FINAL REMEDIAL ACTION REPORT

WESTERN GROUNDWATER OPERABLE UNIT (OU-3)

AEROJET SUPERFUND SITE

SACRAMENTO, CALIFORNIA

Prepared by:

Aerojet

Site Remediation Department

And

CVEI

CENTRAL VALLEY ENVIRONMENTAL, INC.

April 25, 2012

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April 25, 2012

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8/22/12
Date

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
BGS	Below Ground Surface
CVEI	Central Valley Environmental Incorporated
CWD	Carmichael Water District
GMP	General Monitoring Plan
gpm	gallons per minute
GET	Groundwater Extraction and Treatment
EPA	United States Environmental Protection Agency – Region IX
EW	Extraction Well
LR	Long-term Response
µg/L	micrograms per liter
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NDMA	N-Nitrosodimethylamine
NPL	National Priorities List
O&F	Operational and Functional
O&M	Operations and Maintenance
OU	Operable Unit
PCD	Partial Consent Decree
PQL	Practical Quantitation Limit
RA	Remedial Action
RD/RA	Remedial Design/Remedial Action

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LIST OF ACRONYMS (Continued)

RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board – Central Valley Region
SOW	Statement of Work
TCE	Trichloroethylene
UAO	Unilateral Administrative Order
UV-Ox	Ultra-Violet Light Oxidation
VOCs	Volatile Organic Compounds
WGOU	Western Groundwater Operable Unit (OU-3)

FINAL REMEDIAL ACTION REPORT
WESTERN GROUNDWATER OPERABLE UNIT (OU-3)

1.0 INTRODUCTION

This Final Remedial Action Report (RA Report) was prepared for the Western Groundwater Operable Unit [WGOU (OU-3)] of the Aerojet Superfund Site (Site), located in Sacramento County, California (Figure 1-1). This Report documents the completion of the Remedial Action (RA) required by the United States Environmental Protection Agency Region IX (EPA) Record of Decision (ROD) and Unilateral Administrative Order (UAO) issued for the WGOU (EPA, 2001 and 2002).

The WGOU RA is a groundwater containment and restoration remedy. The RA was inspected by EPA and has been determined to be "Operational and Functional" (O&F) on July 7, 2011 (EPA, 2011a). EPA approval of this Report will mark the transition of the RA from the RD/RA Construction Phase to the Long-term Response (LR) Operations and Maintenance (O&M) Phase. A Final Close Out Report will be prepared after cleanup goals have been achieved and beneficial use of the aquifer has been restored.

The content of this RA Report follows EPA Office of Solid Waste and Emergency Response Directive 9320.2-22 "*Close Out Procedures for National Priorities List Sites*" (EPA, 2011b). This guidance supersedes previous directives issued in April 1996, January 2000, and December 2005, and was used instead of the January 2000 Directive cited in the O&F Determination Letter, as requested by the EPA remedial project manager.

1.1 Background

The WGOU includes the western portion of the Aerojet Site. Historical operations and waste management practices resulted in chlorinated solvents, rocket propellants and other chemicals in soil and groundwater.

The most common contaminants in the WGOU include trichloroethylene (TCE), a solvent used for degreasing; perchlorate, a component of solid rocket motor propellant; and N-nitrosodimethylamine (NDMA), a potential combustion by-product of liquid rocket engine fuel.

The Site was placed on the National Priorities List (NPL) on August 8, 1983. In 1989, the EPA, the California Department of Toxic Substances Control and California Regional Water Quality Control Board - Central Valley Region (RWQCB) (collectively "the Agencies") and Aerojet entered into a Partial Consent Decree (PCD). In part, the PCD identified a process and schedule for completing the Remedial Investigation/Feasibility Study (RI/FS) for the Site.

Between July 1998 and April 2002, the PCD was modified and the Site was divided into Operable Units (OUs) to accelerate the RI/FS and allow early implementation of response actions. The WGOU was given the highest priority, primarily due to impacts to public water supply, and the WGOU RI/FS was completed in April 2000 (Aerojet et al., 2000).

The EPA issued the WGOU ROD in July 2001 (EPA, 2001). This was followed by the UAO and Statement of Work (SOW) for Remedial Design and Remedial Action (RD/RA) in August 2002 (EPA, 2002). A "Notice of Need for Additional Response Action" was issued by EPA in December 2003, after NDMA was first detected in groundwater north of the American River (EPA, 2003).

1.2 Previous Remedial Activities

Aerojet has operated interim groundwater extraction and treatment (GET) systems in the WGOU since 1984-85. GETs E and F were constructed near the northwestern and southwestern property boundaries to prevent additional contaminants from migrating off-property in groundwater. Between 1984 and 1998, volatile organic compounds (VOCs) were removed from the extracted groundwater using air-stripping towers.

Following brief periods of land discharge, the treated water from GET E and GET F was directed to a series of recharge wells located between the extraction wells. The recharge wells created a hydraulic mound that directed contaminants in groundwater towards the extraction wells. Before 1998 and 1999, respectively, the GET E and GET F facilities did not treat for perchlorate and NDMA. Recharge water migrated off-property to the west. The former recharge water is the target of much of the WGOU RA.

1.3 WGOU Remedial Action

The WGOU RA addresses groundwater beneath the western portion of the Site. The WGOU land on Aerojet property is currently primarily undeveloped except for the GET E/F treatment plant area. Land uses in the City of Rancho Cordova, and Sacramento County communities of Gold River and Carmichael, include residential, commercial, retail, light industrial, and recreational uses. The American River flows generally southwest through the northwestern portion of the WGOU.

The sources of chemicals to groundwater are located east of the WGOU; there are no source sites within the WGOU. The WGOU RA is a containment remedy for groundwater on-property, and a restoration remedy for groundwater off-property. An "Inner-Barrier" hydraulic containment system was constructed to intercept chemicals migrating off-property, and an "Outer-Barrier" containment system was constructed at the downgradient leading edge of contaminants in groundwater off-property. Groundwater between the two containment barriers is expected to be restored to beneficial uses.

The Site Conceptual Model divided the aquifer beneath the Site into six Hydrostratigraphic Layers (Layers) A through F. The Inner-Barrier GET system is designed to prevent additional VOCs, perchlorate, and NDMA present in Layers A through E from migrating off-property. The Outer-Barrier GET systems are designed to hydraulically contain the leading edge of these same chemicals, primarily present in Layers C and D, and to a lesser extent in Layers A, B, and E. There are no known chemical impacts in Layer F in the WGOU.

1.4 Performance Standards

The WGOU ROD requires that the RA meet performance standards including: remedial action objectives (RAOs), cleanup goals, institutional controls, monitoring requirements, operations and maintenance requirements, and other parameters applicable to the design construction, operation, and performance of the RA. RAOs were selected based on the use of the aquifer as a drinking water source, and include the following:

- Protect human health and the environment from exposure to contaminated groundwater;
- Achieve full containment of the contaminated groundwater to minimize future migration of contaminants until cleanup is accomplished;
- Protect public water supply through short-term and long-term contingency plans including providing alternative water supplies;
- Restore groundwater to beneficial uses in OU-3 between the on-property and off-property extraction systems; and

The performance standards in the ROD are based on State and Federal designation of the aquifer as a municipal drinking water supply. The Cleanup Levels are generally Federal or State Maximum Contaminant Levels, or other risk-based criteria for drinking water. The cleanup levels for the 15 chemicals of concern identified for the WGOU are presented in Table 1-1.

Other requirements or limitations identified as performance standards include:

- Effluent discharge and receiving water limitations, regulated under National Pollutant Discharge Elimination System (NPDES) Permit No. CA 0083861, vary slightly for each GET facility (RWQCB, 2011).
- Monitoring requirements specified for compliance, sentinel, general, and public water supply wells; groundwater extraction rates and chemical mass removal.
- Short- and Long-Term Water Replacement Contingency Plans.

- Operation and Maintenance manuals for each WGOU GET systems.

Certain Institutional Controls were required through the recording of a Declaration of Covenants and Environmental Restrictions Related to Groundwater for Aerojet-owned property within the WGOU that was part of the then existing NPL site. These covenants address groundwater extraction, sedimentation control basins, injection wells, and groundwater encountered during excavations. There are also various notification requirements including notifying water purveyors if treated water discharges will exceed certain concentration at the point of entry to a water purveyors system, and a Public Notice of Extent of WGOU Contaminated Groundwater in local newspapers.

The chemical-specific ARARs for the WGOU include State and Federal requirements for drinking water. Also identified are various California Water Code and RWQCB water quality control plans and standards contained in the Central Valley Region Basin Plan. The RA is also required to comply with various location-specific ARARs addressing flood plain construction, wetlands, historical preservation, and endangered species. There are numerous action-specific ARARs addressing hazardous waste treatment, storage, and disposal; as well as discharges to land, air, or surface water,

1.5 Remedial System Design Summary

Design of the WGOU RA involved modifying the existing on-property GET E/F system, and designing five off-property GET systems. The design components for the RA included systems for groundwater extraction, conveyance, treatment, performance monitoring, and treated water disposition. The criteria used to design the Inner- and Outer-Barrier GET systems, including technical and regulatory considerations, are summarized in the following sections.

1.5.1 Inner-Barrier Remedial System Design

The existing GET E/F system was modified to meet performance standards for groundwater containment, treatment, and discharge. GET E/F is located entirely on Aerojet-owned property (Figure 1-1). GET E/F is the Inner-Barrier hydraulic containment system that intercepts chemicals migrating off-property, with the exception of a small portion of the plume in Layer E which is to be contained off-property. GET J is therefore discussed with the Inner-Barrier, although GET J also provides leading edge containment.

The GET E/F extraction system intercepts VOCs, perchlorate, and NDMA from Layers A through E at different locations along the southwestern, western, and northwestern NPL Site boundary. The shallowest extraction is from Layer A at depths of approximately 100 to 125 feet below ground surface (bgs) in the southwest portion of the Site. Layer A is unsaturated along the western and northwestern Site boundaries. The deepest extraction is from Layer E at depths of up to approximately 530 feet bgs along the western Site boundary.

The primary modifications to the GET E/F system included the addition of treatment for perchlorate and NDMA, modifying the treated water disposition from aquifer recharge to surface water discharge, and adding extraction wells for containment. Regulatory and technical considerations for the GET E/F modifications included:

- Between 1994 and 1998, Aerojet performed a series of bench- and pilot-tests to evaluate potential perchlorate treatment technologies.
- In 1997, the analytical Practical Quantitation Limit (PQL) for perchlorate was reduced from 400 to 4 micrograms per liter (µg/L).
- In 1998, the first-ever fluidized-bed, biological reduction treatment system for perchlorate destruction was added to GET F.
- In 1998, the analytical PQL for NDMA was reduced from 100 to 5 nanograms per liter (ng/L).
- In June 1999, the EPA Office of Research and Development issued "Interim Assessment Guidance for Perchlorate" with an interim reference dose range equivalent to 4 to 18 µg/L in drinking water (EPA, 1999).
- In August 1999, the formerly separate GET E and GET F treatment plants were consolidated into the single GET E/F treatment plant, and an ultra-violet (UV) light oxidation (UV-Ox) system was added for NDMA destruction.
- In 1999, the use of recharge wells for treated water disposition ceased. Treated water was temporarily discharged to ground, and in 2002, the treated water was discharged under NPDES Permit to a tributary of Buffalo Creek and ultimately the American River.
- In November 2002, the hydraulic barrier formerly created by the recharge wells was replaced by nine extraction wells located along the western Aerojet property boundary.

1.5.2 Outer-Barrier Remedial System Design

The Outer-Barrier containment system is a toe-of-plume containment system designed to hydraulically contain the furthest downgradient extent of chemicals in all layers of the aquifer. The off-property plume(s) are up to three miles long and just under four miles wide, encompassing an area of approximately 10 square miles. The majority of contaminated groundwater is present at depths ranging from approximately 250 to 450 feet below ground surface.

During the RD, the Outer-Barrier was divided into Areas 1 through 4, as shown on Figure 1-1. RA implementation was prioritized in areas where contaminants were closest to active water supply wells. Three interim and five final GET systems were designed and constructed. The interim treatment systems were constructed in higher priority areas and have since been decommissioned and removed.

Current configuration of the Outer-Barrier system includes 22 extraction wells, and five treatment plants, GETs H, J, K, L-A, and L-B, as shown on Figure 1-1. The treatment plants remove various combinations of TCE, perchlorate, and NDMA. The volume of groundwater extracted and treated is approximately 9,300 gallons per minute (gpm).

The Outer-Barrier GET system design was iterative to allow data collected during early phases of the remedy implementation to be incorporated into later-stages of the design. The significant regulatory and technical considerations involved with the Outer-Barrier design included the following:

- The RA was located entirely off-property on private and public land. It was necessary to obtaining access from third parties for each system component, including extraction wells, control panels, conveyance pipelines, and treatment plants, and discharge systems. Private property access was obtained through purchasing and leasing. Access to public utility easements and Sacramento County or City of Rancho Cordova right-of-ways was obtained through locally administered permitting processes.

- Various permits were required from Federal, State and Local Agencies including: United State Army Corps of Engineers Section 404 Permit, NPDES Stormwater and Surface Water Discharge Permits; State of California Department of Fish and Game Lake and Streambed Alteration Agreement; California Department of Transportation Encroachment Permit; RWQCB 401 Water Quality Certification; California Environmental Quality Act review; Central Valley Flood Protection Board Flood Plain Encroachment Permit; and County of Sacramento and City of Rancho Cordova Encroachment Permits, Use Permits, Building Permits, and Civil Improvement Plans.

- Utility availability and conflicts limited the siting of some extraction wells, and utility connection times extended the length of RA implementation.

- Coordination with private parties, utility providers, water purveyors, permitting and over-sight Agencies, and numerous contractors and design engineers.

- The hydraulic containment system design was refined many times due to access limitations, and based on hydrologic and water quality data collected during the implementation. The WGOU Groundwater Flow Model was updated and recalibrated in 2004 and 2008, to incorporate aquifer test, pumping, and metrological data [Aerojet and Central Valley Environmental Incorporated (CVEI), 2004a and 2008].

- Treatment technology selection was dependent on the type and combination of contaminants estimated in the influent. Ion-exchange systems were used if perchlorate was present; UV-Ox was used if NDMA was present, with or without VOCs; and granular activated carbon was used for VOC treatment if NDMA was not present.

- NPDES Permit No. CA0083861 was modified by RWQCB to raise the Effluent Discharge Limit for NDMA from 1.3 to 7 ng/L at GETs J, K, L-A, and L-B (RWQCB, 2011).

2.0 CONSTRUCTION ACTIVITIES

The following sections describe the facilities that were constructed for the WGOU RA. RA construction was completed over a period of approximately nine years. A step-by-step summary of RA construction activities as described in the OSWER Directive was not prepared due to the duration of the RA and number of activities involved but with EPA concurrence a streamlined RA Construction Completion Report was submitted June 30, 2011 which is included as Appendix A. Alternatively, Section 2.1 of this Report presents the general approach followed during the construction of the containment systems, conveyance pipelines, and treatment systems. Section 2.2 provides comparisons of the remedy described in the UAO SOW and actual components constructed for each GET system.

2.1 General Construction Activities

This section describes the overall approach and sequence of events followed during the construction of the five Outer-Barrier GET systems. The Inner-Barrier GET system had been constructed prior to the issuance of the ROD and is not included. The general sequence was to construct the extraction wells, and at the same time build the treatment plant and conveyance pipelines. However, each of the GET systems is unique, and the sequence of events varied (e.g., some extraction wells may have been added after the treatment plant was constructed).

2.1.1 Containment System Construction Activities

The Outer-Barrier Containment systems are comprised of a series of extraction wells screened across the appropriate depths to intercept contaminants present upgradient. Following siting and permitting activities, drill rigs and support equipment were mobilized to each well site. The diameter and depths of the wells required the use of mud-rotary drilling methods, with associated ancillary equipment and drilling fluid management. The cuttings from each borehole were logged by a geologist, and geophysical logging (i.e., resistivity and spontaneous potential) was conducted at each borehole. Well design included the selection of screened intervals, slot size, and filter pack. Each extraction well was developed using swabbing, bailing, and air-lift pumping. Aquifer tests were completed at seven of the Outer-Barrier extraction wells and at six public water supply wells.

Each of the Outer-Barrier Extraction wells is housed within a below-grade vault box typically located in the sidewalk or on the roadside. The vaults contain valves, flow meters, sumps and sump pumps, conveyance pipeline connections, and electrical connections for the pumps and telemetry. Control panels were typically constructed in utility easements located near the well.

2.1.2 Conveyance Pipeline Construction Activities

Constructing the pipelines necessary to convey the extracted water from the extraction wells to the treatment plants required significant planning and coordination between Aerojet, contractors, and local permitting agencies. The conveyance pipelines were installed over a period of several years and involved numerous contractors and mobilizations.

The conveyance pipelines were generally installed in the right-of-way on public streets, necessitating traffic control plans, flagging, and heavy equipment. The pipeline constructed to connect Area 1 Extraction Wells 4727 and 4728 with the remaining GET H wells required horizontal borehole drilling beneath Highway 50. Excavators were typically used for trenching due to pipeline diameters ranging in size from 8- to 18-inches. All pipelines were constructed with additional capacity to accommodate additional flow, if needed in the future. An exception is the GET J main conveyance pipeline where the installation of additional extraction wells located at the northern extent of the plume after the installation of the main conveyance pipeline brought this line to capacity. Several modifications of the treatment system have been made to manage the hydraulic condition in this piping section.

2.1.3 Treatment Plant Construction Activities

Treatment plant construction was initiated following acquiring site access whether through purchase or lease of the required property; treatment equipment; building and specialty contractors; and after permitting was completed. The construction activities for each GET system varied depending on the surrounding property development, existing condition of the property, and the treatment technologies employed.

The treatment plants were constructed with sufficient space for current equipment, and for expansion if additional treatment is necessary in the future. The architecture of the treatment plant buildings was designed to blend with the existing land development.

GET H is an open-air facility surrounded by a cinder block wall that is located on Mather Field adjacent to an existing Sacramento County Water storage facility. GET J was constructed inside an existing commercial warehouse in a commercial and light-industrial area. GET K was constructed in a residential area on an undeveloped lot adjacent to a church. The building housing the GET K treatment equipment was constructed to mimic the church architecture. GET L-A was constructed on a municipal golf course at Ancil Hoffman County Park. GET L-B was constructed in a residential neighborhood in a building designed to look like a house and is adjacent to a surface water treatment plant owned by the Carmichael Water District.

Various contractors provided the skills and expertise necessary to construct the buildings, install treatment system equipment, controls, valves, plumbing, electrical, and safety system components. Fire and security systems were also installed at each GET treatment plant.

2.2 Summary of GET System Components

This section describes the containment system, conveyance, treatment plant, and treated water disposition components that were constructed for the Inner- and Outer-Barrier GET systems. Details regarding the materials used and other specifications are included in various O&M Manuals prepared for each GET facility. Deviations from the RA described in the UAO SOW and the completed RA are also presented in this section.

2.2.1 Summary of Inner-Barrier GET System Components

The following sections describe the hydraulic containment, treatment systems, and treated water disposition for the five Outer-Barrier GET systems. The Inner-Barrier containment system was almost complete when the SOW was issued, and with the exception of on-property containment in a portion of Layer E, the remedy described in the SOW is the same as the actual remedy constructed. The Inner Barrier GET systems include 25 extraction wells with a design flow rate of approximately 5,842 gpm.

2.2.1.1 GET E/F

The modifications to the GET E/F containment, treatment, and discharge systems contained in the WGOU ROD are complete. The current configuration of GET E/F extraction wells, conveyance piping, and treatment system is shown on Figure 1-1. There are 23 GET E/F extraction wells: two screened in Layer A, eight in Layer C, five in Layer D, five in both Layers C and D, and three in Layer E. Two Layer E extraction wells at GET J are included with the Inner-Barrier system. Because the GET E/F modifications were mostly complete when the ROD was issued, GET E/F contains the same number of extraction wells as described in the ROD (Table 2-1).

The design flow rate of the GET E/F extraction wells is approximately 5,800 gpm. Three GET E/F extraction wells have been removed from service. Layer A Extraction Well (EW) 4310 is dry, and Layer E EWs 4610 and 4540 are not operated because chemical concentrations in and surrounding the wells are below Cleanup Levels.

The most recent (March 2012) concentrations of TCE, perchlorate, and NDMA in the GET E/F influent were approximately 1,200; 1,400; and 0.049 µg/L, respectively. The GET E/F treatment plant utilizes fluidized bed reactors for biological treatment of perchlorate, UV-oxidation for NDMA and VOC removal, air-stripping towers for VOC removal (polishing step), and sand filters for solids removal of biological solids produced by the perchlorate treatment system. The treated water is discharged under NPDES Permit CA 0083861 to Buffalo Creek, a tributary to the American River.

2.2.1.2 GET J

GET J serves as a part of the Outer-Barrier containment system in Layers C and D, and as part of the Inner-Barrier containment system in Layer E. The current configuration of the GET J extraction wells, conveyance pipelines, and treatment system is shown on Figure 1-1. GET J includes 10 extraction wells: four screened in Layer C, four in Layer D, and two in Layer E. Although not differentiated, the remedy described in the ROD for the GET J area included one extraction well screened in Layer C and two in Layer E (Table 2-1).

The design flow rate for GET J extraction wells is approximately 4,150 gpm. Of this flow, approximately 600 gpm is for the Inner-Barrier and the remainder is for the Outer Barrier. The most recent (March 2012) concentrations of TCE, perchlorate, and NDMA in the GET J influent were approximately 9.9, 9.2, and 0.056 µg/L, respectively. Ion-exchange resins are used for perchlorate removal and UV-oxidation with hydrogen peroxide is used for VOC and NDMA destruction. A filtration system was added for the Layer E extraction wells to remove solids prior to treatment. The treated water is discharged to Buffalo Creek, a tributary to the American River, under NPDES Permit CA0083861. GET J began initial operations in November 2004 and was completed in August 2005. A filtration system added for the Layer E wells was completed in 2012.

There have been technical difficulties with two GET J system components. Two Layer E extraction wells produced solids that plugged the ion-exchange resin system. This was partially resolved by adding filtration equipment to remove solids ahead of the ion-exchange system. The other problem was that the UV-light treatment system was unable to achieve the NDMA effluent limitation of 0.0013 µg/L. After considerable testing and evaluation by Aerojet and vendors, the effluent limitation for NDMA was raised to 0.007 µg/L in the NPDES Permit.

2.2.2 Summary of Outer-Barrier GET System Components

The following sections describe the hydraulic containment, treatment systems, and treated water disposition for the five Outer-Barrier GET systems. A comparison of the actual systems constructed versus those described in the UAO SOW is also presented. The Outer-Barrier containment system described in the UAO SOW included 20 extraction wells operating at a combined pumping rate of 4,750 gpm. The RA that was constructed contains 20 extraction wells operating at a combined flow rate of approximately 8,510 gpm. The SOW also envisioned a centralized treatment plant located on Aerojet instead of the five treatment plants that were constructed.

2.2.2.1 GET H

GET H serves as the southern portion of the Outer-Barrier hydraulic containment system. The current configuration of the GET H extraction wells, conveyance pipelines, and treatment system is shown on Figure 1-1. GET H includes five extraction wells screened in Layer C as described in the ROD for the GET H area (Table 2-1). In addition to these wells, the SOW depicts two additional Layer D extraction wells near the Layer C wells, and four collocated Layer C and D extraction wells further upgradient at the leading edge of perchlorate in Layer D. These wells have not been constructed yet while evaluation of potential containment in Layer D by the existing Layer C extraction wells is on-going. Monitoring is being performed in Layer D, and extraction wells will be added to GET H as necessary.

The groundwater extracted by the GET H wells is conveyed south to the GET H-A treatment plant located at 10699 North Mather Boulevard, on Mather Field. GET H-A was constructed adjacent to the GET H-B treatment plant which treats groundwater extracted from the joint Aerojet and Boeing Company plumes to the south.

GET H-A includes bag filters for solids removal, ion-exchange resins for perchlorate removal, and granular activated carbon for low-level VOC removal. The most recent (March 2012) concentrations of TCE and perchlorate in the GET H influent were approximately 0.35J and 200 µg/L, respectively. NDMA was not detected (<0.005 µg/L) at GET H. Current capacity of the plant is approximately 2,000 gpm. The plant was designed with space to accommodate expansion for UV-oxidation equipment, if necessary. The treated water from GET H-A is discharged under NPDES Permit CA0083861 to the Capital Center Ditch, which flows to Morrison Creek.

2.2.2.2 GET K

GET K is located in the central portion of the Outer-Barrier containment system south of the American River. The current configuration of the GET K extraction wells, conveyance pipelines, and treatment system is shown on Figure 1-1. GET K includes five extraction wells: one screened in Layer A, two in Layer C, one in Layer D, and one in Layers B, C, and D. A sixth extraction well is planned at the location of former water supply well AC-12/1141. Water supply well AC-6, equipped with a wellhead treatment system for perchlorate removal, also provides hydraulic containment in Area 3. Although not differentiated, the remedy described in the SOW for the GET K area included four Layer C extraction wells (Table 2-1).

Extracted groundwater is conveyed to the GET K treatment plant located at 10555 Coloma Road (Figure 1-1). The capacity of GET K is approximately 2,800 gpm, and it removes NDMA and low levels of VOCs using UV-oxidation with the addition of hydrogen peroxide. The most recent (March 2012) concentrations of TCE, perchlorate, and NDMA in the GET J influent were approximately 1.4, 2.9J, and 0.046 µg/L, respectively. GET K was designed with space to accommodate additional equipment for perchlorate treatment, if needed. The effluent from GET K is discharged under NPDES Permit CA0083861 to the Clifton Drainage Channel, which flows to the American River.

2.2.2.3 GETs L-A/L-B

GETs L-A/L-B are individual treatment systems located on the north side of the American River in the community of Carmichael. The GET L-A/L-B extraction wells, conveyance piping, and treatment system locations are shown on Figure 1-1. Both systems consist of a single extraction well and an adjacent treatment plant. The extraction well at GET L-A is screened in Layer C, and the extraction well at GET L-B is screened in Layers C and D. The WGOU ROD did not include extraction wells on the north side of the American River because contaminants were not known to be present there. However, following the discovery of NDMA north of the American River, EPA issued an Additional Response Action Required Letter in February 2004 (EPA, 2004).

GET L-A is located at Ancil Hoffman Park and treats NDMA and low levels of VOCs using UV-oxidation with hydrogen peroxide addition. GET L-A has a capacity of 2,000 gpm, and the plant has space available to add perchlorate treatment if necessary. The most recent (March 2012) concentrations of TCE and NDMA in the GET L-A influent were approximately 0.37 and 0.0083 µg/L, respectively. Perchlorate was not detected (< 1 µg/L) in the influent to GET L-A. A significant portion of the treated water is used for irrigation at the golf course and park. Unused effluent is discharged to the American River under NPDES Permit CA 0083861.

The GET L-B treatment plant is located at the Carmichael Water District (CWD) Bajamont Treatment Plant. GET L-B treats NDMA and low levels of VOCs using UV-oxidation with hydrogen peroxide addition. GET L-B has a capacity of 1,200 gpm, and the plant has space available to add perchlorate treatment if necessary. NDMA was reported at a concentration of 0.0086 µg/L in the most recent sample of the GET L-B influent; TCE (<0.5 µg/L) and perchlorate (<1.0 µg/L) were not detected. The treated water is discharged to a tributary to the American River under NPDES Permit CA0083861 at the same point used by the CWD.

3.0 CHRONOLOGY OF EVENTS

The following is a chronology of the major events and milestones during the WGOU RA implementation. Five GET systems were constructed for the RA, and there were numerous design documents submitted for each phase of construction in each area. The following chronology includes the primary design submittals, construction startup dates, and system startup dates for each GET system.

CHRONOLOGY OF EVENTS	
DATE	**EVENT**
July 20, 2001	WGOU Record of Decision issued by EPA (EPA, 2001).
Aug, 9, 2002	Unilateral Administrative Order and RD/RA SOW for WGOU issued by EPA (EPA, 2002).
Oct. 9, 2002	*Draft RD/RA Work Plan* submittal (Aerojet and CVEI, 2002).
May 23, 2003	*WGOU Conceptual/Preliminary Remedial Design Report* submittal (Aerojet et al, 2003)
Feb. 10, 2004	Additional Response Action Requirement issued by EPA in response to NDMA detected north of the American River.
May 5, 2004	Start construction of the GET J treatment plant and conveyance pipelines.
Aug. 7, 2004	System startup of Interim GET H treatment system for EW 4630.
Sept. 2004	System startup for Interim GET K treatment system for EW 4660.

CHRONOLOGY OF EVENTS	
DATE	**EVENT**
Nov. 2004 to Aug. 2005	Initial system startup for GET J and full-scale by August 2005.
Nov. 2004	*Pre-Final/Final Design Submittal for Area 2* (Aerojet et al., 2004a)
Dec. 22, 2004	*Draft Additional Response Actions Report* submittal (Aerojet and CVEI, 2004b).
April 21, 2005	*Final Design Submittal for Area 1* (Aerojet et al., 2005).
June 28, 2005	Startup of Temporary GET H treatment system for EWs 4675 and 4700.
March 6, 2006	Start construction of GET H-A treatment facility and conveyance pipeline.
June 14, 2006	Startup of wellhead treatment at water supply Well 1033/Chettenham.
Oct. 18, 2006	Startup of Permanent GET H-A treatment system for EWs 4630, 4675, and 4700. Decommission Interim and Temporary GET H systems.
May 8, 2007	*Pre-Final/Final Design Submittal for Area 3* (Aerojet et al., 2007).
Sept. 11, 2007	Startup of GET L-B system for EW 4706.
Jan. 1, 2008	*Technical Memorandum - Supplemental Hydrologic Modeling Performed in Support of the Area 4 Extraction System Design* submittal (Aerojet and CVEI, 2008).

CHRONOLOGY OF EVENTS	
DATE	**EVENT**
April 20, 2009	Start construction of GET L-A treatment plant.
Sept. 17, 2009	Attainment of perchlorate cleanup levels confirmed for water supply well 1033/Chettenham. Begin treatment system decommission.
Oct. 5, 2009	Startup of full-scale GET K treatment system for EWs 4660, 4718, 4719, 4721, and 4726.
May 2010	Startup at GET L-A system for EW 4701.
June 30, 2011	*Remedial Action Construction Complete Report* submitted (Aerojet, 2011a).
July 7, 2011	RA determined to be Operational and Functional by EPA (EPA, 2011a).
Sept. 2011	Final EWs 4727 and 4728 operational.
Jan. 2012	*Draft Outer-Barrier Performance Evaluation Report* submitted (Aerojet and CVEI, 2012)

4.0 PERFORMANCE STANDARDS AND DATA QUALITY CONTROL

This section briefly discusses the data that will be collected during the LR O&M phase of the WGOU RA. These data will be used to measure compliance with performance standards and progress towards achieving cleanup goals. The data collection locations, frequencies, and parameters are included in the, "*Aerojet Site Draft 2011 – 2012 Groundwater Monitoring Plan*" [Sitewide GMP (Aerojet, 2011b)]. A Long-Term O&M Sampling and Analysis Plan is being prepared that will include the data collection specific to the WGOU that is contained in the Sitewide GMP. The quality of the data used to evaluate performance is also described in this section.

4.1 Performance Standards

The performance standards for the WGOU RA include the RAOs described in Section 1.4. In summary, the RAOs include protecting human health and the environment from exposure to site-related chemicals in groundwater, hydraulic containment and aquifer restoration goals, protection of public water supply through water replacement contingency planning, and various other standards such as cleanup levels and effluent discharge limits.

Compliance with performance standards will be assessed by analyzing data collected during the LR O&M phase of the WGOU RA. These include water quality data collected from compliance and sentinel monitoring wells; public, private, and irrigation water supply wells; general monitoring wells; GET system effluent and receiving water bodies. Various other data are also collected including water levels, pumping rates, and mass removal rates.

Data collected to confirm protection of human health and the environment is largely achieved by monitoring public water supply wells, and through California Department of Public Health regulation and policy. Water supply well monitoring is performed in accordance with the requirements identified in the UAO, and various contingency plans have been implemented to provide adequate water supply to affected water purveyors.

Data collected to assess compliance with hydraulic containment performance standards include water level and water quality data collected from a network of compliance, sentinel, and other monitoring wells. The water quality data are analyzed and presented in Quarterly Compliance Monitoring Reports and the water quality and water level data are presented in Performance Evaluation Reports. Corrective actions will be implemented if data indicating non-compliance with performance standards are confirmed.

Aquifer restoration is a long-term objective that will require many years to accomplish. Progress towards this objective is measured by monitoring water quality trends at monitor wells located within the groundwater plumes, and from water quality data collected from extraction wells used to calculate mass removal.

Water supply replacement contingency planning is managed through the Short- and Long-Term Water Replacement Contingency Plans. Various alternatives for providing contingency and replacement water were implemented during the RA construction period. Water supply replacement planning is an ongoing process that will continue until aquifer restoration objectives are reached.

4.2 Construction and Data Quality Control

Construction Quality Control was described in the "Final Construction Quality Assurance Plan" (Aerojet et al., 2004b). EPA has completed Construction Completion Inspection Reports for GETS E-F, H-A, J, K-A, L-A and L-B which are included by reference (Sullivan International Group, 2011 through 2012). Aerojet also conducted extensive quality control inspections and construction management of all GET system components to verify contractor performance as specified in subcontractor agreements. Construction management was also used to oversee the contractors and document design changes and as-built conditions.

Various data will be collected during the LR O&M phase of the RA to monitor and assess compliance with Performance Standards. All data collected during this phase are collected following the "*Standard Operating Procedures for Aerojet Site*" (Aerojet, 2010a) and the "*Quality Assurance Project Plan, Aerojet Superfund Site*" (Aerojet, 2010b). Each of these documents is updated as required, and is subject to review and comment by the Agencies.

5.0 FINAL INSPECTIONS AND CERTIFICATIONS

The Remedial Action construction was completed on June 30, 2011 and documented in the Remedial Action Construction Completion Report which is included as Appendix A (Aerojet, 2011a). EPA approved the RA Construction Completion Report and certified that the WGOU RA was Operational and Functional in a letter dated July 7, 2011 (EPA, 2011a). This letter, included as Appendix B, also indicated that preliminary inspections of all WGOU GET systems had been performed by EPA, and that formal engineering inspections were in progress. Aerojet cooperated with EPA in preparation of the Construction Completion Inspection Reports for GETS E-F, H-A, J, K-A, L-A and L-B (Sullivan International Group, 2011 through 2012) which are included by reference. These documents are posted as Technical Documents at www.epa.gov/region9/Aerojet.

6.0 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals have been prepared for each WGOU GET system. The O&M Manuals outline the routine and periodic maintenance activities for each facility based on the specific treatment technologies and equipment present. Problems with GET system operation are reported in the annual Performance Evaluation Reports.

Treatment plant monitoring is required to verify compliance with NPDES discharge standards. For O&M purposes, the monitoring program is divided into two phases: 1) the initial phase to monitor start-up conditions, and 2) continued operations monitoring to verify NPDES compliance. The NPDES permit requires monitoring at the influent and effluent of the treatment system, and upstream and downstream of the discharge point into the receiving water. Additional monitoring is performed at the mid-point of the treatment vessels to gauge when filter media change-outs are needed.

Site maintenance is necessary to maintain facility appearance, safe working conditions, and to keep the system functioning properly. General observation of the facility grounds is sufficient to determine if any major problems are present. Equipment monitoring protocols are specified in the O&M manuals.

As discussed previously, data will be collected during the LR O&M Phase of the RA to assess attainment of and compliance with performance standards. The data collection locations, frequencies, and parameters are included in the Sitewide GMP (Aerojet, 2011b). A Long-Term O&M Sampling and Analysis Plan is being prepared that will segregate the data collection activities specific to the WGOU that are currently contained in the Sitewide GMP.

7.0 OPERABLE UNIT CONTACT INFORMATION

The following Agency personnel provide joint over-sight of the RA:

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FINAL REMEDIAL ACTION REPORT

WESTERN GROUNDWATER OPERABLE UNIT (OU-3)

APPENDIX A

RA Construction Complete Report, Western Groundwater Operable Unit (OU-3)

FINAL REMEDIAL ACTION REPORT

WESTERN GROUNDWATER OPERABLE UNIT (OU-3)

APPENDIX B

EPA Approval of Remedial Action Construction Complete Report for Western Groundwater Operable Unit (OU-3), Determination of Remedy as Operational and Functional, and Direction to Prepare Interim Remedial Action Report