Location	Requirement	Prerequisite	Citation[a]	ARAR Determination	Comments
STATE ARARs (Continued)					
California Fish & Game Code[b] (Continued)					
McAteer-Petris Act (California Government Code §§ 66600 through 66661)[b] (Continued)					
					legislation for the San Francisco Bay Plan, an approved state management program for the San Francisco Bay. Substantive provisions of the McAteer-Petris Act and the San Francisco Bay Plan are relevant and appropriate because their authority is derived from the CZMA, a relevant and appropriate federal requirement. The Navy will conduct this remedy in accordance with the substantive provisions of the San Francisco Bay Plan.

Notes:

a Only the substantive provisions of the requirements cited in this table are ARARs.

b Statutes and policies, and their citations, are provided as headings to identify general categories of ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the Navy accepts the entire statutes or policies as ARARs; specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered ARARs.

§ Section
§§ Sections
ARAR Applicable or relevant and appropriate requirement

Cal. California
Cal. Code Reg. California Code of Regulations
CFR Code of Federal Regulations
CESA California Endangered Species Act
CZMA Coastal Zone Management Act
FESA Federal Endangered Species Act
tit. Title
USC United States Code

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE					
Federal ARARs					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i]) [a]					
On-site waste generation	Person who generates waste shall determine if that waste is a hazardous waste	Generator of waste	Cal. Code Regs., tit. 22, §§ 66262.10(a), 66262.11	Applicable	Applicable for characterization of waste generated during monitoring and construction of monitoring wells.
	Requirement for analyzing waste to determine whether waste is hazardous.	Generator of waste	Cal. Code Regs., tit. 22, § 66264.13(a) and (b)	Applicable	Applicable for characterization of waste generated during monitoring and construction of monitoring wells.
Container storage	Containers of RCRA hazardous waste must be: • maintained in good condition, • be compatible with hazardous waste to be stored, and • Closed during storage, except to add or remove waste.	Storage in a container of RCRA hazardous waste not meeting small quantity generator criteria before treatment, disposal, or storage elsewhere.	Cal. Code Regs. tit. 22, § 66264.171, 66264.172, and 66264.173	Applicable and relevant and appropriate	The substantive provisions are ARARs for handling small amounts of waste generated in the implementation of the remedies (for example, the construction of new groundwater monitoring wells or other investigation derived waste). The requirements are applicable if waste is determined to be RCRA hazardous or non-RCRA, state-regulated hazardous waste. These requirements are relevant and appropriate for solid waste that is designated or nonhazardous solid waste.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE (Continued)					
FEDERAL ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Container Storage (Continued)	Inspect container storage areas weekly for deterioration.	Storage in a container of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere.	Cal. Code Regs. tit. 22, § 66264.174	Applicable and relevant and appropriate	The substantive provisions are ARARs for handling small amounts of waste generated in the implementation of the remedies (for example, the construction of new groundwater monitoring wells or other investigation derived waste). The requirements are applicable if waste is determined to be RCRA hazardous or non-RCRA, state-regulated hazardous waste. These requirements are relevant and appropriate for solid waste that is designated or nonhazardous solid waste.
	Place containers on a sloped, crack-free base, and protect from contact with accumulated liquid. Provide containment system with a capacity of 10 percent of the volume of containers of free liquids. Remove spilled or leaked waste in a timely manner to prevent overflow of the containment system.	Storage in a container of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere.	Cal. Code Regs. tit. 22, § 66264.175(a), (b)	Applicable and relevant and appropriate	The substantive provisions are ARARs for handling small amounts of waste generated in the implementation of the remedies (for example, the construction of new groundwater monitoring wells or other investigation derived waste). The requirements are applicable if waste is determined to be RCRA hazardous or non-RCRA, state-regulated hazardous waste. These requirements are relevant and appropriate for solid waste that is

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE (Continued)					
FEDERAL ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
	Keep incompatible materials separate. Separate incompatible materials stored near each other by a dike or other barrier.	Storage in a container of RCRA hazardous waste not meeting small-quantity generator criteria before treatment, disposal, or storage elsewhere	Cal. Code Regs. titl 22, § 66264.177	Applicable and relevant and appropriate	designated or nonhazardous solid waste. The substantive provisions are ARARs for handling small amounts of waste generated in the implementation of the remedies (for example, the construction of new groundwater monitoring wells or other investigation derived waste). The requirements are applicable if waste is determined to be RCRA hazardous or non-RCRA, state-regulated hazardous waste. These requirements are relevant and appropriate for solid waste that is designated or nonhazardous solid waste.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE (Continued)					
FEDERAL ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
	At closure, remove all hazardous waste and residues from the containment system, and decontaminate or remove all containers and liners.	Hazardous waste.	Cal. Code Regs. tit. 22, § 66264.178	Applicable and relevant and appropriate	The substantive provisions are ARARs for handling small amounts of waste generated in the implementation of the remedies (for example, the construction of new groundwater monitoring wells or other investigation derived waste). The requirements are applicable if waste is determined to be RCRA hazardous or non-RCRA, state-regulated hazardous waste. These requirements are relevant and appropriate for solid waste that is designated or nonhazardous solid waste.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Waste pile	Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary tanks and container storage areas.	Hazardous remediation waste temporarily stored in piles.	Cal. Code Regs. tit. 22, § 66264.553(b),(d), (e), and (f)	Applicable and relevant and appropriate	The substantive provisions are applicable for temporarily storing excavated soil that is RCRA hazardous or non-RCRA, state-regulated hazardous waste prior to on-site relocation or off-site disposal. The substantive provisions are relevant and appropriate for temporarily storing excavated soil that is designated or nonhazardous waste.
	Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary tanks and container storage areas.	Hazardous remediation waste temporarily stored in piles.	40 CFR§ 264.554(d)(1)(i–ii) and (d)(2),(e), (f), (h), (i),(j), and (k)	Applicable and relevant and appropriate	The substantive provisions are applicable for temporarily storing excavated soil that is RCRA hazardous or non-RCRA, state-regulated hazardous waste prior to on-site relocation or off-site disposal. The substantive provisions are relevant and appropriate for temporarily storing excavated soil that is designated or nonhazardous waste.
	At closure, owner shall remove or decontaminate all waste residues, contaminated containment system components, contaminated subsoils, and structures and equipment contaminated with waste and leachate, and manage them as hazardous waste. If waste is left on site, perform postclosure care in	Waste pile used to store hazardous waste.	Cal. Code Regs. tit. 22, § 66264.258(a) and (b) except references to procedural requirements	Applicable and relevant and appropriate	The substantive provisions are applicable for temporarily storing excavated soil that is RCRA hazardous or non-RCRA, state-regulated hazardous waste prior to on-site relocation or off-site disposal. The substantive provisions are relevant and appropriate for temporarily storing

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
EXCAVATION AND DISPOSAL OF WASTE (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])a (Continued)					
	accordance with the closure and postclosure care requirements that apply to landfills.				excavated soil that is designated or nonhazardous waste.
Military Munitions Rule (40 CFR part 266 subpart M)[a]					
Management of military munitions	Identification of hazardous waste munitions and treatment and storage requirements for hazardous waste munitions.	Presence of military munitions	40 CFR §§ 266.203, 266.205, and 266.206	Applicable	The substantive provisions of these requirements are applicable to any MPPEH found while implementing the remedy.
Clean Water Act of 1977 (33 USC § 1344)[a]					
Storm Water Discharge	General requirements for a storm water management plan and implementation of best management practices.	Construction involving one acre or more of soil disturbance	40 CFR § 122.44(k)(2)and (4)	Applicable	Substantive provisions are applicable for soil excavation alternatives wherein acre or more of soil disturbance is expected.
Clean Air Act (42 USC §§ 7401–7671)[a]					
Discharge to air	A person shall not emit from any source for a period or periods aggregating more than 3 minutes in any hour a visible emission which is as dark as or darker than No. 1 on the Ringelmann chart or of such opacity as to obscure an observer's view to an equivalent or greater degree. A person shall not emit for a period or periods aggregating more than3 minutes in any hour, an emission equal to or greater than 20 percent opacity.	Emissions	BAAQMD Regulation 6, § 6-301 and 302	Applicable	Substantive provisions are applicable for the earthwork and soil excavation activities.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
SOIL COVERS					
Federal ARARs					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a]					
Site closure	Minimize the need for further maintenance controls and minimize or eliminate, to the extent necessary to protect human health and the environment, postclosure escape of hazardous waste, hazardous constituents, leachate, contaminated rainfall or runoff, or waste decomposition products to groundwater or surface water or to the atmosphere.	Hazardous waste management facility	Cal. Code Regs. tit. 22, § 66264.111(a) and (b)	Relevant and Appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Clean closure	During the partial and final closure periods, all contaminated equipment, structures, and soils shall be properly disposed or decontaminated by removing all hazardous waste and residues.	Hazardous waste management facility	Cal. Code Regs. tit. 22, § 66264.114	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Final cover	The final cover shall be designed and constructed to function with minimum maintenance.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22 § 66264.310(a)(2)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil cover.
Final cover	The final cover shall be designed and constructed to promote drainage and minimize erosion or abrasion of the cover.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22 § 66264.310(a)(3)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil cover.
Final cover	The final cover shall be designed and constructed to accommodate settling and subsidence so that the cover's integrity is maintained.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22 § 66264.310(a)(4)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil cover.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
SOIL COVER (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i]) [a] **(Continued)**					
Final cover	The final cover shall be designed and constructed to accommodate lateral and vertical shear forces generated by the maximum credible earthquake so that the integrity of the cover is maintained.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.310(a)(5)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Postclosure care	Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events throughout the postclosure period.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.310(b)(1)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Site security	Prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock onto the active portion of the facility.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.14(a)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Clean Water Act of 1977 (33 USC § 1344)[a]					
Storm Water Discharge	General requirements for a storm water management plan and implementation of best management practices.	Construction involving one acre or more of soil disturbance	40 CFR § 122.44(k)(2)and (4)	Applicable	Substantive provisions are applicable for constructing the soil cover.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
SOIL COVER (Continued)					
State ARARs					
Landfill gas control	The operator shall ensure that landfill gases generated at a disposal site are controlled. Methane must not exceed 1.25 percent by volume in air within on-site structures, concentrations of methane gas migrating from the landfill must not exceed 5 percent by volume in air at the property boundary, and trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted.	Cal. Code Regs. tit. 27, § 20921(a)(1),(2), and (3)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Erosion control	Diversion and drainage facilities shall be designed, constructed, and maintained to accommodate the anticipated volume of precipitation and peak flows. Collection and holding facilities associated with precipitation and drainage control systems shall be emptied immediately or otherwise managed to maintain system design capacity.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted.	Cal. Code Regs. tit. 27, §§ 20365(c) and(d), 21090(c)(4),and 21150	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.

Table 13-3: Action-Specific Applicable or Relevant and Appropriate Requirements (Continued)

Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
SOIL COVER (Continued)					
State ARARs (Continued)					
Engineered alternatives to final cover standard	Alternatives to prescriptive standards may be considered provided the prescriptive standard is not feasible and there is a specific engineered alternative that is consistent with the performance goal and affords equivalent protection against water quality impairment. The Water Board can allow any alternative final cover that it finds will continue to isolate the waste and irrigation waters at least as well as would a final cover built in accordance with applicable prescriptive standards.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted.	Cal. Code Regs. tit. 27, §§ 20080(b) and(c) and 21090(a)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Vegetative layer	Closed landfills shall be provided with an uppermost cover layer consisting of either a vegetative layer consisting of knotless than 1 foot of soil capable of sustaining native or other suitable plant growth or a mechanically erosion resistant layer.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted	Cal. Code Regs. tit. 27, § 21090(a)(3)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.
Final grading	The final cover of closed landfills shall be designed, graded, and maintained to prevent ponding and to prevent site erosion due to high runoff velocities. Slopes should be at least 3 percent.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted	Cal. Code Regs. tit. 27, § 21090(b)(1)	Relevant and appropriate	Substantive provisions are relevant and appropriate for the soil covers.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
RADIOLOGICAL SCREENING AND MPPEH SWEEP					
Federal ARARs					
Atomic Energy Act of 1954 (42 U.S.C. ch. 23, § 2011 et seq.)[a]					
Temporary storage of radiologically contaminated soil	The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.	Existing NRC-licensed site	10 CFR § 20.1801	Relevant and appropriate	This requirement is not applicable to Site 1 because Site 1 is not an NRC-licensed facility. The substantive provisions of this requirement are relevant and appropriate for staging excavated soil contaminated with ROCs at levels at or above remediation goals prior to off-site disposal.
	The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.	Existing NRC-licensed site	10 CFR § 20.1802	Relevant and appropriate	This requirement is not applicable to Site 1 because Site 1 is not an NRC-licensed facility. The substantive provisions of this requirement are relevant and appropriate for staging excavated soil contaminated with ROCs at levels at or above remediation goals prior to off-site disposal.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
WETLAND MITIGATION PLAN					
Federal ARARs					
Clean Water Act of 1977 (33 USC § 1344)[a]					
Discharge of dredged material	U.S. Army Corps of Engineers requirements for permitting discharges of dredged material to waters of the United States.	Discharge of dredged material to waters of the United States, including adjacent wetlands	33 CFR § 320.4 40 CFR §§ 230.10, 230.11, 230.20-230.25, 230.31, 230.32, 230.41, 230.42 and 230.53	Applicable	Substantive provisions are applicable for the soil covers.
INSTITUTIONAL CONTROLS					
State ARARs					
California Civil Code (Cal. Civil Code § 1471)[a]					
Land use controls	Provides conditions under which land use restrictions will apply to successive owners of land	Transfer property from the Navy to a nonfederal agency	Cal. Civil Code § 1471	Relevant and appropriate	Substantive provisions are the following general narrative standard: "to do or refrain from doing some act on his or her own land … where (c) Each such act relates to the use of land and each such act is reasonably necessary to protect present or future human health or safety of the environment as a result of the presence of hazardous materials, as defined in § 25260 of the Cal. Health & Safety Code." This narrative standard would be implemented through incorporation of restrictive covenants in the deed at the time of transfer.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
INSTITUTIONAL CONTROLS (Continued)					
State ARARs (Continued)					
California Health and Safety Code Land Use Controls (Cal. Health & Safety Code §§ 25202.5, 25222.1, 25232(b)(1)(A)-(E), 25233(c), § 25234, § 25355.5)					
Land use controls	Allows DTSC to enter into an agreement with the owner of a hazardous waste facility to restrict present and future land uses.	Transfer property from the Navy to a nonfederal agency	Cal. Health & Safety Code § 25202.5	Relevant and appropriate	The substantive provisions of this section are the general narrative standards to restrict "present and future uses of all or part of the land on which the facility …is located."
Land use controls (Continued)	Provides a streamlined process to be used to enter into an agreement to restrict specific use of property in order to implement the substantive use restrictions.	Transfer property from the Navy to a nonfederal agency.	Cal. Health & Safety Code § 25222.1	Relevant and appropriate	Cal. Health & Safety Code § 25222.1 provides the authority for the state to enter into voluntary agreements to establish land use covenants with the owner of the property. The substantive provision of Cal. Health & Safety Code § 25222.1 is the general narrative standard: "restricting specified uses of the property."
	Prohibits certain uses of land containing hazardous waste without a specific variance.	Hazardous waste property.	Cal. Health & Safety Code § 25232(b)(1)(A)–(E)	Relevant and appropriate	Land-use restrictions will be used to prohibit the following activities at Site 1: residential use of the sites, construction of hospitals for humans, schools for persons under 21 years of age, day care centers for children, or any permanently occupied human habitation on the sites.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
INSTITUTIONAL CONTROLS (Continued)					
State ARARs (Continued)					
California Health and Safety Code Land Use Controls (Cal. Health & Safety Code §§ 25202.5, 25222.1, 25232(b)(1)(A)-(E), 25233(c), § 25234, § 25355.5)					
	Provides a process for obtaining a written variance from a land use restriction.	Transfer property from the Navy to a nonfederal entity.	Cal. Health & Safety Code § 25233(c)	Relevant and appropriate	Cal. Health & Safety Code § 25233(c) sets forth substantive criteria for granting variances from the uses prohibited in § 25232(b)(1)(A)-(E) based on specific environmental and health criteria.
	Provides a process by which DTSC can remove land use restrictions	Transfer property from the Navy to a nonfederal entity	Cal. Health & Safety Code § 25234	Relevant and appropriate	Cal. Health & Safety Code § 25234 sets forth the following "relevant and appropriate" substantive criteria for the removal of a land-use restriction on the grounds that "…the waste no longer creates a significant existing or potential hazard to present or future public health or safety."
	Authorizes DTSC to enter into an enforceable agreement that imposes restrictions on present and future uses of the property	Transfer property from the Navy to a nonfederal entity	Cal. Health & Safety Code § 25355.5(a)(1)(C)	Relevant and appropriate	The substantive requirements of the following Cal. Health & Safety Code § 25355.5(a)(1)(C) provisions are "relevant and appropriate": "…execution and recording of a written instrument that imposes an easement, covenant, restriction, or servitude, or combination thereof , as appropriate, upon the present and future uses of the site."

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
INSTITUTIONAL CONTROLS (Continued)					
State ARARs (Continued)					
Cal/EPA Department of Toxic Substances Control (Cal. Code Regs., tit. 22, § 67391.1)[a]					
Land use covenants	A land use covenant imposing appropriate limitations on land use shall be executed and recorded when facility closure, corrective action, remedial or removal action, or other response actions are undertaken and hazardous materials, hazardous wastes or constituents, or hazardous substances will remain at the property at levels which are not suitable for unrestricted use of the land.	Property transfer by federal government to nonfederal entity.	Cal. Code Regs., tit. 22, § 67391.1	Relevant and appropriate	Relevant and appropriate when the Navy is transferring property to a nonfederal agency. EPA considers the following portions of 22 CCR 67391.1 to be relevant and appropriate for this ROD: (a)(1), (a)(2), (d), (e)(1) and (e)(2). The Navy has selected ICs as part of the remedies for soil and groundwater. These requirements are ARARs for those ICs. EPA agrees that the substantive portions of the regulations referenced are ARARs. EPA specifically considers sections (a), (b), (d), and (e) of Cal. Code Regs. tit. 22 § 67391.1, to be ARARs for this ROD. DTSC's position is that all of the state regulation is an ARAR.
PLACEMENT OF RIPRAP COVER					
Federal ARARs					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a]					
Placement of rip rap cover	Protect and maintain surveyed benchmarks throughout the postclosure period.	Hazardous waste treatment, storage, or disposal facility.	Cal. Code Regs. tit. 22 § 66264.310(b)(5)	Relevant and appropriate	The Navy has identified these requirements as relevant and appropriate to construction and maintenance of the riprap covers in the exposed beach areas of Area 5.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
PLACEMENT OF RIPRAP COVER (Continued)					
Federal ARARs (Continued)					
Clean Water Act of 1977 (33 USC § 1344)[a]					
Storm Water Discharge	General requirements for a storm water management plan and implementation of best management practices.	Construction involving one acre or more of soil disturbance	40 CFR § 122.44(k)(2)and (4)	Applicable	Substantive provisions are applicable for constructing the riprap covers.
State ARARs					
Erosion control	Diversion and drainage facilities shall be designed, constructed, and maintained to accommodate the anticipated volume of precipitation and peak flows. Collection and holding facilities associated with precipitation and drainage control systems shall be emptied immediately or otherwise managed to maintain system design capacity.	Cal. Code Regs. tit. 27 requirements are applicable only for waste discharged after July 18, 1997, unless otherwise noted.	Cal. Code Regs. tit. 27, §§ 20365(c) and(d), 21090(c)(4),and 21150	Relevant and appropriate	Substantive provisions are relevant and appropriate for constructing the riprap covers.
REMOVAL OF RADIOLOGICALLY-IMPACTED WASTE					
Federal ARARs					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a]					
On-site generation of waste	Person who generates waste shall determine if that waste is a hazardous waste	Generator of waste	Cal. Code Regs., tit. 22, §§ 66262.10(a), 66262.11	Applicable	Applicable for characterization of waste generated during removal of radiological hot spots prior to placing the soil cover. .
	Requirement for analyzing waste to determine whether waste is hazardous.	Generator of waste	Cal. Code Regs., tit. 22, § 66264.13(a) and (b)	Applicable	Applicable for characterization of waste generated during removal of radiological hot spots prior to placing the soil cover. .

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
REMOVAL OF RADIOLOGICALLY-IMPACTED WASTE (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Temporary waste pile	Alternative requirements that are protective of human health or the environment may replace design, operating, or closure standards for temporary tanks and container storage areas.	Hazardous remediation waste temporarily stored in piles.	40 CFR§ 264.554(d)(1)(i–ii) and (d)(2),(e), (f), (h), (i),(j), and (k)	Applicable and relevant and appropriate	The substantive provisions are applicable for temporarily storing excavated soil that is RCRA hazardous or non-RCRA, state-regulated hazardous waste prior to on-site relocation or off-site disposal. The substantive provisions are relevant and appropriate for temporarily storing excavated soil that is designated or nonhazardous waste.
Clean Water Act of 1977 (33 USC § 1344)[a]					
Storm Water Discharge	General requirements for a storm water management plan and implementation of best management practices.	Construction involving one acre or more of soil disturbance	40 CFR § 122.44(k)(2)and (4)	Applicable	Substantive provisions are applicable for the excavation of waste.
Atomic Energy Act of 1954 (42 U.S.C. ch. 23, § 2011 et seq.)[a]					
Temporary storage of radiologically contaminated soil	The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.	Existing NRC-licensed site	10 CFR § 20.1801	Relevant and appropriate	This requirement is not applicable to Site 1 because Site 1 is not an NRC-licensed facility. The substantive provisions of this requirement are relevant and appropriate for staging excavated soil contaminated with ROCs at levels at or above remediation goals prior to off-site disposal.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
REMOVAL OF RADIOLOGICALLY-IMPACTED WASTE (Continued)					
Federal ARARs (Continued)					
Atomic Energy Act of 1954 (42 U.S.C. ch. 23, § 2011 et seq.)[a] (Continued)					
	The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.	Existing NRC-licensed site	10 CFR § 20.1802	Relevant and appropriate	This requirement is not applicable to Site 1 because Site 1 is not an NRC-licensed facility. The substantive provisions of this requirement are relevant and appropriate for staging excavated soil contaminated with ROCs at levels at or above remediation goals prior to off-site disposal.
GROUNDWATER MONITORING					
Federal ARARs					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a]					
Groundwater monitoring	After final closure, maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of article 6 of chapter 14.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.310(b)(3)	Relevant and appropriate	The substantive provisions are relevant and appropriate for the groundwater monitoring associated with constructing the soil cover over the waste in Site 1. The specific provisions of chapter 14, article 6 that the Navy has identified as ARARs are discussed below.

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
GROUNDWATER MONITORING (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Monitoring	The owner or operator shall establish and implement, in conjunction with the corrective action measures, a water quality monitoring program that will demonstrate the effectiveness of the corrective action program and be effective in determining compliance with the water quality protection standard and in determining the success of the corrective action measures under subsection (c) of this section.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.100(d)	Relevant and Appropriate	This section is an ARAR for groundwater monitoring.
Completion of response action	The corrective action program is complete when compliance with the water quality standard is demonstrated based on the results of sampling and analysis for all constituents of concern for a period of 1 year.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.100(g)(1)	Relevant and Appropriate	This section is an ARAR for groundwater monitoring.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
GROUNDWATER MONITORING (Continued)					
Federal ARARs (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Chemicals of concern	Identify constituents of concern including the waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the regulated unit.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.93	Relevant and Appropriate	This section is an ARAR for groundwater monitoring.
Monitoring	Requirements for monitoring groundwater, surface water, and the vadose zone.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.97(b)(1)(A), (B) and (C), 66264.97(b)(1)(D)(1) and (2), 66264.97(b)(2), 66264.97(b)(4)-(7), 66264.97(e)(6), 66264.97(e)(12)(A) and (B), 66264.97(e)(13), and 66264.97(e)(15)	Relevant and Appropriate	These sections are ARARs for groundwater monitoring.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
GROUNDWATER MONITORING (Continued)					
Federal (Continued)					
Resource Conservation and Recovery Act (42 USC, Chapter 82, §§ 6901-6991[i])[a] (Continued)					
Monitoring (Continued)	Requirements for a detection monitoring program.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.98(e)(1-5), (i), (j), (k)(1-3), (4)(A) and (D),(5), (7)(C) and (D),(n)(1),(2)(B), and (C)C	Relevant and Appropriate	These sections are ARARs for groundwater monitoring.
	Requirements for an evaluation monitoring program.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.99(b), (e)(1)–(6), (f)(3), and (g)	Relevant and Appropriate	These sections are ARARs for groundwater monitoring.
	Requires continued monitoring until the regulated unit has been in compliance with the water quality protection standard for a period of three consecutive years and all waste, waste residues, contaminated subsoils and all other contaminated geologic materials are removed or decontaminated at closure.	Hazardous waste treatment, storage, or disposal facility	Cal. Code Regs. tit. 22, § 66264.90(c)(1) and (c)(2)	Relevant and Appropriate	These sections are ARARs for groundwater monitoring.

TABLE 13-3: ACTION-SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)
Record of Decision for Installation Restoration Site 1, 1943-1956 Disposal Area, Alameda Point, Alameda, California

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
GROUNDWATER MONITORING (Continued)					
State ARARs					
	For compliance demonstration each "must have remained at or below its respective concentration limit during a proof period of at least one year . . . and . . . (2) each Monitoring Point must have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per Monitoring Point."	Waste discharged after July 18, 1997	Cal. Code Regs. tit. 27, § 20430(g)(1)	Relevant and Appropriate	This section is an ARAR for groundwater monitoring.

Notes:

a Statutes and policies, and their citations, are provided as headings to identify general categories of ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the Navy accepts the entire statutes or policies as ARARs; specific ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered ARARs.

§ Section
§§ Sections
ARAR Applicable or relevant and appropriate requirement
BAAQMD Bay Area Air Quality Management District
Cal. Code. Regs. *California Code of Regulations*
Cal. Civil Code *California Civil Code*
Cal/EPA California Environmental Protection Agency
CFR *Code of Federal Regulations*
DTSC California Environmental Protection Agency Department of Toxic Substances Control
EPA Environmental Protection Agency
POC Point of compliance
RCRA Resource Conservation and Recovery Act
ROC Radionuclides of concern
ROD Record of Decision
tit. Title
USC *United States Code*
Water Board San Francisco Bay Regional Water Quality Control Board

APPENDIX F

OPEN CELL WASTE ISOLATION BULKHEAD ENGINEER DESIGN MEMORANDA

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DRAFT

P | N | D ENGINEERS, INC.

MEMORANDUM

To:	Peter Guerra, AMEC	Date:	June 18, 2012
		Project No:	124017

From: John Olson, Ogetsu Terao, Mike Hartley, Nels Sultan and Bill Gunderson, PND Engineers, Inc.

Subject: Alameda IR Site 1 OPEN CELL WIB – Preliminary Seismic Analysis including Liquefaction

This memo presents preliminary analysis of the OPEN CELL® Waste Isolation Bulkhead (WIB) at the Alameda IR Site 1 in a seismic event, including liquefaction. The analysis is an update of the previous work in 2002, included in two reports on Alameda IR Site 1 by Foster Wheeler Environmental Corporation (FWEC, 2002 and 2003). New geotechnical information has been used for this study with a focus on analyzing the OPEN CELL WIB alternative. This preliminary analysis is suitable for evaluating alternatives and meeting the needs of the Feasibility Study. Additional calculations will be completed by PND during final design. At that time final details for the bulkhead will be developed. Changes to sheet pile lengths and sheet pile quantities may occur.

The seismic stability and liquefaction analysis results have not changed substantially since the 2002 analysis. The key finding is that some displacement may occur during the Maximum Credible Earthquake (MCE) and/or liquefaction event. The exact amount of movement is difficult to predict. However, the initial computations indicate the bulkhead will remain intact and prevent the release of contaminated sediments into the waters of San Francisco Bay.

INTRODUCTION

The analysis and conclusions in this memo are based on the following:

1. A review of documents and previous studies, listed in the References.
2. Preliminary seismic analyses, using standard desktop calculation methods and assumptions.
3. Engineering judgment and experience, including knowledge gained while working on similar steel sheet pile bulkhead projects.

BACKGROUND

IR Site 1 is located at the northwestern comer of Alameda Point. IR Site 1 was once used at times for waste disposal at the former Naval Air Station Alameda. Prior to 1940, the site was under water to a depth of approximately 10 to 20 feet along the current western shoreline of the site. Docks and ferry lands used part of the site. The area was reclaimed by dredging operations and fill, which included the placement of sunken barges and pontoons on the western edge of the disposal area, and clay and silt sediments in the disposal area. The method used by NAS Public Works to dispose of wastes was to bulldoze trenches to the water table, fill with waste, and then compact the surface. In the early years of operation, the waste was simply pushed into the water.

SUBSURFACE CONDITION

A typical soil profile based on the most recent geotechnical information is shown in Figure 1. Soil borings and trenches were completed in summer 2010 focused on the burn area. The soil profile is similar to that assumed in the 2002 analysis (Figure 2). The soil properties are summarized in Table 1 and described below.

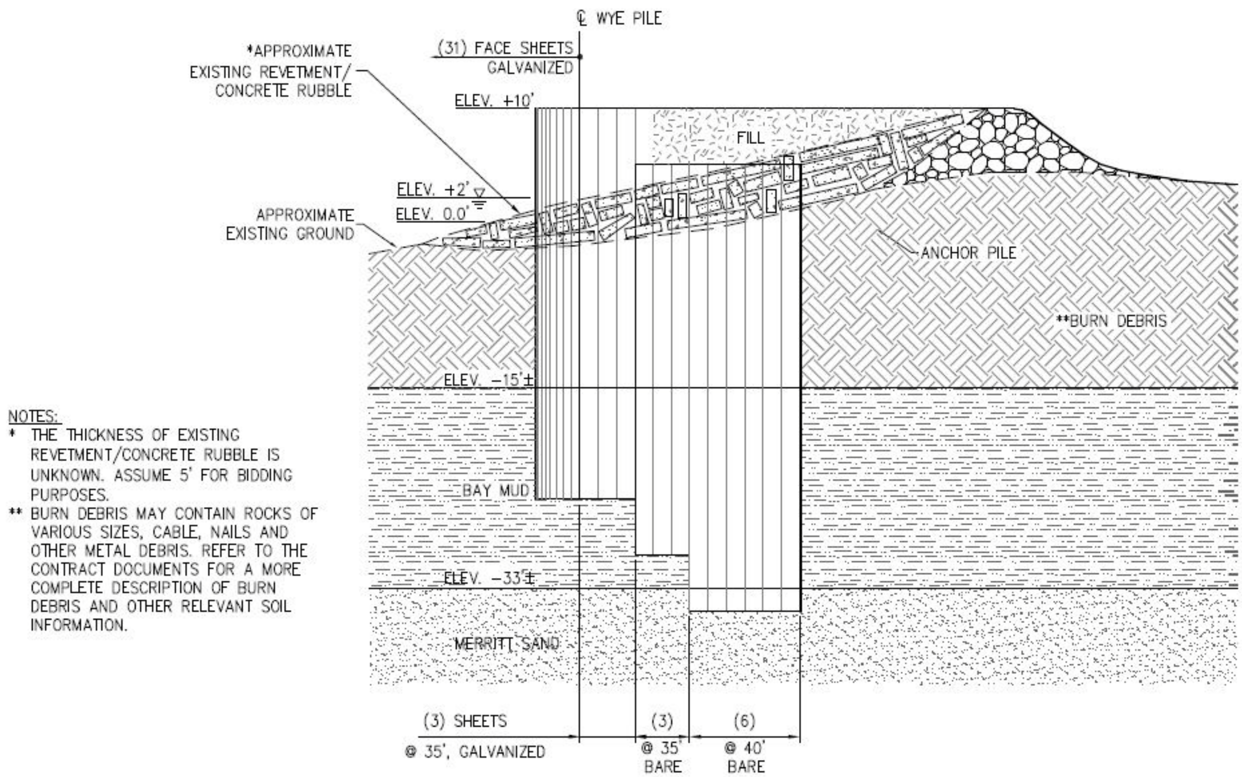


Figure 1. Typical Soil Profile and Planned Waste Isolation Bulkhead (Based on 2010 borings and trenches)

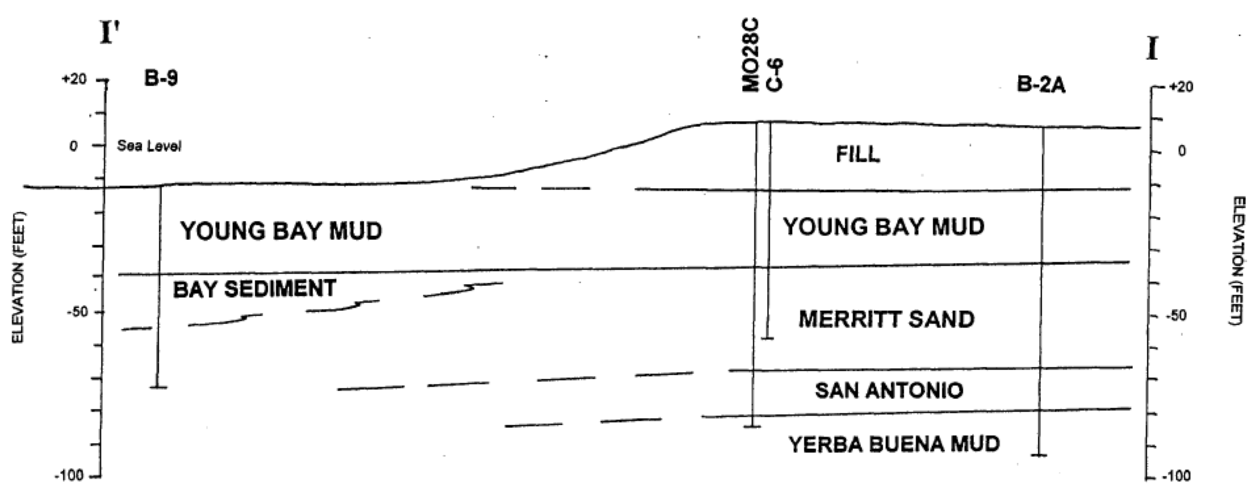


Figure 2. Assumed Typical Soil Profile in 2002 Liquefaction Analysis (Foster-Wheeler, 2002)

Fill

The fill is composed of sand, silt, and clay dredged from the surrounding bay with thickness ranging from about 10 to 30 feet. The soil type and properties vary. The fill surface is covered with a rock dike to keep the fill in place. Throughout most of the site, the bottom of the fill is near sea level. The strength of the fill varies widely because of the wide variety of materials.

Young Bay Mud

The Young Bay Mud contains mixtures of silts and fine-grained sand. The material was deposited within the bay and the surrounding estuaries and tidal flats. The shear wave velocity of the Young Bay Mud measured at the SFOBB was generally in the 400 to 650 feet per second range, indicating soft soil but can be firm locally.

Merritt Sand

The Merritt Sand unit consists primarily of fine-grained sand to SM. The shear-wave seismic velocity of the unit measured at the SFOBB was generally in the 400 to 1,650 feet/second range indicating a dense to very dense soil layer.

LIQUEFACTION POTENTIAL EVALUATION

Liquefaction occurs when the effective soil strength is reduced by the rising pore water pressure due to strong ground shaking in an earthquake. The primary factors that influence the potential for liquefaction include groundwater table elevation, soil type and grain size characteristics, relative density of the soil, initial confining pressure, and intensity and duration of ground shaking. Liquefaction potential is greatest in saturated, loose, poorly graded fine sands. However non-plastic silty soils such as Young Bay Mud can be considered potentially liquefiable. The 2002 evaluation of the site concluded that the fill and Young Bay Mud were potentially liquefiable (Foster-Wheeler, 2002). The project site is also within a region mapped by the USGS as "Very High Susceptibility" to liquefaction (Figure 3).

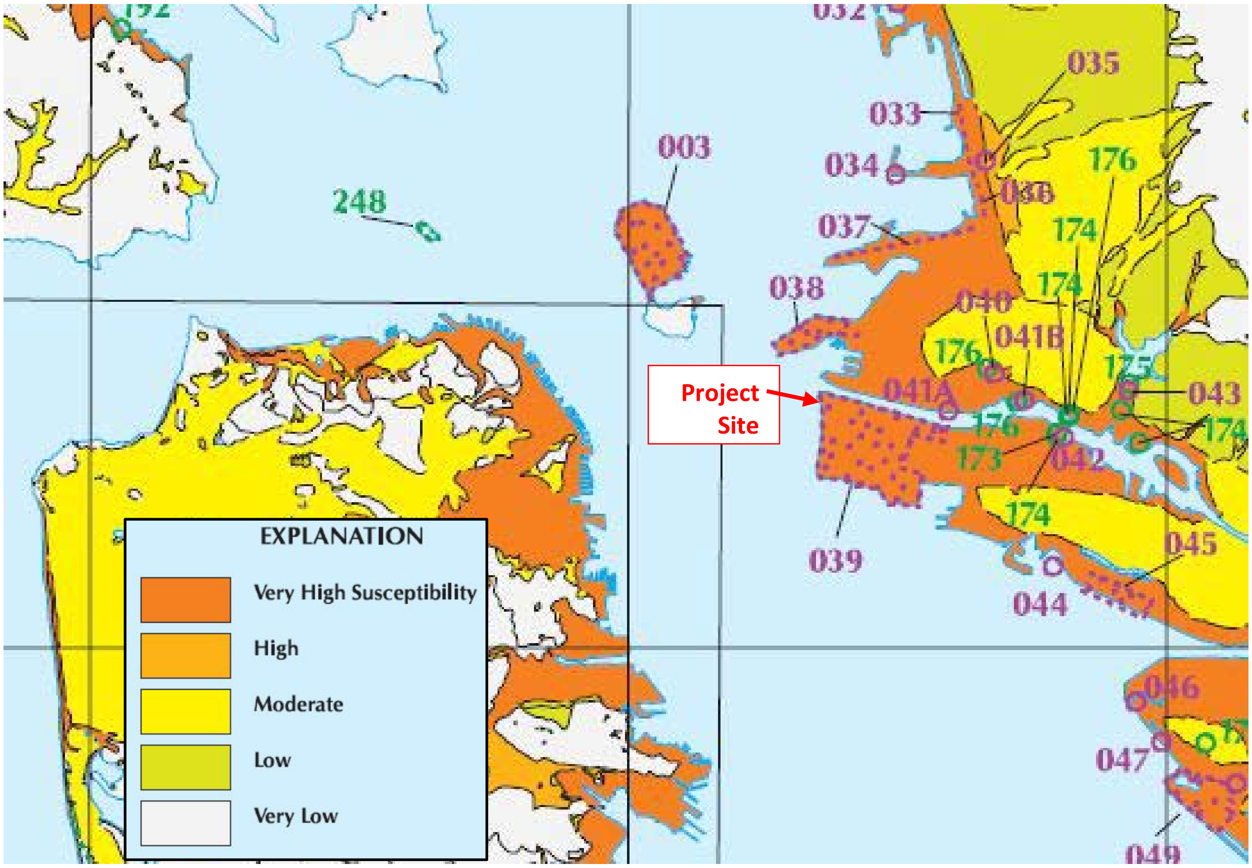


Figure 3. Bay Area Liquefaction Potential (USGS, 2000).

LIQUEFACTION-INDUCED DEFORMATIONS

The effect of earthquake-induced liquefaction in a saturated sandy soil in general varies widely. The 2002 analysis roughly estimated liquefaction-induced ground settlements and lateral displacements using empirical methods. The methods use correlations between soil penetration data (CPT-qc and SPT-N values) with results of well-documented laboratory tests and site design ground motion parameters to estimate volumetric strains in soils and accumulated ground settlements. Lateral spread displacements were also estimated from empirical relations developed based on soil penetration data, earthquake ground motion parameters, and a dataset of well-documented case histories of field performance where earthquake motions and ground deformations were measured during and after an earthquake. The horizontal displacement of unreinforced ground at the site was estimated to be on the order of 10 to 20 feet depending on location. This estimate is based on preliminary calculations and should be refined by using numerical modeling methods.

DESIGN CRITERIA

The following are the assumed criteria for the seismic design. The design life for the bulkhead shall be a 30 year minimum, with a target of at least 100 years.

Dead Load: all

Live Load: 50psf (50% of design uniform live load)

Seismic Load: Peak ground acceleration of 0.4g per 2002 Foster Wheeler report[1].

DESIGN SOIL PROPERTIES

Design soil properties for pseudo-static and post-earthquake analyses are based values reported in the 2003 report (Tables 2 and 3).

Table 2. Design Soil Properties: Pseudo-static

Soil Type	$gamma_{sat}$ (pcf)	c' (psf)	phi (degree)
Fill	128	-	30
Young Bay Mud	115	-	25
Merritt Sand	131	-	38

Table 3. Design Soil Properties: Post Earthquake

Soil Type	$gamma_{sat}$ (pcf)	c (psf)	phi (degree)
Fill	128	300	-
Young Bay Mud	115	400	-
Merritt Sand	131	-	38

ANALYSIS METHODS

The following three desktop calculation methods were used for the preliminary analysis of the OPEN CELL WIB bulkhead.

Global Stability

Conventional two-dimensional limit equilibrium stability analyses were performed to evaluate the pseudo-static stability of the wall. Spencer's method of analysis is used to calculate the factors of safety against potential failure. The computation is performed by the computer program SLOPEW. The program uses two-dimensional limit equilibrium theory to provide general solutions to slope stability problems. The target factor of safety is a minimum of 1.15 for during and after (liquefaction and lateral spreading) earthquake.

Active Wedge Analysis

This internal stability analysis assumes an active soil wedge failure plane with activating forces, consisting of active soil force, phreatic water force and seismic force. The resisting force consists of tail wall resistance for the portion embedded outside the active wedge failure plane and passive earth pressure acting on the front of the wall. The target factor of safety is a minimum of 1.15 for during and after (liquefaction and lateral spreading) earthquake.

Sheet Pile Interlock Load

Loads in the sheet pile interlock and connection elements are checked using the maximum tension load in the face and tail walls. The check is incorporated into the Active Wedge Analysis. This analysis combined with active wedge analysis will demonstrate that the structure will move as a complete unit, with all material contained within the bulkhead. The target factor of safety is a minimum of 2.0 for during and after (liquefaction and lateral spreading) earthquake.

CONCLUSIONS AND RECOMMENDATIONS

PND has performed initial analysis of the OPEN CELL Waste Isolation Bulkhead (WIB) with respect to preliminary global stability, active wedge, and interlock load assessment to determine if the WIB can withstand the potential for liquefaction and lateral spreading. The key findings and recommendations are the following:

1. In a large seismic event, the wall is likely to move with the surrounding soils butremain intact, with the sheet piles within 5° of vertical, as indicated by the internal stability analysis (Active Wedge).
2. The interlocks will remain intact after the design seismic event and the wall will be able to retain all contaminated soils, preventing movement into bay waters.

This initial assessment indicates a high potential for meeting performance criteria. Additional refinement of the wall geometry will be needed in the design phase to determine the optimal configuration and to determine the optimal make-up of the face sheets and tail wall system for the WIB. The refined analysis during the design phase will be used to meet design criteria for containment during liquefaction or lateral spreading during seismic events.

REFERENCES

FWEC (2002). “Final Ordnance and Explosives Waste/Geotechnical Characterization Report-Revision0”, Foster Wheeler Environmental Corporation

FWEC (2003). “Final Feasibility Report”, Revision 0, Volume 2, Foster Wheeler Environmental Corporation.

USGS (2000). “Preliminary Maps of Quaternary Deposits and Liquefaction Susceptibility, Nine-County San Francisco Bay Region, California”, US Geological Survey, Open-File Report 00-44, Sheet 2 of 2.

DRAFT

MEMORANDUM

To: Peter Guerra, AMEC

Date: November 5, 2012

Project No: 124017

From: John Olson and Bill Gunderson, PND Engineers, Inc.

Subject: Alameda IR Site 1 OPEN CELL WIB – Corrosion Protection Design

This memo presents information to be used in the selection of an appropriate corrosion protection system for steel sheet piles at the Alameda IR Site 1. This memo is a preliminary analysis of steel corrosion, and presents a recommended corrosion protection system best suited to this project.

This analysis will be used for the focused feasibility study of the OPEN CELL Waste Isolation Bulkhead (WIB) at the Alameda IR Site 1. This technical memo has been prepared by PND Engineers, Inc. for AMEC. It is intended to be included as an appendix to the Focused Feasibility Study Report.

INTRODUCTION

The analysis and conclusions in this memo relating to corrosion are based on the following:

1. A review of documents and previous studies, listed in the References section below.
2. Observation and direct measurement of corrosion on comparable OPEN CELL steel sheet pile bulkheads in comparable environments.
3. Engineering judgment and experience, including knowledge gained while working on similar steel sheet pile projects in similar corrosive environments.

The best source of information on likely corrosion rates would be measured steel corrosion rates in the same Bay waters. Reports from Caltrans and the Port of Oakland that include inspection of existing steel structures would be ideal but have not been acquired at this time. PND has found very limited information on steel corrosion of existing structures in the region. A 1960 US Navy report has some data, and is described in this memo. Additional investigation of corrosion rates based on existing in-water steel structures would improve the confidence of the corrosion predictions in this memo.

DESIGN CRITERIA

The design life for the bulkhead is assumed to be 50 years minimum, with a target of 100 years. Corrosion of the sheets shall be controlled to acceptable levels to ensure full bulkhead function through all design conditions and loads, including extreme seismic events as defined in the associated Memorandum titled, "Preliminary Seismic Analysis including Liquefaction".

It is important to note that an OPEN CELL SHEET PILE structure functions purely in hoop tension. (See Figure 1.) There are no bending loads in the sheets, and there are no stress concentrations like in a tie-back wall system or combi-wall. The lower stresses greatly reduce the typical issue of stress-amplified corrosion across a local band. The lack of stress concentrations and reserve strength capacity of the steel increases the amount of acceptable corrosion loss before the steel allowable stress is exceeded.

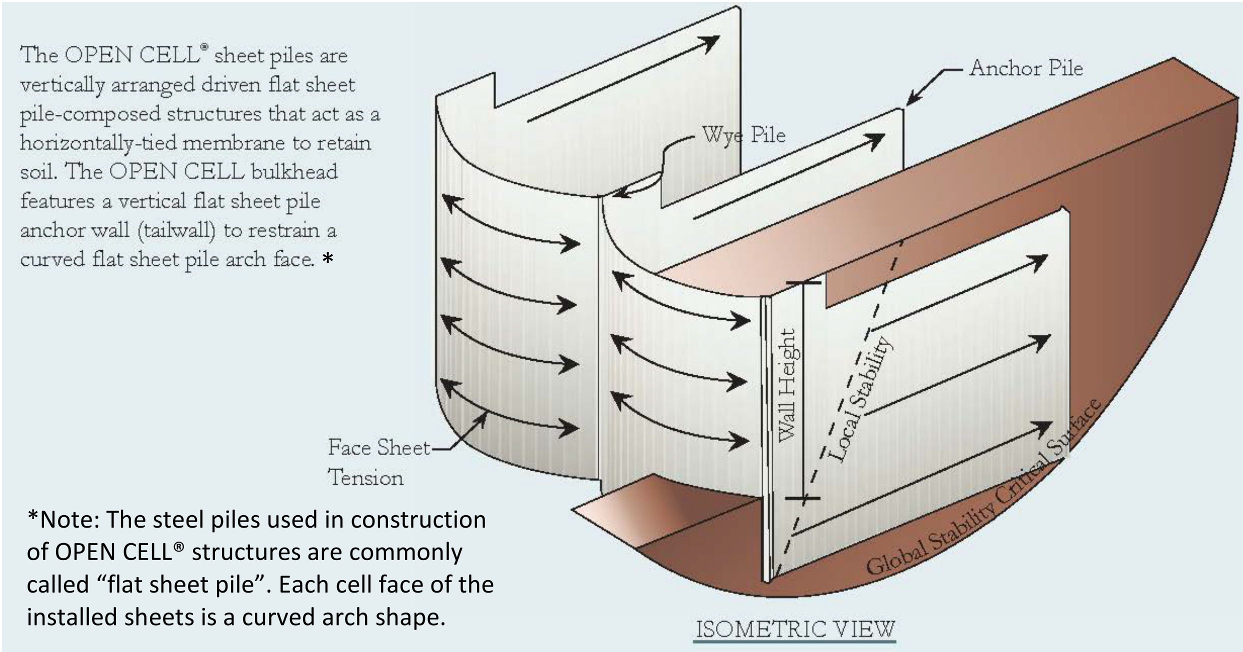


Figure 1. OPEN CELL Bulkhead Hoop Tension (PND, 2012)

PREVIOUS CORROSION STUDIES IN THE BAY AREA

Corrosion rates on steel piles along the Alameda waterfront were measured by the U.S. Naval Civil Engineering Laboratory in 1960. The measured rates are in the following section. Additional local information is in the “Corrosion Guidelines” report by Caltrans (2003).

These rates also conform to the lower range of CALTRANS assumed consumption rates, discussed below.

CORROSION RATES

Guidance on corrosion is included in a number of codes and references. Listed below are typical corrosion rates assumed for different environments. Special considerations for Mechanically Stabilized Earth (MSE) structures have been considered. An MSE structure is the use of mechanical means to artificially reinforce soil, such as a bulkhead. The following are general guidelines from different codes, standards and handbooks, conveniently presented in a 2012 Webinar from Skyline Steel.

The corrosion rates from codes in California, Florida, and Europe, summarized below, are for in-water marine use. Note that the CALTRANS values are the highest corrosion rates. It is assumed that all corrosion rates below are conservative estimates. The 1960 US Navy investigation found slightly higher rates of corrosion than the CALTRANS assumptions on a steel sheet pile structure at the Alameda Naval Air Station.

<u>CALTRANS</u>

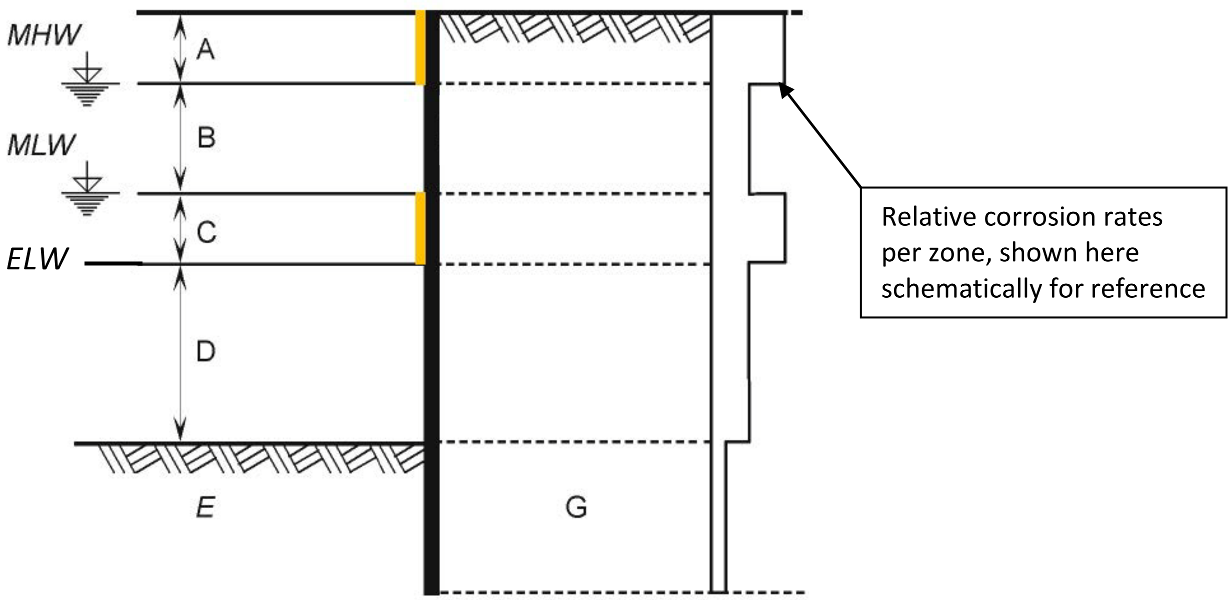
- Soil Embedded Zone 0.025mm (0.001in) per year
- Immersed Zone 0.100mm (0.004in) per year
- Scour Zone 0.125mm (0.005in) per year

FDOT

- Slightly Aggressive 0.025mm (0.001in) per year
- Moderately Aggressive 0.051mm (0.002in) per year
- Extremely Aggressive 0.076mm (0.003in) per year

Eurocode ENV 1993-5

- Non-Compact Fill 0.024mm (0.001in) per year
- Permanent Immersion 0.035mm (0.0014in) per year
- Splash Zone 0.075mm (0.003in) per year



A: Splash Zone (high attack)
B: Intertidal Zone (moderate attack)
C: Low Water Zone (high attack)
D: Permanent Immersion Zone (moderate attack)
E/G: Buried Zone, both sides (low attack)

Top of Wall: Elev. +10.0’
MHW (mean high water): Elev. +6.0’
MLW (mean low water): Elev. +1.1’
ELW (extreme low water): Elev. -3.3’

Figure 2. Zones of Corrosion (Skyline Steel, 2012)

Figure 2 shows the different zones used for analyzing corrosion on waterfront structures. It is commonly known that the highest rates of corrosion are in the splash zone and the low water zone. These zones correspond to approximate elevations of +10.0’ to +6.0’ (splash zone) and +1.1’ to -3.3’ (low water zone) at the project site. The vertical datum is MLLW of 0.0’. The permanent immersion zone will actually be the buried zone with low corrosive attack at the WIB project site (Figure 3).

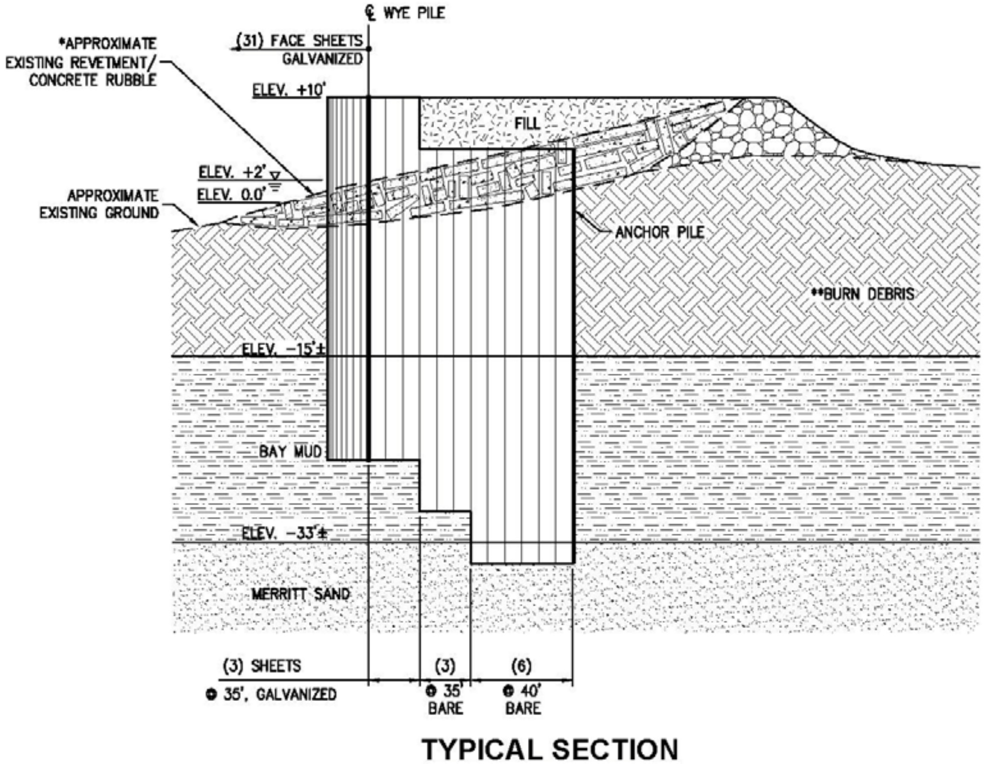


Figure 3. Typical Cross Section of OPEN CELL WIB

The U.S. Navy conducted a survey of several naval facilities in December 1960, one of which was the U.S. Naval Air Station in Alameda, California. The survey consisted of cutting samples from existing sheet pile walls at varying locations to measure material loss in the steel at each tide range and depth. The wall surveyed at the Alameda site was Pier 1, a fueling pier. The sheets were 0.50-inch thick when installed in 1939.

From U.S. Naval Civil Engineering Laboratory, Corrosion Survey of Steel Sheet Piling, Technical Report:

> *Twenty samples were cut from the sheet piling of Pier 1 for use in this investigation. The maximum rate of corrosion, 8.6 mpy (mils per year), and (sic)occurred in the tidal range approximately two-thirds of the way from MLW (0-ft) to MHW (10-ft). Weight loss measurements showed that the average corrosion rate in this area was 5.6 mpy. A maximum corrosion rate of 6 mpy occurred at one foot above the mudline and again at the top of the piling about 5 feet above MHW.*
>
> *An unusually low rate of corrosion, about 0.5 mpy, was found in the splash zone, 2-feet above MHW. This is interpreted to be a consequence of fuel oil, which typically coated the piling above MHW and was not leached away by splash and spray during periods of high tide. The report notes a sheen observed in the water at the time of the study, which was typical in that region of the Bay during that era. The thin layer of fuel oil continuously coated the steel piles and greatly reduced the corrosion rate.*
>
> *After 20 years, the most corroded section of piling observed was about 3 feet above MLW where about 64 percent of the piling remained.*

PND concludes that the unusually low corrosion rate of 0.5 mpy should be disregarded due to the oil and water pollution that is not present today. The maximum rate of corrosion of 8.6 mpy (0.0086-inch per year) found within the tidal range is a better indication of the controlling corrosion rate to be used in calculations.

In addition to atmospheric, splash zone, immersed and scour enhanced corrosion present on the face of the sheet piles, there is a component of corrosion present on the back side and buried portion of steel waterfront structures. Typically, this component of corrosion is negligible. However, given the nature of the material being contained by the bulkhead (burn debris and other contaminants), potential corrosion on the buried side of the sheets should be considered.

From CALTRANS, Corrosion Guidelines:

> *Local corrosion cells may exist in non-homogeneous fills that can lead to increased corrosion rates of driven steel piles. These types of fills include combinations of natural soils (clays and sands), construction debris, ash and cinder material, as well as waste inorganic materials. Increased corrosion rates have been documented in these fills where soil pH was low, 5.5 or less, and soil minimum resistivity was below 1,000 ohm-cm. For these reasons, Caltrans recommends testing fill material for corrosion potential.*
>
> *The following are corrosion related guidelines, per CALTRANS, for backfill material in an MSE (mechanically stabilized earth) structure:*
>
> 1. *Minimum resistivity must be greater than 1,500 ohm-cm, CTM 643*
> 2. *Chloride concentration must be less than 500 ppm, CTM 422*
> 3. *Sulfate concentration must be less than 2,000 ppm, CTM 417*
> 4. *pH must be between 5.5 and 10.0, CTM 643*

MSE backfill material that meets the above criteria will be considered non-corrosive to the metallic soil reinforcement (sheet piles). It must be noted that these are requirements for the selection of backfill material for a new structure. Because the purpose of this project is to contain existing contaminated material, PND considers these criteria as recommendations rather than requirements. CALTRANS recommends that metallic soil reinforcement be galvanized in accordance with the Department's standard galvanizing requirements.

PIANC: Accelerated Low Water Corrosion

Accelerated Low Water Corrosion (ALWC) is defined as the localized and aggressive corrosion phenomenon that typically occurs at or below low-water level and is associated with microbial induced corrosion. PIANC (2005) reviews the issue and provides design guidance. ALWC corrosion rates are typically 0.5 mm/side/year averaged over time to the point of complete perforation of the steel plate. Maritime structures should be designed to ensure that high bending moments do not occur near anticipated ALWC sites. OPEN CELL structures have a purely hoop tension load path with no bending loads. Design considerations for ALWC and OPEN CELL structures is the same as for design in the splash zone and no special design elements are needed to account for ALWC at this project site.

Eurocode 3 Corrosion Rates

The corrosion rates in Table 1 are from Eurocode 3, Design of Steel Structures-Piling. The corrosion rates in Eurocode 3 are similar to the corrosion rates used by CALTRANS. However, CALTRANS assumed consumption rates and measurements from the U.S. Navy investigation in 1960 are generally higher and should be used for design of this project as a more conservative approach. The Eurocode values are for a useful comparison that improves the confidence of the design assumptions.

Table 1. Steel Pile Loss of Thickness Due to Corrosion (Eurocode 3, 2007)

Loss of thickness [mm] due to corrosion for piles and sheet piles in fresh water or in sea water

Required design working life	5 years	25 years	50 years	75 years	100 years
Common fresh water (river, ship canal, ...) in the zone of high attack (water line)	0,15	0,55	0,90	1,15	1,40
Very polluted fresh water (sewage, industrial effluent, ...) in the zone of high attack (water line)	0,30	1,30	2,30	3,30	4,30
Sea water in temperate climate in the zone of high attack (low water and splash zones)	0,55	1,90	3,75	5,60	7,50
Sea water in temperate climate in the zone of permanent immersion or in the intertidal zone	0,25	0,90	1,75	2,60	3.50

Notes:

1) The highest corrosion rate is usually found in the splash zone or at the low water level in tidal waters. However, in most cases, the highest bending stresses occur in the permanent immersion zone, see Figure 4-1.

2) The values given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

EXAMPLE CALCULATIONS

Corrosion of design life with bare steel:

The following is an example calculation for section loss of a bare PS27.5 flat sheet pile, with corrosion at the low water scour zone, applying local corrosion rates:

Material Thickness: 0.4-inch
Corrosion Allowance: assume wall will continue to function at full capacity until 0.125-inch thick*
Corrosion Rate: 0.0086-inches per year (extreme case from U.S. Navy investigation)
Exposed Face: only water side, assumes no measurable corrosion on the fill side of wall

*Note: The sheet pile webs will continue to develop the required tension loads through hoop tension in the face sheets if reduced to 0.125-inches in thickness.

Allowable steel thickness loss: 0.4-inch - 0.125-inch = 0.275-inch
Expected life: 0.275-inch / 0.0086-inch per year = 32 years (without any corrosion protection system)

Calculations to design passive cathodic protection (sacrificial anodes):

Addition of hot dip galvanizing will slow the section loss considerably in the splash and intertidal zones. The low water and permanent immersion zones can be protected further by addition of galvanic anodes. It is recommended that anodes be installed after deterioration of the coating system becomes evident. This is likely around 20 years after construction if only galvanizing is applied.

After the coating system starts to show distress, addition of anodes will help protect the sheets in the submerged zones. Below is a sample calculation for sizing an aluminum alloy anode:

Harbalum aluminum alloy anode, electrochemical properties:
Potential difference: -1,150 mv
Consumption: 7.62 lbs / amp-year
Efficiency: 85%

Assume loss of approximately 10 percent of the coatings after 20 years of service life:
Assume protection needed from elevation +5' to 0' over 640 linear foot of wall: 3,200 sq. ft

Current required to polarize bare portion of steel: 0.1 x 0.03 amp / sq. ft = 0.003 amp / sq. ft
Current required to polarize coated portion of steel: 0.9 x 0.003 amp / sq. ft = 0.0027 amp / sq. ft
Total current required to polarize wall: 3,200 sq. ft x (0.003 + 0.0027 amp /sq. ft) = 18.24 amp

Current required to maintain protection of bare: 0.1 x 0.007 amp / sq. ft = 0.0007 amp / sq. ft
Current required to maintain protection of coated: 0.9 x 0.001 amp / sq. ft = 0.0009 amp / sq. ft
Total current required to maintain wall: 3,200 sq. ft x (0.0007 + 0.0009 amp /sq. ft) = 5.12 amp

Total weight of anode material required for 20 year service life (replace anodes after 20 years):
Weight (lbs) = {Consumption Rate (lbs/amp-yr) x Life (yr) x Total Current (amp)} / Efficiency Factor
Weight = {7.62 lbs/amp-yr x 20 yrs x 5.12 amp} / 0.85 = 918 lbs

Anodes should be spaced no more than 10 feet apart along the 640 foot long wall. Therefore, approximately 64 anodes will be required at a unit weigh of approximately 15 pounds each, installed at the very lowest portion of the wall. Because the aluminum anode will draw the potential from the system, proper maintenance of the anodes will ensure that the full design life of the structure will be met.

SOIL TEST RESULTS

Soil samples were tested for pH, chloride concentration, and sulfate concentration following the test standards outlines in the CALTRANS corrosion guidelines. The test results are summarized in Table 2, with additional details in the lab report (TestAmerica, 2012). The samples tested were from borings completed in 2010 and 2011. The boring locations are in Figure 4.

All tests were done in the lab with the exception of Resistivity that was not tested at this time because of cost and logistics issues associated with field testing at a contaminated site. Resistivity testing involves inserting probes into the ground and measuring the electrical resistance.

The test results show that chloride concentrations typically exceed the recommended limit, indicating an increased risk of corrosion from the soils. Corrosion protection for the tailwalls and inside face of the face sheets is typically not necessary for OPEN CELL bulkheads, but should be further evaluated during design and provided if necessary to meet the design criteria.

Table 2. Soil Test Results - Summary

Sample ID	Location	pH (-)	Cl (mg/Kg)	SO4 (mg/Kg)
02-1204	PMW-1 @ 8.5' bgs	6.48	893	366
02-1208	PMW-1 @ 25' bgs	6.98	2650	1560
02-1261	PMW-8 @ 5' to 18' bgs composite	6.75	4600	2820
02-1264	PMW-8 @ 22.5' bgs	7.32	4240	3580
02-1285	PMW-11 @ 6.5' to 21' bgs composite	6.67	1470	2950
02-1212	PB-2 @ 7' bgs	10.1	3310	194
02-1216	PB-2 @ 23' bgs	7.47	3570	1100
02-1293	PMW-12 @ 7' to 9' bgs composite	7.61	49	1850
02-1296	PMW-12 @ 37.5' bgs	8.17	1370	199
02-1309	PMW-14 @ 8' to 13 ' bgs composite	7.15	799	2500
02-1312	PMW-14 @ 22' bgs	7.74	2890	997
	Minimum	6.48	49	194
	Maximum	10.1	4600	3580
	Average (mean)	7.49	2349	1647
	75% Confidence Limits	6.74 – 7.73	1025 – 3625	425 - 2750
	Standard Deviation	0.9998	1516	1190
	CALTRANS Guidelines for backfill in MSE (mechanically stabilized earth) structures	5.5 to 10.0	less than 500	less than 2000

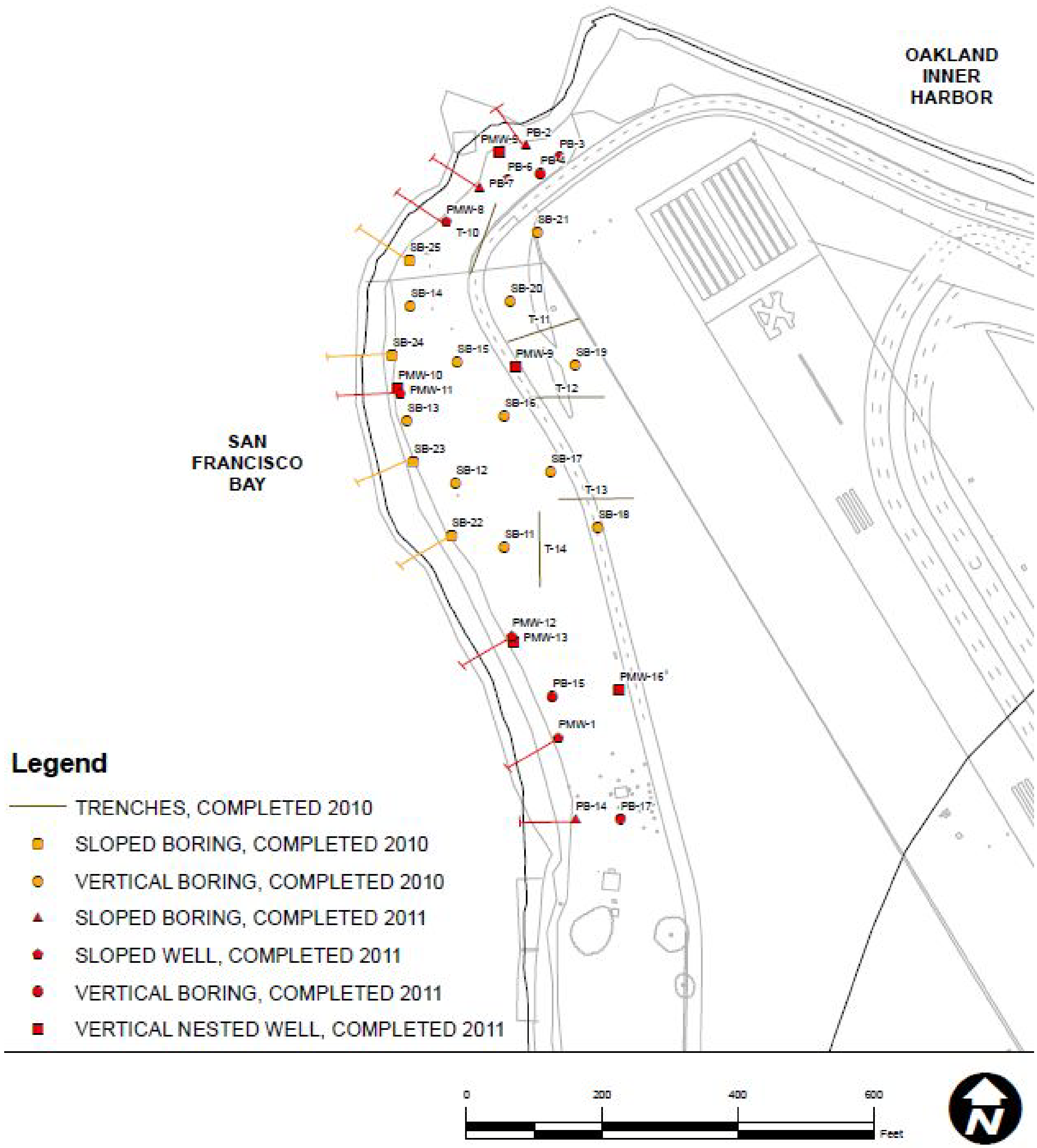


Figure 4. Borings and Trenches Location Map (AMEC, 2012)

MAINTENANCE AND INSPECTION RECOMMENDATIONS AND ESTIMATED COSTS

Maintenance consists of regular inspections and replacement of the sacrificial anodes on the face of wall as needed. Visual inspections are recommended annually, with measurements of steel thickness with an ultra-sonic gage or other non-destructive test method every 5 years. The cost of each inspection every 5 years, including the thickness gage data collection, is estimated to be $25,000. Major maintenance including replacement of the sacrificial zinc or aluminum anodes can be assumed necessary every 10 years at an estimated cost of $50,000.

CONCLUSIONS AND RECOMMENDATIONS

The key findings and recommendations are the following:

1. PND recommends that the soil to be contained behind the wall be further evaluated during final design to determine if corrosion from both sides of the sheet piles should be considered. A coating system or other corrosion protection system could be applied to both sides of the sheets and possibly the tailwalls if needed to meet the design criteria..

2. A coating system of hot dip galvanizing should be considered. This system should be applied to the top 20-feet of all face sheets to protect the steel on the surface exposed to seawater and scour. Galvanizing is typically applied to both sides of the sheet piles by hot dipping. The coating system would meet the design criteria if regular inspection and cathodic protection (aluminum anodes) were used when the galvanized coating shows signs of distress. Uncoated, bare steel sheets are not recommended. Coating with only a paint system such as coal tar epoxy is not recommended.

3. The buried portion of the wall may be subject to corrosive elements, but the effect in this zone is not anticipated to be large enough to warrant application of protection in this zone. There are no high bending stresses in an OPEN CELL structure, so the acceptable corrosion near the mudline is higher than would be expected in a tied-back or heavy section z-sheet wall.

4. Aluminum anodes should be added to the submerged portion of the wall to add protection, particularly at the scour zone, after coating distress becomes evident. These anodes will provide protection for the entire submerged portion of the sheets during high tides and at the scour zone during low tides.

5. Annual inspection and maintenance of the corrosion protection system should be done. Inspections that include measurements with an ultrasonic thickness gage are recommended every 5 years. This would include inspection of the coatings in the atmospheric and splash zones and inspection of the anodes for material loss. Maintenance would include coating repairs, replacement of anodes and possibly welding of steel patches to retain soil in the event of any local anomalies causing holes in the wall. It is important to note that an OPEN CELL structure does not need to resist bending forces like a typical bulkhead, with all loads being in hoop tension. As a result, corrosion allowances are much greater and corrosion concerns much less critical than a tie-back or combi-wall bulkhead.

6. With proper maintenance and inspection of the corrosion protection system a steel structure can have an indefinite design life. PND is confident that a steel bulkhead, with an appropriate coating system, inspection and maintenance program, can meet or exceed a 100 year design life for the project.

REFERENCES

AISI (1981), Handbook of Corrosion Protection for Steel Pile Structures in Marine Environments, American Iron and Steel Institute, 1981.

AMEC (2012). “Borings and Trenches Location Map”, Figure No. 2-10 from Burn Area Focused Feasibility Study.

CALTRANS (2003), Corrosion Guidelines, Version 1.0, California Department of Transportation, Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch, September 2003.

Eurocode (2007). “BS EN 1993-5:2007 Eurocode 3. Design of steel structures. Piling”

Harbor Island Supply (June 2012). “Technical Data Sheet –Sacrificial Anodes”. <http://www.harboranodes.com/anode_technical.html>

PIANC (2005). Accelerated Low Water Corrosion, Report of Working Group 44 of the Maritime Navigation Commission, 2006.

PND Engineers, Inc. (2012), “OPEN CELL Sheet Pile Technology”, brochure, 12 pp. <http://www.pndengineers.com/Modules/ShowDocument.aspx?documentid=407>

Skyline Steel (2012), Overcoming Corrosion and Designing Life into Steel Structures, Webinar, 2012.

TestAmerica (2012), “Analytical Report”, Project No. 8151020002, Alameda CTO-002 IR Site 1, by TestAmerica Laboratories, Inc. , June 29, 2012, pp. 35.

U.S. Naval Civil Engineering Laboratory (1960), Corrosion Survey of Steel Sheet Piling, Technical Report 097, December 27, 1960.

DESIGN COMMENTARY

This package contains the design calculations for the Alameda Waste Isolation Bulkhead using the OPEN CELL SHEET PILE® system. The new bulkhead will serve as a containment structure.

The design criteria, analysis description and general assumptions are summarized in this design commentary.

LOADS

DL: All
LL: 50 psf
EQ: PGA = 0.4

Dead Load (DL): The dead load consists of the soil mass supported by the bulkhead structure.

Live Load (LL): The live load is assumed to be 50 psf, uniformly distributed.

Seismic Load (EQ): A peak ground acceleration of 0.4 will be used.

SOIL PROPERTIES

Design soil properties for pseudo-static and post-earthquake analyses are based values reported in the 2003 report (Tables 2 and 3).

Design Soil Properties: Pseudo-static

Soil Type	$gamma_{sat}$ (pcf)	c' (psf)	phi (degree)
Fill	128	-	30
Young Bay Mud	115	-	25
Merritt Sand	131	-	38

Design Soil Properties: Post Earthquake

Soil Type	$gamma_{sat}$ (pcf)	c (psf)	phi (degree)
Fill	128	300	-
Young Bay Mud	115	400	-
Merritt Sand	131	-	38

<u>Fill</u>
The fill is composed of sand, silt, and clay dredged from the surrounding bay with thickness ranging from about 10 to 30 feet. The soil type and properties vary. The fill surface is covered with a rock dike to keep the fill in place. Throughout most of the site, the bottom of

the fill is near sea level. The strength of the fill varies widely because of the wide variety of materials.

Young Bay Mud
The Young Bay Mud contains mixtures of silts and fine-grained sand. The material was deposited within the bay and the surrounding estuaries and tidal flats. The shear wave velocity of the Young Bay Mud measured at the SFOBB was generally in the 400 to 650 feet per second range, indicating soft soil but can be firm locally.

Merritt Sand
The Merritt Sand unit consists primarily of fine-grained sand to SM. The shear-wave seismic velocity of the unit measured at the SFOBB was generally in the 400 to 1,650 feet/second range indicating a dense to very dense soil layer.

Thickness (elevation) of each soil layer and corresponding soil parameters are shown in the attached Active Wedge soil profiles.

ANALYSIS METHODS

GLOBAL STABILITY ANALYSIS

A slip circle analysis is used to check the global stability of the structure. The analysis is performed using a computer program, SLOPE/W to perform Spencer's method. The resulting analysis computer output is included.

Typically, a slip circle failure plane is drawn to include the entire structure within the moving soil mass, thus excluding any resistance from the tail walls. However, in this case we considered a pseudo-static analysis with liquefied soil properties with the goal of containment of the contaminated material regardless of wall deflection and outward movement. The base of the circle is set at the same depth as the toe of the face sheets. As a result, the analysis (slip circle) failure plane passes through the tail wall, therefore activating a component of tail wall resistance.

The activating moments along the circumference of the slip circle may consist of the soil mass, phreatic water pressure, live loads or seismic loads about the center of the slip circle. The resisting moments derive from the friction and cohesion of the soil along the failure plane, multiplied by the moment arm, which is equal to the radius of the slip circle. And the tail wall resistance is derived from the effective soil pressure on the sides of the tail wall sheets.

The global stability analysis yields a factor of safety of 1.55, greater than the target of 1.15 during and after an earthquake.

LOCAL STABILITY ANALYSIS

The OPEN CELL Bulkhead is a reinforced earth structure and functions much like an MSE wall. The following analyses establish the internal stability of the structure as it interacts with the soil that is part of its structure.

Active Wedge Analysis:

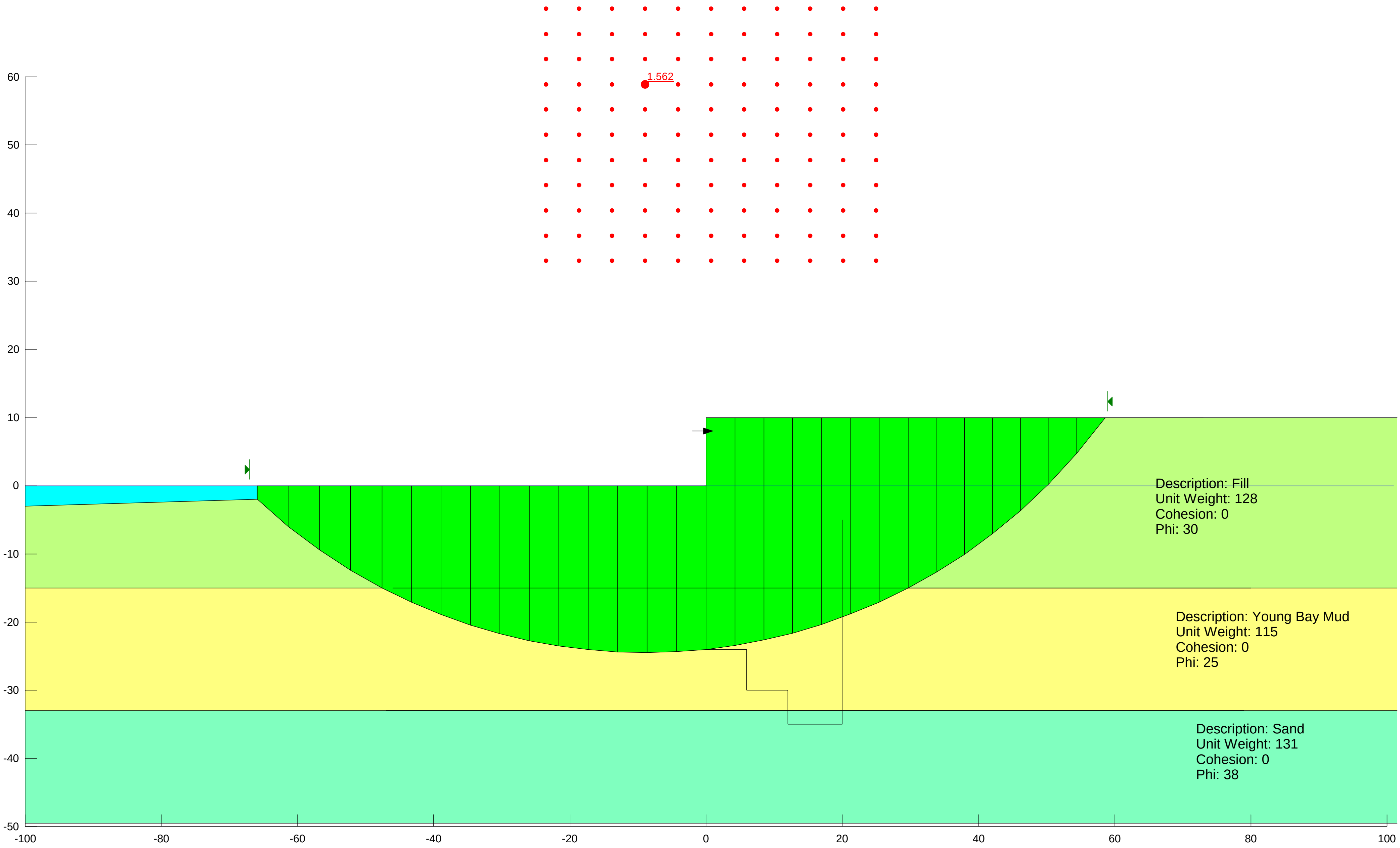
This analysis assumes an active soil wedge failure plane with activating forces, consisting of Rankine active soil force, live load and seismic forces. The resisting force consists of tail wall resistance that is embedded outside the active wedge failure plane and Rankine passive earth pressure. The analysis is presented in a spreadsheet form with graphic diagrams showing the earth pressures (active earth pressure as activating force and passive earth pressure as resisting force) and tail wall resistance from soil pressure against the sides of the tail wall sheets.

The active wedge analysis yields a factor of safety of 1.17, greater than the target of 1.15, after liquefaction of the soil in an earthquake.

Sheet Pile Interlock Load:

Loads in the sheet pile interlock and connection elements are checked using the maximum tension load in the face and tail walls. The check is incorporated into the Active Wedge Analysis. This analysis combined with Active Wedge Analysis demonstrates that the structure will move as a complete unit, with all material contained within the bulkhead.

The sheet pile interlock load analysis yields a factor of safety of 3.2, greater than the target of 2.0, during and after liquefaction of the soil in an earthquake.


1.562
Description: Fill
Unit Weight: 128
Cohesion: 0
Phi: 30
Description: Young Bay Mud
Unit Weight: 115
Cohesion: 0
Phi: 25
Description: Sand
Unit Weight: 131
Cohesion: 0
Phi: 38
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-100
-80
-60
-40
-20
0
20
40
60
80
100

Cell width (w)	50ft
sheet length (L)	35ft
live load	0 psf
mud elv	0ft
unit wt of water	64 pcf
Water elv	2ft
bot. face elv	-25ft
bot. tail elv	-35ft
Interlock Strength (Fu)	20 k/in

Active Earth Pressure

	Top Elv	depth	unit wt (pcf)	eff unit wt	phi	c (pcf)	ka	kp	h	σ'_o	σ_{atop}	σ_{abot}	h'	Pa (k/ft)
Fill	10ft	0ft	128	128		300	1	1	8ft	1024	-600	424	3ft	0.70225
Fill (submerged)	2ft	8ft	128	64		300	1	1	17ft	2112	424	2536	17ft	25.16
Bay Mud	-15ft	25ft	115	51		400	1	1	10ft	2622	1312	3934	10ft	26.23
Sand	-33ft	43ft	131	67	38		0.24	4.20	0ft	2622	624	1247	0ft	0
														52.09

Passive Earth Pressure

	Top Elv	depth	unit wt (pcf)	eff unit wt	phi	c (pcf)	ka	kp	h	σ'_o	σ_{ptop}	σ_{pbot}	h'	Pp (k/ft)
Fill (submerged)	0ft	0ft	128	64		300	1	1	15ft	960	600	1560	15ft	16.2
Bay Mud	-15ft	15ft	115	51		400	1	1	10ft	1470	1760	2270	10ft	20.15
Sand	-33ft	33ft	131	67	38		0.24	4.20	0ft	1470	350	350	0ft	0
														36.35

Tailwall Resistance

	Top Elv	depth	unit wt (pcf)	eff unit wt	N	c (pcf)	h	σ'_o	Atail	k	σ'_{cg}	$R_{granular}$ (kip)	$R_{cohesive}$ (kip)	R/w(k/ft)
Fill	10ft	0ft	128	128	3		8ft	1024	50	1.4807499	832	61.60	-	1.23
Fill (submerged)	2ft	8ft	128	64	3		17ft	2112	320	1.4807499	1568	742.98	-	14.86
Bay Mud	-15ft	25ft	115	51		400	10ft	2622	305	-	-	-	305.00	6.10
Sand	-33ft	43ft	131	67	50		2ft	2756	20	2.2280105	2689	119.82	-	2.40
														24.59

Active Wedge

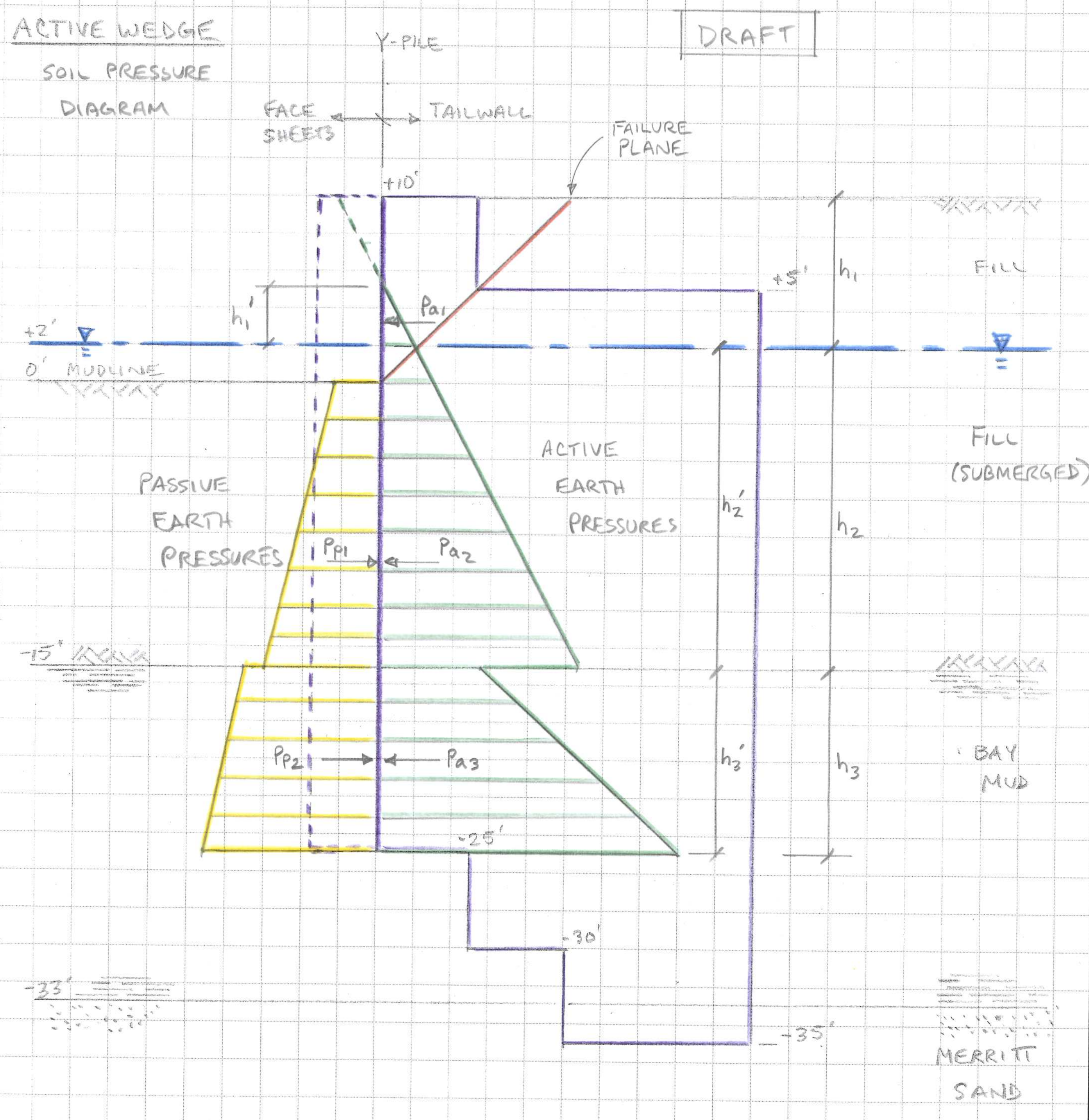
FS = (R/w+Pp)/Pa = 1.17 >1.15 ok

Interlock

FS = Fu/(Pa*w/L) = 3.2 > 2.0 ok

P N D
811 First Avenue, Suite 570
Seattle, Washington 98104
phone 206.624.1387
fax 206.624.1388

Project: 124017.01
Sheet Number: 1 Of:
Calculated by: Date:
Checked by: Date:



P N D

811 First Avenue, Suite 570
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phone 206.624.1387
fax 206.624.1388

Project: 124017.01
Sheet Number: ______ Of: ______
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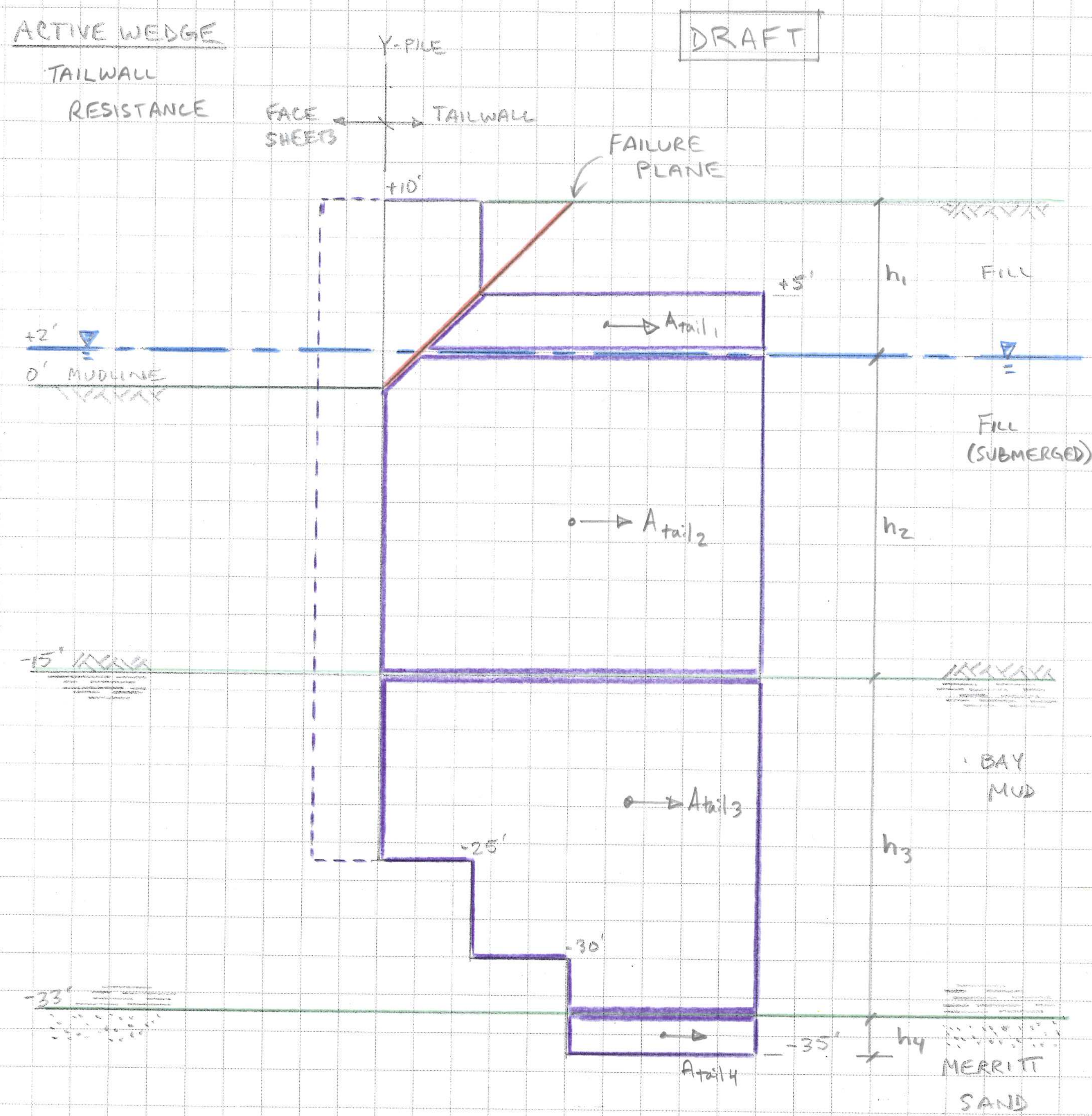
Checked by: ______ Date: ______



APPENDIX G

COST BACKUP

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Detailed Cost Estimate
Burn Area Aspects of Alternative S1-4A

		Task 1		Task 2		Task 3		Task 4		Task 5	
		Remedial Design Datagap Investigation		Remedial Design		Remedial Action Work Plan		IC Implementation Plan		Install Shoring System Bulkhead	
	Rate	Hrs	Amount	Hrs	Amount	Hrs	Amount	Hrs	Amount	Hrs	Amount
Program Manager	$ 215.64	8	1725	16	3450	16	3450	8	1725	24	5175
Senior Manager	$ 215.64	16	3450	24	5175	24	5175	16	3450	40	8626
Project Manager	$ 152.76	0	0	40	6110	40	6110	24	3666	120	18331
Project Services	$ 127.08	0	0	0	0	0	0	0	0	0	0
Project Administration	$ 71.57	80	5726	20	1431	20	1431	8	573	0	0
Subcontracts Administrator	$ 118.48	40	4739	0	0	0	0	0	0	0	0
Subcontracts Administrator	$ 56.79	40	2272	0	0	0	0	0	0	0	0
Project Accountant	$ 79.40	40	3176	0	0	0	0	0	0	0	0
H&S Manager	$ 49.16	80	3933	0	0	0	0	0	0	0	0
Sr. Hydrogeologist	$ 152.76	80	12221	0	0	0	0	0	0	0	0
Project Hydrogeologist	$ 86.69	80	6935	0	0	0	0	0	0	0	0
Remediation Engineer	$ 118.48	670	79382	480	56870	240	28435	120	14218	600	71088
Sr. Geologist	$ 109.94	670	73660	0	0	0	0	0	0	0	0
Project Scientist	$ 79.40	670	53198	0	0	320	25408	240	19056	0	0
Project Geologist	$ 79.40	670	53198	0	0	320	25408	240	19056	0	0
Project Engineer	$ 60.37	670	40448	0	0	0	0	0	0	600	36222
Project Geologist	$ 71.91	670	48180	70	5034	70	5034	0	0	0	0
GIS Analyst	$ 101.76	670	68179	32	3256	32	3256	0	0	0	0
Sr. CADD Operator	$ 65.52	80	5242	640	41933	120	7862	120	7862	0	0
MEC Project Manager	$ 136.14	80	10891	0	0	50	6807	0	0	0	0
Geographic Information Systems Manager	$ 93.98	40	3759	0	0	8	752	0	0	0	0
Administrative (Home Office)	$ 53.19	40	2128	0	0	0	0	0	0	0	0
Senior Chemist/Risk Assessor	$ 152.76	80	12221	0	0	0	0	0	0	0	0
Senior Chemist/Quality Assurance	$ 144.28	670	96668	40	5771	120	17314	0	0	0	0
Hydrogeologist/Geologist	$ 127.08	670	85144	0	0	80	10166	0	0	0	0
Senior Scientist	$ 127.08	0	0	0	0	50	6354	0	0	0	0
Program Quality Control Manager	$ 118.48	0	0	30	3554	140	16587	0	0	0	0
Geologist	$ 101.76	0	0	0	0	2	204	0	0	0	0
GIS/CAD Specialist	$ 79.40	0	0	0	0	20	1588	0	0	0	0
Jr. Chemist	$ 60.37	0	0	0	0	64	3864	0	0	0	0
Database Specialist	$ 60.37	0	0	0	0	32	1932	0	0	0	0
Adminstration Support	$ 53.19	0	0	0	0	80	4255	0	0	0	0
Program Document Control Manager	$ 60.77	40	2431	90	5469	80	4862	0	0	0	0
Word Processor	$ 46.34	0	0	0	0	30	1390	0	0	0	0
Tech Editor	$ 36.33	0	0	0	0	40	1453	0	0	0	0
Graphics	$ 76.93	0	0	0	0	15	1154	0	0	0	0
Construction Manager	$ 81.23	0	0	0	0	0	0	0	0	600	48738
Site H&S Officier	$ 49.30	0	0	0	0	0	0	0	0	600	29580
Field Technician + Field QC Coordinator	$ 29.47	0	0	0	0	0	0	0	0	600	17682
Senior UXO Supervisor	$ 74.39	536	39873	0	0	240	17854	0	0	480	35707
Senior UXO Supervisor OT	$ 108.34	134	14518	0	0	0	0	0	0	120	13001
UXO Safety Officer	$ 71.57	0	0	0	0	240	17177	0	0	0	0
TOTAL HOURS / LABOR		**7524**	**733294**	**1482**	**138056**	**2493**	**225283**	**776**	**69606**	**3784**	**284150**
TRAVEL			41,040		0		3,280		1,540		24,240

Detailed Cost Estimate
Burn Area Aspects of Alternative S1-4A

		Task 1		Task 2		Task 3		Task 4		Task 5	
		Remedial Design Datagap Investigation		Remedial Design		Remedial Action Work Plan		IC Implementation Plan		Install Shoring System Bulkhead	
SUBCONTRACTORS											
RCT Support - Access Control per Day	$ 3,845.60	50	192,280							60	230,736
RCT -Single Task Oversight per Day	$ 1,594.16	50	79,708							60	95,650
Calib/Counting and Equp Support Per Day	$ 2,052.92	50	102,646							60	123,175
RSO per day	$ 1,594.16	50	79,708							60	95,650
Drilling/MW Installation[1]	$ 390,712.32	1	390,712								
Surveying[2]	$ 22,500.00	1	22,500							1	22,500
FSS Soil Sample Analysis[3]	$ 374,776.46	1	374,776								
FSS Groundwater Sample Analysis[4]	$ 167,354.78	1	167,355								
WIB - A/E Services[5]	$ 337,512.47		0	1	337,512						
Sandy Fill per Ton delivered to site[6]	$ 31.35		0								
General Fill per Ton delivered to site[6]	$ 3.85		0								
Topsoil per Ton delivered to site[6]	$ 7.98		0								
Excavate Above Water Table[7]	$ 36.26										
Excavate Below Water Table[7]	$ 60.07										
Backfill Above Water Table[7]	$ 5.46										
Backfill Below Water Table[7]	$ 6.18										
Segregate Wastes Stream[7]	$ 70.03										
Off-site Disposal (Rad.-impacted)[8]	$ 1,614.50										
Off-site Disposal (Cal.Haz.Waste)[7]	$ 49.50										
Off-site Disposal (RCRA Haz.Waste)[7]	$ 308.50										
On-site Disposal[7]	$ 15.91										
Final Grading[7]	$ 55,000.00										
Soil Confirmation Sampling[9]	$ 275.00										
WIB - Sheetpile Installer - Mobilization[10]	$ 429,710.11		0							1	429,710
WIB - Sheetpile Installer - Sediment Control Plan/Permit/Implement (incl'd revetment management)[10]	$ 685,115.27		0							1	685,115
WIB - Sheetpile Installer- Installation of End Cells[10]	$ 233,617.04		0							1	233,617
WIB - Sheetpile Installer - Installation of Face Sheet sq.ft.[10]	$ 29.05		0							23,170	673,089
WIB - Sheetpile Installer - Installation of Tail Wall sq.ft.[10]	$ 24.21		0							10,350	250,574
WIB - Sheetpile Installer - Demobilization[10]	$ 93,667.14		0							1	93,667
WIB - Steel Supplier - 35 ft PS27-5 Sheet Pile (includes delivery)[11]	$ 2,368.43		0							568	1,345,268
WIB - Steel Supplier - 35 ft PS27.5 Sheet Pile (includes delivery)[11]	$ 1,928.25		0							44	84,843
WIB - Steel Supplier - 40 ft PS27.5 Sheet Pile (includes delivery)[11]	$ 2,203.02		0							87	191,663
WIB - Steel Supplier - Sheets (galvanized) 35 ft Wye Pile (includes delivery)[11]	$ 12,426.49		0							16	198,824
WIB - Steel Supplier - Sheets 40 ft PS27.5 Anchor Pile (includes delivery)[11]	$ 7,014.56		0							16	112,233
TOTAL SUBCONTRACTORS			**1,409,686**		**337,512**		**0**		**0**		**4,866,313**
TOTAL COSTS			**2,184,019**		**475,568**		**228,563**		**71,146**		**5,174,703**

NOTES:
1. Test Trenches/Drilling/MW Installation: cost to advance 5 test trenches, 16 vertical borings to 30 feet bgs, 5 vertical borings to 70 feet bgs, 11 battered borings along shoreline slope, and to construct 14 monitoring wells.
2. Surveying: cost to perform construction staking and as-built survey.
3. FFS Soil Sample Analysis: cost to analyze 308 soil samples for primary COCs.
4. FFS Groundwater Sample Analysis: cost to analyze 42 groundwater samples for complete suite of analytes.
5. WIB – A/E Services: cost for specialized services to support design of the OPEN CELL waste isolation bulkhead.
6. Fill per Ton Delivered to site: cost for delivery of fill material to site from offsite sources.
7. Earthwork costs from Ahtna Government Services.
8. Off-site Disposal (Rad-impacted): based on current Dept. of Army contract for removal of radiological impacted waste from Alameda furnished by B&B Environmental Safety, Inc.
9. Soil Confirmation Sampling: cost to analyze samples for soil remediation goal compounds. Includes rapid turn-around-time.
10. WIB installation costs from Manson Construction Company of Seattle, WA.
11. WIB steel costs from LB Foster, Inc. of Oakland, CA. Steel to be manufactured in USA (Waco, TX).

Detailed Cost Estimate
Burn Area Aspects of Alternative S1-4A

			Task 6 Excavation & Backfill		TOTAL BASE	
		Rate	Hrs	Amount	HOURS	LABOR
Program Manager	$	215.64	32	6900	104	22,427
Senior Manager	$	215.64	48	10351	168	36,228
Project Manager	$	152.76	144	21997	368	56,216
Project Services	$	127.08	3	381	3	381
Project Administration	$	71.57	0	0	128	9,161
Subcontracts Administrator	$	118.48	0	0	40	4,739
Subcontracts Administrator	$	56.79	0	0	40	2,272
Project Accountant	$	79.40	0	0	40	3,176
H&S Manager	$	49.16	0	0	80	3,933
Sr. Hydrogeologist	$	152.76	0	0	80	12,221
Project Hydrogeologist	$	86.69	0	0	80	6,935
Remediation Engineer	$	118.48	700	82936	2,810	332,929
Sr. Geologist	$	109.94	0	0	670	73,660
Project Scientist	$	79.40	0	0	1,230	97,662
Project Geologist	$	79.40	0	0	1,230	97,662
Project Engineer	$	60.37	700	42259	1,970	118,929
Project Geologist	$	71.91	0	0	810	58,247
GIS Analyst	$	101.76	0	0	734	74,692
Sr. CADD Operator	$	65.52	0	0	960	62,899
MEC Project Manager	$	136.14	0	0	130	17,698
Geographic Information Systems Manager	$	93.98	0	0	48	4,511
Administrative (Home Office)	$	53.19	0	0	40	2,128
Senior Chemist/Risk Assessor	$	152.76	0	0	80	12,221
Senior Chemist/Quality Assurance	$	144.28	0	0	830	119,752
Hydrogeologist/Geologist	$	127.08	0	0	750	95,310
Senior Scientist	$	127.08	0	0	50	6,354
Program Quality Control Manager	$	118.48	0	0	170	20,142
Geologist	$	101.76	0	0	2	204
GIS/CAD Specialist	$	79.40	0	0	20	1,588
Jr. Chemist	$	60.37	0	0	64	3,864
Database Specialist	$	60.37	0	0	32	1,932
Adminstration Support	$	53.19	0	0	80	4,255
Program Document Control Manager	$	60.77	0	0	210	12,762
Word Processor	$	46.34	0	0	30	1,390
Tech Editor	$	36.33	0	0	40	1,453
Graphics	$	76.93	0	0	15	1,154
Construction Manager	$	81.23	700	56861	1,300	105,599
Site H&S Officier	$	49.30	700	34510	1,300	64,090
Field Technician + Field QC Coordinator	$	29.47	700	20629	1,300	38,311
Senior UXO Supervisor	$	74.39	560	41658	1,816	135,092
Senior UXO Supervisor OT	$	108.34	140	15168	394	42,686
UXO Safety Officer	$	71.57	0	0	240	17,177
TOTAL HOURS / LABOR			**4427**	**333651**	20,486	1,784,039
TRAVEL				26,105		96,205

Detailed Cost Estimate
Burn Area Aspects of Alternative S1-4A

			Task 6 Excavation & Backfill		TOTAL BASE	
SUBCONTRACTORS						
RCT Support - Access Control per Day	$	3,845.60	70	269,192	180	692,208
RCT -Single Task Oversight per Day	$	1,594.16	70	111,591	180	286,949
Calib/Counting and Equp Support Per Day	$	2,052.92	70	143,704	180	369,526
RSO per day	$	1,594.16	70	111,591	180	286,949
Drilling/MW Installation[1]	$	390,712.32			1	390,712
Surveying[2]	$	22,500.00	1	22,500	3	67,500
FSS Soil Sample Analysis[3]	$	374,776.46			1	374,776
FSS Groundwater Sample Analysis[4]	$	167,354.78			1	167,355
WIB - A/E Services[5]	$	337,512.47			1	337,512
Sandy Fill per Ton delivered to site[6]	$	31.35	46,200	1,448,370	46,200	1,448,370
General Fill per Ton delivered to site[6]	$	3.85	58,800	226,380	58,800	226,380
Topsoil per Ton delivered to site[6]	$	7.98	42,000	335,160	42,000	335,160
Excavate Above Water Table[7]	$	36.26	33,000	1,196,580	33,000	1,196,580
Excavate Below Water Table[7]	$	60.07	42,000	2,522,940	42,000	2,522,940
Backfill Above Water Table[7]	$	5.46	33,000	180,180	33,000	180,180
Backfill Below Water Table[7]	$	6.18	42,000	259,560	42,000	259,560
Segregate Wastes Stream[7]	$	70.03	75,000	5,252,250	75,000	5,252,250
Off-site Disposal (Rad.-impacted)[8]	$	1,614.50	2,100	3,390,450	2,100	3,390,450
Off-site Disposal (Cal.Haz.Waste)[7]	$	49.50	31,500	1,559,250	31,500	1,559,250
Off-site Disposal (RCRA Haz.Waste)[7]	$	308.50	21,000	6,478,500	21,000	6,478,500
On-site Disposal[7]	$	15.91	36,000	572,868	36,000	572,868
Final Grading[7]	$	55,000.00	1	55,000	1	55,000
Soil Confirmation Sampling[9]	$	275.00	400	110,000	400	110,000
WIB - Sheetpile Installer - Mobilization[10]	$	429,710.11			1	429,710
WIB - Sheetpile Installer - Sediment Control Plan/Permit/Implement (incl'd revetment management)[10]	$	685,115.27			1	685,115
WIB - Sheetpile Installer- Installation of End Cells[10]	$	233,617.04			1	233,617
WIB - Sheetpile Installer - Installation of Face Sheet sq.ft.[10]	$	29.05			23,170	673,089
WIB - Sheetpile Installer - Installation of Tail Wall sq.ft.[10]	$	24.21			10,350	250,574
WIB - Sheetpile Installer - Demobilization[10]	$	93,667.14			1	93,667
WIB - Steel Supplier - 35 ft PS27-5 Sheet Pile (includes delivery)[11]	$	2,368.43			568	1,345,268
WIB - Steel Supplier - 35 ft PS27.5 Sheet Pile (includes delivery)[11]	$	1,928.25			44	84,843
WIB - Steel Supplier - 40 ft PS27.5 Sheet Pile (includes delivery)[11]	$	2,203.02			87	191,663
WIB - Steel Supplier - Sheets (galvanized) 35 ft Wye Pile (includes delivery)[11]	$	12,426.49			16	198,824
WIB - Steel Supplier - Sheets 40 ft PS27.5 Anchor Pile (includes delivery)[11]	$	7,014.56			16	112,233
TOTAL SUBCONTRACTORS				**24,246,067**		30,859,578
TOTAL COSTS				**24,605,823**		32,739,822

NOTES:
1. Test Trenches/Drilling/MW Installation: cost to advance 5 test trenches, 16 vertical borings to 30 feet bgs, 5 vertical boring
2. Surveying: cost to perform construction staking and as-built survey.
3. FFS Soil Sample Analysis: cost to analyze 308 soil samples for primary COCs.
4. FFS Groundwater Sample Analysis: cost to analyze 42 groundwater samples for complete suite of analytes.
5. WIB – A/E Services: cost for specialized services to support design of the OPEN CELL waste isolation bulkhead.
6. Fill per Ton Delivered to site: cost for delivery of fill material to site from offsite sources.
7. Earthwork costs from Ahtna Government Services.
8. Off-site Disposal (Rad-impacted): based on current Dept. of Army contract for removal of radiological impacted waste fron
9. Soil Confirmation Sampling: cost to analyze samples for soil remediation goal compounds. Includes rapid turn-around-tim
10. WIB installation costs from Manson Construction Company of Seattle, WA.
11. WIB steel costs from LB Foster, Inc. of Oakland, CA. Steel to be manufactured in USA (Waco, TX).

Detailed Cost Estimate
Burn Area Alternative BA-1

		Task 1		Task 2		Task 3		Task 4		Task 5	
		Remedial Design Datagap Investigation		Remedial Design		Remedial Action Work Plan		IC Implementation Plan		Install Shoring System Bulkhead	
	Rate	Hrs	Amount	Hrs	Amount	Hrs	Amount	Hrs	Amount	Hrs	Amount
Program Manager	$ 215.64	8	1725	8	1725	16	3450	8	1725	24	5175
Senior Manager	$ 215.64	16	3450	12	2588	24	5175	16	3450	40	8626
Project Manager	$ 152.76	0	0	20	3055	40	6110	24	3666	120	18331
Project Services	$ 127.08	0	0	0	0	0	0	0	0	0	0
Project Administration	$ 71.57	80	5726	10	716	20	1431	8	573	0	0
Subcontracts Administrator	$ 118.48	40	4739	0	0	0	0	0	0	0	0
Subcontracts Administrator	$ 56.79	40	2272	0	0	0	0	0	0	0	0
Project Accountant	$ 79.40	40	3176	0	0	0	0	0	0	0	0
H&S Manager	$ 49.16	80	3933	0	0	0	0	0	0	0	0
Sr. Hydrogeologist	$ 152.76	80	12221	0	0	0	0	0	0	0	0
Project Hydrogeologist	$ 86.69	80	6935	0	0	0	0	0	0	0	0
Remediation Engineer	$ 118.48	670	79382	240	28435	220	26066	80	9478	650	77012
Sr. Geologist	$ 109.94	670	73660	0	0	0	0	0	0	0	0
Project Scientist	$ 79.40	670	53198	0	0	240	19056	200	15880	0	0
Project Geologist	$ 79.40	670	53198	0	0	240	19056	200	15880	0	0
Project Engineer	$ 60.37	670	40448	0	0	0	0	0	0	650	39241
Project Geologist	$ 71.91	670	48180	20	1438	70	5034	0	0	0	0
GIS Analyst	$ 101.76	670	68179	16	1628	40	4070	0	0	0	0
Sr. CADD Operator	$ 65.52	80	5242	320	20966	80	5242	120	7862	0	0
MEC Project Manager	$ 136.14	80	10891	0	0	50	6807	0	0	0	0
Geographic Information Systems Manager	$ 93.98	40	3759	0	0	8	752	0	0	0	0
Administrative (Home Office)	$ 53.19	40	2128	0	0	0	0	0	0	0	0
Senior Chemist/Risk Assessor	$ 152.76	80	12221	0	0	0	0	0	0	0	0
Senior Chemist/Quality Assurance	$ 144.28	670	96668	20	2886	120	17314	0	0	0	0
Hydrogeologist/Geologist	$ 127.08	670	85144	0	0	80	10166	0	0	0	0
Senior Scientist	$ 127.08	0	0	0	0	50	6354	0	0	0	0
Program Quality Control Manager	$ 118.48	0	0	15	1777	140	16587	0	0	0	0
Geologist	$ 101.76	0	0	0	0	2	204	0	0	0	0
GIS/CAD Specialist	$ 79.40	0	0	0	0	20	1588	0	0	0	0
Jr. Chemist	$ 60.37	0	0	0	0	64	3864	0	0	0	0
Database Specialist	$ 60.37	0	0	0	0	32	1932	0	0	0	0
Adminstration Support	$ 53.19	0	0	0	0	80	4255	0	0	0	0
Program Document Control Manager	$ 60.77	40	2431	20	1215	80	4862	0	0	0	0
Word Processor	$ 46.34	0	0	0	0	30	1390	0	0	0	0
Tech Editor	$ 36.33	0	0	0	0	40	1453	0	0	0	0
Graphics	$ 76.93	0	0	0	0	15	1154	0	0	0	0
Construction Manager	$ 81.23	0	0	0	0	0	0	0	0	650	52800
Site H&S Officier	$ 49.30	0	0	0	0	0	0	0	0	650	32045
Field Technician + Field QC Coordinator	$ 29.47	0	0	0	0	0	0	0	0	650	19156
Senior UXO Supervisor	$ 74.39	536	39873	0	0	120	8927	0	0	520	38683
Senior UXO Supervisor OT	$ 108.34	134	14518	0	0	0	0	0	0	130	14084
UXO Safety Officer	$ 71.57	0	0	0	0	120	8588	0	0	0	0
TOTAL HOURS / LABOR		**7524**	**733294**	**701**	**66430**	**2041**	**190887**	**656**	**58515**	**4084**	**305152**
TRAVEL			41,040		0		3,280		1,540		24,240

Detailed Cost Estimate
Burn Area Alternative BA-1

	Unit Cost	Task 1 Qty	Task 1: Remedial Design Datagap Investigation	Task 2 Qty	Task 2: Remedial Design	Task 3 Qty	Task 3: Remedial Action Work Plan	Task 4 Qty	Task 4: IC Implementation Plan	Task 5 Qty	Task 5: Install Shoring System Bulkhead
SUBCONTRACTORS											
RCT Support - Access Control per Day	$ 3,845.60	50	192,280							60	230,736
RCT -Single Task Oversight per Day	$ 1,594.16	50	79,708							60	95,650
Calib/Counting and Equp Support Per Day	$ 2,052.92	50	102,646							60	123,175
RSO per day	$ 1,594.16	50	79,708							60	95,650
Drilling/MW Installation[1]	$ 390,712.32	1	390,712								
Surveying[2]	$ 18,500.00	1	22,200							1	18,500
FSS Soil Sample Analysis[3]	$ 374,776.46	1	374,776								
FSS Groundwater Sample Analysis[4]	$ 167,354.78	1	167,355								
WIB - A/E Services[5]	$ 337,512.47			1	337,512						
Sandy Fill per Ton delivered to site[6]	$ 31.35										
General Fill per Ton delivered to site[6]	$ 3.85										
Topsoil per Ton delivered to site[6]	$ 7.98										
Excavate Above Water Table[7]	$ 36.26										
Excavate Below Water Table[7]	$ 60.07										
Backfill Above Water Table[7]	$ 5.46										
Backfill Below Water Table[7]	$ 6.18										
Segregate Wastes Stream[7]	$ 70.03										
Off-site Disposal (Rad.-impacted)[8]	$ 1,614.50										
Off-site Disposal (Cal.Haz.Waste)[7]	$ 49.50										
Off-site Disposal (RCRA Haz.Waste)[7]	$ 308.50										
On-site Disposal[7]	$ 15.91										
Final Grading[7]	$ 16,500.00										
Soil Confirmation Sampling[9]	$ 275.00										
WIB - Sheetpile Installer - Mobilization[10]	$ 429,710.11									1	429,710
WIB - Sheetpile Installer - Sediment Control Plan/Permit/Implement (incl'd revetment management)[10]	$ 685,115.27									1	685,115
WIB - Sheetpile Installer- Installation of End Cells[10]	$ 233,617.04									1	233,617
WIB - Sheetpile Installer - Installation of Face Sheet sq.ft.[10]	$ 29.05									23,170	673,089
WIB - Sheetpile Installer - Installation of Tail Wall sq.ft.[10]	$ 24.21									10,350	250,574
WIB - Sheetpile Installer - Demobilization[10]	$ 93,667.14									1	93,667
WIB - Steel Supplier - 35 ft hot-dipped galvanized PS27-5 Sheet Pile (includes delivery)[11]	$ 2,974.56									568	1,689,550
WIB - Steel Supplier - 35 ft PS27.5 Sheet Pile (includes delivery)[11]	$ 1,928.25									44	84,843
WIB - Steel Supplier - 40 ft PS27.5 Sheet Pile (includes delivery)[11]	$ 2,203.02									87	191,663
WIB - Steel Supplier - Sheets (galvanized) 35 ft hot-dipped galvanized Wye Pile (includes delivery)[11]	$ 13,956.26									16	223,300
WIB - Steel Supplier - Sheets (bare) 40 ft PS27.5 Anchor Pile (includes delivery)[11]	$ 7,014.56									16	112,233
TOTAL SUBCONTRACTORS			1,409,386		337,512		0		0		5,231,071
TOTAL COSTS			2,183,719		403,942		194,167		60,055		5,560,463

NOTES:
1. Test Trenches/Drilling/MW Installation: cost to advance 5 test trenches, 16 vertical borings to 30 feet bgs, 5 vertical borings to 70 feet bgs, 11 battered borings along shoreline slope, and to construct 14 monitoring wells.
2. Surveying: cost to perform construction staking and as-built survey.
3. FFS Soil Sample Analysis: cost to analyze 308 soil samples for primary COCs.
4. FFS Groundwater Sample Analysis: cost to analyze 42 groundwater samples for complete suite of analytes.
5. WIB – A/E Services: cost for specialized services to support design of the OPEN CELL waste isolation bulkhead.
6. Fill per Ton Delivered to site: cost for delivery of fill material to site from offsite sources.
7. Earthwork costs from Ahtna Government Services.
8. Off-site Disposal (Rad-impacted): based on current Dept. of Army contract for removal of radiological impacted waste from Alameda furnished by B&B Environmental Safety, Inc.
9. Soil Confirmation Sampling: cost to analyze samples for soil remediation goal compounds. Includes rapid turn-around-time.
10. WIB installation costs from Manson Construction Company of Seattle, WA.
11. WIB steel costs from LB Foster, Inc. of Oakland, CA. Steel to be manufactured in USA (Waco, TX).

Detailed Cost Estimate
Burn Area Alternative BA-1

		Rate	Task 6 Excavation & Backfill Hrs	Amount	TOTAL BASE HOURS	LABOR
Program Manager	$	215.64	2	431	66	14,232
Senior Manager	$	215.64	0	0	108	23,289
Project Manager	$	152.76	8	1222	212	32,385
Project Services	$	127.08	0	0	-	-
Project Administration	$	71.57	0	0	118	8,445
Subcontracts Administrator	$	118.48	0	0	40	4,739
Subcontracts Administrator	$	56.79	0	0	40	2,272
Project Accountant	$	79.40	0	0	40	3,176
H&S Manager	$	49.16	0	0	80	3,933
Sr. Hydrogeologist	$	152.76	0	0	80	12,221
Project Hydrogeologist	$	86.69	0	0	80	6,935
Remediation Engineer	$	118.48	60	7109	1,920	227,482
Sr. Geologist	$	109.94	0	0	670	73,660
Project Scientist	$	79.40	0	0	1,110	88,134
Project Geologist	$	79.40	0	0	1,110	88,134
Project Engineer	$	60.37	60	3622	1,380	83,311
Project Geologist	$	71.91	0	0	760	54,652
GIS Analyst	$	101.76	0	0	726	73,878
Sr. CADD Operator	$	65.52	0	0	600	39,312
MEC Project Manager	$	136.14	0	0	130	17,698
Geographic Information Systems Manager	$	93.98	0	0	48	4,511
Administrative (Home Office)	$	53.19	0	0	40	2,128
Senior Chemist/Risk Assessor	$	152.76	0	0	80	12,221
Senior Chemist/Quality Assurance	$	144.28	0	0	810	116,867
Hydrogeologist/Geologist	$	127.08	0	0	750	95,310
Senior Scientist	$	127.08	0	0	50	6,354
Program Quality Control Manager	$	118.48	0	0	155	18,364
Geologist	$	101.76	0	0	2	204
GIS/CAD Specialist	$	79.40	0	0	20	1,588
Jr. Chemist	$	60.37	0	0	64	3,864
Database Specialist	$	60.37	0	0	32	1,932
Adminstration Support	$	53.19	0	0	80	4,255
Program Document Control Manager	$	60.77	0	0	140	8,508
Word Processor	$	46.34	0	0	30	1,390
Tech Editor	$	36.33	0	0	40	1,453
Graphics	$	76.93	0	0	15	1,154
Construction Manager	$	81.23	60	4874	710	57,673
Site H&S Officier	$	49.30	60	2958	710	35,003
Field Technician + Field QC Coordinator	$	29.47	60	1768	710	20,924
Senior UXO Supervisor	$	74.39	56	4166	1,232	91,648
Senior UXO Supervisor OT	$	108.34	4	433	268	29,035
UXO Safety Officer	$	71.57	0	0	120	8,588
TOTAL HOURS / LABOR			**370**	**26584**	15,376	1,380,861
TRAVEL				5,020		75,120

Detailed Cost Estimate
Burn Area Alternative BA-1

		Unit Cost	Task 6 Excavation & Backfill		TOTAL BASE	
SUBCONTRACTORS						
RCT Support - Access Control per Day	$	3,845.60	6	23,074	116	446,090
RCT -Single Task Oversight per Day	$	1,594.16			110	175,358
Calib/Counting and Equp Support Per Day	$	2,052.92	6	12,318	116	238,139
RSO per day	$	1,594.16			110	175,358
Drilling/MW Installation[1]	$	390,712.32			1	390,712
Surveying[2]	$	18,500.00	1	18,500	3	59,200
FSS Soil Sample Analysis[3]	$	374,776.46			1	374,776
FSS Groundwater Sample Analysis[4]	$	167,354.78			1	167,355
WIB - A/E Services[5]	$	337,512.47			1	337,512
Sandy Fill per Ton delivered to site[6]	$	31.35	2,800	87,780	2,800	87,780
General Fill per Ton delivered to site[6]	$	3.85	7,000	26,950	7,000	26,950
Topsoil per Ton delivered to site[6]	$	7.98	700	5,586	700	5,586
Excavate Above Water Table[7]	$	36.26	5,000	181,300	5,000	181,300
Excavate Below Water Table[7]	$	60.07	2,000	120,140	2,000	120,140
Backfill Above Water Table[7]	$	5.46	5,000	27,300	5,000	27,300
Backfill Below Water Table[7]	$	6.18	2,000	12,360	2,000	12,360
Segregate Wastes Stream[7]	$	70.03	7,000	490,210	7,000	490,210
Off-site Disposal (Rad.-impacted)[8]	$	1,614.50	200	322,900	200	322,900
Off-site Disposal (Cal.Haz.Waste)[7]	$	49.50			-	-
Off-site Disposal (RCRA Haz.Waste)[7]	$	308.50			-	-
On-site Disposal[7]	$	15.91	6,800	108,208	6,800	108,208
Final Grading[7]	$	16,500.00	1	16,500	1	16,500
Soil Confirmation Sampling[9]	$	275.00	50	13,750	50	13,750
WIB - Sheetpile Installer - Mobilization[10]	$	429,710.11			1	429,710
WIB - Sheetpile Installer - Sediment Control Plan/Permit/Implement (incl'd revetment management)[10]	$	685,115.27			1	685,115
WIB - Sheetpile Installer- Installation of End Cells[10]	$	233,617.04			1	233,617
WIB - Sheetpile Installer - Installation of Face Sheet sq.ft.[10]	$	29.05			23,170	673,089
WIB - Sheetpile Installer - Installation of Tail Wall sq.ft.[10]	$	24.21			10,350	250,574
WIB - Sheetpile Installer - Demobilization[10]	$	93,667.14			1	93,667
WIB - Steel Supplier - 35 ft hot-dipped galvanized PS27-5 Sheet Pile (includes delivery)[11]	$	2,974.56			568	1,689,550
WIB - Steel Supplier - 35 ft PS27.5 Sheet Pile (includes delivery)[11]	$	1,928.25			44	84,843
WIB - Steel Supplier - 40 ft PS27.5 Sheet Pile (includes delivery)[11]	$	2,203.02			87	191,663
WIB - Steel Supplier - Sheets (galvanized) 35 ft hot-dipped galvanized Wye Pile (includes delivery)[11]	$	13,956.26			16	223,300
WIB - Steel Supplier - Sheets (bare) 40 ft PS27.5 Anchor Pile (includes delivery)[11]	$	7,014.56			16	112,233
TOTAL SUBCONTRACTORS				1,466,876		8,444,844
TOTAL COSTS				1,498,479		9,900,825

NOTES:
1. Test Trenches/Drilling/MW Installation: cost to advance 5 test trenches, 16 vertical borings to 30 feet bgs, 5 vertical boring
2. Surveying: cost to perform construction staking and as-built survey.
3. FFS Soil Sample Analysis: cost to analyze 308 soil samples for primary COCs.
4. FFS Groundwater Sample Analysis: cost to analyze 42 groundwater samples for complete suite of analytes.
5. WIB – A/E Services: cost for specialized services to support design of the OPEN CELL waste isolation bulkhead.
6. Fill per Ton Delivered to site: cost for delivery of fill material to site from offsite sources.
7. Earthwork costs from Ahtna Government Services.
8. Off-site Disposal (Rad-impacted): based on current Dept. of Army contract for removal of radiological impacted waste fron
9. Soil Confirmation Sampling: cost to analyze samples for soil remediation goal compounds. Includes rapid turn-around-tim
10. WIB installation costs from Manson Construction Company of Seattle, WA.
11. WIB steel costs from LB Foster, Inc. of Oakland, CA. Steel to be manufactured in USA (Waco, TX).

APPENDIX H

RESPONSE TO COMMENTS

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RESPONSE TO COMMENTS ON

Draft
Burn Area Focused Feasibility Study, IR Site 1

PERMAC

Alameda Point, Alameda, California

DCN: AMEC-8816-0002-0161

Comments by:	Responses by:
Xuan-Mai Tran / US EPA Region IX 75 Hawthorne Street San Francisco, CA 94105	AMEC Environment & Infrastructure, Inc.
Comments: October 19, 2012	Responses: February 28, 2013

General Comments

1	The overall objective of the Draft Burn Area Focused Feasibility Study (Draft FFS) is unclear. According to the Section 1.1 (Purpose and Methodology) the purpose of the Draft FFS is "to develop and evaluate an additional remedial action alternative and to compare the alternate remedy to the selected remedial action for IR Site 1 Area 1b soil in the IR Site 1 ROD [Final Record of Decision for IR Site 1]." Subsequently, Section 2.7.1.3 (Groundwater Quality Evaluation) states no significant source of contamination at the IR Site 1 is contributing to groundwater contamination outside the volatile organic compound (VOC) plume area and does "not appear to warrant active remediation." However, contaminants of concern (COCs) for freshwater discharge into San Francisco Bay (the Bay) are listed in Section 2.6.3.1 and Section 4.1.4 (Identification of Burn Area Remedial Technologies) includes three process options retained from the Final Feasibility Study Report IR Site 1, 1943-1956 Disposal Area (Final FS) and ROD for groundwater. In addition, the Draft FFS includes large sections of text discussing groundwater study and sampling results, flow and transport models, as well as providing numerous tables and figures summarizing groundwater sampling data. The connection between the groundwater information/data and its impact on the soil remedial alternatives evaluated in the Draft FFS are unclear. Please revise the Draft FFS to clarify the purpose and objective of the report and to describe the relationship between the additional groundwater data and the selected groundwater remedy as well as the potential impact of the containment remedy on the groundwater.	On January 18, 2011, the BCT held a meeting to discuss the path forward for remedy of the burn area in light of pre-design characterization work conducted in the summer of 2010. During this meeting the process for the proposed change in remedy for the burn area (Area 1b) was determined that an Explanation of Significant Difference (ESD) was not appropriate, and that an Amendment to the Record of Decision (RODA) was required. The reasoning for this decision was 1) the approach was a fundamental change and 2) the exposure pathway where groundwater discharging from the burn area to the San Francisco Bay, in particular concerning dioxins and furans, required further evaluation. During subsequent meetings with the BCT in January, February, and March 2011, the outline for the Focused Feasibility Study and the approach for the supplemental remedial investigation, which supported detailed analysis of the exposure pathway where groundwater discharged from the burn area to the San Francisco Bay, was refined and agreed upon. Following these discussions in early 2011, a sampling and analysis plan was prepared with the BCT to address the additional data required to supplement the Groundwater Evaluation presented in the FS, which concluded that no significant source of contamination at the IR Site 1 is contributing to groundwater or surface water contamination outside the volatile organic compound (VOC) plume area and does not appear to warrant active remediation. In the fall of 2011 and early part of 2012, the additional remedial investigation work was conducted in the burn area. Results from this and former remedial investigation work was used to evaluate in greater

		detail the exposure pathway of groundwater discharging from the burn area to the San Francisco Bay. The lists of chemicals provided in section 2.6.3.1 of the Draft FFS report are not contaminants of concern. The lists of chemicals provided in section 2.6.3.1 of the Draft FFS report are chemicals and radiological materials of potential concern that were further evaluated considering the freshwater replenishment of the San Francisco Bay. The conclusions of this detailed evaluation and risk assessment supported the conclusions of the Groundwater Evaluation presented in the FS in that unacceptable risks associated with the discharge of groundwater to the bay were not predicted. Based on this conclusion, formulation and evaluation of groundwater remedies were not conducted as part of the Focused Feasibility Study for the burn area.
2	The Draft FFS does not clearly identify a list of COCs. Several instances in the text refer to the COCs established in the ROD. COCs for human and ecological receptors and radiological COCs are discussed in the Draft FFS and several of the tables and figures present the COCs; however, a comprehensive list of the COCs from the ROD is not presented within the text. In addition, it is unclear how the COCs were selected. For example, aquatic organisms are sensitive to copper, but there is no data for copper in soil in the Section 2 summary tables. Copper sorbs to organic material forming colloids that are readily transported in groundwater. In addition, copper was detected above the California Toxics Rule (CTR) level in several monitoring wells. For clarity, please revise the Draft FFS to include list of COCs for each receptor category at the IR Site 1. In addition, please revise the text to explain how the COCs were selected and why copper was not included as a COC.	Tables 8-1, 8-2 and 8-3 from the Final ROD have been included in Appendix E of the FFS Report. The omission of these tables was in error. The process for selection of the COCs is discussed in detail between the FS and ROD and would require a significant amount of recitation of these documents. As such, summaries of the applicable portions of these documents were included in the FFS report with citation. With respect to copper, copper (total and dissolved phase) was considered a potential chemical of concern with respect to the freshwater replenishment exposure pathway as part of evaluation and risk assessment presented in the FFS report and in advancement of the Groundwater Evaluation presented in the FS. In addition, the ROD includes provisions that 1) groundwater monitoring outside the VOC plume area will be conducted for radiological materials of concern, arsenic, copper, mercury, nickel, silver, and zinc to determine the potential for the migration of these from groundwater to surface water; 2) an overall groundwater monitoring program will be developed for Site 1 during the remedial design; and 3) a complete list of monitoring analytes and sampling locations will be developed during the remedial design.
3	The Draft FFS does not clearly connect each complete exposure pathway with the established COCs in the conceptual site model (CSM) discussion, and ultimately does not connect the COCs to the proposed remedial alternatives to ensure that each complete pathway is adequately addressed by the remedial alternatives presented. Also, a figure linking the	Exposure pathway analysis for IR Site 1, inclusive of the burn area, is fulfilled in the FS and again in the ROD. The following text has been added to the beginning of Section 2.6.3.1 as an introduction to the Burn Area CSM. *The IR Site 1 conceptual site model (CSM) presented in*

	sources of contamination, the exposure, pathways, and eventual receptors should be included in the FFS. Please revise the Draft FFS to include a comprehensive CSM and address the potential for the residual burn residue to function as a source of contamination at IR Site 1. Further, a figure/diagram linking the sources of contamination, the exposure, pathways, and eventual receptors should be provided.	*Figure 7-1 of the Final ROD (Chadux Tt 2009) was originally presented in the OU-3 RI Report and used to support the risk assessments by identifying the potential receptors and exposure pathways associated with each of the sources of chemicals at IR Site 1. A waste disposal area, burn waste area, former pistol and skeet range (including clay pigeons), and radium-contaminated material in an unlined trench were identified and evaluated (TtEMI 1999c).* *The Final FS Report (BEI 2006a) and Final ROD (Chadux Tt 2009) have descriptions of soil remedial alternatives for Soil Area 1, inclusive of the Burn Area. The ROD states that "Area 1, the former waste disposal area, is approximately 25.8 acres in size. Area 1 is divided into Area 1a (the main disposal area) and Area 1b (the former burn area). Area 1a consists of the main disposal area and is approximately 22.1 acres. Area 1b is the former burn area and is approximately 3.7 acres. Components of the soil remedial alternatives for Area 1 include no action, a soil cover, a low-permeability cap, excavation and off-site disposal of soil, a wetlands mitigation plan (WMP), and institutional controls (IC). Before covering or capping, waste from other areas of Site 1 may be consolidated into the interior of Area 1.* *The shoreline portion of Area 1b is addressed under Area 5 (shoreline) alternatives. It is assumed that Area 1 would be developed for recreational purposes after remediation. The subsections below discuss the components associated with each remedial alternative for Area 1."* *Comparative analysis of the Area 1 Soil Remedy Alternatives as presented in Section 9 of the ROD states that the alternative which consisted of covering the Burn Area and not excavating the burn waste, S1-2, "was judged to be the most effective in the short-term, most implementable, and least costly among the Area 1 remedial alternatives." The current selected remedy, which includes excavation of the burn waste, Alternative S1-4a, was "rated next highest in satisfying the balancing criteria. It was judged to be slightly less implementable and more costly than Alternative S1-2." It should be noted that implementation of Alternative S1-2 would require a geotechnical remedy for stabilization of the Burn Area since the Burn Area wastes are within the area of shoreline slope anticipated to fail (liquefy/slough) as a result of the maximum credible earthquake.* The current first sentence of Section 2.6.3.1, which

		reads as follows: *The conceptual site model (CSM) for the Burn Area is as follows:* Has been changed to read as follows: *Additional information in support of the burn area CSM follows:*
4	The FFS provides a calculation of the dioxin/furan toxicity equivalency quotient (TEQ), but does not provide a calculation of the benzo(a)pyrene equivalent (BaP equiv). While carcinogenic polynuclear aromatic hydrocarbons (cPAHs) are examined separately, for completeness cPAHs should be evaluated based on their relative toxicity to benzo(a)pyrene using relative potency factors (RPFs). Carcinogenic PAH-specific concentrations based on RPFs from Provisional Guidance for Quantitative Risk Assessment of PAHs (EPA, 1993) should then be summed to develop a cumulative benzo(a)pyrene equivalent total concentration (BaPequiv). The BaPequiv should then be compared to the BaP project action limit (PAL). Please revise the FFS to incorporate this approach or provide sufficient rationale for not incorporating the RPF approach.	This additional quantitative evaluation of carcinogenic PAHs has been completed and added to the assessment. The calculations are shown on Tables 2-15c, 2-15d, 2-16c, and 2-16d. The screening results are shown on Tables 2-15a, 2-15b, 2-16a, and 2-16b. The calculated benzo(a)pyrene equivalent concentrations in bay water did not exceed the project action limit for benzo(a)pyrene. The text of Section 2.7.2.1, Project Action Limit Selection, has been revised in two places (revised text shown below in italics): 1. That last sentence in the "Use of Surrogates" discussion now introduces the development of benzo(a)pyrene equivalent (BaP_{equiv}) concentrations: *A more detailed discussion of the use of surrogates for evaluating mononuclear aromatic hydrocarbons (MAHs), cumulative risk from carcinogenic PAHs, and for dioxins/furans is presented below.* *2.* A new paragraph has been added to describe the development of the BaP_{equiv} concentrations: *Carcinogenic PAH PAL – For completeness, carcinogenic PAHs were evaluated cumulatively by comparing a benzo(a)pyrene equivalent (BaP_{equiv}) concentration to the BaP PAL. The BaP_{equiv} concentration is calculated in two steps. In the first step, each carcinogenic PAH concentration is multiplied by its relative potency factor (RPF; U.S. EPA 1993e) to calculate an adjusted concentration. One-half the method detection limit is used if a PAH is not detected. In the second step, the adjusted concentrations are added to calculate a BaP_{equiv} concentration. The BaP_{equiv} bay water estimated concentrations are compared to the BaP PAL. BaP_{equiv} bay water estimated concentrations that are less than the published BaP PAL can be inferred not to contribute to unacceptable risk.*

		The text of the last two sentences of the first paragraph in Section 2.7.2.2, Chemicals and Radiological Materials of Potential Concern Based on Groundwater Results has been revised as follows: *The calculated BaP*$_{equiv}$ *concentration for each sample is shown on Tables 2-15c and 2-15d for the tidally-biased groundwater sampling event and on Tables 2-16c and 2-16d for the study-area groundwater sampling event. The TEQ calculations for each sample are shown on Tables 2-15e through 2-15h for the tidally-biased groundwater sampling event and on Tables 2-16e through 2-16h for the study-area groundwater sampling event.*
5	Section 3.0 (Remedial Action Objectives) states that the remediation goals (RGs) are provided in Appendix E, but only the applicable or relevant and appropriate requirements (ARARs) are included in Appendix E. Although the text of the Draft FFS states the remedial action objectives (RAOs) identified in the ROD remain unchanged based on the risk assessment presented in the Draft FFS, the RAOs and RGs should be presented in this Draft FFS. Without inclusion of the RAO and RGs, it is unclear if the soil remediation alternatives presented in Section 5.0 (Development and Screening of Burn Area Removal Alternatives) are appropriate. Please revise the Draft FFS to include the RGs and RAOs. Also, as discussed during the BCT monthly conference call for Site 1 on September 5, 2012, the RAOs need to be included in the main text of the FFS, not in the Appendix E.	The RG tables (Table 8-1, 8-2, and 8-3) were omitted accidently from Appendix E of this Draft FFS report and will be included in the draft final version of this report. The RAOs, RGs, and ARARs have been added to Section 3.0 of the Draft Final version of the report. It should be noted that these are unchanged from the Final ROD (Chadux Tt 2009).
6	The Draft FFS does not include any treatment alternatives or discuss innovative technologies. At a minimum, the FFS should explain why treatment alternatives and innovative technologies were not considered. Please revise the Draft FFS to provide remedial alternatives that include treatment and innovative technologies or explain why treatment and innovative technologies were not considered.	During FFS scoping meetings in January, February, and March 2011, the BCT concluded there is no need to return to that early phase of FS analysis. The focus is on comparing the soil remedial alternative selected in the ROD to the new proposed alternative.
7	Soil remediation Alternative S1-4a includes the installation of an Open Cell non-galvanized steel sheet pile bulkhead to provide bracing along the shoreline during excavation that would remain in-place after excavation and backfilling operations are completed due to costs associated with the removal, decontamination, and confirmatory sampling of the steel sheets. However, according to the Alameda IR Site 1 OPEN CELL WIB – Corrosion Protection Design Memorandum presented in Appendix F an untreated steel sheet pile system has an expected life of only 32 years. Additionally, no inspections or	The last sentence of the second paragraph of Section 6.2.1.2 which reads: *The steel bulkhead would remain and not be removed because of the cost associated with removal, decontamination, and confirmatory sampling of the steel sheets.* will be stricken and replaced with the text that follows: *The shoreline slope with revetment will be returned to its angle and condition prior to excavation. The steel*

	maintenance activities and costs are included in Table 6-1 (Cost Estimate Summary Burn Area Aspects of Alternative S1-4a). The Draft FFS does not adequately address the potential issues that could arise by leaving an untreated steel sheet pile wall in-place at the site, such as a deteriorating or failing wall that presents safety hazards (the proposed land use for IR Site 1 is recreational) due to lack of inspection and maintenance over time. Please revise the Alternative S1-4a to include additional consideration for the remaining steel sheet pile wall or its removal. Alternatively, at a minimum, please revise the Draft FFS to include information addressing the concerns by leaving the steel sheet pile wall in place.	*sheet pile extending above the restored slope will be cut off at ground surface following the restoration of the shoreline slope. The subsurface steel sheet pile will remain in place.*
8	The level of detail provided in Table 6-1 (Cost Estimate Summary for Burn Area Aspects of Alternative S1-4a) and Table 6-2 (Cost Estimate Summary for Burn Area Aspects of Alternative BA-1) is insufficient to demonstrate the level of effort necessary to implement each of the alternatives. For example, on Table 6-2, the total cost to inspect and maintain the waste isolation bulkhead (WIB) is listed as a lump sum of $970,000 over 30 years; however, it is unclear what is included in the lump sum cost. Vendor quotes and engineer's estimates should be provided to support the cost-breakdown. Also, the Alameda IR Site 1 OPEN CELL WIB – Corrosion Protection Design memorandum presented in Appendix F recommends additional soil sampling for pH and resistivity to determine if a corrosion preventative coating should be applied to the land side of the steel sheet piles. It is unclear whether Table 6.2 includes the additional costs associated with this soil sampling. Please revise the FFS to include the detail and specificity requested in order to demonstrate an understanding of the complexity of the proposed remedial alternatives. Further, please provide vendor quotes and engineer's estimates to support the costs.	Backup information for cost estimates has been added to Appendix G. Specifically, the example for total cost to inspect and maintain the WIB was refined by PND Engineers in their technical memorandum on Corrosion Protection Design. Select soil samples from borings advanced at an angle under the shoreline slope were analyzed for pH, chloride, and sulfate. Results from these analyses were used to augment the information provided in the Corrosion Protection Design memorandum, which now includes a section of soil test analysis results.
9	The groundwater model consists of 20 layers, which appears to be excessive. The CSM suggests that the first water-bearing zone (FWBZ) is in contact with the Bay water. Although the FWBZ is represented with the top 11 layers, only Layer 1 includes the Bay water. This implies that a tracer introduced in Layer 6 will have a very different path than a tracer introduced in Layer 1 at the same location, but this is not discussed in the text and the text does not explain why 20 layers are necessary. Please revise the text to explain why 20 layers are necessary.	The groundwater model was constructed with sufficient vertical (and horizontal) discretization to manage the spatial resolution of the data. For instance, the sloped wells and borings plunge 5 feet for each 7.7 feet of horizontal run (battered at a 33° angle off horizontal). The smaller grid size in the vertical and horizontal directions is needed to construct these wells within the model. Furthermore, vertical numerical resolution is required to provide accurate transport simulations without excessive numerical dispersion. It should be noted that the FWBZ pinches out under the bay and, consistent with the conceptual geological model (Figure D-1), the hydraulic conductivity values

		within layers 2-10 are representative of the bay mud beyond where the FWBZ pinches out under the bay. Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to include additional text and cross section in Appendix D of the Draft Final FFS Report, which show the layering of the model. The following text has been added to Section D.2.1 of Appendix D. *Figure D-7 shows a cross section of the model layer discretization.*
10	Particle tracking should have been conducted before the solute transport model was developed. This would have been much more computationally efficient and potentially could screen out all the contaminants that take more than 1,000 years to migrate to the Bay. Particle tracking would also show where the contaminants enter the Bay. Use of particle tracking could identify potential point sources regardless of where the existing wells are located. Travel times could have been compared for particles starting in the FWBZ and for particles starting in the second water-bearing zone (SWBZ). Once the pathlines of interest were selected (i.e., those associated with particles with travel times to the Bay that were less than 1,000 years), monitoring points should have been established along the pathlines. The adsorption process using the appropriate retardation for the particle velocities should be incorporated. Please conduct particle tracking and provide the results in the next version of the FFS	Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to simulate particle tracking from monitoring well locations. Additional text and figures are included in Appendix D that show the results of the particle tracking in plan and cross-section views. Time-of-travel markers are presented on particle trace lines. Adsorption processes will still be handled as previously provided in the Draft FS report. The last sentence of the first paragraph of Section D.5 in Appendix D was stricken including Figure D-17, from the report. A new paragraph has been added after the first paragraph of Section D.5 in Appendix D as follows: *Particle tracking analysis was conducted to trace flow from well locations to the bay. Particles were seeded at the midpoint of each layer corresponding to the X,Y-location of the well screen being tested. Figure D-22 shows the plan view of the particle tracking from each of the nine FWBZ wells to the bay. Figures D-22 through D-24 show a cross section view of the particle tracks from the FWBZ wells to the bay. Figure D-26 shows the plan view of particle tracking from each of the five SWBZ wells to the bay. Figures D-26 and D-27 show a cross sectional view of the particle tracks from the SWBZ wells to the bay. Time-of-travel markers are shown on each cross section.* The figures listed in the new paragraph above have been added to Appendix D.
11	After conducting particle tracking, the solute transport model should be used to simulate the effect of adsorption and the effect of dispersion (and diffusion). The point source concentration would be assigned with a 1 milligram per liter (mg/L) accuracy at locations selected during the particle tracking (including the hypothetical and existing monitoring wells). Changes in the concentration could be	Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to adjust target locations in the bay to align with the particle trace results. In addition to the bay-water concentrations at the target where the maximum bay-water concentration was predicted, the concentration of groundwater at the model cell immediately inland of said bay-water target has been reported in Appendix D.

	observed along the pathlines in groundwater up to the last model cell representing the aquifer material before the contaminant is discharged into the Bay water. Please rerun the model using this approach.	A new paragraph was added below the new paragraph included in response to General Comment 10 (above) as follows: *Cross section views of the simulated distribution or plume of four contaminants emanating from well PMW-10FWBZ at the time of maximum bay water concentration are provided in Figure D-28. The four contaminants simulated have K_d values of 10 L/Kg, 100 L/Kg, 250 L/Kg, and 500 L/Kg.* Figure D-29 has been added to Appendix D. A new sentence has been added to the end of the second paragraph in Section D.5 of Appendix D, which starts, "The transport simulation results…", as follows: *Tables D-7 through D-15 also include the predicted groundwater concentration immediately inland of the bay water target where the maximum bay water concentration was predicted. The ratio of the contaminant concentration predicted at the groundwater target immediately inland of the bay water target to the predicted bay water concentration are also included in Tables D-7 through D-15.* Tables D-7 through D-15 have been modified to include the changes described in the text above.
12	Bay water should have been first modeled as a simple bathtub where the "hydraulic heads" in the cells corresponding to the Bay water would be all equal (i.e., the constant heads along the Bay water boundary and the high hydraulic conductivity values would essentially keep all the Bay water at the sea level). Please provide the results of modeling runs with this change.	Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to perform sensitivity analysis of the effect of longshore current on the maximum bay water concentrations predicted by the model. Text Section D.5.2 was added to the end of Section D.5 in Appendix D of the FFS Report as follows: ***D.5.2 Sensitivity of Longshore Current Velocity*** *To gauge the sensitivity of the simulated bay water concentrations to the longshore current velocity, five longshore current velocities; zero, 0.237 feet per day (feet/day; value used in Draft FFS Report model), 26.3 feet/day, 3,950 feet/day, and 7,900 feet/day were simulated. These later longshore current velocities (3,950 and 7,900 feet/day) represent the average and maximum values reported in literature. Figure D-35 shows the maximum bay water concentration vs. longshore current speed, and Table D-18 provides the related data and analysis. It is noted that a bathtub representation of the bay with zero longshore current speed provides a concentration only slightly higher*

		than the longshore speed used in the simulations to derive DAF values. On the other hand, use of realistic values of longshore current speeds in the model result in simulated concentrations that are not quantifiable by the model. The results of this sensitivity analysis demonstrate the extreme degree of conservatism that was required to provide meaningful concentration values for prediction of bay water concentrations.
13	Simulation of the contaminant mass flux to the Bay water rather than use of individual point sources is recommended. The concentration ratio of the initial concentration in a well and the concentration in the Bay water does not appear to be correct. For example, some calculated dilution-attenuation factors (DAFs) appear to be too high. Please run the model to simulate contaminant mass flux to the Bay.	Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to not perform analyses for estimation of mass flux into the bay. It was agreed that the presentation of the groundwater concentrations immediately inland of the bay, the particle tracking, and the longshore current velocity sensitivity analyses would provide the information for reviewers to assess the influence of mass flux across the shoreline slope from groundwater discharge to the bay. Additionally, the model, as presented in the Draft FFS Report, provides an improved estimate for anticipated bay water maximum concentration compared with a mass-flux plus mixing model (e.g. – Summers model) approach.
14	The Draft FFS notes that there were a number of locations where radiological material, which exceeded the twice background field screening standard was encountered. Additional details are provided in the description of the trenches, including a description of the locations where the material was encountered. However, there is no discussion of a Navy response to address this radiological contamination. One of the trenched areas encountered radiological contamination at the surface; however, two others indicate that the material was encountered at a depth of 24 inches. Because the Site 1 ROD selected excavation for the Burn Area, the adequacy of a radiological surface scan was not considered at the time the Site 1 ROD was finalized. There does not appear to have been any effort to define the extent of the radiological contamination, which was encountered during the trenching and soil borings. Based on the limited field screening data, it appears that allowing the material encountered during the trenching operation to remain would be inconsistent with EPA's landfill guidance. However, because it is not clear that a surface scan would identify the remaining radiological material which was encountered at the 24 inches bgs level; a focused effort within these areas to delineate and remove the radiological material should be undertaken.	Soil remedies for IR Site 1, inclusive of all areas, were formulated accounting for the presence of radiological contamination at depth below the upper foot of the site surface. These remedies do not consider removal of radiological contamination below a depth of one foot.
15	Since Site 1 ROD identified the substantive portions of the Bay Plan as ARARs, the Navy should be working with the Bay Conservation and Development	The Bay Conservation and Development Commission may provide comments on any Navy CERCLA document. The Navy will solicit for comments

	Commission to address any concerns that may be raised by the installation of the waste isolation bulkhead and the excavation of the burn material along the shoreline.	regarding work along the shoreline for the planned sheet pile work and earthwork (hot-spot removal, excavation, backfill, and rip-rap placement) during the Remedial Design phase of the project.
Specific Comments		
1	**Section 2.6.1, Setting Characteristics Summary:** The text does not provide the characteristics of the Burn Area, which should be included because only the Burn Area is the subject of this FFS. For example, details specific to the Burn Area should be included in the sections discussing topography, ecology, geology, hydrogeology, etc. Please revise Section 2.6.1 to include the characteristics of the Burn Area.	The information provided in Section 2.6.1 is consistent with the statement provided, "The climate, topography, land and groundwater use, ecology, geology, hydrogeology, and surface water hydrology at and in the vicinity of IR Site 1 and the Burn Area are summarized in the sections below." The topography, ecology, geology, hydrogeology, etc. at and in the vicinity of IR Site 1 and the Burn Area are germane to the focused feasibility study and for a part of the conceptual and numerical model for the study; and therefore, will remain as presented in the draft version of the report.
2	**Section 2.6.1.4, Ecology, Page 2-7:** This section provides a very limited discussion of the ecological setting for IR Site 1, but there is no description of the ecology specific to the Burn Area. Additionally, it appears that several species have been omitted from the IR Site 1 ecology discussion including seasonal wetland species, species widely known to inhabit the area such as the California Least Tern, burrowing mammals, and others that may be adapted to urbanized settings. Please revise this section to include a more thorough evaluation and description of the ecology associated with IR Site 1 and the Burn Area.	The following text has been added below the first paragraph of section 2.6.1.4. *The following five ecological habitats occur within approximately one mile of the Burn Area:* *1. barren habitat;* *2. urban habitat;* *3. nonnative grassland habitat;* *4. wetland habitat; and* *5. estuarine habitat.* *Barren habitat occurs in the vicinity of the Burn Area as bare soil, paved areas, runways, and buildings. Urban habitat occurs in the vicinity as ornamental shrubs, trees, and once-landscaped areas.* *Nonnative grassland habitat occurs at many locations on Alameda Point as well as over the inland portions of the Burn Area. Nonnative grassland habitat offers shelter, forage, and nesting opportunities for a variety of birds and small mammals.* *Wetland habitat occurs as saline emergent wetlands at Alameda Point salt marshes (e.g. West Beach Landfill wetland and other small locations) and as seasonal wetlands at grassy meadows that are intermittently flooded during the wet season. The saline emergent wetland habitat supports characteristic vegetation, abundant invertebrates, and various birds and mammals. Several seasonal wetlands were identified at IR Site 1 (TtFW 2004b) and are characterized by hydrophobic vegetation (i.e. plants which have adapted to growing in the low-oxygen [anaerobic] conditions associated with prolonged saturation or flooding). The seasonal wetlands also provide rest, shelter, and*

		*forage for Canada geese (*Branta canadensis*) and other migratory waterfowl. Seasonal wetlands are not located within the Burn Area.* *Alameda Point is bordered to the north, west, and south by open-water aquatic habitats. The San Francisco Bay and the Oakland Inner Harbor border IR Site 1 to the west and north, respectively. Estuarine habitat occurs as intertidal and subtidal zones of the San Francisco Bay and the Oakland Inner Harbor. The Burn Area, which is located at the western tip of Alameda Point, is bordered to the west and north by the San Francisco Bay. The estuarine habit bordering the Burn Area consists of an open-water and riprap portion.* *Phytoplankton (dominated by diatoms and dinoflagellates) and green and blue-green algae are the dominant plants found in the open-water portions of the estuarine habitat of San Francisco Bay. Red algae are the dominant plant in the benthic zone and provide forage for herbivorous invertebrates and fish (Kozloff 1993). Zooplankton, filter-feeding invertebrates, and fish consume the phytoplankton. Dominant zooplankton groups include rotifers and crustaceans, such as cladocera (water fleas), copepods, and opossum shrimp. Dominant filter-feeding invertebrates include mussels, clams, shrimp, scallops, barnacles, hydrozoa, and invertebrate larvae (Carefoot 1977). Dominant benthic herbivorous invertebrates include chitons, limpets, snails, and abalones. Dominant filter-feeding fish species include anchovies, herring, and larval fishes. The dominant small carnivorous fish include gobies, sculpins, and surfperches. The dominant large carnivorous fish include striped bass, halibut, rock fish, and starry flounder (McConnaughey and McConnaughey 1985). The open-water areas also provide habitat for piscivorous birds and shorebirds such as pelicans, herons, and terns and for carnivorous marine mammals such as sea lions and seals. The larger fish and bird species, however, are migratory and have large home ranges.* *The riprap habitat lines the shoreline of the Burn Area and forms the breakwater at the turning basin south of Alameda Point. Dominant plant species include fig-marigold, fescue, and ryegrass. Pelicans and double-crested cormorants use the breakwater areas for roosting. Western gulls use the breakwater and the riprap near the wetland habitats for nesting as well. Feral cats have been observed in the riprap near the*

		wetland habitats. *Special-status species are those plant and animal species that are classified as threatened, endangered, or species-of-concern by state or federal agencies, and that are known to occur or have the potential to occur in the terrestrial or aquatic habitats in the vicinity of the Burn Area (CDFG 2002a, b, c, d). There are no recent records of these species occurring at the Burn Area or IR Site 1 (LSA 2001, WRT 2002, TtFW 2004b). A survey has not been performed to identify special-status species; however, because of historical use and disturbances, the listed species are unlikely to occur at the site.*
3	**Section 2.6.1.4, Ecology, Page 2-7:** According to Section 2.7.1.2 (Page 2-30), the purpose of the screening-level Ecological Risk Assessment (ERA) is "to evaluate potential risk to aquatic ecological receptors from contaminants in shallow groundwater that could migrate to San Francisco Bay;" however, in this discussion there is neither a description of the ecology of the portion of the Bay considered in the ERA nor a description of the potential ecological receptors that inhabit the Bay (aquatic/benthic species, aquatic/migratory birds, upland species, marine mammals, etc.). Please revise this section to include a thorough evaluation and description of the ecology associated with the adjacent portions of San Francisco Bay.	Response provided in response to specific comment 2 above.
4	**Section 2.6.3.1, Burn Area Conceptual Site Model, Page 2-20:** The paragraph "Based on the previous and recent soil sampling and field screening, exposure to contaminated soil and buried waste by human and ecological receptors is supported by the conclusions of previous risk assessments and the RAO's established in the ROD (Chadux Tt 2009)." A phrase seems to be missing in front of "exposure to …"	This paragraph has been stricken.
5	**Section 2.6.3.2, Numerical Model Description, Pages 2-23 and 2-24:** Advection is not controlled by "pressure" nor it is controlled by the hydraulic head (the sum of the elevation head and the pressure head) as stated in the text; rather, it is controlled by the changes in the hydraulic head (or the hydraulic gradient) and other parameters (e.g., the effective porosity, the hydraulic conductivity). Please correct the definition/ description of advection in the text.	The text in Section 2.6.3.2 which reads: *The parameters that control advection are based on hydrogeology, pressure, and site geology and geometry; they are independent of the specific chemicals and/or radiological materials of potential concern. Similarly, dispersion variables are independent of the specific chemicals and/or radiological materials of potential concern.* was changed to: *Advection describes mass transport of contamination due to the bulk flow of groundwater in which the mass is dissolved, or movement of solute as a consequence*

		of groundwater flow. The direction and rate of transport coincides with that of groundwater flow; which is controlled based on hydrogeology, groundwater gradient, and site geometry. These parameters are independent of the specific chemicals and/or radiological materials of potential concern. In the absence of retardation, mass transport takes place at the average linear velocity of the groundwater. The average linear velocity (average pore velocity) is calculated as the Darcy velocity divided by the effective porosity. The effective porosity is the part of the pore space where water is actually flowing. The effective porosity is smaller than the total porosity, as it only includes that void space that forms part of the interconnected flow paths through the medium and excludes void space in isolated or dead-end pores.
6	**Section 2.6.3.2, Numerical Model Description, Page 2-23 and Section 2.6.3.3, Numerical Model Assumptions, Page 2-26:** Advection, dispersion, and adsorption were listed in Section 2.6.3.2 as "pertinent and relevant to predicting the fate and transport of chemicals and radiological materials," but one of the primary assumptions concerning fate and transport is that "mass diffusion coefficient was uniform across all layers" (page 2-26). It is unclear if this reference should be to the "dispersion coefficient." Please clarify.	The mass diffusion coefficient was uniform across all layers. Two additional bullets below the fifth bullet located at the end of 2.6.3.3 which read: • *The mass diffusion coefficient was uniform across all layers.* were added as follows: • *Longitudinal, transverse, and vertical dispersivity values were uniform across all layers representing the subsurface.* • *Transport simulations were conducted under steady-state flow conditions. Preliminary simulations indicated that travel times from well locations are on the order of hundreds of years for maximum conditions to occur in the bay and average conditions over tidal or seasonal fluctuations will be applicable for continuous discharge over the much larger time scales.* The word "diffusion" has been added to the first sentence of the fourth paragraph of Section 2.6.3.2, Numerical Model Description. The first sentence of the fourth paragraph of Section 2.6.3.2 now reads: *Advection, dispersion, adsorption, and diffusion were considered as potentially pertinent and relevant to predicting the fate and transport of chemicals and radiological materials of potential concern in the model.*
7	**Section 2.6.3.2, Numerical Model Description, Page 2-24 and Section 2.6.3.4, Numerical Model Results, Page 2-27:** According to Section 2.6.3.2, the DAF for	With respect to the definition of DAF, the text on page 2-27 that reads:

	each well was determined by dividing the initial groundwater concentration by the predicted maximum bay water concentration; however, on page 2-27, the DAF was defined as "the ratio of the maximum bay water concentration to the initial groundwater concentration."The listed DAF estimates (1.3E03 to 2.8E07) suggest that the first definition was applied. Please resolve this discrepancy.	*…the ratio of the maximum bay water concentration to the initial groundwater concentration.* Has been changed to read: *…the ratio of the initial groundwater concentration to the maximum bay water concentration.*
8	**Section 2.6.3.3, Numerical Model Assumptions, Page 2-26:** The assumption that "predictions beyond 1,000 years are not reliable" implies that the predictions up to 1,000 years are reliable, but this does not appear to be the intended meaning of the assumption. It is unclear how the prediction was considered accurate for 1,000 years. Please clarify.	The last bullet at the end of Section 2.6.3.3 which reads: • *Predictions beyond 1,000 years are not reliable.* has been removed and a paragraph which reads as follows: *The model time of simulation was set at 1,000 years. The decision to terminate the model run at 1,000 years was based on the travel time from well locations to the bay for a large portion of the potential chemicals and radiological materials of concern exceeding 200 years.* has been added to the end of Section 2.6.3.3.
9	**Section 2.6.3.4, Numerical Model Results, Page 2-26:** The text does not discuss how tidal influence was addressed in the model or whether tidal influence was considered in evaluating the simulated heads. Further, it is not clear how tidal fluctuations and the mean standard deviation of the groundwater elevations are related. Please revise the text to discuss how tidal influence was addressed in the model and clarify how tidal fluctuations and the mean standard deviation of groundwater elevations are related.	The last two sentences of the second paragraph of the Model Calibration and Verification subsection within Section 2.6.3.4 were stricken and replaced with the following: *Groundwater level data were compared with precipitation and tidal efficiency to assess if relationships exist. Sixteen years (1994 through 2010) of groundwater gauging data were analyzed from ten FWBZ monitoring wells at IR Site 1; M031-A, M030-A, M034-A, M003-A, M035-A, M028-A, M033-A, M001-A, M029-A, and M002-A. Mean monthly groundwater elevations at each of the ten wells were compared with mean monthly precipitation (Figure 2-36). This comparison revealed that groundwater levels at IR Site 1 were highest and lowest near ends of the wet and dry seasons, respectively. Also, the magnitude of groundwater elevation fluctuations between wet and dry season were greatest at wells further inland as compared with wells near the shoreline. The relationship between the standard deviation of the 16 years of groundwater elevation data at each of the ten wells was compared to their distance from the shoreline and is shown in Figure 2-37. Groundwater elevation fluctuations in the FWBZ vary greatest at locations furthest inland from the shoreline. The standard deviation of groundwater elevations measured at the furthest inland wells was approximately 1.5 feet while the standard deviation of*

		the well closest to the shoreline was approximately 0.27 feet. This observation reveals that net groundwater recharge over the course an average year has a significantly greater effect on the general water level gradients in the Burn Area FWBZ than tidal influence.
10	**Section 2.6.3.4, Numerical Model Results, Page 2-26; Figure 2-35, Comparison of Observed and Modeled Head for Steady State; and Figure 2-36, Comparison of Observed and Modeled FWBZ Groundwater Elevations (FT, MSL):** A comparison of Figures 2-35 and 2-36 indicates that there is apparent spatial bias in the simulated head results. In general, the observed heads at inland locations were higher than the simulated heads, while the observed heads at locations along the shoreline were lower than the simulated values. It is unclear if this occurred because of tidal influence, because the observed heads were averaged, or due to unresolved bias in the model results. The simulated heads should be compared to several individual sets of groundwater elevations that were collected at known tidal stages to provide confidence that the averaged head values can be used. Please evaluate the reasons for this apparent spatial bias and clarify how tidal influence was incorporated into the model. In addition, please compare the simulated heads to several individual sets of groundwater elevations that were collected at known tidal stages.	Time-of-day data was not collected with groundwater gauging data outside the specific study designed to support the Burn Area Focused Feasibility Study. Groundwater gauging data collected as part of the Focused Feasibility Study was conducted in two steps. First five gauging events were conducted between the end of March and mid May 2012 at up to 24 monitoring well locations at IR Site 1. Time-of-day and tide stage were recorded during these five groundwater gauging events. Second each of the 15 wells installed as part of the Burn Area FFS were instrumented with submersible pressure transducers for between one week and two months and between March and May 2012 to measure groundwater pressure fluctuations induced by tidal influence and recharge. A pressure transducer was installed in the San Francisco Bay immediately south of the Burn Area to log sea level fluctuations during the study. The observed and modeled FWBZ groundwater pressure heads provided in Figure 2-35 for sloped wells; PMW-1, PMW-8, PMW-11, and PMW-12, which are closest to the bay, were incorrect. The observed heads were calculated as though the well was vertical; however, the position of the submersible pressure transducer (SPT) is not vertically below the reference elevation or respective initial groundwater elevation measured immediately prior to installing the SPT. Instead the SPTs were installed at the approximate midpoint of the sloped well. Based on this observation the observed mean and standard deviation of these sloped wells was adjusted. Similarly, the modeled heads at the sloped wells were selected as though the sloped wells were vertical wells installed at the respective wellhead location. Based on this observation the location of modeled head at the sloped wells were changed to correspond to the location (vertically and horizontally) of the SPT. These corrections have been made and incorporated into figures as described in the additional text below. The third paragraph of the Model Calibration and Verification subsection within Section 2.6.3.4 was stricken and replaced with the following: *A simulation of steady-state groundwater flow showed*

		modeled heads at most of the measurement locations within one standard deviation of the observed mean head values. Figure 2-38 shows the modeled heads compared to observed heads at 22 FWBZ well locations. Groundwater heads in the model are representative of observed and conceptual site conditions; flow progressing from a regional hydraulic divide located approximately under the middle of Runway 13, which bisects Alameda Point, to the San Francisco Bay and Oakland Inner Harbor. Close examination of the comparison between modeled and observed heads west of the groundwater divide and within the Burn Area are shown in Figure 2-39. Eighteen years of gauging data from 1994 to 2012 were available from six of the 15 wells shown in Figure 2-39. Comparison between the mean of all of the gauging data and gauging data from March through May revealed that annual mean groundwater elevations were between 0.52 feet and 1.72 feet lower than mean elevations observed between March and May over the 18 years of gauging data. Based on these observations and the relationship between groundwater levels and distance from the shoreline, the annual mean FWBZ groundwater elevations at the Burn Area FFS monitoring wells (PMW-1, PMW-5FWBZ, PMW-8, PMW-9FWBZ, PMW-10FWBZ, PMW-11, PMW-12, PMW-13FWBZ, and PMW-16FWBZ) were estimated based on the gauging conducted at these wells between March and May 2012. These annual mean groundwater elevation estimates at the Burn Area FFS wells are shown in Figure 2-39. Modeled heads were within one standard deviation of the FWBZ observed or estimated mean of observed heads at 19 of 22 wells. Figure 2-40 shows a comparison between modeled and observed conditions for the mean groundwater elevation contours within the FWBZ. Observed and simulated gradients are noted to be similar. *Figure 2-41 shows the modeled heads compared to observed heads at the eight SWBZ well locations. Modeled heads were within one standard deviation of the SWBZ observed at six ofeight8 wells. Figure 2-42 shows a comparison between modeled and observed conditions for mean groundwater elevation contours within the SWBZ. Groundwater heads in the model are representative of observed and conceptual site conditions; flow progressing towards the west-northwest in the SWBZ.* The second paragraph of Section D.4.1 of Appendix D was stricken and replaced with the above text.

11	**Section 2.6.3.4, Numerical Model Results, Page 2-27:** The report states that the north and south current along the western shoreline is represented by the model using a simulated current velocity of 3E-05 feet per second (ft/sec), but on United States Geological Survey (USGS) studies, the actual current velocity ranges between zero and 0.3 ft/sec. The MODFLOW-SURFACT model is designed to simulate the groundwater flow and transport. Using it to simulate the currents in the Bay or to provide conservative estimates of flow and mixing (page 2-6) is a rather crude way of representing the surface water flow. Please acknowledge the limitations of this approach.	The level of modeling is appropriate for this effort to determine the mixed concentration of water in the bay. The transport equation that is solved in the bay as well as the subsurface includes advection, dispersion and storage terms in all directions, which is consistent with transport modeling for vertically averaged conditions within the bay or within the subsurface. The groundwater flow model parameters are adjusted such that the cells that represent the bay appropriately account for advection, dispersion and mixing of effluent groundwater for the desired longshore current velocity. Using the two-dimensional hydrodynamic equations (St. Venant;s equations) to achieve the same velocity does not change the results of the transport simulation. Also, this level of detail is higher than the generally accepted Summers mixing model of leachate with groundwater flow whereby dilution rules are applied to contaminant flux from a rectangular area of known dimensions into an ambient velocity field over the mixing thickness. The following text has been included in Section D.2.2, Boundary Conditions: *The San Francisco Bay longshore current velocities and overall flow pattern were simulated in the model by adjusting the hydraulic conductivity value and lateral boundary heads within the model cells representing the bay. The purpose of the model was to conservatively estimate the maximum bay water concentration for potential contaminants of concern within the 1,000-year simulation period. Using the model, which is designed to simulate three-dimensional flow and transport in porous media, to, in part, simulate flow and transport of and within an open water body, has limitations. The application of the model for the purpose of estimating bay water contamination is conservative compared to other recognized approaches, which involve linking the output of the porous media flow and transport model to a surface water mixing model.*
12	**Section 2.7.1.2, Ecological Risk Assessments, Pages 2-30 to 2-31:** The text does not provide the basis for eliminating terrestrial receptors. Please revise the text to indicate the guidance used to eliminate terrestrial receptors for consideration in the ERA. Specifically, address the rationale behind eliminating foraging species, burrowing mammals, and other terrestrial receptors that may be present not only in the burn area, but also in the potentially impacted area within the San Francisco Bay from inclusion in the ERA.	DTSC Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities – Part B, Scoping Assessment (CalEPA, 1996) allows the evaluation of terrestrial receptors to be stopped if the scoping assessment demonstrates impacted areas of the site are not "significantly utilized by biota and do not contain significant wildlife habitats" and if there are no complete exposure pathways. The ERA presented in the OU-3 RI Report, Sections 5 and 6 (TetraTech, 1999) concluded that further evaluation of terrestrial receptors was not necessary because: (1) there was

		limited terrestrial habitat and fauna identified at IR Site 1, and (2) there would be no complete exposure pathways for terrestrial receptors after remedy implementation because the cap will eliminate contact with impacted soils. The first paragraph of Section 2.7.1.2 has been revised as follows: *The RI assumed a presumptive remedy of capping for the IR Site 1 (CalEPA 1996); therefore completed exposure pathways for terrestrial ecological receptors were not identified. The conclusion of the scoping assessment completed for terrestrial receptors during the RI can be found in Sections 5 and 6 of the OU-s RI Report (TtEMI 1999c). Additionally, and as stated in the Final ROD (Chadux Tt 2009) the shoreline portion of Area 1b is addressed under the Area 5 (shoreline) alternatives.* The following reference was added to Section 7.0, References: *CalEPA (California Environmental Protection Agency). 1996. Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, State of California, California Environmental Protection Agency, Department of Toxic Substances Control, Human and Ecological Risk Division. Available at http://www.dtsc.ca.gov/AssessingRisk/eco.cfm. July 1996.*
13	**Section 2.7.1.3, Groundwater Quality Evaluation, Page 2-31:** The text states, "Based on the groundwater quality evaluation, groundwater in the FWBZ outside the VOC plume area and groundwater in the SWBZ area do not appear to warrant active remediation," but detected concentrations of some metals exceed the CTR values. For example, copper was detected at nearly 10 times the CTR of 3.1 micrograms per liter (μg/L). In addition, no support is provided for the statement that CTR "exceedances are isolated both spatially and temporally." Metal solubility may change as the oxidation-reduction (redox) conditions change, so temporal variations need to be evaluated with this parameter. Also, apparent spatial isolation may be due to the location of monitoring wells and whether those wells are located near areas with soil contamination and/or preferential migration pathways. These factors need to be discussed in detail. Please provide detailed justification for the quoted statements, including an evaluation of metals concentrations compared to redox conditions and an evaluation of the apparent spatial	Section 2.7.1.3 provides a summary of the Groundwater Quality Evaluation previously provided as Appendix F of the Final FS Report (BEI, 2006b). Evaluation of the potential risks from exposure to surface water in the San Francisco Bay, including additional evaluation of copper as a chemical of potential concern, is provided in Section 2.7.2 of the FFS report. Text was added to the end of section 2.7.1.3 as follows: *The Groundwater Evaluation (Appendix F of the FS Report [BEI 2006b]) does not offer a written explanation of the conclusion that exceedances are isolated both spatially and temporally. To examine this conclusion, groundwater metal detections at IR Site 1 were compared to their mean groundwater concentrations, which were determined using detected metal analysis results from dissolved analysis. Based on this approach, it ws determined that metals in the FWBZ at IR Site 1 are spatially isolated. Examples include the following: (1) manganese concentrations detected in samples collected from monitoring wells*

	isolation.	*PMW-12 and PMW-13FWBZ, which are less than 20 feet apart, are an approximate order of magnitude different; (2) barium detected in groundwater samples from M001-A, M029-A, and PMW-9FWBZ are close to or just below the mean, whereas at nearby wells PMW-10FWBZ and PMW-11, the barium concentration is approximately three times the mean; and (3) selenium is approximately three times greater than its mean at M033-A, whereas at nearby well PMW-16FWBZ, selenium is less than the mean. Similar evidence of spatial isolation was observed by comparison with the mean in the SWBZ. Examples include the following: (1) antimony, copper, and nickel were detected above their mean values in only one of the eight SWBZ monitoring wells at IR Site 1; and (2) arsenic was detected above its mean in only two of the eight SWBZ monitoring wells. Temporal isolations were also observed in the groundwater metal analysis results. For example, barium and manganese show temporal spikes, oscillating above and below their mean values in samples collected between 1991 and 2012 from six FWBZ and three SWBZ monitoring wells.* *Correlations between metal concentrations and oxidation reduction potential (ORP), pH, and specific conductance was examined using the groundwater sample analysis and field screening results from IR Site 1 collected between 1991 and 2012. Of the 14 dissolved metal analytes, six had sufficient data to analyze for correlation to ORP, pH, and specific conductance in the FWBZ. Data were considered significant if (1) three or more data pairs were available and (2) the dissolved metal analysis results in the data pairs were a detection or estimated detection. The six dissolved metals with significant data for correlation analyses were cadmium, zinc, nickel, arsenic, barium, and manganese. The remaining eight metals are chromium, copper, mercury, silver, antimony, selenium, lead, and thallium.* *Dissolved nickel and zinc concentrations correlated well with pH and specific conductance, respectively. The correlation coefficient with specific conductance was 0.98 for the five nickel detections. The correlation coefficient with pH was -0.92 for the four dissolved zinc detections. The correlation coefficients between the six metals with significant data for analysis with ORP were all less than 0.11 (average less than 0.05). Dissolved nickel, arsenic, barium, and manganese showed weak correlation with pH (correlation coefficients between -0.2 and -0.5). Dissolved cadmium and zinc showed weak correlation to specific*

		conductance with correlation coefficients between 0.15 and 0.22. Dissolved arsenic, barium, and manganese detections did not correlate with specific conductance (correlation coefficients less than 0.012). For clarity, the title of Section 2.7.1.3 has been changed from "Groundwater Quality Evaluation" to *"Groundwater Quality Evaluation from 2006 Feasibility Study"*.
14	**Section 2.7.2, Evaluation of Potential Risks from Exposure to Surface Water in San Francisco Bay, Page 2-31:** The first paragraph of this section states, "The purpose of this FFS evaluation is to establish if chemicals or radiological materials of potential concern dissolved in the Burn Area groundwater discharged to the San Francisco Bay are below surface water criteria," but it appears that no consideration was given to the potential for accumulation of site contaminants into bay sediments. Please revise the text to indicate why sediments were omitted as a pathway (or medium of interest) for risk assessment purposes.	As stated in the Final ROD (Chadux Tt 2009) the shoreline portion of Area 1b is addressed under the Area 5 (shoreline) alternatives. Additionally, as part of the January 18, 2011 BCT meeting to discuss the path forward for remedy of the burn area it was determined that the exposure pathway where groundwater discharging from the burn area to the San Francisco Bay, in particular concerning dioxins and furans, required further evaluation. A sentence has been added to the first paragraph of Section 2.7.2 Evaluation of Potential Risks from Exposure to Surface Water in San Francisco Bay. The first paragraph now reads: The purpose of this FFS evaluation is to establish if chemicals or radiological materials of potential concern dissolved in the Burn Area groundwater that have discharged to the San Francisco Bay are below surface water criteria. *As stated in the Final ROD (Chadux Tt 2009), the shoreline portion of Area 1b is addressed under the Area 5 (shoreline) alternatives.* This FFS evaluation was performed as part of the Pre-design Characterization work conducted during 2010, 2011, and 2012.
15	**Section 2.7.2, Evaluation of Potential Risks from Exposure to Surface Water in San Francisco Bay, Page 2-31:** Paragraph two of this section indicates that "The exposure pathways evaluated are for saltwater aquatic life that reside in San Francisco Bay and for humans that may consume this saltwater aquatic life," but it does not appear that pathways were evaluated for benthic receptors or that food chain modeling was performed to determine ecological risk associated with consumption of benthic or aquatic species. Please revise the text to address these potential pathways or to explain why they were not considered.	The evaluation was designed as a screening level assessment to provide a conservative evaluation of the potential for chemicals in groundwater that replenishes bay water to contribute to unacceptable risk. Assessment of multiple aquatic receptor groups is accomplished for this screening level evaluation by applying project action limits that are developed to be protective of a wide range of aquatic receptors, including benthic species. The PALs are based on toxicity to multiple taxa within the aquatic community and are considered to be protective of benthic species that would be directly exposed to the attenuated concentrations of groundwater at the points of discharge into the bay. Specifically, the CTR states that the developed criteria "… might be thought of as an estimate of the highest concentration of a substance in water which does not present a significant risk to the

		aquatic organism in the water and their uses" (45 FR 79341)". CTR criteria are established using EPA guidance and methods that account for a minimum of eight families of organisms to minimize the potential for criteria to overprotect or underprotect. Additional food chain modeling was not performed and was considered to be outside of the scope of this screening level assessment. The text of the second paragraph has been revised: *The evaluation of potential risks to human and ecological receptors from exposure via surface water (i.e. bay water) consists of a screening level assessment to select appropriate risk-based screening values and compare estimated surface water concentrations to those screening values to identify compounds that could potentially contribute to unacceptable risk. The receptors evaluated are saltwater aquatic life that reside in San Francisco Bay (a wide range of aquatic receptors, including benthic receptors, are considered through the screening levels employed) and humans that may consume this saltwater aquatic life. Food chain modeling was not conducted because it was outside the scope of this FFS. The prior risk assessments did not fully evaluate these exposure pathways for chemicals and radiological materials of potential concern because the remedy envisioned was capping or isolation of the buried wastes, which eliminated the complete exposure pathway. Screening value selection was conducted to identify the most protective value for the two receptor groups being evaluated using the applicable screening criteria for IR Site 1. The California Toxics Rule (65 FR 31682) was the primary source of the water criteria used as screening values. These criteria are based on the Clean Water Act section 304(a) methodology and therefore "… might be thought of as an estimate of the highest concentration of a substance in water which does not present a significant risk to the aquatic organism in the water and their uses." (45 FR 79341). The CTR criteria account for a minimum of eight families of organisms to minimize the potential for criteria to over-protect or under-protect. The data used in this evaluation include groundwater results from the tidal-bias monitoring event and the study-area groundwater monitoring event, each conducted in May 2012.*
16	**Section 2.7.2.3, Potential Risks from Exposure to Estimated Bay Water Concentrations, Page 2-37, Third Paragraph:** The text indicates that acetone is a common laboratory contaminant. Since acetone can	The following text was added after the third paragraph: *Examination of the laboratory report demonstrates that detections of acetone in these samples were false*

	also be a degradation product, please revise the text and tables to include an evaluation of field and laboratory quality control samples to further support this as an explanation for the acetone detections.	*positives related to field or laboratory contamination. More than 50% of the acetone results were qualified during validation due to the presence of acetone in laboratory blanks. In addition, acetone was detected in the majority of the method blanks associated with project samples at concentrations as high as 1.6 µg/L, and reported acetone concentrations in the field samples fell in the range of 1.15 to 8.89 µg/L.* *Only six reported acetone results were not qualified during validation due to blank contamination, and most of these appear to be only slightly above 5x the associated blank concentration. Only one field sample (02-1530), had a reported acetone result greater than 10x the concentration in the associated laboratory blank, and the concentration in this sample was less than 11x the associated blank concentration. Based on this evaluation, all results should have arguably been U-qualified, and the acetone results are clearly related to analytical artifacts.*
17	**Section 2.7.2.3, Potential Risks from Exposure to Estimated Bay Water Concentrations, Page 2-37, Paragraph 3:** The text does not provide the basis for the assertion that attenuation and dilution of 2-hexanone and acetone (each of which had detections in groundwater) would result in no added risk, since no PALs were established for those compounds and no dilution attenuation factors were applied to estimate bay water concentrations. Please revise the text to provide the basis for this assertion.	The text of paragraph 3 has been revised below: *Acetone and 2-hexanone were each detected at least once. The single detection of 2-hexanone was at a concentration of 0.234 µg/L. The highest detection limit for 2-hexanone was 1.12 µg/L. Estimated bay water concentrations based on these values would be substantially lower and thus 2-hexanone is not likely to contribute significantly to unacceptable risk. Acetone was detected six times, with concentrations ranging between 2.91 µg/L and 8.89 µg/L (estimated). Acetone detection limits were as high 5.92 µg/L. Estimated bay water concentrations based on these values would be substantially lower and therefore would be unlikely to contribute significantly to unacceptable risk. These conclusions are further supported by the physical and chemical properties of acetone (ATSDR, 1994) and 2-hexanone (ATSDR, 1992), which indicate they will attenuate in water through biodegradation, though dilution also can be expected to occur because of the high solubility of each compound. The detections of acetone and 2-hexanone also are below other publically-available and conservative screening criteria, including the EPA Regional Screening Level values for tap water consumption (U.S. EPA 2012), EPA Region 5 Ecological Screening Levels (U.S. EPA 2003b), and ecological screening levels from Los Alamos National Laboratory (LANL) ECORISK Database, Release 3.1 (LANL 2012). These criteria are not directly applicable to the exposure pathways evaluated in this FFS, but they provide quantitative evidence that exposure through similar pathways at the*

		levels detected at the site are not likely to contribute to unacceptable risk. In addition the following have been added to Section 7.0 References: *U.S. EPA, 2003b. United States Environmental Protection Agency RCRA Corrective Action Ecological Screening Levels. August 22, 2003.* *U.S. EPA, 2012. United States Environmental Protection Agency Regional Screening Levels. November 2012 update: http://www.epa.gov/region9/superfund/prg/index.html* *Los Alamos National Laboratory. 2012. ECORISK Database Release 3.1 (October 2012): http://www.lanl.gov/environment/cleanup/ecorisk.shtml*
18	**Section 2.7.2.4, Conclusions of Burn Area Evaluation of Potential Risks from Exposure to Surface Water in San Francisco Bay, Page 2-38:** The conclusion is overly broad. For example, the text should specify that risk was evaluated for chemicals and radiological materials of concern, associated with groundwater emanating from the burn area infiltrating into the San Francisco Bay. Additionally, the text should specify to what the unacceptable risk refers (i.e., human health and ecological receptors exposed to bay water). Please revise the text to more clearly identify the scope of the conclusions.	The text of the conclusions has been revised to specify that the conclusions are specific to the media and receptors evaluated for exposure to surface water. *The results of the risk evaluation indicate that no chemicals or radiological materials in groundwater that replenishes bay water are considered to pose unacceptable risk to saltwater aquatic life or to humans consuming that saltwater aquatic life from exposure to bay water. No new COCs related to the freshwater replenishment pathway at the Burn Area are identified.*
19	**Section 5.0, Development and Screening of Burn Area Removal Alternatives, Page 5-1:** This section indicates that the groundwater and soil remedial alternatives are described in Sections 5.2 and 5.3, respectively, but these sections provide information on the development of soil alternatives, descriptions of the soil alternatives, and screening of the soil alternatives only. Additionally, the last paragraph of Section 5.3 (Screening of Burn Area Remedial Alternatives states groundwater remedial alternatives were not considered in the FFS. Please revise this section to clarify which media the alternative development and screening are based on, and if necessary, incorporate the development and screening of groundwater alternatives.	The introductory paragraph to Section 5.0 has been changed as follows: *The technologies and associated process options retained after the screening evaluation were assembled into remedial alternatives to address the soil contamination at the Burn Area. Section 5.1 describes the development of the Burn Area remedial alternatives for soil, Section 5.2 presents the Burn Area remedial alternatives, and Section 5.3 discusses the screening of the alternatives.*
20	**Sections 6.2.1.5 and 6.2.2.6, Evaluation by CERLCA Threshold Criteria, Pages 6-5 and 6-8, respectively:** The Compliance with Applicable or Relevant and Appropriate Requirements sections of the two proposed soil remediation alternatives do not state whether the proposed alternatives actually	A sentence has been added to the end of the third paragraph of Section 6.2.1.5 as follows: *Alternative S1-4a complies with the ARARs presented in the IR Site 1 Final ROD (Chadux Tt 2009).*

	comply with the ARARs. Both sections state the ARARs are the same as the ROD, but do not indicate overall compliance. Please revise the Draft FFS to confirm ARAR compliance for both alternatives.	The third paragraph in Section 6.2.2.6 has been changed as follows: *ARARs associated with the excavation, soil cover, and ICs would be the same as those provided in Table 13-1, Table 13-2, and Table 13-3 from the ROD (Chadux Tt 2009; copies provided in Appendix E). A portion of the ARARs applicable to the soil cover will also be applied to the WIB. The soil cover action-specific ARAR, which includes the substantive provisions of CCR title 22 § 66.264.310(a)(5) which requires that the cover maintain integrity during and following the maximum credible earthquake will apply to the design and performance of the WIB. Alternative BA-1 complies with the ARARs presented in the IR Site 1 Final ROD (Chadux Tt 2009).*
21	**Section 6.3.3, Long-Term Effectiveness and Permanence, Page 6-9:** Alternative BA-1 is rated as medium high in long-term effectiveness, but the Draft FFS does not explain why the ranking was assigned. Lesser replacement and repair costs are briefly mentioned when compared to Alternative S1-4a. However, no justification for the Alternative BA-1 ranking is included. Please revise the Draft FFS to provide the basis for the medium high ranking.	In Subsection 6.9.2.3 Long-Term Effectiveness and Permanence of the Comparative Analysis of Remedial Alternatives Section of the Final IR Site 1 FS (BEI, 2006a) Alternatives S1-2 and S1-4a rated medium in long-term effectiveness and permanence. Each of these alternatives required ICs and long-term management of contaminants, Alternatives S1-2 and S1-4a were determined to have fewer components that would require replacement and fewer continuing repair and maintenance needs than other alternatives. Alternative S1-2 is equivalent to BA-1; however, Alternative BA-1 is explicit in the addition of the steel sheet pile wall as a part of the remedy to facilitate meeting the seismic stability requirements of the soil cover, whereas Alternative S1-2 requires seismic stability without explicitly deciding on the engineered control. The Burn Area remedy when broken out of Alternatives S1-2 and S1-4a are assessed in a different light. Alternative S1-4a includes the excavation and offsite disposal of the materials exceeding remediation goals from the Burn Area; therefore, the long-term effectiveness and permanence of this portion of the Area 1 soil alternative was ranked high as opposed to medium. For comparison, the explicit addition of the steel sheet pile bulkhead to the Alternative S1-2 when considering the Burn Area remedy separate from the remainder of Area 1 improves the long-term effectiveness and permanence from a medium to medium high. The reasons for this improvement from medium to medium high ranking for long-term effectiveness and permanence when considering the explicit addition of the steel sheet pile bulkhead have been added to Section 6.3.3 as follows: *A ranking of medium high for the long-term*

		effectiveness and permanence of Alternative BA-1 was selected considering the ranking of medium assessed in the Final FS Report (BEI 2006a) to this alternative without the explicit addition of the WIB, and the adequacy and reliability of the WIB for the containment of the residual wastes. The WIB has a certain lifespan and will require periodic inspection, and potentially maintenance and replacement. However, compared with other geotechnical remedies for stabilization of the shoreline slope, inspection and maintenance for general wearing of the WIB is easily performed with readily available resources (steel sheet pile bulkheads are located very nearby the site) and at the prescribed review periods for other IR Site 1 remedies (e.g. soil cover). In the event that the WIB is damaged during seismic loading (earthquake event), the damages will be readily observable compared to geotechnical remedies located in the inland subsurface portions of the site. Furthermore the WIB can be placed at the furthest extent of the site and wastes opposed to inland geotechnical remedies that would leave portions of the shoreline slope unprotected.
22	**Table 2-13, Summary of PALs Used to Evaluate Potential Risks from Exposure to Surface Water in San Francisco Bay.** It is unclear why the maximum detected concentration for each radionuclide was selected as the PAL. Please revise Table 2-13 to include a footnote that provides the rationale for selection of the radionuclide PALs.	The PAL selected to evaluate each radionuclide is the *minimum* detected concentration, as indicated in the approved Sampling and Analysis Plan (AMEC, 2012). The minimum detected concentration was selected because there are no CTR criteria for radionuclides in surface water. Additional explanation has been added to the definition of MDC provided in Table 2-13 as follows: *MDC [1] = minimum detected concentration (the MDC is selected as the project action limit in accordance with the approved Sampling and Analysis Plan (SAP) because there are no CTR criteria for radionuclides in surface water).*
23	**Tables 2-15 and 2-16:** It appears that there should be DAFs and a subsequent bay water concentration (estimated) included on these tables when there is a measured concentration or method detection limit in groundwater greater than the PAL in at least one of the tidal profiles, and not otherwise. Currently the tables include DAFs and estimated bay water concentrations when these criteria are not met (for example, in Tables 2-15a and 2-16a, 1,2-dibromomethane). Conversely, in some instances the tables indicate a measured concentration or method detection limit above the PAL, and neither a DAF nor an estimated bay concentration is provided (for example, Table 2-15b, naphthalene, Low Tide, PMW-9). Please verify information contained in these tables and revise as necessary.	Corrections have been made to calculate estimated bay water concentrations for compounds with detections or MDLs in groundwater that exceed the PAL, and to remove bay water calculations where the detection limit or MDL in groundwater is less than the PAL. Revised tables are provided. Estimated bay water concentrations are now calculated for naphthalene. Estimated bay water concentrations are no longer calculated for 1,2-dibromomethane, 1,2-dibromo-3-chloropropane, 1,2-dichlorobenzene, 4-isopropyltoluene, or toluene because detections or MDLs were less than PALs. Estimated bay water concentrations are not calculated for beryllium and cobalt because there is no PAL; these metals are evaluated qualitatively. Table 2-14 (list of PCOCs) also was updated to remove 1,2-dibromo-3-

		chloropropane because the MDL in groundwater was less than the PAL. Table 2-17, Summary of Well-Specific Dilution Attenuation Factors for Chemical and Radiological Materials of Potential Concern, was updated to remove 1,2-dibromo-3-chloropropane, beryllium, and cobalt.
24	**Table 2-17, Summary of Well-Specific Dilution Attenuation Factors for Chemicals and Radiological Materials of Potential Concern:** Some DAFs appear to be missing from this table. For example, on Table 2-15b, Low Tide, PMW-9, naphthalene is shown as exceeding the PAL, which should require application of a DAF and subsequent bay water concentration estimate. However, the DAF is not included on Table 2-17. Please revise the table to include all applicable DAFs used for estimating bay water concentrations.	The well-specific DAF for Naphthalene is included on Table 2-17.
25	**Table 2-17, Summary of Well-Specific Dilution Attenuation Factors for Chemicals and Radiological Materials of Potential Concern.** Table 2-17 indicates that the distribution coefficient (Kd) was calculated for various compounds. However, the approach followed to calculate the Kd values is not presented. Please revise Footnote 1 of Table 2-17 to provide the equations used to calculate the Kd values for organic and inorganic compounds.	Note 4 has been added to Table 2-17 as follows: *Detailed description of the calculation of K_d values based on soil and/or groundwater detections and /or analyses method detection limits is provided in Section 2.7.2.3 of the report.*
26	**Figure 2-36, Comparison of Observed and Modeled FWBZ Groundwater Elevations (FT, MSL):** Figure 2-36 is difficult to interpret. Use of separate colors to indicate wells where the simulated head is greater than the observed head and wells where the simulated head is less than the observed head would make the figure easier to interpret. Please make this change.	This figure has been replaced – see response to Specific Comment 10.
27	**Appendix D, Section D.1.1, Geologic Model, Pages 1-1 and 1-2:** When the text refers to "the site" it is unclear if the reference is to Alameda Point, to Site 1, or to the Burn Area. For example, the description of the Bay Sediment Unit states that there is a paleochannel "beneath the southwestern portion of the site," but Figures D-1 and D-2 do not depict a paleochannel. Please revise the text to use specific references (i.e., Alameda Point, Site 1, or the Burn Area) and explain where the paleochannel is located in reference to the Burn Area.	Section D.1.1 is now corrected for specific references for either the IR Site 1 or the Burn site. This section is based on the findings of FS Report (BEI, 2006a) regarding geology at IR Site 1. Therefore, most of the geological interpretation covers a large area as compared to the area of interest for this study. The text has been revise as follows: *The paleochannel is reported in the southwest portion of IR Site 1. No such channel is reported in the proximity of the Burn Area.*
28	**Appendix D, Section D.1.2, Hydrogeology, Page 1-3:** The text describes the "Bay Sediment Unit or BM [Bay Mud] Clay" as a "semi-confined aquitard," but the term semiconfined is only used to describe an aquifer. Aquifers can be unconfined, confined or semi-confined, but these terms do not apply to aquitards. Please delete the word "semiconfined."	The text has been changed as follows: *The BSU is mainly composed of clay, fine sand, and silt materials representing the BSU. For most hydrological purposes this unit can be considered as an aquitard.*
29	**Appendix D, Section D.2.1, Domain Discretization,**	See response to General Comment 9.

	Page 2-1 and Table D-2, The Minimum and Maximum Thickness of Each Model Layer: The model is unusual because of the large number of layers (20) for a 71-foot thick domain. Because the layers were "continuous," the minimum thickness of the layers is less than a foot (e.g., Layer 3 has a minimum thickness of 0.01 ft). The text does not provide the rationale for selecting this extremely fine vertical discretization. The available data do not justify the fine resolution and some computational difficulties were likely encountered (e.g., "drying" cells of the top layers, the computational time, etc.). Also, a layer with a thickness of 0.01, 0.05, or 0.06 foot is meaningless; it is unclear why layers were not combined and 10 averaged values used. Further, it is unclear how these layers are related to site geology. Please revise the text to explain in detail why it was necessary to include 20 layers in the model. Also, please explain how each layer is related to site geology and why layers were not combined with averaged properties.	Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to include additional text and cross section in Appendix D of the Draft Final FFS Report, which show the layering of the model.
30	**Appendix D, Section D.2.1, Domain Discretization, Page 2-1:** The Draft FFS indicates that the water in San Francisco Bay and Oakland Inner Harbor was simulated using Layer 1 (the top at 0 feet above mean seal level [ft MSL] and the bottom of the layer was the bottom of the bay and harbor). Figure D-1 shows the Bay water and the FWBZ, which is represented by the first 11 model layers. This is unusual discretization because only Layer 1 is horizontally connected to the Bay. One would assume that all top 11 model layers are in contact with the Bay water as the Bay mud is below the Bay water and the FWBZ. Please provide an additional text to justify/explain the modeling approach.	See response to General Comment 9 and 10. Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to include additional text and cross section in Appendix D of the Draft Final FFS Report, which show the layering of the model and to simulate particle tracking from monitoring well locations.
31	**Appendix D, Figure D-6, Boundary Conditions for Steady State Model:** The model does not simulate offshore (current) flow well. To simulate the longshore current velocity, the offshore boundary head varied from +0.5 feet (the northeast corner) to -0.5 feet (the southwest corner). The total length of the constant boundary is 4,160 feet; the gradient is 1/4,160; the porosity is 1; and the hydraulic conductivity is 10,000 ft/day. Using the listed parameter values, the "velocity" would be 2.8E-05 ft/sec which is significantly lower than the average longshore current velocity of 0.1 ft/sec. The no flow boundaries are set perpendicular to the shore (the red lines in Figure D-6), which will force the currents in the Bay not to be parallel to the shoreline. It seems that the model set up is rather simplistic for simulating the surface water effect on the concentrations in the Bay water	Response to General Comment 12 addresses a large portion of this comment. With respect to the reviewer's request to better simulate the longshore current direction along the shoreline we have replaced the no flow boundary conditions with constant head boundary conditions as follows: a) The eastern no-flow boundary condition was replaced with a constant head boundary of 0.5 ft. b) The southern no-flow boundary condition was replaced with a constant head boundary of -0.5 ft. With these modifications (a) and (b), the longshore

	compared to the groundwater effect. Please revise the text to discuss this issue.	currents are parallel to the shoreline throughout the simulated bay as noted by the reviewer. This change does not affect the contaminant concentrations previously predicted in the bay water. Regarding the model set up to simulate the surface water flow, the model set up is sufficient in the bay water to meet the objectives of the modeling endeavor. The objective of developing the groundwater flow and transport model was not to simulate the highly non-linear turbulent flow and turbulent transport questions, but to conservatively estimate the resulting bay water concentration from the discharge of contaminated groundwater. The level of modeling considered is appropriate for this effort to determine the mixed concentration of water in the bay. The transport equation that is solved in the bay as well as the subsurface includes advection, dispersion and storage terms in all directions, which is consistent with transport modeling for average conditions within the bay or the subsurface. The groundwater flow model parameters are adjusted such that the cells that represent the bay appropriately account for advection, dispersion and mixing of effluent groundwater for the desired longshore current velocity. Using hydrodynamic equations to achieve the same velocity does not change the results of the transport simulation. This level of detail is higher than the generally accepted Summers mixing model of leachate with groundwater flow whereby dilution rules are applied to contaminant flux from a rectangular area of known dimensions into an ambient velocity field over the mixing thickness.
32	**Appendix D, Section D.2.2, Boundary Conditions, Page 2-2:** The extinction depth for the evapotranspiration process was set to a constant – 6.56 feet, based on a value suggested by Houston (2009) for aquifers in arid climates, but the San Francisco Bay area climate cannot be considered an arid climate, particularly near the shoreline. The California Department of Water Resources should have a more appropriate value for the extinction depth. Please check the California Department of Water Resources for an area-appropriate extinction value.	Additional reference search was conducted pursuant to the reviewer's request. The Houston 2009 reference and arid climate discussion has been stricken and these new references have been included. One of the two references, a California Department of Water Resources study suggests an extinction depth of 2.10 meters (~6.9 feet). The other reference, a peer-reviewed journal article, provides a table of extinction depths that supports the value of 6.56 feet used in the IR Site 1 flow model.
33	**Appendix D, Section 2.3, Initial Conditions, Page 2-3:** Some assumptions for sources do not appear to have been included. The text states "Initial conditions for transport included zero contamination throughout the model domain except at the well location whose Dilution Attenuation Factor (DAF) was being calculated. Furthermore, at the well location an initial	The assumptions associated with the source are provided in the text as follows: *The initial source of contaminated soil and groundwater was added spanning all layers of the water-bearing zone at the well under study. The initial mass of the contamination was set so that the*

	concentration of 1 milligram/Liter (mg/L) was used." Thus the point sources were included in the model assuming that the source concentration is 1 mg/L. It is unclear if there are the other assumptions associated with sources. Also, the text does not state whether the source concentration was assumed constant over the whole simulation period. Please provide all of the assumptions associated with the sources and explain whether the source concentration as assumed to be constant over the entire simulation period.	*groundwater concentration at the well location under study was 1 mg/L at equilibrium with the soil considering the value of the distribution coefficient (K_d). Once the simulation was initiated with this mass, additional contaminant was not added to the model.*
34	**Appendix D, Section 2.4, Governing Equations and their Numerical Solution Procedures, Page 2-3:** MODFLOW-SURFACT does not calculate the variable Ss internally as stated at the bottom of page 2-3. The user must specify the Ss value and the code computes the storage coefficient (S) for every cell by multiplying the Ss value by the aquifer thickness (S = b x Ss). Please correct the text.	The existing text in section D.2.4. Governing Equations and their Numerical Solution Procedures which reads: *Note: the software package, MODFLOW-SURFACT, calculates the variable Ss internally, therefore, an input of storativity and/or specific yield is needed.* has been revised to: *Note: the software package, MODFLOW-SURFACT, requires specific storage (Ss) as input, and it internally computes the storage coefficient (S) by multiplying the specific storage by cell thickness. Therefore, input data for specific storage (Ss and/or specific yield (Sy) are required.* The existing text in section D2.5 Flow and Transport Properties which reads: *Figure D-9 shows spatial extent of various storativity/specific yield zones for top, shallow, and deep model layers. The final calibrated values for storativity / specific yield for each zone are listed in Table D-4.* has been revised to: *Figure D-10 shows spatial extent of various specific storage/specific yield zones for top, shallow, and deep model layers. The final calibrated values for specific storage/specific yield for each zone are listed in Table D-5* NOTE: Figure and Table numbering changed with revisions to draft report..
35	**Appendix D, Section 2.5, Flow and Transport Properties, Page 2-6:** The report indicates that "a constant value (equal to 8.47E-04 square feet per day [ft2/day]) for the molecular diffusion coefficient was used in all simulations," but the basis for the value is not provided. Although the molecular diffusion is not	Similar to the views presented by the reviewers, we believe the molecular diffusion process is insignificant in governing the fate and transport of a contaminant. As the contaminant is hypothetical (varying only K_d values) and with unit concentration only at a given location of interest (well location), a constant

	likely an important process, it should not be assumed that the diffusion coefficient value is the same for all contaminants. Please use contaminant-specific molecular diffusion coefficients or explain in detail why this is not necessary.	representative value of molecular diffusion for contaminants in water was selected for the simulations instead of using the typical value of zero. The following text has been included in Section D.2.5, Flow and Transport Properties, subsection Transport Properties: *The process of molecular diffusion does not play a significant role in governing the fate and transport of a contaminant in a porous media flow field dominated by advection. A conservative constant representative value of molecular diffusion for contaminants in water was selected for the simulations instead of using the typical value of zero.*
36	**Appendix D, Section D.4.1, Steady State Flow Model Calibration, Page 4-1:** The units used in the report should be consistent. The longshore current velocity was specified earlier in the text (page 2-27) in ft/sec rather than the centimeter per second (cm/sec) value discussed in Section 4.1. Please revise the text to use consistent units throughout the FFS and Appendix D.	Units across the document were checked and adjusted for consistency.
37	**Appendix D, Table D-4, Storativity and Specified Yield of Various Material Types:** It is unclear if the "Ss column" provides data for storativity (S) or specific storativity (Ss). For Specific Storativity units should be included (e.g., 1/ft). Also, it appears that Zones 2 through 13 all have the same value (1.00E-07), but it is very unlikely that all these different geologic and man-made materials will have the same Ss value. Please clarify whether the "Ss column" provides S or Ss data and include units if this column lists Ss data. In addition, please verify that the Ss value (1.00E-07) is correct for Zones 2 through 13 and if it is correct, explain why there is no variation in the Ss values for units with varying properties.	The table has been rectified. For all the units representing the FWBZ material, it is the specific yield parameter which governs the storage volume in the zone, and this parameter is different for all the FWBZ units. For the BSU and SWBZ material, it is mainly the storage coefficient (S) which governs the water storage volume in the two units as they are fully saturated. There was no data available to allow for a variable S value for the different materials and therefore a uniform value was used for the calibration.
38	**Appendix D, Figure D-8, Porosity Distribution in Layers 1, 5, and 15:** The colors associated with the zone numbers in the legend do not match the zones depicted on the figure. For example, Layer 15 shows "purple" (reddish) zones that are not shown in the legend. Also, the basis for assigning the zones (e.g., site-specific stratigraphy) is not discussed in the text. Please revise the figure to define all of the colors used on the figure in the legend. In addition, please revise the text to discuss the basis for assigning the porosity values.	The issues with the Figure D-10 (formerly Figure D-8), and the updated figure now included with Appendix D, have been fixed. The basis for assigning zones for porosity distribution is contained and described in the transient model verification step. The following text has been included in Section D.2.5, Flow and Transport Properties, subsection Hydrologic Properties. *The rationale behind using zones for the specific storage / specific yield distribution in the model is to improve the model match to the conceptual geologic*

		model. In the initial step of the transient flow verification, each of the zones used for hydraulic conductivity distribution were assigned specific storage / specific yield values estimated from values reported in the Final Feasibility Study Report (BEI 2006a). These values were refined with each forward model run to better match the modeled to the observed transient groundwater elevation. During this process, 4 additional specific storage / specific yield zones were added to the original 10 zones to better match the conceptual geologic model and the transient model with observed groundwater elevations, which resulted in the specific storage / specific yield zones and values as shown in Figure D-10.
Minor Comment		
1	The Draft FFS appears to contain several incorrect references to other sections (perhaps carried over from the Final FS Report). Examples include, but are not limited to: • Section 4.3.4, Disposal, On-Site Disposal section, Page 4-13: A reference to the soil cover or engineered cap in Section 4.3.3.5. • Section 5.0, Development and Screening of Burn Area Removal Alternatives, Page 5-1: Incorrect references to Sections 5.2 and 5.3. • Section 6.2.2.6, Evaluation of CERCLA Threshold Criteria, Compliance with Applicable or Relevant and Appropriate Requirements subsection, Page 6-8: The text states that action-specific ARARs are summarized in Table 3-1, but these ARARs are presented in Table 13-3 in Appendix E. Please review the Draft FFS to verify that all references to sections, tables, and figures are correct within the text..	In Section 4.3.4 Disposal, OnSite Disposal, sentence 4, the text has been revised as follows: *After consolidation, Area 1 would be graded and capped with a soil cover or engineered alternative cap, as described in Section 4.3.2.* In Section 5.0 Development and Screening of Burn Area Removal Alternatives, sentence 2, the text has been revised as follows: *Section 5.1 describes the development of the Burn Area remedial alternatives for soil, Section 5.2 presents the Burn Area remedial alternatives, and Section 5.3 discusses the screening of the alternatives.* In Section 6.2.2.6 Evaluation by CERCLA Threshold Criteria, subsection Compliance with Applicable or Relevant and Appropriate Requirements, the text has been revised as follows: *ARARs associated with the excavation, soil cover, and ICs would be the same as those provided in Table 13-1, Table 13-2, and Table 13-3 from the ROD (Chadux Tt 2009; copies provided in Appendix E). A portion of the ARARs applicable to the soil cover will also be applied to the WIB. The soil cover action-specific ARAR, which includes the substantive provisions of CCR title 22 § 66.264.310(a)(5) which requires that the cover maintain integrity during and following the maximum credible earthquake will apply to the design and performance of the WIB. Alternative BA-1 complies with the ARARs presented in the IR Site 1 Final ROD (Chadux Tt 2009).*

		Figure and Table references were checked as well, and no erroneous references were found. However, please be advised that in addressing other comments, figures and tables have been added and revised at various locations throughout the text and figure and table references throughout the text will change as appropriate.
2	**Section 1.2, Report Organization, Page 1-3:** The Draft FFS does not include an executive summary as stated in Section 1.2. Please revise the Draft FFS to include an executive summary or delete the reference.	The first sentence of Section 1.2 Report Organization has been revised as follows: *The FFS Report is divided into seven main sections and seven appendices.*
3	**Section 2.7.2.3, Potential Risks from Exposure to Estimated Bay Water Concentrations, Page 2-37, Paragraph 3, Second Sentence:** Please revise the text with the correct spelling of 2-hexanone.	The paragraph in which this typo occurred has been edited per Specific Comment 17.
4	**Figure 2.9, Tidal Efficiency Map First Water Bearing Zone:** The well symbols presented in legend do not appear to be correctly depicted on the figure. The figure indicates the well as black circles; the legend three monitoring well designations: a red square, a red pentagon, and gray square. Please review and revise the figure to accurately depict the correct well symbols.	The omission of well symbols was caused by an exporting error. This figure will be revised to include the well symbols on the map as indicated in the legend.
5	**Table 2-15a:** Some entries in the “Estimated BW” column are “#VALUE!” which is an Excel indication that cells may contain data types other than numbers. Please check these entries and ensure that this problem does not occur in other tables.	The tables have been corrected to show numerical results in all cells. Revised tables are provided.
6	**Section 2 Tables:** The definition of "presumptively identified concentration" is unclear. Please revise the tables to provide a more specific definition of a "presumptively identified concentration."	The Table note for the N-flag notation has been changed from: N = presumptively identified concentration To: N = analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
7	**Figures 2-34 and D-2:** The cross-sections embedded in these figures are illegible. Please provide figures with legible cross-sections.	The cross-sections embedded in the 3-D representation of the conceptual geologic model show their placement and use within the model. Higher resolution, legible versions of these hand-drawn cross sections are provided in Figures 2-12 through 2-14 of the Draft Burn Area FFS Report.
8	**Figure D-19, Sensitivity Analysis Results, Effects of Hydrodynamic Dispersion on DAF Estimate:** For the graph titled “Sensitivity of DAF to Horizontal Transverse Dispersivity” the x-axis label “Longitudinal Dispersivity (ft)” is incorrect. Please correct the x-axis label.	The x-axis label in Figure D-32 (formerly Figure D-19) is corrected and now reads as follows: *Horizontal Transverse Dispersivity*

RESPONSE TO COMMENTS ON

Draft
Burn Area Focused Feasibility Study, IR Site 1

PERMAC

Alameda Point, Alameda, California

DCN: AMEC-8816-0002-0161

Comments by: California Department of Toxic Substances		Responses by: AMEC Environment & Infrastructure, Inc.
Comments: Multiple Reviewers - October 22, 2012		Responses: February 28, 2013
Reviewer: Alice Campbell, PG, CHg / Appendix D Groundwater Transport Reactive-Model Discussion		
1	Hydrogeology. The Groundwater Flow section does not clearly discriminate between demonstrable facts, assumptions, and interpretation. One important example is the paragraph discussing hydrological communication. No evidence is cited showing that recharge due to rainfall is limited, and that communication is poor. This appears to be an assumption, not a fact. Groundwater data should be cited to show that there is no fresh water beneath the landfill, which would prove that there is limited recharge and little infiltration. At many industrial sites, the assumption that pavement prevents infiltration has been proved optimistic, and leaks through subbase, gutters, cracks, and other defects has occurred. Since the amount and location of recharge is one of the most critical inputs to the model, more justification of these assertions is required. A good place to begin might be with a discussion of the salinity in upgradient and downgradient wells perforated in the first and second waterbearing zones, and concentration gradients supporting the conclusions.	The recharge to the Second Water Bearing Zone (SWBZ) is limited by the separating unit, the Bay Mud, which has a low vertical conductivity. Results of a pumping test conducted in the SWBZ while monitoring head in the FWBZ provide a line of evidence that hydraulic flow between the SWBZ and FWBZ is greatly restricted. The results of this pumping test are summarized in the final RI and FS Reports. In addition to the pumping test, the RI and FS report provide the results of other hydrogeologic-property tests conducted at IR Site 1 and the Burn Area. The hydraulic conductivities of geologic units that comprise the subsurface and are represented in the calibrated model are listed in Table D3 within Appendix D. The hydraulic conductivity values in Table D3 are based on and are the mean values of the results of the hydrogeologic-property tests reported in the RI and FS. We agree with the reviewer that “the assumption that pavement prevents infiltration has been proved optimistic…”, and we have included the paved areas at the site with a thickness of greater than 0.01 foot as a separate hydrological unit. The hydraulic conductivity for this unit, although very low, is not zero, thus permitting some water infiltration. The second and third sentences of the second paragraph of Section D.1.2.1 of Appendix D has been changed to read as follows: *The recharge due to rainfall is, for the most part, limited to the unpaved zones above the FWBZ. Recharge to the SWBZ is focused at the paleochannel located in the southeastern portion of IR Site 1 and through vertical flow from the FWBZ. Recharge of the*

		SWBZ through the BSU is limited. In response to the reviewer's request to consider salinity in the FWBZ and SWBZ as line of evidence of freshwater recharge a new paragraph and figure was added after the second paragraph in Section D.1.2.1 in Appendix D as follows: *Mean electrical conductivity of groundwater in the FWBZ and SWBZ measured during sampling was contoured (Figure D-4). Considering the salinity, and, therefore electrical conductivity, seawater is considerably higher than that of freshwater (recharging precipitation). The comparison between the electrical conductivities in the FWBZ and SWBZ provide a line of evidence that freshwater recharge from the FWBZ to the SWBZ is limited. In addition, the distribution of conductivities which in general show that lower electrical conductivities are further inland from the seashore, reveal a gradient of freshwater flow from inland to the bay.* The text above was added to the main report text at the end of Section 2.6.1.7. Figure D4 is Figure 2-10 in the main report.
2	One unstated assumption of the model appears to be that the main mechanism governing outflow is broad advective flow with diffusion into the bay. Other conceptual models could be imagined, including local preferential pathways. Was any analysis undertaken to show that subsurface outflow is spatially homogeneous? A set of groundwater contour maps prepared using the linear triangular interpolation method (TIN over a Delauany triangulation) could be used to show that there are no features suggesting local drains.	DTSC's observation about our representation of groundwater flow in the groundwater model is partially correct. The main mechanisms are advection and dispersion, both in the porous media and in the bay water, and adsorption only in the subsurface. The standard advective-dispersive equation is used to solve for the transport of contaminants within the bay. Pursuant to the BCT meeting held on 08 November 2012, the agreed upon resolution to this comment was to include lines of evidence that support broad advective flow as the main mechanism governing flow from the Burn Area subsurface through the shoreline slope to the bay. In addition to the new paragraph provided in the response to General Comment 1 above, a new paragraph has been added to Section D.1.2.1 of Appendix D as follows: *The primary lines of evidence that support the assumption that the main mechanism governing groundwater discharge to the bay is broad advective*

		flow with dispersion are as follows: • *Continuous core sediment/soil samples (logs provided in Appendix C) collected at 31 locations from within and around the Burn Area were inspected and revealed uninterrupted porous media, albeit heterogeneous, throughout. Fractures in the subsurface were not observed.* • *Mean groundwater elevations in the FWBZ water table aquifer are higher than mean sea level. Specifically the water table elevations are highest near the center of IR Site 1 and approach mean sea level at the shoreline.* • *Tidal efficiency, the ratio of groundwater to sea level change, measured at wells screened in the FWBZ at IR Site 1 are, for the most part, greatest closest to the shoreline as described in the main body of the report (Section 2.6.1.6, Table 2-1, Figure 2-9). Two of the angled wells installed under the shoreline slope; PMW-1 and PMW-11, exhibited relatively low tidal efficiencies, despite their close proximity to the sea. It is believed that these lower tidal efficiencies are related to localized, low-permeability heterogeneities around these wells. Spatial variations in tidal efficiencies suggesting fractures or preferential pathways for flow at inland locations were not observed within or around the Burn Area.* • *The lag in groundwater elevation change response time to ocean tides (lag time) was greatest closest to the shoreline as described in the main body of the report (Section 2.6.2.3 and Table 2.6). The relatively high values for lag time observed at the angled wells under the shoreline (mean of 1.4 hours) and increasing lag times with distance inland, provide an additional line of evidence that preferential flow paths were not encountered in the vicinity*

		of Burn Area monitoring wells. *Although preferential pathways may exist, none were observed during the remedial investigation. Therefore, the equivalent porous medium approach is assumed to be a reasonable conceptualization considering the available data.*
3	Topological depressions. A groundwater contour map showing smoothed data (to remove tidal influence) is needed to show whether the cited depressions are over groundwater mounds. Likewise, groundwater salinity data showing lack of fresh water beneath the depressions would show that they are not significant sources of recharge, and justify using a drain in the model.	Groundwater monitoring wells have not been installed directly within seasonal wetlands, and water quality data from surface water in the seasonal wetlands is not available. Figure D12 of the Draft Burn Area FFS Report (currently Figure D14 in Draft Final) shows the mean observed groundwater contours in the FWBZ. The observed contours in Figure D12 (now Figure D14) were developed using mean and mean-estimate values, which were based on comparison of time-of-year measurements and high-frequency groundwater pressure monitoring. Additionally, the locations of the seasonal wetlands are within trace tidal influence (tidal efficiencies less than ~5%). Groundwater mounds beneath the seasonal wetlands were not evident with this groundwater contouring approach. We believe that our model conceptualization of seasonal wetlands as drains is correct. The seasonal wetlands generally exist during winter seasons when the water table is high and when it intersects the topological depressions (BEI, 2006).
4	Evapotranspiration (ET). The assumption of two inches of ET per year needs to be justified. The California CIMIS network is a good source of local ET data. The state map shows the area of the site to have around 32 inches per year potential ET; actual ET depends on availability of water to evaporate. The ET assumption is a critical value for calculating recharge, so better documentation of assumptions and data is required. Potential ET in the Bay area is found at http://wwwcimis.water.ca.gov/cimis/pdf/CimisRefEvapZones.pdf.	The evapotranspiration (ET) value at 2.2 inches per year provided in Section D.2.2 of Appendix D is the groundwater ET value, which does not include the unsaturated-zone portions of this term. A significant portion of ET is contained within processes occurring in the unsaturated zone near and at the ground surface which is not included within the groundwater ET value reported in the text. The numerical model considers groundwater recharge and ET from the groundwater. Groundwater recharge is obtained as precipitation minus runoff minus unsaturated zone ET. Potential ET from groundwater is estimated as potential evapotranspiration (PET) minus vadose zone ET, which is estimated as 87% of PET. Therefore, the potential ET from groundwater is 13% of the PET or 2.2 inches per year. For clarity, an additional sentence has been added to the end of the second paragraph in Section D.2.2 as follows:

		The ET value at 2.2 inches/year is groundwater ET and does not include ET occurring between the ground surface and the water table of the FWBZ.
5	The reasoning for the selection of model should be given. In particular, the use of a model which assumes steady-state recharge in a semiarid climate with strong seasonality of rainfall should be discussed. Time series charts of chloride in selected wells should be prepared showing that there is a lack of strong seasonality in the groundwater data justifying use of steady recharge.	The objective of the simulations was to evaluate bay water concentrations of contaminants emerging from the subsurface. The time scales for this transport are on the order of tens to hundreds of years. A transient transport evaluation was therefore conducted over the 1000 year time span. A steady-state flow field was set up for this transient transport evaluation. The small time-scale fluctuations due to tidal activity or seasonal recharge patterns have little impact on the average flow behavior (this finding is also asserted in the Final FS Report (BEI, 2006a)), which govern transport; and are therefore neglected in the evaluations as a practical approach to modeling long-term behavior. Increased dispersion is often applied to account for the additional mixing effects of tidal fluctuations. We have not done so, to err on the side of conservatism. A new paragraph has been added following the first paragraph of Section D.2.3 as follows: *Transient transport simulations using steady-state flow fields have been used to evaluate transport for small time scales when practicality of simulations is not that urgent. For instance, transport within bay waters (where pulsing is at its maximum, un-damped by diffusive groundwater influences) has been analyzed using a steady-state flow field (Marquis and Smith 1994 and Hunt et al. 2003).* Two references have been added to the footnotes of Appendix D as follows: *R. J. Hunt, H. M. Haitjema, J. T. Krohelski, and D. T. Feinstein, Simulating ground water-lake interactions: Approaches and Insights, Ground Water, 41 (2), pp. 227-237, 2003.* *S. A. Marquis, Jr., and E. A. Smith, Assessment if Ground-Water flow and chemical transport in a tidally influenced aquifer using geostatistical filtering and hydrocarbon fingerprinting, Ground Water 32(2), pp. 190-199, 1994.*

6	The site-specific aquifer test or lab-derived hydraulic conductivity data used in the model should be included in the report. If hydraulic conductivities were assumed, then the values should be justified. Without site-specific data, models can only be used to show differences between alternative land uses, not for actual quantitative information.	The groundwater flow model was initialized with the hydraulic conductivity values summarized in the Final FS Report (BEI, 2006a), for all units. Thus, the parameters used in the model have site-specific relevance, and they can be used for quantifying the required information from the model. Furthermore, the parameters were later modified, including recharge and ET, to better match the observed heads at various locations. Four concluding paragraphs were added to Section D.1.2 as follows: *An aquifer pumping test was conducted at IR Site 1 in April 1996. The pumping well and six observation wells were located in the southern portion of IR Site 1. The depth to groundwater at the start of the test was 2.4 feet. The maximum observed drawdown at the pumping well was 14.6 feet at a pumping rate of 11.5 gallons per minute (gpm). Based on an analysis of the drawdown curves using three different analytical methods, the transmissivity ranges from 0.22 to 0.65 square foot per minute (ft^2/min)with an average of 0.34 ft^2/min. Hydraulic conductivity values were determined for the FWBZ (fill material) and SWBZ from slug tests and geotechnical samples. Slug test hydraulic conductivity values for the FWBZ ranged from 0.001 to 0.0037 feet per minute (ft/min), and slug test values for the SWBZ ranged from 0.0015 to 0.0024 ft/min. Vertical permeability tests were conducted on six geotechnical samples from the BSU. Vertical permeability for the BSU ranged from 8.3E-09 to 9.0E-08 ft/min. Pumping test, slug test, and laboratory permeability test results are provided in Appendix G of the Final RI Report (TtEMI 2001a).* *The response at each of the FWBZ wells to the tidal fluctuations in the bay was relatively uniform. This relatively uniform response along the length of the shoreline results in short-term temporal changes in the magnitude of the gradient, but the flow directions are not impacted. Therefore, it is not anticipated that flushing of landfill material would occur as a result of tidal fluctuations in the bay. Solvent plume movement*

		at IR Site 1 is also not tidally influenced (TtEMI 2001a). *All the SWBZ monitoring wells were tidally influenced. The SWBZ is semi-confined, and thus water level fluctuations are caused by pressure changes from tidal rise and fall. These pressure changes propagate throughout the confined zone much more quickly than the fluctuations in the FWBZ (TtEMI 2001a).* *Potentiometric surface maps based on April 1998 groundwater elevation data are provided in Figures 2-14a through 2-14f of the Final RI Report (TtEMI 2001a). These potentiomentric maps represent the tidally averaged groundwater hydraulic gradient. Historical groundwater elevation data are provided in Appendix H of the Final RI Report (TtEMI 2001a).*
7	The calculations for the 6.6 inches/year of recharge should be shown. A unit water budget would be helpful, particularly a monthly unit water budget. This could show monthly values of rainfall, evapotranspiration, runoff, and net deep percolation. It is likely that this analysis would show strong seasonality in recharge. If mean rainfall is 18 inches, then the model is assuming 25% recharge, which is much, much higher than is generally observed in California, unless there are extenuating circumstances. As a rule of thumb, in an average year with about 18 inches of rain, only 10% of rainfall becomes recharge for a vegetated site with average conditions. Higher values are used in wetter years, and lower values in drier years.	The water balance equation for any representative volume embedded in the Burn Area is as shown below: Change in storage= (rainfall + inflow) – (outflow +ET +Direct run off+ deep percolation) = (rainfall - ET - Direct run off) + (inflow -outflow - deep percolation) For steady state scenario: Change in storage =0 Thus, rainfall - ET - Direct run off = (outflow + deep percolation - inflow) The left hand side of the above equation can be called net recharge. Thus the final water balance equation is: Net recharge = (outflow + deep percolation - inflow) Given this water balance equation, the spatial variability of the terms defining the net recharge term

		(ET and direct run off, assuming the rainfall data from a single station is applicable for the whole site) are hard to quantify even for a small watershed, let alone the landfill site which is a highly disturbed. Therefore, in the model, the net recharge is varied by varying recharge, ET, and the hydraulic conductivity of the various soil types to better match the simulated heads with the observed heads at various locations. While varying the previously mentioned parameters, it was made sure that the hydraulic conductivity values still occurred in the range determined by pumping, slug, and laboratory tests (see response to General Comment 6) and as suggested by literature. This is a non-linear problem, and mostly results in a non-unique solution. To deal with this non-linearity and non-uniqueness, we varied hydraulic conductivity within an acceptable range, and then we varied recharge and ET. The values of recharge and ET, for which the model showed acceptable calibration, are 6.6 in/year and 2.2 in/year, respectively. While it is instinctive to use a "rule of thumb" to get the ball park answer for recharge for a site, we caution against using such rules of thumb for a highly disturbed and man-made site. At the request of the reviewer the HELP (Hydrologic Evaluation of Landfill Performance) model was used to evaluate the groundwater recharge and ET values stemming from the flow model. New text and table were added following the second paragraph of Section D.2.2 as follows: *Using the Hydrologic Evaluation of Landfill Performance (HELP) (Schroeder et al. 1997) model, the ET and recharge values estimated and discussed above were substantiated. The HELP model is a quasi-two-dimensional, deterministic model for determining water balances.* *The HELP model requires daily climatologic data, soil and ET-related input characteristics, and geologic layer geometry information to simulate water balance. The HELP model was set up to simulate the water balance of a homogenous soil layer of constant slope and fixed length (Layer 1) exposed to 30 years of San*

		Francisco climate. The leakage through Layer 1 was considered analogous to recharge since the layer thickness was set approximately equal to the unsaturated zone at the IR Site 1. *The hydraulic conductivity and porosity of the homogeneous soil layer, Layer 1, was set equal to the average values used in the FWBZ materials estimated in the calibrated groundwater flow model, which are also approximately equal to values reported by slug test analysis conducted in the Burn Area (TtEMI 2001a). Field capacity and wilting point values for the HELP model soil comprising Layer 1 were calculated based on default relationships with porosity for the soil types encountered at IR Site 1. These default relationships were provided with the HELP model, material type database. ET-related parameters including leaf area index, rooting depth, growing season, humidity, and wind speed were entered as default values from the HELP model database for San Francisco, California.* *The HELP model geometry consisted of a single layer of free draining soil at a constant slope and slope length calculated based on the average distance and elevation drop from the center of the runway bisecting IR Site 1 to the top of the San Francisco Bay shoreline slope. This layer was set to a constant thickness of 5 feet, which corresponds to the approximate mean depth to groundwater under the Burn Area and IR Site 1.* *Climate data, including daily precipitation, daily temperature, and daily solar radiation data, were constructed for input to the model using the HELP Synthetic Weather Generator. Thirty years of synthetic daily climate data were generated based on the HELP model database for San Francisco. All defaults were used to generate the synthetic data except for the monthly averages for rainfall, which were entered into the weather synthesizer from the Alameda weather station (1941 to 1991) database.*

		Input and output from the HELP model simulation is summarized in Table D3 and provided in Appendix D, Attachment 1. The average annual percolation through Layer 1 of the HELP model is analogous to recharge and was calculated at 6.24 inches per year (in/yr) with a standard deviation of 2.66 in/yr over the 30-year simulation. The average annual precipitation and ET were calculated at 18.24 in/yr and 12.02 in/yr, respectively. The remaining water balance was accounted for as runoff and water storage change within Layer 1. *In comparison to the recharge value estimated in the groundwater flow model, the analogous recharge value calculated by HELP (leakage through Layer 1) is nearly equal (6.6 in/yr vs. 6.24 in/yr). Considering the groundwater flow model estimate of 2.2 in/yr groundwater ET, the average annual ET value of 12.02 in/yr calculated by HELP gives insight into the unsaturated zone portion of ET. Comparison of the HELP recharge (leakage through Layer 1) and ET values with those values calculated in the groundwater flow model provide corroboration for the estimates.*
8	Absorption should not be assumed for indefinite future scenarios, since sites for absorption may become saturated. This is not a very conservative assumption.	Without considering absorption, all the contamination would have exited the site and traveled into the bay within a very short amount of time. In order to obtain any usable results from the contaminant transport model, some adsorption must be considered. A linear assumption for adsorption is in line with standard practice and is what is available in most groundwater transport modeling codes including MODFLOW-SURFACT and MODFLOW's counterpart, MT3D. Adsorption coefficients are different in the Burn Area from other materials to reflect mass held initially in the burn materials which act as a source to the dissolved contaminant. With respect to the concern that adsorption sites might become saturated in future scenarios, a worst case estimate for total soil and groundwater contamination was calculated to examine the extent to which adsorption site could become saturated. The first step in the calculation was to estimate a worst case-scenario for groundwater contaminant concentration within the burn area by tabulating the

		maximum concentrations for each analyzed contaminant. For contaminants that did not have a detectable concentration, the largest minimum detection limit was used as a value for dissolved-phase concentration. Next the distribution coefficients (K_d) for each contaminant were tabulated. For contaminants that did not have a K_d already calculated or researched for the model, a K_d was calculated using the Organic Carbon/Water partitioning coefficients (K_{oc}) using the formula $K_d = K_{oc}$*%Organic Carbon in Soil. For contaminants that a K_d or K_{oc} could not be found, a K_d from a compound with a similar molecular structure was used. Next, the K_d and the ground water concentrations were used to calculate a theoretical maximum soil concentration. Finally, the individual concentrations were summed, resulting in a total worst case soil contaminant concentration of 44 g contaminant/Kg soil. The theoretical maximum soil concentration at 4.4% represents a reasonably achievable value. It should be noted that this theoretical value does not represent the actual spatial distribution of contamination we observed in the soil borings or monitoring wells, but instead applies the maximum measured (or assumed) concentrations across the entire study area as a conservative estimate for this examination.
9	Page 2-3 principal, not principle.	Thank you for the correction, which has now been applied.
10	Section D.2.4. The formulas used for the model have numerous parameters (reviewer did not count), yet values for basically all of them were assumed, not measured, for the model. The range of error of the assumed values should be discussed.	The modeling approach implemented is based on the historical "Parsimonious approach". For example, for a steady state model, the key input parameters are: hydraulic conductivity, recharge, and ET. We estimated a value of these parameters based on: (a) previously conducted hydrogeologic testing conducted in the FWBZ, BSU, and SWBZ within IR Site 1 and the Burn Area; and (b) measured groundwater heads at various locations. For the transient model, we used the high resolution groundwater elevation data at various Burn Area locations to estimate specific storage and specific yield values. Furthermore, we assumed porosity is equal to specific yield - another example of our Parsimonious

		approach. We considered advection, dispersion, molecular diffusion, and adsorption mechanisms for the transient transport. For the transport part of the model, we obtained the required input parameters as described below: a) Hydraulic Conductivity: hydraulic conductivity values were based on the results of slug and pumping test conducted at IR Site 1. The ultimate values used for aggregated soil textures (e.g.- silty sand) were adjusted during the model calibration process to consider groundwater ET, groundwater recharge, and site-specific groundwater elevation data. The calibrated hydraulic conductivity values conform to the results of *in-situ* tests conducted at the site. Minimum, maximum, and average hydraulic conductivity values for aquifer materials tested were added to Table D4. b) Porosity: these values were the same as the values obtained for specific yield from the transient flow model calibration. Minimum, maximum, and average specific yield and specific storage values reported in previous studies conducted at IR Site 1 were added to Table D5. c) Dispersion coefficient: measurement of dispersion coefficient is very difficult in field conditions, and even when such field measurements can be made, the values obtained are highly dependent on the field measurement scale (Lallemand-Barres and Peaudecerf, 1978). Therefore, we used the approach described by Xu and Eckstein (1995) to obtain the coefficient in the longitudinal direction with respect to the flow field. Furthermore, for the transverse and vertical directions, we used a ratio of 1.0:0.1:0.01 (following suggestions from Fetter, 1999, and

		Anderson, 1979) representing longitudinal: transverse: vertical dispersivity coefficients. Since, tests (e.g.- dipole tracer test) were not conducted to quantify *in-situ* dispersion, sensitivity analyses were conducted to assess if the terms selected were reasonable and conservative for the deterministic model. Sensitivity analysis results show that the selected dispersion coefficients were both reasonable and conservative considering the goal of the model to predict bay water concentrations from groundwater discharge. d) Molecular diffusion coefficient: with respect to the dispersion mechanism, the molecular diffusion mechanism contributes very little in solute concentration spreading, though we still included this in our model, just for completeness. Since we wanted the developed model to provide us with a way to calculate the maximum bay water concentration of the contaminants, which are still not fully characterized at the site (there were 165 required contaminants to consider), we used a single value of the molecular diffusion coefficient that is the literature value of one of the contaminants of concern, which serves as a default value in all subsequent transport models. e) Adsorption coefficient: see response to Comment 13. f) Groundwater ET and recharge: groundwater ET and groundwater recharge values were determined primarily through calibration of the hydraulic conductivity and porosity terms to match groundwater elevations (pressure). The steady-state model considered the mean groundwater pressures as calibration targets and bound the adjustment of the hydraulic conductivity terms, groundwater ET, and groundwater recharge to within those values reported by in-situ testing. By this means the

		groundwater ET and recharge terms were estimated. Using the HELP model to estimate groundwater recharge and ET (see Repsonse to Comment 7) supports the calibrated average values estimated for the steady-state model. In this way, the developed flow and transport model is not only a theoretical exercise, but is based on site-specific data and is able to provide quantifiable and useful results. A. Mary, Using models to simulate the movement of contaminants through groundwater flow systems, Critical Reviews in Environmental Controls, 9 (2), pp. 97-156, 1979 C. W. Fetter , Contaminant Hydrology, Prentice Hall, NJ, 2nd edition, p. 500, 1999. P. Lallemand-Barres and P. Peaudecerf, Recherche des relations entre la valeur de la dispersivite macroscopique d'un milieu aquifere, ses autres caracteristiques et les conditions de mesure, etude bibliographique. Bulletin, Bureau de Recbercbes Geologiques et Minieres. Sec. 3/4:277-87, 1978. Xu, Moujin and Yoram Eckstein, Use of weighted least-squares method in evaluation of the relationship between dispersivity and field scale, Ground Water, 33 (6), pp. 905-908, 1995.
11	Section D.2.5. Figure D7 does not actually show the hydraulic conductivities, only zone numbers. Having to refer to a table for the actual numbers, particularly in an electronic version of the text, burdens the reader. Furthermore, formatting the tables in scientific notation places another burden on the reader. Efforts should be made so that future documents are more readable.	The figures will be edited to show the actual hydraulic conductivity values, rather than the zone numbers. Values on tables in Appendix D expressed scientific notation will be changed to general numerical notation if the values are less than or 100,000 or greater than 0.00001.
12	D.2.5. While a steady state model would seem to only require hydraulic conductivity, in actuality it also requires excellent recharge data, and other inflow and outflow data. Errors in recharge become errors in conductivity otherwise. An excellent water balance for the site should be provided in lieu of excellent hydraulic	Please refer to our responses to Comments 4, 5, 6, 7, and 10. Further confidence is achieved in the model due to the transient verification simulation, which requires that hydraulic conductivity and storage terms be appropriate to capture the amplitude and rapid fluctuations.

	conductivity data.	
13	Justify the Kd value. Was this based on any site-specific measurements, and if so, what are they and what is their range? The report should include either the data or the supporting calculations.	For the chemicals and radiological materials of potential concern that required further evaluation following the screening comparison of groundwater results to PALs, bay water concentrations were calculated using DAF estimates. The first step to calculating bay water concentrations was to determine a K_d for each of the chemicals and radiological materials of potential concern that required further evaluation. Determination of K_d estimates for chemicals and radiological materials of potential concern was accomplished as follows: • If a chemical or radiological material of potential concern was detected in soil and groundwater samples from corresponding locations and depths, then the K_d was calculated as the ratio of soil to groundwater detections. If multiple detections of both solid- and liquid-phases were available for a specific chemical or radiological material of potential concern at a single location (one boring/well) then the values were averaged to determine K_d. For cases where multiple detections of both solid- and liquid-phases were available at multiple locations (two or more borings/wells) then the lowest K_d value was selected for input to the model for these chemicals or radiological materials of potential concern as a measure of conservativism. • If a chemical or radiological material of potential concern was detected in either soil or groundwater samples, but not both from corresponding locations and depths, then the K_d was calculated as greater than or equal to the ratio of soil analysis method detection limit (MDL) or detection to the groundwater analysis MDL or detection. If a chemical or radiological material of potential concern was not detected in either a soil or groundwater, then the K_d was determined based on literature research.

		The information above was provided in the main body of the report text in Section 2.7.2.3 and Table 2-17.
14	D.3. Seawater density effects may not be neglected. Fresh water floats on seawater, and the literature is extensive on freshwater-saltwater interaction. Analysis of the mixing zone can give a good estimate of the fate of contaminants from the burn dump materials. There is even a version of Modflow designed for freshwater-saltwater use. At a very minimum, hydraulic conductivity of saline units must be decreased in proportion to the specific gravity, and a figure showing data on the location of the interface should be provided.	The flow system analyzed is relatively shallow; and therefore, the density impacts are small. This is detailed in the Flow Assumptions section of the report. Also, neglecting density effects provides greater conservatism to the results by increasing the potential within the bay thus increasing gradients towards the bay and increasing the transmissivity of the subsurface at the shoreline for freshwater flow by discounting the saltwater wedge below. However, a saline wedge was added to the model. This change slightly altered the outcome considering the location of the highest bay water concentration and the predicted bay water concentration. The overall concept (pathlines and contaminant fronts) and the results of the model were not altered significantly. This change did not affect the conclusion that no PCOCs yield unacceptable bay water concentrations. Appendix D Figures showing particle tracking analysis, Figures D-22 through D-28, have been edited to reflect the addition of a saline wedge.
15	Does the model reproduce the salinity patterns found in the monitoring data? If the model cannot replicate the salt distribution beneath the site, it cannot be expected to do a better analysis of the other inorganics.	Distribution of inorganics is uncertain and depends on many factors including what is available in the source. The objective of the model is to evaluate bay water concentrations occurring from Burn Area contaminants. The time span for this is in the tens to hundreds of years, while the time-span for tidal fluctuations, which affect salinity patterns in monitoring data, is on the order of a few hours (the tidal cycles are semi-diurnal at the site). Use of a steady-state average flow field for transient transport analyses is not uncommon as can be seen by investigations in tidal situations (Townley, 1995). In our particular case, we found aquifer response to be very quick pertaining to the tidal fluctuations (see Figure D-13). Over the course of a tide cycle, the sea level rises above and below the groundwater pressures at some distance inland of the shoreline slope. The propagation of these pressure waves and resulting mixing of ground- and seawater depend primarily on the hydraulic conductivity of the sediments. Other factors such as fractures, piping, or heterogeneities can play a significant role also. To investigate the effects

		of this tidal mixing, tidally-biased groundwater sampling was conducted during which groundwater samples were collected from three wells; one angled under the shoreline slope, one at the top of the shoreline slope, and one approximately 100 feet from the top of the shoreline slope. The pressure response to tidal change observed at the well located approximately 100 feet from the top of the shoreline slope was longer than the period of the tide. Samples were collected at each of the FWBZ wells corresponding to the pressure lag times at the low, halfway between low and high-high, high-high, halfway between high-high and low-low, and low-low tides. Each of the 15 samples were collected using low-flow sampling techniques and submitted for analysis for PCOCs and PROCs. General water quality, including conductivity and pH, and laboratory test results showed no quantifiable dilution or concentration with tide cycle change. The details of this sampling, analysis, and results are provided in Section 2.7.2.2 of the FFS Report. Considering the results of the tidally-biased sampling and analysis, as well as the timescale associated with the transport of the PCOCs and PROCs, a steady-state approach to the simulation of submarine groundwater discharge to the bay was deemed appropriate for estimating the bay water concentrations. The tidal pumping, which occur over a rapid timescale compared to the time of travel for the PCOCs and PROCs, is averaged over the steady-state model approach. L. R. Townley, The response of aquifers to periodic forcing, Advances in Water Resources 18 (3), pp. 125 – 146, 1995.
Conclusions and Recommendations		
1	GSU recommends further discussion if the model is to be retained.	Pursuant to the BCT meeting held on 08 November 2012, the reviewers received additional insight into the model choice and use and it was agreed by all parties that the model is appropriate for use in this scenario.
2	GSU recommends simpler and more robust methods be used before recommencing modeling, including the items described above. It is likely that many of the questions the model is being asked could be answered with a better analysis of existing data, or other methods.	The analysis is sufficiently simple and robust for the objectives of the modeling effort. Several comments suggested increasing complexity by including tidal and density effects which would result in a more robust model that would predict lower bay water concentrations compared with the simpler approach used in the model presented.

3	Without site-specific data, the model cannot be expected to produce anything other than order-of magnitude estimates. Quantitative results require quantitative inputs.	For justification of the parameters, please refer to our responses to comments 4, 5, 6, 7, 10, and 13. The model further makes several assumptions on parameter values that may not be directly quantified. We have kept to the conservative side with these assumptions so that the results are accordingly conservative.
Reviewer: James M. Polisini, Ph.D / IR Site 1		
General Comment		
1	Correction of the statement of fractional risk associated with radionuclides compared to chemical exposure is required for the Cal/EPA human health results as well as additional explanation of the results. Several sections require additional justification of assumptions.	The text has been revised to address these comments as described below for Specific Comments 6 and 7.
Specific Comments		
1	Please correct the typographical error which refers to 2,3,7,8-tetrachlorodibenzodixon (TCDD) as '2,3,.8-TCDD' (Section 2.3, page 2-3)	The typographical error has been corrected and now reads "2,3,7,8-TCDD".
2	The human health exposure scenario evaluated in the Record of Decision (ROD) is recreational (Section 2.6.1.3, page 2-6). A deed restriction, or some legal document of equivalent enforcement capability, is required to prohibit development of the Burn Area for any other purpose except non-instrusive recreational use. This deed restriction should prohibit disturbance of the Western Bayside subsurface sediments adjacent to the Burn Area. HERO, then HERD, commented on the higher subsurface sediment concentrations in the Western Bayside Burn Area sediments in a May 7, 2007 review memorandum.	Section 2.6.1.3, page 2-6 includes, "… the future land use for IR Site 1 addressed in the ROD is recreational." Details related to deed restrictions, covenants, and land use requirements is beyond the scope of this document. Details pertaining to future land use can be found in the Record of Decision (Chadux Tt 2009).
3	The text states that 'the extent of the burn layer was mapped entirely' following the additional pre-design characterization (Section 2.6.2.2, page 2-12). The southern portions of some of the iso-contour lines in the figures displaying the Burn Area soil concentrations for some Contaminants of Concern (Figures 2-17 through 2-30) appear abnormally truncated (i.e., have a straight line on the southern boundary). Some of these concentration iso-contour lines are truncated at concentrations greater than the Remedial Goal (RG) (e.g., Lead Figure 2-27; 4 feet MSL and 2 feet MSL and Cadmium Figure 2-26; 4 feet MSL and 2 feet MSL). Examples	The sentence in the introductory paragraph of section 2.6.2.2, which read; "Following completion of the additional pre-design characterization the extent of the burn layer and surrounding geology was mapped entirely." was revised to read; *Following completion of the additional Pre-design Characterization, the extent of the burn layer and surrounding geology was mapped sufficiently to implement the selected remedy for the Burn Area as described in the Final ROD (Chadux T, 2009).*

	with truncation at lower concentrations are 'Carcinogenic PAHs' (Figure 2-3; 5 feet MSL); Zinc (Figure 2-28; all depths); DDD (Figure 2-29; all depths); DDT (Figure 2-30; all depths). It would appear from some of the figures that the boundary of the burn area, as portrayed by the COC soil concentrations, has not been bounded. Please explain this apparent discrepancy between the text and the figures, particularly along the southern boundary.	The truncation seen in the figures mentioned represents the domain of the kriging model. The kriging-model domain was constructed to surround the study area wells. The horizontal extent of this domain, which encompasses the burn layer, provides the soil COC data required to develop the remedial design pursuant to the remedy described in the Final ROD (Chadux Tt, 2009).
4	The spatial distribution of the COC soil concentrations differs across the Burn Area (Section 2.6.2.2, page 2-17) with the most extensive exceedances of RGs by cadmium, lead and zinc (2.6.3.1, page 2-20).	We agree with this statement.
5	HERO defers to the DTSC Geological Services Unit (GSU) or project hydrogeologist for review of the numerical groundwater model (Section 2.6.3.2, page 2-22); Appendix D) and model results (Section 2.6.3.4, page 2-26).	No response required.
6	This document states that the recreational user is the exposure scenario evaluated in the ROD (Section 2.6.1.3, page 2-6). However, the incremental cancer risk and the non-cancer hazard are presented for both an occupational exposure scenario and the recreational exposure scenario (Section 2.7.1.1, page 2-29). For risk communication purposes, the HHRA summary in this document must explain how the two exposure scenarios (i.e., occupational and recreational), with widely differing exposure parameters, could result in exactly the same estimate of cancer risk (i.e., $1x10^{-4}$) when using the U.S. EPA risk assessment parameters.	The total risk for the occupational receptor and the recreational receptor are in fact the same (1×10^{-4}) but the underlying risks from soil and groundwater chemicals and radiological materials are different as shown on Table 2-22 from the FS (BEI, 2006a). The last sentence above the summary of risk was revised as follows: *Total radiological and chemical cancer risk values and non-cancer HIs are summarized below; underlying cancer risks for the occupational and recreational receptors vary by media and can be found in Table 2-22 of the FS (BEI 2006a).*
7	The HHRA risk and hazard estimates indicate that the Cal/EPA estimate of cancer risk for the recreational user scenario is $5.5x10^{-4}$ (Section 2.7.1.1, page 2-30) for exposure to radionuclides and chemicals. The contribution from chemicals for the Cal/EPA estimate of cancer risk is described as '$8.9x10^{-4}$ or approximately 4 percent'. This cancer risk, for chemical exposure alone, exceeds the Cal/EPA total for chemicals and radionuclides. Please amend the description of the relative contribution to the Cal/EPA cancer risk estimate so that it is correct and makes arithmetic sense.	There appears to be a typographical error in the summary presented for the recreational receptor in the FS. The correct cancer risks, as taken from Table 2-22 of the FS (BEI, 2006a) are provided in the revised text as shown below: • *Cancer risk: 1×10^{-4} (U.S. EPA) or 5.5×10^{-4} (Cal/EPA)* o *Contribution from radionuclides: 2.0×10^{-5} (U.S. EPA and Cal/EPA), which is approximately 16 percent (U.S. EPA) or 4 percent (Cal/EPA)*

		o *Contribution from chemical COCs: 8.4 x 10^{-5} or approximately 84 percent (U.S. EPA), 5.3 x 10^{-4} or approximately 96 percent (Cal/EPA)*
8	Project Action Limits (PALs) for the evaluation of the San Francisco Bay surface water exposure risk (Section 2.7.2, page 2-31) were selectively checked (Table 2-13) and found to be arithmetically correct based on the projected receptor. However, the PALs listed are generally segregated into: a) the group that is protective of ecological receptors (i.e., 'saltwater life'); and, b) the group that is protective for human fish consumption exposure routes (i.e., 'fish consumption'). For example, the PAL listed for mercury (CAS 7439-97-6) in Table 2-13 is the California Toxic Rule (CTR) value of 5.1E-02 µg/L which is protective for human fish consumption. The on-line State Water Resources Control Board database listed as 'checked in June 2012' (http://www.waterboards.ca.gov/water issues/programs/water quality goals/search.shtml) however, does not list a concentration for total mercury protective of ecological receptors even though mercury exposure and food web transfers are known to produce adverse ecological effects. The California Ocean Plan, referenced in the same database, lists a six month median mercury concentration of 0.04 µg/L for the protection of marine aquatic life. While HERO agrees that the California Toxic Rule is the enforceable standard, please indicate in the text how the risk and/or hazard attributed to human consumption of fish and/or shellfish is separated from ecological hazard when the PAL table is a mix of differing targeted receptors.	PAL selection included review for fish consumption and aquatic life criteria from the sources used in this evaluation, consistent with the approach used during preparation of the FFS Groundwater SAP (AMEC, 2012). This approach was taken to identify values that would be protective of both receptor groups and there was no change to this approach in the FFS risk evaluation. The majority of the PALs selected are for human exposure through fish consumption, which is commonly the most sensitive receptor group (from bioaccumulation) and therefore are protective of aquatic receptors. In the case of mercury, a slightly more conservative screening value is published in another source – that is not applicable at IR Site 1 – but that indicates aquatic receptors, rather than human receptors, are slightly more sensitive to mercury exposure. This small difference in screening values has no impact on the conclusions of this risk evaluation because the estimated concentration of mercury in bay water is more than 5 orders of magnitude less than the PAL. Estimated bay water concentrations for most compounds are at least three or more orders of magnitude below the PAL, so there is a low potential for the conclusions of this risk evaluation not to protect the receptor groups evaluated. The text of the FFS was revised in two places to clarify that both receptor groups were considered and that screening levels used in the risk evaluation were selected consistent with the approach used during development of the FFS Groundwater SAP (AMEC 2012): 1. The second paragraph of the introductory text in Section 2.7.2 was revised as follows: *The evaluation of potential risks to human and ecological receptors from exposure via surface water (i.e. bay water) consists of a screening level assessment to select appropriate risk-based screening values and compare estimated surface water concentrations to those screening values to identify compounds that could potentially contribute to*

		unacceptable risk. The receptors evaluated are saltwater aquatic life that reside in San Francisco Bay (a wide range of aquatic receptors, including benthic receptors, are considered through the screening levels employed) and humans that may consume this saltwater aquatic life. Food chain modeling was not conducted because it was outside the scope of this FFS. The prior risk assessments did not fully evaluate these exposure pathways for chemicals and radiological materials of potential concern because the remedy envisioned was capping or isolation of the buried wastes, which eliminated the complete exposure pathway. Screening value selection was conducted to identify the most protective value for the two receptor groups being evaluated using the applicable screening criteria for IR Site 1. The California Toxics Rule (65 FR 31682) was the primary source of the water criteria used as screening values. These criteria are based on the Clean Water Act section 304(a) methodology and therefore " … might be thought of as an estimate of the highest concentration of a substance in water which does not present a significant risk to the aquatic organism in the water and their uses." (45 FR 79341). The CRT criteria account for a minimum of eight families of organisms to minimize the potential for criteria to over-protect or under-protect. The data used in this evaluation include groundwater results from the tidal-bias monitoring event and the study-area groundwater monitoring event, each conducted in May 2012. 2. The second sentence of Section 2.7.2.1, Project Action Limit Selection, was revised as follows: *PALs were selected from the chemical-specific ARARs established in the FS (BEI 2006a) and the ROD (Chadux Tt 2009) and from the sources used to identify PALs in the SAP (AMEC 2012). PALs previously established in the SAP or ROD were verified against the sources referenced in the SAP or the ROD, and corrected or updated, if needed. PALs for compounds without previously established values were selected by reviewing the applicable criteria for each receptor group using the hierarchy of sources provided below. The receptor group associated with the selected PAL is identified in Table 2-13.*

9	The surrogates proposed for those compounds lacking screening concentrations (Section 2.7.2.1, page 2-33) are acceptable. The corrections to PALs for Polychlorinated Biphenyls (PCBs) and dibromochloromethane (Section 2.7.2.1, page 2-33) are more protective than the values originally listed in the SAP Worksheet 15 (AMEC, 2012) and are acceptable. These comments are meant for the DTSC Project Manager and no response is required from the Navy or Navy contractor.	No response required.
10	Naphthalene is one of the few organic compounds listed among the Volatile Organic Compounds (VOCs) which exceeds screening concentrations (Table 2-15b) based on protection of saltwater aquatic life (Table 2-13). In 2004, the OEHHA designated naphthalene a carcinogen with a unit risk value of naphthalene of 3.4 $x10^{-5}$ $(\mu g/m^3)^{-1}$ and slope factor of 1.2x 10^{-1} $(mg/kg\text{-}day)^{-1}$ (http://oehha.ca.gov/air/hotspots/naphth.html) . The HHRA calculations do not appear to be included in the tables appended to this report. Please verify that the Burn Area human health risk assessment for the recreational exposure scenario evaluated naphthalene as a carcinogen.	The scope of the FFS did not include updates or revisions to prior baseline risk assessments that were completed during the RI and integrated into the ROD because each potentially complete exposure pathway in the baseline risk assessment was fully evaluated, with the exception of bay water replenishment by groundwater. The updated risk assessment provided in the FFS was a screening level evaluation designed to evaluate bay water replenishment by groundwater pathway and exposure to bay water by saltwater aquatic life and humans consuming saltwater aquatic life. This approach is consistent with the ROD and with the approved SAP (AMEC, 2012). The updated risk assessment in the FFS evaluated naphthalene using the project action limit provided in the approved SAP (AMEC, 2012). The project action limit for naphthalene is based on saltwater aquatic life as no fish consumption criteria for naphthalene were identified in the sources used in this evaluation. Estimated naphthalene concentrations in bay water were three to six orders of magnitude below the project action limit, which also makes them below other conservative human health screening criteria based on other exposure pathways (such as drinking water ingestion or air). The conclusion of the updated risk assessment for bay water is that naphthalene does not contribute to unacceptable risk and is not identified as a COC for IR Site 1.

11	The Institutional Controls (ICs) listed for transfer of the property are limited to those for transfer to a non-federal entity (Section 4.3.1, page 4-7). Please describe the ICs which would apply for transfer to a federal entity.	As stated in the Final ROD (Chadux Tt, 2009), the Navy has determined that it will rely upon proprietary controls in the form of lease restrictions contained in the "Lease in Furtherance of Conveyance (LIFOC) Between the United States of America and the Alameda Reuse and Redevelopment Authority for the Former Naval Air Station Alameda until the property containing Site 1 is conveyed. More specifically, the land use restrictions contained in the LIFOC will serve as interim ICs between the time the ROD is signed and the date upon which the Navy transfers the property to the non-federal entity. Through the LIFOC, the Navy will maintain conditions at Site 1 that are consistent with the IC objectives for the chosen remedial alternative. The LIFOC contains provisions that the Navy can use to prevent the following: • Changes in land use by requiring the lessee and sublessee(s) to get written consent of the Navy before beginning excavation, construction, alteration, or repairs of leased property (Section 8.1 of the LIFOC) • The lessee from conducting operations that interfere with environmental restoration activities by the Navy, EPA, state regulators, or their contractors by requiring written approval for any work by lessee or sublessee in proximity to the site (Section 11 of the LIFOC) • The lessee or sublessee from any excavation, digging, drilling or other disturbance of the subsurface without written approval of the Navy (Section 13.11 of the LIFOC) No specific provisions otherwise are intended for transfer of the property to a federal entitiy.
12	The design of any soil cover for the Burn Area (Section 5.2, page 5-3; Section 6.2.2.3, page 6-7) will require design components to discourage excavation by burrowing mammals.	With respect to ecological receptors, an entirely separate document, a Terrestrial Ecological Receptor Exposure Mitigation Plan, in addition to the Operations & Maintenance manual for the Soil Cover, which will specifically address burrowing mammals, is called for in the Addendum. Furthermore, this comment has already been addressed as a response to comment in the original ROD, which was accepted by the Navy and regulators on September 19, 2009. Alameda Site 1, Final ROD, Attachment C, Responsiveness Summary, Responses to Comments from the RAB (from Peter Strauss, TAPP Consultant),

		Major Comments in Cover Letter, Comment 16. "Comment: The cap design should include a bio-barrier to prevent burrowing animals. Response: The minimum thickness (2 feet plus pavement thickness at Area 2b and 4 feet at Area 1a) of the soil cover is sufficient to prevent any burrowing animals from penetrating the soil cover and coming into contact with waste or subsurface contamination. The riprap cover at Area 5 will also prevent burrowing animals from contacting any subsurface contamination. The cover will be inspected to ensure that the integrity of the cover remains intact, which will include looking for evidence of burrowing animals."
13	Please provide the basis for the assumption that 2 percent of the excavated soil in Area 1b is radiologically-impacted (Section 6.2.1.2, page 6-3) in the text of the discussion of Alternative S1-4a (Section 6.2.1, page 6-2).	The 2 percent assumption is based on an analysis of the 2x background radiological material found while trenching and boring during pre-characterization work in 2010. Laboratory reports can be found in Appendix A, trench logs can be found in Appendix B, and boring logs can be found in Appendix C.
14	Please provide the basis for the assumption that 48% of the total excavated material is non-hazardous debris (Section 6.2.1.2, page 6-4) in the text of the discussion of Alternative S1-4a (Section 6.2.1, page 6-2).	The 48 percent assumption is based on an analysis of the hazardous material found while trenching and boring during pre-characterization work in 2010. Laboratory reports can be found in Appendix A, trench logs can be found in Appendix B, and boring logs can be found in Appendix C.
Conclusions		
1	Several sections require additional justification for the stated assumptions. Among them: the apparent discrepancy between statements of complete characterization and straight iso-contour lines requires explanations; separation of the estimates of adverse effects on humans and ecological receptors in the groundwater evaluation requires additional description; and, evaluation of naphthalene in the recreational exposure scenario calculations of the HHRA.	Referring back to the text of Draft FFS Report in light of the reviewer's request for clarification regarding "statements of complete characterization and straight iso-contours lines"; the sentence in the introductory paragraph of section 2.6.2.2, which read; "Following completion of the additional pre-design characterization the extent of the burn layer and surrounding geology was mapped entirely." was revised to read; *Following completion of the additional Pre-design Characterization, the extent of the burn layer and surrounding geology was mapped sufficiently to implement the selected remedy for Burn Area as described in the Final ROD (Chadux Tt 2009).* Section 2.7.1.3 Groundwater Quality Evaluation provides a summary of a previously conducted study that was included in the Final FS Report (BEI, 2006). Revision to the processes and conclusions of the

		groundwater quality evaluation in this document is not possible. Revision to the HHRA that was used to support the development of RAOs and remedial-alternative development and evaluations does not require revision to support this FFS. The combinations of process options that form the two alternatives being evaluated in this document were evaluated in the Final FS Report (BEI, 2006a), which concluded that the preferred remedy was equivalent to the alternate remedy being evaluated in this FFS.
	Assuming approval of the ground water modeling methodology and results by the DTSC GSU or a DTSC hydrogeologist, once the specific comments listed above are resolved, this document will provide a summary of risk assessment conclusions sufficient to evaluate the remedial alternatives for the IR Site 1 Burn Area based on the current characterization.	No response required.
Reviewer: Eileen Hughes, PG, Berkeley GSU		
Comment and Recommendation		
1	The Berkeley GSU has found the report to be acceptable pending resolution of comments provided by the Chatsworth GSU on issues related to the numerical modeling.	No response required.
Reviewer: Stephen C. Sterling, PG / Review of Section 2.8 through 2.8.3 and Appendix F		
Comment and Recommendation		
1	The reviewed portions of the Feasibility Study appear to adequately present the geologic conditions of the site and the methodology used in the preliminary analysis for the proposed Open Cell Waste isolation Bulkhead (WIB) at Alameda IR Site 1. The Maximum Credible Earthquake considered (7.9 magnitude on the San Andreas Fault and 7.1 magnitude on the Hayward Fault) and Peak Ground Acceleration of 0.4g appear to be appropriate for the site; the brief descriptions of the three "desktop calculation methods" used during the preliminary stability analysis appear to be appropriate as well. It should be noted that further analysis will be conducted by PND Engineers (engineering consultants to the Department of the Navy) during the final design of the WIB	Thank you for the comment and recommendation. We concur with the reviewer's recommendation that detailed design analysis should be conducted as part of the Remedial Design.

	Recommendations The seismic parameters and geologic aspects used during the preliminary stability analysis of the WIB should be accepted. However, further review of the stability of the proposed WIB should conducted as part of the final design, including engineering and geotechnical considerations of the proposed steel sheet pile bulkhead, connector wyes, and anchor piles.	