State Water Resources Control Board (SWRCB) Division of Drinking Water in accordance with California Water Code section 13176. Laboratories that perform sample analyses shall be identified in all monitoring reports. All Quality Assurance-Quality Control shall follow protocols outlined in “Collection of Water Quality Samples for Laboratory Analysis” (DWR 2019). All analyses shall be conducted in accordance with the latest edition of “Guidelines Establishing Test Procedures for Analysis of Pollutants,” promulgated by the U.S. EPA in title 40 Code Federal Regulation (40 C.F.R.) 136 or equivalent methods that are commercially and reasonably available and that provide quantification of sampling parameters and constituents sufficient to evaluate compliance with applicable effluent limits and to perform reasonable potential analysis. Equivalent methods must be more sensitive than those specified in 40 C.F.R. 136 if the method is available in the 40 C.F.R. 136, and must be approved for use by the CVRWB Executive Officer.

Any procedures to prevent the contamination of samples as described in the monitoring program in the APAP shall be implemented.

Records of monitoring information shall include the following:

1. The date, exact place, and time of sampling or measurements;
2. The individuals who performed the sampling or measurements;
3. The dates analyses were performed;
4. The individuals who performed the analyses;
5. The analytical techniques or methods used; and
6. Results of analyses.

All monitoring instruments and devices used to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their accuracy. Monitoring results, including noncompliance, shall be reported at intervals and in a manner specified in this MRP.

Monitoring Locations and Sample Types

Monitoring Locations

Since the application of imazapyr and glyphosate will target Arundo growing in the riparian zone, sampling within the treatment area cannot occur and, instead samples will be collected adjacent to the treatment area. Three monitoring locations will be sampled according to the sample types described below. Samples and measurements will occur

at low tide at distances expected to cover the range of direct drip or drift resulting from the application.

Sample Types

1. **Background Monitoring (BM**) samples shall be collected upstream at the time of the application event or just prior to (up to 24 hours in advance of) the application event.

2. **Event Monitoring (EM)** samples shall be collected immediately downstream of the treatment area (but upstream of any secondary discharge or disturbance such as tributaries), immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.

3. **Post-Event Monitoring (PEM)** samples shall be collected adjacent to the treatment area (at the same distances described above) within one week after application or when treatment is complete.

Visual, Physical, and Chemical Monitoring

Appendix C of the General Permit describes the parameters to be tested, analytical test methods required, methods of collection, event types and frequency of sample collection. Because there are less than six application events in a year, the sampling events will equal the number of application events for non-glyphosate applications. For pesticide products with the active ingredient of glyphosate, only one set of background, event, and post-event samples will be taken (Table 1). The ITP indicates two initial treatments, November 2021 and November 2022 to expose sand bar habitats. More treatments may be applied as needed in following years. A summary of the visual, physical and chemical monitoring requirements is presented in Table 1.

Field Recording

A field logbook/binder with datasheets will be maintained by members of the sampling team to provide a record of sample location, observations, and measurements taken during sampling. Observations and measurements will be supplemented with pictures of site conditions at the time of sampling. Field datasheets are intended to provide sufficient data and observations to enable project team members to reconstruct events that occurred during the sampling. When recording observations in the field datasheet, the sampling team will note the presence or absence of: 1) Floating or suspended matter; 2) Discoloration; 3) Bottom deposits; 4) Aquatic life; 5) Visible films, sheens, or coatings; 6) Fungi, slimes, or objectionable growths; 7) Potential nuisance conditions; and 8) river flow rates will be noted. A template for field datasheets is provided as Appendix B. River flow rates will be measured by placing a flow meter calibrated according to the manufacturer's directions as close to the center of the river as possible (alternatively close to the sampling location) and a reading taken in feet per second (ft/sec). Alternatively, the time a common floating object (branch, leaf, etc.) travels 25 feet or more will be estimated and noted on the field data sheet in ft/sec.

TABLE 1. MONITORING REQUIREMENTS

Sample Type	Constituent/Parameter	Units	Sample Method	Minimum Sampling Frequency	Sample Type Requirement	Required Analytical Test Method
Visual	1. Monitoring area description (pond, lake, open waterway, channel, etc.) 2. Appearance of waterway (sheen, color, clarity, etc.) 3. Weather conditions (fog, rain, wind, etc.)	Not Applicable	Visual Observation	1	Background, Event and Post-event Monitoring	Not Applicable
Physical	1. Temperature[2]	°F	Grab	5	Background, Event and Post-event Monitoring	6
	2. pH[3]	Number				
	3. Turbidity[3]	NTU				
	4. Electric Conductivity[3] @25°C	µmhos/cm				
Chemical	1. Active Ingredient[7]	µg/L	Grab	5	Background, Event and Post-event Monitoring	6
	2. Nonylphenol[8]	µg/L				
	3.Hardness (if copper is monitored)	µg/L				
	4. Dissolved Oxygen[2]	µg/L				

NOTES:

1 All applications at all sites.

2 Field testing.

3 Field or laboratory testing

4 Samples shall be collected at three feet below the surface of the water body or at mid water column depth if the depth is less than three feet.

5 Collect samples from a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year, except for glyphosate. If there are less than six application events in a year, collect samples during each application event for each active ingredient in each environmental setting (flowing water and non-flowing water). If the results from six consecutive sampling events show concentrations that are less than the receiving water limitation/trigger for an active ingredient in an environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting. If the yearly sampling event shows exceedance of the receiving water limitation/trigger for an active ingredient in an environmental setting, then sampling shall return to six application events for that active ingredient in each environmental setting. For glyphosate, collect samples from one application event from each environmental setting (flowing water and non-flowing water) per year.

6 Pollutants shall be analyzed using the analytical methods described in 40 C.F.R. part 136.

7 2,4-D, acrolein, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, and triclopyr.

8 It is required only when a surfactant is used.

Sample Collections

Sample collection will be done no closer than 50 feet from herbicide application equipment and preferably upwind. Sample collection personnel will not be allowed to handle or come into contact with herbicide application equipment, containers, or personal protective equipment (PPE) used by the applicators. Care will be taken by samplers to minimize contact with any treated vegetation. In the event that sampling equipment will be used in more than one location, the equipment will be thoroughly cleaned with a non-phosphate cleaner, triple-rinsed uncontaminated water, and then rinsed once with the water being sampled prior to its first use at a new sample collection

location. Repeated sample collection events will occur at the same stage of the tide (i.e. either flood or ebb) for consistency.

Sampling Equipment and Containers

Samples collected to measure imazapyr and glyphosate residuals will be analyzed in the laboratory. Turbidity, electrical conductivity, and pH may be measured in the field using field meters as available, or analyzed in the laboratory. Temperature and dissolved oxygen will be field measured. Turbidity, pH, and dissolved oxygen meters will be calibrated according to manufacturer's specifications at the recommended frequency, and checked with a standard prior to each use. If the calibration is outside the manufacturer's specifications, the conductivity probe will be recalibrated. Calibration logs are maintained for all instruments to document calibration.

DWR has established guidelines for water quality sampling as outlined in “Collection of Water Quality Samples for Laboratory Analysis” (DWR 2019). All the containers used for collections will be supplied by the laboratories that will perform the analyses. Containers will be pre-cleaned and ready to use without the need for pre-rinsing or cleaning. None of the analytes collected under this permit require preservation. Water samples will be collected via boat, or from land if access to water without coming into contact with treated Arundo is possible. In order to collect water samples, sampling containers will be affixed to a telescoping, long-handled sampling pole. The pole will be cleaned by rinsing three times with distilled water and dried in-between use at the different stations. Prior to use at the new location, the pole will be rinsed with water being sampled. After sampling, the pole and any other sampling equipment will be cleaned thoroughly with a non-phosphate cleaner, triple-rinsed with distilled water, and dried before storage.

Reporting Requirements

Annual Notification

Public agencies and landowners that could be affected by intended pesticide applications will be notified at the beginning of every calendar year at least 15 days prior to the first application.

Annual Report

An annual report for each reporting period, from January 1 to December 31 will be prepared by March 1 of the following year and will be submitted to the Central Valley Water Quality Control Board (CVWQCB). In years when no algaecides or aquatic herbicides are used, a letter stating no applications will be sent to the CVWQCB in lieu of an annual report. The annual report will contain the following information as described in Attachment C of the Permit:

1. An Executive Summary discussing compliance or violation of the Permit and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with herbicide applications;

2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of aquatic herbicide application, if appropriate, and recommendations for improvement to the APAP (including proposed BMPs) and monitoring program based on the monitoring results. All receiving water monitoring data will be compared to applicable receiving water limitations and receiving water monitoring triggers;
3. Identification of BMPs and a discussion of their effectiveness in meeting the Permit requirements;
4. A discussion of BMP modifications addressing violations of the Permit;
5. A map showing the location of each treatment area;
6. Types and amounts of aquatic herbicides used during each application event;
7. Information on the surface area of the treatment area and any other information used to calculate dosage, concentration, and quantity of each aquatic herbicide used;
8. Sampling results will indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results will be tabulated so that they are readily discernible; and
9. Summary of Aquatic Pesticide Application Logs (APAL)

Twenty-Four Hour Report

Any noncompliance, including any unexpected or unintended effect of an aquatic herbicide use that may endanger health or the environment shall be reported to the SWRCB or appropriate Regional Water Quality Control Board (RWQCB) within 24 hours from the time of discovery and will include the following information:

1. The caller's name and telephone number;
2. Applicator name and mailing address;
3. Waste Discharge Identification (WDID) number;
4. The name and telephone number of a contact person;
5. How and when DWR became aware of the noncompliance;
6. Description of the location of the noncompliance;
7. Description of the noncompliance identified and the U.S. EPA pesticide registration number for each product applied in the area of the noncompliance; and
8. Description of any steps that DWR has taken or will take to correct, repair, remedy, cleanup, or otherwise address any adverse effects.

If DWR is unable to notify the SWRCB and the appropriate RWQCB within 24 hours, DWR will do so as soon as possible and will provide the rationale for reason why notification was not provided within 24 hours.

Five Day Written Report

DWR will provide a written submission within five (5) days of the time it becomes aware of any noncompliance. The written submission will contain the following information:

1. Date and time DWR contacted the SWRCB and the appropriate RWQCB notifying of the noncompliance and any instructions received from the SWRCB and/or RWQCB; information required to be provided in Section D.1 (24-Hour Reporting);
2. A description of the noncompliance and its cause, including exact date and time and species affected, estimated number of individual and approximate size of dead or distressed organisms (other than the pests to be eliminated);
3. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc.);
4. Magnitude and scope of the affected area (e.g. aquatic square area or total stream distance affected);
5. Aquatic herbicide application rate, intended use site (e.g., banks, above, or direct to water), method of application, and name of herbicide product, description of herbicide ingredients, and U.S. EPA registration number;
6. Description of the habitat and the circumstances under which the noncompliance activity occurred (including any available ambient water data for aquatic herbicides applied);
7. Laboratory tests performed, if any, and timing of tests. A summary of the test results will be provided within five days after they become available;
8. If applicable, an explanation of why DWR believes the noncompliance could not have been caused by exposure to the aquatic herbicides from the application; and
9. Actions taken to prevent recurrence of adverse incidents.

Best Management Practices

DWR will employ the following Best Management Practices (BMPs) to ensure the safe, efficient and efficacious use of herbicides.

a. Spill Prevention Measures

Applicators will take care when mixing herbicides and adjuvants. All label language will be followed to ensure safe handling and loading of herbicides. Application equipment is regularly checked and maintained to identify and minimize the likelihood of leaks developing or failure that would lead to a spill. If possible, the herbicides will be mixed and loaded prior to arrival at the application site. If herbicides are spilled, they will be

prevented from entering any waterbodies to the extent practicable. The Applicator's vehicles will contain absorbent materials such as kitty litter, "pigs" and "pillows" and their staff will be trained in the use of these materials. Spills will be cleaned up according to label instructions, and all equipment and materials used to remove spills will be properly contained and disposed of or decontaminated, as appropriate. Applicators will report spills as required and in a manner consistent with local, state and federal requirements.

b. Label Rates and Requirements

The following measures help ensure the appropriate herbicide application rates are used.

- Site scouting. Prior to treatment, qualified staff will scout sites to evaluate 1) the density and 2) extent/spread of the Arundo stands in the location to be sprayed. Depending on the aforementioned factors, the amount of herbicide needed to be applied in order to cover the stand(s) will be calculated. In addition, site geography will be considered and evaluated to ensure minimal impacts to the riverine environment from the application. If the application can be made without negatively impacting the water quality, then an application will be made.
- Written Recommendation. Prior to spraying of herbicide, a PCA will scout the area to be treated, make a positive identification of Arundo stand(s) present, check applicable product label(s) for control efficacy, and prepare a written recommendation, including rates of application, and any warnings or conditions that limit the application so that non-target flora and fauna are not adversely Impacted. Licensed PCAs must complete 40 hours of continuing education every two years to stay licensed, and therefore are up-to-date on the latest techniques for pest control.
- Herbicide Application. All herbicide applications will be made according to the product label in accordance with regulations of the U.S. EPA, CalEPA, Cal OSHA, DPR, and the local Agricultural Commissioner. For this project, a DPR-licensed Qualified Applicator Certificate (QAC) holder or Qualified Applicator License (QAL) holder will regularly monitor updates and amendments to the label so that applications are in accordance with label directions. Staff under the supervision of QACs/QALs will make applications or supervise applications recommended by the PCA. These staff have knowledge of proper equipment loading, nozzle selection, calibration, and operation so that spills are minimized, precise application rates are made according to the label, and only target plants are treated.

c. Avoiding Potential Adverse Effects

To minimize potential negative impacts from the herbicide application, only licensed personnel will supervise the applications. Licensed QALs and QACs must complete 20 hours of continuing education every 2 years to stay licensed, and therefore are up-to-date on the latest techniques for pest control.

d. Planning and Coordination

In order to minimize the impact of herbicide application to water users, water users potentially affected by any water use restrictions will be notified prior to an application being made. As necessary, gates, weirs, etc. will be closed as necessary to prevent discharge of residual aquatic herbicides to locations identified as potential water intakes.

e. Prevention of Fish Kills

Unintentional fish kills will be prevented to the extent possible by ensuring that herbicide applications are made according to the label, recommendations on how to apply the herbicide are made by a licensed PCA, and that herbicide applications are performed by QAC OR QAL holders as outlined below:

- Each herbicide application will be made according to the product label in accordance with regulations of the U.S. EPA, CaiEPA, DPR, Cal OSHA and the local Agricultural Commissioner. Precautions on the product label will be followed in order to prevent fish kills resulting from direct or indirect impacts of herbicide applications. For example, fish may be indirectly impacted if dissolved oxygen (DO) levels in the water decrease below levels which sustain fish. Such a decrease could result from aquatic vegetation coming into contact with the herbicide, dying and accumulating along the bottom of the river. Depression of DO from bacterial remineralization of the organic matter could ensue if enough dead vegetation accumulated and if water flow was sufficiently restricted. Minimization of the quantity of herbicide application as well as the timing of the application such that there is no run-off and discharge into the water will be prioritized.
- Application of herbicide will follow written recommendations prepared by a PCA licensed by the DPR. These recommendations will include rates of application and any warnings or conditions that limit the application so that fish are not adversely impacted. The PCA will base the recommendations on prior knowledge of the area to be treated, positive identification of the presence of Arundo, combined with a review of applicable herbicide product label(s) and use of an adjuvant to enhance efficacy of the herbicide.
- Herbicides will only be applied by personnel holding a QAC or QAL, or those under their direct supervision, in accordance with the recommendations by the PCA. These applicators will have knowledge of proper equipment loading, nozzle selection, calibration, and operation so that spills are minimized, precise application rates are made according to the label, and only target vegetation is treated. Calibration will ensure that the correct quantity and rate of herbicide will be applied.

Possible Alternatives

Once Arundo stands develop into a certain size, management options may be limited as this weed grows back very quickly following fire and mechanical removal. Plants reproduce vegetatively from rhizomes, stems, and fragments of either, which disperse with water, mud, and human activities. Stem or root parts of only 2 inches in size have the potential to resprout if a node is present. Therefore, being able to remove all organic material above and below ground in order to eradicate Arundo may not be realistic. Control efforts may require several years of persistent treatment, and combinations of different treatment modes, to achieve removal goals. Below are examples of several treatment options.

Evaluation of Management Options

A number of management options were considered for this mitigation effort, summarized below and in Table 2.

No Action

No action will result in continued growth, spreading, and invasion with Arundo of new riparian locations.

Prevention

Prevention is generally recognized as the first line of defense in reducing the introduction and further spread of invasive species, including Arundo. Prevention tools include watercraft inspection stations, use of weed-free forage and straw, responsible landscaping, and cleaning equipment, clothing, and vehicles that were in contact with Arundo.

Mechanical or Manual Methods

Above-ground growth (stems and leaves) can be removed by large-scale, tractor-mounted mechanical methods such as hammer-flail mower, root plow, rotary brush cutter and chainsaws. The best timing for cutting above-ground vegetation is when the plants begin to flower as this is the time when energy reserves are lowest in the rhizomes and resprouting will be more difficult. Arundo can also be excavated using a backhoe, grapple or excavator. Excavating is not recommended near streambeds or river edges because root material may wash downstream and recolonize new locations. Similarly, tilling and discing may expose erodible soils and root material, lead to sedimentation and erosion of river banks, and recolonization of new locations. All removed Arundo material should be mulched or burned to prevent resprouting.

Arundo Plants less than 6 ft in height growing from a new stem or rhizome fragment can be hand pulled. Hand-pulling is most effective in soils loosened by rains. Arundo can also be dug using hand tools such as pick-axes and shovels. If hand pulling is the

preferred method, but stands are taller than 6 ft, then the canopy can be cut close to the ground by chain saw, machete or pruning shears before the remaining stems are pulled by hand or using hand tools. The root mass and associated rhizomes must also be removed from the soil. Uprooted material must be removed from site to prevent re-rooting.

Cultural Methods

The most successful grazers of Arundo are Angora and Spanish goats. Goats will eat any vegetation, can negotiate steep slopes, are small in size (particularly Angora goats), and can be easily transported. They have been found to be effective in suppressing resprouts of Arundo after other removal methods.

Because Arundo is a fire hazard, setting fire to large stands of Arundo can be dangerous. In addition, wildfires in some areas have shifted riparian communities towards monocultures of Arundo. However, broadcast burning can be used for targeted burns. In addition, a flame thrower or weed burner devise can be used to heat-girdle the stems at the base of the plant to kill the plant. Burning may be used in combination with an herbicide, which can be applied prior to the burn to desiccate the plants and afterwards to treat resprouting plants. As mentioned above, onsite burning is an effective way to dispose of cut biomass.

Biological Control Agents

While there are insects that graze Arundo roots in its native ranges in the Middle East, Asia and Africa, none have been approved as biological control agents here in the U.S. For example, the Arundo scale *Rhizaspidiotus donacis* is an insect that attacks the rhizomes and developing underground buds of Arundo. In addition, the wasp *Tetramesa romana* has been found to graze specifically on Arundo. Both these insects are evaluated as potential biological control agents of Arundo in the U.S. but have not yet been approved.

Chemical (Aquatic Herbicides)

The goal when applying chemical herbicides as a weed control method is to reduce the quantity of herbicide used to a minimum. This can be accomplished in a variety of ways include modifying the timing of herbicide application and combination of herbicide application with non-herbicide controls to improve removal and/or resprouting. With respect to Arundo control and removal, the herbicides glyphosate and imazapyr are considered the best options for control in pure stands, particularly if used in combination with cutting or a controlled burn, i.e. cut-regrow-spray method (USDA 2014, DiTomaso et al. 2013). After cutting or burning, herbicides can be applied to newly emergent, green, healthy growth (foliar treatment) which will be of uniform height. Both glyphosate and imazapyr prevent synthesis of amino acids in plants, and they prevent synthesis of different types of amino acids, such that their combination is thought to provide better control at lower rates of application of each herbicide. In addition to foliar treatment,

undiluted glyphosate can be applied directly to cut stems, within 1 to 2 minutes after stem cutting. According to a weed report available through UC Davis (wric.ucdavis.edu), application of glyphosate as a cut stem treatment provides excellent Arundo control with limited to no resprouting.

As stated previously in this document, the choice of the most appropriate formulation and combination of herbicides, their rate of application, timing of application, and combination with other control methods will be made by a PCA. The PCA will scout the area to be treated, identify presence and extent of Arundo in area to be treated, may apply a decision matrix to the choice of most appropriate herbicide formulations, check appropriate herbicide product label(s) for control efficacy, recommend use of an adjuvant to enhance efficacy of the herbicide, and prepare a written document detailing their recommendations.

TABLE 2. DECISION MATRIX FOR MOST APPROPRIATE MANAGEMENT ACTION

Management Option	Applicable to Goals	Appropriateness to Site
No Action	No	Not appropriate
Prevention	Yes	Recommend applicable prevention measures
Mechanical/Manual	Yes	Area too large for relying solely on manual methods. Mechanical methods not advisable due to potential for downstream spread of fragments
Cultural	No	No cultural options available for this site
Biological	No	Biocontrol agent would not result in adequately exposed sand bars for smelt egg deposition
Chemical	Yes	Repeated treatments could result in improved sand bar habitat for smelt
Integrated	Yes	Combination of chemical treatment with manual removal of biomass

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Appendix A

Template: Aquatic Pesticide Application Log (APAL)

Aquatic Pesticide Application Log

Important To be completed every time an aquatic pesticide application is made

I. GENERAL

Date: _____	Start Time: _____	Stop Time: _____
Location: _____	Weed: _____	Area Treated: _____
Personnel: _____		Agency: _____
Weather: _____		

II. PESTICIDE AND ADJUVENT INFORMATION

Herbicide #1 Used: _____	Target Concentration:_____	Total Amount Applied: _____
Herbicide #2 Used: _____	Target Concentration:_____	Total Amount Applied: _____
Adjuvant #1 Used: _____	Target Concentration:_____	Total Amount Applied: _____
Adjuvant #2 Used: _____	Target Concentration:_____	Total Amount Applied: _____
Method of Application: _____	Application Made: With Water Flow / Against Water Flow / Not Applicable (circle one)	

III. TREATED WATERBODY INFORMATION

Is Treated Area a Waterbody? _____	If YES, Waterbody Type: River / Lined Canal / Unlined Canal / Creek / Drain / Ditch / Reservoir / Lake / Pond / Other (circle one)	
Water Flow (ft/s, cfs): _____	Water Depth (ft): _____	Water Temp. (C): _____
Percent Weed Cover: _____		Sheen: YES NO (circle one)
Color: None / Brown / Green / Other (circle one)		Clarity: Poor / Fair / Good (circle one)
Other Information: _____		

IV. POST-TREATMENT EFFICACY IMPACT

Treatment Efficacy (circle one): Poor / Fair / Good/ Unknown	Water Quality Impact (circle one): None / Some / Significant / Unknown	If "None" or "Unknown" describe: _____

V. GATES, WEIRS, CHECKS OR OTHER CONTROL STRUCTURES (only fill out if applicable)

Before Application:	Gates/control structures present (circle one): YES NO	Have structures been closed/sealed (circle one): YES NO	Have structures been inspected for leaks (circle one): YES NO
During Application:	Have Structures been inspected for leaks (circle one): YES NO	If leaks found were the sealed (circle one): YES NO	If answer to any question is NO Explain:_____
Gate: _____	Time Closed: _____	Time Opened: _____	How was time opened determined:_____

VI. CERTIFICATION

I (print name):_____	Certify that the APAP has been followed (sign):_____

Appendix B

Template: Field Datasheets

Aquatic Pesticide Field Monitoring & Sampling Form – Moving Water

Important Attach Aquatic Pesticide Application Log

Agency: _____ Site Name: _____

SAMPLE #1 BACKGROUND (BG) – Collect upstream of riparian treatment area before treatment.

Draw sample location and points of reference (Scale 1"=)				Sampler Name:	
				Date/Time:	
				Herbicide/Surfactants Applied?	
				Approximate Water Speed:	
				Sample GPS Coordinates LAT: LONG:	
				Target Vegetation:	
				Site Description:	
				DO (mg/L):	EC (us/cm):
				pH:	Temp (C):
				Turbidity (NTU):	
DO YOU NOTICE	YES	NO	UNKNOWN	IF YES, DESCRIBE OBSERVATIONS	
Floating material					
Settleable substances					
Suspended material					
Taste and odors					
Water coloration					
Aquatic community degradation					

Aquatic Pesticide Field Monitoring & Sampling Form – Moving Water

Important Attach Aquatic Pesticide Application Log

Agency: _____ Site Name: _____

SAMPLE #2 EVENT MONITORING (EM) – Collect downstream of riparian treatment area shortly after application.

Draw sample location and points of reference (Scale 1"=)				Sampler Name:	
				Date/Time:	
				Herbicide/Surfactants Applied?	
				Approximate Water Speed:	
				Sample GPS LAT: Coordinates LONG:	
				Target Vegetation:	
				Site Description:	
				DO (mg/L):	EC (us/cm):
				pH:	Temp (C):
				Turbidity (NTU):	
DO YOU NOTICE	YES	NO	UNKNOWN	IF YES, DESCRIBE OBSERVATIONS	
Floating material					
Settleable substances					
Suspended material					
Taste and odors					
Water coloration					
Aquatic community degradation					

Aquatic Pesticide Field Monitoring & Sampling Form – Moving Water

Important Attach Aquatic Pesticide Application Log

Agency: _____ Site Name: _____

SAMPLE #3 POST EVENT MONITORING (PEM) – Collect in treatment area/where discharge from riparian treatment area could potentially occur within 7 days of herbicide application.

Draw sample location and points of reference (Scale 1"=)				Sampler Name:	
				Date/Time:	
				Herbicide/Surfactants Applied?	
				Approximate Water Speed:	
				Sample GPS LAT: Coordinates LONG:	
				Target Vegetation:	
				Site Description:	
				DO (mg/L):	EC (us/cm):
				pH:	Temp (C):
				Turbidity (NTU):	
DO YOU NOTICE	YES	NO	UNKNOWN	IF YES, DESCRIBE OBSERVATIONS	
Floating material					
Settleable substances					
Suspended material					
Taste and odors					
Water coloration					
Aquatic community degradation					